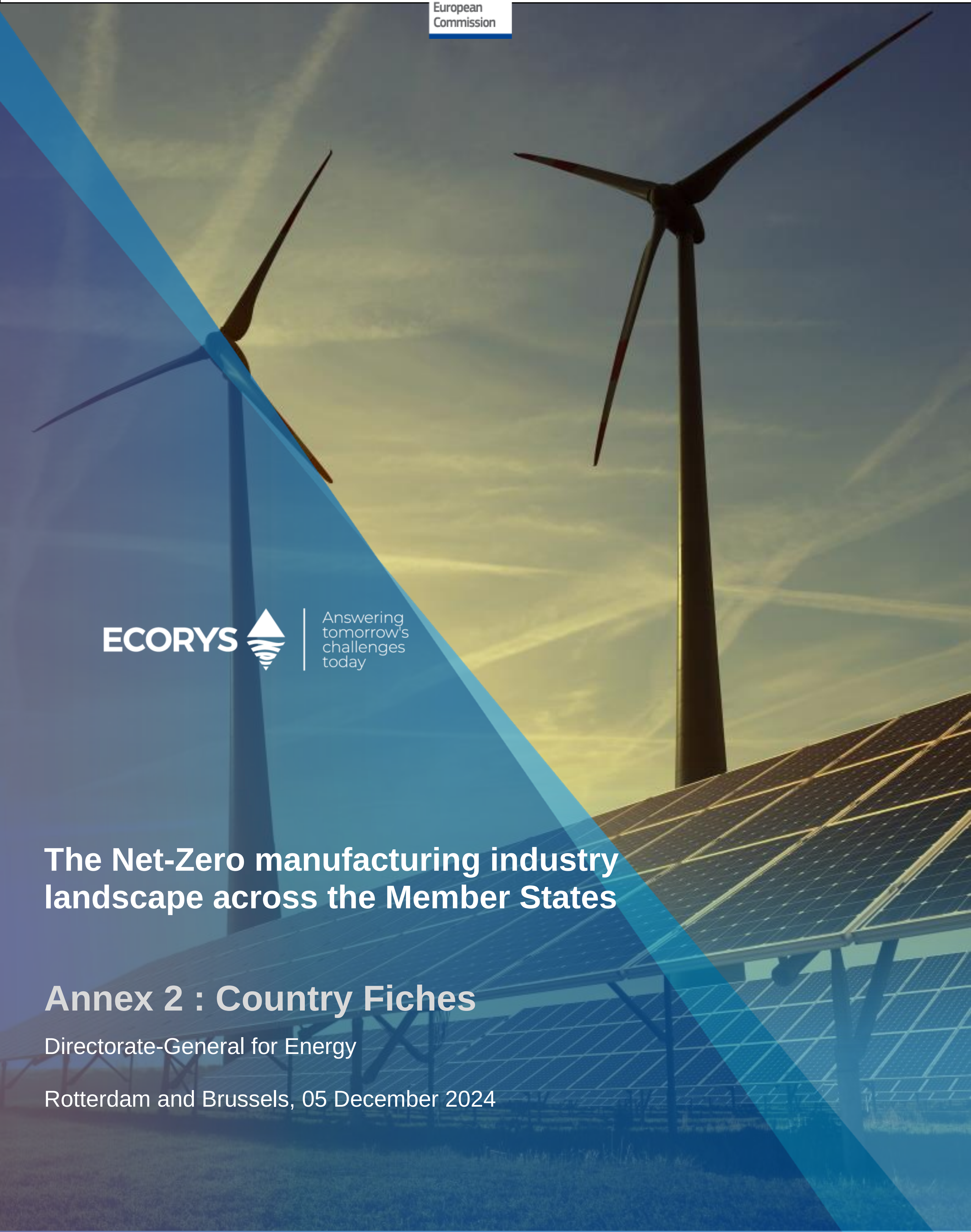


The Net-Zero manufacturing industry landscape across the Member States

Annex 2 : Country Fiches

Directorate-General for Energy

Rotterdam and Brussels, 05 December 2024

The Net-Zero manufacturing industry landscape across the Member States

Annex 2: Country Fiches

DG ENER Unit TF2 - Relations with the Member States and the Energy Community

Rotterdam and Brussels, 05 December 2024

In consortium with:

Luxembourg: Publications Office of the European Union, 2025

PDF MJ-01-25-008-EN-N ISBN 978-92-68-23682-6 DOI 10.2833/2582750

Country Factsheet Austria

Key findings

Manufacturing capacity:[1] Austria's manufacturing capacity amounts to between 400 and 800 MW/y (2-4% of EU capacity) for solar PV and between 800 and 850 MWh/y (a negligible share of total EU capacity) for battery and storage technologies. At least three facilities were identified that produce wind turbine components, and one facility designing and manufacturing electrolysers and fuel cells. In terms of heat pumps, Austria boasts two production facilities, adding to the nation's array of manufacturing capabilities. No capacity data were identified for these facilities.

Industrial production:[2] Austria's three largest industrial Net-Zero sectors by value are wind power, with a production amounting to EUR 3 billion (3% of total EU production); EUR 2.1 billion (3% of EU production) for grid technologies, and EUR 2 billion (2% of EU production) for solar PV and solar thermal.

International positioning:[3] Austria holds EUR 2.6 billion in untapped export potential for key solar PV components, with its RCA for electric static transformers outperforming China.

Policy framework: Currently, Austria has a masterplan on environmental technologies and a hydrogen strategy that can support the build-up of manufacturing capacity for Net-Zero technologies.

Industrial permitting: General information on the industrial permitting of new production facilities for Net-Zero technologies is not available. However, permitting for projects requiring an environmental impact assessment usually requires 22 to 23 months.

Incentive instruments: Austria has incentives in place to support investment in Net-Zero technologies, including investment support for companies expanding their production capacities in renewable energy technologies. Part of the support targets SMEs in particular. Additionally, there is a skill programme in place providing vocational training in the environmental sector.

[1] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[2] Industrial production refers to total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[3] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in Austria[4]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[5]	Import dependence (extra-EU)[6]
	400 - 800 MW/y[7] 10GW inverters *(2 - 4% of EU capacity)*[8]	-	-	2% *(Disclosure: 49%)*	**0.32**
	At least three facilities identified[9]	-	-	3% *(Disclosure: 53%)*	**0.17**
	800 - 850 MWh/y[10] *(negligible share of EU capacity)*	-	-	«Negligible share of EU production» *(Disclosure: 77%)*	**0.32**
	At least two facilities identified	-	-	2% *(Disclosure: 53%)*	**0.14**
	At least one facility identified[11]	-	-	«Negligible share of EU production» *(Disclosure: 63%)*	**0.01**
	At least one facility identified[12]	N/A	N/A	1% *(Disclosure: 56%)*	**0.16**
	N/A	N/A	N/A	1% *(Disclosure: 65%)*	**0.09**
	At least two facilities identified[13]	N/A	N/A	3% *(Disclosure: 47%)*	**0.24**
	−	−	−	−	✓
	−	−	−	−	✓

	Technologies								
	Solar photovoltaic and solar thermal		*Onshore and offshore wind renewables*		*Batteries and storage*		*Heat pumps and geothermal*		*Electrolysers and fuel cells*
	Sustainable biogas/ biomethane		*Carbon capture and storage*		*Grid technologies*		*Data coverage*		*Data reliability*

Austria's main production facilities include the Fronius' inverters facility in Sattledt, with an estimated capacity of 10 GW. Austria is also home to modules producers Kioto Solar, with an estimated annual production capacity of 150MW, and DAS Energy. In the wind energy sector, Austria hosts a number of component manufacturers, including Bachmann Electronic (a manufacturer of turbine control systems); Hexcel Composites (a developer and producer of materials for blades); and Elin EBG

[4] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[5] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[6] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[7] Manufacturing capacity is provided exclusively for solar photovoltaic and does not include capacities for solar thermal manufacturing. The breakdown by component for solar PV is as follows: modules 980 MW and inverters 10000 MW.
[8] This does not include the 10GW of manufacturing capacity identified for inverters.
[9] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes. The following facilities were identified: Bachmann Electronic GmbH (a manufacturer of turbine control systems); Hexcel Composites GmbH (a producer of materials for blades) and Elin EBG Motoren GmbH (a supplier of generators for turbines).
[10] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[11] AVL List GmbH designs, manufactures, and installs both electrolysers and components for hydrogen production plants. The company has recently opened a new fuel cell test center in Graz, Austria.
[12] ÖKOBIT GmbH is a manufacturer of custom-built biogas plants, which also supplies plant components.
[13] Siemens Austria manufactures transformers in Weiz. Omicron is a manufacturer of grid systems and components.

Motoren. Austria is also home to CellCube, a producer of vanadium-based redox flow batteries. No new manufacturing facilities are announced or foreseen.

Evolution of Austria's international positioning

As depicted in Figure 1, Austria exhibits notable strengths as an exporter in several Net-Zero technology sectors[14], including solar PV, grid technologies, and wind turbines. In the solar PV sector, Austria has established a solid export profile, particularly in electric static transformers, machinery for semiconductors, and electric static converters. These three critical components, integral to the solar PV value chain, collectively represent an estimated EUR 2.6 billion in untapped export potential for the country.

Austria's export performance varies across these components, with market saturation levels offering important insights. For electric static transformers and semiconductor machinery, the relatively low market concentration suggests that no single country dominates global exports, leaving ample space for Austria to expand its presence in these segments. This combination of strong export capacity and a fragmented global marketplace provides Austria with favourable conditions to capitalise on its comparative strengths. Conversely, the market for electric static converters is significantly more saturated, driven primarily by China's substantial 40% share of global exports as of 2022.

The EUR 2.6 billion in export potential for these components reflect Austria's capacity to expand its market share should trade barriers ease or demand in international markets increase. This figure highlights areas where Austrian producers are well-positioned to respond to shifts in global demand or supply chain dynamics.

In the wind turbine sector, Austria also demonstrates considerable potential. The country plays a prominent role in exporting ball bearings and aluminum structures, components that together hold an estimated EUR 960 million in export potential. This reflects Austria's capacity to expand in markets where it already enjoys a comparative advantage. For policymakers and businesses, this potential is actionable—it suggests that targeted export promotion strategies could translate into measurable increases in export volumes. Austria's RCA for these wind turbine components surpasses that of both China and the USA in 2022 (see Figure 2)[15], indicating that the country is well-positioned to strengthen its export share in these areas of the wind turbine value chain.

[14] Figures 1 and 2 present Austria's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Austria's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Austria's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets. Export potential is calculated using a gravity model, reflecting the hypothetical value Austria could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Austria could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies. For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.

[15] Figure 2 builds on Figure 1 by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Austria's trade strategy. Taken together, these figures provide a nuanced understanding of Austria's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: Austria's RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

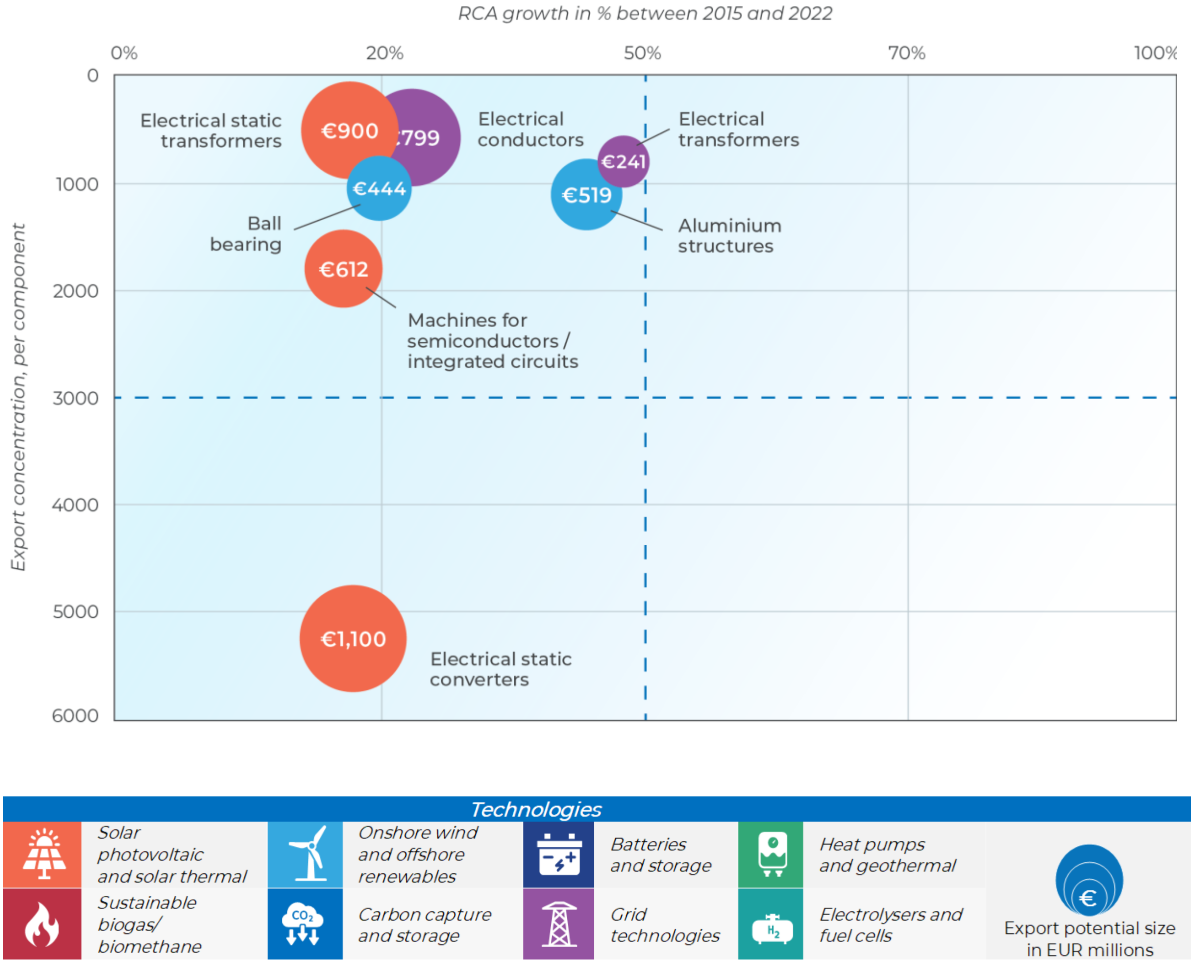
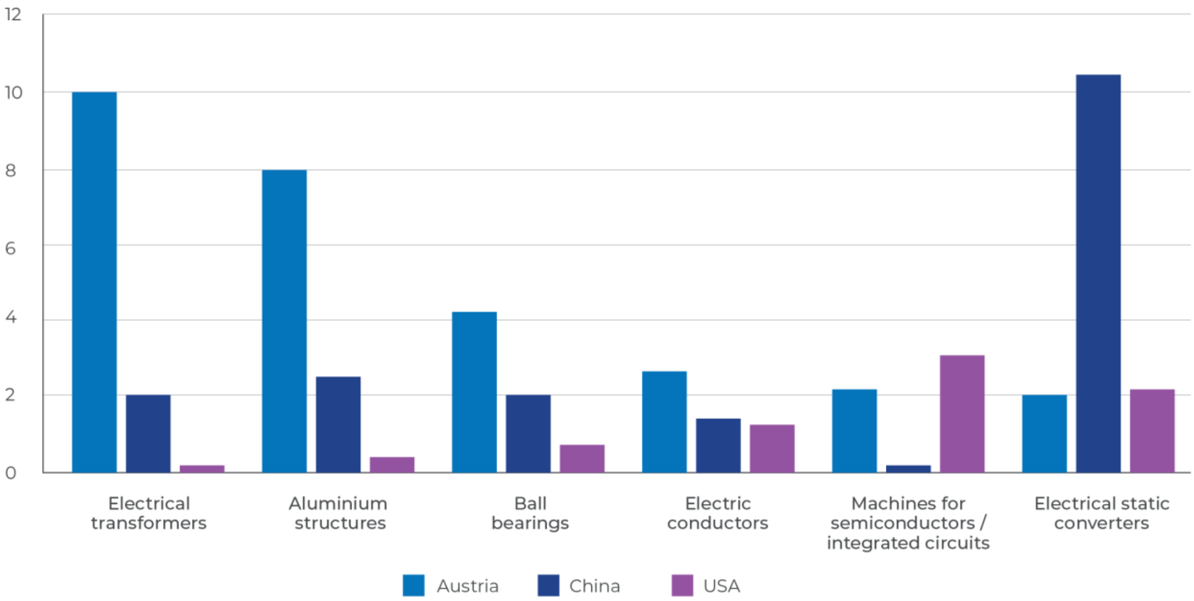


Figure 2: Absolute value of RCAs of Austria, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

The **Masterplan environmental technologies** (Masterplan Umwelttechnololgie) identifies areas to support environmental policies between 2019 and 2030. Several of them have an impact on manufacturing, even though an explicit objective on this has not been defined. Areas include incentives for clean technologies through modernising the legal framework for thresholds, supporting innovation and pilot projects, targeted financial support programmes and platforms for collaboration between environmental technology companies. Additionally, the branding of Austrian products for export is envisaged as support to local manufacturing as well as increasing the attractiveness of environmental professions. The Masterplan defines environmental technologies broader than NZIA, including water management, waste treatment and energy efficiency technologies.

The **Austrian Hydrogen Strategy** identifies policy strategies to support the deployment and use of hydrogen as an energy carrier. It includes the action area "Create support and incentives for the production of renewable hydrogen" which entails the simplification of permit procedures as well as zoning regulations for the construction and commissioning of hydrogen production plants and infrastructure. Moreover, the strategy supports innovation and market access studies for technology demonstration through IPCEI and EU Innovation Fund financing. Legal frameworks for the introduction of hydrogen to gas grids form another part of the plan.

In November 2023, the European Commission approved a €60 million **state aid scheme under the TCTF** in Austria.[16] The purpose of the scheme is to support investments for the production of batteries, solar panels, wind turbines, heat-pumps, electrolysers, equipment for carbon capture usage and storage, as well as key components designed and primarily used as direct input for the production of such equipment or related critical raw materials necessary for their production.

Scope of the policy framework

Industrial permitting

Average duration[17]	For projects requiring an environmental impact assessment, the average process duration is up to 22 to 23 months.[18]	**One-stop shop for permitting**	No general one-stop shop for permitting has been identified. In cases where an EIA is required, the competent regional authority (Landesregierung) takes on the role of a central coordinating body, effectively acting as a one-stop shop.

Brief summary of the permitting processes

The necessary permits for the production of Net-Zero technologies include operating permits, building permits in line with spatial planning requirements, environmental impact assessment, permits based on emissions of pollutants and noise, as well as water use permits.

The main permit is the operating permit for a commercial site, which is administered by the regional authorities (Bezirksverwaltungsbehörde) and is necessary for all commercial activities except marginal office use. The specific activities at a future renewable energy production site may require all other permits mentioned above. These need to be obtained in addition to the operating permit. The authorities in charge of

[16] See here.
[17] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.
[18] The Federal Environment Agency (link).

these permits vary from local to Länder-level (Landesregierung responsible for EIA, which acts as a one-stop shop).

Stakeholders consulted identified various factors contributing to the length of permitting processes. Limited digitalisation, with communication often relying on traditional methods like letters, faxes, and physical document submission, was noted as one such factor. Environmental impact assessments, requiring expert studies and consultations, were also seen as significant contributors to longer timelines. Additionally, spatial planning decisions, particularly regarding the allocation of use types, can vary in duration depending on the local context. Some stakeholders also mentioned that public authorities may not have sufficient capacity to efficiently manage the volume of procedures[19].

Procurement

Procurement rules favouring the purchase, installation, and use of Net-Zero technologies have been in effect since 2021. These rules establish a minimum requirement for the use of solar PV power constituting at least 1% of the total renewable electricity mix. For central government entities, 100% of the purchased electricity must come from renewable sources (RES). For other federal public procurers, the share of RES is to incrementally increase, reaching 100% by 2030. At least 10% of the electricity must be sourced from power plants that are either less than 15 years old or have been revitalized or expanded within the past 15 years.[20]

In June and July 2024, the federal government and parliament passed legislation to introduce a "Made-in-Europe" bonus in the form of a top-up for investment support for new photovoltaic projects.[21] Investment support can increase by up to 20% of the value of the support granted, depending on the components used. Reliance on modules and inverters produced in the EEA can be supported by a 10% increase in the support for each.[22]

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

IPCEI Wasserstoff **IPCEI Hy2Tech**

2021-2026	**Grant**	**Total funding available: EUR 125 million**
Technologies Electrolysers and fuel cell technologies	**Eligibility** IPCEI requirements	**Available support** No information available on funding volume

Description

The project aims to build a competitive, innovative and sustainable European hydrogen value chain in Europe. It focuses on promoting projects along the entire hydrogen value chain. Hy2Tech focuses on the development and upscaling of new highly efficient electrolysis processes and fuel cell systems to innovative storage and transport technologies.

AVL develops the world's first 1 MW high-temperature electrolyser based on metal-supported cells (MSCs) to series production. This means that renewable hydrogen can be produced with significantly higher efficiency and therefore more cost-effectively than is possible with currently available technologies. With the subsequent possibility of integrating this high-temperature electrolyser into a wide range of industrial sectors (including steel, cement, chemical industries and waste treatment), the project makes a significant contribution to the decarbonization of the energy and industrial system. In addition, Plastic Omnium New Energies Wels will develop a hydrogen fuel cell system for heavy commercial vehicle applications (trucks, buses, etc.) as a series-ready product and the production process required for it. Innovations in components, in the process and in the operating strategy of the fuel cell are intended to increase the efficiency, service life and environmental friendliness in the life cycle. By applying and transferring manufacturing processes from the automotive

[19] Stakeholder interview.
[20] See here.
[21] See here.
[22] See here.

industry and using modern automation and digitalization technologies, both the manufacturing costs and the development time until suitability for everyday use are to be significantly reduced.

Green!Invest

2022-2027	**Grant**	**Total funding available: EUR 9 million**
Technologies All[23]	**Eligibility** Manufacturing SMEs located in Styria, minimum project value of EUR 300,000	**Available support** Up to 35% of project costs (if less than 50 employees); up to 25% (if 50-250 employees)

Description
The scheme supports new production facilities or expansions of SMEs in the following areas: Plant manufacturers for renewable energy technologies, manufacturers of recycling plants, timber construction companies, manufacturers of products for sustainable construction (insulation materials, building technology), manufacturers of e-mobility components, system providers for sustainable production processes, manufacturers of organic/ sustainable food, non-energy companies - or GHG-intensive areas (life science/medical technology, digitalisation).

aws growth investment TWIN TRANSITION (aws Wachstumsinvestition TWIN TRANSITION)

2023-2026[24]	**Grant**	**Total funding available: EUR 196 million**
Technologies Potentially all[25]	**Eligibility** Minimum project value of €4 million, which suggests that the support is relevant for medium and large companies[26]	**Available support** Depending on the type of support and size of the company, support can equal 10% to a maximum of 35% (for small companies) of the investment.[27] This suggests that the minimum support per project amounts to EUR 400,000.

Description
The aws growth investment TWIN TRANSITION is a specific support line of the much broader aws growth investment instrument. This programme supports new businesses, new plants, modernisations and expansions in relation to the twin transition. The supported project has to demonstrate its support for a sustainable and digital economy. Upscaling is a key focus area of the scheme. The scheme makes explicit reference to the production of (components of) Net-Zero technologies, including batteries, solar PV, wind turbines, heat pumps, electrolysers, and CCS technologies.[28]

Umweltstiftung

2022 – 2025	**Skills programme**	**Type of programme** Upskilling, Re-skilling (post-secondary)
Technologies Potentially all (NZ technologies not explicitly mentioned)	**Description** Between April 2022 and April 2025, the Federal Ministry of Labor (BMA) and the Employment Service (AMS) are investing EUR 10 million to provide around 1,000 people without vocational training with the best possible qualifications in the environmental sector. The programme targets people with completed education but without employment. The up- or re-skilling can be done in areas related to waste management and circular economy, green mobility, energy generation and distribution, technical building services, agroforestry, or education and lifestyle consulting.	

[23] The instrument offers support to a wide range of manufacturing activities that ae aligned with the ambitions of the European Green Deal. Therefore, the instrument may cover all technologies covered by this study, but is not limited to these.
[24] See here.
[25] Not all NZ technologies are mentioned explicitly, see description.
[26] See here.
[27] See here.
[28] Ibid.

Opportunities and challenges

Opportunities

General

Austria's investments in energy R&D are higher than the average of other members of the IEA[29] and Austria is strong in green innovation and green jobs[30]. Backed by its Energy Research and Innovation Strategy[31], Austria notably focuses on strengthening innovation-intensive companies and enhancing its role as a location for green tech production by defining national areas of strength and reinforcing them at the EU level. In addition to these research and innovation efforts, Austria supports the local manufacturing of innovative energy technologies in three regions selected for the Flagship Region Energy, one of them focusing on the Austrian hydrogen market[32].

Technology-specific

In the solar PV industry, Austria's industry is a competitive exporter of converters and inverters and the Austrian company Fronius is a technology leader in inverters. Austrian inverter production has notably steadily increased since 2019 and reached a new record with 5,397 MW in 2023.[35] Moreover, the Austrian government has recently introduced a "Made-in-Europe" bonus scheme by adapting Austria's Renewable Energies Expansion Act to more strongly subsidise solar PV projects that contain European-manufactured components[36].

For onshore wind, Austria's industry is already involved in the production of mechanical components for gearboxes and could tap into its EUR 960 million[37] export potential for ball bearings and aluminium structures.

Challenges

General

Austria's industry is negatively affected by high labour costs, energy and material prices regulatory burden and the availability of skilled labour, which is leading companies to relocate component manufacturing, production and pre-assembly into third countries. While the majority has relocated to other EU countries, more companies are considering relocating to Asia and the USA[33].

Lengthy spatial planning and permitting procedures are particularly affecting investments in the electricity grid and renewable energy sources[34]

Technology-specific

The scale of the Austrian solar PV industry is limited compared to leading players globally and needs to grow to improve its global competitiveness[38]. However, Austrian manufacturers are not able to compete with the low-price competition from China. The share of Austrian-manufactured modules in residential PV systems fell from 14% (2021) over 9.5% (2022) to 2.4% (2023) despite a growing domestic market[39]. Cross-border cooperation with Italy and Germany could help Austria scale up the production of solar PV and create a knowledge hub.

Austria's heat pump industry experienced a sharp decline in sales in the second half of 2023 despite an upward trend in the first half of the year. By the end of 2023, sales were 9% lower than the previous year. This decrease was notably driven by a significant drop in new single-family house construction, coupled with rising construction prices and decreasing purchasing power[40].

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

[29] IEA (2020), Austria 2020, IEA, Paris https://www.iea.org/reports/austria-2020, Licence: CC BY 4.0.
[30] Office of the Austrian Productivity Board (2023) The competitiveness of the Austrian economy: a review of current assessments by international organizations, available here.
[31] Federal Government Republic of Austria (2020) RTI Strategy 2030. Strategy for Research, Technology and Innovation of the Austrian Federal Government
[32] Ibid.
[33] Deloitte (2024) Österreichs Industrie im Wandel. Wettbewerbsfähigkeit und Wertschöpfung unter Druck, available here.
[34] Office of the Austrian Productivity Board (2023) The competitiveness of the Austrian economy: a review of current assessments by international organizations, available here.
[35] Biermayr, P., & Prem, E. (2023) Innovative Energietechnologien in Österreich Marktentwicklung, Technologiereport Bauteilaktivierung. Available here.
[36] Bundesministerium Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie, 07.06.2024, »Made in Europe Bonus« – Höhere Förderung für Photovoltaik-Anlagen mit Komponenten aus Europa, available here
[37] See the above descriptive statistics for Austria and the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[38] Solar Power Europe (2023), EU Market Outlook for Solar Power 2023-2027, available here.
[39] Biermayr, P., & Prem, E. (2023) Innovative Energietechnologien in Österreich Marktentwicklung, Technologiereport Bauteilaktivierung. Available here.
[40] European Heat Pump Association (2024), Pump it down: why heat pump sales dropped in 2023. Available here.

Country Factsheet Belgium

Key findings

Manufacturing capacity:[41] Belgium's manufacturing capacity amounts to between 250 and 650 MW/y (4-11% of EU capacity—a large share) for electrolysers; and between 100 and 150 MW/y (1% of EU capacity) for solar PV. At least three facilities producing components for wind turbines were identified, but no capacity estimates could be found for these facilities. Additionally, Belgium has at least one battery production facility and is home to three factories that specialize in the manufacturing of heat pumps, further diversifying its manufacturing portfolio.

Industrial production:[42] Belgium's three largest industrial Net-Zero sectors by value are Grid technologies, with a production amounting to EUR 600 million (1% of total EU production), EUR 231 million (1% of EU production) for CCS, and EUR 211 million (a negligible share of total EU production) for solar PV and solar thermal components.

International positioning:[43] Belgium is an internationally competitive exporter of grid technology components and equipment.

Policy framework: Belgium currently has a Draft National Energy and Climate Plan that potentially addresses the manufacturing of several Net-Zero technologies, including Carbon Capture, Utilization, and Storage (CCUS), as well as electrolysers and fuel cells.

Industrial permitting: Information on the duration of industrial permitting processes could not be identified.

Incentive instruments: In Wallonia, one relevant incentive programme has been identified which provides investment support to companies producing batteries.

[41] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[42] Industrial production refers to total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[43] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in Belgium[44]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[45]	Import dependence (extra-EU)[46]
Solar photovoltaic and solar thermal	100 – 150 MW/y[47] *(1% of EU capacity)*	-	-	«Negligible portion of EU production» *(Disclosure: 54%)*	**0.41**
Onshore and offshore wind renewables	At least three facilities identified[48]	-	-	Insufficient data coverage *(Disclosure: 47%)*	**0.07**
Batteries and storage	At least one facility identified[49]	-	2900 - 3200 MW/y	«Negligible portion of EU production» *(Disclosure: 77%)*	**0.33**
Heat pumps and geothermal	At least three facilities identified	-	-	«Negligible portion of EU production» *(Disclosure: 71%)*	**0.28**
Electrolysers and fuel cells	250 – 650 MW/y *(4 - 11% of EU capacity[50])*	-	900 - 1100 MW/y	Insufficient data coverage *(Disclosure: 37%)*	**0.04**
Sustainable biogas/ biomethane	N/A	N/A	N/A	1% *(Disclosure: 56%)*	**0.14**
Carbon capture and storage	N/A	N/A	N/A	1% *(Disclosure: 45%)*	**0.43**
Grid technologies	N/A	N/A	N/A	1% *(Disclosure: 65%)*	**0.26**
Data coverage	−	−	−	✓	✓
Data reliability	−	−	−	−	✓

Technologies				
Solar photovoltaic and solar thermal	*Onshore and offshore wind renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Belgium's main production facilities include the Cummins' electrolyser factory in Oevel, with an estimated capacity of between 450 and 600 MW, Bekaert's porous transport layers (PTL) production in Wetteren with an estimated capacity of 1 GW and Belga Solar' PV manufacturing facility in Marche-en-Famenne with an estimated capacity of 100 MW. Smulders produces foundations for offshore wind turbines. Announced manufacturing facilities include factories by ABEE and Cummins, with expected outputs of 3 GWh (batteries) and 1 GW (electrolysers) respectively. Bekaert will double its production of PTL to over 2 GW. By the end of 2025, the John Cockerill facility in Seraing will start to assemble cells produced in its French facility into stacks aimed at achieving a production capacity of up to 1GW/year (electrolysers)[51]. By September 2025, the Agfa industrial-scale hydrogen zirfon

---

[44] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
45 The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[46] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[47] Manufacturing capacity is provided exclusively for solar photovoltaic and does not include capacities for solar thermal manufacturing.
[48] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[49] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[50] For consistency purposes, manufacturing capacity is provided exclusively for electrolyzers as an end-product - hence manufacturing capacity for components such as membranes and transport layers is not considered in the table.
[51] To avoid double-counting and in line with the data providers used for this study, the Franco-Belgian two-site operation's upcoming capacity was only counted in the French country factsheet.

membrane production plant will enter into operation, with up to 20 GW capacity. Belgium also hosts Umicore, one of the world's largest producers of materials used in cathodes.

Evolution of Belgium's international positioning

The figures[52] below reveal that Belgium is well-positioned as an exporter of several Net-Zero technology components.

Isolating break switches, categorised under electrical apparatus for grid technologies, have shown the largest gains in export performance between 2015 and 2022. This grid component is estimated to hold EUR 15 million in untapped export potential for Belgian producers and benefits from a relatively low level of market saturation. The absence of a dominant exporter in this component signals that the global market remains open for competition, providing Belgium with an opportunity to further strengthen its foothold in grid technologies.

As shown in Figure 2[53], Belgium holds a competitive edge over both China and the USA in this specific component, having a higher RCA index than either country. This advantage highlights Belgium's capacity to compete effectively on the international stage and signals potential for export growth. Moreover, Belgium emerges as a highly competitive exporter of hydrogen.[54]

[52] Figures 1 and 2 present Belgium's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Belgium's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand.
This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Belgium's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Belgium could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Belgium could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies. For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.
[53] Figure 2 builds on Figure 1 by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Belgium's trade strategy. Taken together, these figures provide a nuanced understanding of Belgium's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.
[54] It should be noted that the available trade data does not differentiate between green, grey, or blue hydrogen. While most of Belgium's hydrogen exports may currently consist of grey hydrogen, the data still provides a useful indication of Belgium's existing export capacity and infrastructure, which could be repurposed or scaled up for green hydrogen production as the technology and regulatory frameworks evolve.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

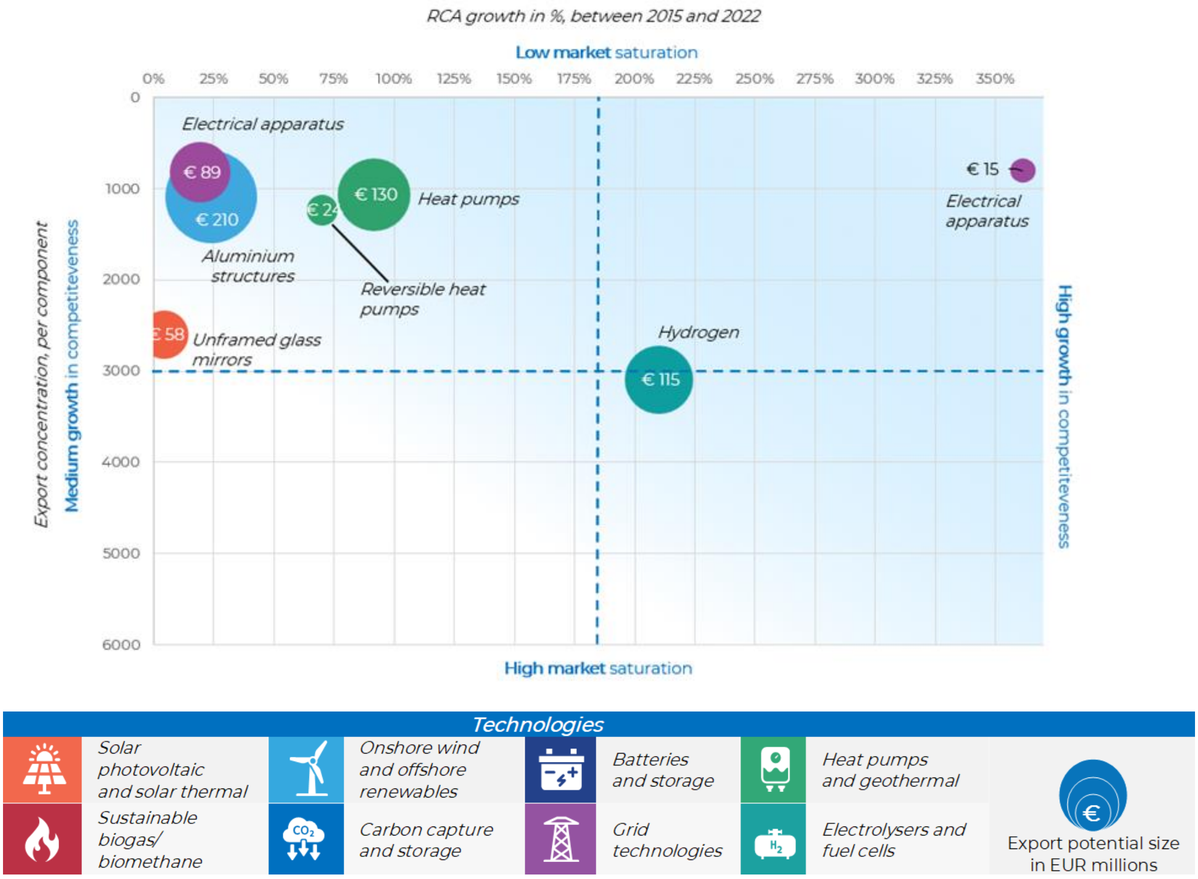
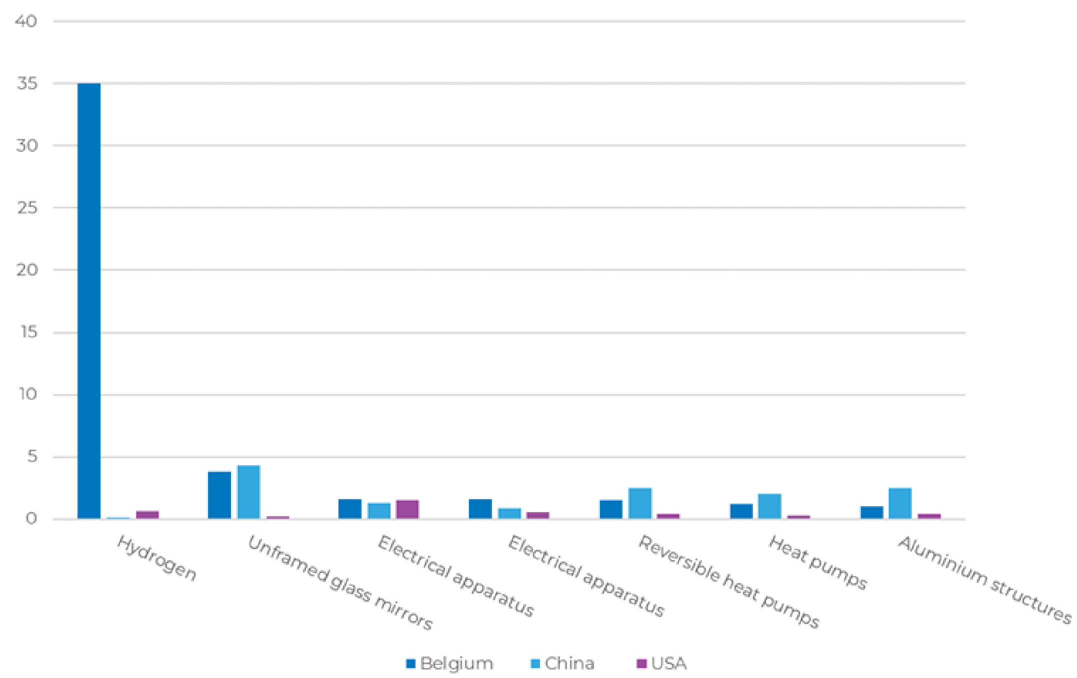


Figure 2: Absolute value of RCAs of Belgium, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

The draft updated **National Energy and Climate Plan** (2023) outlines the transition towards a sustainable, secure, and affordable energy system in line with the five dimensions of the European Energy Union: low-carbon EU (reduction of greenhouse gas emissions and development of renewable energy), energy efficiency, security of supply, internal energy market, research, innovation, and competitiveness.
In terms of Net-Zero manufacturing, CCUS is widely mentioned as a strategy for Belgium to invest in and support. While this refers mainly to R&D, it also relates to a regulatory framework for CCUS, a CO_2 and hydrogen backbone. Other Net-Zero technologies are not specifically mentioned in relation to manufacturing.

Scope of the policy framework

Industrial permitting

Average duration	No information on the duration of permitting has been identified	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

Brief summary of the permitting processes

Several permits are necessary before establishing new industrial activities, including the production of Net-Zero technologies. These permits include environmental and building permits. Permits are issued at both the federal and regional levels. While cooperation is encouraged among federal government services, the regions of Flanders and Wallonia have distinct permitting procedures. In Flanders, the process is governed by the integrated environmental permit system, which merges urban planning and environmental regulations into a single procedure.[55] This system covers activities such as construction, renovation, demolition, and environmental operations. In Wallonia, an environmental permit is required for a wide range of activities, including industrial, commercial, and artisanal operations.[56]

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox has been identified

[55] See here.
[56] See here.

Key incentive instruments

Tender for gigafactory for batteries (Appel à projets destiné à déployer l'écosystème des batteries)		
2023 only	**Grant**	**Funding available in 2023: EUR 50 million (at least)**[57]
Technologies: Batteries and storage technologies	**Eligibility:** Belgian and international companies with proven experience in the batteries sectors. Projects must involve the construction of an industrial unit in Wallonia.	**Available support:** Conditions of support per project are unspecified and vary depending on the quality of projects selected. Information suggest that the financial support might amount to up to 50% of the investment costs.[58]
Description: The Walloon government launched an open call in April 2023 for industrial projects to produce batteries, announcing plans to provide €50 million in subsidies, as the global race steps up to manufacture batteries for electric vehicles and devices.		

Opportunities and challenges

Opportunities

General

Belgium's energy R&D efforts focus on ensuring the energy transition while maintaining the competitiveness of the country's energy-intensive industries. While the Energy Transition Fund supports efforts in energy R&D at a federal level, Flanders prioritises energy innovation clusters and the competitiveness of Flemish companies by fostering cross-sector collaboration. Wallonia's Smart Specialisation Strategy[59] notably supports energy R&D in PV, grid and CCS technologies, and fosters private efforts through competitive clusters[60].

Technology-specific

Belgium's capacity in electrolysers and fuel cells looks promising as it expects an additional output of 1 GW in electrolysers from the factories announced by Cummins, and Plug Power's large-scale hydrogen plant for PEM electrolysis in Antwerp with a 100 MW capacity[63]. Belgium is also emerging as a transportation hub for hydrogen and has signed a Memorandum of Understanding with Germany and the

Challenges

General

Belgium faces a severe shortage of labour and skills, as many other EU countries, accentuated by inflationary pressures[61]. The country's labour cost increased by nearly double the average EU increase, posing significant challenges to Belgian companies in hiring skilled workers[62].

Technology-specific

Regarding heat pump manufacturing, the fall in heat pump demand in 2023 and high costs for heat pumps remain significant challenges with Belgium-based company Daikin cutting 500 jobs and putting some of its workforce on economic unemployment (until March 2024)[69].

Hydrogen infrastructure development implies different permitting procedures

---

[57] See here.
[58] Available support will follow the logic of maximum 1 euro of public support for 1 euro of private investment.
[59] The Smart Specialisation Strategy notably supports strategic innovation initiatives, one of which focuses on the creation of a hydrogen economy in Wallonia (E-WallonHY). EIB, 2023, Belgium: EIB to help Wallonia create a hydrogen industry, available here.
[60] IEA (2022), Belgium 2022, IEA, Paris https://www.iea.org/reports/belgium-2022, Licence: CC BY 4.0
[61] OECD, 14 June 2022, 'Belgium must continue reforms to sustain recovery and future growth', available here.
[62] C. Lemaire, 22 March 2024, 'Belgian businesses particularly hit by rising labour costs, inflation', available here.
[63] Plug Power, 8 June 2022, 'Plug to Build Large-Scale Green Hydrogen Generation Plant in Europe at Port of Antwerp-Bruges', available here.
[69] European Heat Pump Association (2024), European heat pump market development. See also Daikin, 22 January 2024, 'Additional days of temporary unemployment at Daikin's Ostend heat pump factory', available here.

Netherlands highlighting a potential to further invest in cross-border collaboration[64].

Regarding battery and storage technologies, new manufacturing and recycling facilities have been announced by ABEE, which has already opened a new R&D and upscaling facility for next-generation batteries in 2023[65]. Similarly, Energy companies TotalEnergies[66] and Engie have launched large battery energy storage system projects in Belgium with the former relying on their subsidiary Saft for providing the battery storage systems. However, the latter will be supplied by the Chinese company Sungrow[67]. Moreover, the Walloon government launched a EUR 50 million call for projects producing, reconditioning and/or recycling batteries[68].

and competency levels both at the federal and regional level. While Belgium aims to become a major Hydrogen hub, streamlining permitting procedures and tailoring them to hydrogen would be needed as there is currently no simplified or fast-tracked permitting procedure across regions[70].

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

64 The three countries notably jointly committed to develop the industry at the last Hydrogen Summit in May 2024 through a Memorandum of Understanding. Belgium also engaged in discussions with Denmark and Norway to support the overall CO2 infrastructure. See L. Meillaud, 5 May 2024, 'Belgium, the Netherlands and Germany join forces to develop hydrogen', available here and Government.no, Strenghtened energy ties to Belgium, available here.

65 Agoria, 14. December 2023, 'ABEE opens state-of-the-art R&D facility and upscaling center for next-generation batteries in Ninove', available here.

66 TotalEnergies, 4 March 2024, 'TotalEnergies Launches New Battery Storage Project in Belgium', available here.

67 P. Tisheva, 12 July 2024, 'Sungrow lands order for Engie's 800-MWh battery project in Belgium', available here.

68 RTL info, 06 April 2023, La Wallonie lance un appel à projets autour des batteries et du stockage d'énergie, available here

70 Linklaters, January 2022, 'Hy-Politics – Political considerations shaping the evolution of clean hydrogen policy', available here.

Country Factsheet Bulgaria

Key findings

Manufacturing capacity:[71] Bulgaria's manufacturing capacity across all Net-Zero technologies remains very limited. It amounts to between 75 and 125 MW/y for solar PV (a negligible share of total EU capacity) and between 10 and 25 MW/y for electrolysers (0-1% of EU capacity). At least two manufacturing facilities for batteries and two for heat pumps were identified. With regard to batteries, plans to build a new factory of 10 GW in the next 3 to 5 years were announced at the end of 2023 (Avesta Battery and Energy Engineering).

Industrial production:[72] Bulgaria's three largest industrial Net-Zero sectors by value are wind power, with a production amounting to EUR 346 million (a negligible share of total EU production), EUR 284 million (a negligible share) for solar PV and thermal energy, and EUR 145 million (a negligible share) for grid technologies.

International positioning:[73] Bulgaria shows a high growth rate and higher Revealed Comparative Advantage than China and the USA in grid components. The market saturation for these components is relatively low. Regarding other Net-Zero technologies, Bulgaria is competitive in offshore wind, heat pumps, and geothermal technologies. However, the export potential in these sectors is smaller compared to grid technologies. Thermostats and aluminium structures have experienced high RCA growth, but China is more competitive than Bulgaria in aluminium structures, and the USA is more competitive than Bulgaria in thermostats.

Policy framework: Bulgaria's draft NECP provides a high-level strategy for stimulating the manufacturing of Net-Zero technologies. In addition, Bulgaria's Ministry of Economy and Industry is currently working on an industrial strategy for the processing and mining industries. The essence of this project is to realise the economic transformation of Bulgarian enterprises in the context of the production of Net-Zero technologies.

Industrial permitting: General information on industrial permitting suggests that the process usually takes between half a year and three years, depending on the type of investment and the complexity of the project.

Incentive instruments: In Bulgaria, identified incentive programmes appear to focus on hydrogen as well as sustainable biogas. Relevant skill programmes provide vocational training that could potentially benefit a range of Net-Zero technologies.

[71] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[72] Industrial production refers to total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[73] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in Bulgaria[74]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[75]	Import dependence (extra-EU)[76]
	75 - 125 MW/y[77] *(1% of EU capacity)*	-	950 – 1050 MW/y	«Negligible share of EU production» *(Disclosure: 56%)*	0.30
	No facilities identified[78]	-	-	«Negligible share of EU production» *(Disclosure: 58%)*	0.06
	At least two facilities identified[79]	-	1000 MWh/y	«Negligible share of EU production» *(Disclosure: 77%)*	0.44
	At least two facilities identified	-	-	«Negligible share of EU production»*(Disclosure: 65%)*	0.38
	10 - 25 MW/y *(a negligible share of EU capacity)*	-	-	«Negligible share of EU production» *(Disclosure: 84%)*	0.80
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 89%)*	0.71
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 90%)*	0.17
	N/A	N/A	N/A	«Insufficient data coverage» *(Disclosure: 44%)*	0.40
	–	–	–	–	✓
	–	–	–	–	✓

Technologies											
	Solar photovoltaic and solar thermal		*Onshore wind and offshore renewables*		*Batteries and storage*		*Heat pumps and geothermal*		*Electrolysers and fuel cells*		
	Sustainable biogas/ biomethane		*Carbon capture and storage*		*Grid technologies*		*Data coverage*		*Data reliability*		

Bulgaria's main production facilities include the EXE solar PV factory, with an estimated capacity of 100 MW; and Hydrogenera, which produces electrolysers, with an estimated capacity of 15 MW. Both are based in Sofia. Announced manufacturing facilities include factories by AE Solar Horizon and Avesta Battery & Energy Engineering, with expected outputs of 1 GW and 10 GWh[80] respectively.

---

[74] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[75] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[76] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[77] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[78] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[79] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[80] Belgium-based ABEE to invest EUR 1.1 billion in battery production in Bulgaria, Balkan Green Energy News (2023), available here.

Evolution of Bulgaria’s international positioning

As illustrated in Figure 1, Bulgaria demonstrates significant strengths as an exporter of various Net-Zero technology components.[81] In particular, Bulgaria exhibits high growth in the export of electric boards and panels, both large and small, which are essential for grid technologies. Bulgaria's Revealed Comparative Advantage (RCA) for these products is notably higher than that of both China and the USA (Figure 2).[82] The relatively low market saturation for these grid components in international trade indicates that no single country dominates this market, leaving room for Bulgaria to further expand its presence. This combination of strong export performance and a fragmented market provides a promising opportunity for Bulgaria to solidify its competitive position in grid technologies. Bulgaria's export potential in these components is also noteworthy. With an estimated EUR 625 million in untapped export potential for electric boards and panels alone. Combined with other grid components in which Bulgaria holds a competitive advantage, the total untapped export potential is estimated at EUR 1.2 billion. For businesses and policymakers alike, the export potential provides a direction for investment and strategic focus, underscoring the importance of maintaining and expanding Bulgaria’s capabilities in this sector.

[81] Figures 1 and 2 present Bulgaria’s position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Bulgaria’s export performance over 2015-2022. This index is used as an indicator of a country’s relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand.
This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Bulgaria’s competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Bulgaria could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Bulgaria could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.
[82] Figure 2 builds on Figure 1 by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Bulgaria’s trade strategy. Taken together, these figures provide a nuanced understanding of Bulgaria’s growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

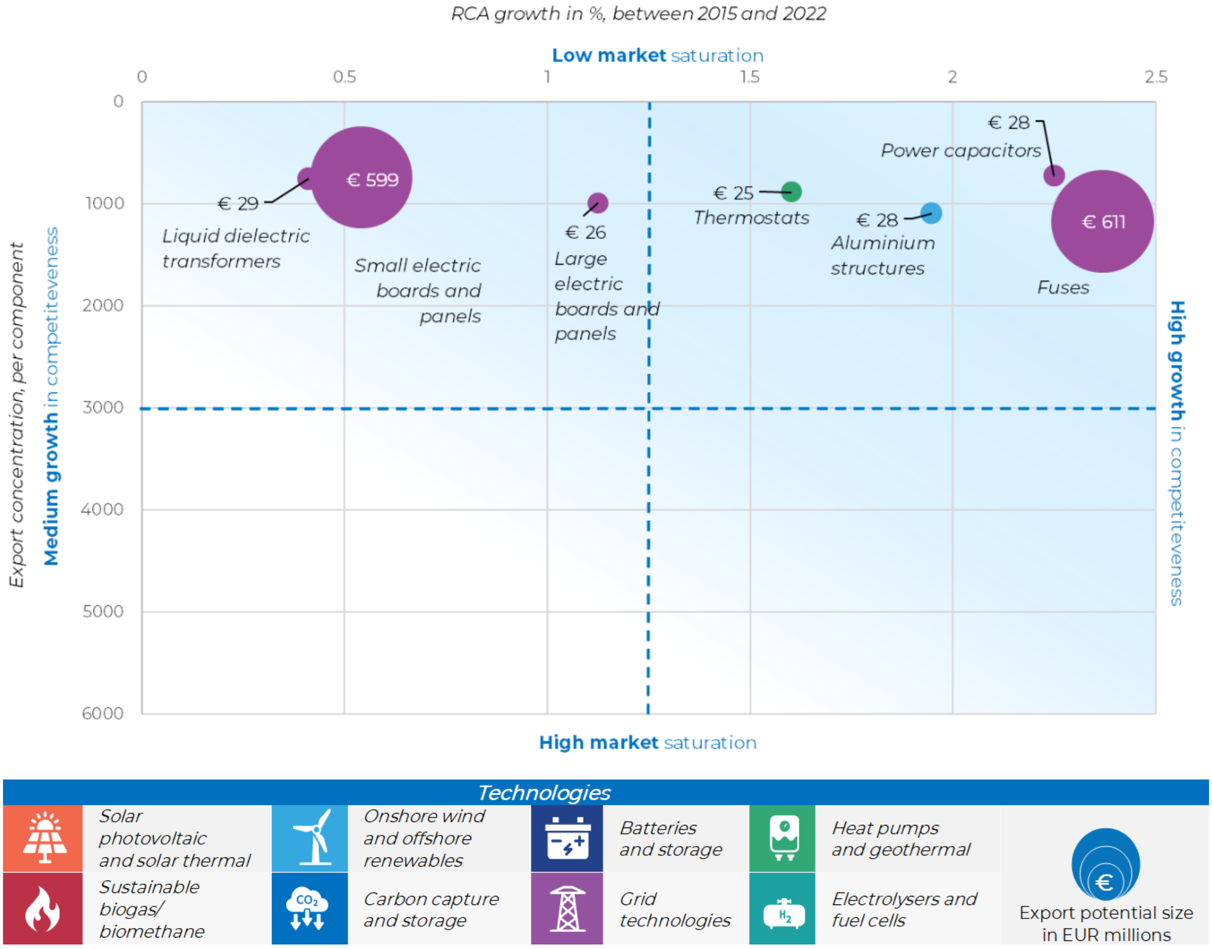
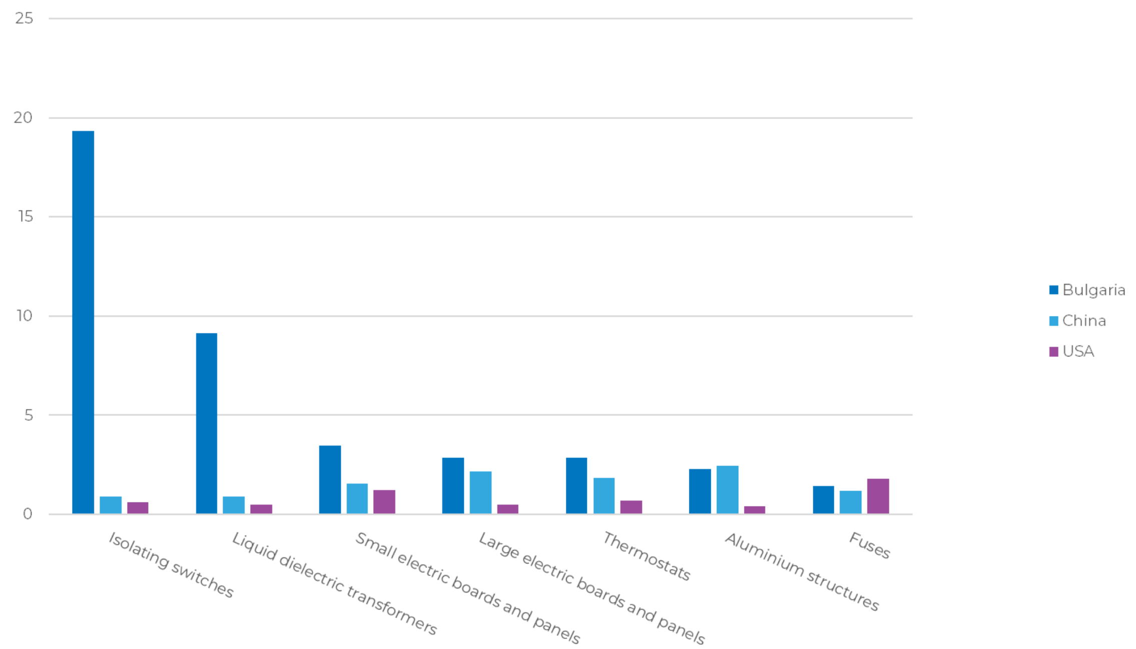


Figure 2: Absolute value of RCAs of Bulgaria, China and the USA, 2022



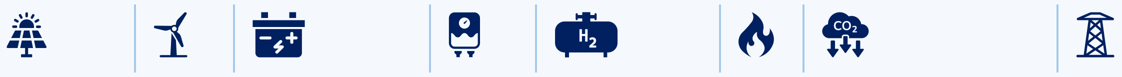
Regulatory and incentive landscape

Policy framework

Bulgaria's draft NECP discusses planned measures to stimulate the Net-Zero industry. These include improving the conditions for investment in Net-Zero technologies, improving the permitting procedures for strategic Net-Zero technologies, promoting the purchase of Net-Zero technologies with financial compensation, creating a skilled workforce for the manufacturing of Net-Zero technologies, and the establishment of industrial parks.[83] The draft NECP does not set concrete targets or provide details on concrete measures in that regard.

Bulgaria's Ministry of Economy and Industry is currently working on an industrial strategy for the processing and mining industries. The essence of this project is to realise the economic transformation of Bulgarian enterprises, in the context of the production of Net-Zero technologies.[84]

Scope of the policy framework



[✓] [✓] [✓] [✓] [✓] [✓] [✓] [✓]

Industrial permitting

Average duration[85]	The duration of the procedure is very case-dependent and can range from 6 months to 3 years.	**One-stop shop for permitting**	No one-stop shop for permitting has been identified.

Brief summary of the permitting processes

The duration of the permitting process is very hard to estimate, because it depends on the particularities of each case and the variance is large. In general, the most important steps of the permitting process are the following.

In the first place, the project developer needs a construction permit.[86] The duration of the process varies depending on the specifics of each site. If the project developer's investment intentions do not correspond with the provisions of the current detailed development plan (DDP), the DDP needs to be amended. The DDP needs to be approved by the municipality or the Ministry of Regional Development and Public Works. The process also involves a consultation of adjacent landowners[87] and competent environmental authorities. The level of digitalisation and the length of the process differ depending on the municipality in question and the necessity to carry out the strategic environment assessment of the DDP. Roughly, the municipality/Ministry takes 14-30 days to approve the development of a DDP. Afterwards, the affected stakeholders have 14 days to make submissions. The municipality/Ministry then has 1 month to approve the DDP. If certain parts of the DPP cannot be approved, the procedure is restarted (with the same steps and durations) with regard to those parts. Thus, it is very difficult to estimate the total duration, but in theory, the shortest time would be 2 months. In

[83] See, in particular, pp. 88-89 and p. 163.
[84] Interview with representatives of the Ministry.
[85] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.
[86] See here
[87] See here.

practice, some industry sources cite an approximate duration of 6 months.[88] This step is not necessary if there is an effective DDP that corresponds with the investment intentions of the project promoter.
Depending on the type and scope of the investment projects, the competent authority who approves the investment project and issues a construction permit can be: the chief architect of the municipality, the regional governor, the minister of regional development and public works or the minister of defense. The term for approving investment projects, depending on the compliance assessment, can be 14 days or one month. The construction permit can be issued simultaneously with the approval of the investment project when this is requested in the application, and in cases where there is an approved investment project, the construction permit is issued within 7 days.

An additional precondition to obtaining a construction permit is the opinion or the decision in regard to the environmental impact assessment. The competent environmental authority (the Ministry of Environment and Water (MoEW), regional inspectorates of the Environment and Water (RIEW)) determines within 14 days of notification.[89] The necessary activities to be undertaken include conducting the screening environmental assessment or mandatory environment impact assessment. If the determination is that a screening procedure is required, the final screening decision should be issued within 30 days after the submitted application. If an environmental impact assessment is needed, the next step is to hold consultations and determine the scope, contents and form of the EIA report. Depending on the complexity of the project, the time needed for preparation of the report varies. Upon submission of the report, the competent authority evaluates it within 30 days.[90] Next, a public consultation is organized and 45 days later, the competent authority takes a decision on the EIA. For the types of manufacturing that come within the scope of the present study, it is likely that an integrated permit is required.[91] The time needed for this varies greatly with the complexity of the project. There is a possibility, at the request of the developer, to conduct a joint EIA and integrated permit procedure. An indicative timeline can be estimated at 6 months.[92], but in practice, it can take up to 1.5 to two years. Producers of batteries who do not hold an integrated permit need an additional permit for collecting and treating waste. However, they can also fulfil their obligations by entering into a contract with a company that possesses such a permit and specializes in waste collection and treatment, which is a standard practice.

Under the Investment Promotion Act, projects that meet certain requirements (incl. thresholds for investment size and/or jobs created) can receive different statuses in law (class A, B, C, or Priority class). Such investment projects benefit from a range of measures, including faster administrative procedures (up to 1/3 reduction in time), individual administrative assistance, financial assistance, tax relief, and others. The obtaining of a special status in law is, however, not related to whether the investment is in the manufacturing of Net-Zero technologies or not.

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified.	**Plans for regulatory sandboxes under the NZIA**	There are plans to create a regulatory sandbox specifically aimed at implementing the relevant provisions of the Net Zero Industry Act. Details are planned to be announced later in 2024.[93]

Key incentive instruments

Planned measure under the RRP - Scheme to support pilot projects for the production of green hydrogen and biogas (Планирана инвестиция, заложена в ПВУ - Схема за подпомагане на пилотни проекти за производство на зелен водород и биогаз)

2022-2026	**Unspecified type of instrument**	**Total funding available: EUR 35 million**[94]

[88] See here.
[89] See here.
[90] See here.
[91] Article 117 of the Environmental Protection Act
[92] See here.
[93] Based on an interview with the Ministry of Economy and Industry
[94] Available here, pp. 106-107

Technologies: Electrolysers and fuel cell technologies; Biogas and biomethane technologies	**Eligibility:** The scope of the instrument encompasses new machinery, equipment and facilities. It does not include support for research and development, connection to electricity and gas networks of the installations for the production of hydrogen from renewable energy and installations for the production of biogas.	**Available support:** N/A
Description: The main purpose of the measure is to provide support for designing pilot projects enabling the introduction of green hydrogen and biogas with application in industrial productions, as well as to be used in the future in transport and for electricity and thermal energy production. Taking into account the technological level, the existing practices and the underdeveloped commercialisation of hydrogen technological solutions, efforts will be focused on launching projects which can be implemented in close cooperation between research and industry.		

Planned measures under the Territorial Just Transition Plans and Programme "Development of the Regions" (Планирани инвестиции в определени региони по Териториалните планове за справедлив преход и ОП "Развитие на регионите")		
2021-2027	**Unspecified type of instrument**	**N/A**
Technologies: All[95]	**Eligibility:** N/A	**Available support:** N/A
Description: While they are not grouped under a single measure, in the territorial just transition plans (TJTPs) for certain regions in Bulgaria, as well as under the Programme "Development of Regions",[96] there are plans to boost the manufacturing capacity of strategic Net-Zero technologies. For example, see Pillar I: Industry for sustainable energy solutions in the TJTP of Stara Zagora.[97] These include plans to establish industrial parks for the manufacturing of clean technologies and schemes to invest in pilot projects for hydrogen.[98]		

Programme Education 2021-2027		
2021 – 2027	**Skills programme**	**Type of programme:** Vocational training
Technologies: All[99]	**Description:** The ESF+ Education Programme of Bulgaria supports the development of Centres of Excellence in vocational education and training (VET) and dual learning. One area of intervention is 'green' skills and jobs and a 'green' economy.	

Trainings organised by the Institute for Sustainable Transition and Development		
Since 2023	**Skills programme**	**Type of programme:** Vocational training
Technologies: Electrolysers and fuel cell technologies	**Description:** The Institute for Sustainable Transition and Development organises trainings related to the hydrogen economy. On its website, there's information about 2 current trainings (secondments) - "Hydrogen Technologies: Fuel Cells and Electrolyzers" and "Hydrogen Electrical Mobility". The initiatives are part of the project KICstartH.	

[95] The scope of the instrument may cover all Net-Zero technologies covered by this study.
[96] Available here.
[97] Available here.
[98] ibid.
[99] The scope of the instrument may cover all Net-Zero technologies covered by this study.

Opportunities and challenges

Opportunities

General

Labour costs in Bulgaria are relatively low compared to the rest of the EU. In 2023, the country's hourly labour cost was the lowest among EU Member States.[100] This cost advantage, combined with Bulgaria's traditional metal manufacturing industry (structures and processing) and mechanical engineering industry[101], positions the country to potentially attract investments in net-zero manufacturing activities.

Technology-specific

While not a manufacturing hub currently, Bulgaria has seen recent investments in battery and storage technologies. EUR 1.1 billion of planned investment by Belgium-based ABEE for an R&D centre, a gigafactory and a recycling centre as well as EUR 1.53 million for a battery factory by the South African company solarMD.

Regarding electrolyser manufacturing, Bulgaria is also home to the startup Hydrogenera which successfully secured EUR 2 million from investors in 2022 to support the development of its megawatt-scale electrolyser. The company could expand its production beyond its home market after recently attracting attention from investors and industry representatives in Bulgaria.[104]

Challenges

General

The permitting procedure can take from 6 months to multiple years, depending on the complexity of the project. However, Bulgaria recently digitalised its 'integrated permit' procedure.

With the phase-out of coal power plants planned between 2025 and 2030, Bulgaria is expected to lose 10,000 coal-related jobs[102] and needs to ensure a just transition of the associated regions. The skill sets of these workers could, however, be transferred to the country's renewable energy industries[103].

Technology-specific

Bulgaria's Exclusive Economic Zone in the Black Sea could be home to the development of offshore renewable activities and induce stronger demand also for local manufacturers and port infrastructure thereby boosting investments. Specifically, northeastern Bulgaria has the potential to develop local supply chains thanks to skilled workers from the Bulgarian Maritime University and an existing subsidiary of Vestas operating in Varna.[105] However, offshore renewables in the Black Sea basin face significant hurdles, notably insufficient marine spatial planning, alongside permitting difficulties.[106] To overcome these bottlenecks a strategic orientation towards offshore wind energy would be needed.

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

[100] Eurostat, 2023, Hourly labour costs, available here.
[101] BG Advise, Manufacturing and Engineering industries, Bulgaria, available here.
[102] Alves Dias, P., Kanellopoulos, K., Medarac, H., Kapetaki, Z., Miranda-Barbosa, E., Shortall, R., ... & Tzimas, E. (2018). EU coal regions: opportunities and challenges ahead. European Commission, Joint Research Centre: Petten, The Netherlands, 20-32.
[103] OECD. (2019). A review of "Transition Management" strategies - Lessons for advancing the green low-carbon transition. Available here.
[104] I. Shumkov, 7 May 2024, 'Hydrogenera presents 1-MW electrolyser, preps for international partnerships', available here.
[105] M. Trifonova and M. Vladimirov (2021) Wind power generation in Bulgaria Assessment of the Black Sea offshore potential. Center for the Study of Democracy. ISBN: 978-954-477-428-8. Available here.
[106] A. Seman, 7 September 2023, 'Sunny Short: Unlocking Offshore Wind Energy Potential in the Black Sea', CAN Europe, see here.

Country Factsheet Cyprus

Key findings

Manufacturing capacity:[107] According to estimates, Cyprus does not possess any manufacturing capacity in Net-Zero technologies at the moment.

Industrial production:[108] Based on the information available, Cyprus' industrial production in Net-Zero technologies is negligible.

International positioning:[109] Cyprus is a competitive exporter of grid technology components, including insulated electric conductors (both exceeding and not exceeding 1000 volts) and automatic circuit breakers. For the two types of insulated electric conductors, Cyprus has a higher RCA than both China and the USA.

Policy framework: Currently, there is no relevant policy framework targeting Net-Zero manufacturing capacity in Cyprus.

Industrial permitting: General information on the permitting of new production facilities for Net-Zero technologies are not available. Permitting for example of a warehouse requires about 1.5 years, while it is likely that the permitting duration for factories takes longer, suggesting that the length of permitting procedures in Cyprus are above-average.[110]

[107] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[108] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[109] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides details on each indicator.
[110] Based on the data available for other countries collected by this study.

Key descriptive statistics for Net-Zero technologies in Cyprus[111]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[112]	Import dependence (extra-EU)[113]
	No facilities identified[114]	-	-	«Negligible portion of EU production» *(Disclosure: 100%)*	**0.26**
	No facilities identified[115]	-	-	«Negligible portion of EU production» *(Disclosure: 100%)*	**0.11**
	No facilities identified[116]	-	-	«Negligible portion of EU production» *(Disclosure: 100%)*	**0.42**
	No facilities identified	-	-	«Negligible portion of EU production» *(Disclosure: 100%)*	**0.33**
	No facilities identified	-	-	«Negligible portion of EU production» *(Disclosure: 100%)*	**0**
	N/A	N/A	N/A	«Negligible portion of EU production» *(Disclosure: 100%)*	**0.18**
	N/A	N/A	N/A	«Negligible portion of EU production» *(Disclosure: 100%)*	**0.44**
	N/A	N/A	N/A	«Negligible portion of EU production» *(Disclosure: 100%)*	**0.45**
	✔	⊖	⊖	⊖	✔
	✔	⊖	⊖	⊖	✔

Technologies				
Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Based on the information available, Cyprus does not have relevant manufacturing facilities. Additionally, no facilities have been announced.

Evolution of Cyprus's international positioning

Cyprus has made strides in increasing its export competitiveness in specific grid technology components, despite having a limited presence in the broader Net-Zero technology export landscape. Notable components where Cyprus has improved its position include insulated electric conductors, both exceeding and not exceeding 1000 volts, as well as automatic circuit breakers. Although Cyprus

---

[111] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[112] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[113] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[114] Manufacturing capacity is provided exclusively for solar photovoltaic and does not include capacities for solar thermal manufacturing.
[115] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[116] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.

has seen growth in the export performance of these goods between 2015 and 2022, the country still has limited or no export presence in many other key Net-Zero technology components.

Regulatory and incentive landscape

Policy framework

No relevant strategies or legislation have been identified

Industrial permitting

Average duration[117]	Total number of days required to build a warehouse (median duration that local experts indicate is necessary to complete the above procedure in practice): 507 days[118]	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

Brief summary of the permitting processes

The general permit procedure in Cyprus based on the information collected for Nicosia entails several steps, starting with a request of a copy of the site plan (Department of Lands and Surveys), followed by applications for a town planning permit at the town planning department, a building permit at the municipality, as well as final approval and final inspection (municipality). Once inspected and the certificate of final approval has been received, the land title is updated at the Department of Lands and Surveys before requests are made to obtain sewerage connection from the sewerage board and water connection from the water board.[119]

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

No relevant incentive instruments have been identified

[117] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.
[118] World Bank Group, Doing Business Archive, available here
[119] World Bank Group, Doing Business Archive, available here

Opportunities and challenges

Opportunities	Challenges
General	**General**
Cyprus can leverage various EU funds to boost its competitiveness and clean energy investments. For instance, the country has already taken steps to simplify its permitting procedures for the deployment of renewables through a reform funded by the Recovery and Resilience Facility.[120] Similar steps for the permitting of Net-Zero industries could enable small-scale industries if other enabling conditions such as affordable electricity prices are met.	It remains challenging for Cyprus to establish its Net-Zero manufacturing base due to its economic and geographical characteristics, including its small size and remote location, which hinders economies of scale due to transportation costs.[121] Cyprus faces particularly high prices for electricity and a low power grid flexibility due to its isolated grid network. This will remain an issue until it ensures a grid connection with Greece through the Great Sea Interconnector project.[122]
Technology-specific	**Technology-specific**
Cyprus is home to an innovative biomethane production unit developed by the startup InoMob representing an opportunity to use farms' by-products to produce biomethane which, in turn, can be used to decarbonise Cyprus' transportation sector.[123] Cyprus also owns nickel production, with an estimated annual capacity reaching 50,000 tons of nickel sulfate. As the final product is solely exported, Cyprus has the potential to become a player in the European battery value chain.[124]	No technology-specific challenges have been identified for Cyprus.[125]

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

[120] European Commission (2024), '2024 Country Report – Cyprus, SWD(2024) 613 final, available here.
[121] Ibid.
[122] See A. Tomaras (2024), 'Obstacles to Cyprus' EU grid connection', available here & A. Kades (2024), 'Urgent search for electricity interconnector solution', available here.
[123] Maritime Cyprus (2023), 'Innovative BioMethane production unit unveiled by InoMob and Island Oil Holdings', available here.
[124] See Hellenic Minerals' website: https://www.hellenicminerals.com/en/operations/
[125] Due to the lack of current Net-Zero manufacturing, no specific challenges were identified, however cross-cutting challenges identified in the main report such as lack of skilled workers, dependencies on third countries for materials and components as well as tough price competition also apply to Cyprus.

Country Factsheet Czechia

Key findings

Manufacturing capacity:[126] Czechia's manufacturing capacity amounts to between 1,000 and 1,100 MW/y for battery and storage technologies (a negligible share of total EU capacity) and between 700-750 MW/y for wind turbine towers (1% of EU capacity). Czechia is home to at least twelve factories that specialise in the manufacturing of heat pumps. No manufacturing facilities for electrolysers or solar PV were identified.

Industrial production:[127] Czechia's three largest industrial Net-Zero sectors by value are grid technologies, with a production amounting to EUR 4.1 billion (5% of total EU production), EUR 2.4 billion (2% of EU production) for wind power, and EUR 1.8 billion (2% of EU production) for solar PV and solar thermal energy.

International positioning:[128] Czechia's export potential in electrical static converters is notable, with its RCA competitiveness more than doubling between 2015 and 2022. However, the market faces high saturation levels, led by China, which dominates global exports and holds a higher RCA than both the United States and Czechia. Czechia is a more competitive exporter of heat pumps and turbine components than China and the USA.

Policy framework: Currently, Czechia has a Hydrogen Strategy in place that develops target areas for the production of related technologies.

Industrial permitting: General information on industrial permitting suggests that the process may take at least 1 year, potentially extending to several years. However, Czechia is currently in the process of adjusting the rules on permitting with the aim to streamline and shorten the processes. Czechia also has a one-stop shop for permits in place by providing additional competencies to the local authorities.

Incentive instruments: In Czechia, a public-private partnership aims to boost the manufacturing capacity for batteries and storage technologies in the country. Additionally, a programme has been set up to boost skills relevant to the production of hydrogen-related technologies.

---

[126] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).

[127] Industrial production refers to total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.

[128] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in Czechia[129]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[130]	Import dependence (extra-EU)[131]
	No facilities identified[132]	-	-	2% *(Disclosure: 46%)*	0.54
	700 – 750 MW/y[133] *(1% of EU capacity)*	-	-	2% *(Disclosure: 63%)*	0.96
	1000 – 1100 MW/y[134] *(a negligible share of EU capacity)*	400 - 500 MW/y	3750 - 4000 MW/y	«Negligible share of EU production» *(Disclosure: 50%)*	0.57
	At least 12 facilities identified	-	-	5% *(Disclosure: 65%)*	0.32
	No facilities identified	-	-	2% *(Disclosure: 58%)*	0.01
	N/A	N/A	N/A	3% *(Disclosure: 72%)*	0.26
	N/A	N/A	N/A	2% *(Disclosure: 75%)*	0.34
	N/A	N/A	N/A	5% *(Disclosure: 62%)*	0.45
	–	–	–	–	✓
	–	–	–	–	✓

Technologies

Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Czechia's main production facilities include the SIAG Industries wind tower factory in Chrudim; and the Stankovice factory producing power packs for wind turbines. Additionally, A123 has a lithium-ion battery factory in Ostrava. A 1 GWh battery facility is operated by Magna Energy Storage - HE3DA. Cinovec, a location which hosts the largest lithium reserves in the EU, is currently the site of a project aimed at hosting the EU's first vertically integrated battery metal production site.

---

[129] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[130] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[131] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[132] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[133] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[134] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.

Evolution of Czechia's international positioning

As illustrated in Figure 1, Czechia is estimated to have a large export potential (EUR 841 million) in electrical static converters, a key component in grid technologies.[135] While its competitiveness, measured by the RCA, in exporting this component has more than doubled between 2015 and 2022, the component is found to have a high level of market saturation.

Czechia is also a competitive exporter of heat pumps. As illustrated in Figure 1, its competitiveness in exporting heat pumps rose by 215%. The country holds an estimated export potential of EUR 249 million and, relative to China and the USA, is a more competitive exporter (Figure 2).[136] While trade data suggests Czechia outperforms China and the USA in these components, it is essential to consider that this advantage could stem from particular production or assembly activities rather than a comprehensive domestic manufacturing presence across all components. It should be therefore interpreted as indicative of its relative advantage within a niche rather than a reflection of large-scale manufacturing activities when compared to larger players like China and the USA.

Finally, Czechia is found to be a highly competitive exporter of turbine components for heat pumps. Its RCA index of 14 surpasses that of both China and the USA, each with an RCA of 2.5.

[135] Figures 1 and 2 present Czech Republic's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Czech Republic's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness
but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Czech Republic's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Czech Republic could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Czech Republic could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategiesFor more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.
[136] Figure 2 builds on Figure 1 by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Czech Republic's trade strategy. Taken together, these figures provide a nuanced understanding of Czech Republic's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

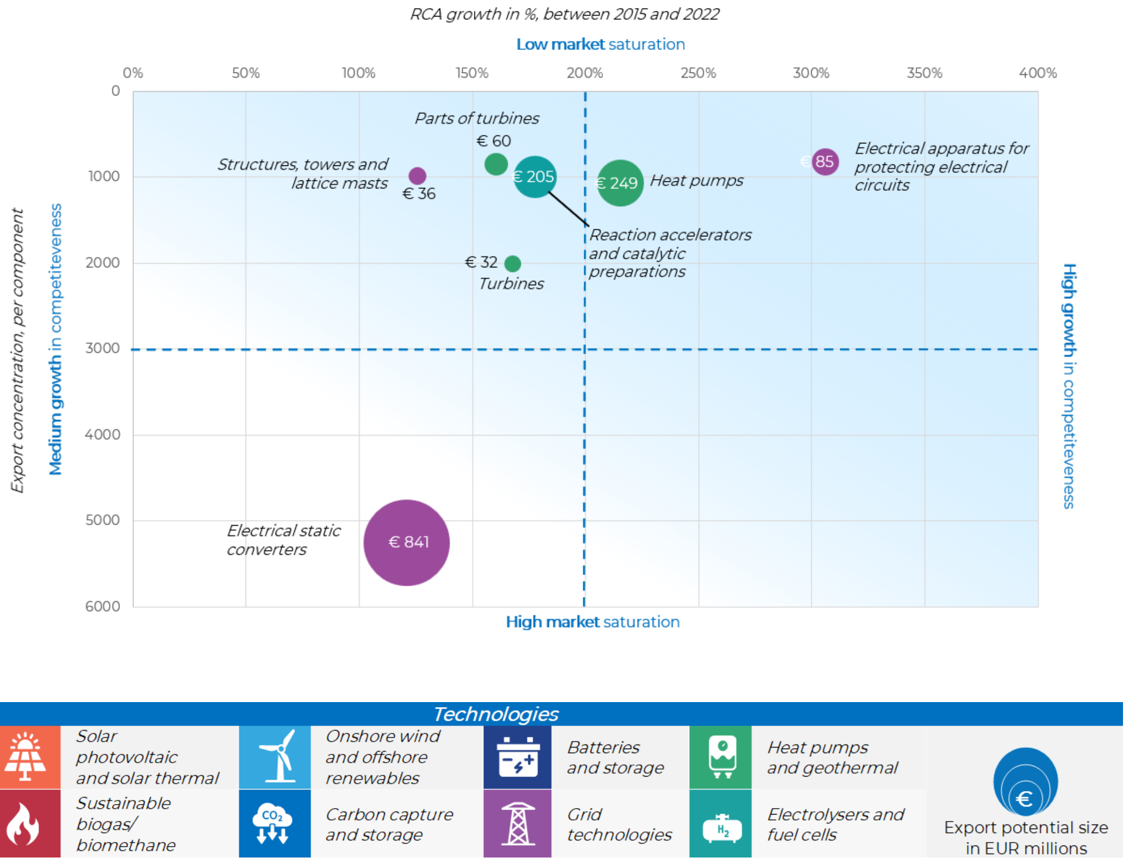
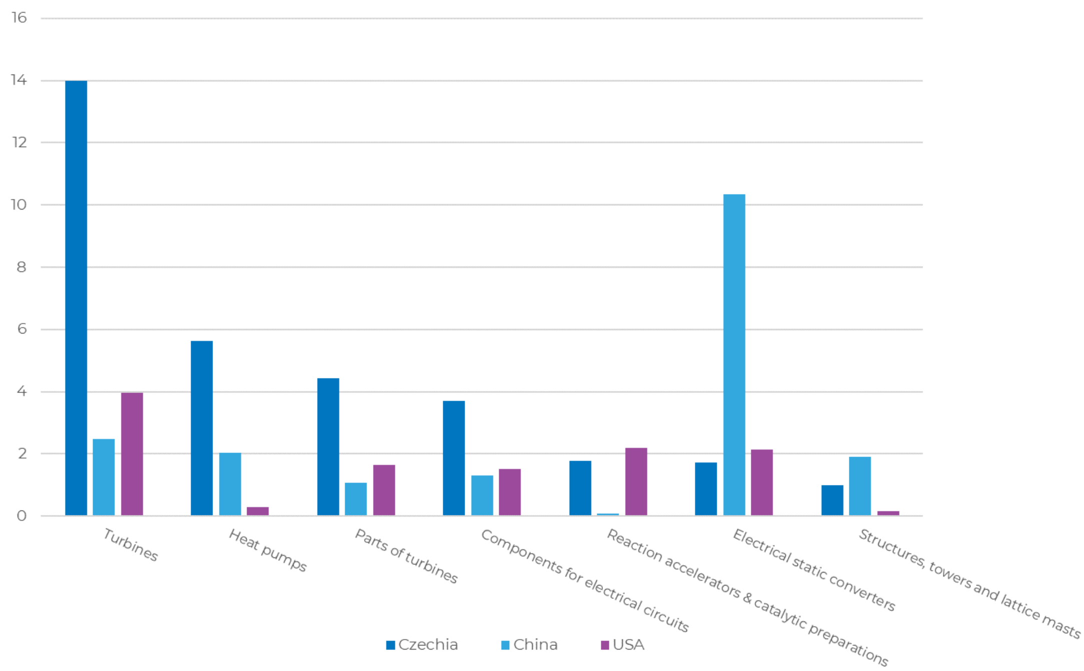


Figure 2: Absolute value of RCAs of Czechia, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

Czechia's **Hydrogen Strategy** outlines strengths, weaknesses and needs for action to make the country ready for large-scale hydrogen usage. The strategy contains a target area of making progress in R&D and the production of hydrogen technologies to promote economic growth in connection with a hydrogen transition. However, no specific overall targets are defined. Specific task cards focus on the R&D aspects. Beyond this, the strategy contains sections on hydrogen technologies that are needed for the implementation, without providing much detail. Most technologies are described at a high level, without specific actions for the Czech market. The main concrete points relate to hydrogen-powered vehicles such as trucks and buses.

Scope of the policy framework

Industrial permitting

Average duration[137]	12 months to several years[138].	**One-stop shop for permitting**	A one-stop shop for obtaining the necessary permits is in place. New competencies have been given to the construction permitting authorities at the local level, coordinated by a builder's portal at the national level. This is coordinated under the Ministry for Regional Development. Under this change, a unified binding opinion has been introduced, for which the information submitted is shared between all relevant departments to issue a single opinion that forms part of the final construction permit.[139]

Brief summary of the permitting processes

The permitting procedure is currently changing. New rules came into effect on July 1st 2024, which aim to streamline the process. One construction permit is issued, with subordinate binding decisions on emissions, water use, environmental impact assessments, etc. Environmental considerations are grouped in a unified binding opinion that combines up to nine previously separated permits/procedures.

With the new law, the processing time by the national construction authority should be limited to 60 days. However, this excludes the two main drivers of permitting duration: (1) local spatial planning decisions with

[137] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.
[138] Based on interview with interview with the Ministry of Regional Development
[139] Based on interview with interview with the Ministry of Regional Development. Additional information available here

citizen consultations and (2) environmental inputs for which monitoring studies and stakeholder consultations can be required. [140] The new permitting law also introduces a fully digitalized process.

Key drivers of permitting length include the variability in local spatial planning decisions, which differ based on the municipality and the scale of the construction project, often causing significant delays. Another key factor is the environmental impact assessments required for environmental permits (or binding opinions in the future). These assessments involve detailed studies that can be time-consuming. [141]

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

Czech Battery Cluster (Český bateriový klastr)

Since 2022	**A public-private partnership with the organisation of meetings**	**No information on the funding volume available**
Technologies: Batteries and storage technologies	**Eligibility:** Membership structure	**Available support:** N/A

Description: The Czech Battery Cluster is a public-private partnership between SMEs, large companies, research and public agencies to develop value chains and project implementation related to battery-powered vehicles. The focus of the Cluster has been to facilitate the cooperation and exchanges of public and private stakeholders to support the creation and development of a battery economy. In addition, Memorandums of Understanding have been signed with several stakeholders from the battery sectors such as the Korean Battery Ecosystem Agencies to strengthen cooperation and collaboration on research and development and education to scale up the production of batteries in the country[142].

GET Center UJEP

Since 2024	**Skills programme**	**Type of programme:** Post-secondary education
Technologies: Electrolysers and fuel cell technologies	**Description:** This programme has just been initiated and information on it is limited. It sets up new science and education capacity for innovative and sustainable energy systems in the local faculty of mechanical engineering in the region of Ústi. One pillar focuses on hydrogen technologies, while the other is more general energy and technology-centred. The initiative uses Just Transition Fund financing to support research and education programmes that strengthen the resilience and sustainability of the region.	

[140] Based on interview with interview with the Ministry of Regional Development
[141] Based on interview with interview with the Ministry of Regional Development
[142] Source here

Opportunities and challenges

Opportunities	Challenges
General Czechia's coal-transitioning regions present an opportunity for Net-Zero manufacturing investments and skill transfers. These regions have available brownfield sites and are supported by competitive state aid and EU funds. Additionally, the country's low industrial costs can make it an attractive destination for investment.[143]	**General** Czechia faces a serious shortage of workers, which could slow down the country's green transition and economic growth. Skilled labour is also reported as one of the main investment barriers for firms.[144]
Technology-specific Czechia is emerging as a significant production hub for lithium-ion batteries in Central and Eastern Europe with a rising potential also thanks to it being home to one of the largest hard rock lithium deposits in Europe, where mining and production of lithium hydroxide is expected to commence in 2026.[145] Opportunities arise also from Czechia's strong automotive sector and the transition to electric vehicles[146]. Moreover, Czechia could also benefit from regional cooperation with other Member States from Central and Eastern European countries.[147] Alongside Poland and Slovakia, Czechia is emerging as a key actor in heat pump manufacturing developing a heat pump valley thanks to cheap and skilled labour.[148] Czechia benefits from regional cooperation and has a strong competitive position as it outperformed China and the USA for its respective components in 2022 and has an estimated untapped export potential of EUR 249 million. Additionally, Czechia's exports rose by 215% between 2015 and 2022.[149]	**Technology-specific** While Czechia has a large automotive manufacturing sector and significant potential for EV battery production, it has been facing several challenges in securing stable foreign investment, partly due to infrastructure limitations, regulatory and bureaucratic hurdles and available skilled workforce.[150] Regarding wind technologies, one of the fundamental challenges of scaling up manufacturing is accessing the necessary raw materials in sufficient quantities, as shown in Chapter 4.1 of the main report. Similarly to other wind manufacturing hubs, Czechia faces a critical dependence on third-country imports, as seen above, with an extra-EU import dependency of 96%.[151]

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential

[143] CEZ Group (2023), Opportunities in the Czech Republic, available here.
[144] European Commission (2024), '2024 Country Report – Czechia, SWD(2024) 603 final, available here.
[145] Cyrani, Pavel (2022), Cinoves lithium extraction and processing project. Available here.
[146] However, recent hopes of a battery gigafactory planned by Skoda's parent company Volkswagen have been suspended, see here: Central European Times, 03.11.2023, VW suspends plan for EV gigafactory in CEE, available here.
[147] PSPA (2023). Europe runs on Polish lithium-ion batteries, available here.
[148] Euractiv, 1 June 2023, 'Europe's 'heat pump valley' takes root in the East', available here.
[149] See the above descriptive statistics for Czechia and the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[150] Columby (2024), The Czech Gigafatory Shuffling, 2020-2024. Semantic Visions. Available here.
[151] See the above descriptive statistics for Czechia and the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.

Country Factsheet Germany

Key findings

Manufacturing capacity:[152] Germany is a major manufacturing hub across several Net-Zero technologies. The country's manufacturing capacity amounts to between 7.8 and 11.2 GW/y (36-53% of EU capacity) for solar PV, with capacity being primarily concentrated in modules (between 5.9 and 8.5 GW/y) and cells (between 1.6 and 2.5 GW/y); between 55 and 60 GWh/y (21-23% of total EU capacity) for battery and storage technologies; and between 3.3 and 3.5 GW/y (59-63% of EU capacity) for electrolysers. Concerning wind power, Germany has a manufacturing capacity of approximately 11.4 – 17.75 GW for nacelles, around 4 GW for towers, and 0.5 GW for blades. Moreover, Germany is home to at least 33 factories that specialise in the manufacturing of heat pumps (approximately 10% of production facilities in the EU).

Industrial production:[153] Germany's three largest Net-Zero industries by value are wind power, with a production amounting to EUR 29.9 billion (31% of total EU production), EUR 20.4 billion (27% of EU production) for grid technologies, and EUR 19.4 billion (24% of EU production) for solar PV and thermal.

International positioning:[154] Germany is the largest EU exporter of heat pumps and geothermal technologies, with high export growth and a higher RCA (revealed comparative advantage) index than international competitors such as China and the USA. Germany is also a competitive exporter of grid technologies.

Policy framework: Currently, Germany has three dedicated strategies (Industriepolitik in der Zeitenwende, Dachkonzept Batterieforschung, Nationale Wasserstoffstrategie), one stakeholder dialogue (Stakeholderdialog industrielle Produktionskapazitäten für die Energiewende) and a legal framework amending state aid rules (BKR-Bundesregelung) that support the manufacturing of Net-Zero technologies in the country.

Industrial permitting: General information on the industrial permitting of new production facilities for Net-Zero technologies indicates an average duration of 11 months (13 months for a standard procedure, and 9 months for a simplified procedure), which is generally aligned with the aims of the NZIA and relatively swift compared to other Member States.

Incentive instruments: In Germany, several incentives support investment in Net-Zero technologies. This includes grants and loans supporting companies' investments in the production of Net-Zero technologies equipment and their key components. A skill programme provides post-secondary education to young scientists in the area of battery cell research.

[152] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[153] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The selection of components and end-use products is reported in the Main Report.
[154] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides details on each indicator.

Key descriptive statistics for Net-Zero technologies in Germany

	Manufacturing Capacity (MW), % of EU-27	Additional announced capacity (MW) (2024-25)	Additional announced capacity (MW) (2026 onwards)	Production, % of EU-27*	Import dependence (extra-EU)[155]
	7750 – 11250 MW/y[156] *(36 - 53% of EU capacity)*	900 - 10400 MW/y	8000 - 14000 MW/y	24% *(Disclosure: 80%)*	**0.62**
	15650 - 22450 MW/y[157] *(17 - 25% of EU capacity)*	900 - 1100 MW/y	-	31% *(Disclosure: 89%)*	**0.11**
	55000 – 60000 MWh/y[158] *(21 - 23% of EU capacity)*	11200 - 171000 MWh/y	110000 - 173000 MWh/y	26% *(Disclosure: 86%)*	**0.54**
	At least 33 facilities identified	-	-	29% *(Disclosure: 82%)*	**0.38**
	3300 – 3500 MW/y *(56 - 60% of EU capacity)*	4250 - 4550 MW/y	2100 - 3200 MW/y	29% *(Disclosure: 84%)*	**0.05**
	N/A	N/A	N/A	28% *(Disclosure: 78%)*	**0.33**
	N/A	N/A	N/A	34% *(Disclosure: 75%)*	**0.36**
	N/A	N/A	N/A	27% *(Disclosure: 79%)*	**0.39**
	–	–	–	✓	✓
	–	–	–	✓	✓

**(% of product codes for which data is reported as confidential)*

Technologies					
Solar photovoltaic and solar thermal	*Onshore and offshore wind renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*	
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*	

Germany remains the EU's strongest manufacturing and innovation hub across several Net-Zero technologies. The country hosts the EU's only solar-grade polysilicon supplier, Wacker, with facilities operating in Saxony and Bavaria[159], with an estimated capacity of 60,000 metric tons.[160] While the ongoing restructuring of the solar PV industry has hit German-based producers hard—with Meyer Burger shutting off operations in Freiberg in March 2024[161] and recently announced cuts[162] in its remaining workforce—Germany remains a leading producer of modules, with facilities including Heckert Solar in Saxony and Soluxtec in Rhineland-Palatinate. Germany is also an important supplier of wind turbine components, particularly nacelles and towers, with facilities including Ge Vernova's and Enercon, both based in Saxony.

[155] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[156] Manufacturing capacity is provided exclusively for solar photovoltaic and does not include capacities for solar thermal manufacturing.
[157] Manufacturing capacity relates only to the production of wind turbine components, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[158] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[159] More information is available at the following link.
[160] Information is available at the following link. It is worth stressing that Wacker is an important supplier to the semiconductor industry, which accounts for a large share of its production volume.
[161] PV Magazine, 23.02.2024m Meyer Burger prepares to shut down plant in Germany. Available here.
[162] Financial Times, 18.09.2024, Solar-panel maker Meyer Burger to cut fifth of its workforce. Available here.

In the battery and storage sector, Germany's largest facility is Tesla's gigafactory, which produces batteries for EVs as well as EVs in Brandenburg, with an estimated capacity of at least 50 GWh/y.[163] Additionally, Northvolt is reportedly continuing construction of its Northvolt Drei gigafactory in Heide, which aims to reach a manufacturing capacity of 60 GWh/y[164]. Germany is currently the EU country with the highest installed electrolyser manufacturing capacity, both in polymer electrolyte membrane (PEM) and alkaline, with leading manufacturers including Thyssenkrupp Nucera and Siemens Energy.

Evolution of Germany's international positioning

As illustrated in Figure 1, Germany is an internationally competitive exporter of various Net-Zero technology components.[165,166]

Notably, for heat pumps and geothermal and their components such as compressors, Germany exhibits a high growth rate and a higher RCA than both China and the USA, while the international trade of this particular component has a relatively low market saturation rate. The relatively low level of market saturation in these sectors suggests that no single country dominates the global export market for these components. Additionally, Germany is estimated to have untapped export potential in the heat pump segments. Were trade obstacles[167] in third countries to be removed, German exports in this segment could increase by up to EUR 699 million. Combining the export potential of the three heat pumps and geothermal components in which Germany holds a significant competitive position, the total export potential is estimated to be over EUR 2 billion.

Germany is also a competitive exporter of grid technologies. Specifically, Germany is estimated to have an export potential of EUR 801 million in electrical inductors and EUR 129 million in fuses. However, while Germany is competitive in exporting these components, China has a higher RCA than Germany (Figure 2).[168] Compared to other EU Member States, Germany is found to be somewhat less competitive than some other EU Member States, including Romania, Croatia, and Hungary.

[163] Tesla aims at expanding capacity to 100 GW/y. More information is available at the following link.
[164] Battery News, 10.09.2024, Northvolt Cuts Projects After Realignment. Available here.
[165] Figures 1 and 2 present Germany's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.
[166] Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Germany's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Germany's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets. Export potential is calculated using a gravity model, reflecting the hypothetical value Germany could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Germany could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
[167] Such as non-tariff barriers (NTBs), including standards and regulations, rules of origin, customs and administrative barriers, etc.
[168] Figure 2 builds on Figure 1 by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Germany's trade strategy. Taken together, these figures provide a nuanced understanding of Germany's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

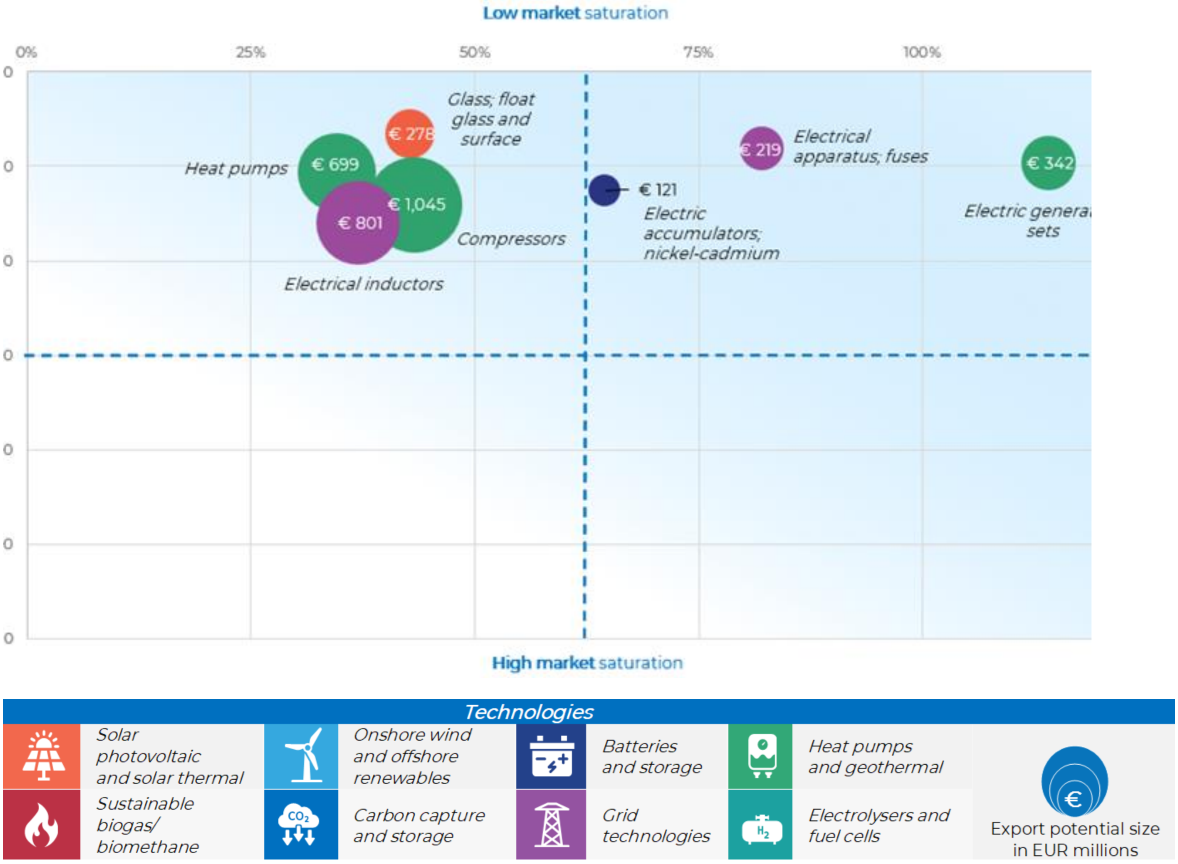
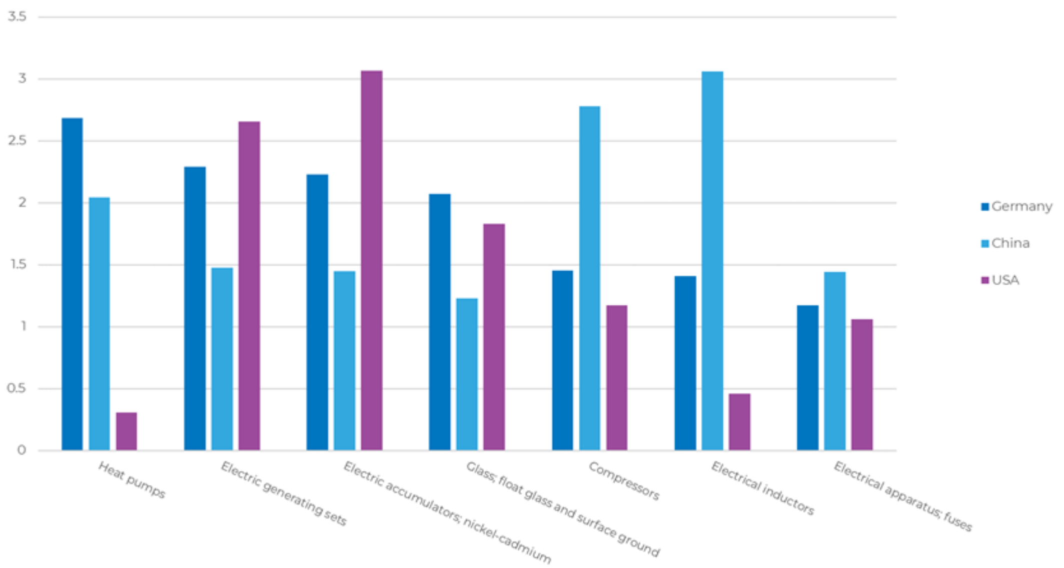


Figure 2: Absolute value of RCAs of Germany, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

The **Industrial policy at the turn of an era** (Industriepolitik in der Zeitenwende) is the overarching industrial strategy of the German federal government published in October 2023. The strategy aims to diversify the value chains for Net-Zero technologies and to develop production capacities in Germany and the EU. The strategy lists incentive instruments and financial guarantees for different Net-Zero industrial sectors. It also proposes the addition of qualitative criteria to public procurement that support sustainability and industrial resilience.

The **Stakeholder dialogue on industrial production capacities for the energy transformation** (Stakeholderdialog industrielle Produktionskapazitäten für die Energiewende) was conducted throughout 2022. The dialogue process started with roundtable discussions between the Minister of Economic Affairs and Climate Action Robert Habeck and industry representatives. During eight working sessions, the stakeholders discussed challenges and potential measures to increase production capacities. The results were validated in a second roundtable discussion. The process was concluded with a report by the German energy agency Dena, which makes eleven concrete recommendations for future industrial policy.

The **Umbrella Concept for Battery Research** (Dachkonzept Batterieforschung) is a strategy of the Federal Ministry for Education and Research to develop a competitive and sustainable German battery cell industry. The initiative integrates various activities across the country to enhance the development and production-readiness of innovative battery technologies. The concept focuses on fostering collaboration between academic institutions, research centres, and industry in areas ranging from material research, and scaling up production processes, to developing an ecosystem for innovation. While the ultimate aim of the strategy is developing the industrial production of battery cells in Germany, all its initiatives apply at the stage of research and development, including research on the up-scaling of production and developing synergies in the value chain.

The **National Hydrogen Strategy** (Nationale Wasserstoffstrategie) was first adopted in June 2020 and proposed measures for the development of a hydrogen infrastructure and the use of hydrogen as an energy carrier in industry and transport. With the update of the strategy in June 2023, industrial leadership in hydrogen technologies such as electrolysers was introduced as a goal. The measures proposed to achieve this aim relate to industrial research and innovation.

In a **joint declaration** with industry stakeholders in August 2022, the Federal Ministry for Economic Affairs and Climate Action announced its aim to reach a rate of 500,000 newly installed heat pumps per year by 2024. The declaration, which outlines a range of measures to be taken by the government as well as by the industry, followed a summit of the minister with 26 representatives of companies and business associations. A second summit in November of the same year led to a detailed roadmap for supporting the production and installation of heat pumps. The measures listed on the government's side relate to research, skills for installation, and a regulatory framework conducive to the installation of heat pumps.

The **BKR-Bundesregelung Transformationstechnologien**, adopted and approved by the European Commission under the TCTF,[169] provides the legal basis for incentive programmes for increasing production capacities of Net-Zero technologies. While the BKR-Bundesregelung does not contain specific support measures, it amends state aid rules to allow for direct subsidies, tax breaks, and guarantees for Net-Zero production capacities. Investments in the production of Net-Zero technologies, in key components, and in the production or recovery of related critical raw materials are eligible for support. The BKR-Bundesregelung allows for the distribution of up to EUR 3bn to support private investments between 2023 and 2025.

Scope of the policy framework

[169] See here.

Industrial permitting

Average duration[170]	On average, the duration is 11 months: 13 months for a standard procedure, and 9 months for a simplified procedure. The average length of preparation needed to complete an application for an immission control permit is 10.7 months. The legal limit for the duration of an immission control permit is 7 months for standard procedure and 3 months for simplified procedure. [171]	**One-stop shop for permitting**	No one-stop shop for permitting has been identified. The competent authority depends on the place of the industrial facility.

Brief summary of the permitting processes

As part of the immission control permit, projects may require an environmental impact assessment (Umweltverträglichkeitsprüfung). Whether an environmental impact assessment is mandatory depends on the type and size of the facility as listed in UVPG[172] Anhang 1, as well as on whether it is a new construction project and on certain risk factors listed in UVPG Anhang 3. For certain types of facilities, a simplified procedure (V-Verfahren) without public participation is applicable. The applicable procedure depends on the type and size of the industrial facility as listed in BImSchV 4 Anhang 1.

The details of the procedure depend on the competent regional authority**.** Nine out of 16 federal states have jointly developed a digital tool for the creation and submission of applications, called ELiA.[173] A federal government website[174] assists in identifying the competent authority and obtaining the relevant documents based on the location of the planned development.

The Federation of German Industries (BDI) identifies four main areas of potential for accelerating the permitting procedure about immission control permits: expanding the possibility of early commencement of preparatory construction works; removing the requirement for an administrative hearing of potential opponents (Erörterungstermin) of the project or to make it optional; accelerating the assessment of completeness of documents; expanding the possibility to hand in certain documents later, in particular, those not needed at an early stage.[175] In the summer of 2024, the legislator passed a law amending the rules on immission control permits, moving to a fully digitalised permitting process, removing the general requirement for Erörterungstermine, and shortening the permitting process to 7 months and 3 months for a simplified procedure.[176]

Procurement

The German energy agency Dena published a report on the possibilities for introducing relevant requirements for onshore wind and photovoltaic. The industrial strategy published by Germany's Federal Ministry for Economic Affairs and Climate Action also proposed the addition of qualitative criteria to public procurement on CO_2 intensity and industrial resilience.

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

[170] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.
[171] See here and here
[172] Gesetz über die Umweltverträglichkeitsprüfung, see here.
[173] Description of ELiA on the websites of the regional administration of Berlin, see here
[174] See here
[175] See here
[176] See here

Key incentive instruments

Resilience and sustainability of the ecosystem for the production of battery cells (Resilienz und Nachhaltigkeit des Ökosystems der Batteriezellfertigung)		
2023-2025	**Grant**	**Funding available in 2024: EUR 344.9 million[177]**
Technologies: Batteries and storage technologies	**Eligibility:** Investments in the battery cell value chain or R&D in direct connection with the expansion of production capacities	**Available support:** Up to EUR 150M and 15% of project costs; EUR 200 million and 20% in economically underdeveloped regions
Description: The non-repayable grant is provided under the framework of the BKR-Bundesregelung Transformationstechnologien implementing the TCTF. It supplements private investments that create or expand production capacities in Germany for the supply chain of battery cells.		
Climate protection offensive for companies (Klimaschutzoffensive für Unternehmen)		
Since 2020	**Loan**	**Funding disbursed in 2023: EUR 1.5 billion (across all modules)[178]**
Technologies: All	**Eligibility:** Production facilities in Germany or the EU (for companies based in Germany) for technologies fulfilling certain minimum requirements. Projects located in Germany; projects within the EU, provided that the company has significant German participation (at least 25%), subsidiaries of German companies or a headquarters in Germany. (Module A+)	**Available support:** Up to EUR 25 million (more in exceptional cases) and 100% of project costs. For Module A+, legally possible up to EUR 150 million and 40% of project costs depending on company size; in economically underdeveloped regions up to EUR 200 million and 45%
Description: The instrument offers loans to companies for investments that help to reduce or avoid greenhouse gas emissions in line with the EU taxonomy for sustainable activities. The instrument features several modules from which companies can benefit. Module A of the KfW programme supports the production of environmentally friendly technologies, including Net-Zero technologies. The support is provided as a loan with a favourable interest rate. Support under different modules can be combined. Support under Module A+ became available in 2023, building on the BKR-Bundesregelung Transformationstechnologien. The support under Module A+ is available for all technologies covered by the scope of the study except for grid technologies, and the ceiling for support per project exceeds the limits of Module A and is available for (key) components needed for the manufacturing of Net-Zero technologies.		
Promotion of lighthouse projects to ramp up industrial production capacities in the field of photovoltaics		
To be announced	**Planned initiative under the TCTF (type of support to be determined)**	**No information on the funding volume available**
Technologies: Solar technologies	**Eligibility:** Investments in the photovoltaic value chain with proven sustainability and effectiveness. The projects should include a production setup that correlates with the production of at least 2 GW/year of PV modules.	**Available support:** To be announced
Description: The new subsidy line was announced for selected "lighthouse" projects for the production of photovoltaic components in line with the TCTF. The goal is to establish a total production capacity of around 10 GW/year along the value chain. A call for expressions of interest was conducted in 2023 and gathered significant interest from the industry.[179]		

177 See here
178 See the KfW financial report here
179 See here

Deep Tech and Climate Fund		
2021-2030[180]	**Financial instrument**	**Total funding available: EUR 1 billion**
Technologies: All[181]	**Eligibility:** Start-ups at various stages of maturity	**Available support:** DeepTech and Climate Fonds: EUR 1–30 million per project
Description: The DeepTech & Climate Fonds was launched to provide equity capital to start-ups in various areas of the economy. It is financed with funds from the Zukunftsfonds and the ERP Special Fund. It targets companies in deep-tech and climate-related sectors with high financial needs over prolonged development cycles. The areas of activity covered by the fonds include new energy, energy storage, and grid technologies. The support combines public (up to 70%) and private (up to 30%) funding.		

Joint task "Improving the regional economic fabric" (Gemeinschaftsaufgabe „Verbesserung der regionalen Wirtschaftsstruktur" (GRW))		
2023-2025	**Grant**	**Funding available in 2024: EUR 407.6 million**[182]
Technologies: All	**Eligibility:** Projects in one of the eligible regions	**Available support:** Up to EUR 200 million and 20% of project costs
Description: GRW was created in 1969 as an instrument for even regional development. In 2023, the existing GRW instrument was extended in line with the TCTF by raising the cap on grants for Net-Zero technologies in the relevant regions. The limitations on subsidies to large enterprises were also relaxed.		

Key project H2Giga (Leitprojekt H2Giga)		
From 2021[183]	**Grant**	**Funding available in 2024: EUR 70 million (across all three key projects)**[184] **Total funding available: EUR 700 million (across all three key projects)**[185]
Technologies: Electrolysers and fuel cell technologies	**Eligibility:** N/A	**Available support:** N/A
Description: H2Giga is one of three key projects led by the Ministry of Education and Research for the implementation of the national hydrogen strategy. H2Giga aims to develop technologies for the serial production of electrolysers. Projects fall into one of three categories: 1. Scale-up projects develop serial production for established electrolysis processes. 2. Next-generation scale-up projects develop more innovative electrolysis processes and include additional research on key components. 3. Innovation pool projects conduct overarching research related to electrolysis.		

BattFutur		
2023-2034	**Skills programme**	**Type of programme:** Post-secondary education programme
Technologies: Batteries and storage technologies	**Description:** The programme BattFutur supports young scientists in the area of battery cell research to advance their research interests, enhance their qualifications, and boost their career prospects. The programme includes a number of eligibility criteria that suggest that the target group are highly qualified individuals with a PhD. It provides grants for up to five years and up to a total amount of EUR 2.15 million for the creation of research groups with a concrete connection to industrial applications. The support also extends to the founding of a business.	

[180] Note that first investments were completed at the end of 2022 or beginning of 2023, see here.
[181] The scope of support includes new energy, which may cover all technologies explored in this study. This includes for example projects on batteries and hydrogen, see here.
[182] See here. Note that this budget is available for the overall fund, it is not clear which share of this money will benefit Net-Zero technologies.
[183] From August 2021 onwards.
[184] See here
[185] See here

Opportunities and challenges

Opportunities	Challenges
General	**General**
Germany's revised industrial policy published in October 2023 aims to diversify the value chains for Net-Zero technologies and to develop production capacities in Germany and the EU. It lists incentives and financial guarantees and proposes qualitative criteria for public procurement that support sustainability and industrial resilience.	High labour[186] and energy costs make it challenging to compete with lower-cost producers in China and other third countries. Moreover, Germany's demographic shift exacerbates this shortage of skilled workers needed for manufacturing and installation.[187] Political tensions in the German government and budgetary constraints due to the debt break in the German constitution have led to decreases in government spending and put into doubt Germany's ambitious industrial policy increasing uncertainties for industry and investments[188]. For example, a planned subsidy for domestic solar manufacturing was scrapped[189].
Technology-specific	**Technology-specific**
Opportunities for Germany lie in its advanced manufacturing capabilities and potential for innovation in next-generation battery technologies thanks to the country's excellent research capacity, dedicated research centres[190] and targeted government support[191]. The closeness to key customers in the form of automotive manufacturers also provides an opportunity as many are looking to nearshore battery production for increased resilience. Germany is one of the world's top five exporters of wind turbines and has a relatively low import dependency with only 11% of extra-EU imports. A recent guarantee scheme backed by the EIB and the Deutsche Bank is set to improve risk-sharing for wind manufacturers addressing risks such as slow permitting, supply-chain bottlenecks, uncertain demand and high inflation.[192]. Combined with increasing political support for wind power in Germany[193] this facilitates investment decisions for manufacturers. Another opportunity is the replacement of first-generation wind turbines. As an early developer, many of Germany's wind farms have been in operation	Cancellations of battery projects in Germany are a cause for concern. Both Automotive Cells Co SE[195] and Svolt Energy Technology Co Ltd[196] suspended the construction of battery cell factories. A challenging business environment has been cited as the reason, pointing to the early end of EV purchase subsidies, a slowdown in the growth of EV battery demand, a potential shift to cheaper and safer lithium iron phosphate (LFP) batteries, and a lack of legal and planning certainties including delays in permissions. Another bottleneck is the relatively high import dependency for battery and storage technologies with 54% of extra-EU imports, which paired with the high energy prices increases cost disadvantages for German manufacturers. While at the forefront of solar PV research, Germany is increasingly dependent on imports of solar PV components from low-cost manufacturing third countries. In 2022, it imported over 60 per cent of all its components from non-EU countries, with over 20 per cent coming from China. Import competition has led to restructuring in the solar PV industry with Meyer Burger and Solarwatt closing their module production facilities in

[186] Schröder, Christoph, 2022, Lohnstückkosten im internationalen Vergleich. Kostenwettbewerbsfähigkeit der deutschen Industrie in Zeiten multipler Krisen, in: IW-Trends, 49. Jg., Nr. 3, S. 45-66
[187] Fuchs, Johann, Doris Söhnlein & Brigitte Weber (2021): Projection of the potential workforce until 2060: Demographic development is causing the labor supply to shrink sharply. (IAB Short Report 25/2021), Nuremberg, 12 p.
[188] See: Sabine Kinkartz, 01.11.2023, German industry: Can the backbone of the economy be saved?, available here; And Peter Bofinger, 08.01.2024, Germany: the 'sick man' of Europe—but 'dumb' as well?, available here.
[189] Riham Alkousaa, 27.03.2024, Germany drops plans for domestic solar industry subsidies, Reuters, available here.
[190] For example, the Fraunhofer Research Institution for Battery Cell Production or the Advanced Battery Technology Center.
[191] For example through the 'Umbrella Concept for Battery Research', which focuses on ocuses on material and component development, process and production technology, recycling and the circular economy as well as digitalization and scaling research. See here: Federal Ministry for Education and Research, 30.04.2024, Batterieforschung in Deutschland: wettbewerbsfähig und nachhaltig, available here.
[192] Wind Industry in Germany, 01.08.2024, €5 billion initiative: EIB and Deutsche Bank to boost Europe's wind energy manufacturers, available here.
[193] Nick Ferris, 20.05.2022, What the closure of Germany's only wind blade factory says about its energy transition, Energymonitor, available here.
[195] Jameson Dow, 04.06.2024, Mercedes and Stellantis pause EU battery factories, may switch to LFP cells, available here.
[196] Carla Westerheide, 27.05.2024, SVOLT will not build battery factory in Germany, available here.

for 20 years or more. Modernising these wind turbines could boost demand for manufacturers[194].

More than half of the European electrolyser manufacturing is located in Germany and the National Hydrogen Strategy introduced industrial leadership in hydrogen technologies as a goal. Already, the hydrogen economy is supported through Germany's participation in the Hy2Tech IPCEI and national projects such as H2Giga.

Germany has an opportunity to leverage its technological expertise to scale up CCS manufacturing. This is reflected in Germany's recent shift to embrace CCS as shown by the introduction of a Carbon Contract for Difference scheme, the upcoming Carbon Management Strategy and an amendment of the Carbon Dioxide Storage Act. However, high capital and operational costs alongside a lack of long-term regulatory stability and public acceptance are an issue.

Germany accounts for the largest share, notably 27%, of the EU's total grid technology production, excelling in both cable and smart grid technology manufacturing. The country is also a competitive exporter of electrical inductors and fuses, with an export potential of EUR 801 million and EUR 129 million, respectively. However, to enable further expansion, Germany needs to overcome issues with the supply chain of materials, such as steel, and a lack of skilled workers.

Germany as they cannot compete on price. Meyer Burger is shifting its operations to the United States due to the more conducive environment and government support schemes such as the Inflation Reduction Act[197]. The overreliance on Wacker Chemie as the sole European producer of polysilicon poses another risk considering the recent difficulties Wacker Chemie's polysilicon division has encountered[198].

There is a risk that Germany's onshore and offshore wind manufacturing sector follows a similar path as the solar manufacturing industry. A slow and complicated permitting process and restrictive zoning have led to slower deployment and thereby reduced demand for manufacturers and increased uncertainties[199]. The slowdown in domestic demand combined with increasing price competition from Chinese manufacturers who benefit from government support and cheaper raw materials put German manufacturers in a challenging position[200].

For heat pumps and geothermal technologies, Germany has an estimated export opportunity of over EUR 2 billion, however, demand slowed down in 2023, leading several companies including Vaillant and Stiebel Eltron to reduce working time for their employees. High electricity costs and lack of skilled workers remain the key challenges.

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential

[194] Wind Industry in Germany, 20.12.2023, Repowering: An Efficient Tool to Boost Wind Power, available here.
[197] As communicated by Meyer Burger to Shareholders in 2024. See also: Meyer Burger, 04.10.2022, Meyer Burger Announces Solar Cell Production Facility in Colorado, USA, available here.
[198] Sandra Enkhardt, 31.07.2024, Sales at Wacker Chemie's polysilicon division fall by 55% – pv magazine International, PV magazine, available here.
[199] Nick Ferris, 20.05.2022, What the closure of Germany's only wind blade factory says about its energy transition, Energymonitor, available here.
[200] Andrew Hayley, 10.04.2024, Explainer: China's dominance in wind turbine manufacturing, Reuters, available here.

Country Factsheet Denmark

Key findings

Manufacturing capacity:[201] Denmark's manufacturing capacity across Net-Zero technologies amounts to substantial wind power capacity, providing between 14 and 19% of the total EU capacity. This includes approximately 5.9-6.7 GW for nacelles, around 4.7-5 GW for towers, and 5.5-5.6 GW for blades. In addition, Denmark has manufacturing capacity in electrolysers (400 - 650 MW/y, 7-12% of the EU total). The output of the identified solar PV facilities is minimal (25-75 MW/y, a negligible share), and no capacity data could be found for the two identified battery producers. In terms of heat pumps, Denmark boasts at least five production facilities, adding to the nation's array of manufacturing capabilities.

Industrial production:[202] Denmark's three largest industrial Net-Zero sectors by value are wind power, with a production amounting to EUR 6.4 billion (7% of total EU production) (primarily focused on offshore), EUR 1.0 billion (1% of EU production) for grid technologies, and EUR 849 million (1% of EU production) for solar energy.

International positioning:[203] Denmark has strong export potential in grid and hydrogen technologies, with EUR 300 million estimated for grid components and EUR 219 million for hydrogen catalysts. Denmark's export position in wind turbine components is highly competitive, showing a 91% growth in competitiveness since 2015 and an untapped export potential of EUR 189 million, outperforming China and the USA in this sector.

Policy framework: Currently, Denmark does not have a relevant and dedicated policy framework for Net-Zero technology production in place.

Industrial permitting: Information on industrial permitting suggests that processes usually take between 1 and 3 years for activities covered by the NZIA.

Incentive instruments: Denmark implemented a grant scheme authorised under the TCTF that provides state aid support to the production of wind technology and electrolysers.

[201] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[202] Industrial production refers to total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[203] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in Denmark[204]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[205]	Import dependence (extra-EU)[206]
	25 – 75 MW/y[207] *(negligible share of EU capacity)*	-	-	1% *(Disclosure: 98%)*	**0.33**
	16050 – 17300 MW/y[208] *(18 - 19% of EU capacity)*	2200 - 2300 MW/y	-	7% *(Disclosure: 100%)*	**0.12**
	At least two facilities identified[209]	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	**0.52**
	At least five facilities identified	-	-	2% *(Disclosure: 94%)*	**0.21**
	400 - 650 MW/y *(7-12% of EU capacity)*	450 - 500 MW/y	450 - 600 MW/y	1% *(Disclosure: 100%)*	**0.01**
	No facility identified	N/A	N/A	1% *(Disclosure: 100%)*	**0.26**
	N/A	N/A	N/A	1% *(Disclosure: 100%)*	**0.40**
	N/A	N/A	N/A	1% *(Disclosure: 100%)*	**0.32**
	−	−	−	✓	✓
	−	−	−	✓	✓

Technologies					
Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*	
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*	

Denmark's main production facilities include Vestas' Wind factory in Ringkøbing, with an estimated capacity of 5-6 GW and Welcon's Wind manufacturing facility in Give with an estimated capacity of around 2 GW. Both these firms are key players in the global wind turbine value chain. Announced manufacturing facilities include factories for electrolysers by Green Hydrogen Systems and Topsøe, with expected outputs of around 500 MW respectively. Nature Energy, a Danish firm now acquired by Shell, builds and operates biogas facilities throughout Europe. However, no specific operational production facilities in Denmark were identified. In the realm of grid technologies, the firm NKT is planning to build its largest production site of high-voltage offshore cables.[210]

[204] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[205] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[206] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[207] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[208] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[209] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[210] As reported by NKT here.

Evolution of Denmark's international positioning

As illustrated in Figure 1, Denmark is positioned to leverage significant export potential in grid components, estimated to exceed EUR 300 million.[211] While Danish exporters, particularly in insulated electric conductors and electricity supply meters, have improved their competitiveness, their Revealed Comparative Advantage (RCA) across all components remains lower than that of leading international competitors, China and the USA (Figure 2[212]). The relatively low level of market saturation in these sectors suggests that no single country dominates the global export market for these components. This landscape provides Denmark with substantial opportunities to strengthen its export position, particularly in grid technologies.

In the realm of electrolyser technologies, Denmark excels as a competitive exporter of catalysts and reaction initiators, crucial during the manufacturing phases of electrolysers. The country boasts an estimated export potential of EUR 219 million, with an RCA of 33, significantly surpassing that of both China and the USA.

Moreover, Denmark demonstrates international competitiveness in exporting wind turbine components. As Figure 1 highlights, the competitiveness of Danish exports for wind turbine structures has increased by 91% between 2015 and 2022. With an RCA value of 5, Denmark outperforms both Chinese and US exporters in this sector. The estimated untapped export potential of EUR 189 million for this wind turbine component further indicates that Denmark is well-placed to capitalise on its global position in this Net-Zero technology.

[211] Figures 1 and 2 present Denmark's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Denmark's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Denmark's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Denmark could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Denmark could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.

[212] Figure 2 builds on Figure 1 by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Denmark's trade strategy. Taken together, these figures provide a nuanced understanding of Denmark's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

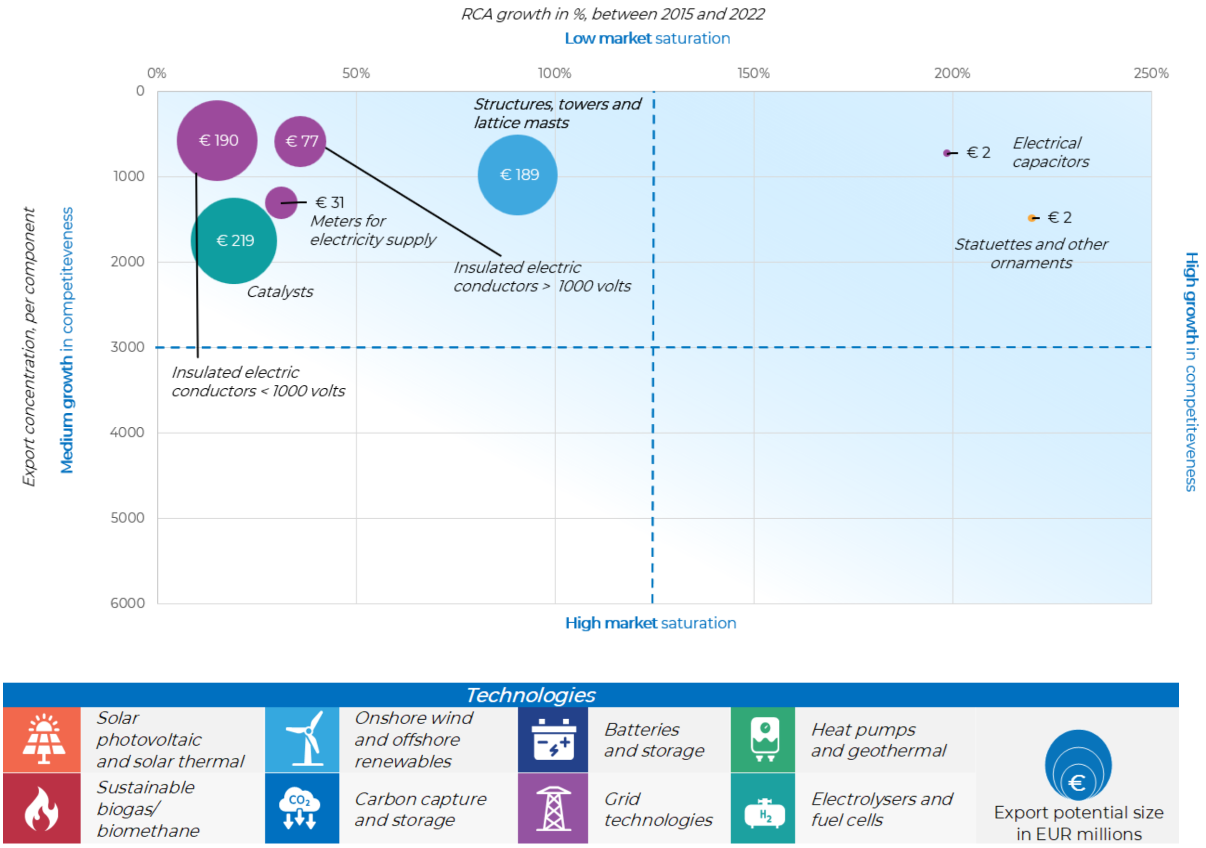
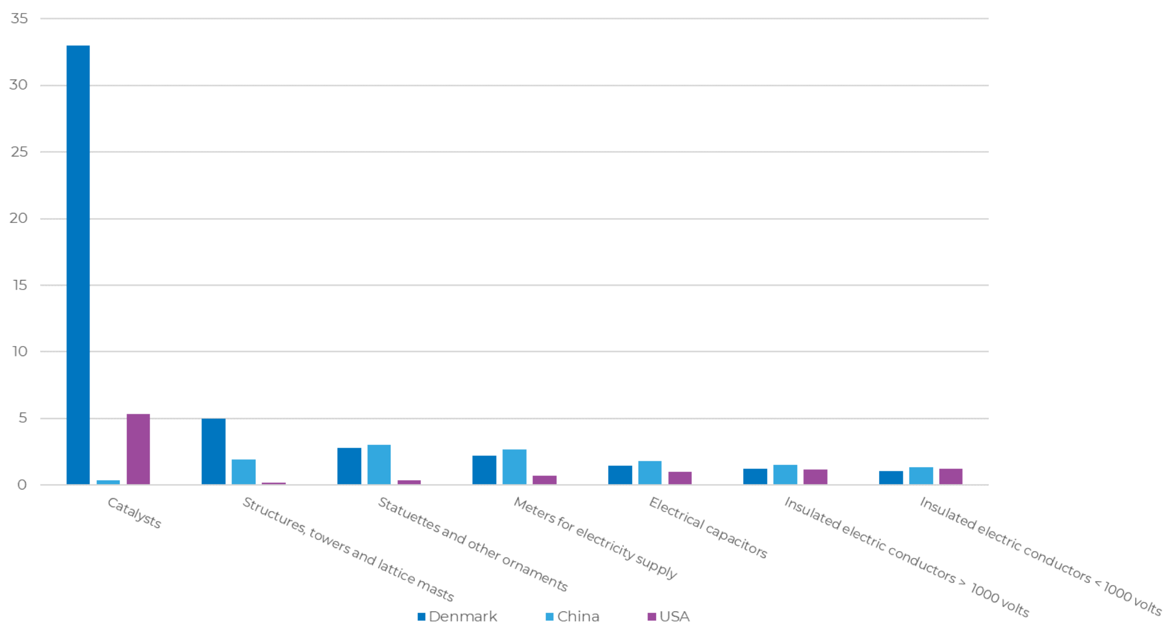


Figure 2: Absolute value of RCAs of Denmark, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

No relevant strategies or legislation has been identified.

In February 2024, the European Commission approved **state aid in Denmark** in the scope of the Temporary Crisis and Transition Framework for up to about EUR 240 million supporting the production of goods that foster the Net-Zero transition. Under the scheme, the aid can take the form of direct grants, subsidised loans or guarantees.

Industrial permitting

Average duration[213]	Permitting processes for activities covered by the NZIA take approx. 1 to 3 years.[214]	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

Brief summary of the permitting processes

Building permits, required before construction, can be obtained from the relevant municipality.

Environmental impact assessments, regulated by the Environmental Protection Act, now include a life-cycle calculation (LCA) for new constructions and a CO2 emissions limit of 12 kilos per m² for buildings over 1,000 m². These requirements, effective from 1 January 2023, will tighten gradually towards 2030 and will extend to smaller buildings from 2025. Currently, there is no one-stop shop for obtaining the necessary permits. However, the creation of such a one-stop shop is planned in the scope of the implementation of the NZIA until early 2025.[215]

Procurement

For offshore wind, there are minimum environmental requirements associated with the tender which include requirements that the concession holder must obtain third-party verified environmental product declarations for the main components, e.g. blades and the tower, based on a life cycle analysis, and the concession holder must prepare a third-party verified life cycle assessment covering installation, operation and dismantling of the offshore wind farm. In addition, reusable turbine blades must generally be used, and offshore wind farms must be established with so-called nature-inclusive designs adapted to the local area. Further, compliance with social clauses, including protection against social dumping, human rights and international conventions is required.[216]

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

[213] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays.
Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.
[214] Interview with national authority.
[215] Interview with national authority.
[216] See here.

Key incentive instruments		
Investment Scheme for Green Industrial Production (Den grønne investeringsordning)		
2024 - 2025	**Grant**	**Funding available in 2024: EUR107 million[217]**
Technologies: Wind technology and electrolysers	**Eligibility:** Companies need to demonstrate that funding would also be available in other countries and that there is sufficient financial interest for the project in Denmark.[218]	**Available support:** A maximum of 15% of eligible costs per project[219]
Description: The Investment Scheme for Green Industrial Production aims to support companies producing wind technology and electrolysers. The scheme was launched under the state aid scheme approved by the European Commission under the TCTF to support the production of investments in specific strategic goods to foster the transition towards a Net-Zero economy. The scheme can also cover support for activities in support of the production of these technologies, including the extraction of critical raw materials. The executive order providing the legal framework for the instrument provides a list of technologies and materials eligible for support.[220] The first round of calls for applications was closed on 12 March 2024. A new round will be announced in 2025.		
Vocational Education and Training (VET) provision for new green occupations and greening established jobs and occupations		
Ongoing	**Skills programme**	**Type of programme:** Upskilling, Re-skilling (post-secondary)
Technologies: Potentially all (NZ technologies are not explicitly mentioned)	**Description:** The programme aims to adapt existing vocational education and training (VET) programmes to meet the rising demand for green skills and to develop new lines of vocational education related to emerging jobs in the green economy. It includes the adaptation of existing occupations and the introduction of entirely new vocational education programmes directly related to strategic Net-Zero technologies. In July 2024, the Danish government allocated approx. EUR 28 million over the following four years for related programmes. The scope of the support is very wide, ranging from upskilling teachers in green competencies to the promotion of international study tours and set-up of knowledge centres that may also benefit skills in relation to the manufacturing of Net-Zero technologies.[221]	

[217] See here. The total amount of funding is not available, but the state aid scheme approved by the European Commission under TCTF provides a maximum ceiling of €240 million.
[218] See here.
[219] In line with the requirements of the TCTF, support for individual projects cannot exceed €150 million.
[220] See here.
[221] See here. Available funding amounted to €13.44 million in 2021 and 2022, respectively (see here).

Opportunities and challenges

Opportunities

General

Denmark's high share of wind and solar power offers an affordable and renewable energy supply crucial for the sustainable manufacturing of net-zero technologies. Moreover, Denmark has a strong focus on circular economy principles, particularly in the recycling and reuse of battery materials, as well as wind turbine blades[222], which offers opportunities to reduce waste and dependency on raw materials.[223]

Technology-specific

Denmark boasts substantial manufacturing capacity for both onshore and offshore wind turbines and is among the top five global exporters thanks to leading manufacturers such as Vestas. The country's pioneering position in the industry is built on its favourable wind conditions, strong R&D, innovation, technology, and efficiency.[225] With financial support from the government's green investment scheme, Denmark is set to further strengthen its wind industry and global position.[226]

For electrolysers and fuel cells, Denmark can tap into an estimated export potential of EUR 219 million. It also has growth potential with the factories announced by Green Hydrogen Systems and Topsøe with expected outputs of 600 MW and 500 MW respectively. Generally, Denmark's geographical location, access to renewable energy and government support for hydrogen (see above) put the country in a good position to further develop in this area.

In the grid value chain, Denmark's high-voltage offshore cable production capacity is planned to expand significantly with NKT's plan to build the world's largest production site.[227] Considering the strong global demand for high-voltage cables which is expected to outstrip supply[228] and a large order backlog[229], there is potential to further increase manufacturing. Additionally, Denmark has a strong export potential in grid components, such as insulated electric conductors and meters for electricity supply.

Challenges

General

Denmark faces an overall shortage of skilled technicians and engineers across its green energy sector, with an estimated need for 45,000 additional full-time equivalents (FTEs) annually from 2023 to 2030 to meet climate targets. Companies indicated to have moved production abroad in order to hire employees.[224]

Technology-specific

Denmark also faces challenges to wind turbine manufacturing. Danish and other European manufacturers have experienced declining earnings, attributed to rising material and logistics costs, as well as intense price competition from China.[230] Additionally, uncertainties remain due to geopolitical volatility, permitting bottlenecks and insufficient grid build-out across markets.[231]

Unlike its other Nordic neighbours, Denmark lacks substantial domestic deposits of critical minerals needed for battery production and has a high dependence on non-EU imports for battery technologies. This poses a supply chain risk. However, Denmark has an opportunity to enhance its role in the value chain with the mineral deposits available in Greenland.[232]

For grid technologies, similar to other EU Member States, there is a reliance on imported materials that can vary strongly in prices, especially aluminium and copper. With increasing global demand for grid infrastructure, reliance on imported materials can pose a risk to supply chains. Increased use of recycled materials could mitigate this risk[233].

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

---

[222] In February 2023, Vestas announced a new solution to reuse epoxy-based turbine blades. Once matured, this innovation could eliminate the need for the redesign of blades or landfill disposal. See here.
[223] IEA (2023), Denmark 2023, IEA, Paris, https://www.iea.org/reports/denmark-2023, License: CC BY 4.0
[224] Green Power Denmark (2023) Mere arbejdskraft til den grønne omstilling. Available at the following link.
[225] Ministry of Foreign Affairs of Denmark, 'Join our powerhouse for wind power technology', see here.
[226] More than 500 million euros will be invested in establishing new production facilities or expanding existing ones. See here.
[227] NKT, 'We are building the world's largest high voltage offshore cable production site', see here.
[228] The Financial Times, 30.07.2023, Will there be enough cables for the clean energy transition?, available here.
[229] Power Technology, 01.08.2024, NKT to expand Swedish high-voltage cable factory with extrusion tower, available here.
[230] Green Power Denmark (2023), Havvind til Danmark og Europa. Available here.
[231] Vestas (2024), Vestas Annual Report 2023. Available here.
[232] Innovation Norway, Business Finland, Business Sweden, and the Swedish Energy Agency Conducted by Business Sweden (2023), The Nordic Battery Value Chain - Market drivers, the Nordic value proposition, and decisive market necessities. See here.
[233] As done for copper cables in this project by NKT and Prysmian: *TenneT, 03.03.2023, TenneT selects NKT and Prysmian for world's largest offshore cable systems to connect increasing Dutch offshore wind volumes, available here.*

Country Factsheet Estonia

Key findings

Manufacturing capacity:[234] Estonia's manufacturing capacity amounts to between 50 and 100 MW/y (a negligible share of total EU capacity) for solar PV. At least two facilities producing wind turbine components, and foundations and substations, were identified. There is at least one facility in Estonia dedicated to the production of heat pumps.

Industrial production:[235] Estonia's three largest industrial Net-Zero sectors by value are wind power, with a production amounting to EUR 584 million (1% of total EU production), EUR 450 million (1% of EU production) for grid technologies, and EUR 79 million (a negligible share of EU production) for solar PV and thermal energy.

International positioning:[236] Estonia is competitive in exporting grid components, such as electrical boards, panels, and insulated electric conductors, outperforming China and the USA. It is also a strong exporter of wind turbine structure components, surpassing both China and the USA based on the RCA index. Estonia is heavily dependent on imports for other wind turbine components, with over 50% of imports coming from non-EU countries in 2022, compared to the EU average of 27%.

Policy framework: Currently, no relevant policy framework related to enhancing the Net-Zero technology manufacturing capacity could be identified in Estonia.

Incentive instruments: In Estonia, some relevant incentive schemes are in place. Two of them have a broad focus that may encompass all Net-Zero technologies, while one is focused on batteries and storage technologies.

[234] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[235] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[236] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides details on each indicator.

Key descriptive statistics for Net-Zero technologies in Estonia[237]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[238]	Import dependence (extra-EU)[239]
	50 – 100 MW/y[240] *(0-1% of EU capacity)*	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	**0.33**
	At least two facilities identified[241]	-	-	1% *(Disclosure: 100%)*	**0.54**
	No facilities identified[242]	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	**0.69**
	At least one facility identified	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	**0.21**
	No facilities identified	150 - 250 MW/y	900 - 1100 MW/y	«Negligible share of EU production» *(Disclosure: 100%)*	**0.01**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	**0.16**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	**0.29**
	N/A	N/A	N/A	1% *(Disclosure: 100%)*	**0.28**
	–	–	–	✓	✓
	–	–	–	✓	✓

	Technologies								
	Solar photovoltaic and solar thermal		*Onshore wind and offshore renewables*		*Batteries and storage*		*Heat pumps and geothermal*		*Electrolysers and fuel cells*
	Sustainable biogas/ biomethane		*Carbon capture and storage*		*Grid technologies*		*Data coverage*		*Data reliability*

Estonia's main production facilities include Solarstone's Solar PV factory in Viljandi, with an estimated capacity of 50 - 100 MW. Announced manufacturing facilities include factories by Stargate and Elcogen, with expected outputs of 900 – 1100 MW and 150 – 250 MW respectively in electrolyser capacities.

[237] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[238] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[239] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[240] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[241] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[242] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.

Evolution of Estonia's international positioning

As illustrated in Figure 1, Estonia is internationally competitive in exporting grid components, such as electrical boards and panels, electrical machinery for protecting electrical circuits, and insulated electric conductors.[243] For the latter, Estonia's export competitiveness has grown by 30% between 2015 and 2022. Across these components, Estonia is a more competitive export country than China and the USA, as shown in Figure 2.[244] These three components alone are estimated to have EUR 360 million of export potential for the country. The relatively low level of market saturation in these sectors suggests that no single country dominates the global export market for these components. This landscape provides Estonia with opportunities to strengthen its export position, particularly in grid technologies.

Estonia is also an internationally competitive exporter of structural components that can be used in the manufacturing of wind turbines. With an estimated EUR 216 million of export potential, Estonian exporters are more competitive than those in China and the USA, based on the RCA index for this component (Figure 2). However, despite this competitiveness in structural components of wind turbines, Estonia remains largely dependent on imports for other wind turbine components. Over 50% of its imported wind turbine components were sourced from non-EU countries in 2022, significantly higher than the EU average of 27%.

[243] Figures 1 and 2 present Estonia's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture [10] Estonia's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Estonia's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Estonia could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Estonia could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.

[244] Figure 2 builds on Figure 1 by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Estonia's trade strategy. Taken together, these figures provide a nuanced understanding of Estonia's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

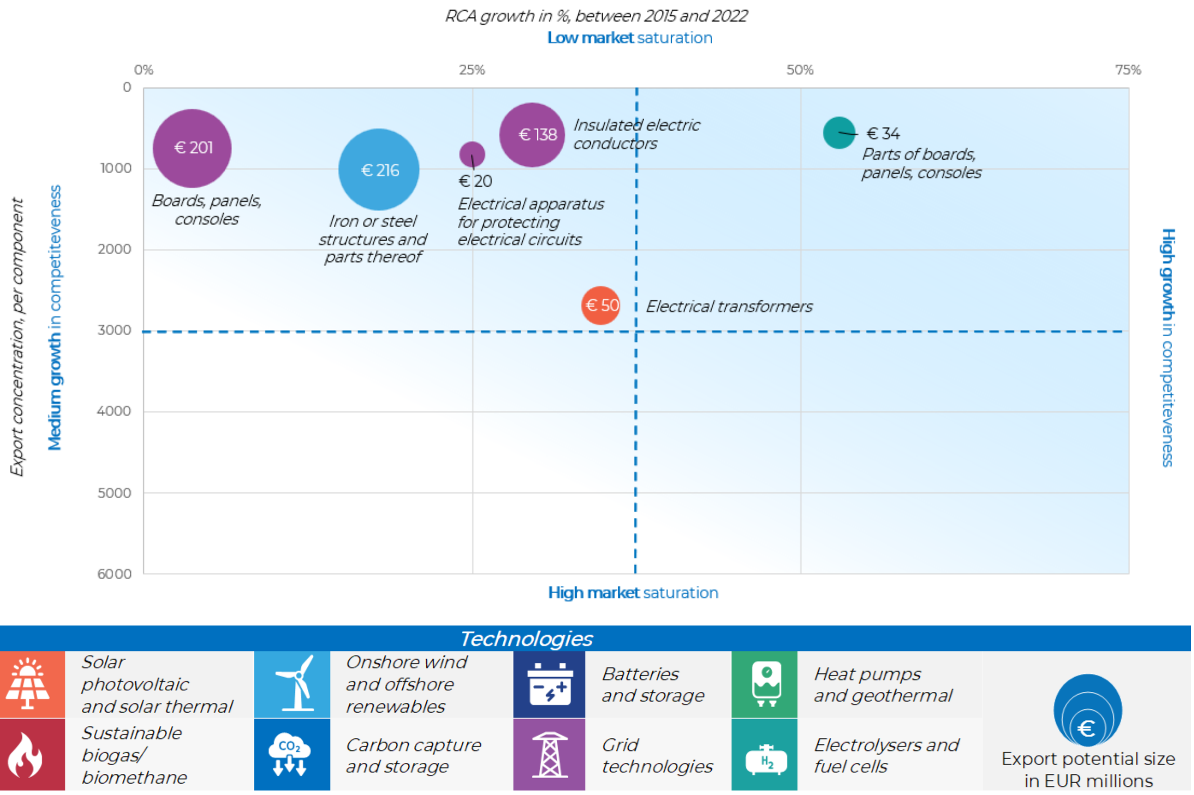
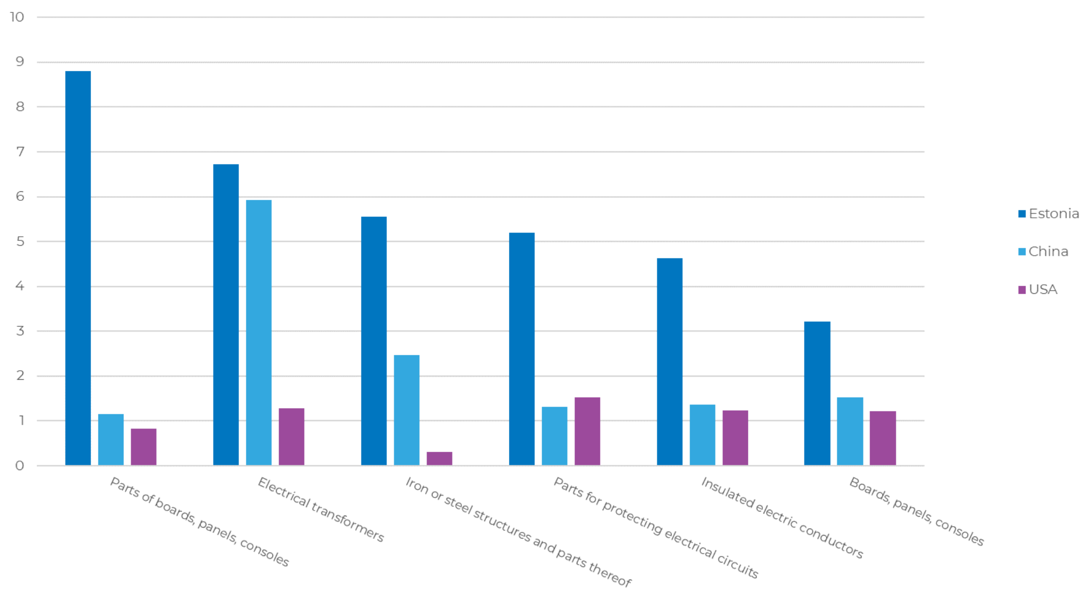


Figure 2: Absolute value of RCAs of Estonia, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

No relevant strategies or legislation have been identified

Industrial permitting

Average duration	No data on the duration of permitting procedures have been identified	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

Brief summary of the permitting processes

The **National Recovery and Resilience Plan** aims to facilitate the deployment of renewable energy sources by focusing on optimising the permitting process, land operations and legal processes, and strengthening cooperation between government agencies. However, this is not specific to Net-Zero technology manufacturing.

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

Support for the development of green technologies (Rohetehnoloogiate arendamise toetus)

2024 - 2026	**Grant**	**Total funding available: EUR 3.1 million**
Technologies: Potentially all	**Eligibility:** SMEs registered in Estonia, with the exception of sole proprietorships, that develop innovative green technologies can apply for support. This includes for example green technologies that contribute significantly to the achievement of environmental and climate goals, including climate change adaptation or climate change mitigation or solutions that have a measurable and justified significant positive impact on the environment. The green technologies must have a TRL of at least 4 but no more than 6 and with the help of the support, the technology must achieve an increase in the level of at least TRL 1. The green technology must include a hardware or physical component.	**Available support:** The minimum grant amount per project is EUR 30,000, and the maximum amount is EUR 300,000

Description: The purpose of the grant is to accelerate the development of green technologies in Estonia in order to provide solutions to the challenges caused by climate change, achieve environmental and climate goals and increase the competitiveness of the economy by making use of the potential of exported technologies. The support measure was developed by the Climate Ministry together with the Environmental Investment Center (KIK), distributing support from the Recovery and Resilience Fund (RRF).

Development of pilot projects for energy storage devices (Energiasalvestuse seadmete pilootprojektide arendamine)		
2024 - 2026	**Grant**	**Total funding available: EUR 4.8 million[245]**
Technologies: Batteries and energy storage technologies	**Eligibility:** Eligible applicants are Estonian companies that produce energy from renewable sources.	**Available support:** The maximum subsidy amount per megawatt of electricity storage capacity is EUR 360,000 without VAT. The maximum amount for each 1,000 cubic meters of heat energy storage capacity is EUR 220,000 without VAT.
Description: The fund supports the development of pilot projects for energy storage equipment from renewable energy sources. In particular, the measure supports the designing and construction of an energy storage device for heat or electricity produced from renewable energy. It aims to increase the use of renewable energy in heating and electricity systems, thereby reducing fossil fuel use. The support was developed by the Ministry of Economic Affairs and Communications and the Ministry of Climate together with the Environmental Investment Center (KIK) using funds from the Recovery and Resilience Fund (RRF).		
Smartcap Green Fund and associated specialist green tech VC funds		
2022-2026	**Financial instrument – Equity Investment**	**Total funding available: EUR 100 million**
Technologies: Potentially all	**Eligibility:** Development of innovative and/or research-intensive technologies that contribute to environmental objectives including climate change mitigation and adaptation	**Available support:** N/A
Description: The aim of SmartCap Venture Capital Fund investments is to contribute to the development of the local capital market and growth of innovative Estonian companies, and through that support changes that help to modernise the Estonian economy. Especially relevant is the Green Fund which aims to increase the supply of venture capital to new green technologies by financing innovative and/or research-intensive green technology companies. SmartCap Green Fund is financed by the European Union NextGenerationEU Recovery and Resilience Facility funds.		

[245] Of this, EUR 2.64 million are intended for the construction of thermal energy storage devices and EUR 2.18 million for the construction of electrical energy storage devices.

Opportunities and challenges

Opportunities	Challenges
General Estonia has the potential to expand its critical materials supply. The country is home to one of the few rare earth elements processing facilities, and construction has started on Europe's first rare earth magnet factory, which will be established in 2025, together with an R&D centre in Narva. This would be beneficial specifically for wind turbines and electric vehicles. Additionally, Estonia's large phosphate deposits, which may contain other critical materials, could further support the energy transition. The country could leverage the skills and expertise developed in the oil shale industry to tap into these resources.[246]	**General** Estonia's small size creates a challenge in attracting investments for the energy transition and in providing sufficient skilled labour in the energy sector. This could lead to bottlenecks and slow down the energy transition.[247] There is limited administrative capacity in regard to permitting and environmental impact assessments. However, steps have been taken through the Recovery and Resilience Plan to reduce permitting time and streamline the environmental impact assessment process for renewable energy projects.[248]
Technology-specific Offshore wind technologies are a key area in Estonia. The government's ambitious target to generate 100% of electricity from renewable sources by 2030, along with new tenders and cooperation with neighbouring countries, is expected to drive investments in the sector. Estonia has also innovative wind turbine companies such as Eleon and the country focuses on R&D and innovation within the industry, with plans to establish a large, cutting-edge manufacturing base and innovation platform for new-generation offshore wind technology solutions.[249] Estonia is home to advanced solutions in battery and storage technologies and electrolysers, such as ultracapacitor and supercapacitor energy storage systems[250], ceramic-based electrolysers[251], and solid oxide electrolyser cell (SOEC) technology[252], developed by companies like Skeleton Technologies, Stargate Hydrogen and Elcogen. These technologies could help establish Estonia's presence in the battery and electrolyser industries.	**Technology-specific** Estonia lacks a fully developed local supply chain for critical components and relies on extra-EU imports, particularly for wind power technologies and battery and storage technologies. Accessing the necessary raw materials for scaling up manufacturing is one of the fundamental challenges to wind and battery technologies, as discussed in Chapter 4.1 of the main report.

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

[246] IEA (2023), Estonia 2023, IEA, Paris, https://www.iea.org/reports/estonia-2023, License: CC BY 4.0
[247] Ibid.
[248] Ibid.
[249] Invest in Estonia, 'Offshore wind tech', available here.
[250] Ibid.
[251] Stargate Hydrogen, 2 May 2024, 'Stargate Hydrogen raises 42 million Euros for scaling up ceramic-based electrolysers, and appoints Skeleton founder as a non-executive Chairman'. See here.
[252] Invest in Estonia, April 2024, 'Elcogen secures a €31M investment to scale hydrogen manufacturing capacity'. See here.

Country Factsheet Greece

Key findings

Manufacturing capacity:[253] Greece's manufacturing capacity amounts to between 5.3 and 11 GWh/y (2-5% of total EU capacity) for battery and storage technologies and between 500 and 550 MW/y (1% of EU capacity) for wind turbine towers. No facilities are identified for solar energy, heat pumps or electrolysers.

Industrial production:[254] Greece's three largest industrial Net-Zero sectors by value are grid technologies, with a production amounting to EUR 445 million (1% of total EU production), EUR 349 million (a negligible share of EU production) for wind power, and EUR 65 million (a negligible share of EU production) for solar PV and thermal energy.

International positioning:[255] Greece has enhanced its competitiveness in exporting lead-acid electric accumulators and manganese dioxide cells and batteries from 2015 to 2022, with an RCA index higher than China and the USA. Greece imports 46% of its batteries from foreign sources, which is lower than the EU average of 59%.

Policy framework: Currently, Greece does not have a policy framework for Net-Zero technologies in place.

Incentive instruments: No incentive instruments supporting investment in Net-Zero technologies were identified in Greece.

[253] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).

[254] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.

[255] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides details on each indicator.

Key descriptive statistics for Net-Zero technologies in Greece[256]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[257]	Import dependence (extra-EU)[258]
	No facilities identified[259]	-	-	«Negligible share of EU production» *(Disclosure: 61%)*	**0.32**
	500 – 550 MW/y[260] *(1% of EU capacity)*	-	-	«Negligible share of EU production» *(Disclosure: 79%)*	**0.11**
	5300 - 11000 MWh/y[261] *(2 - 5% of EU capacity)*	-	-	«Negligible share of EU production» *(Disclosure: 73%)*	**0.46**
	No facilities identified[262]	-	-	«Negligible share of EU production» *(Disclosure: 53%)*	**0.25**
	No facilities identified	-	1250 - 1500 MW/y	«Negligible share of EU production» *(Disclosure: 74%)*	**0.84**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 78%)*	**0.55**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 80%)*	**0.39**
	N/A	N/A	N/A	1% *(Disclosure: 62%)*	**0.39**
	–	–	–	✓	✓
	–	–	–	✓	✓

Technologies					
Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*	
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*	

Greece's main production facilities include Sunlight Technosystems's battery factory in Xanthi, with an estimated capacity between 5.3 - 11 GWh and EMEK S.A.'s wind tower manufacturing facility in Aspropyrgos with an estimated capacity of 500 – 550 MW.

[256] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[257] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[258] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[259] Manufacturing capacity is provided exclusively for solar photovoltaic and does not include capacities for solar thermal manufacturing.
[260] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[261] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[262] Manufacturing capacity data in MW is typically not available for facilities producing biogas and biomethane; grid technologies; CCS; and heat pumps. For heat pumps, manufacturing data is typically expressed in terms of sold equipment.

Evolution of Greece's international positioning

Greece has emerged as a competitive exporter of components in grid, solar, and battery technologies. The country has made notable strides in enhancing its competitiveness in the export of lead-acid electric accumulators and manganese dioxide cells and batteries, demonstrating a capacity to outperform, in terms of revealed comparative advantage (RCA), major exporters such as China and the USA in these specific sectors.

Nonetheless, the landscape of Greek exporters of Net-Zero technologies remains relatively constrained, with only a limited number of key players actively participating in the market. Furthermore, Greece's position in the battery sector is characterised by a significant reliance on imports, with a considerable portion of its batteries sourced from third countries.

Regulatory and incentive landscape

Policy framework

No relevant strategies or legislation have been identified.

Industrial permitting

Average duration[263]	No specific information on the average duration for NZ manufacturing has been identified. The median duration to build a warehouse is estimated to 6 months.	**One-stop shop for permitting**	No one-stop shop for permitting has been identified.[264] However, the NRRP envisions the review and simplification of licensing processes for new economic activities under law 4442/2016.

Brief summary of the permitting processes

General permitting procedures in Greece include the obtention and completion of several main documents and steps[265]. These include obtaining proof of ownership, cadastral extract and cadastral plan (Hellenic Cadastre) and a Topographical Survey map (Private firm). Then, operators need to submit a petition for an archaeological clearance certificate (Archaeology Supervisory Authority) and obtain an archaeological clearance certificate (Archaeology Supervisory Authority). They also need to obtain approval of the project from the Board of Architects (Board of Architects) and active fire protection approval (Regional Fire Department of Attica). Operators also need to request and obtain an initial permit/approval and a building permit from the Municipality (Municipality of Athens, Building Office) and a foundation work inspection (Municipality of Athens, Building Office / Board of Building Inspectors).

Environmental licences may also be required. The environmental licensing process in Greece is categorised into two primary groups: Category A and Category B, with Category A further divided into two sub-categories: A1 and A2, depending on the scale and nature of the project. Category A involves a more comprehensive

---

[263] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays.
Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.

[264] For strategic investments that fall under the regime of Law 4864/2021 the General Directorate of Strategic Investments operates as a one-stop shop for centralized licensing. This regime is not specific to the manufacturing of Net-Zero technologies and not all investments in the manufacturing of Net-Zero technologies fall within its scope.

[265] General Permit procedure, based on info collected in Athens, here.

procedure for higher-impact projects, while Category B focuses on simpler, less environmentally significant projects[266].

For Category A, the procedure to obtain an Environmental Terms Approval Decision (ETAD) involves several stages. First, an Environmental Impact Assessment (EIA) must be submitted to the competent environmental authority, which will run a completeness check. A consultation with the general public and the competent services on the EIA is also performed and informs the evaluation of the EIA. For A1 projects, the Directorate for Environmental Permitting of the Ministry of the Environment and Energy is responsible for issuing the ETAD and managing the entire procedure, while A2 projects, on the other hand, fall under the authority of the Directorate for the Environment and Spatial Planning of the Decentralised Administration concerned.

Category B projects require a simpler process, involving the submission of an application or declaration about the project and its surroundings. These projects are subject to Standard Environmental Commitments (SECs). If no authorization is needed, the regional service handles the process. Amendments must undergo a new subjection procedure.

All environmental licensing procedures are carried out through the Digital Environmental Register[267].

Since 2018, the majority of manufacturing activities have been simplified and can start their operation following a simple notification according to law 4442/2016 after they have collected various approvals or certificates like ETAD. Only activities of high risk are obliged to get final approval instead of issuing a notification. These developments are part of a major reform of the business environment with a focus on the simplification of licences for a wide range of economic activities, setting as a priority the manufacturing sector.

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	The Hellenic Competition Commission (HCC) has established a sandbox for initiatives contributing significantly to the sustainable development goals.[268] Various industrial companies involved in the technological, environmental and energy sectors can benefit from the sandbox.	**Plans for regulatory sandboxes under the NZIA**	No plans for other relevant regulatory sandboxes have been identified

Key incentive instruments

No relevant incentive instruments have been identified

[266] Available here.
[267] Available here.
[268] Available here.

Opportunities and challenges

Opportunities	Challenges
General Greece's Net-Zero manufacturing industry could benefit from the growing demand for renewables, driven by the phase-out of lignite and the increasing adoption of renewables in the country. Supporting the economic transition of regions affected by the lignite phase-out remains a priority for the country, offering opportunities for investments and the upskilling and reskilling of workers.[269] Greece could also leverage the EU's Strategic Technologies for Europe Platform (STEP) and other initiatives to increase investments in these regions.[270]	**General** Although Greece is working to reduce licensing and permitting times for renewable energy projects, for example, through a one-stop shop funded by the Recovery and Resilience Plan, the existing regulatory and bureaucratic processes can slow down the deployment of Net-Zero technologies, which could hinder investments in manufacturing.[271] Greece faces challenges in attracting and retaining talent and ensuring a robust supply chain for new technology development. Specifically, Greece experienced an exodus of skilled workers in the energy sector due to the country's prolonged economic crisis. This links also with ensuring a fair transition for Greece's lignite-mining regions due to the phasing out of coal-powered power plants. These regions could represent an opportunity for investments and skill transfers.[272]
Technology-specific For grid technologies, Greece is expected to grow its capacity in the coming years as Hellenic Cables, a leading cable manufacturer, has invested over EUR 280 million over the past decade to achieve the most advanced production and storage facilities for submarine cable systems.[273] The Greek cable industry could also benefit from the promising market outlook with high demand across both onshore and offshore projects.[274] Additionally, Greece has an export potential of EUR 67 million in electrical apparatus for protecting electrical circuits. As an emerging player, Greece could further boost its role in the battery value chain. The country is an internationally competitive exporter of lead-acid batteries, owing to the presence of Sunlight Group[275], with an estimated export potential of EUR 353 million.[276] Additionally, financing from the EIB is expected to increase manufacturing capacity for lithium batteries and enhance research, development and innovation in the Greek battery industry, offering growth opportunities.[277]	**Technology-specific** Challenges may arise in the Greek grid technologies and cable manufacturing industry, including water scarcity during dry periods and the limited supply of raw materials, which could impact production. Additionally, as sustainability standards increase, the availability of high-quality recycled materials can become a concern. Cable manufacturing could also be affected by the implementation of CBAM, leading to increased purchasing costs of aluminium and steel, as also discussed in Chapter 4.1 of the main report.[278]

[269] IEA (2023), Greece 2023, IEA, Paris https://www.iea.org/reports/greece-2023, License: CC BY 4.0
[270] European Commission (2024), '2024 Country Report – Greece', SWD(2024) 608 final, available here.
[271] IEA (2023), Greece 2023, IEA, Paris https://www.iea.org/reports/greece-2023, License: CC BY 4.0
[272] Ibid.
[273] Hellenic Cables's submarine cable systems brochure, available here.
[274] Hellenic Cables (2023), Sustainability Report 2023, available here.
[275] Sunlight: World-leading technology company in the production of batteries for the energy storage industry, Olympia Group, available here.
[276] See the above descriptive statistics for Greece and the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[277] EIB, 15 December 2023, 'Greece: EIB to support innovative battery production with €25 million loan to Sunlight', available here.
[278] Hellenic Cables (2023), Sustainability Report 2023, available here.

Country Factsheet Spain

Key findings

Manufacturing capacity:[279] Spain is a leading manufacturer in the wind power supply chain, with a manufacturing capacity amounting to approximately 5–5.25 GW for nacelles, around 15.5 – 18.5 GW for towers, and 8 – 8.25 GW for blades. Spain's manufacturing capacity amounts to between 500 and 600 MW/y (9-11% of EU capacity) for electrolysers, and between 500 and 650 MW/y (3% of EU capacity) for solar PV, as well as over 30GW inverter capacity. Additionally, there are at least 27 facilities dedicated to the production of heat pumps.

Industrial production:[280] Spain's three largest industrial Net-Zero sectors by value are wind power, with a production amounting to EUR 8.4 billion (9% of total EU production), EUR 2.5 billion (3% of EU production) for grid technologies, and EUR 1.8 billion (2% of EU production) for solar PV and thermal.

International positioning:[281] Spain excels in exporting offshore wind components, such as gears and gearing, with a high growth rate and an RCA index surpassing China and the USA. Spain is also competitive in exporting grid technology components, with an RCA index indicating greater competitiveness than China and the USA.

Policy framework: Currently, Spain's regulatory framework for Net-Zero technologies is shaped by the Spanish Recovery, Transformation, and Resilience Plan. Within this framework, the Strategic Projects for Economic Recovery and Transformation (PERTE) were established. These are public-private collaborations involving various public administrations, companies, and research centres. Two PERTE in particular focus on advancing clean energy technologies and related industrial capacities. In addition, the Just Transition Strategy aims to ensure a fair and socially beneficial shift to a low-carbon economy, emphasising clean technologies, and the Hydrogen Roadmap seeks to drive renewable hydrogen development, supporting industrial value chains, technological innovation, and sustainable employment.

Industrial permitting: Industrial permits for Net-Zero technology production in Spain involve multiple authorities at local, regional, and national levels, each requiring separate procedures. Key permits include the Autorización Ambiental Integrada (AAI) for significant industrial activities, the Permiso de vertido for waste disposal, the Licencia ambiental for activities impacting the environment, and the Autorización Previa y de Construcción (ACC) for infrastructure projects, among others, managed by regional departments, municipal authorities, and the Ministry for Ecological Transition depending on the scale and impact of the project.

Incentive instruments: Spain has various incentives in place to support investment in Net-Zero technologies. The primary support mechanisms are the Strategic Projects for Economic Recovery and Transformation (PERTE), funded through the Spanish Recovery, Transformation and Resilience Plan. Notably, the PERTE VEC focuses on electric vehicle batteries, while the PERTE ERHA targets various renewable energy technologies. These initiatives launch various calls to support the manufacturing of key equipment and components linked to various Net-Zero technologies, including solar and wind technologies, batteries, electrolysers, and heat pumps.

[279] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[280] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[281] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides more details

Key descriptive statistics for Net-Zero technologies in Spain[282]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[283]	Import dependence (extra-EU)[284]
	500 - 650 MW/y[285] *(3% of EU capacity)* 30 GW/y inverters	0 - 2400 MW/y	900 - 1000 MW/y	2% *(Disclosure: 71%)*	**0.42**
	28500 - 32000 MW/y[286] *(31 - 35% of EU capacity)*	900 – 1100 MW/y	-	9% *(Disclosure: 79%)*	**0.55**
	No operational facilities identified[287]	12000 - 12250 MWh/y	90000 - 100000 MWh/y	«Negligible share of EU production» *(Disclosure: 55%)*	**0.77**
	At least 27 facilities identified[288]	-	-	3% *(Disclosure: 59%)*	**0.31**
	500 - 600 MW/y *(9 - 11% of EU capacity)*	450 - 550 MW/y	400 - 600 MW/y	2% *(Disclosure: 68%)*	**0.02**
	N/A	N/A	N/A	1% *(Disclosure: 67%)*	**0.26**
	N/A	N/A	N/A	1% *(Disclosure: 70%)*	**0.23**
	N/A	N/A	N/A	3% *(Disclosure: 74%)*	**0.40**
	−	−	−	✓	✓
	−	−	−	✓	✓

	Technologies								
	Solar photovoltaic and solar thermal		*Onshore wind and offshore renewables*		*Batteries and storage*		*Heat pumps and geothermal*		*Electrolysers and fuel cells*
	Sustainable biogas/ biomethane		*Carbon capture and storage*		*Grid technologies*		*Data coverage*		*Data reliability*

Spain is a leading wind power hub, with the presence of facilities owned and operated by Vestas, Nordex and GRI Renewable Industries which are among the country's largest Net-Zero manufacturing facilities. Spain's main production facilities also include Power Electronics' factory producing solar PV inverters in Valencia, with an estimated capacity of 30 GW, which makes Spain a leading EU producer of inverters. Additionally, Spain has a substantial pipeline of investments in the battery sector. Announced manufacturing facilities include lithium-ion battery production facilities constructed by Volkswagen in the Valencia province with a capacity of 10 GW by 2026 and 40 GW by

---

[282] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[283] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[284] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[285] Manufacturing capacity is provided exclusively for solar photovoltaic modules and inverters and does not include capacities for solar thermal manufacturing.
[286] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[287] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[288] Manufacturing capacity data in MW is typically not available for facilities producing biogas and biomethane; grid technologies; CCS; and heat pumps. For heat pumps, manufacturing data is typically expressed in terms of sold equipment.

2030. Additionally, Basquevolt SA, Envision AESC Holding Ltd and PHI 4 Technology SL all have announced plans for battery production facilities over 10 GWh each, to be developed between 2024 and 2027.

Evolution of Spain's international positioning

As illustrated in Figure 1, Spain is an internationally competitive exporter of various Net-Zero technology components.[289] Notably, for offshore wind components such as gears and gearing, crucial for offshore wind technologies, Spain exhibits a high growth rate and a higher RCA than both China and the USA, while the international trade of this particular component has a relatively low market saturation rate. Additionally, Spain is estimated to have over EUR 600 million in untapped export potential for this component. Combining the export potential of the two offshore wind components in which Spain holds a significant competitive position, the total export potential is estimated to be over EUR 900 million.

Spain is also a competitive exporter of grid technologies. Specifically, Spain is estimated to have an export potential of EUR 292 million in boards for electric control of electricity, and EUR 157 million in electrical transformers. For these components of grid technologies, Spain's RCA index indicates it is a more competitive exporter than China or the USA (Figure 2).[290]

[289] Figures 1 and 2 present Spain's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Spain's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Spain's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets. Export potential is calculated using a gravity model, reflecting the hypothetical value Spain could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Spain could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.

[290] Figure 2 builds on Figure 1 by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Spain's trade strategy. Taken together, these figures provide a nuanced understanding of Spain's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

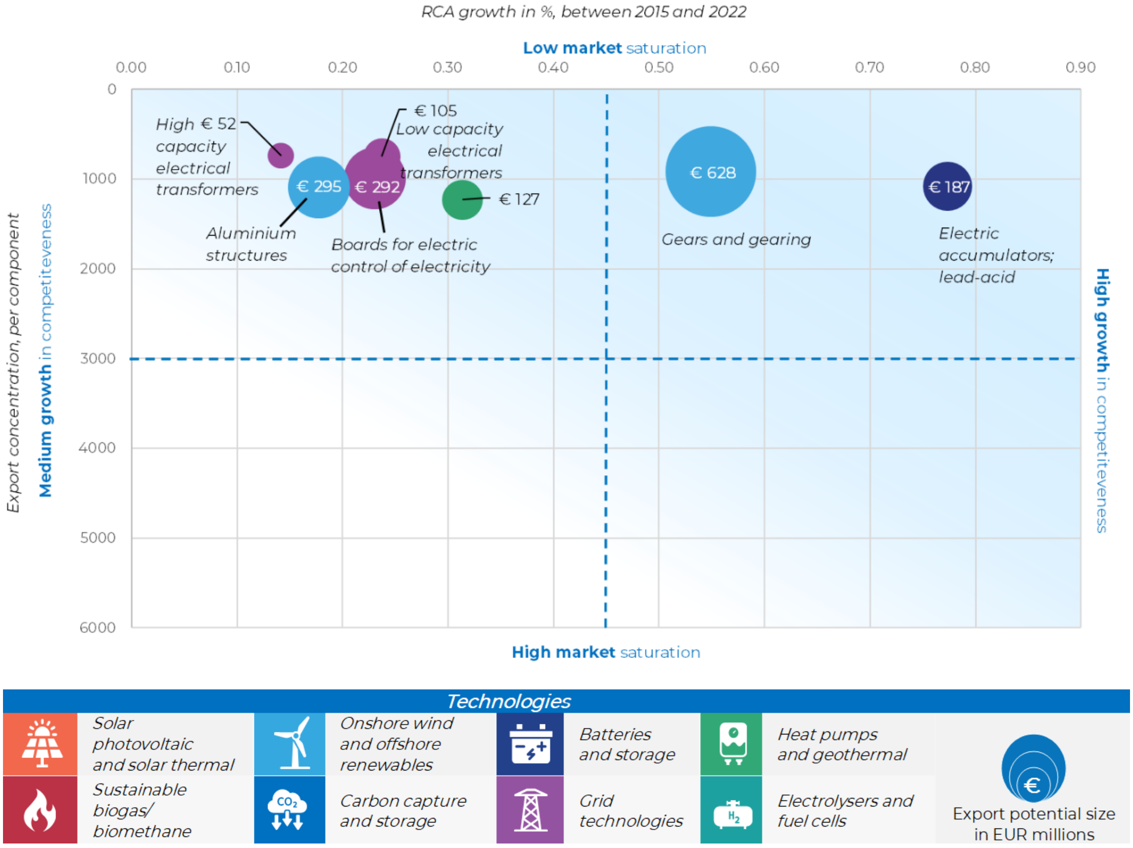
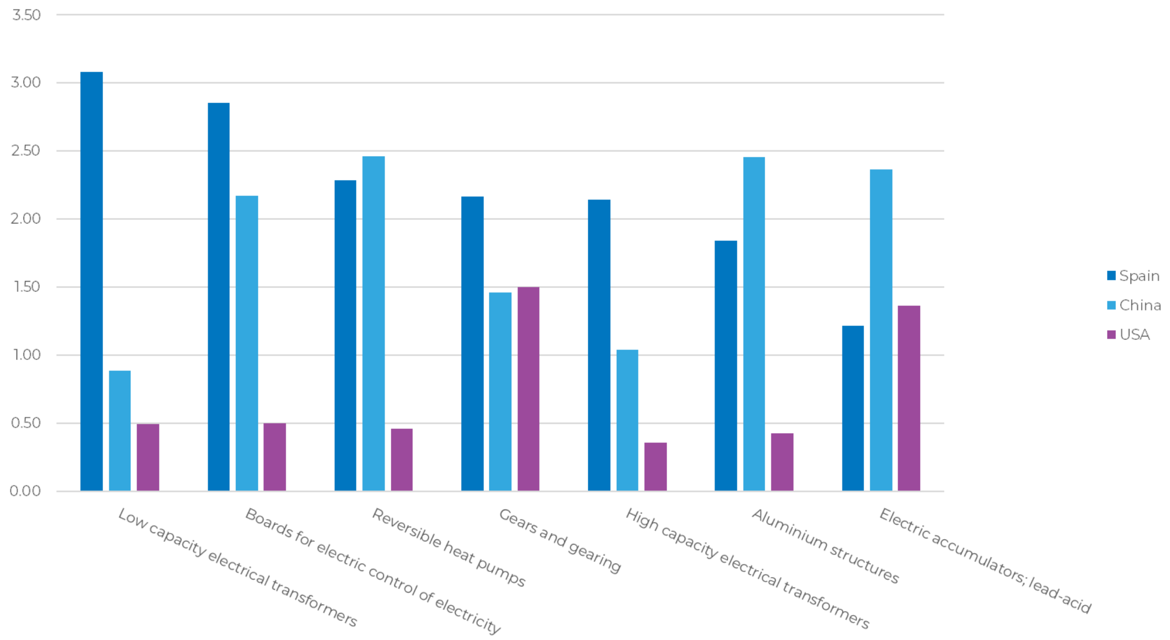


Figure 2: Absolute value of RCAs of Spain, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

The Spanish **Recovery, Transformation, and Resilience Plan** (Plan de Recuperación, Transformación y Resiliencia - PRTR) allocates nearly 40% of its investments to the ecological transition[291]. Within this framework, the **Strategic Projects for Economic Recovery and Transformation** (Proyectos Estratégicos para la Recuperación y Transformación Económica – PERTE) were established. PERTE are public-private collaborations involving various public administrations, companies, and research centres. To date, twelve strategic projects have been approved.

The PERTE for Renewable Energies, Renewable Hydrogen and Storage (PERTE de Energías Renovables, Hidrógeno Renovable y Almacenamiento) aims to promote Spain's energy transition towards a more sustainable model that is less dependent on external energy sources. This strategic plan seeks to develop technology, industrial capacities and new business models that strengthen Spain's leading position in the field of clean energy. The PRTR is the comprehensive framework under which various strategic projects and programmes, the PERTEs, are implemented.

The PERTE VEC (PERTE Vehículo Eléctrico y Contectado) focuses on the production of electric vehicle components, such as batteries and hydrogen cells, to boost industrial capacity and raw material recovery.

The Just Transition Strategy (Estrategia de Transición Justa) promotes the development of policies in industrial innovation, research and development, economic activity, employment, and vocational training to ensure that the transition to a new productive framework is both fair and socially beneficial for everyone. Particular emphasis is placed on advancing clean technologies.

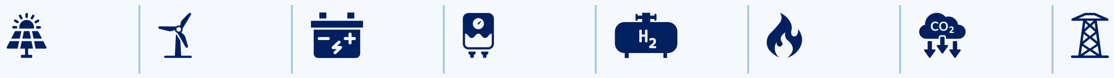
The Hydrogen Roadmap, aiming for climate neutrality by 2050, promotes renewable hydrogen development, fostering industrial value chains, technological knowledge, and sustainable employment. It emphasizes manufacturing high-power electrolysers and fuel cells, supporting their deployment in various industries and the automotive sector.

In May 2023, the European Commission approved a **state aid scheme** in Spain amounting to EUR 837 million that aims at supporting the production of batteries that can be used in electric and connected vehicles. The scheme is partially funded by the Recovery and Resilience Facility and can be disbursed through grants and loans.

In November 2023, the European Commission approved a EUR 1.1 billion **Spanish State aid scheme to support investments in equipment necessary to foster the transition to a net-zero economy**, under the State aid Temporary Crisis and Transition Framework. Under this measure, which will be funded through the Recovery and Resilience Facility (RRF), the aid will take the form of direct grants. The measure will be open to companies producing relevant equipment, namely batteries, solar panels, wind turbines, heat pumps and electrolysers, as well as key components designed and primarily used as direct input for the production of such equipment or related critical raw materials necessary for their production.

In May 2024, the European Commission approved another **state aid scheme** with a volume of EUR 120 million specific to the region of Asturias.

Scope of the policy framework



✓	✓	[✓]	✓	[✓]	✓	✓	✓

Industrial permitting

Average duration	No average duration has been identified.	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

[291] See here

Brief summary of the permitting processes

Permitting requirements for Net-Zero technology production in Spain generally fall under industrial legislation, since they are manufacturing installations. Prior administrative authorization from the competent Administration may only be required when it is necessary for the fulfilment of State obligations derived from community regulations or international treaties.

The Autorización Ambiental Integrada (AAI) is necessary for industrial activities with significant environmental impact, covering all emissions, discharges, and resource use. This permit is issued by Regional Environment Departments and, in cases of significant national impact, may involve the Ministry for Ecological Transition. However, it is uncommon for Net-Zero technology production projects to require an AAI[292].

The Permiso de vertido (Landfill permit) regulates waste disposal in landfills to minimize risks to human health and the environment, managed by the Regional Environment Departments[293]. The Licencia ambiental (Environmental license) is required for industrial and commercial activities that impact the environment, including emission control and waste management. This license is issued by municipal authorities or Regional Environment Departments for larger projects[294].

For activities with low environmental impact, a Declaración responsable ambiental (Responsible environmental declaration) is submitted by the activity owner to declare compliance with environmental requirements, handled by municipal authorities and sometimes involving regional authorities[295]. The Autorización de uso de agua (Authorisation of water use) regulates the usage of water resources for supply, irrigation, or industrial processes, managed by River Basin Authorities under the Ministry for Ecological Transition[296].

The Permiso de transporte de residuos (Waste shipment permit) is required for the safe and legal transport of waste, particularly hazardous waste. This permit is issued by Regional Environment Councils, and for international shipments, it may also involve the Ministry for Ecological Transition[297]. Finally, the Autorización Previa y de Construcción (ACC) is necessary before constructing infrastructure This permit includes an environmental impact assessment and ensures compliance with all environmental regulations. It is issued by Regional Environment Departments for regional projects, and the Ministry for Ecological Transition for projects of national importance[298].

Procurement

No relevant procurement rules have been identified.

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

Aid for the production of electric vehicle batteries within the PERTE VEC (Ayudas para producción de baterías del vehículo eléctrico dentro del PERTE VEC)

2022-2024[299]	**Grants and loans**	**EUR4.12 billion[300]**
Technologies: Batteries and storage technologies	**Eligibility:** Projects producing electric vehicle batteries, their essential components and related raw materials in Spain.	**Available support:** N/A

Description: The objective is to incentivise investment in industrial production capacity for batteries intended for electric vehicles, their essential components, and the production or recovery of critical raw materials

---

[292] Ministerio para la Transición Ecológica y el Reto Demográfico, see here
[293] Ministerio para la Transición Ecológica y el Reto Demográfico, see here
[294] See here
[295] See here
[296] See here
[297] See here
[298] See here
[299] The fourth call is scheduled to launch at the end of 2024, with additional calls anticipated thereafter.
[300] See here

needed[301]. The fourth call will be launched before the end of 2024[302]. According to the data provided in the addendum to the Recovery Plan approved in June 2023, transfers to the PERTE VEC from the first phase of the Recovery Plan amount to EUR 2.87 billion. The addendum reinforces this strategic project with an additional EUR 250 million in transfers and EUR 1 billion in loans, bringing the total amount between the first phase of the Recovery Plan and the addendum to EUR 4.12 billion[303].

PERTE for renewable energy, renewable hydrogen and storage (PERTE de energías renovables, hidrógeno renovable y almacenamiento)

2022-2026	**Grant**	**EUR 4.2 billion[304]**
Technologies: Electrolysers and fuel cell technologies, Batteries and storage technologies, Wind technologies, Solar technologies, Heat pumps and geothermal energy technologies.	**Eligibility:** Open to any legal entity, public or private, that is legally and validly constituted, provided they carry out the activity that justifies the grant.	**Available support:** Not specified

Description: This PERTE aims to support the energy transition of Spain and support various renewable energy technologies. The scheme is divided into various sub-programs and has led to a number of calls for proposals that aim to develop the country's technological and industrial capacities, new business models, and their implementation within the country's productive framework.

Some calls have directly supported the manufacturing capacity of Net-Zero technologies. For instance, PERTE has financed:

- EUR 74 million under the Important Project of Common European Interest Hy2Tech (Proyecto Importante de Interés Común Europeo), a measure dedicated to developing innovative technologies for producing renewable and low-carbon hydrogen through electrolysis, pyro-gasification, or other processes.[305]
- EUR 316 million for programmes to support the innovative value chain of renewable hydrogen (Programas de ayuda a la cadena de valor innovadora del hidrógeno renovable). This includes 4 programmes, that range from the promotion of new testing and manufacturing lines to large-scale electrolysis demonstrators or basic research, development and innovation projects. [306]

In the last quarter of 2024, a call for total funding of EU R750 million was published to strengthen the value chain of equipment needed for the transition to a net-zero emissions economy and increase Spain's strategic manufacturing capacity for solar panels, wind turbines, heat pumps, batteries, electrolysers, and their essential components. It is managed through the Institute for Energy Diversification and Saving (IDAE)[307].

Aid programs and actions under the PERTE, originally planned to be available between 2022 and 2023 (with beneficiary projects to be implemented by 2026), received an additional EUR4.2 billion in funding through an addendum to the Recovery Plan, approved in October 2023 by the European Commission. In particular, renewable hydrogen received double the initially planned investment, with an additional EUR1.6 billion allocated for value chain development, pioneering projects, the creation of hydrogen valleys, and support for IPCEI projects.[308] The PERTE also includes a new investment of EUR1 billion specifically aimed at strengthening industrial capacity in renewable energy value chains.

[301] See examples of funded projects here
[302] See here
[303] See here
[304] This amount refers to the additional funding allocated in 2023 to PERTE ERHA, as specified in the Addendum to Spain's Recovery Plan, approved by the European Commission that same year. Not all of these resources are dedicated to manufacturing capacity. However, some resources specifically allocated to support manufacturing capacity are detailed in the description.
[305] See here
[306] Idae, see here
[307] Spanish Government, see here
[308] Spanish Government, see here

Opportunities and challenges

Opportunities

General

Spain has a significant potential for renewable energy, particularly in solar and wind power. The country is on track to achieve 81% of its energy generation from renewables by 2030[309]. This provides a strong foundation for cleantech manufacturing, particularly in sectors like green hydrogen, energy storage, and renewable energy technology manufacturing.

Spain's cleantech investment ecosystem is maturing, with EUR 465 million in 2022. There is a growing interest from domestic and international investors, corporates, and venture capital funds. Increasing investment flows create opportunities for scaling innovative net-zero startups and developing new technologies. Relevant deals include H2Site (hydrogen) and Basquevolt (Lithium Battery Manufacturer)[310].

Technology-specific

Spain's Green Hydrogen Roadmap aims to make renewable hydrogen supply 25% of the total energy consumed by industry by 2030. More recently, the National Energy and Climate Plan 2023-2030 estimates that 74% of the hydrogen used in industry in 2030 could be green hydrogen.

The NECP also estimates 12 GW of electrolysers for 2030. Combined with Spain's existing infrastructure for energy transport, including the H2Med project to connect the Iberian Peninsula with France and the rest of Europe, offers opportunities to serve as a major clean energy hub for Europe[313]. This growing green hydrogen industry presents a significant opportunity for Spain to lead in hydrogen production, distribution, and technology development. Additionally, Spain benefits from its grants and support initiatives for electrolysers and fuel cells, alongside its participation in the IPCEI Hy2Tech.

Spain, already a net exporter of wind components, could tap into its over EUR 900 million export potential for tower manufacturing in the wind value chain.[314] Additionally, the domestic market is expected to grow with additional investments planned for offshore wind. This will benefit Spanish

Challenges

General

The net-zero manufacturing ecosystem in Spain is fragmented, with limited collaboration between startups, research institutions, corporates, and government entities[311]. Additionally, a weak transfer of knowledge and research from universities and public research centres to the private sector limits innovation[312]. A stronger, more coordinated approach is needed to integrate different stakeholders and enhance the cleantech value chain. Improved coordination could facilitate innovation, investment, and scaling of cleantech manufacturing capabilities.

Technology-specific

Supply chain risks are a potential bottleneck since the Spanish industry is highly dependent on imports with over 40% of materials used being imported (double the EU average)[316]. Specifically for net-zero technologies our data shows a high extra-EU import dependency for batteries (77%), wind power (55%), solar power (42%) and grid technologies (40%). Import dependencies for rare earth metals like manganese and electronics particularly affect net-zero technologies and could be an additional cost and barrier to scaling up Spanish manufacturing[317].

Spain's lack of financial support for injection lines, that connect biomethane plants to the gas grid, along with permitting issues, cause challenges in terms of demand. Spain needs to address several challenges to realise the full potential of biomethane. This includes greater connection support from grid operators and better visibility over distribution networks and injection points[318]. The situation may gradually improve following the recent adoption of a procedure to improve the connection of biomethane facilities to the transport and distribution grid.[319]

---

[309] Cleantech for Iberia. Becoming a leader in Europe's clean energy transition, available here.
[310] Ibid.
[311] Cleantech for Iberia. Becoming a leader in Europe's clean energy transition, available here.
[312] European Commission (2024). 2024 Country Report - Spain, available here.
[313] Ibid.
[314] See the above descriptive statistics for Spain regarding its international positioning.
[316] European Commission (2024). 2024 Country Report - Spain, available here.
[317] Lucía Salinas Conte (2022) The dependency on China of Spain's supply chains, available here.
[318] Mc Kinsey & Company (2024) The Iberian green industrial opportunity: Biomethane. Available here.
[319] This procedure notably addresses the timing for answering requests and the need for visibility over distribution networks capacity. Alfonso et al, 2024, The CNMC approves the procedure for managing the connection of biomethane generation facilities to the transport and distribution grid, available here. See also Resolución de 19 de abril de 2024, de la Comisión Nacional de los Mercados y la Competencia, por la que se establece el procedimiento de gestión de conexiones de plantas de generación de biometano con la red de transporte o distribución, available here.

manufacturers such as Siemens Gamesa and Nordex-Acciona, which in 2023 led in installed capacity in Spain[315].	

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

[315] Spanish Wind Energy Assocation, Installed wind power & generation, see here.

Country Factsheet Finland

Key findings

Manufacturing capacity:[320] Finland's manufacturing capacity amounts to between 100 and 200 MW/y (1% of total EU capacity) for solar PV. Finland also has at least two facilities producing wind turbine generators; one lithium-ion battery factory; and at least four facilities that manufacture heat pumps.

Industrial production:[321] Finland's three largest industrial Net-Zero sectors by value are grid technologies, with a production amounting to EUR 1.9 billion (3% of total EU production), EUR 1.7 billion (2% of EU production) for solar PV and thermal energy—concentrated chiefly in the production of inverters, converters, and generators—and EUR 1.7 billion (2% of EU production) for wind energy.

International positioning:[322] Finland is highly competitive in exporting grid components, such as insulated electric conductors and electricity supply meters, with an RCA surpassing that of China and the USA. Finland relies heavily on third-country imports, with over 80% of batteries and more than 50% of wind turbine components sourced from non-EU countries, including 24% from China.

Policy framework: Finland has a National Battery Strategy, which targets the manufacturing capacity of Finnish firms. The strategy aims to enhance the competitiveness and positioning of Finnish companies in the batteries value chain.

Industrial permitting: General information on industrial permitting suggests that the process may take more than one year (especially if an EIA is required), placing Finland among the countries where these processes are the fastest.[323] For the batteries sector, permitting is likely to be more complex due to a potential need for additional permits.

Incentive instruments: In Finland, the identified incentives partially target specific Net-Zero technologies (batteries and storage technologies) and may partially benefit the technologies more broadly. There are plans in Finland to establish one of the first Net-Zero industry academies within the EU.

[320] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[321] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[322] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides details on each indicator.
[323] Based on a comparison with data from other countries where available.

Key descriptive statistics for Net-Zero technologies in Finland[324]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[325]	Import dependence (extra-EU)[326]
	100 – 200 MW/y[327] *(1% of EU capacity)*	-	-	2% *(Disclosure: 100%)*	0.52
	At least two facilities identified[328]	-	-	2% *(Disclosure: 100%)*	0.22
	At least one facility identified[329]	-	29000 - 31000 MW/y	«Negligible share of EU production» *(Disclosure: 100%)*	0.81
	At least four facilities identified	-	-	2% *(Disclosure: 100%)*	0.30
	No facilities identified	-	-	1% *(Disclosure: 100%)*	0.30
	N/A	N/A	N/A	«Negligible share of EU production»% *(Disclosure: 100%)*	0.23
	N/A	N/A	N/A	«Negligible share of EU production»% *(Disclosure: 100%)*	0.51
	N/A	N/A	N/A	3% *(Disclosure: 100%)*	0.28
	–	–	–	✓	✓
	–	–	–	✓	✓

	Technologies										
	Solar photovoltaic and solar thermal		*Onshore wind and offshore renewables*		*Batteries and storage*		*Heat pumps and geothermal*		*Electrolysers and fuel cells*		
	Sustainable biogas/ biomethane		*Carbon capture and storage*		*Grid technologies*		*Data coverage*		*Data reliability*		

Finland's main production facilities include the Salo Tech Oy and Valoe Oy solar module solar factories based in, respectively, Salo and Juva, with an estimated capacity of around 100 MW and around 50 MW. Valoe Oy is currently undergoing a process of restructuring, however.[330] One announced manufacturing facility is by Johnson Matthey, which will produce Nickel-rich eLNO cathodes for batteries, starting in 2026. In addition, in 2023 US firm Plug Power announced a 1GW project to produce green hydrogen in Kristinestad.[331]

[324] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[325] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[326] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[327] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[328] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[329] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators. Celltech Solutions Oy, based in Tampere, is a Finnish producer of lithium-ion and other typologies of batteries.
[330] See news releases here and here.
[331] See the press release here.

Evolution of Finland's international positioning

As illustrated in Figure 1, Finland is particularly competitive in exporting components for grid and heat pump technologies.[332] For grid components, insulated electric conductors and electricity supply meter components have grown in export competitiveness, measured by the RCA index. Combined, these components are estimated to hold over EUR 150 million of export potential for the country. With an RCA of 2.1, which has grown by 34% between 2015 and 2022, Finland is a more competitive exporter of insulated electric conductors than China and the USA (Figure 2).[333] Heat pump components, heat exchange units, regulating instruments, and reversible heat pumps are exported competitively by Finland. For reversible heat pumps, the country's export competitiveness increased by 130% between 2015 and 2022. Combined, these three heat pump components are estimated to have over EUR 160 million in export potential.

However, Finland remains particularly dependent on third-country imports for various Net-Zero technologies. In 2022, over 80% of all imported batteries were sourced from third countries. Similarly, for wind turbine components, over 50% were sourced from non-EU countries, with 24% of all Finnish wind turbine components imported from China.

[332] Figures 1 and 2 present Finland's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Finland's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Finland's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Finland could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Finland could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.

[333] Figure 2 builds on Figure 1 by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Finland's trade strategy. Taken together, these figures provide a nuanced understanding of Finland's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

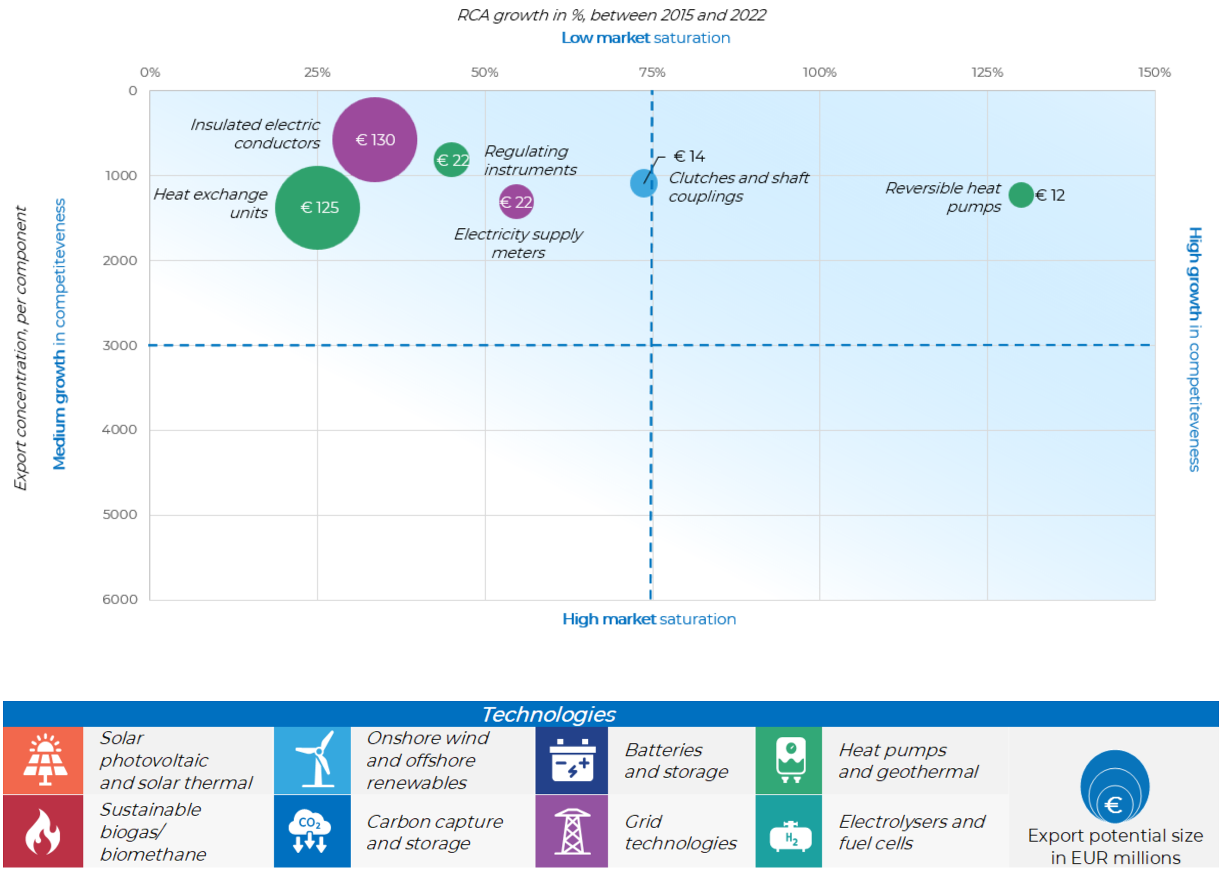
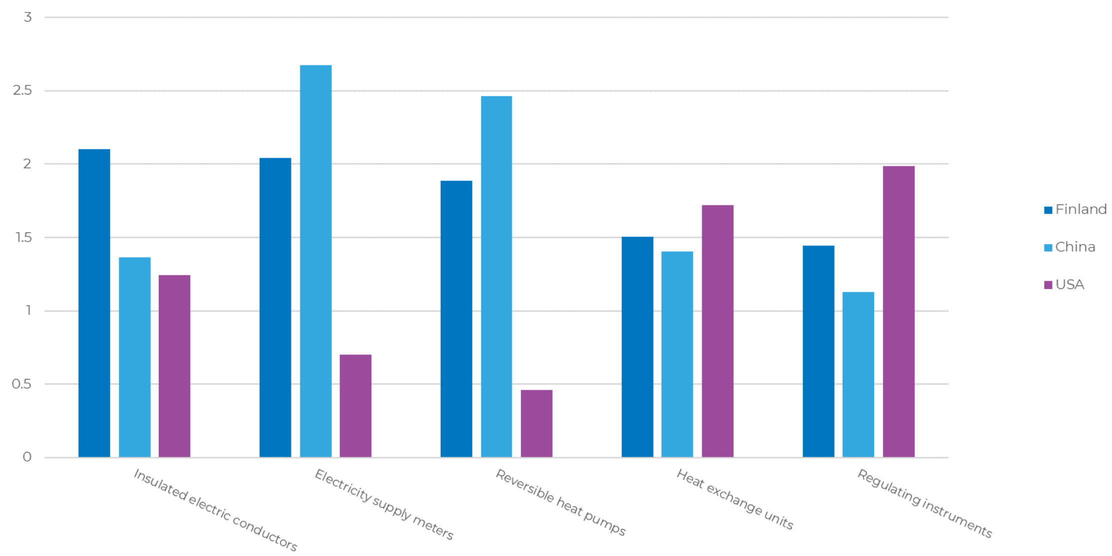


Figure 2: Absolute value of RCAs of Finland, China and the USA, 2022

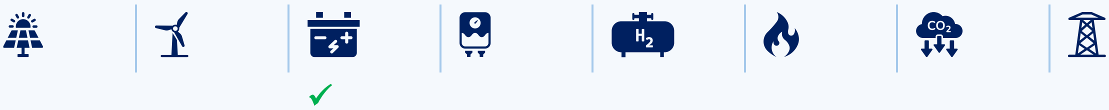


Regulatory and incentive landscape

Policy framework

The **National Battery Strategy** 2025 aims to strengthen the position of Finnish companies, products and services in global competition. It aims to significantly increase investment in Finland and promote the development of Finnish exports of electrification, battery and recycling solutions. The strategy proposes seven objectives for the period from 2021 to 2025: growth and renewal of the battery and electrification cluster, investment growth, promoting competitiveness, increasing global awareness, responsibility, key roles in new value chains in the sector, and promoting the circular economy and digital solutions. To achieve the objectives, the working group proposes an action list. The strategy aims to identify the actions that Finland can take to become a major international player in the battery sector and electrification.

Scope of the policy framework



Industrial permitting

Average duration[334]	Building permit: weeks to months (if the site is zoned). EIA: more than 10 months (average has been 16 months) Chemical permit: 8 months Permits to expand production are easier to receive	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

Brief summary of the permitting processes

At its largest scale, production typically requires an environmental impact assessment (the coordinating authority is the Centre for Economic Development, Transport and the Environment (ELY)), a detailed zoning plan (from the municipality), a building permit (from the municipality), an environmental and water permit (from the Regional State Administrative Agency (AVI)), a chemical permit (from Tukes), as well as other permits and plans. Typically, a plant needs at least an environmental permit, chemical permit, and building permit. Other possible permits needed are a soil removal permit (depending on the plot's topography, site layout, and construction base level), a landscape permit (to perform certain early works, tree felling, ground levelling etc. before the building permit is granted), water permit (depends on cooling/process water intake/discharge), project permit (needed if >110 kV high voltage power cable is built, not needed for cables inside the property), flight obstacle permit (depending on the proximity of the airport as well as permanent building heights and also temporal cranes during construction). The permits required also depend on the activity to take place. Permitting processes for batteries are usually complex, due to the chemicals used in the production processes. Many other Net-Zero technologies may fall in the group of metallurgy industry, which suggests that fewer permits may be required when compared to battery plants.

All relevant permits can be handled digitally. Key drivers of permitting procedure length include the right to appeal, which allows two levels of appeal, each taking up to a year. Limited administrative capacity, especially

[334] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.

in ELY centres managing wind power projects, and multiple authorities working on the same issues, also contribute to delays.

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

Plan for a new scheme

Planned	**Grant**	**EUR 400 million**[335]
Technologies: Potentially all	**Eligibility:** Unclear, to be planned	**Available support:** N/A

Description: The Ministry of Employment and the Economy is preparing an investment aid scheme that would enable the use of the EUR 400 million business policy reserve in the government programme for investments in Net-Zero technology (based on the Commission's TCTF communication).

Jamk's Net-Zero Industry Academy

Planned	**Skills programme**	**Type of programme:** Upskilling, Re-skilling (post-secondary)
Technologies: Potentially all	**Description:** Jamk has published the "Net-Zero Industry Academy" project, which aims to identify the skills and development needs for Net-Zero technologies in Finland by 2024. The aim is also to create a training model to meet these requirements, which will be piloted in the future. The project aims to identify relevant competencies by the end of 2024. It aims to create a training model tailored to their requirements, which will be piloted in the future. One of the main goals of the project is to engage a wide range of companies and other stakeholders in Central Finland and Finland. The unique testing, development, and training environment at Saarijärvi Bioeconomy campus provides an excellent foundation for the operation of the Net-Zero industry academy. The project has been funded through the AKKE (Allocation to support sustainable growth and vitality of regions) fund.	

[335] See here

Opportunities and challenges

Opportunities

General

Finland is a global innovation leader and ranks high in public spending for R&D in energy.[336] This funding can be leveraged to drive innovation in Net-Zero technologies. Finland also has strong environmental policies, a commitment to sustainability, and affordable clean electricity[337], which could push forward Net-Zero projects and attract investments.

Technology-specific

In the battery value chain, Finland has several mines and refineries for raw materials alongside plans to exploit additional deposits. In 2021, Finland refined around 10% of global cobalt output.[340] Other materials include nickel, manganese, copper, graphite and lithium. Alongside access to raw materials, Finland has a developed recycling system and strong R&D throughout the value chain.[341] Combined with the country's National Battery Strategy's focus on enhancing the competitiveness and positioning of Finnish companies, these present an opportunity to further promote the development of battery manufacturing in Finland. The industry's growth is further underscored by the large investments planned with a total amount of EUR 6 billion estimated by Finnish industry by 2028.[342]

Regarding energy storage, Finland is a leader in thermal storage solutions which boost the resilience and flexibility of electricity grids and heating networks[343]. Several Finnish companies are investing in thermal storage projects[344].

Challenges

General

Finland faces a challenge in the availability of skilled personnel which are key for permitting and project deployment.[338] The growing number of projects related to the green transition is expected to surpass the capacity of authorities in the coming years, leading to delays in the permitting process. In addition, the high demand for skilled labour, combined with Finland's ageing population, could create bottlenecks across various industries. Attracting foreign labour could help mitigate these challenges.[339]

Technology-specific

There is a growing demand for skilled workers throughout the battery value chain in Finland, with an estimated employment need of around 4000 in 2025-2026.[345] Additionally, Finland depends on extra-EU imports, in particular for battery and storage technologies but also solar PV and solar thermal technologies.

While witnessing a 130% increase in estimated export competitiveness for reversible heat pumps between 2015 and 2022, more recently, Finland experienced a 42% fall in heat pump sales between 2022 and 2023, partly driven by a decline in the construction of new housing, which affected mostly air-to-air heat pumps.[346] However, despite the setback, Finland's heat pump sector is expected to grow in the future, thanks to increasing profitability, electrification and large investments in heat pumps.[347]

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential

[336] IEA (2023), Finland 2023, IEA, Paris, https://www.iea.org/reports/finland-2023, Licence: CC BY 4.0
[337] Finland produced 94% of its electricity from emission-free sources and had the second cheapest power prices in Europe in 2023. See here.
[338] IEA (2023), Finland 2023, IEA, Paris, https://www.iea.org/reports/finland-2023, Licence: CC BY 4.0
[339] State Treasury Republic of Finland (2023), 'Finland is well positioned for green investments', available here.
[340] Ibid.
[341] Innovation Norway, Business Finland, Business Sweden, and the Swedish Energy Agency Conducted by Business Sweden (2023) The Nordic Battery Value Chain - Market drivers, the Nordic value proposition, and decisive market necessities. See here.
[342] Nordic Battery Report, 2023, available here
[343] Vatnaan Energia, 04.04.2024, World's largest thermal energy storage to be built in Vantaa, Finland, available here.
[344] Euronews, 10.03.2024, 'A very Finnish thing': Big sand battery to store wind and solar energy using crushed soapstone, available here.
[345] Innovation Norway, Business Finland, Business Sweden, and the Swedish Energy Agency Conducted by Business Sweden (2023) The Nordic Battery Value Chain - Market drivers, the Nordic value proposition, and decisive market necessities. See here.
[346] EHPA (2024), Pump it down: why heat pump sales dropped in 2023, Brussels, available here.
[347] Ibid.

Country Factsheet France

Key findings

Manufacturing capacity:[348] France is a strong manufacturer in the Net-Zero field. Its manufacturing capacity amounts to 14.5 – 16.0 GWh/y (6 - 7% of total EU capacity) for battery and storage technologies (specifically for lithium-ion EV batteries). For wind turbine components, France boasts a manufacturing capacity of approximately 2.5 GW for nacelles, around 1.7 – 1.8 GW for towers, and 3.3-3.5 GW for blades; between 60 to 160 MW/y (1-3% of EU capacity) for electrolysers; and between 1.7 GW and 2.6 GW (9 - 13% of EU capacity) for solar PV, primarily in modules and with marginal shares of cells (0.1-0.15 GW) and wafers (0.2 GW). In terms of heat pumps, France hosts at least 42 production facilities.

Industrial production:[349] France's three largest industrial Net-Zero sectors by value are wind power, with a production amounting to EUR 5.7 billion (6% of total EU production), EUR 2.6 billion (4% of EU production) for grid technologies, and EUR 1.4 billion (2% of EU production) for solar energy. It must be noted that France has strict confidentiality regulations on the publication of production data and therefore lower reliability.[350]

International positioning:[351] France is competitive in exporting grid components, like insulated electric conductors, with a Relative Competitive Advantage index exceeding that of China and the USA. It also has significant export potential in lead-acid and nickel-cadmium batteries, though its battery imports have been multiplied by 7 since 2016, with 40% from China. France relies heavily on third-country imports for solar PV components (90%), heat pumps and geothermal technology (42%), and onshore/offshore renewables, with China being the primary import partner.

Policy framework: France currently has one national strategy and one dedicated legislation that can support the build-up of manufacturing capacity for Net-Zero technologies in the country.

Industrial permitting: The time needed to obtain permits for new or expanded production sites ranges from 9 to 17 months. At the national level, the Green Industry Law aims to shorten permitting procedures for Net-Zero technology manufacturing to a duration of 6 to 9 months.

Incentive instruments: In France, dedicated measures exist to support investments in the manufacturing of Net-Zero technologies. These notably include an investment tax credit for investments in green industries which supports the production of battery cells (various chemistries), solar panels, wind turbines and heat pump technologies and the value chains of those equipment (production of key components primarily used as direct input for the production of those equipment, as well as production or recovery of related critical raw materials, excluding the sole production of black mass); grants from the France 2030 investment plan supporting industrial capacities for offshore renewable energy and grid technologies; and support to training and (re)skilling programmes, notably used in the sector of electric vehicle batteries.

[348] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[349] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[350] In PRODCOM, France only reports data on the production of different categories of gearboxes and ball bearings (wind power); electrical control apparatus, such as switchgears (grid technologies); and PV generators, inverters and converters, and machinery that can be employed in the manufacturing of modules (solar PV).
[351] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides more details.

Key descriptive statistics for Net-Zero technologies in France[352]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[353]	Import dependence (extra-EU)[354]
	1700 - 2600 MW/y[355] *(9 - 13% of EU capacity)*	150 – 5100 MW/y	8500 – 14000 MW/y	2% *(Disclosure: 46%)*	**0.90**
	7400 - 7850 MW/y[356] *(8 - 9% of EU capacity)*	-	-	6% *(Disclosure: 47%)*	**0.41**
	14500 - 16000 MWh/y[357] *(6 - 7% of EU capacity)*	16000 – 43000 MWh/y	117000 – 215000 MWh/y	«Insufficient data coverage» *(Disclosure: 32%)*	**NC**
	At least 42 facilities identified	-	-	«Insufficient data coverage» *(Disclosure: 29%)*	**0.42**
	60 - 160 MW/y *(1-3% of EU capacity)*	1355 - 1855 MW/y	900 - 1000 MW/y	«Insufficient data coverage» *(Disclosure: 37%)*	**0.01**
	N/A	N/A	N/A	«Insufficient data coverage» *(Disclosure: 28%)*	**0.22**
	N/A	N/A	N/A	«Insufficient data coverage» *(Disclosure: 30%)*	**0.33**
	N/A	N/A	N/A	4% *(Disclosure: 68%)*	**0.37**
	⊖	⊖	⊖	✖	✔
	⊖	⊖	⊖	✖	✔

Technologies					
Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*	
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*	

France has a strong manufacturing base, particularly in the batteries and storage; and electrolysers and fuel cells value chains. France hosts the Automotive Cells Co SE's Battery factory in Billy-Berclau Douvrin, with an estimated capacity of 40 GWh/y in the medium term (15 GWh for the 1st bloc, to be achieved by the end of 2025). In the batteries and storage segment, the Hauts de France region is positioning itself as home to an emerging battery cluster, with announcements from Taiwan's ProLogium Technology reportedly, which aims to start production of a 48 GWh/y solid-state battery facility in Dunkirk by 2028 already, and Verkor, which has recently obtained financing to support the construction of a 16 GWh/y Gigafactory (27 GWh in the medium-term), also in Dunkirk.[358] The Chinese company Envision AESC aims to produce up to 34 GWh in Douai. Among other announcements, Tiamat—a producer of sodium-ion batteries—has also announced plans for a battery factory, with a

---

[352] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[353] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[354] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[355] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing. France also produces wafers, at a minimal volume. Announced facilities may also produce PV cells.
[356] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[357] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[358] Reuters, 23.01.2024, Taiwan EV battery maker ProLogium eyes mass production in France in 2027. See here; and Natixis, 24.05.2024, Verkor Secures EV Battery Gigafactory Financing. See here.

target of 5GWh/y.[359] France's other notable Net-Zero facilities include the John Cockerill electrolysers manufacturing plant in Aspach, which, according to the company[360], is aiming to ramp up capacity to 1 GW/y by the end of 2025. LM Wind Power's blade manufacturing facility in Cherbourg with an estimated annual capacity of 2.1 GW. France is also home to one of the EU's few remaining solar wafer manufacturers, Photowatt, with an estimated 200 MW in capacity.[361]

Evolution of France's international positioning

As illustrated in Figure 1, France is an internationally competitive exporter of various Net-Zero technology components.[362] Notably, for grid components such as insulated electric conductors, crucial for grid technologies, France exhibits a high growth rate and a higher RCA than both China and the USA, while the international trade of this particular component has a relatively low market saturation rate. This relatively low level of market saturation suggests that no single country, including France, commands a significant share of global exports. This leaves room for France to potentially strengthen its export position.

Additionally, France is estimated to have over EUR 400 million in untapped export potential for this component. Combining the export potential of the three grid components in which France holds a significant competitive position, the total export potential is estimated to be over EUR 1,100 million, suggesting that France could increase its exports rapidly if trade barriers were reduced. This strong international position underscores France's significant manufacturing presence within the EU, accounting for over 7% of the EU's production in grid technology components.

France is also a competitive exporter of batteries. Specifically, France is estimated to have an export potential of EUR 436 million in lead-acid electric accumulators and EUR 167 million in nickel-cadmium electric accumulators, both chemistries threatened in the medium to long-term by the ban on certain substances in batteries (Battery Regulation). For the latter, France's RCA index indicates it is a more competitive exporter than China or the USA (Figure 2).[363] Nevertheless, France is still heavily dependent on imports from third countries for overall battery technologies, beyond lead-acid accumulators and nickel-cadmium electric accumulators. In 2022, it imported 55% of all its batteries from third countries, particularly from China, which supplied 31% of these imports.

France's dependence on third-country imports is also visible in other Net-Zero technologies (see table above). In 2022, France imported 46% of all its solar PV-related components and goods, 42% of its heat pumps and geothermal technology, and 41% of its onshore and offshore renewables. Across all these technologies, France's main import partner was China.

---

[359] Nord France Invest, Tiamat: a sodium-ion gigafactory opens in Hauts-de-France. See here.
[360] John Cockerill, Manufacturing Facilities. A global player with a unique multi-local presence. See here.
[361] Photowatt was recently acquired by French modules manufacturer Carbon, with the objective of integrating the facility within Carbon's new industrial production. See here for additional information.
[362] Figures 1 and 2 present France's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture France's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand.
This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where France's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value France could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where France could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.
[363] Figure 2 builds on Figure 1 by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for France's trade strategy. Taken together, these figures provide a nuanced understanding of France's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

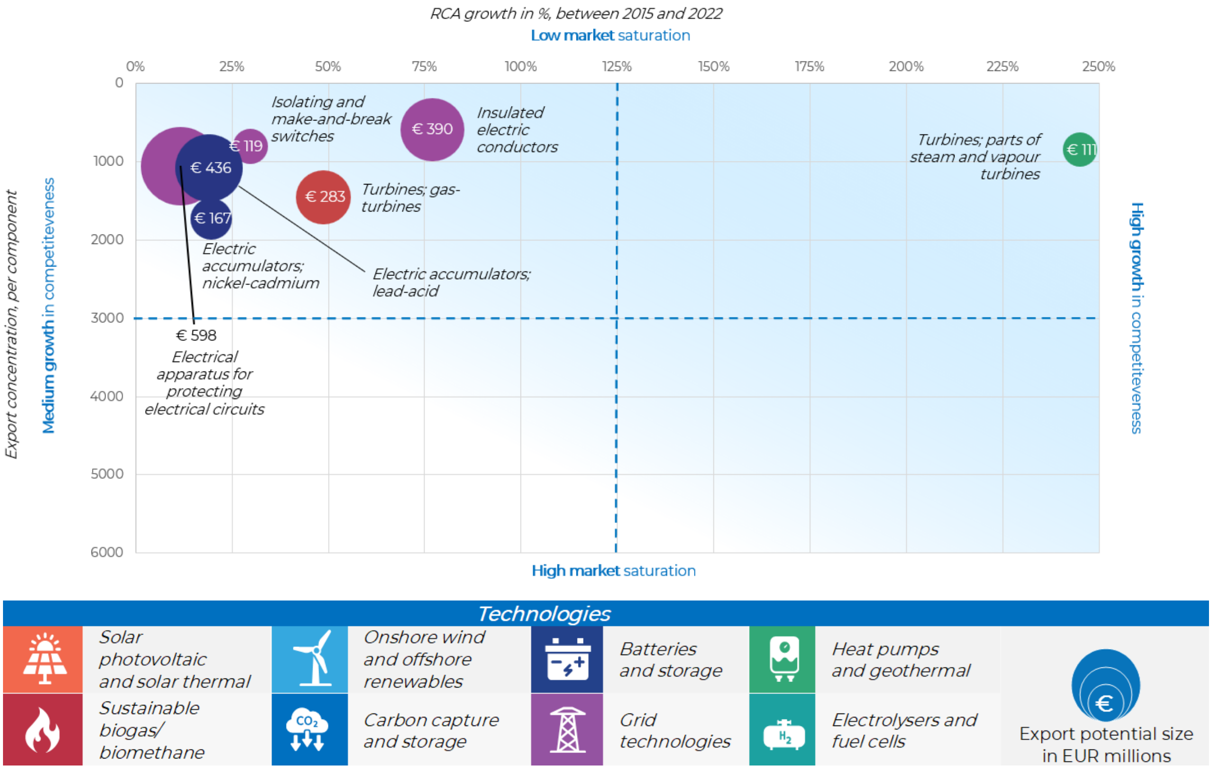
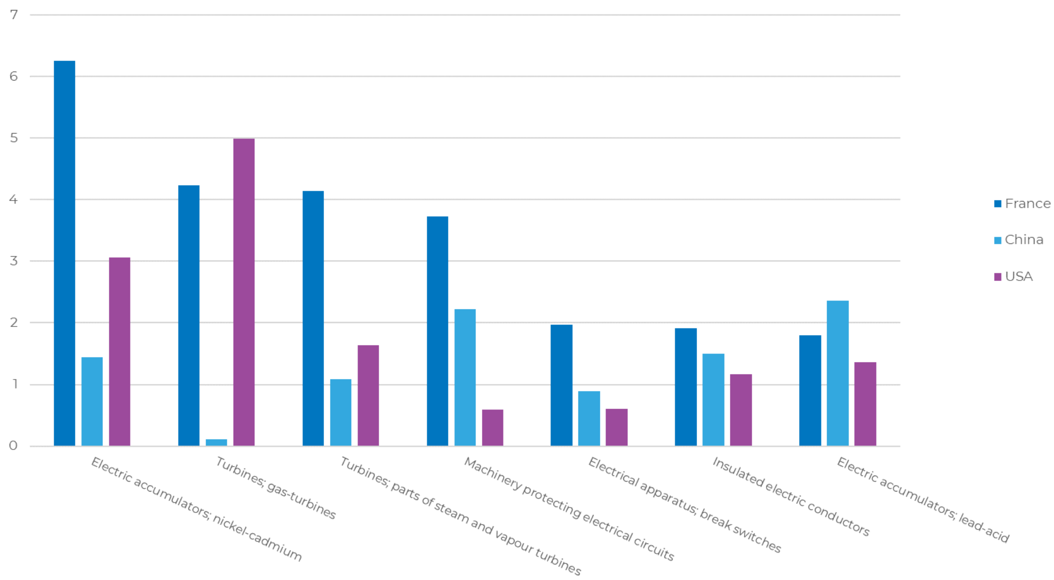


Figure 2: Absolute value of RCAs of France, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

Currently, there is a dedicated policy on Net-Zero technologies which is shaped by the Strategy **France Nation Verte** and implemented through the **Loi Industrie Verte** (Green Industry Law). The policy framework covers all Net-Zero technologies (see below).

France Nation Verte is the national action plan aiming to make France the first European green economy by 2040 and to increase the production of renewable energy. France's Green Industry Law implements this vision by accelerating permitting procedures by allowing it to conduct the instruction process in parallel with public consultations, therefore halving the length of environmental authorisations necessary to set up industrial factories.

The *Loi Industrie Verte* foresees simplified procedures for planning permissions for the eight strategic Net-Zero technologies and industrial projects of major national interest (i.e., having particular importance for the ecological transition or national sovereignty).

In January 2024, the European Commission approved state aid in France in the scope of the Temporary Crisis and Transition Framework for up to about EUR 2.9 billion supporting investments in green industries. The aid will take the form of a tax credit to companies investing in the production of solar panels, batteries, wind turbines and heat pumps, as well as key components for producing this equipment and critical materials required for their production.[364]

Scope of the policy framework

Industrial permitting

Average duration[365]	Between 9 to 17 months, however, the Green Industry Law will shorten this to 6-9 months.	**One-stop shop for permitting**	No, but one coordinating authority (DREAL)[366]

Brief summary of the permitting processes

Industrial permitting processes involve public authorities at the national, regional and local levels. The environmental authorisation is coordinated by the State's services (DREAL) but the departmental prefect is also involved at different stages of the process (e.g., when it comes to the public consultation). Urban planning permits are dealt with at the local and regional levels (mayor or president of intercommunity) and other services of the Ministry of Culture, namely the regional directorates for cultural affairs (DRAC), the cultural affairs departments (DAC) in the overseas territories, or the Department of Underwater and underwater archaeological research (DRASSM) may be mobilised when the project requires preventive archaeological

[364] See here.

[365] Our research suggests that the permitting time can vary considerably across and within countries. The project size is among the key factors, partly determining the scope and type of permits needed. Another factor is the nature of the economic activity. Activities that create greater emissions or bear a higher risk of negative environmental externalities (e.g. battery production) usually need to follow a more comprehensive permitting process, which may increase the overall permitting duration. Generally, evidence suggests that projects that need to perform an environmental impact assessment see increased permitting times overall. Some interviewees also pointed to the quality of the documentation submitted by the economic operator as a determining factor of the duration of permitting processes.

[366] Based on an interview conducted with the Ministry of Economics and Finance.

studies/permits. The average duration of industrial permitting varies between 9 (theoretical time) and 17 months (effective time) – with the aim to shorten it to 6 to 9 months with the Green Industry Law.[367]

Differences in length can be explained by the insufficient quality of applications submitted, a lack of coordination across stakeholders involved in the procedure, the number of authorisations and permits necessary as well as the length of litigation procedures.[368] To fasten procedures, competent authorities are notably aiming to run in parallel some steps of the instruction process, mutualise public consultations for industrial zones where several projects are expected, proceed with new recruitment to reinforce administrative capacities and simplify litigation procedures.

Procurement

Through the Solar Pact initiative, the State will launch the *Induscore*, a label reflecting the European Industrial content of solar PV. The current 29 companies that signed the Pact are committed to ensuring that at least 30% of the solar PV deployed or bought is manufactured (i.e., with 1 or more industrial steps) within the EEA area from 2025 onwards.[369]

Additionally, the offshore sector deal between the French Government and the wind industry targets 50% local content in projects by 2035 in the sector, based on voluntary commitments.[370]

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

Tax credit for investment in green industries (C3IV)

2023-2025	**Investment tax credit**	**Total funding available: EUR 2.9 billion[371] with EUR 23 billion in investments expected**
Technologies: Batteries and storage, solar, wind and heat pump technologies	**Eligibility:** As regards the production of relevant key components and the production or recovery of related critical raw materials, the project company must demonstrate that at least 50% of the turnover generated by their project is planned to be achieved with companies engaged in production activities of the four equipment (and/or their key components as regards projects involving the production/recovery of critical raw materials) identified by the European Temporary Crisis and Transition Framework (TCTF).	**Available support:** The support varies between 20% and 45% of investment costs for mainland France (up to 60% for overseas territories), depending on the size of the project. The total amount of the tax credit cannot exceed EUR 150 million per company but can reach 200 million for investments in assisted areas for mainland France and 350 million for overseas territories. Companies must apply for an agreement from the Tax Administration before 31 December 2025.

Description: The scheme supports companies planning to invest in the production of the four mentioned technologies and their value chains (production of equipment, components, critical raw materials) by granting a tax credit. The tax credit is deducted directly from the corporate income tax due for the year or financial year in which the investment plan expenditure is incurred by the company.

France 2030 – Investment support to the clean mobility industry

[367] Based on an interview conducted with the Ministry of Economics and Finance.
[368] See here.
[369] See here.
[370] See here.
[371] See here.

2021-2025	**Multiple**[372]	**Total funding available: EUR 4.9 billion for the two NZ technologies** (likely broader than manufacturing)
Technologies: Electrolysers and fuel cells, batteries and storage technologies	**Eligibility:** Dependent on specific calls	**Available support:** Dependent on specific calls

Description: France 2030 is an investment plan aiming to make up for France's lag in some specific industrial sectors and develop new industrial and technological sectors with a focus on innovation and carbon emission reductions. The plan will support France's objective to be a leader in clean hydrogen by 2030 (EUR 2.3 billion) and produce electric vehicles and batteries (EUR 2.6 billion).

France 2030 - Investment support for the renewable energy industry

2022-2024	**Grant**	**Total funding available: EUR 400 million (investment target)**[373]
Technologies: Geothermal energy, grid technologies, onshore and offshore wind, solar and heat pump technologies.[374]	**Eligibility:** A minimum investment of EUR 1 million for individual projects led by an SME, EUR 2 million for individual projects, and EUR 4 million for collaborative projects. The project duration must be between 36 and 60 months.	**Available support:** The support varies between 15% and 35% of investment costs depending on the size of the company.

Description: The measure aims to support the best investment projects contributing to developing industrial capacities in the field of renewable energy and network technologies. The scheme supports the industrialisation of component production and/or assembly, including innovative network technologies.

France 2030 - Support for the industrialisation of solutions to decarbonise industry

2022 (at least)	**Grant**	**The total amount for the specific call is not available**
Technologies: Carbon capture and storage, heat pump technologies	**Eligibility:** A minimum investment of EUR 1 million.	**Available support:** The support varies between 15% and 35% of investment costs depending on the size of the company

Description: The measure supports investment projects in key French industrial sectors. It aims to decrease dependency vis-a-vis non-EU providers and enhance the autonomy and resilience of the industry.

Develop clean hydrogen (Recovery and Resilience Plan)

2021-2030	**Grant**	**Total funding available: EUR 1.575 billion**
Technologies: Electrolysers and fuel cell technologies	**Eligibility:** Projects eligible include support to R&D and the industrialisation of hydrogen technologies, and research programmes supporting the production of hydrogen technologies, among others.	**Available support:** Dependent on specific calls

Description: This measure integrated as part of France's Recovery and Resilience Plan encompasses a set of incentives. These include support through a Project of Common Interest notably aiming to develop electrolysers to produce low-carbon hydrogen (EUR 1,575 billion)

France 2030 - Skills and professions of the future

[372] The exact types of instruments are not specified and are likely to take multiple forms of public support.
[373] See here.
[374] The scheme also mentions support for renewable marine energy.

2019-2024	**Skills programme**	**Type of programme:** Training and (re)skilling programme
Technologies: Batteries and energy storage technologies	**Description:** This programme supports training/skills/re-skilling projects for a large range of industries, notably electric vehicle batteries. The scheme supports educational programmes, new campuses and training locations dedicated to training workers in the industry. It notably supported the set-up of the first "Battery school to enable apprentices, at all levels of qualification, to be trained in the battery industry. The support is a maximum of EUR 200k for projects identifying vocational training needs and up to 70% of investment costs for training programmes (with a minimum subsidy threshold of EUR 1 million).	

Opportunities and challenges

Opportunities

General

Among EU Member States, France has placed early on the strongest emphasis on promoting green industries. Initiatives such as the France Nation Verte strategy, the France 2030 Investment Plan, and the Loi Industrie Verte law have put Net-Zero industries at the centre of French policies. These initiatives have simplified permitting procedures and introduced an investment tax credit for green investments (CI3V) based on the TCTF. Another law is planned to simplify business procedures.

Technology-specific

Regarding the development of battery and storage technologies, considering France's important car manufacturing industry, there is a strong domestic demand for electric vehicle batteries. France has already attracted investments to build gigafactories, including those by ACC, AESC, Prologium, Blue Solutions, Tiamat and Verkor.[376] These investments will not only expand production capacity but also enhance the talent pool, supported by the network of specialized battery schools under the 'École de la Batterie' initiative.

For solar PV manufacturing, the Solar Pact initiative introduced the voluntary Induscore system, which scores European industrial content in public procurement and could help revitalise the French solar industry by increasing purchases of French and European modules[377]. Opportunities arise also from the two planned solar gigafactories by Carbon in Fos-sur-Mer and by the Holosolis consortium in Hambach[378]. France could also leverage its potential in crystalline silicon solar panels thanks to its strong silicon production capacity[379]. There are also opportunities to reduce import dependencies with innovations such as perovskite technology and heterojunction technology

Challenges

General

While permitting has improved, by allowing certain procedures to run in parallel, administrative capacity remains a potential bottleneck as indicated in an interview with a national authority.

Labour and skills shortages pose a challenge across most sectors of the French economy and are reported as one of the main barriers to investment[375]. The demand for skills is expected to grow further considering France's large investments in battery manufacturing and other Net-Zero technologies.

Technology-specific

France faces a dependence on extra-EU imports, specifically for batteries, with China as its main import partner. France has the potential to reduce this dependency thanks to its efforts to attract investments covering the entire battery value chain[384]. However, the increased manufacturing capacities could lead to supply chain vulnerabilities as they will increase dependencies on raw and processed materials as well as components and production equipment which are currently primarily sourced from Asia. Material costs remain the primary cost drivers[385] and thereby negatively affect the price competitiveness of EU manufacturers, which has started a trend of automotive manufacturers such as Renault[386] switching to lower-cost lithium iron phosphate (LFP) cells.

Similar to its European counterparts, the French solar PV manufacturing value chain has been facing severe difficulties. Photowatt is looking for a buyer[387] while companies such as Systovi and Recom-Silia have gone into liquidation. This is despite previously filled order books and caused by a lack of price competitiveness with solar panels being four times more costly than those

---

[375] European Commission (2024), 2024 Country Report – France, SWD(2024) 610, available here.
[376] EIB (2024), 'Giga-push for European batteries', available here; ProLoqgium (2023) ProLogium Announces €5.2b Gigafactory in Dunkirk France and Greets French President Emmanuel Macron., available here; Reuters, 29.05.2024, Battery maker Blue Solutions plans 2 billion euro gigafactory in France, available here.
[377] Actu-Environnement, 10.04.2024, Industrie photovoltaïque : des règles du jeu assainies dans une compétition redoutable, available here.
[378] Révolution Énergétique, 09.05.2024, Hécatombe dans l'industrie solaire française : une nouvelle usine placée en liquidation judiciaire, available here.
[379] IEA (2021), France 2021, IEA, Paris, https://www.iea.org/reports/france-2021, Licence: CC BY 4.0
[384] Business France, 'The national "Batteries" strategy, a key priority for France on sustainable mobility', available here.
[385] BloombergNEF, 26 November 2023, Lithium-Ion Battery Pack Prices Hit Record Low of $139/kWh.
[386] Renault will source LFP cells from CATL produced in Hungary and NMC and LFP cells from LG Energy Solutions produced in Poland, which will then be assembled into battery packs in France. However, France-based AESC and Verkor manufacturing plants will continue to supply NMC cells, see here: electrive, 02.07.2024, Renault embraces LFP batteries, available here.
[387] Révolution Énergétique, 14.09.2024, Qui reprendra le dernier grand fabricant français de panneaux solaires Photowatt ?, available here.

which are expected to increase panel efficiency and reduce the need for silicon and other materials[380].

France's increasing commitment to offshore wind development[381] has attracted significant investments in wind technology manufacturing. Companies like Siemens Gamesa, General Electric, and LM Wind Power have established facilities in the country, positioning France as a key player in the European wind industry.[382] An offshore sector deal between the French government and the wind industry targets 50% local content in projects by 2035, which is expected to boost local manufacturing further.[383]

imported from Asia[388]. Chinese manufacturers can undercut European prices as they dominate the production and processing of polysilicon into PV modules and Chinese imports have led to overstocking in Europe following the closure of the US market.[389]

In 2023, the French heat pump value chain experienced a 14% decrease in sales of air-to-water heat pumps. This decline was attributed to reduced new housing construction, uncertainty around incentive schemes, and volatile energy prices which overall negatively affected demand.[390] As a result, several manufacturers, including Saunier Duval[391] and Groupe Atlantic[392] resorted to partial unemployment measures in the last quarter of the year. However, there are also new planned investments, such as a new manufacturing plant by Groupe Atlantic in the Grand Chalon region[393] which could benefit should demand pick up again.

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

[380] Actu-Environnement, 10.04.2024, Industrie photovoltaïque : des règles du jeu assainies dans une compétition redoutable, available here.
[381] Ministry of Economy, Finance and Industrial and Digital Sovereignty (2024), 'Bruno Le Maire and Roland Lescure announce new measures to support the development of offshore wind power and its industry', available here.
[382] France Energie Eolienne, Capgemini Invent (2023), Wind Energy Observatory 2023, available here.
[383] WindEurope (2022), 'France commits to 40 GW offshore wind by 2050', available here.
[388] Révolution Énergétique, 09.05.2024, Hécatombe dans l'industrie solaire française : une nouvelle usine placée en liquidation judiciaire, available here.
[389] RystadEnergy, 20.07.2023, Europe hoarding Chinese solar panels as imports outpace installations; €7 billion sitting in warehouses, available here.
[390] European Heat Pump Association (April 2024), Pump it down: why heat pump sales dropped in 2023. Available here.
[391] Eurofound (2024), Saunier Duval, Internal restructuring in France, factsheet number 201405, European Restructuring Monitor. Dublin, available here.
[392] Ouest France (2023), 'Du chômage partiel en vue à l'usine Saunier Duval de Nantes', available here.
[393] Groupe Atlantic, GROUPE ATLANTIC investit 150 millions d'euros dans un nouveau site de fabrication de pompes à chaleur en Saône-et-Loire (71), France. Available here.

Country Factsheet Croatia

Key findings

Manufacturing capacity:[394] Croatia's manufacturing capacity amounts to between 300 and 350 MW/y (2% of EU capacity) for solar PV. In addition, two facilities producing batteries were identified. Moreover, Croatia is home to at least four factories that specialise in the manufacturing of heat pumps.

Industrial production:[395] Croatia's three largest industrial Net-Zero sectors by value are grid technologies, with a production amounting to EUR 702 million (1% of total EU production), EUR 338 million (a negligible share of EU production) for Wind, and EUR 281 million (a negligible share of EU production) for solar PV and thermal energy.

International positioning:[396] Croatia has significantly increased its competitiveness in exporting grid technology components, such as small insulated electric conductors for a voltage not exceeding 1000 volts and liquid dielectric transformers, with an RCA index higher than China and the USA. Croatia relies on third countries for 40% of its battery imports, with China as the primary supplier (20%), though this is lower than the EU average of 53%.

Policy framework: In Croatia, the National Hydrogen Strategy is expected to contribute to the capacity build-up for the production of electrolysers and fuel cells.

Industrial permitting: The duration of industrial permitting processes differs depending on the type of permit: environmental permits typically take 2-6 months, but may extend up to 2 years in practice, location permits take around 2.5 months, construction permits up to 2 months, and use permits up to 1.5 months.

Incentive instruments: No relevant incentive schemes have been identified.

[394] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[395] Industrial production refers to total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[396] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in Croatia[397]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[398]	Import dependence (extra-EU)[399]
	300-350 MW/y[400] *(2% of EU capacity)*	-	350 - 550 MW/y	«Negligible share of EU production» *(Disclosure: 100%)*	**0.21**
	No facilities identified[401]	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	**0.10**
	At least two facilities identified[402]	300 MW/y	-	«Negligible share of EU production» *(Disclosure: 100%)*	**0.40**
	At least four facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	**0.26**
	No facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	**0.03**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	**0.15**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	**0.15**
	At least three facilities identified	N/A	N/A	1% *(Disclosure: 100%)*	**0.26**
	−	−	−	✓	✓
	−	−	−	✓	✓

Technologies				
Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Croatia's main production facilities include Solvis's factory in Varaždin Hrvatska where solar PV modules are produced, with an estimated capacity of 300-350 MW. FRIŠ d.o.o. is an active producer of lithium-ion batteries, but no estimates on its capacity could be found. Rimac Technology, a producer of battery management systems, has announced that it will open an additional facility producing 300MW/y stationary energy storage systems in 2025.[403] Two manufacturing facilities for grid technologies were identified, Eur0Cable Group and Elka. However, their exact manufacturing capacity is unclear. Next to these two existing manufacturing facilities, a EUR 100 million investment

[397] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[398] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[399] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[400] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[401] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[402] Manufacturing capacities are primarily related to the production of battery packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[403] The SineStack battery system helps reducing losses and energy usage but also improves safety. See D. Sito-sucic, 31 January 2024, 'Electric carmaker Rimac to produce stationary energy-storage batteries', available here.

is planned by the company TTCables for the construction of a new cable factory for medium and high-voltage cables.[404]

Evolution of Croatia's international positioning

As illustrated in Figure 1, Croatia is an internationally competitive exporter of grid technology components.[405] Its export competitiveness for small insulated electric conductors for a voltage not exceeding 1000 volts has grown by 182% between 2015 and 2022. This particular component has a relatively low export market saturation rate, and Croatia's RCA is higher than that of China and the USA. With an estimated export potential of EUR 199 million, Croatia is well-positioned to play a significant role in the global export market for this grid technology component. The same applies to liquid dielectric transformers, both exceeding and not exceeding 1000 volts, where Croatia is also a high-performing exporter compared to China and the USA (Figure 2).[406]

Regarding import dependence on third countries, Croatia is particularly reliant on batteries, importing 40% from third countries, with China as its major import partner (20%). However, this is below the EU average for battery technologies, which was 53% in 2022.

[404] TTCables, 1 August 2024, 'Our new cable factory for medium and high voltage in Bedekovcina/Croatia', available here.

[405] Figures 1 and 2 present Croatia's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Croatia's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Croatia's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Croatia could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Croatia could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.

[406] Figure 2 builds upon this by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Croatia's trade strategy. Taken together, these figures provide a nuanced understanding of Croatia's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

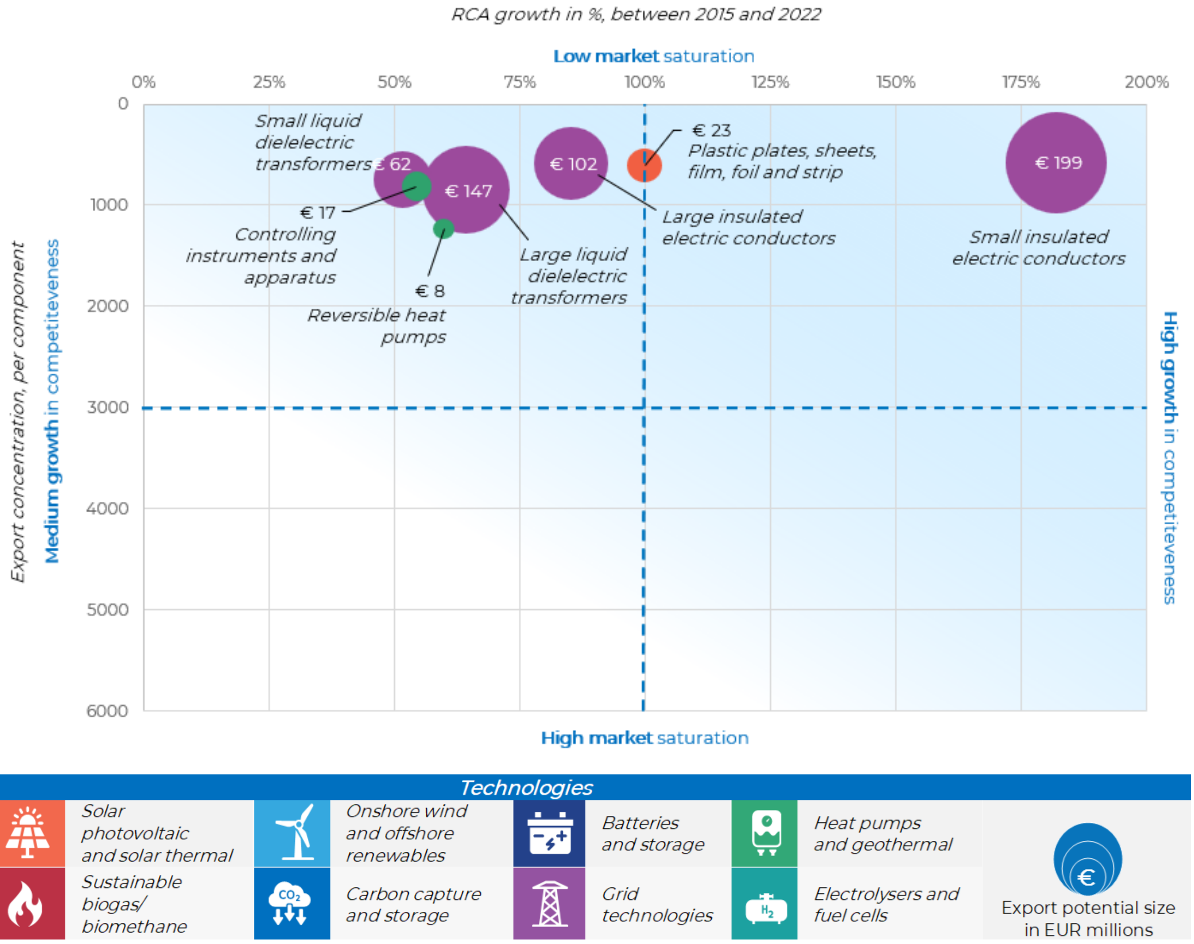
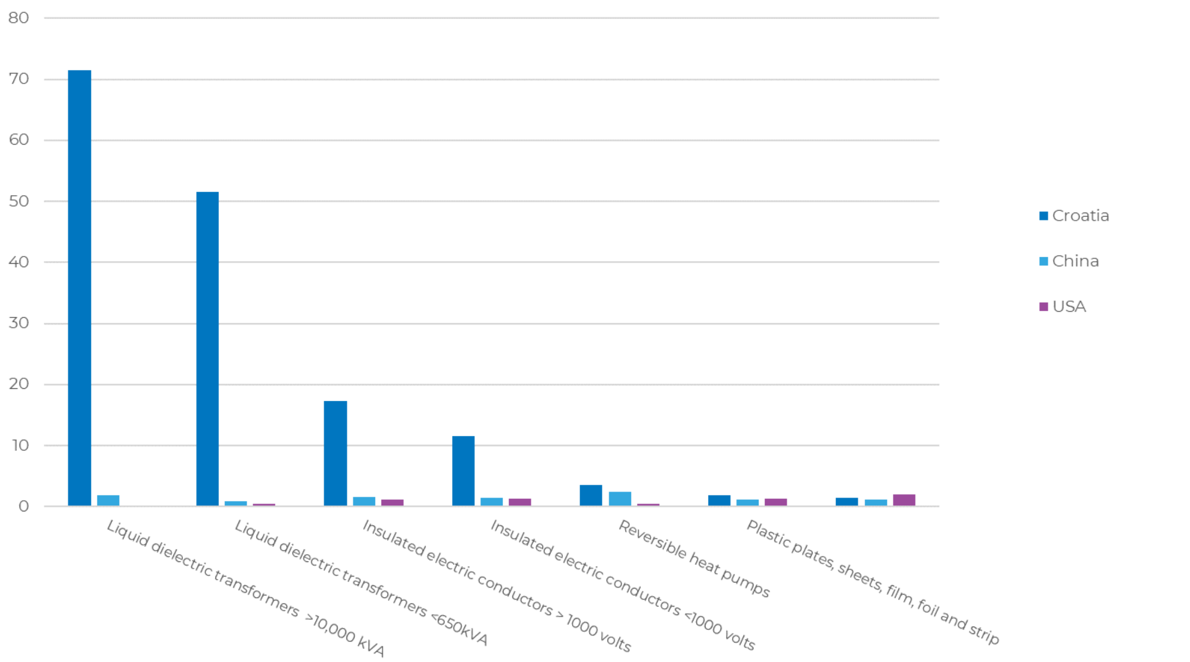


Figure 2: Absolute value of RCAs of Croatia, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

The **Croatian Hydrogen Strategy** sets out indicative possibilities for the development of the production, storage, transport, and general use of green hydrogen with the aim of reducing CO2 emissions, as well as the possibility of including the equipment production sector (such as electrolyser layers and bundles of fuel cells, measuring and control equipment, sensors, etc.). Specific objectives related to the production of hydrogen (low-carbon hydrogen and renewable hydrogen) and the storage and transport of hydrogen, including the repurposing of existing infrastructure to transport hydrogen from the production site to the place of consumption in the long term. Another objective relates to the use of hydrogen in industrial processes, agriculture, etc., as well as developing the use of hydrogen in transport by providing incentives for the purchase of hydrogen vehicles and vessels. A fourth objective focuses on education, research, and innovation to ensure the development and commercialisation of new technologies in the production, safe use and transport of renewable hydrogen.

Scope of the policy framework

Industrial permitting

Average duration[407]	Obtaining environmental permits for industrial activities generally takes between 2-6 months (although, in practice, the process can extend to up to 2 years due to necessary studies and delays).[408] A location permit takes about 2.5 months depending on the size of the land, Construction permits take up to 2 months, and use permits usually take up to 1.5 months to be processed.[409]	**One-stop shop for permitting**	No one-stop shop for permitting has been identified.

Brief summary of the permitting processes

The administrative procedure consists of obtaining a number of permits, approvals and contracts in the field of: spatial planning, environmental protection, construction, and energy regulations (including connection to the power grid, energy approval, energy permit, status of privileged electricity producer and else), but also general procedures such as concessions, easements and property-legal relations, local utility fees and the like. The basic administrative procedure consists of 12 key administrative acts at five different institutions.[410] Depending on the type, size and location, the project may include several acts and involved institutions. The process usually begins with the planning of the location in spatial plans, followed by the environmental impact assessment. In an administrative sense, the project begins with the issuance of an energy permit, the technical definition of the connection to the network and obtaining building permits.

Delays in energy and environmental permitting are major factors in prolonging the overall process. The Croatian Chamber of Commerce attributes this to insufficient administrative capacity, incomplete by-laws, and overlapping regulations. Additionally, the Ministry of Economy and Sustainable Development points to high staff turnover as a significant issue, further weakening administrative and institutional capacities. [411]

---

[407] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.

[408] Croatia Chamber of Commerce, available here

[409] Ibid.

[410] See here and here.

[411] Croatia Chamber of Commerce, available here, and stakeholder interview

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

No relevant incentive instruments have been identified

Opportunities and challenges

Opportunities

General

Croatia's strong traditional manufacturing and construction base in the energy sector can be an asset, coupled with the country's noteworthy efforts to direct capital flows towards the green transition and green investments to support its climate goals. The Croatian Smart Specialisation Strategy notably steers investments towards R&D and innovation and enabling technologies that support its climate goals[412].

Technology-specific

Regarding the manufacturing of energy storage technologies, the Croatian electric carmaker Rimac Technology will launch in 2025 a 300 MW innovative stationary energy storage system in Zagreb.[416] While a pilot project has been launched in 2024 with another Croatian company, the technology could become a strong export product thanks to its cost competitiveness and efficiency.[417] The Croatian carmaker notably announced a long-term deal with BMW to produce high-voltage batteries and intends to expand to the rest of Europe. [418]

Regarding solar components, Croatia is home to Solvis, which currently has 2 factories that produce modules and a total capacity of 300 MW. The company has planned an additional factory with a capacity of 300 MW for the start of Q2 in 2025. An opportunity also for domestic manufacturers is that Croatia offers one of the highest potentials for solar energy in the EU as well as favourable conditions such as a reduced VAT rate and support for agrivoltaic deployment. However, grid and permit bottlenecks have been seriously slowing down deployment[419].

There is potential in Croatia regarding grid technologies due to high export competitiveness for both large and small insulated electric conductors as well as liquid dielectric transformers. Current manufacturing capacities are however low with only a few companies such as EuroCable Group and Elka. However, a EUR 100 million investment is planned by

Challenges

General

Croatia faces a significant challenge in securing a skilled workforce that meets the demand from its companies, notably in renewable energy engineering. Innovation and competitiveness are also hindered by the lack of managerial and entrepreneurial skills among its workforce[413]. The emigration of skilled workers is higher than for other EU Member States which further affects smart and clean energy companies[414]. A second challenge for Croatia is its lack of specialised R&D institutions for solar PV and other Net-Zero technologies such as grids.[415]

Technology-specific

Regarding energy storage technologies, one of the fundamental challenges of scaling up manufacturing is accessing the necessary raw materials in sufficient quantities, as discussed in the main report. Similarly to other battery manufacturing hubs, Croatia relies on extra-EU imports for batteries, mainly from China. Although with 40% of extra-EU imports, this reliance remains lower than the EU average at the EU level.

---

[412] EC-OECD (2024), STIP Compass: International Database on Science, Technology and Innovation Policy (STIP), edition September 13, 2024, available here.
[413] World Bank (2022), Report on Smart Skills, *Croatia Public Expenditure Review in Science, Technology and Innovation,* see here.
[414] Ibid.
[415] Netherlands Enterprise Agency (2023) Factsheet. Renewable Energy in Croatia, available here.
[416] The SineStack battery system helps reduce losses and energy usage but also improves safety. See D. Sito-sucic, 31 January 2024, 'Electric carmaker Rimac to produce stationary energy-storage batteries', available here.
[417] Lauren Simmonds, 15 March 2024, 'New Rimac battery system now in certification phase', available here.
[418] Ibid.; See also Kathryn Fisk, 12 April 2024, 'Rimac to build high-tech batteries for future BMW electric cars', available here.
[419] Angela Skujins, 30 November 2023, 'Croatia's solar streak marred by 4-year finalization waiting times', available here.

the company TTCables for the construction of a new cable factory for medium and high-voltage cables.[420]	

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

[420] TTCables, 1 August 2024, 'Our new cable factory for medium and high voltage in Bedekovcina/Croatia', available here.

Country Factsheet Hungary

Key findings

Manufacturing capacity:[421] Hungary's manufacturing capacity amounts to between 40 and 42 GWh/y (17-18% of total EU capacity) for battery and storage technologies and between 100 and 400 MW/y (approximately 1-2% of the EU capacity) for solar PV, with capacity for both equal shares of modules and cells. Additionally, there are five facilities in Hungary dedicated to the production of heat pumps.

Industrial production:[422] Hungary's three largest industrial Net-Zero sectors by value are batteries, with a production amounting to EUR 6.0 billion (26% of total EU production), EUR 1.0 billion (1% of EU production) for solar PV and thermal energy, and EUR 0.8 billion (1% of EU production) for grid technologies.

International positioning:[423] Hungary is an internationally competitive exporter of heat pump components, such as centrifugal pumps, heat exchange units, and electric generating sets. For the latter, it also has a higher RCA than China and the USA. Hungary is also a competitive exporter of electrical static converters, an essential component in solar PV technologies. However, this component has a considerably high rate of market saturation, with China holding 39% of the global export market share in 2022.

Policy framework: Currently, Hungary has national strategies on hydrogen, batteries and a broader strategy to support the development of clean technologies in place that can support the build-up of manufacturing capacity for Net-Zero technologies in the country.

Industrial permitting: The average duration of industrial permitting procedures is usually at least one year and may extend depending on specific circumstances.

Incentive instruments: In Hungary, incentives are in place that support investment in Net-Zero technologies. This includes investment support for companies expanding their production capacities in relation to renewable energy technologies. A skill programme is in place providing post-secondary education in the hydrogen sector.

[421] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[422] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[423] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides details on each indicator.

Key descriptive statistics for Net-Zero technologies in Hungary[424]

	Manufacturing Capacity (MW), % of EU-27	Additional announced capacity (MW) (2024-25)	Additional announced capacity (MW) (2026 onwards)	Industrial production % of EU-27 (component disclosure rate)[425]	Import dependence (extra-EU)[426]
	100 – 400 MW/y[427] *(1-2% of EU capacity)*	150 - 250 MW/y	1750 - 2000 MW/y	1% *(Disclosure: 76%)*	0.39
	No facilities identified[428]	-	-	1% *(Disclosure: 47%)*	0.86
	40000 - 42000 MWh/y[429] *(17-18% of EU capacity)*	15000 - 16500 MW/y	98000 - 155000 MW/y	26% *(Disclosure: 100%)*	0.67
	At least five facilities identified	-	-	1% *(Disclosure: 47%)*	0.33
	No facilities identified	-	-	1% *(Disclosure: 79%)*	0.01
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 83%)*	0.13
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 80%)*	0.05
	N/A	N/A	N/A	1% *(Disclosure: 62%)*	0.37
	⊖	⊖	⊖	⊖	✓
	⊖	⊖	⊖	⊖	✓

Technologies

Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Hungary's main production facilities include SK Innovation's battery factory in Komaron, with an estimated capacity of around 7.5 GW and the EcoSolifer solar cell manufacturing facility in Csorna with an estimated capacity of 100 MW. Substantial manufacturing facilities for batteries are announced by Automotive Cells Co SE (40 GWh, although the starting date is unknown), SK Innovation (30 GWh by 2028) and Eve Energy (28 GWh ready by 2026). Four manufacturing facilities of heat pumps, which, include a newly built facility by the Swedish manufacturer Qvantum.[430]

---

[424] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[425] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[426] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[427] Manufacturing capacity is provided exclusively for solar photovoltaic and does not include capacities for solar thermal manufacturing. Hungary produces both modules and cells, Additional capacities are also for both modules and cells, the relative share between modules and shares will remain around 50%.
[428] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[429] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[430] PV Magazine (2023). Qvantum plans a heat pump factory in Hungary. Available here.

Evolution of Hungary's international positioning

As illustrated in Figure 1, Hungary is found to be an internationally competitive exporter of heat pump components, such as centrifugal pumps, heat exchange units, and electric generating sets.[431] For the latter, Hungary increased its exports by 52% between 2015 and 2022 to EUR 290 million, boosting its RCA index by over 130% during the same period. With an RCA of 21, Hungary outperforms both China and the USA in terms of competitiveness for this component (Figure 2).[432] Considering these three heat pump technology components together, Hungary is estimated to have over EUR 1.1 billion in untapped export potential. Moreover, these components have a relatively low export concentration, suggesting that their export markets are not dominated by a single exporter.

Hungary is also a competitive exporter of electrical static converters, an essential component in solar PV technologies. For this component, Hungary is estimated to hold over EUR 1.8 billion in untapped export potential. However, this component is calculated to have a considerably high rate of market saturation. This is primarily due to China's competitive position in the export of this component, holding 39% of the global export market share in 2022, followed by Germany (8.6%) and the USA (4.7%).

[431] Figures 1 and 2 present Hungary's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Hungary's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand.
This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Hungary's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Hungary could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Hungary could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.

[432] Figure 2 builds upon this by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Hungary's trade strategy. Taken together, these figures provide a nuanced understanding of Hungary's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

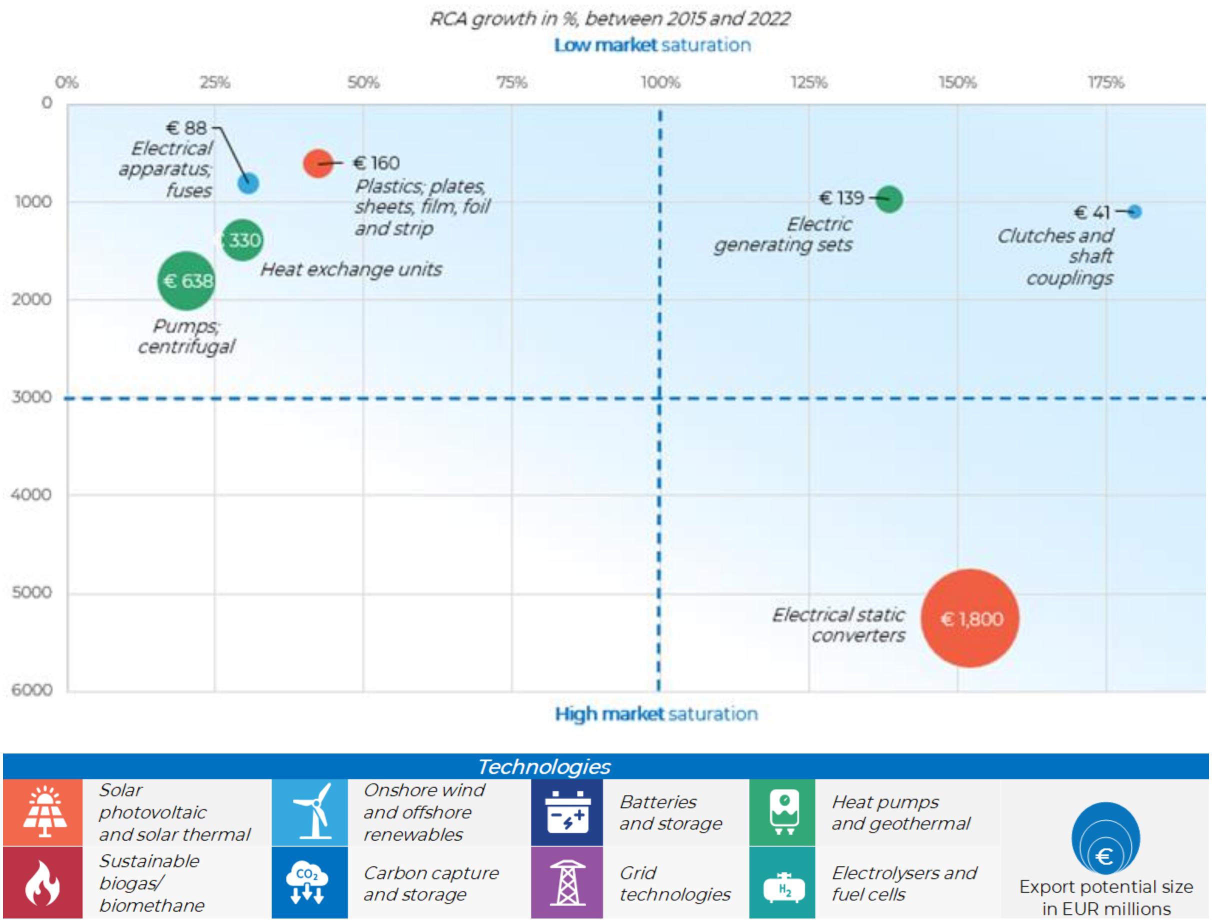
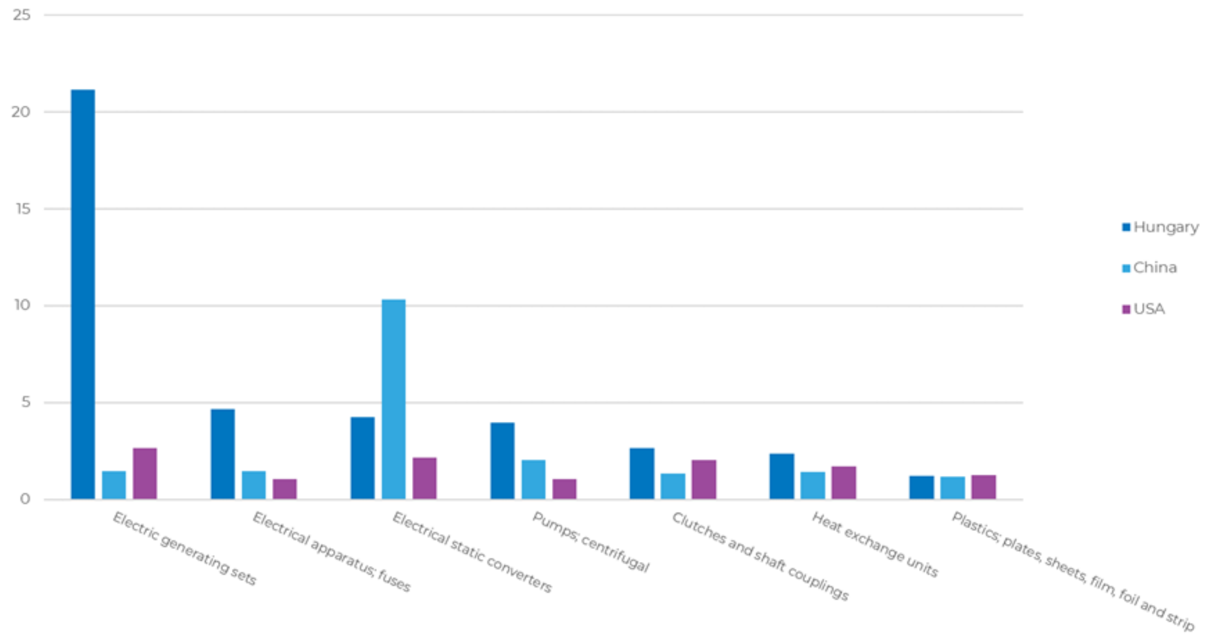


Figure 2: Absolute value of RCAs of Hungary, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

Hungary's National Hydrogen Strategy outlines the country's vision for developing hydrogen and aims to make Hungary an active player in the European hydrogen space. One of the medium-term objectives identified within the framework of industrial development is to increase electrolyser manufacturing capacity mostly based on licenses, in cooperation with international partners. The strategy also foresees the establishment of two new hydrogen valleys in Hungary.

The **National Battery Industry Strategy 2030's vision** supports the creation of a Hungarian battery value chain based on high Hungarian value-added services and production, and the joint value creation of international and national actors that are embedded in the European ecosystem and committed to environmentally and socially sustainable battery production. The strategy includes measures such as providing national regulatory frameworks building on EU-level regulation to create new business opportunities, developing financial instruments to support sustainable technologies for innovative clean technology companies in the battery value chain, creating incentives to finance sustainable investments and providing financial support for workforce training along the entire value chain.

The **National Clean Development Strategy 2020-2050** identifies some intervention areas linked to stimulating the use of renewables. One of the main goals set by the government is to increase the resilience and sovereignty of the country notably regarding high-tech and green technologies development. To realise these goals, the strategy sets several objectives. These include providing a supportive environment and dedicated financial resources for micro, small and medium-sized enterprises that use innovative and environmentally friendly solutions to strengthen their market opportunities, specific (ad-hoc) tender programs for targeted economic stimulus interventions and a continuous dialogue with stakeholders.

Scope of the policy framework

[✓]	[✓]	✓	[✓]	✓	[✓]	[✓]	[✓]

Industrial permitting

Average duration[433]	The average duration is usually at least one year and may extend depending on specific circumstances (e.g., a project having archaeological significance). Environmental permitting procedures usually take between half a year and a full year from the application phase to the obtention of the permit.	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

Brief summary of the permitting processes

No specific permitting procedure was identified. For manufacturing plants, land permits are usually required for securing the construction area, additional permits may apply depending on the manufacturing capacity and technology used.

Environmental protection permits for activities with significant environmental impact listed in Annex 1 and Annex 3 of Government Decree 314/2005 (XII. 25.) are required. Environmental permits for specific activities (e.g., battery plants, geothermal energy production facilities, wind power plants and wind farms above a

[433] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.

certain capacity or located in protected natural and Natura 2000 areas) are subject to an environmental impact assessment procedure.

The single environmental use permit (IPPC permit) may be issued as a permit for activities listed in Annex 2 of Government Decree 314/2005 (XII. 25.). The issuance of an IPPC permit is subject to a single environmental permit procedure (possibly in conjunction with the environmental impact assessment procedure).

The environmental impact assessment of a renewable project is required if the project exceeds certain thresholds in terms of the size of the land or the installed capacity and pursuant to a preliminary assessment, the project has a significant impact on the environment (see also above). If a project is subject to environmental impact assessment, the activity may only begin after the issuance of the environmental protection permit.

Additionally, other permit procedures may include building permits and grid connection agreements (with the Hungarian transmission system operator (TSO), MAVIR Zrt. or the distribution companies).

The industrial permitting process is partially digitalised, but the level of digitisation is not at the point where it is truly a one-stop shop or a fully integrated process. The building permit procedure is fully digitalised by using the electronic documentation system.

Procurement

No relevant procurement rules have been identified.

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified[434]	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

New subsidy scheme under Government Decree No. 210/2014 (VIII.27) (A 210/2014 (VIII.27.) Kormányrendelet szerinti új támogatási rendszer)

2023 – 2025	**Grants and/or tax advantages**	**Total funding available: €2.36 billion**
Technologies: Batteries and storage technologies, solar technologies, wind technologies, heat pumps and geothermal energy technologies, electrolysers and fuel cell technologies, CCS technologies	**Eligibility:** According to the regulation, the amount of support for investments varies depending on cities and district capitals and is determined by the eligible costs of the investment.	**Available support:** The intensity of support in Budapest cannot exceed 15% of the eligible costs of the investment, max EUR 150 million at current prices. In settlements outside Budapest, the investment support cannot exceed 35% of its costs, provided that the level of support is no more than EUR 350 million. The support amount takes into account the significance and size of the investment. The subsidy cannot be higher than what the investor could demonstrably get for a similar investment in a third jurisdiction outside the EEA or more than the amount needed to cover the financing gap.

Description: This 2023 amendment to Government Decree 210/2014 aims at facilitating investments in Net-Zero technologies manufacturing. The new provisions introduce subsidies into Net-Zero technology investments in the country. The measures have been screened and approved by the Commission following a review under the GBER process.

Recovery and Resilience Facility REPowerEU Chapter: Investment 4: Building green economic manufacturing capacity (Magyarország Helyreállítási és Ellenállóképességi Terve REPowerEU-fejezet: Beruházás 4: Zöld gazdasági gyártókapacitások kiépítése)

[434] Hungary has a general background regulation for the application of regulatory sandboxes, but until now no special sandbox has been set up.

2024 - 2026	**Grant**	**Total funding available: €504 million**
Technologies: Potentially all	**Eligibility:** Manufacturing capacity development and service expansion projects that result in a product or service that contributes to the green transition may be eligible.	**Available support:** Aid intensity: maximum 50%
Description: The aim is to create and develop green industrial manufacturing capacity and services. The scheme notably supports investments in the production of Net-Zero technologies.		

Vocational training in hydrogen technology (Hidrogéntechnológiai szakképzés)		
Since 2023	**Skills programme**	**Type of programme:** Post-secondary education programme
Technologies: Electrolysers and fuel cell technologies	**Description:** The Hydrogen Technology Association and DUNAGÁZ Gas Industry Education and Qualification Ltd. launched a training course for hydrogen technology specialists. The training program aims to enhance know-how and expertise in Hungary. The general goal is to train engineers who have the appropriate technical knowledge and skills in the field of operation, production and further development of fuel cells and related hydrogen technology equipment for the specialized areas of the mechanical industry and energy sector.	

Opportunities and challenges

Opportunities	Challenges
General As Hungary phases out coal, it can leverage the EU's Just Transition Fund (JTF) and other initiatives to support economic diversification and clean energy projects in affected regions. Three of Hungary's regions are eligible for funding from the JTF, which will also support the reskilling of the workforce with the potential to support skill development in Net-Zero technologies.	**General** The labour shortage is a significant concern among Hungarian companies, which is not necessarily limited to highly skilled labour. Hungary has therefore started attracting foreign nationals through temporary agencies including Serbians, and Ukrainians but also guest workers from other third countries such as the Philippines[435].
Technology-specific In terms of lithium-ion battery production capacity, Hungary is one of Europe's leaders and the country has high ambitions with its 2024 National Battery Strategy aiming to increase production to 87 GWh by 2030. Hungary benefits from its attractiveness to foreign direct investment for Asian firms as the country can serve as "a bridge between East Asian battery manufacturers and European automotive OEMs" while also providing cheaper labour costs, cheap land and natural resources and subsidies[436]. For heat pumps and geothermal energy, while only being a minor producer (e.g. of pumps and compressors, thermostats and regulators), Hungary is particularly competitive for centrifugal pumps, heat exchange units and electric generating sets and has a combined untapped export potential of over EUR 1.1 billion[437]. Moreover, the domestic market has also huge potential with the government aiming to install at least 100,000 systems or 400 MW of heat pumps by 2030. Similarly, Hungary has a huge potential for the deployment of geothermal energy especially for district heating according to the IEA[438].	**Technology-specific** The labour shortage is particularly an issue in the battery value chain where many jobs have been created with companies attracting workers from each other, other value chains and third countries. Current retraining and vocational training programmes in Hungary are struggling to provide the necessary skills for the battery industry[439]. While Hungarian battery companies cover the whole value chain (apart from raw material extraction), Hungary faces a high extra-EU import dependency of 67%[440] due to the overall dependency of the battery value on Asian suppliers.

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential

[435] Oxford Analytica (2024), "Hungary will ease immigration to meet labour shortage", available here.
[436] Márton Czirfusz (2023). The battery boom in Hungary: Companies of the value chain, outlook for workers and trade unions. Available here.
[437] See the above RCA for Hungary and the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[438] IEA (2022), Hungary 2022, IEA, Paris https://www.iea.org/reports/hungary-2022, Licence: CC BY 4.0
[439] Márton Czirfusz (2023). The battery boom in Hungary: Companies of the value chain, outlook for workers and trade unions. Available here.
[440] See the above descriptive statistics for Hungary and the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.

Country Factsheet Ireland

Key findings

Manufacturing capacity:[441] Ireland's manufacturing capacity across Net-Zero technologies remains limited.

Industrial production:[442] Ireland's current industrial production amounts to EUR 945 million (1% of total EU production) in components that can be used in the wind power industry, EUR 364 million (a negligible share of EU production) for grid technologies, and EUR 227 million (a negligible share of EU production) for components that can be used for solar PV and thermal energy applications.

International positioning:[443] Ireland is a competitive exporter of two key components in the solar PV value chain: electric integrated circuits and plastic components. For the former, it also has a significantly higher RCA than China and the USA.

Policy framework: Currently, Ireland has an Offshore Wind Industrial Strategy in place that can support the build-up of manufacturing capacity for Net-Zero technologies in the country.

Industrial permitting: The average duration of industrial permitting new production facilities for Net-Zero ranges between 15 to 24 months for environmental permits.

Incentive instruments: In Ireland, incentives are in place that support investment in Net-Zero technologies. This includes the Disruptive Technologies Innovation Fund which provides support to the development of renewable energy equipment and other innovative technologies. Two skill programmes are in place providing vocational training and upskilling opportunities in the renewable energy industries.

---

[441] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).

[442] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.

[443] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides details on each indicator.

Key descriptive statistics for Net-Zero technologies in Ireland[444]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[445]	Import dependence (extra-EU)[446]
	At least one facility identified [447]	250 - 350 MW/y	-	«Negligible share of EU production» *(Disclosure: 68%)*	0.94
	No facilities identified[448]	-	-	1% *(Disclosure: 58%)*	0.14
	At least two facilities identified[449]	-	-	«Negligible share of EU production» *(Disclosure: 86%)*	0.77
	No facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 59%)*	0.54
	No facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 84%)*	0.59
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 72%)*	0.74
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 70%)*	0.46
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 74%)*	0.62
	⊖	⊖	⊖	⊖	✓
	⊖	⊖	⊖	⊖	✓

Technologies

	Solar photovoltaic and solar thermal		*Onshore wind and offshore renewables*		*Batteries and storage*		*Heat pumps and geothermal*		*Electrolysers and fuel cells*
	Sustainable biogas/ biomethane		*Carbon capture and storage*		*Grid technologies*		*Data coverage*		*Data reliability*

Ireland's main production facilities for li-ion batteries are the Xerotech in Galway and Li-Gen in Tipperary, while Nines photovoltaics produces solar PV cells in Dublin. Eirsun has announced the opening of a facility producing solar PV modules by 2024, with an expected capacity of 250 - 350 MW per year.

[444] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[445] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[446] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[447] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[448] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[449] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.

Evolution of Ireland's international positioning

Ireland has emerged as a competitive exporter of two key components in the solar PV value chain: electric integrated circuits and plastic components. Between 2015 and 2022, Ireland significantly enhanced its competitive position in these markets, with the RCA for electric integrated circuits soaring by 199% and for plastic components by 158%. Ireland's RCA for electronic integrated circuits reached almost 6, eclipsing major export competitors such as China and the USA. Nonetheless, the landscape of Irish exporters remains relatively constrained, with only a limited number of key players actively participating in the market.

Regulatory and incentive landscape

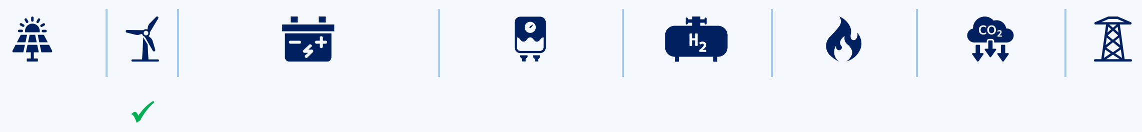
Policy framework

The **Offshore Wind Industrial Strategy** focusing on action in 2024 and 2025, sets out a pathway to 2030 for Ireland to become internationally recognised as a source of growing entrepreneurial companies that offer innovative value propositions to the offshore wind sector both at home and overseas. Measures within the strategy to strengthen manufacturing capacities include the establishment of an Offshore Wind Centre of Excellence (OWCE) in Ireland to facilitate collaboration between supply chain companies, government agencies, and education institutions to access and implement new technologies, such as floating offshore wind and digital solutions, to address industry challenges and enhance sector competitiveness.

The strategy will investigate Green Energy Industrial Parks, aiming to provide comprehensive property, utility, and infrastructure solutions on a large scale. These parks would attract significant investments, situated alongside renewable energy generation sites. This approach creates new industrial opportunities, especially in areas where complementary renewable energy sources like offshore and onshore wind are available or can be developed.

The strategy aims to deliver up to 5,000 jobs in the offshore wind sector and related industries.

Scope of the policy framework



Industrial permitting

Average duration[450]	It can take up to 15-24 months to process licenses such as Industrial emissions licences within the EPA. The length of the procedure depends on the nature, size, and complexity of the project. The planning authorities make decisions within 8 weeks with an additional 4 weeks allowed for applications that require an environmental assessment.	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

[450] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.

New legislation in October 2024 means that timelines are being introduced for appeals as well as the various consent applications made directly to An Coimisiún Pleanala, including Strategic Infrastructure Developments.

These periods will range from 18 weeks for appeals of decisions of planning authorities, to 48 weeks for Strategic Infrastructure Developments.

Brief summary of the permitting processes

The overall permitting process includes the obtention of several permissions or licences**.** There are 67 permits/licences across 18 Issuing Bodies. The main permits are issued by the Planning Authorities and the Environmental Protection Agency (EPA).

Examples of EPA permits include Integrated Pollution Control (IPC) licences and Industrial Emissions (IE) licences. These licenses are to prevent and control pollution from industrial activities. The administrative process for obtaining an IPC or IE license begins with the operator of a proposed industrial facility submitting an application to the EPA, detailing the activity, potential emissions, proposed control measures, and an assessment of the environmental impact. The applicant must also publish a notice of the licence application in a local or national newspaper and erect a site notice to inform the public and invite submissions or observations within a specified period. The EPA reviews the application, considering the potential impacts on air, water, and soil, and may request additional information. Consultations with relevant bodies, such as local authorities and the Health Service Executive (HSE), are conducted. Based on the assessment and consultations, the EPA decides to grant or refuse the license. The decision is published, and those who made submissions or observations are informed.

An Environmental Impact Assessment Report (EIAR) often accompanies an IPC or IE license application. The EIA process involves:

- screening to determine whether a project requires an EIA,
- scoping to determine the content and extent of what should be covered in the EIAR,
- preparation of said EIAR which describes the likely significant effects of the project on the environment and measures to mitigate these effects.

For industrial emissions, licensing, and integrated pollution control, the majority of the application, including the submission of the EIAR, is digitalised however, there are requirements to erect physical site notices and publish notices in local newspapers.[451]

In addition to an IPC or IE licence, planning permission[452] may also be required for the proposed industrial facility. In such circumstances, a planning application is submitted to the relevant planning authority or to An Coimisiún Pleanala (as may be appropriate for certain large-scale projects). The planning application may need to be accompanied by an EIAR, to address environmental matters not covered by the EIAR submitted with the IPC or IE licence application. As part of the planning process, a public consultation will be held, providing an opportunity for the public and, inter alia, environmental agencies to make submissions or observations on the planning application and any accompanying EIAR., The planning authority or An Coimisiún Pleanala will decide whether to grant permission, subject to or without conditions or to refuse permission. The enforcement of conditions attached to a grant of planning permission is a matter for the relevant planning authority. A decision of the planning authority may be appealed to An Coimisiún Pleanala.

Similar to the process for IPC and IE licences, the majority of the planning application process, including the submission of the relevant EIAR, is digitalised. However, this can depend on the individual systems in place by the local planning authorities where the project is located[453]. Notwithstanding the ongoing requirement to erect physical site notices and publish notices in local newspapers, all planning authorities are moving towards the implementation of a digitalised planning application process.

The key drivers of the permitting procedure's length include several factors such as available resources of individual permitting bodies, application prioritisation and the quality of the submitted application[454].

[451] See here.
[452] See here.
[453] See here.
[454] See here.

While not acting as a one-stop-shop, the Sustainable Energy Authority of Ireland (SEAI) operates the Single Point of Contact[455] for guidance on the licencing and permitting requirements for renewable energy projects in Ireland (including solar, wind, thermal, battery storage and district heating).

Procurement

No relevant procurement rules have been identified. The provisions of the NZIA will apply.

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

Disruptive Technologies Innovation Fund (DTIF)

Since 2018 (annual calls)[456]	**Grant**	**Total amount available under the Fund: EUR 500 million, Total amount awarded to date: EUR 371 million[457]**
Technologies: Potentially all.[458]	**Eligibility:** Open to projects that will potentially alter markets, alter the way businesses operate, involve the creation of new products, or contribute to the emergence of new business models.[459]	**Available support:** All projects should be seeking minimum funding of €1.5 million over three years. Each project is to have at least three independent partners seeking funding from DTIF, including at least one SME and one other enterprise partner. SMEs can claim no more than 50% of their eligible costs, whereas large companies can claim no more than 40% of their eligible costs. Research organisations (including colleges) can claim up to 100% of their eligible costs but can receive no more than 50% of the total DTIF grant aid per project.

Description: The Disruptive Technologies Innovation Fund seeks to invest in the development and deployment of disruptive technologies and applications on a commercial basis, drive collaboration between Ireland's world-class research base and industry, facilitate enterprises to compete directly for funding in support of the development and adoption of these technologies and seed a new wave of start-ups. The Fund supports projects addressing one of the six National Research Priority Areas, including manufacturing and materials.

Green Tech Skillnet

Since 2014 (annual calls)	**Since 2014 (annual calls)**	**Since 2014 (annual calls)**
Technologies: (Offshore) wind, grid and solar technologies	**Description:** The Green Tech Skillnet is an enterprise-led network facilitating the workforce and development needs of the Irish renewable energy industry. The network is co-funded by Skillnet Ireland and Network companies. Skillnet Ireland is funded through the Department of Further and Higher Education, Research, Innovation, and Science. The network in its previous guise as Wind Skillnet,	

[455] See here.
[456] The DTIF is one of the four funds in the National Development Plan 2018-2027. DTIF projects can be funded for up to three years. See here.
[457] Based on the latest information provided in 2024. See here.
[458] The Fund refers to renewable energy equipment and other innovative technologies.
[459] The call for applicants for 2024 notes that the maximum project duration is three years and that projects of less than two years duration are unlikely to be funded. See here.

	successfully delivered value-added training and networking activities to the wind industry over the past 10 years through its contracting organisation, the Wind Energy Ireland (WEI). Since 2014, the network has successfully engaged 1,149 trainees over 2,050 training days equating to approximately 25% of those employed within the wind industry in Ireland.
Skills for the Green Transition	
Since 2024	**Skills programme** **Type of programme:** Upskilling
Technologies: solar, offshore wind, batteries and storage, heat pumps and grid technologies	**Description:** The Department of Further and Higher Education, Research, Innovation and Science supports numerous initiatives to meet the challenges and skills needs of the green transition – from developing transferable green skills for life to specific requirements for emerging green sectors such as Near Zero Energy Buildings/ Retrofit, eMobility and sustainability. The national agency SOLAS has recently launched a new National Strategy on Further Education and Training (FET) Skills for the Green Transition. This Strategy outlines how the FET sector can ensure the challenges and skills needs associated with the green transition are met, including by developing new courses, updating curricula, and expanding clear FET pathways. Skills and training initiatives developed in recent years include the establishment of a dedicated skills and workforce Workstream as part of the cross-government Offshore Wind Energy Programme; the expansion of green skills courses through the Human Capital Initiative and Springboard+; and the development of enterprise-focused sustainability courses in the FET sector. In recognition of the growing importance of green skills development, additional funding of €5m has been allocated in 2025, through the NTF Skills Package, to allow SOLAS and Skillnet Ireland to develop targeted interventions in areas including renewable energy and offshore wind, sustainable construction, and electric vehicle skills.

Opportunities and challenges

Opportunities	Challenges
General Ireland boasts a high attractiveness for international investments due to high productivity, a skilled workforce, policy stability and a business-friendly environment.[460] Specifically, Ireland's Centres of Excellence promote collaboration between industry and research institutions and Ireland has prospects to advance manufacturing in emerging technologies such as hydrogen, bioenergy, ocean energy and offshore wind.[461]	**General** A challenge to the timely delivery of projects is the range of permits (67 permits/licences) required across 18 Issuing Bodies. It can take 15 to 24 months to obtain all relevant permits under the EPA. There is a need for a more effective and efficient link between the various consenting regimes.[462]
Technology-specific In the solar value chain, Irish competitiveness has been particularly strong for electric integrated circuits and plastic components. This could unlock further growth of the sector as these components have a respective EUR 8.9 billion and EUR 420 million estimated untapped export potential.[463] Ireland's Offshore Wind Industrial Strategy foresees several measures to strengthen its manufacturing capacities including the set-up of an Offshore Wind Centre of Excellence and Green Energy Industrial Parks.	**Technology-specific** Ireland faces a strong extra-EU import dependency for solar with 94% of extra-EU imports and for batteries with 77% of extra-EU imports.[464] Generally, there is a high import dependency in Ireland across the Net-Zero technologies.

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential

[460] IMD World Competitiveness Yearbook 2024, available here.
[461] IEA (2019), Ireland 2019, IEA, Paris https://www.iea.org/reports/energy-policies-of-iea-countries-ireland-2019-review, Licence: CC BY 4.0.
[462] This also affects the deployment of renewable energy and infrastructure, for example, WindEurope reports that there are 0.6 GW of wind energy developments, with planning permission, waiting for their grid connection offer.[462] See WindEurope (2024) Grid access challenges for wind farms in Europe, available here.
[463] See the above descriptive statistics for Ireland and the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[464] See the above descriptive statistics for Ireland and the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.

Country Factsheet Italy

Key findings

Manufacturing capacity:[465] Italy's manufacturing capacity amounts to between 2.7 and 2.8 GW/y (14% of EU capacity) for solar PV, with capacity equally distributed in modules (1.2-1.3 GW) and cells (1.5GW); between 3.5 and 3.8 GW/y (4% of EU capacity) for wind power. This includes the capacity of approximately 1 – 1.1 GW for towers and 2.5-2.7 GW for blades; between 310 and 325 MW/y (5-6% of EU capacity) for electrolysers; and between 200 and 350 MWh/y (a negligible share of total EU capacity) for battery and storage technologies. Italy is also home to at least fifty factories that specialise in the manufacturing of heat pumps, further diversifying its manufacturing portfolio.

Industrial production:[466] Italy's three largest industrial Net-Zero sectors by value are wind power, with a production amounting to EUR 11.9 billion (12% of total EU production), EUR 11.3 billion (14% of EU production) for solar PV and thermal energy, and EUR 9.6 billion (13% of EU production) for grid technologies. Italy is a leading cable manufacturer, owing to the presence of the Prysmian Group in the country.

International positioning: [467] Italy is a strong exporter of components that can be used in the solar PV and solar thermal industry, including solar plates, sheets, and film. Italy is also an important exporter of high-voltage cables and machinery that can be used in the production of sustainable biogas.

Policy framework: Italy's policies for Net-Zero technologies are outlined in the 2021 National Recovery and Resilience Plan (PNRR) and subsequent updates, which allocated significant funds to renewable energy and Net-Zero technologies. The National Hydrogen Strategy Preliminary Guidelines emphasise the need for increased electrolysers' production. Additionally, legislative measures support biogas and biomethane production and regulate the permanent geological storage of CO2.

Industrial permitting: Italy does not have a specific industrial permitting procedure solely for manufacturing Net-Zero technologies. Permits are granted at various institutional levels and must comply with urban planning, environmental, and historical constraints. Environmental Impact Assessment (VIA) procedures, as established in the relevant regulations, can take anywhere from 5 or 6 months up to more than one year to complete, depending on the complexity of the project and specific circumstances. A recent "Simplification" decree-law expedites the process for projects under the National Recovery and Resilience Plan (PNRR) to 175 days. In practice though, delays can still occur, extending the process to various years.

Incentive instruments: Italy offers various incentive schemes for Net-Zero technologies. In particular, development contracts provide substantial support for large-scale investments, including EUR 1 billion for renewables and batteries and EUR 2 billion for zero-emission technologies under the National Recovery and Resilience Plan (PNRR).

[465] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[466] Industrial production refers to total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[467] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in Italy[468]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[469]	Import dependence (extra-EU)[470]
Solar photovoltaic and solar thermal	2700 - 2800 MW/y[471] *(14% of EU capacity)*	3400 - 4250 MW/y	2000 - 8500 MW/y	14% *(Disclosure: 78%)*	0.38
Onshore wind and offshore renewables	3500 - 3800 MW/y[472] *(4% of EU capacity)*	-	-	12% *(Disclosure: 89%)*	0.73
Batteries and storage	200 - 350 MWh/y[473] *(negligible share of EU capacity)*	600 - 5000 MW/y	35500 - 113000 MW/y	2% *(Disclosure: 73%)*	0.40
Heat pumps and geothermal	At least 50 facilities identified	-	-	16% *(Disclosure: 82%)*	0.39
Electrolysers and fuel cells	310 - 325 MW/y *(5-6% of EU capacity)*	1900 - 2100 MW/y	300 - 600 MW/y	7% *(Disclosure: 68%)*	0.13
Sustainable biogas/ biomethane	N/A	N/A	N/A	12% *(Disclosure: 78%)*	0.54
Carbon capture and storage	N/A	N/A	N/A	9% *(Disclosure: 70%)*	0.31
Grid technologies	N/A	N/A	N/A	13% *(Disclosure: 82%)*	0.34
Data coverage	–	–	–	–	✓
Data reliability	–	–	–	–	✓

Technologies									
	Solar photovoltaic and solar thermal		*Onshore wind and offshore renewables*		*Batteries and storage*		*Heat pumps and geothermal*		*Electrolysers and fuel cells*
	Sustainable biogas/ biomethane		*Carbon capture and storage*		*Grid technologies*		*Data coverage*		*Data reliability*

Italy is a strong Net-Zero manufacturer, especially in the solar PV, wind power, and grid technology value chains. Italy's main production facilities in the on- and offshore wind power industry include the Vestas offshore blade facility in Taranto, and the eTaBlades (part of Nabla Wind Hub) facility in Fano. Italy is also home to some of the EU's larger manufacturers of solar modules, including Enel Greenpower's 3Sun Gigafactory in Sicily, with a current operational capacity of at least 200MW which is reportedly expected to increase to 3GW within 2024[474]; and Futurasun in the Veneto region. Italy is also an EU and global leader in the production of cables and systems for power transmission and distribution, owing, in large part, to the presence of the Prysmian Group in the country. Announced manufacturing facilities include Faam SpA's 8 GWh battery production facility to be opened by 2028 in the Campania region.

---

[468] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[469] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[470] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[471] Manufacturing capacity is provided exclusively for solar photovoltaic and does not include capacities for solar thermal manufacturing. Italy's manufacturing capacity is focused on modules, around 30% of the capacity is aimed at PV cell production.
[472] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[473] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[474] See here: Balkan Green Energy News, 09.02.2023, Enel's 3Sun to become biggest solar panel factory in Europe, available here.

Evolution of Italy's international positioning

As illustrated in Figure 1, Italy is an internationally competitive exporter of various Net-Zero technology components.[475] Notably, for solar photovoltaic and solar thermal such as plastic plates, sheets, film, foil and strip, crucial for solar technologies, Italy exhibits a high growth rate and a higher RCA than both China and the USA, while the international trade of this particular component has a relatively low market saturation rate. The relatively low level of market saturation in these components suggests that no single country dominates the global export market for these components. This landscape provides Italy with possible opportunities to strengthen its export position. Additionally, Italy is estimated to have EUR 1,900 million in export potential for this component. Combining the export potential of the two solar photovoltaic and solar thermal components in which Italy holds a significant competitive position, the total export potential is estimated to be EUR 3.895 million.

Italy is also a competitive exporter of grid technologies. Specifically, Italy is estimated to have an export potential of EUR 3.515 million in insulated electric conductors and EUR 229 million in transformers. For both components, Italy's RCA index indicates it is a more competitive exporter than China or the USA (Figure 2).[476]

[475] Figures 1 and 2 present Italy's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Italy's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand.
This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Italy's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Italy could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Italy could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.

[476] Figure 2 builds on Figure 1 by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Italy's trade strategy. Taken together, these figures provide a nuanced understanding of Italy's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

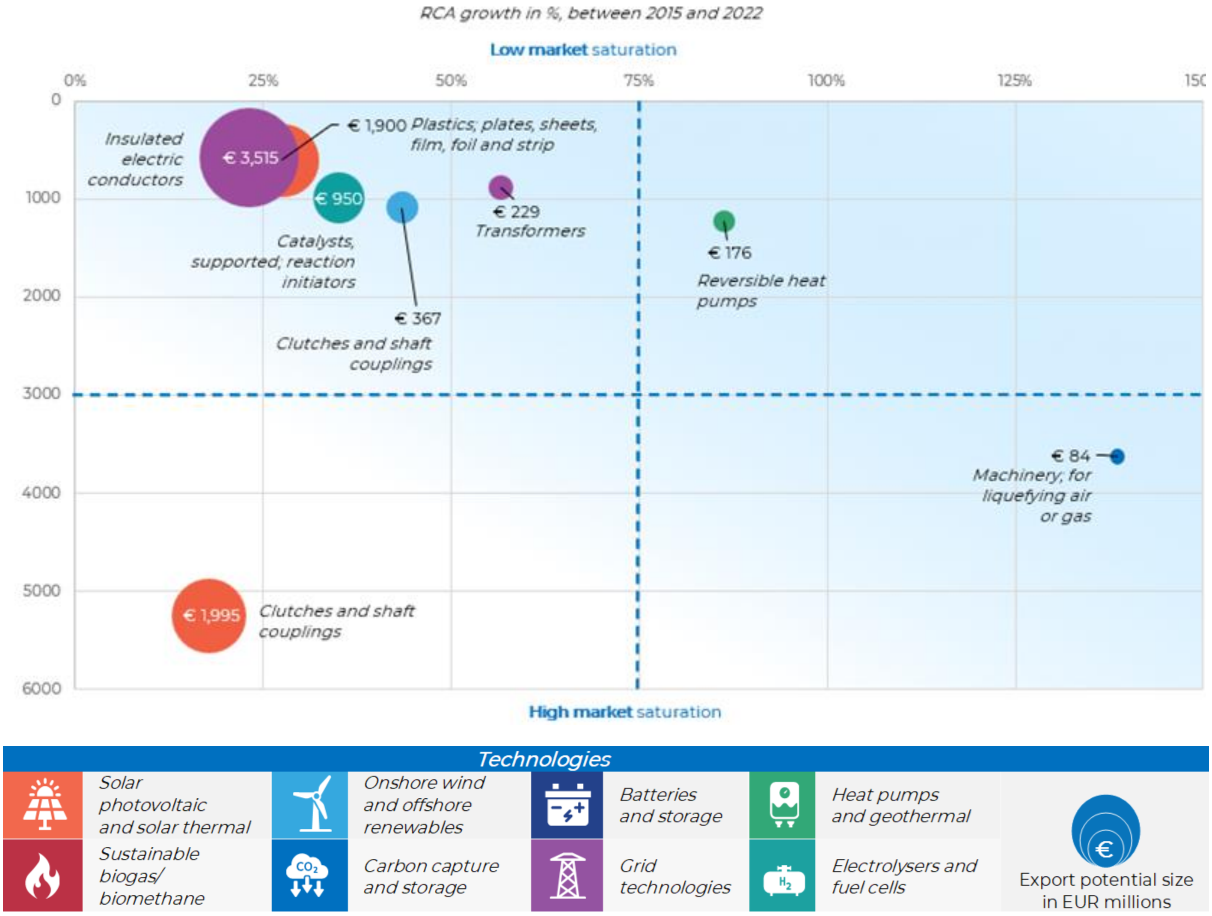
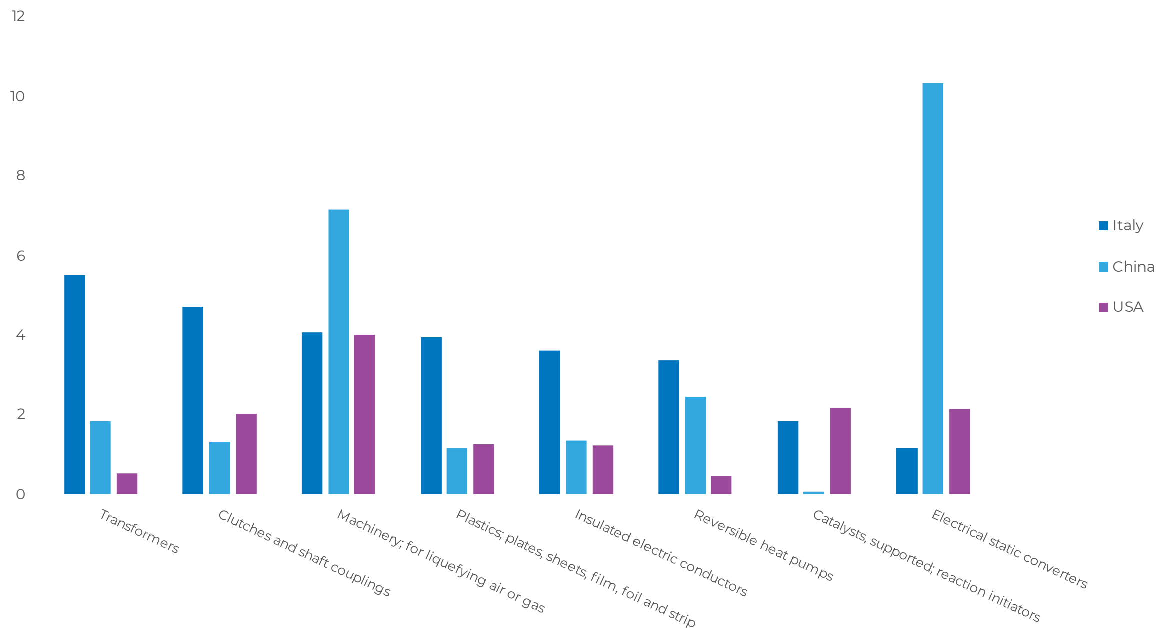


Figure 2: Absolute value of RCAs of Italy, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

In the 2021 **National Recovery and Resilience Plan (PNRR)**, Italy allocated EUR 1 billion to "Renewables and batteries" under Mission 2, Component 2. In the 2023 revision, the Italian Government introduced Mission 7 for the REPowerEU initiative, reallocating resources to include six new measures, such as EUR 2 billion for zero-emission technologies and EUR 500 million for strategic supply chain resilience. The EUR 2 billion for zero-emission technologies is distributed as follows: EUR 1.25 billion to support the ecological transition of the national production system, EUR 200 million for energy efficiency in production processes, EUR 150 million for sustainable production processes, and EUR 400 million through the Industrial Transition Fund for investment programs aligned with Net-Zero emission technologies.

Within Mission 2, measure M2C2-I5.1, dedicated to renewable sectors and batteries, has been updated with EUR 1 billion and structured into two sub-investments: EUR 500 million for photovoltaic and wind technologies to increase production capacity by 2.4 GW/year, and EUR 500 million for battery production to boost capacity by 13 GW/year. Following two funding rounds, EUR 514 million remains for photovoltaic, wind, and battery sectors[477]. To fully utilize these funds and support ecological transition devices, a decree issued on June 14, 2024, regulates access to remaining funds, with full implementation expected by 2026.

The National Hydrogen Strategy Preliminary Guidelines (Strategia Nazionale Idrogeno Linee Guida Preliminari) emphasize the need to significantly increase Italy's electrolyser production capacity, develop end-to-end capabilities from storage to installation, and invest in R&D and pilot projects for large-scale electrolysers. It highlights the necessity of a national R&D program focusing on priority areas like electrolyser technologies (Alkaline, Proton Exchange Membrane, Solid Oxide) and fuel cell technology, aiming to boost the growth of the electrolyser production market.

The Energy Decree (Decreto Energia), published in February 2024, introduces measures to address high energy costs and promote Italy's energy transition. Key measures that may facilitate the manufacturing of Net-Zero technologies include streamlining authorization procedures for renewable energy facilities, designating maritime areas for offshore wind infrastructure, establishing a photovoltaic technology registry maintained by ENEA, and allowing exploration licenses and authorizations for geological CO2 storage. Additionally, a study by the Ministry of Environment and Energy Security (MASE) will support regulatory revisions to enhance the carbon capture and storage (CCS) value chain.

Italian legislation promotes renewable electricity production focusing on biogas and biomethane through various incentives. Key measures include the Interministerial Decree of 2013 and the Ministerial Decree of 2018, supporting the construction and conversion of plants for integration into gas networks, transport, and cogeneration. The 2020 Stability Law extended incentives for older plants, with new rules under the PNRR introduced in 2024.

Legislative Decree 162/2011 establishes the framework for permanent geological storage of CO2 in Italy and has been amended by Decree-Laws 76/2020, 77/2021, and 181/2023.

In 2023, the European Commission has approved two Italian State aid schemes under the State aid Temporary Crisis and Transition Framework :

- EUR 1.1 billion **Italian State aid scheme to support investments in equipment necessary to foster the transition to a net-zero economy** [478]. Under this measure, which will be partially funded through the Recovery and Resilience Facility ("RRF"), the aid will take the form of direct grants. The scheme is open to companies producing relevant equipment, namely batteries, solar panels, wind turbines, heat pumps, electrolysers, equipment for carbon capture usage and storage, as well as key components designed and primarily used as direct input for the production of such equipment or related critical raw materials necessary for their production. The maximum aid amount per beneficiary will be EUR 150 million, which can be increased to EUR 200 million for beneficiaries located in specific regions.
- EUR 100 million **Italian scheme to support the production of electrolysers to foster the transition to a net-zero economy**[479]. Under this measure, the aid will take the form of direct grants. The purpose of the

[477] Based on an interview with the Ministry of Enterprises and Made in Italy (MIMIT)

[478] The resources allocated by this measure should not be combined with those from other measures mentioned below in the *Key incentives instruments* section (development contracts) since they draw from the same resources allocated by the PNRR (National Recovery and Resilience Plan). Notably, the Ministry of Enterprises and Made in Italy issues the decree regulating access to development contracts derived from PNRR funds. The European Commission approves this based on the Temporary Crisis and Transition Framework for State aid.

[479] The resources allocated by this measure should not be combined with those from other measures mentioned below in the *Key incentives instruments* section (development contracts) since they draw from the same resources allocated by the PNRR (National Recovery and Resilience Plan). Notably, the Ministry of Enterprises and Made in Italy issues the decree regulating access to development contracts derived from PNRR funds. The European Commission approves this based on the Temporary Crisis and Transition Framework for State aid.

scheme is to build up capacities for the production of strategic equipment necessary for the diversification of energy sources.

Scope of the policy framework

✓ ✓ ✓ ✓ ✓ ✓ ✓ [✓]

Industrial permitting

Average duration[480]	Environmental Impact Assessment (VIA) procedures, as established in the relevant regulations, can take anywhere from 5/6 months up to more than one year to complete, depending on the complexity of the project and specific circumstances (e.g. need for pre-screening, request for integration of information etc.). A fast-track process has recently been introduced through a "Simplification" decree-law for PNRR projects, reducing the permitting procedure's duration from the current 360 days of the ordinary process to 175 days of the expedited process[481]. In practice, delays can be experienced, with overall durations of multiple years[482].	**One-stop shop for permitting**	There is a form of a one-stop shop (Sportello Unico per le Attività Produttive – SUAP) for obtaining permits[483], but it is not within the definition of the NZIA. SUAP is established in each municipality. In addition to authorizations and procedures managed at the local and regional levels through the SUAP and other local authorities, some specific authorizations or approvals at regional and national levels (e.g., VIA) may be required, depending on the nature and size of the plant. A single environmental authorization (AUA) can be requested through the SUAP for projects not subject to VIA[484].

Brief summary of the permitting processes

There is no specific permitting procedure identified solely for manufacturing Net-Zero technologies in Italy. Permits are granted at different institutional levels. Various permits are required for new facilities or extending existing ones, with land needing to comply with urban planning and not be subject to environmental or historical constraints. Documentation on urban planning compliance, environmental impact assessment, and energy certification must be provided.

Environmental permits depend on the type, size, and impact of the plant and are issued by national or regional authorities. Key permits include the Strategic Environmental Assessment (VAS) for overall program compatibility and the Environmental Impact Assessment (VIA) for individual projects. The permitting

[480] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.
[481] Source available here
[482] See here
[483] Source available here
[484] See here

procedure for Environmental Impact Assessment is digitalised, and requests and documentation can be submitted through digital means[485].

The integrated environmental authorisation (AIA) evaluates the plant's management and operation aspects, while the single environmental authorisation (AUA) simplifies requirements for SMEs and projects not subject to VIA, replacing several environmental authorisations[486]. Projects under the National Recovery and Resilience Plan (PNRR) and the National Integrated Energy and Climate Plan (PNIEC) are deemed essential and urgent, with a specific technical commission responsible for their environmental assessments.

The length of permitting procedures is driven by several factors, as highlighted by industry sources[487]. These include the involvement of multiple institutions without a centralised authority overseeing the entire process, regional variations in practices and timelines, uncertainty or absence of regulations for new solutions like batteries and heat pumps, and limited capacity within the public administration.

Procurement

The Plan for Environmental Sustainability of Consumption in the public administration sector includes the establishment of Minimum Environmental Criteria (*Criteri Ambientali Minimi* - CAM). These criteria consist of technical and performance requirements that public administrations must follow in procurement processes for products, services, and works. The CAM aims to promote the use of environmental technologies and eco-friendly products through public procurement. They are mandatory in public tenders and are a key component of Italy's Green Public Procurement (GPP) policies.

The Ministry of the Environment sets these criteria, covering sectors such as construction, waste management, energy services, and office products. Particularly significant are the criteria for "Construction," which include the requirement that new construction projects or urban redevelopment must meet their energy needs predominantly through on-site or nearby renewable energy systems. Examples of these systems include cogeneration or trigeneration plants, photovoltaic or wind parks, solar thermal collectors, low enthalpy geothermal plants, heat pump systems, and biogas plants. The criteria also encourage participation in renewable energy communities.[488]

Regulatory sandboxes

Existing sandboxes

The "Sperimentazione Italia" (“*Experimentation Italy*”) allows start-ups, businesses, universities, and research centres to obtain temporary exemptions from regulatory provisions to experiment with technologically innovative projects. The applicant submits an application to both the Department for Digital Transformation and the Ministry of Economic Development. Once the application is approved, and after the experiment concludes, the Department for Digital Transformation certifies whether the initiative was successful and provides an opinion to the relevant authorities. Within 90 days, necessary regulatory changes may be promoted to allow the tested activity to continue without further derogations. The regulation covers sectors such as generic manufacturing activities and the supply of electricity and gas. The main objectives include: i) achieving a positive impact on the quality of the environment, life, and the socio-economic fabric of the country; ii) enhancing the country's competitiveness through the experimentation of new technologies[489].

The Italian regulatory authority (ARERA) has promoted experiments to test new technologies, including more recently, regulatory sandboxes for large-scale experiments in the regulated industry[490]. However, these were not targeted to manufacturers of Net-Zero technologies so far, but rather to improve network reliability, innovate systems for renewable gases and hydrogen development, and enhance infrastructure innovation.

Plans for regulatory sandboxes under the NZIA

No plans for a relevant regulatory sandbox have been identified

[485] Ministry of Environment and Energy security (MASE), see here
[486] Ministry of Environment and Energy security (MASE), see here
[487] See here and here
[488] See here
[489] Italian Government, Department for Digital Transformation, see here
[490] JRC (2023), *Making energy regulation fit for purpose. State of play of regulatory experimentation in the EU, available here*

Key incentive instruments

Development contracts (Contratti di sviluppo)

Structural support measures without time constraints[491]. 36 months for the completion of the investment from the approval concessions of subsidies in favour of the final beneficiaries	**Grant**	**Total funding available: EUR 3 billion**
Technologies: All Net-Zero technologies	**Eligibility:** large-scale investments in the industrial, agro-industrial, tourism, and environmental protection sectors. A Fast Track procedure is provided for large-scale strategic projects with significant impact on the production system. Beneficiaries are large enterprises and SMEs, both Italian and foreign, that make investments within the national territory. Eligible investments: the creation of new production units, expansion of existing capacity, conversion, or restructuring. The minimum amount for industrial investment (the main and core business investment), is 20 million euros: 10 million for the proposing company, and 1.5 million for participating companies. Depending on the type of development contract, the minimum value can decrease.	**Available support:** There is no upper ceiling for support. However, beyond certain thresholds, there are stricter procedures and notification requirements.

Description: The development contract is the most important support measure for large enterprises undertaking strategic production projects. The measure is refinanced annually through the Budget Law (Legge di Bilancio). The Development Contract has been selected as the implementing measure for certain investments outlined in Italy's National Recovery and Resilience Plan. In particular, of relevance for Net-Zero technologies in the 2021 version of the NRRP:

- Investment 5.1 "Renewables and batteries" (Mission 2, Component 2), with a budget of EUR 1 billion[492], targeted to photovoltaic, wind, battery and hydrogen.

The 2023 revised National Recovery and Resilience Plan foresees: M1C2, Investment 7 - Support for the productive system for Ecological Transition, Net-Zero Technologies, and competitiveness and resilience of strategic supply chains:

- EUR 2 billion for sub-investment 1 *Zero-emission technologies*[493].

Entry into force of the relevant implementing agreement is foreseen by T4 2024. Signing by Invitalia (National Agency for Inwards Investments and Economic Development, responsible for managing and disbursing

[491] However, when employed as a measure to utilise resources allocated by the National Recovery and Resilience Plan (PNRR), specific calls for tenders are issued with deadlines established in accordance with the provisions and timelines of the PNRR.
[492] For the implementation of investment under measure M2C2-I5.1, two funding rounds have been opened, the last one closed on February 28, 2023. Following the instructional activities conducted by the Managing Entity (INVITALIA), resources remain, net of fees due to the Managing Entity, totalling EUR 514 million, of which EUR 309 million relate to photovoltaic and wind industries and EUR 205 million to the battery sector (Source: Interview with national authority).
[493] Resources are distributed as follows:

- EUR 1.25 billion to support the ecological transition of the national production system at various levels, supporting investments to strengthen the production chains of devices useful for ecological transition (such as batteries, solar panels, wind turbines, heat pumps, electrolysers, and carbon capture and storage devices);
- EUR 200 million to support energy efficiency in production processes (including through self-consumption of electricity from renewable sources, excluding biomass);
- EUR 150 million to support the sustainability of production processes, also for circular economy and more efficient use of resources;
- EUR 400 million used within the facilitation tool of the Industrial Transition Fund to support investment programs eligible for Fund intervention, consistent with the objectives of "net zero emission technologies.

resources) of legal financing agreements (through development contracts) with the final beneficiaries for an amount necessary to utilize 100% of the resources is foreseen by 2026		
M2 C2.5.2 Hydrogen (National Recovery and Resilience Plan) (M2C2, Investimento 5.2, linea c) – Idrogeno)		
Until 2026	**Until 2026**	**Until 2026**
Technologies: Electrolysers and fuel cell technologies	**Technologies**: Electrolysers and fuel cell technologies	**Technologies**: Electrolysers and fuel cell technologies
Description: The measure consists of three project lines: - Line A – Production of gigafactory for electrolysers [250 million EUR]: The MASE co-finances the MIMIT projects approved within the IPCEI framework. The projects are currently under evaluation. - Line B – Production of gigafactory for electrolysers [100 million EUR]: the submission window for project proposals has recently closed and the projects are under evaluation. - Line C – Hydrogen supply chain/components [100 million EUR]: The submission window for project proposals has recently closed. It was possible to apply for support for the development of the component supply chain for the production of renewable hydrogen, including components for electrolysers[494].		
Sustainable Investments 4.0 (Investimenti sostenibili 4.0)		
Since 2023	**Grant**	**Total funding available EUR 400 million**
Technologies: Not targeted specifically	**Eligibility:** Targeted to SMEs. The investment programs must be aimed at expanding capacity or diversifying production to obtain products never previously manufactured or fundamentally changing the production process of an existing production unit or creating a new production unit. The investment program has to be carried out at a production unit located in the territories of the less developed regions of the South (Basilicata, Calabria, Campania, Molise, Puglia, Sicily, and Sardinia).	**Available support:** Eligible expenses must be no less than EUR 750k and no more than EUR 5m
Description: For investments related to the fundamental change in the production process, incentives are granted in the form of non-repayable contributions. The value of the intensity is regulated by the Regional Aid Map, based on the size of the requesting enterprises and the area of investment.		
Fondo Nuove Competenze (New Skills Fund)		
From 2024 (planned)	**Skills programme**	**Type of programme:** Upskilling, Re-skilling
Technologies: The previous edition explicitly mentioned among skills supported those for "designing electrical components and blades used in equipment that harnesses wind energy and converts it into electricity". The previous edition also foresaw support for strategic investment projects realised through development contracts. As Net-Zero technologies will be supported through development contracts, they would fall within the scope.	**Description:** The New Skills Fund, now in its 3rd edition, was created to counteract the economic effects of the Covid-19 epidemic and co-financed by the European Social Fund. It supports companies in training their employees to adapt to new organisational and production models in response to ecological and digital transitions, as well as for strategic investment projects or industrial transitions. The Fund reimburses the cost of hours dedicated to training attendance. The 3rd edition is currently being discussed and is expected for the end of 2024.	

[494] Based on an interview with the Ministry of Enterprises and Made in Italy (MIMIT)

Opportunities and challenges

Opportunities

General

Italy's traditionally strong manufacturing base, one of the least energy-intensive among IEA countries[495], provides access to components and skills needed for various Net-Zero technologies. This is specifically the case for wind power, solar thermal and solar PV as well as biogas, heat pumps and electrolysers.

Technology-specific

For grid technologies, Italy is the EU leader in cable manufacturing cable with a production value of EUR 1.2 billion. Italy has growth potential for further cable manufacturing thanks to investments in expanding capacity and upskilling[498] and also a relatively strong industrial ecosystem for smart grid applications[499]. Italy is also a competitive exporter of insulated electric conductors and transformers, with an estimated export potential of EUR 3,515 million and EUR 229 million

Investments in solar PV production in Italy could be a catalyst for reshoring solar manufacturing to Europe. This includes the extension of Enel's 3Sun solar PV factory to a gigafactory[500] and a project funded through the National Recovery and Resilience Plan (NRRP) to establish a recycling line for batteries and solar modules alongside a solar module production line and a storage battery plant[501]. In terms of demand, Italy has also become one of the largest growing solar markets in Europe thanks to support schemes such as the Superbonus.

Italy is home to 5-6% of the EU's electrolyser production capacity, with facilities that manufacture electrolyser machinery, compressors and storage. Italy is focusing on hydrogen development as a key decarbonisation pathway[502]. Substantial funds from the NRRP are allocated to R&D for hydrogen technologies and industrial applications incl. the

Challenges

General

Italy faces high energy prices due to high energy taxes, high reliance on fossil fuels and limited grid interconnectors. While prices for business use are lower than for residential use they are still among the highest in the EU.[496]

Italy is heavily relying on public funding to support growth however with government debt rising (Italy has the second highest debt-to-GDP ratio in the EU), additional fiscal policy space is limited. Funding from the NRRP can address gaps, but delays in its implementation further cause risks[497].

Technology-specific

Regarding onshore and offshore renewable technologies, one of the fundamental challenges of scaling up manufacturing is accessing the necessary raw materials in sufficient quantities, as shown in Chapter 4.1 of the main report. Similarly to other wind manufacturing hubs, Italy faces a high extra-EU import dependency especially regarding onshore and offshore renewable technologies, with 73% of non-EU imports as seen above.

The Automotive Cells Company (ACC) suspended the construction of its battery cell factories for nickel manganese cobalt batteries (NMC). This change in the planning reflects a shift away from NMC batteries to lithium iron phosphate (LFP) batteries, favoured for their cost-effectiveness and safety. In response, the Italian government has decided to redistribute the EU funds earmarked for the ACC factory to other purposes as there is concern that these funds will become unavailable after 2026, the cut-off date for Recovery and Resilience funds.[504].

Despite the potential for CCUS to play a role in mitigating industrial emissions, there is strong public resistance to implementing CCUS in Italy. This resistance is due to earthquake risks and the infrastructure needed for CO2 transport. Current legislation only covers the

---

[495] IEA (2023), Italy 2023, IEA, Paris https://www.iea.org/reports/italy-2023, License: CC BY 4.0
[496] See: Dashboard for energy prices in the EU and main trading partners 2023, available here; and: European Commission: Directorate-General for Energy, Smith, M., Jagtenberg, H., Lam, L., Torres, P. et al., *Study on energy prices and costs – Evaluating impacts on households and industry – 2023 edition*, Publications Office of the European Union, 2024, available here.
[497] OECD (2024), "Key policy insights", in *OECD Economic Surveys: Italy 2024*, OECD Publishing, Paris, available here.
[498] Prysmian has announced that it will invest EUR 1.8 billion by 2027 in expanding capacity and upskilling. Available here.
[499] Deloitte and Confindustria (2024), Le competitività nelle tecnologie verdi Una nuova politica industriale per le imprese italiane. Available here.
[500] EIB, 24 January 2024, Italy: Europe's biggest solar gigafactory 3Sun secures €560 million financing from EIB and pool of Italian banks led by UniCredit and backed by SACE. Available here.
[501] SoliTek, 29 May 2023, Italians entrusted SoliTek with the first-ever RRF project in the EU. Available here.
[502] IEA (2023), Italy 2023, IEA, Paris https://www.iea.org/reports/italy-2023, License: CC BY 4.0
[504] Carla Westerheide, 19.09.2024, Italy withdraws funding commitment for ACC cell plant in Termoli, available here.

installation of gigafactories through EUR 250 million of grants[503].	experimental phase of CCUS, which hinders industrial-scale uptake[505].

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential

[503] Interview with national authority referred to the notification available here.
[505] IEA (2023), Italy 2023, IEA, Paris https://www.iea.org/reports/italy-2023, License: CC BY 4.0.

Country Factsheet Lithuania

Key findings

Manufacturing capacity:[506] Lithuania's manufacturing capacity amounts to between 450 and 500 MW/y (2-3% of EU capacity) for solar PV. Lithuania has one identified facility for battery and storage technologies, one for offshore foundations, as well as one for (industrial) heat pumps. No facilities were identified for electrolysers.

Industrial production:[507] Lithuania's three largest industrial Net-Zero sectors by value are wind power, with a production amounting to EUR 474 million (a negligible share of total EU production), EUR 326 million (a negligible share of EU production) for solar energy, and EUR 238 million (a negligible share of EU production) for grid technologies.

International positioning:[508] Lithuania holds considerable export potential in wind turbine components, including wind turbine structures, and electric motors and generators used in the nacelle of wind turbines, with a significantly higher RCA index compared to China and the USA. Lithuania is also a competitive exporter of plastic-related components for solar PV technologies as well as of grid technologies, where its RCA index for boards, panels, and consoles for the distribution of electricity grew by 65% between 2015 and 2022.

Policy framework: Currently, Lithuania has a National Energy Independence Strategy and actions foreseen under its National Energy and Climate Action Plan in place that can support the build-up of manufacturing capacity for Net-Zero technologies in the country.

Industrial permitting: There is no standard duration for industrial permitting procedures in Lithuania. Indicative average duration ranges from 1.5 to 3.5 years.

Incentive instruments: In Lithuania, SMEs and large companies can apply to receive loans for projects that support investments in Net-Zero technologies. Two skill programmes are in place providing placement and education training for the green transition.

[506] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[507] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[508] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides details on each indicator.

Key descriptive statistics for Net-Zero technologies in Lithuania[509]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[510]	Import dependence (extra-EU)[511]
	450 - 500 MW/y[512] *(2-3% of EU capacity)*	50 - 100 MW/y	900 - 1000 MW/y	«Negligible share of EU production» *(Disclosure: 100%)*	**0.30**
	At least one facility identified [513]	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	**0.19**
	At least three facilities identified[514]	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	**0.64**
	At least one facility identified	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	**0.16**
	No facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	**0.00**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	**0.17**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	**0.21**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	**0.31**
	−	−	−	−	✓
	−	−	−	−	✓

Technologies

Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Lithuania's main production facilities include the Solitek solar PV module factory, with an estimated capacity of 200 - 250 MW and the Valoe/Solitek solar cell manufacturing facility with an estimated capacity of 50 - 100 MW, both of which are based in Vilnius. Solitek also produces lithium-ion batteries.

[509] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[510] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[511] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[512] Manufacturing capacity is provided exclusively for solar photovoltaic modules and cells and does not include capacities for solar thermal manufacturing. A small share of Lithuania's manufacturing capacity is for PV cell production.
[513] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[514] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.

Evolution of Lithuania's international positioning

As illustrated in Figure 1, Lithuania holds considerable export potential in wind turbine components.[515] This includes wind turbine structures, and electric motors and generators used in the nacelle of wind turbines. Together, these components are estimated to hold over EUR 460 million in export potential. Additionally, these components are estimated to have relatively low levels of export concentration, indicating that the global export market for these goods has a low level of saturation. Lithuania also holds significantly larger RCA indices for the two wind turbine structure components compared to China and the USA, showcasing its international competitiveness in exporting these components (Figure 2).[516]

Lithuania is also a competitive exporter of plastic-related components for solar PV technologies, with over EUR 175 million in untapped export potential. The country is further competitive in grid technologies, where its RCA index for boards, panels, and consoles for the distribution of electricity grew by 65% between 2015 and 2022. For this particular grid component, Lithuania also has a slightly higher RCA index than China and the USA.

[515] Figures 1 and 2 present Lithuania's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Lithuania's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Lithuania's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets. Export potential is calculated using a gravity model, reflecting the hypothetical value Lithuania could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Lithuania could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies. For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.

[516] Figure 2 builds upon this by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Lithuania's trade strategy. Taken together, these figures provide a nuanced understanding of Lithuania's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

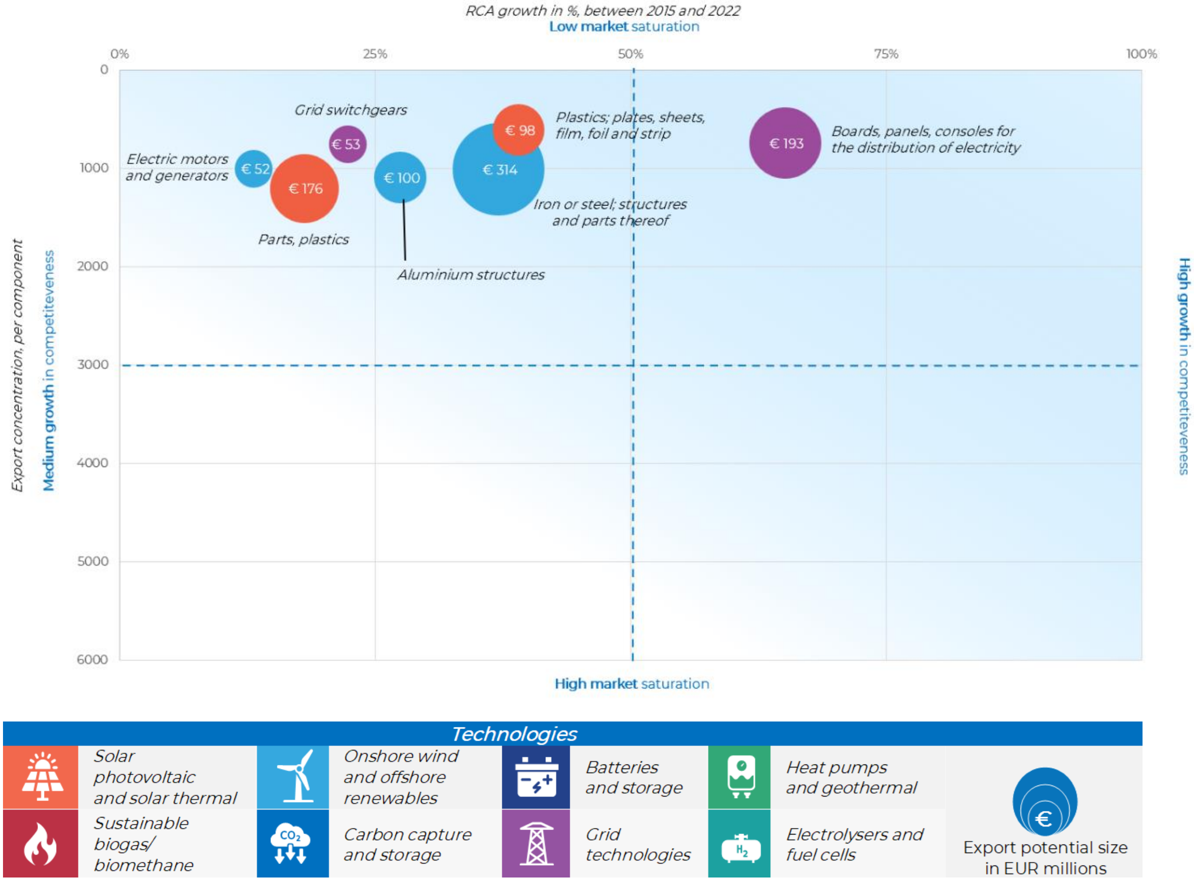
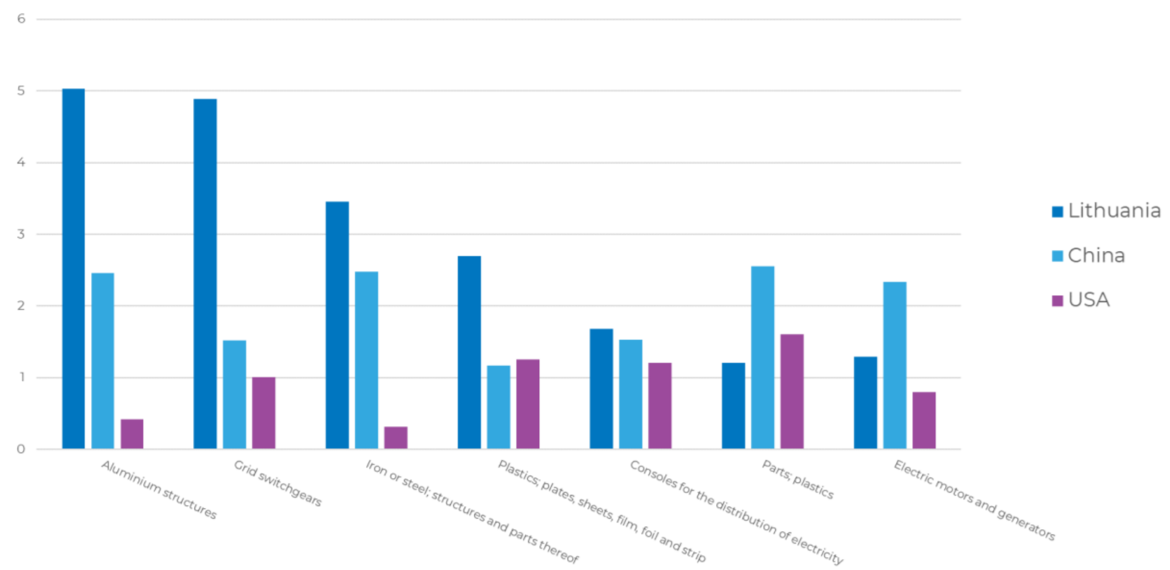


Figure 2: Absolute value of RCAs of Lithuania, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

The **Lithuanian draft National Energy and Climate Action Plan** foresees measures intended to support R&I and investments in manufacturing, and a scaling-up of commercially available clean energy technologies, equipment and components. Lithuania considers the following strategic value chains to be particularly important: batteries; connected, clean environment and autonomous vehicles; low-carbon industry; hydrogen technologies and systems. Related measures notably include supporting the production of electricity storage technologies as well as attracting investors in the production of electric car batteries. The measure provided for in the NENS Implementation Plan (PPP) is intended to attract investments in order to create production capacity for batteries or their components in Lithuania. Draft guidelines in the action plan also integrate industry competitiveness-promoting measures aimed at promoting the development and/or implementation of environmentally friendly products or technologies.

The **National Energy Independence Strategy** is a strategy with the objective set for Lithuania to evolve from an energy technology importer into an energy technology developing and exporting country. The goal for Lithuania is to become a centre of information technology and cybersecurity solutions for energy, biomass and biofuel technologies, solar and wind energy technologies, and geothermal technologies, among others. Competitive measures to promote investments in the development of reliable local generation facilities are planned to be created and applied.

Scope of the policy framework

✓	✓	✓	✓	✓	✓	[✓]	[✓]

Industrial permitting

Average duration[517]	While some specific terms are established for responsible institutions to respond to requests, a standard duration for permitting procedures cannot be identified, as it varies significantly on a case-by-case basis. Indicative average duration ranges from 1.5 to 3.5 years[518].	**One-stop shop for permitting**	No one-stop shop for permitting has been identified.

Brief summary of the permitting processes

The standard permitting procedure includes several documents: An Environmental Impact Assessment of the Proposed Economic Activity (Planuojamos ūkinės veiklos poveikio aplinkai vertinimas), an Integrated Pollution Prevention and Control (IPPC) permit, Pollution Permits (Taršos leidimai) and Building Permits (Statybą leidžiantys dokumentai).

For the Integrated Pollution Prevention and Control (IPPC) permit (Taršos integruotos prevencijos ir kontrolės (TIPK) leidimai), the Environmental Protection Agency (AAA) evaluates the application no later than within 30 working days from the date of receipt. The decision to accept an IPPC application or not to accept an IPPC application is made no later than 30 working days from the date of receipt of the IPPC application. The National

[517] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.
[518] Based on an interview with the Ministry of the Economy and Innovation; Industry Policy Division

Public Health Center (NVSC) processes the application no later than 10 working days from the day of receiving the revised application and/or explanations from AAA.

For Pollution Permits (Taršos leidimai), the Environmental Protection Agency (AAA) registers the application and publishes it (without attachments) publicly on AAA's website within 3 working days. The interested public has the right to get acquainted with the application and submit suggestions or comments regarding the application and the issuance or change of the permit within 10 working days from the date of publication of information about the received application on the AAA website. The permit review period can be extended by a decision of the AAA by no more than 10 working days from the day of receiving additional information.

The permitting procedure is partially digitalised. No physical (paper) documents are required; however, there is no integrated information system through which the permits could be requested. Such an integrated information system is currently being developed. The project is funded by the Cohesion Fund and includes the creation of the information system encompassing EIA, different permits, the creation of the map (in which the objects can be found), etc.

Procurement

Recently, Lithuania initiated a public procurement reform aimed at reducing the nation's carbon footprint by integrating environmental considerations into procurement decisions. The Ministry of Environment supported this effort by issuing a decree that established Green Public Procurement (GPP) criteria (including the use of renewable energy) and mandated regular progress reporting. To track progress, the Lithuanian Public Procurement Office (LPPO) utilises open procurement data through a user-friendly public dashboard, prompting authorities to improve their adoption of green practices. Additionally, initiatives such as green fairs, catalogues, and outreach events for vendors have been launched to encourage environmentally friendly procurement habits among government buyers.[519]

Regulatory sandboxes

Existing sandboxes	The Lithuanian National Energy Regulatory Council (Valstybinė Energetikos Reguliavimo Taryba - VERT[520]) introduced a regulatory sandbox scheme aimed at testing innovative products and business solutions in a real-life environment, promoting regulatory learning and informing regulatory reforms. The regulatory sandbox is available for activities in the electricity, gas and district heating sectors. Derogations can be granted for a maximum of 1 or 3 years depending on the area of experimentation, with possible extensions of respectively 1 and 2 years. [521] While it is not specifically mentioned whether the sandbox is also applicable for manufacturers, the sandbox's description, which focuses on energy innovators, suggests that manufacturers can benefit from it. The sandbox intends to allow developers of energy innovations to be able to test the products and services they are developing in real conditions in the Lithuanian energy systems, to improve the new solutions they are creating and to commercialise them at a later stage.	**Plans for regulatory sandboxes under the NZIA**	No plans for further relevant regulatory sandbox have been identified

[519] OECD (2024), *Harnessing Public Procurement for the Green Transition - Good Practices in OECD Countries*, available here. This policy does not focus specifically on supporting local net-zero industries, however, one of its goals is to stimulate investments in green technologies and innovation.
[520] Website available here
[521] JRC (2023), *Making energy regulation fit for purpose. State of play of regulatory experimentation in the EU*, available here

Key incentive instruments

"Billion for Business" scheme (Finansinė priemonė „Milijardas verslui“)		
2024-2026	**Loan**	**Total funding available: EUR 2 billion**[522]
Technologies: Potentially all	**Eligibility:** Micro, small and medium-sized enterprises (SMEs) and large companies can apply for loans. The maximum duration of the loans is 15 years, with the possibility of extension up to 20 years. Other criteria for companies to benefit from the measure include having no links with countries hostile to Lithuania, ensuring that projects do not cause significant damage to the environment and that the project involves suppliers and/or contractors that are not controlled by third-country entities and whose management bodies are based in the EU.	**Available support:** Companies will have access to direct or subordinated loans from INVEGA of up to EUR 150 million, while syndicated loans can be financed up to EUR 250 million.
Description: The loans will be made available for projects investing in green technologies, circularity, decarbonisation, energy efficiency, low-carbon, advanced, innovative and digital technologies, as well as in the development of production capacities for high-value-added products and in the defence and security industry. Loan applications will be accepted from 29 April 2024 and loan agreements will be signed until 30 June 2026. The measure will be implemented through the Innovation Support Fund. A tripartite agreement will be signed between the Ministry of Economy and Innovation, the Ministry of Finance and INVEGA.		
Greening Apprenticeships: Lithuania		
2022-2026	**Skills programme**	**Type of programme:** Placement/internship programme
Technologies: Potentially all (NZ technologies not explicitly mentioned)	**Description:** A new support scheme for apprenticeships and workplace learning is currently being introduced (legislation in force since 2022, 20 million EUR earmarked from the National Resilience and Recovery Plan). The support scheme includes a rapid update of VET programmes, to match labour market needs, particularly by promoting digital and green transformation. The update will be related to competencies needed for the development of green technologies and innovations (energy efficiency, circular economy as well as digitisation), ensuring that new occupation needs are met. Beyond VET and apprenticeships, modules of IVET programmes will be offered to 4,900 learners in basic and general secondary education by 2026 – the objective is that 40% of these modules should be dedicated to digital skills and skills for the green transition.	
Updating and/or preparation of formal vocational training programs (Formaliojo profesinio mokymo programų atnaujinimas ir (ar) parengimas)		
2023-2026	**Skills programme**	**Type of programme:** Post-secondary education programme
Technologies: Potentially all (NZ technologies not explicitly mentioned)	**Description:** The goal of the project is to develop modern vocational education content that meets the needs of the labour market by promoting skills needed for digital and green transformation. The total amount of project financing is approximately EUR 2.1 million. The project is financed with the funds of the New Generation Lithuania Plan for Economic Revitalization and Resilience.	

[522] Starting with EUR 1 billion, but the interest accrued and the loan repayments will be reinvested. It is estimated that the total effect should be up to EUR 2 billion.

Opportunities and challenges

Opportunities	Challenges
General	**General**
Lithuania's national energy independence strategy aims to reduce its dependency on imported energy technologies and "become a country creating and exporting energy technologies"[523]. This could be a basis for government support and investments in Net-Zero technologies. Lithuania is paying also more attention to green public procurement and established Green Public Procurement criteria as well as improving the monitoring of green procurement practices[524].	The indicative average duration of permitting ranges from 1,5 to 3,5 years depending on the size of the projects. While documents can be submitted digitally there is no integrated information system through which the permits can be requested. Potential improvement could come from a project funded by the Cohesion Fund to create an integrated information system.
Technology-specific	**Technology-specific**
Lithuania's manufacturing capacity for batteries is expected to increase with the launch by the company SoliTek of a smart battery production line.[525]	Lithuania faces obstacles in attracting investors for offshore wind energy tenders, as it recently decided to relaunch its second 700MW offshore tender after meeting limited interest from developers.[526]

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential

[523] Lithuania, National Energy Independence Strategy, available here.
[524] This policy does not focus specifically on supporting local net-zero industries, however, one of its goals is to "create a stimulus for investments in green technologies and innovation". Lithuania is generally considered a leading country in regard to green procurement policy and has commissioned additional research on how the industry is impacted by the policy. For more information, see: OECD (2024), "Lithuania", in Harnessing Public Procurement for the Green Transition: Good Practices in OECD Countries, available here.
[525] SoliTek, 23 April 2024, SoliTek launches smart battery production line in Lithuania, available here.
[526] Baltic Wind, 18 April 2023, Lithuania Scraps Plans for Second Offshore Wind Farm Tender, available here.

Country Factsheet Luxembourg

Key findings

Manufacturing capacity:[527] Luxembourg's manufacturing capacity is very limited, amounting to between 25 and 75 MW/y (a negligible share of EU capacity) in solar PV and no other manufacturing facilities have been identified.

Industrial production:[528] Luxembourg's current industrial production in Net-Zero technologies remains negligible.

International positioning:[529] Luxembourg has shown growth in competitiveness and export potential for four key components, including 1) small electric boards and panels for electric control or the distribution of electricity, 2) iron or steel containers for compressed and liquefied gas—an essential component in the electrolysers and fuel cells value chain—, 3) electric static converters used in solar PV technologies, and 4) machinery for protecting electrical circuits.

Policy framework: Currently, Luxembourg has one draft legislation (Bill n°8284) to support the build-up of manufacturing capacity for Net-Zero technologies in the country.

Industrial permitting: General information on the industrial permitting of new production facilities for Net-Zero technologies indicates a duration between 3 to 4 months on average.

Incentive instruments: No incentives supporting investment in Net-Zero technologies were identified in Luxembourg.

[527] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[528] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[529] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in Luxembourg[530]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[531]	Import dependence (extra-EU)[532]
Solar photovoltaic and solar thermal	25 – 75 MW/y[533] *(a negligible share of EU capacity)*	-	100 MW/y	«Negligible share of EU production» *(Disclosure: 100%)*	0.66
Onshore wind and offshore renewables	No facilities identified[534]	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	0
Batteries and storage	No facilities identified[535]	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	0.39
Heat pumps and geothermal	No facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	0.13
Electrolysers and fuel cells	No facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	0
Sustainable biogas/biomethane	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	0.23
Carbon capture and storage	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	0.15
Grid technologies	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	0.38
Data coverage	–	–	–	✓	✓
Data reliability	–	–	–	✓	✓

Technologies

Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Luxembourg's main production facility is SOCOM (JV from Solarcells SA & Evocells), with an estimated capacity of 25 - 75 MW solar modules. They have announced that production will be scaled up, adding another 100 MW by 2026.[536]

[530] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[531] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[532] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[533] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[534] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[535] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[536] see here

Evolution of Luxembourg's international positioning

Luxembourg has made strides in certain Net-Zero technologies, showing growth in export competitiveness, particularly in components related to grid technologies and electrolysers and fuel cells. However, its presence in these markets is still limited, with relatively few exporters contributing to the country's performance. For example, small electric boards and panels used for the distribution of electricity have shown increased importance in the country's export profile.

Luxembourg has also demonstrated competitiveness in exporting iron or steel containers for compressed and liquefied gas, a critical element in the electrolyser and fuel cell value chains. Similarly, the country shows growing potential in electric static converters for solar PV technologies. However, the scale of Luxembourg's export activity in these sectors remains modest.

Regulatory and incentive landscape

Policy framework

The new government is currently developing new strategies and planning to support the manufacturing of Net-Zero technologies under the new mandate. **Bill n°8284 for the acceleration of administrative procedures for the manufacturing of renewable energy** is likely to be integrated with the implementation of the Net Zero Industry Act (NZIA) or replaced. Moreover, rather than focusing exclusively on the manufacturing of Net-Zero technologies, the new legislation relative to the acceleration of administrative procedures is likely to be extended to all industries given the small size of the Luxembourg domestic market.

Scope of the policy framework

Industrial permitting

Average duration[537]	The average duration of permitting procedures is around 3 to 4 months[538]	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

[537] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.

[538] Based on an interview conducted with the Ministry of Economics and Finance.

Brief summary of the permitting processes[539]

The permits necessary to produce Net-Zero technologies include the right to land, environmental permits and work safety permits.

The length of the permitting procedure in Luxembourg to set up a new business, particularly for classified establishments, varies depending on the class of the establishment. For Class 1 establishments, the process includes application submission, checks within 45 days, a public inquiry lasting 15 days, and a notification decision within 45 days after the commune's decision. For Class 2, applications are checked within 45 days, followed by a 15-day public inquiry and a decision within 30 days after the inquiry period. For Class 3, the process is similar to Class 2, with a 45-day initial check, 15-day public inquiry, and a final decision within 30 days after the commune's decision. For Class 4, timelines can vary depending on the specific regulation applied.[540]

Operating permits for classified establishments do not release the operator from the obligation to obtain other authorisations required (e.g., regarding building permits; authorisations with regard to the protection of nature and natural resources, road permits; watercourse permits; deforestation/clearing permits; greenhouse gas emission permit; authorisations concerning sites and monuments; authorisations from the CFL).[541]

Any change to the nature, operation or extension of an installation which might require a renewal of the GHG emission permit must be notified to the Minister at least 2 months in advance. Requests can be submitted online for environmental permits and classified establishments while building permits and GHG emission permits need to be submitted on paper.

Procurement

No relevant procurement rules have been identified.

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

No relevant incentive instruments have been identified.

Opportunities and challenges

Opportunities	**Challenges**
General Luxembourg could accelerate its administrative procedures for the manufacturing of renewable energy, distribution and storage, heat pumps, electrolysers, and fuel cell technologies through a proposed bill on the	**General** Labour shortages are an issue in Luxembourg with 72% of companies indicating a lack of labour limiting production. This includes also a lack of relevant skills for the transition to a net-zero economy and specifically, in research and innovation Luxembourg relies on attracting foreign

[539] Information in this section primarily comes from interviews with relevant authorities. Other sources can be found here, here, here, and here.
[540] Based on an interview conducted with the Ministry of Economics and Finance.
[541] See here.

acceleration of administrative procedures relating to the manufacture of renewable energy technologies.[542]	talents[543]. This was also identified by an IEA report which argued that "given its small size, Luxembourg does not possess the critical mass of researchers to engage in all areas of energy research" recommending to prioritise energy R&D that could support policy goals[544].
Technology-specific Manufacturing solar PV panels using cutting-edge technology. The Luxembourg plant Solarcells delivers some of the highest power output ratings in the European market. Furthermore, the company utilises 95% recyclable materials and claims that the majority of its raw materials are sourced from Europe.[545]	**Technology-specific** The solar PV panels manufactured in Luxembourg are not price-competitive with those made in China and the prices are almost twice as high due to Chinese subsidies[546].

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

[542] Projet de loi n°8284 relative à l'accélération de procédures administratives relatives à la mise en œuvre et la fabrication de technologies d'énergies renouvelables, available here.
[543] European Commission (2024), 2024 Country Report. Luxembourg, available here.
[544] IEA (2020), Luxembourg 2020, IEA, Paris https://www.iea.org/reports/luxembourg-2020, License: CC BY 4.0
[545] See Solarcells' website, available here.
[546] Pierre Théobald, 15 February 2024, Photovoltaic crisis: Luxembourg's Solarcells up against Chinese products, available here.

Country Factsheet Latvia

Key findings

Manufacturing capacity:[547] Latvia's Net-Zero manufacturing capacity remains very limited.

Industrial production:[548] Latvia's current industrial production is also very limited, amounting to EUR 23 million in the production of components that can be used in the wind power industry; and EUR 9 million for components that can be used in the solar PV and solar thermal industries.

International positioning:[549] Latvia is a robust exporter of grid technology components, notably switchgears, circuit breakers, and electronic control panels for the distribution of electricity, with higher RCA indices compared to China and the USA. The global export market for these technologies also has a low market saturation rate. Beyond grid components, Latvia is an internationally competitive exporter of wind turbine structures, with its RCA significantly larger than that of China and the USA.

Policy framework: Currently, Latvia does not have a policy framework for Net-Zero technologies in place.

Industrial permitting: Currently, Latvia does not have specific industrial permitting procedures for Net-Zero technologies Genera permits required for new and modified facilities include environmental permits for technology-specific impacts, land use permits for renewable projects, and technology-specific permits like waste management for biogas production.

Incentive instruments: Country research did not yield relevant instruments that incentivize investments in the manufacturing capacity of Net-Zero technologies.

[547] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[548] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[549] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides details on each indicator.

Key descriptive statistics for Net-Zero technologies in Latvia[550]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[551]	Import dependence (extra-EU)[552]
Solar photovoltaic and solar thermal	No facilities identified[553]	-	-	«Negligible portion of EU production» *(Disclosure: 54%)*	**0.31**
Onshore wind and offshore renewables	At least two facilities identified[554]	-	-	«Negligible portion of EU production» *(Disclosure: 58%)*	**0**
Batteries and storage	No facilities identified[555]	-	-	«Negligible portion of EU production» *(Disclosure: 77%)*	**0.07**
Heat pumps and geothermal	No facilities identified	-	-	«Negligible portion of EU production» *(Disclosure: 59%)*	**0.16**
Electrolysers and fuel cells	At least one facility identified	-	-	«Negligible portion of EU production» *(Disclosure: 79%)*	**0**
Sustainable biogas/biomethane	N/A	N/A	N/A	«Negligible portion of EU production» *(Disclosure: 67%)*	**0.15**
Carbon capture and storage	N/A	N/A	N/A	«Negligible portion of EU production» *(Disclosure: 60%)*	**0.28**
Grid technologies	N/A	N/A	N/A	«Negligible portion of EU production» *(Disclosure: 59%)*	**0.15**
Data coverage	⊖	⊖	⊖	⊖	✓
Data reliability	⊖	⊖	⊖	⊖	✓

Technologies

Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Latvia's main production facility is Naco Technologies' Riga plant, which produces nano coatings for electrolysers.

[550] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[551] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[552] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[553] Manufacturing capacity is provided exclusively for solar photovoltaic and does not include capacities for solar thermal manufacturing.
[554] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[555] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.

Evolution of Latvia's international positioning[556]

Latvia has shown promising export capabilities in grid technology components, particularly in the export of switchgears, circuit breakers, and electronic control panels for electricity distribution. Despite its growing competitiveness, the export landscape for these components remains relatively limited, with only a few key players driving Latvia's presence in this market.

Regulatory and incentive landscape

Policy framework

No relevant strategies or legislation have been identified

Industrial permitting

Average duration	No average duration for permitting has been identified	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

Brief summary of the permitting processes[557]

Currently, Latvia lacks specific permitting procedures to support the manufacturing of Net-Zero technologies. Necessary permits for production include:

- General permits: required for building and operating new facilities, or extending or modifying existing ones.
- Environmental permits: necessary for activities impacting the environment, specific to the technology (e.g., solar, wind).
- Land use permits: required for using land for renewable energy projects.
- Technology-specific permits: for example, biogas production may require specific waste management permits.

Procurement

No relevant procurement rules have been identified for Net-Zero technologies

Regulatory sandboxes

Existing sandboxes	Latvia is currently establishing regulatory sandboxes in the energy sector, focusing on key areas such as renewable energy	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

[556] Figures 1 and 2 below illustrate Latvia's international positioning in selected Net-Zero technologies and components. Figure 1 highlights components where Latvia has increased its competitiveness between 2015 and 2022, using the Revealed Comparative Advantage (RCA) index as a proxy for export performance. This is plotted against the global export concentration of specific Net-Zero components, illustrating market saturation levels. Each data point is weighted based on Latvia's export potential, estimated through a gravity model, which indicates the potential export value if trade barriers were removed.
Figure 2 maps the absolute value of the RCA index for each component and EU MS relative to the strongest international competitors, China and the USA. Together, these figures provide insights into Latvia's growth in competitiveness for selected Net-Zero components, their export potential, and a comparison with leading global manufacturers.
The RCA index, based on Balassa's formulation, measures a country's export performance for a specific product relative to the global average. A country has a revealed comparative advantage if its RCA value exceeds 1, indicating competitive export and production efficiency in that product. This includes the relative costs of production (such as materials, labour, energy) as well as differences in non-price factors - such as policies, incentives, or technical regulations.
[557] Information in this section primarily comes from interviews with relevant authorities.

	production (solar, wind, biomass), energy storage solutions, smart grid technologies, and energy efficiency measures. [558]

Key incentive instruments
No relevant incentive instruments have been identified

Opportunities and challenges

Opportunities	Challenges
General Latvia has specific public procurement rules to ensure sustainability, requiring compliance with environmental standards and promoting the use of EU-origin technologies where possible.[559]	**General** Access to the grid and deployment remains a challenge for new applications and can be delayed as the legislation prioritises full grid access for connected producers.[560]
Technology-specific Regarding wind power, Latvia has no offshore wind farm yet, however its potential is estimated at 15 GW and the State-owned Latvenergo Group aims to invest in offshore wind projects. Latvia's two ports on the Baltic Sea could fulfil a role in offshore wind park support. Currently, there are only a few Latvian companies active in this field with two examples being Aerones, a robotised wind farm maintenance company, and East Metal which produces steel components and structures[561]. However, there is potential for growth with Latvia being a competitive exporter of wind turbine structures. The country's RCA for this component has grown by 30% between 2015 and 2022, with an estimated EUR 184 million in untapped export potential.	**Technology-specific** No technology-specific challenges have been identified for Latvia.[562]

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential

[558] Based on interviews with the Investment and Development Agency and national renewable energy associations.
[559] See here: https://www.varam.gov.lv/lv/zala-publiska-iepirkuma-piemerosanas-vadlinijas.
[560] IEA (2024), Latvia 2024, IEA, Paris https://www.iea.org/reports/latvia-2024, Licence: CC BY 4.0.
[561] Baltic Wind, 14th April 2023, LWEA: Unlocking the potential of Latvian offshore wind. Available here.
[562] Due to the lack of current net-zero manufacturing, no specific challenges were identified, however cross-cutting challenges identified in the main report such as lack of skilled workers, dependencies on third countries for materials and components as well as tough price competition also apply to Latvia.

Country Factsheet Malta

Key findings

Manufacturing capacity:[563] Malta does not have any Net-Zero manufacturing facilities.

Industrial production: [564] Malta's current level of industrial production is negligible.

International positioning:[565] Malta is not a large exporter of Net-Zero technologies.

Policy framework: Currently, Malta does not have a policy framework for Net-Zero technologies in place.

Industrial permitting: General information on the industrial permitting of new production facilities for Net-Zero technologies is not available. The length of general permitting procedures ranges from 6 to 11 months on average.

Incentive instruments: No incentive instruments for Net-Zero technologies were identified in Malta.

[563] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[564] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[565] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides details on each indicator.

Key descriptive statistics for Net-Zero technologies in Malta[566]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[567]	Import dependence (extra-EU)[568]
	No facilities identified[569]	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	0.61
	No facilities identified[570]	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	0.81
	No facilities identified[571]	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	0.29
	No facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	0.45
	No facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 100%)*	0.01
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	0.52
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	0.17
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 100%)*	0.54
	−	−	−	✓	✓
	−	−	−	✓	✓

Technologies

Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

[566] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[567] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[568] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[569] Manufacturing capacity is provided exclusively for solar photovoltaic and does not include capacities for solar thermal manufacturing.
[570] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[571] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.

Evolution of Malta's international positioning

Malta is gradually emerging as an exporter of a handful of components that can be relevant for Net-Zero technologies, such as parts for electric accumulators, though exports remain very modest.

Regulatory and incentive landscape

Policy framework

No relevant strategies or legislation have been identified.

Industrial permitting

Average duration[572]	The average duration for permitting procedures is approximately 11 months	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

Brief summary of the permitting processes[573]

In Malta, no targeted permitting procedures for Net-Zero technologies have been identified. Generally, the permitting procedure application process is managed by the Planning Authority. Local planning legislation and environmental permits are also to be considered and followed.

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

No relevant incentive instruments have been identified

[572] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.

[573] Based on interviews with the Ministry for the Economy, Enterprise and Strategic Projects and Malta Enterprise

Opportunities and challenges

Opportunities	Challenges
General Given its small size, Malta's competitive advantage lies in low-volume but high-quality production. The presence of an STMicroelectronics assembly and testing plant for semiconductors showcases this[574]. Local expertise in electronics could also enable Net-Zero industries that require electronic components (e.g. solar PV, grid technologies).	**General** As a small island economy, Malta faces challenges related to its small market size and remoteness. These include labour market constraints, reliance on external trade and high operating costs due to logistical costs.
Technology-specific Malta's offshore wind capacity could increase as it witnessed interest from developers following the launch of its first offshore wind and floating solar tender for a 50MW capacity[575]. This could also enable growth in local manufacturing and maintenance companies in Maltese ports.	**Technology-specific** Planning procedures and permitting still represent a bottleneck for offshore renewables. Nevertheless, a one-stop shop was announced to facilitate procedures.[576] Malta lacks investments in its grid infrastructure which constitutes a barrier to the further growth of offshore renewable energy.[577] Chinese imports have led to overstocking in Europe following the closure of the US market.[578]

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential

[574] The Maltese electronics industry has received targeted support from the EU and Maltese government, see: Times of Malta, 08.06.2024, STMicroelectronics to get injection in EU-approved state aid, available here.
[575] Offshore Energy, 28 May 2024, 'Strong' investor interest brings Malta 13 proposals for floating solar farms, available here.
[576] Ibid.
[577] The Energy & Water Agency (2023) National Policy for the Deployment of Offshore Renewable Energy, available here.
[578] RystadEnergy, 20.07.2023, Europe hoarding Chinese solar panels as imports outpace installations; €7 billion sitting in warehouses, available here.

Country Factsheet Netherlands

Key findings

Manufacturing capacity:[579] Netherlands' Net-Zero manufacturing capacity amounts to between 350 and 550 MW/y (2-3% of EU capacity) for solar PV; between 300 and 350 MW/y (a negligible share of total EU capacity) for wind turbines; and between 300 and 500 MWh/y (a negligible share of total EU capacity) for battery and storage technologies. Additionally, there are at least eight production facilities for heat pumps. One active producer of lithium-ion batteries has been identified.

Industrial production:[580] The Netherlands' three largest industrial Net-Zero sectors by value are solar energy, with a production amounting to EUR 2.2 billion (3% of total EU production), EUR 1.3 billion (6% of EU production) for electrolyzers, and EUR 0.8 billion (1% of EU production) for grid technologies.

International positioning:[581] The Netherlands is a competitive exporter of components across various Net-Zero technologies, including break switches, electrical static converters, and accessories for semiconductor devices. However, the Revealed Comparative Advantage (RCA) indices for the latter two are lower than those of China and the USA. The Netherlands is also becoming more competitive in exporting lithium cells and batteries, with rapidly growing RCA between 2015 and 2022.

Policy framework: Currently, the Netherlands has two action plans for batteries and heat pumps in place that can support the build-up of manufacturing capacity for Net-Zero technologies in the country.

Industrial permitting: The average length of environmental and planning procedures for the manufacturing of Net-Zero technologies ranges from two to six months. This appears to be comparable to the length of procedures in other Member States, based on the information available.

Incentive instruments: In the Netherlands, incentives are in place that support investment in Net-Zero technologies. This includes investment support through the National Growth Fund and a measure under the TCTF benefitting batteries, solar and electrolyser technologies.

[579] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[580] Industrial production refers to total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[581] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in the Netherlands[587]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[582]	Import dependence (extra-EU)[583]
	350 – 550 MW/y[584] *(2-3% of EU capacity)*	400 - 500 MW/y	5500 - 6000 MW/y	3% *(Disclosure: 51%)*	**0.67**
	300 – 350 MW/y (a negligible share of EU capacity)[585]	-	-	«Negligible share of EU production» *(Disclosure: 53%)*	**0.07**
	300 – 500 MW/y (a negligible share of EU capacity)[586]	-	-	«Negligible share of EU production» *(Disclosure: 73%)*	**0.83**
	At least 8 facilities identified	-	-	2% *(Disclosure: 59%)*	**0.37**
	No facilities identified	-	-	6% *(Disclosure: 58%)*	**0.00**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 56%)*	**0.39**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 55%)*	**0.55**
	N/A	N/A	N/A	«Insufficient data coverage» *(Disclosure: 47%)*	**0.58**
	⊖	⊖	⊖	⊖	✓
	⊖	⊖	⊖	⊖	⊖

Technologies									
	Solar photovoltaic and solar thermal		*Onshore wind and offshore renewables*		*Batteries and storage*		*Heat pumps and geothermal*		*Electrolysers and fuel cells*
	Sustainable biogas/ biomethane		*Carbon capture and storage*		*Grid technologies*		*Data coverage*		*Data reliability*

The Netherlands' main production facilities for solar PV modules are Energyra Europe BV, Exasun and Solarge, with an estimated capacity of 100 - 300 MW each. Announced manufacturing facilities for solar are expected by MCPV. For batteries, current facilities include ELEO in Helmond, and facilities by Eurocells and LeydenJar are expected to open in 2025 and 2026 respectively. Darwind is the only operating company producing onshore wind turbines. In addition, the Netherlands hosts several important offshore installation firms, including, among others, Van Oord, Boskalis, IHC, and Huisman.

[582] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[583] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[584] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[585] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[586] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[587] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.

Evolution of Netherlands's international positioning

As illustrated in Figure 1, the Netherlands is a competitive exporter of components across various Net-Zero technologies.[588] For grid technologies, the country is becoming increasingly competitive in exporting break switches and electrical static converters. The latter, which is also an essential component in solar PV technologies, is estimated to hold over EUR 2.1 billion in untapped export potential for the Netherlands. This reflects the value the Netherlands could increase its exports by of the component if trade barriers were reduced and other competitive conditions aligned. By identifying these opportunities, the figures serve as a potential indication for shaping national policies, guiding efforts toward trade facilitation, and developing targeted export strategies that focus on the components with the highest growth potential. Nevertheless, as shown in Figure 2, the Netherlands, in terms of the RCA index, is not found to be more competitive than its main export competitors, China and the USA.

The Netherlands is also competitive in exporting accessories for semiconductor devices, which are essential components in the solar PV value chain. The country is estimated to hold nearly EUR 2 billion in untapped export potential for these components. However, similar to static converter components, the Netherlands is not found to be more competitive than the USA, although the margin is very slight.

According to the calculated RCA indices, the Netherlands is also becoming more competitive in exporting lithium cells and batteries. While the estimated export potential for these components is relatively smaller at EUR 66 million, the RCA has grown rapidly between 2015 and 2022 by nearly 150%. Here, again, it has not surpassed major competitors China and the USA in terms of competitiveness (Figure 2).[589]

[588] Figures 1 and 2 present Netherlands's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Netherlands's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand.
This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Netherlands's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Netherlands could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Netherlands could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.
[589] Figure 2 builds upon this by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Netherlands's trade strategy. Taken together, these figures provide a nuanced understanding of Netherlands's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

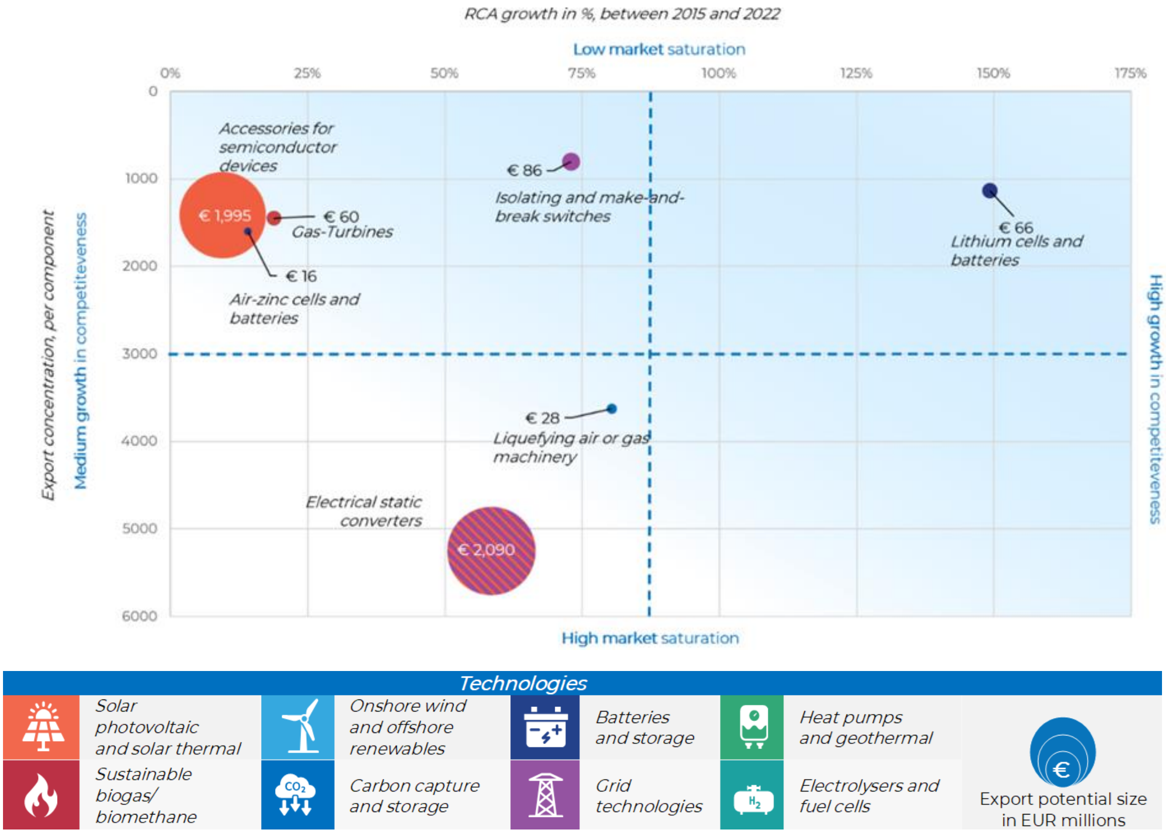
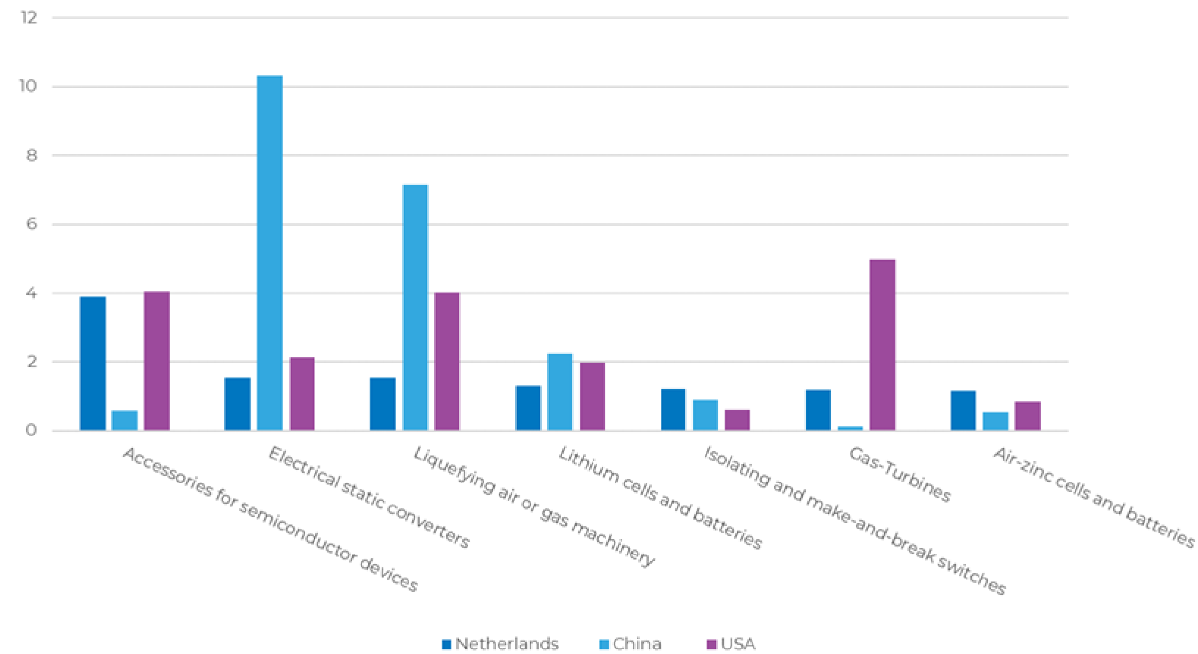


Figure 2: Absolute value of RCAs of Netherlands, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

The **National Action Agenda for Battery Systems** aims to enhance the Dutch battery production landscape. The Agenda aims to ensure that the Netherlands is among the 5 leading countries in developing safe and sustainable new battery materials and cells in 2025. The Agenda's ambition is to have an independent Dutch infrastructure with access to recycled resources by 2030 and have its industry recognised for its efforts on battery technology for the heavy-duty mobility sector allowing it to design, develop, produce and test internationally renowned battery systems for heavy-duty mobility. The Netherlands plans to build on a strong heritage in developing complex (thin-film) production equipment where the Dutch high-tech industry will supply production equipment to European gigafactories.

The **Action Plan for Hybrid Heat pumps** is an action plan that aims to enhance conditions for the short-term upscaling of hybrid heat pumps. These pumps are understood as electric ones in combination with gas or sustainable gas, according to the authorities.

This initiative will foster robust growth in hybrid heat pump adoption and production, thereby contributing significantly to achieving the CO2 targets for 2030. Key actions foreseen aim to ensure that manufacturers are committed to innovating and standardising hybrid heat pumps to reduce manufacturing costs over the next few years. The target is to achieve a 40% cost reduction compared to 2021 price levels. Additionally, the plan aimed to implement new legislation to replace all central heating boilers installed after 2026 with hybrid heat pumps, but this legislative proposal was later withdrawn.

In July 2024, the European Commission approved a **state aid scheme** of up to EUR 750 million under the Temporary Crisis and Transition Framework which also allows investments in the build-up of the production capacities of Net-Zero technologies.

Scope of the policy framework

Industrial permitting

Average duration[590]	The average duration for an environmental and planning permit ranges between 2 to 6 months depending on the type of procedure.[591]	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

Brief summary of the permitting processes[592]

The permission permits have two preparation procedures: the short preparation procedure and the extensive preparation procedure. The decision period for the short procedure is normally a maximum of 8 weeks. When an environmental impact assessment is required, the extended procedure applies. In such a case, the

---

[590] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.
[591] See here.
[592] Information in this section primarily comes from interviews with relevant authorities.

competent authority will provide its decision within 6 months after the application. The timeline can be extended once by up to six weeks. Afterwards, objections and appeals are still possible. Appeal procedures can extend this period substantially and up to one year.[593]

In principle, any facility or building should have planning permissions, and a building permit (Omgevingswet), as well as an environmental permit and a municipal approval where relevant.

There are accelerated permitting procedures for critical energy infrastructure projects. However, these are only relevant for the deployment of essential infrastructure, primarily the grid, or during the energy crisis for the construction of an LNG terminal. The implementation of the digitalized system that harmonises all planning permissions is expected to reduce permitting times and facilitate permitting by bundling several permits. However, it is not yet clear to what extent the permitting system has been improved. In addition, not all permits are combined, namely environmental permits are not included in this system.[594]

Procurement

There are no general national minimum requirements specified for net zero technologies in public procurement. One specific requirement identified in the latest tender to develop the "Ten noorden van de Waddeneilanden Wind Farm Zone (TNWWFZ)" mentions that the development of the electrolyser capacity should be "in line with the European value chain".

In August 2024, the city of Amsterdam introduced resilience criteria in its public procurement rules for "sustainable and fairly produced solar panels" that emit 50% less CO2 emissions and are produced without toxic substances.[595]

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

National Growth Fund (SolarNL) (Nationaal Groeifonds (SolarNL))

2021-2025	**Grant**	**Total funding available: EUR 412 million[596]**
Technologies: Solar technologies	**Eligibility:** Projects need to develop one of the following three innovative solar PV technologies: High-efficiency silicon heterojunction 'HJT' cells; Flexible perovskite films; or Customised solar PV products for integration into buildings and automotive applications.	**Available support:** N/A

Description: The National Growth Fund invests in three solar PV innovation chains linking research, technology and product development, industrialisation and scale-up. The programme includes research, technology and product development, industrialisation and scale-up. It pays attention to circular design in each technology and product. Each programme line includes an innovation chain connecting different phases: from research to technology and product development, industrialisation and upscaling.

Investment grant for manufacturing climate-neutral economy (IMKE) (Investeringssubsidie maakindustrie klimaatneutrale economie (IMKE))

[593] See here and here.
[594] Information based on interview with relevant national authorities.
595 See The State of Play report on Support for European Solar Manufacturing here.
[596] See here. Of this amount, €135 million has been disbursed already, and another €177 million have been awarded conditionally to date. The Fund reserved about €100 million as a possible loan for one of the beneficiaries.

2024-2025	**Grant**	**Total funding available: EUR 148 million**[597]
Technologies: Solar technologies, batteries and storage technologies, and electrolysers and fuel cell technologies	**Eligibility:** Applicant companies must be established or have a subsidiary in the Netherlands. Investments across the EEA are eligible but applicants need to show a benefit of the project for the Dutch economy. Projects need to start within 5 months after the grant decision, need to be completed within 5 years, and production lines must remain open for at least 5 years for large companies and 3 years for small companies.	**Available support:** Up to EUR 20 million for batteries projects, up to EUR 50 million for electrolyser projects, and up to EUR 25 million for solar technology projects. Support can cover between 15% and 40% of eligible costs, depending on the size of the company and the area of investment.
Description: The Investment Subsidy for Manufacturing Climate Neutral Economy (IMKE) aims to support companies with investments needed to produce (the essential parts of) electrolysers, batteries and solar panels. It provides state aid under the TCTF. The support targets the setting up, expanding, or converting production lines for these three technologies. The support is also available to produce or recover raw materials that are needed for the production of batteries and covers the products themselves as well as their components.		
National Growth Fund (Material Independence & Circular Batteries) (Nationaal Groeifonds (Material Independence & Circular Batteries))		
2021-2025	**Grant**	**Total funding available: EUR296 million**[598]
Technologies: Batteries and storage technologies	**Eligibility:** Support is provided to a broad range of organisations, including SMEs, large companies, start- and scale-ups, and research organisations.	**Available support:** N/A
Description: This program aims to strengthen the international positioning of the Netherlands in the batteries sector and make the country less dependent on international suppliers of necessary raw materials necessary for batteries. The program provides support to projects ensuring a sustainable material supply (supply of raw materials through refining and battery recycling) developing and scaling up sustainable battery technology (materials, components and equipment) and developing circular battery systems for transport applications and grid stability (heavy transport and large-scale pilots and demos for bulk batteries).		

Opportunities and challenges

Opportunities	Challenges
General	**General**
The Netherlands' investment in innovation through the National Growth Fund could provide growth opportunities for net-zero technologies. Other funded projects include projects on green hydrogen, and circular solar panels to reduce foreign dependencies[599]. However, the National Growth Fund has been put on	Public investments have been slower to materialise than anticipated and net public investments are below the EU average[603]. With key funds for net-zero technologies such as the National Growth Fund having been put on hold and delays in the rollout of the Recovery and Resilience Plan this creates potential uncertainties for investors.

[597] A total of €20 million are foreseen for batteries, €100 million for electrolysers, and €28 million for solar technologies. Until November 2024, some €106 million have been disbursed already. Interest for support for the production of batteries exceeds the funds available considerably (applications amounting to €69.7 million).
[598] See here. Of this, almost €158million have been awarded conditionally already.
[599] SolarNL (see here), Material Independence & Circular Batteries (see here) and Groenvermogen of green hydrogen (see here).
[603] European Commission (2024), 2024 Country Report - Netherlands. Available here.

hold by the new government and EUR 7.4 billion remains of the EUR 20 billion[600].

The Netherlands is an innovation leader in the EU, performing above the EU average with strong increases in R&D performance in past years[601]. The IEA also reported that the Netherlands provides substantial R&D funding for energy technologies but highlighted the need for supporting emerging technologies in reaching commercial scale[602].

Shortages in skilled labour persist across many sectors and are a bottleneck for investments related to the green transition. Increasing labour participation is unlikely to address this problem considering the Dutch labour participation rate is among the highest in the EU[604].

Technology-specific

The Netherlands is at the forefront of carbon capture and storage technology deployment thanks to its strategic geographic position and existing infrastructure to further develop storage sites and enhance its role as a key player in the EU's CCS network. Projects such as the Aramis and Porthos[605] projects in the Port of Rotterdam can ensure the development of knowledge in setting up complex CCS projects.

The Netherlands could leverage its respective ports to produce renewable hydrogen where offshore wind farms are implanted.[606] Moreover, the Netherlands has put significant attention to becoming a hub for hydrogen through for example the Hy2Tech IPCEI which supports the development of a fuel cell gigafactory in the Netherlands[607].

The Netherlands has a robust offshore wind policy framework that has been driving rapid deployment and cost reductions[608], which in turn has also benefited manufacturers specialising in offshore wind (e.g. specialised parts, installations, maintenance, foundations, turbines etc.)[609]. Companies include SIF (offshore foundations), TKF (cables), AkzoNobel (paints and coatings) and various installation companies (Van Oord, Boskalis, IHC, Huisman, etc). However, compared to other EU countries, the overall sector is small.

While currently having only minor manufacturing capacities in batteries, there is potential for growth with the opening of a factory for high-performance battery systems in Helmond by the startup ELEO. Furthermore, there is a conducive ecosystem through the Dutch Battery Competence Cluster, various applied research, test & validation centres, close links to high-tech equipment industries and access to end-users in the mobility industry[610].

Technology-specific

The Netherlands faces challenges in securing sufficient long-term investment and developing the necessary infrastructure to scale up operations in CCS.[611]

For offshore wind, while playing a central role in installations (e.g. through Boskalis, Van Oord) it relies on third countries for manufacturing, especially for components in the nacelle (generator). As our data shows there is a negligible amount of onshore wind and offshore renewables manufacturing capacity in the Netherlands.

For solar PV, the Netherlands cannot compete on scale with larger countries and is reliant on extra-EU imports (67%). However, there is an opportunity to focus on high-value machinery and innovation. The Netherlands' strengths in high tech and electronics are showcased also by the estimated export competitiveness for accessories for semiconductor devices needed in solar PV manufacturing. Solar PV innovations are developed by organisations such as TNO that work on scaling up perovskite solar cells beyond the laboratory phase.[612]

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential

[600] Holland High Tech, 20 March 2024, Continued existence of National Growth Fund uncertain, available here.
[601] European Commission (2023) European Innovation Scoreboard 2023 Country profile Netherlands.
[602] IEA (2020), The Netherlands 2020, IEA, Paris https://www.iea.org/reports/the-netherlands-2020, License: CC BY 4.0
[604] Ibid.
[605] For more information on Aramis see here, for Porthos see here. The Porthos project is further advanced and will be delivered by a consortium of Dutch, German and Greek companies.
[606] WindEurope's case studies in WindEurope (2021), A 2030 Vision for European Offshore Wind Ports, available here.
[607] RVO, Fuel Cell Giga Factory (FCGF), available here.
[608] IEA (2020), The Netherlands 2020, IEA, Paris https://www.iea.org/reports/the-netherlands-2020, Licence: CC BY 4.0
[609] WindEurope, Wind supply chain map, available here.
[610] Invest in Holland. The Netherlands: prospect for battery companies. EU's hotspot for next generation scalable battery technology, available here.
[611] Carl Deconinck, 8 March 2024, Groundbreaking Dutch CO2 storage-project costs soar, available here.
[612] TNO, Perovskite solar cells, available here.

Country Factsheet Poland

Key findings

Manufacturing capacity:[613] Poland is a strong manufacturer in the Net-Zero field. Its manufacturing capacity amounts to between 85 and 90 GWh/y (36 - 39% of total EU capacity) for battery and storage technologies and between 400 and 450 MW/y (2% of EU capacity) for solar PV. For wind energy, Poland's capacity amounts to approximately 1.75-2 GW for towers, and 2 – 2.5 GW for blades. For electrolysers, two facilities were identified. Additionally, there are 24 facilities dedicated to the production of heat pumps, contributing to the country's overall manufacturing capacity. Since 2021, Poland also hosts a new perovskite technology PV factory targeting 100 MW/y in manufacturing capacity.

Industrial production:[614] Poland's three largest industrial Net-Zero sectors by value are wind power, with a production amounting to EUR 4.7 billion (5% of total EU production), EUR 3.1 billion (4% of EU production) for solar PV and thermal energy, and EUR 2 billion (3% of EU production) for grid technologies.

International positioning:[615] Poland is a competitive exporter of various Net-Zero technologies, with the most significant growth in competitiveness in electrical devices for switching electrical circuits. Poland is also a competitive exporter of aluminium structures for wind turbines, outperforming China and the USA. These structures also have a low market saturation rate. Other competitive export components include manganese dioxide batteries, where Poland has increased its export competitiveness by over 120%.

Policy framework: Currently, Poland's Industrial Policy supports Net-Zero technologies while various sectoral agreements aim to develop hydrogen, photovoltaics, biogas, biomethane, and offshore wind energy, enhancing market participation, and boosting employment and education initiatives.

Industrial permitting: Typically, building permits should be processed within 65 days, extendable if additional information is needed, with applications submitted at various offices or online. Decisions on the environmental permit should be taken within 1-2 months after submission of the necessary documents but often take longer due to additional requirements, and require a lengthy environmental impact assessment before issuance (more than one year), obtainable at the specified office.

Incentive instruments: In Poland, incentives are in place that explicitly support investment in Net-Zero technologies. This includes investment support for companies expanding their production capacities in relation to various Net-Zero technologies.

[613] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[614] Industrial production refers to total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report. .
[615] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in Poland[616]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[617]	Import dependence (extra-EU)[618]
Solar photovoltaic and solar thermal	400 - 450MW/y[619] *(2% of EU capacity)*	400 - 500 MW/y	1750 - 2000 MW/y	4% *(Disclosure: 56%)*	0.39
Onshore wind and offshore renewables	3750 - 4500 MW/y[620] *(4-5% of EU capacity)*	5000 - 5150 MW/y	-	5% *(Disclosure: 63%)*	0.69
Batteries and storage	85000 - 90000 MWh/y[621] *(36 - 39% of EU capacity)*	13500 - 14500 MW/y	3000 - 7000 MW/y	1% *(Disclosure: 41%)*	0.80
Heat pumps and geothermal	At least 24 facilities identified	-	-	3% *(Disclosure: 53%)*	0.44
Electrolysers and fuel cells	At least two facilities identified	-	-	2% *(Disclosure: 53%)*	0.02
Sustainable biogas/ biomethane	N/A	N/A	N/A	1% *(Disclosure: 56%)*	0.43
Carbon capture and storage	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 50%)*	0.36
Grid technologies	N/A	N/A	N/A	3% *(Disclosure: 53%)*	0.43
Data coverage	⊖	⊖	⊖	⊖	✓
Data reliability	⊖	⊖	⊖	⊖	✓

Technologies

Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Poland is a strong and growing manufacturer of Net-Zero technology and equipment. The country is the EU's leading producer of lithium-ion batteries. Poland's main production facilities include LG Energy Solution's Battery factory in Wroclaw, which has an estimated capacity of 70 GWh/y and aims to increase capacity to at least 100 GWh/y by 2025.[622] Poland is also well positioned in the solar PV value chain, with Saule Technologie's innovative perovskite solar cell factory operating in Wroclaw, and a solar cell gigafactory reportedly awaiting financing to launch production in 2025-26 in Racibórz.[623] Poland is also an active manufacturer of wind towers and blades (see section below on

[616] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[617] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[618] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[619] Manufacturing capacity is provided exclusively for solar photovoltaic and does not include capacities for solar thermal manufacturing. Announced capacities also include facilities for PV cells.
[620] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[621] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[622] See here. The factory primarily supplies the EV market. Recently, the specialised press has reported that the slowdown in EV sales may be incentivising LG Energy Solutions to pivot towards the manufacturing of energy storage systems (ESS).
[623] See here and here, respectively.

Poland's exports in this segment). Among the country's key facilities is the LM Poland Blades manufacturing facility in Goleniów[624] with an estimated capacity of 10 GW/y. Additionally, large-scale facilities supplying offshore towers have been announced in Gdánsk and Szczecin.[625]

Evolution of Poland's international positioning

As illustrated in Figure 1, Poland has emerged as a competitive exporter of various Net-Zero technologies.[626] The most significant growth in competitiveness, measured by the RCA indices, is observed in electrical devices for switching electrical circuits, an essential component in grid technologies. Poland's export competitiveness in these components has increased by 415% between 2015 and 2022. Moreover, Poland is estimated to hold EUR 154 million in untapped export potential for these components and is found to be more competitive than China and the USA (Figure 2).

Poland is also a competitive exporter of aluminium structures for wind turbines, with an estimated untapped export potential of EUR 749 million. In this sector, Poland outperforms major competitors like China and the USA. Furthermore, these structures have a low market saturation rate, suggesting that no single country currently dominates the export market for these components.

Other competitive export components include manganese dioxide batteries. Poland has increased its export competitiveness by over 120% and holds an estimated EUR 333 million in untapped export potential. However, the country is slightly less competitive in exporting these types of batteries compared to China (Figure 2).[627]

[624] See here.
[625] See the press releases here and here.
[626] Figures 1 and 2 present Poland's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Poland's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand.
This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Poland's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Poland could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Poland could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies. For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.
[627] Figure 2 builds upon this by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Poland's trade strategy. Taken together, these figures provide a nuanced understanding of Poland's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

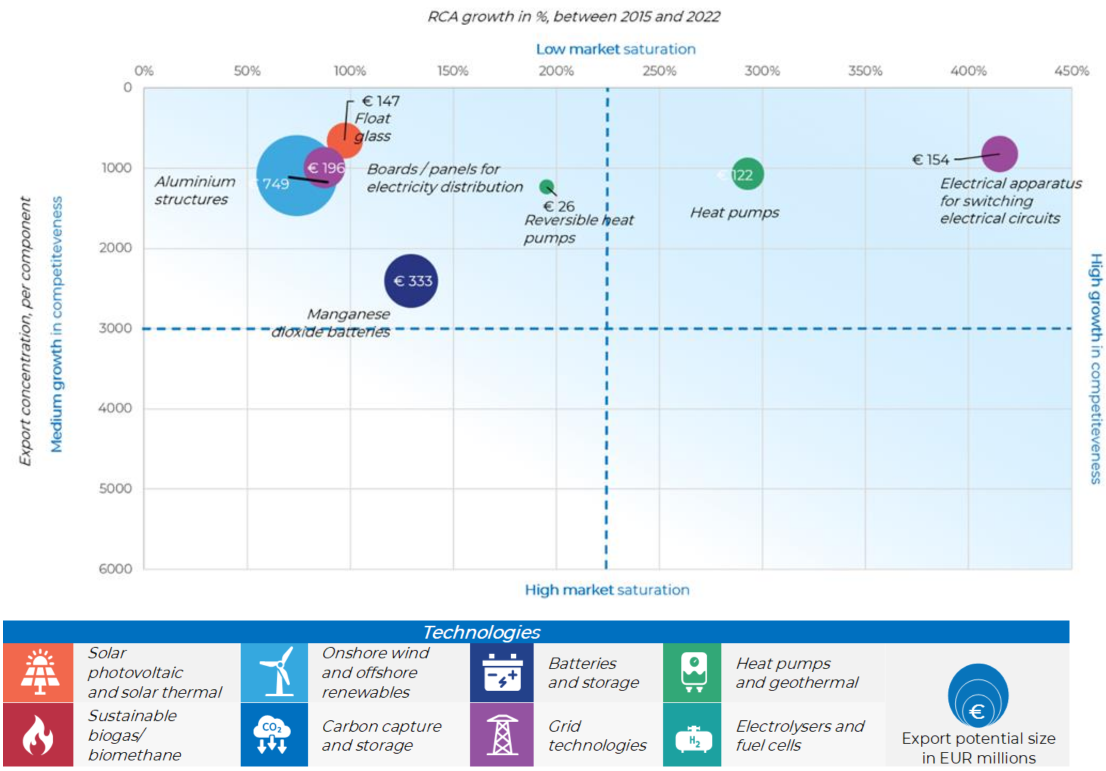
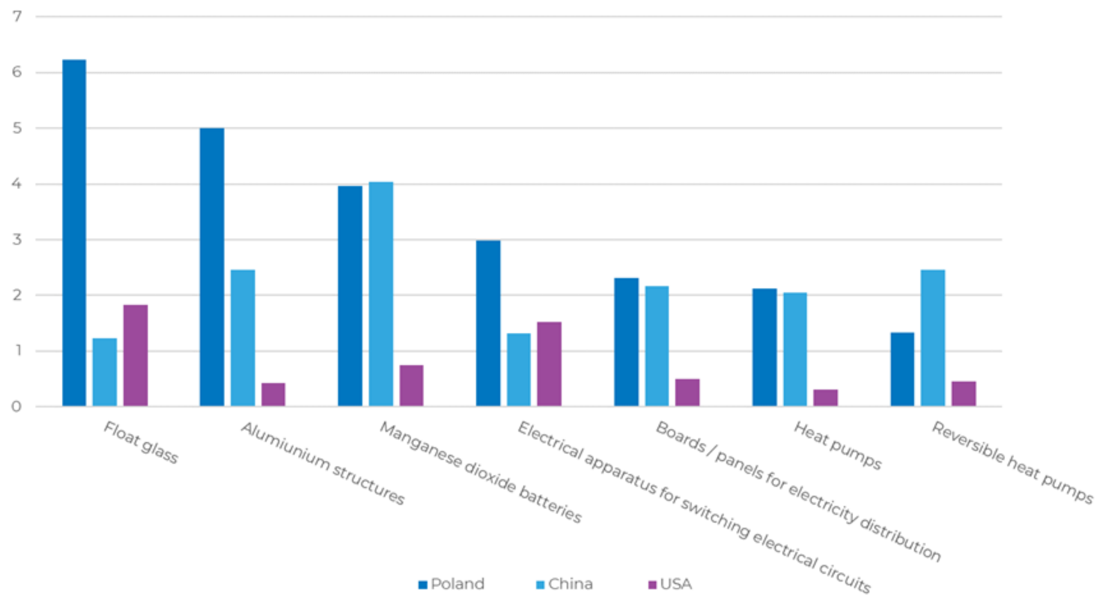


Figure 2: Absolute value of RCAs of Poland, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

Poland's Industrial Policy is a strategy that foresees various measures to support, among others, Net-Zero technologies, including:

- Fostering technology development and investments in components for the production of photovoltaic systems; and
- Supporting enterprises engaged in hydrogen technologies and systems through projects focused on research, development and innovation (R+D+I), as well as the first industrial deployment (FID) and infrastructure projects. This support will be provided in accordance with the public aid rules established for the IPCEI mechanism.

The Sector agreement for the development of the hydrogen economy aims to create conditions and establish cooperation for the development of hydrogen technologies and their application, as well as to maximize the level of local content. The Agreement is implemented by seven working groups focusing on energy, transport, industrial decarbonization, production, distribution, storage, value chain development, and education.

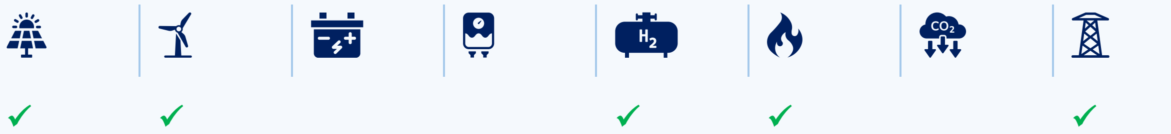
The cooperation agreement for the development of the photovoltaics sector pursues the fulfilment of the following objectives: development of the domestic photovoltaic equipment industry, identification of barriers preventing PV development, development of new photovoltaics segments, integration with the grid, education and promotion,

The cooperation agreement for the development of the biogas and biomethane sector aims to support the development of the sector by maximizing the so-called local content. This includes enhancing the participation of Polish entrepreneurs and technologies in the supply chain for the construction and operation of national biogas and biomethane plants, as well as the development of the market and widespread use of biogas and biomethane in the economy.

The sectoral agreement for the development of offshore wind energy supports the development of the sector by maximising "local content", namely by increasing the participation of Polish entrepreneurs in the supply chain for offshore wind farms being built in the Polish exclusive economic zone. Other objectives include boosting employment, providing training and educational offers, and connecting offshore wind farms, with a target of 5.9 GW of installed capacity by 2030 and 11GW by the end of 2040.

In September 2024, the European Commission approved a **state aid scheme** in the amount of EUR 1.2 billion to support investments in the production of batteries, solar panels, wind turbines, heat pumps, electrolysers, and equipment for carbon capture usage and storage, as well as components of these Net-Zero technologies. The support can take the form of grants.

Scope of the policy framework



Industrial permitting

Average duration[628]	At least 12 months if an environmental impact assessment is required	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

[628] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher

Brief summary of the permitting processes[629]

Building permits should be processed within 65 days of the application, with fines imposed for delays, although the actual average time to receive a permit is unknown. This period can be extended if additional information is needed. Permit applications can be submitted at various local and provincial offices or online.

Environmental permits should be resolved within 1 month, extendable to 2 months for special cases. In practice, the actual time may be longer because it does not include the deadlines provided for in the regulations for obtaining agreements, opinions or periods of suspension of the proceedings. Moreover, the issuance of a decision may be delayed for other reasons, e.g. the fault of the party or reasons beyond the control of the office, such as the need for the party to complete the documentation.

Prior to an environmental permit being granted, an environmental impact assessment has to be carried out, which can be a lengthy process, taking at least a year for natural inventory and several more months for coordination and finalization. The environmental permit can be obtained at district offices, city or commune offices, regional environmental protection directorates, and other specified offices.

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

Program to support investments of significant importance for the Polish economy for 2011-2030 (Program wspierania inwestycji o istotnym znaczeniu dla gospodarki polskiej na lata 2011-2030)

2011-2030	**Grant**	**Total funding available: €820 million**[630]
Technologies: Potentially all	**Eligibility:** The minimum size of investment depends on the type of investment, the size of the beneficiary entity, the number of new jobs created, and whether the investment is in a priority location.[631]	**Available support:** The maximum intensity of the grant depends on the type of investment and the size of the beneficiary entity.[632]

Description: The program supports investment projects aimed at increasing the innovation and competitiveness of the Polish economy. The investor may obtain a subsidy for the implementation of the project, which, in accordance with the applicable criteria, should obtain the status of a project of significant importance for the Polish economy.

Aid scheme for the implementation of investment projects of strategic importance for the transition to an economy with net zero emissions (Rozporządzenie Ministra Rozwoju i Technologii z dnia 29 września 2023 r. w sprawie udzielania pomocy publicznej na realizację projektów inwestycyjnych o znaczeniu strategicznym dla przejścia na gospodarkę o zerowej emisji netto)

emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.

[629] Information in this section primarily comes from interviews with relevant authorities.

[630] Available here.

[631] Available here.

[632] Available here.

2023-2025	**Grant**	**Total funding available: €1.2 billion**
Technologies: Solar technologies, Wind technologies, Batteries and storage technologies, Heat pumps and geothermal energy technologies, Electrolysers and fuel cell technologies, Biogas and biomethane technologies, CCS technologies	**Eligibility:** The main eligibility criteria are that investment projects need to have eligible costs of at least €110 million and which will create at least 50 new jobs.	**Available support:** 15%-35% of eligible costs depending on the location of the investment and size of the company requesting aid with upper ceilings of €150 million to €350 million
Description: The support programme is implemented in the context of the Temporary Crisis and Transition Framework and aims to support the development of strategic Net-Zero technologies.		
Hydrogenization of the Economy Program (Program Wodoryzacja Gospodarki)		
2023-2026	**Grants and loans**	**Total funding available: €258 million**[633]
Technologies: Electrolysers and fuel cells	**Eligibility:** Construction of low-emission/renewable hydrogen production capacity and hydrogen infrastructure.	**Available support:** Minimum eligible costs per project - PLN 10 million (€2.3m), maximum grant amount per project – PLN 150 million (€35m), maximum loan value - PLN 300 million (€70m)[634]
Description: The program is aimed at the development of a low- and zero-emission economy by supporting projects related to the implementation of hydrogen technologies along with the technical infrastructure for the production, storage, transport and use of hydrogen. It is part of the RRF implementation.		

[633] Available here.
[634] ibid

Opportunities and challenges

Opportunities

General

Poland's strong manufacturing base, one of the largest in the EU, provides a solid foundation also for net-zero technologies. Specifically, technologies requiring more basic components such as biogas, electrolysers, grid technologies and heat pumps can benefit from that. However, there is also potential for onshore and offshore wind, solar PV and batteries.

Poland is one of the EU countries with the highest number of jobs in the coal sector, specifically in regions such as Silesia, Lower Silesia and Wielkopolska. Efforts have been made to support the transition in these regions and labour market conditions have improved which could provide workers for the emerging net-zero technology manufacturing hubs[635].

Technology-specific

Poland, historically known for producing battery separators has become a leader in lithium-ion battery production in Europe with one of the largest factories in the world operated by LG Energy Solution near Wroclaw. Lithium-ion batteries already account for over 2.4% of all Polish exports with net exports exceeding EUR 8 billion in 2022. This strong position offers a foundation to further expand into other areas of energy storage technologies which is indicated by investments from companies such as Northvolt, Umicore, SK hi-tech battery materials, Capchem, Guotai Huarong, BMZ and more[640].

The strong presence of the automotive industry in Poland paired with relatively lower labour costs constitutes an opportunity for Poland's emerging battery industry. R&D investments can provide opportunities to improve products and material availability, leading to a stronger positioning. Various

Challenges

General

Despite expanding R&D spending, Poland's investment rate in green transition and clean technologies is below the EU average. There are significant gaps in funding for innovation, especially for high-risk, early-stage R&D projects in clean-tech sectors and Poland lacks an overarching strategy for energy R&D and dedicated innovation clusters that support collaboration[636]. However, Poland's Green Technology Accelerator[637] could serve as a model for cooperation between the public sector and businesses in green innovation.

The regulatory environment in Poland is seen as burdensome, especially regarding the creation of new firms, which increases uncertainty for investors. While reforms have been proposed in the RRP, progress has been slow and research indicates that these might be insufficient[638]. Additionally, the legislative process needs improvement to make Poland a more attractive destination for investments in clean-tech manufacturing[639].

Technology-specific

Poland relies heavily on imports for its battery manufacturing value chain (extra-EU import dependency of 80%)[645]. This dependency is prevalent for battery-active materials[646] and critical raw materials such as cobalt, lithium and nickel which are not mined in Poland except the Szklary nickel deposit. Investments in recycling and the production of battery active materials for example through Umicore's battery materials gigafactory in Nysa[647] are going in the right direction to address this bottleneck.

Poland faces an unfavourable electricity-to-gas ratio as gas is four times cheaper than electricity in the country which notably hinders heat pumps demand. Additional challenges are the absence of visibility on electricity prices and the slowdown in new home or renovation projects.[648]

---

[635] Sokołowski J., Frankowski J., Mazurkiewicz J., Lewandowski P (2022), Hard coal phase-out and the labour market transition pathways: The case of Poland, Environmental Innovation and Societal Transitions, Volume 43, 2022, ISSN 2210-4224, available here.
[636] IEA (2022), Poland 2022, IEA, Paris https://www.iea.org/reports/poland-2022, License: CC BY 4.0
[637] GreenEvo Technology Accelerator, see here.
[638] Terrero-Dávila, J., C. Vitale and E. Danitz (2023), "Improving the business regulatory environment in Poland", *OECD Economics Department Working Papers*, No. 1764, OECD Publishing, Paris, available here.
[639] European Commission (2024). 2024 Country Report - Poland. Available here.
[640] PSPA (2023), Europe runs on Polish lithium-ion batteries. The potential of the battery sector in Poland and the CEE Region, available here.
[645] Based on our data, see above.
[646] See p. 20, PSPA (2023), Europe runs on Polish lithium-ion batteries. The potential of the battery sector in Poland and the CEE Region, available here.
[647] Umicore, 21 March 2023, Umicore accelerates European E-Mobility with Nysa Gigafactory, available here.
[648] European Heat Pump Association (2024), Pump it down: why heat pump sales dropped in 2023. Available here

R&D initiatives are already underway, primarily pertaining to recycling and second-life applications.[641]

Regarding the heat pump value chain, Poland is a competitive exporter of heat pumps and reversible heat pumps with close to EUR 150 million in export potential. Poland, together with Czechia and Slovakia are labelled as an emerging 'heat pump valley'[642]. Enhancing cross-border collaboration to leverage a rich industrial ecosystem and develop a local skilled workforce, offers an opportunity.

For biomethane, Poland stands out in gas storage components and is a strong exporter of machinery for filtering or purifying gases. Poland's exports in this segment increased by over 200 percent between 2015 and 2022, and now amount to EUR 2.9 billion. Poland's significant investments (the second highest in the EU) in biogas and biomethane technologies[643] and its supportive policy[644] allow Poland to strengthen its manufacturing base in this technology.

Challenges for Poland's CCS industry lie in the lack of investment, infrastructure, and public acceptance.[649]

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential

[641] PSPA (2023), Europe runs on Polish lithium-ion batteries. The potential of the battery sector in Poland and the CEE Region, available here.

[642] Euractiv (2023), *Europe's 'heat pump valley' takes root in the East*, available here.

[643] European Biogas Association (2024), 2nd EBA Investment Outlook on Biomethane. Available here.

[644] For example, the amended Renewable Energy Act encourages investment in biogas and biomethane by introducing a definition of biomethanes, guarantees of origin (also for renewable hydrogen) and a support scheme, including a feed-in premium. See here.

[649] J. Fabiszewska-Solares, K. Kobyłka, K. Laskowski, K. Marszał, A. Śniegocki (2021) Assessment of current state, past experiences and potential for CCS deployment in the CEE region – Poland. Available here.

Country Factsheet Portugal

Key findings

Manufacturing capacity:[650] Portugal's manufacturing capacity amounts to 2.4 - 5.55 GW for wind turbine towers, and 3.5 – 3.75 GW for wind turbine blades; between 450 and 500 MW/y (8-9% of EU capacity) for electrolysers; and between 50 and 100 MW/y (negligible share of total EU capacity) for solar PV. Portugal hosts at least two facilities dedicated to the production of heat pumps. No battery production facilities were identified.

Industrial production:[651] Portugal's three largest industrial Net-Zero sectors by value are solar power (PV and thermal), with a production amounting to EUR 638 million (1% of total EU production), EUR 260 million (1% of EU production) for heat pumps and geothermal, and EUR 220 million (a negligible share of EU production) for wind.

International positioning:[652] Portugal is a competitive exporter of grid technologies, including non-glass electrical insulators, relays, ceramic electrical insulators, parts of electrical devices, and small electric boards and panels, with an estimated export potential of EUR 1.1 billion and higher RCA compared to China and the USA. Portugal is also a competitive exporter of other Net-Zero technology components, including iron or steel structures for wind turbines and compressors for heat pumps, outperforming China and the USA regarding export competitiveness in both categories.

Policy framework: The European Commission has approved two Portuguese measures under the Temporary Crisis and Transition Framework to support investments in the production of certain Net-Zero technologies, namely batteries, solar panels, wind turbines, heat pumps, electrolysers, and equipment for carbon capture usage and storage.

Industrial permitting: The permitting procedure for the production of Net-Zero technologies is the same as for any other industrial production processes. The length of the process depends on several factors, including the complexity of the project and the category of the industrial establishment.

Incentive instruments: The country research did not yield relevant instruments that incentivize investments in the manufacturing capacity of Net-Zero technologies.

[650] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[651] Industrial production refers to total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[652] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in Portugal[653]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[654]	Import dependence (extra-EU)[655]
	50 – 100 MW/y[656] *(a negligible share of EU capacity)*	-	-	1% *(Disclosure: 73%)*	**0.27**
	5900 - 9300MW/y[657] *(7 - 10% of EU capacity)*	-	-	«Negligible share of EU production» *(Disclosure: 68%)*	**0.34**
	No facilities identified[658]	4750 - 5250 MW/y	9000 - 11000 MW/y	1% *(Disclosure: 91%)*	**0.48**
	At least two facilities identified	-	-	1% *(Disclosure: 71%)*	**0.27**
	450 - 500MW/y *(8 - 9% of EU capacity)*	375 - 500 MW/y	-	1% *(Disclosure: 89%)*	**0.02**
	N/A	N/A	N/A	1% *(Disclosure: 78%)*	**0.22**
	N/A	N/A	N/A	0% *(Disclosure: 75%)*	**0.12**
	N/A	N/A	N/A	0% *(Disclosure: 85%)*	**0.23**
	⊖	⊖	⊖	✓	✓
	⊖	⊖	⊖	✓	✓

Technologies				
Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Portugal's main production facilities in the wind power industry include Siemens Gamesa's blade manufacturing plant in Vagos, with an estimated capacity of around 2 GW and CS tower manufacturing facility in Aveiro, with an estimated capacity of around 2 GW. Announced manufacturing facilities include a factory by CALB (China Aviation Lithium Battery Technology) producing lithium-ion batteries and starting up in 2025. In addition, Fusion-fuel is investing in electrolyser facilities, which are expected to be operational in 2025.

---

[653] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[654] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[655] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[656] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[657] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[658] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.

Evolution of Portugal's international positioning

As illustrated in Figure 1, Portugal has demonstrated growing competitiveness in the export of grid technologies, particularly in components such as non-glass electrical insulators, relays, ceramic electrical insulators, parts of electrical devices, and small electric boards and panels.[659] Among these, small electric boards and panels hold notable untapped export potential, estimated at EUR 950 million in 2022. Collectively, the export potential for these grid components amounts to approximately EUR 1.1 billion. While Portugal's export competitiveness—measured by the RCA index—has seen growth of nearly 90% for parts of electrical devices and ceramic electrical insulators between 2015 and 2022, its relative position should be considered with caution. Although Portugal has shown a stronger RCA in specific components than larger economies like China and the USA, this does not necessarily imply a dominant global position (Figure 2)[660]. RCA measures comparative advantage, which may reflect Portugal's specialisation in particular niches rather than absolute export volumes. In addition, the relatively low level of market saturation across these components suggests that no single country, including Portugal, commands a significant share of global exports. This leaves room for Portugal to potentially strengthen its export position in grid technologies.

Beyond grid components, Portugal has also demonstrated a degree of competitiveness in other Net-Zero technology exports, including iron or steel structures for wind turbines and compressors for heat pumps.

[659] Figures 1 and 2 present Portugal's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Portugal's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Portugal's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Portugal could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Portugal could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.
[660] Figure 2 builds on Figure 1 by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Portugal's trade strategy. Taken together, these figures provide a nuanced understanding of Portugal's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

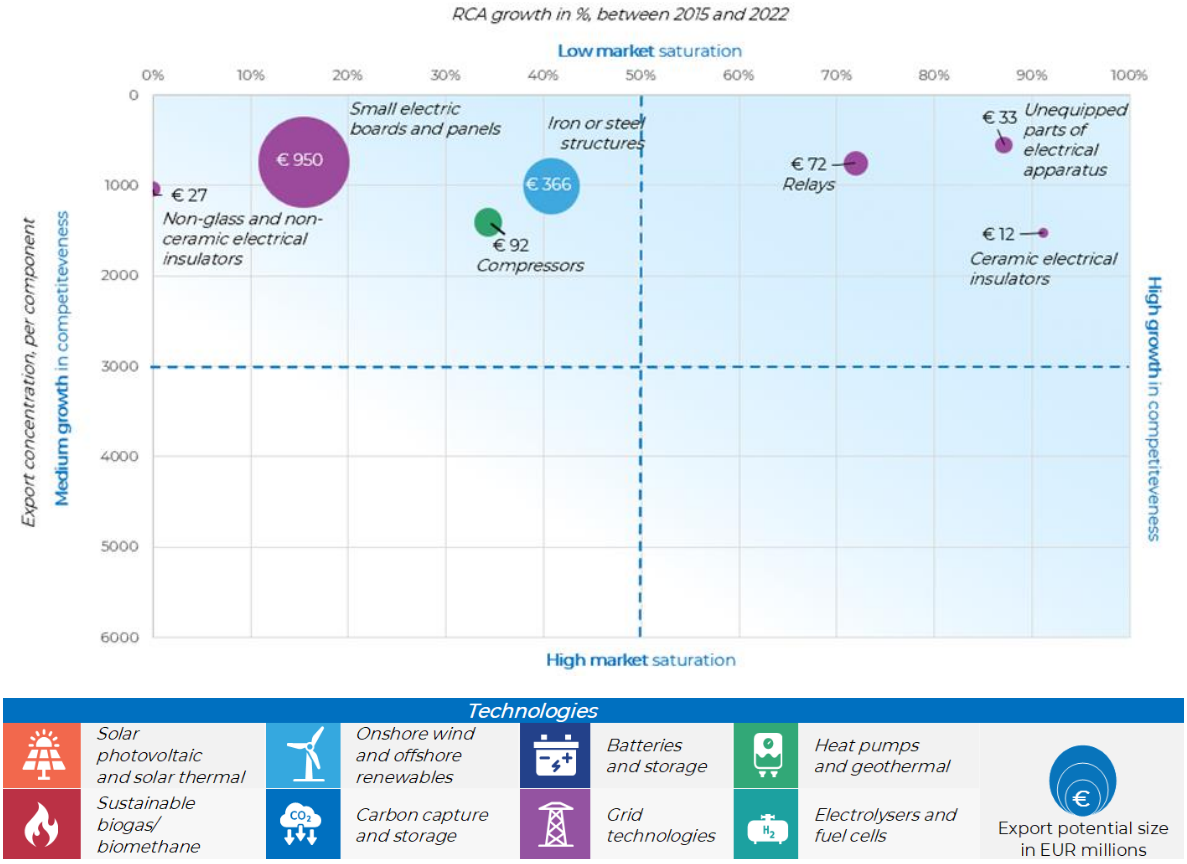
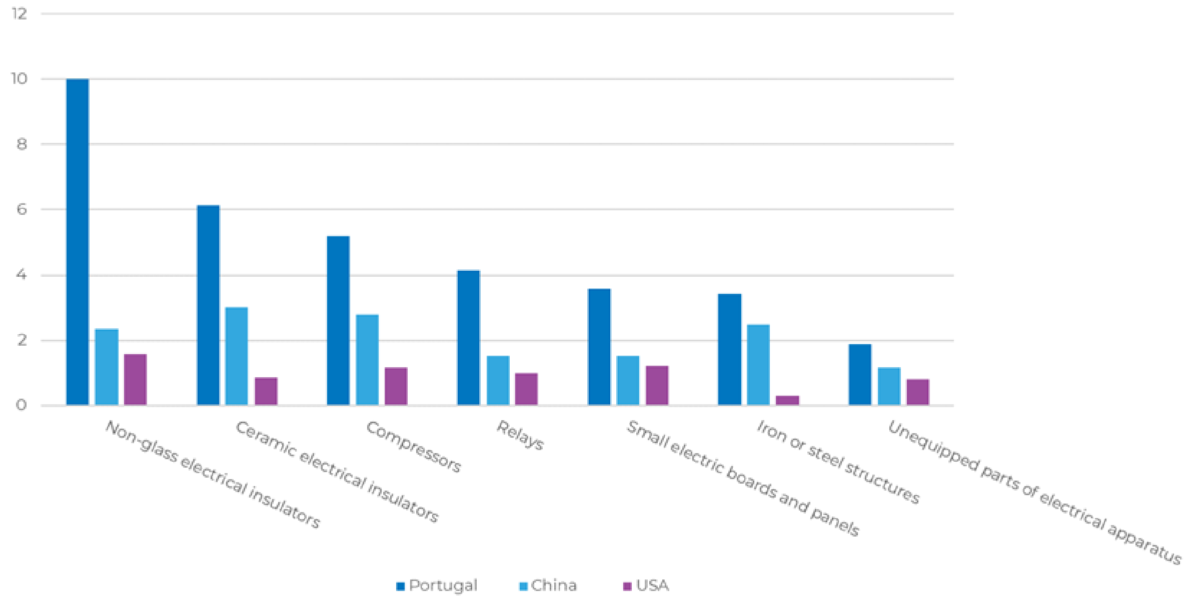


Figure 2: Absolute value of RCAs of Portugal, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

The European Commission has approved two Portuguese measures under the Temporary Crisis and Transition Framework to support investments in the production of certain Net-Zero technologies, namely batteries, solar panels, wind turbines, heat pumps, electrolysers, and equipment for carbon capture usage and storage.

The first measure is a €350 million Portuguese **State aid scheme** to support investments in equipment necessary to foster the transition to a net-zero economy which was approved by the European Commission in March 2024. It will be implemented in the form of direct grants. The source of funding is the Recovery and Resilience Facility and it supports the production of batteries, solar panels, wind turbines, heat pumps, electrolysers, equipment for carbon capture usage and storage, components of these technologies, and raw materials needed for the manufacturing.

The second measure is a €1 billion Portuguese **State aid scheme** approved by the European Commission in September 2024 to support investments in strategic sectors necessary to foster the transition to a net-zero economy. It will be implemented in the form of direct grants. The source of funding is the state budget, and support can be provided to batteries, solar panels, wind turbines, heat pumps, electrolysers, and equipment for carbon capture usage and storage, components of these technologies, and raw materials needed for production.

Industrial permitting

Average duration	N/A	**One-stop shop for permitting**	The Responsible Industry System (SIR)[661] Platform provides a one-stop shop for submitting permitting applications. It integrates environmental and industrial permitting processes.

Brief summary of the permitting processes

The permitting procedure for the production of Net-Zero technologies is the same as for any other industrial production (industrial production permits. The length of the industrial permit application process under the Sistema da Indústria Responsável (SIR) depends on several factors, including the complexity of the project and the category of the industrial establishment. The process involves coordination between various entities, environmental assessments, and adherence to national and European regulations.

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	Free Technology Zones (Zonas Livres Tecnologicas – ZLT) are test zones created so that new technology that is at an advanced level of development can be tested. They were proposed by the Ministry of the Economy and Digital Transition (Decree-Law 67/202) and the Ministry of the Environment and Climate Transition (Decree-Law 15/2022). Decree-Law 15/2022 established an appropriate legal framework for innovation and development pilot

[661] The platform is not specifically targeting net-zero technologies but can be used for all industrial permitting processes. See the platform here.

	projects through the creation of three ZLTs for renewable energy pilot projects. Projects will be able to run for a period of 6 years to test the technology.

Key incentive instruments
No relevant incentive instruments have been identified

Opportunities and challenges

Opportunities

General

Portugal has a high proportion of renewables already in its energy mix and could leverage its favourable climate to further increase energy generation from renewables. This provides access to cheap and ample energy and positions Portugal well for net-zero manufacturing, specifically for electrolysers and the production of green hydrogen.

Technology-specific

Regarding electrolysers, Portugal's government heavily supports the production of renewable hydrogen. Portugal participates in all IPCEI (Hy2Tech, Hy2Use and Hy2Infra) and the Portuguese company Fusion-Fuel is already manufacturing electrolysers in Portugal. Considering the political support there is the potential for further progress. Portugal has also set up the H2Med corridor with Spain and France to supply hydrogen to Northwest Europe. Further cooperation organised for example through the yearly Iberian summits could allow for strengthening value chains across countries.

Portugal has the largest lithium deposits in Europe, which could reduce dependencies on critical raw materials of European battery manufacturers. The reserves were already quantified in 2017. However, exploitation has been delayed due to environmental concerns[665]. Approval was only granted in May 2024 to the UK firm Savannah Resources and exploitation is expected to start only in 2026[666]. Nevertheless, paired with the announcement of a lithium-ion batteries factory by CALB this could enable a wider uptake of battery manufacturing in Portugal.
Portugal could tap into an EUR 1.1 billion export potential for grid technologies. Additionally, the relatively low level of market saturation for these components offers Portugal an opportunity to further strengthen its export position.[667]

Challenges

General

While there has been some progress, Portugal's research and development (R&D) intensity is still below the EU average. Moreover, a dedicated policy framework is missing[662] and Portugal has generally a challenge in scaling up innovation[663]. Additional investments and efforts to enhance innovation capacity and coordination are necessary to compete in Net-Zero innovation.

A lack of national industrial champions and strategic orientation of industrial policy (apart from hydrogen) means that there is a lack of clear signals and scale to make a push for investments into net-zero industries[664].

Technology-specific

With access to critical raw materials and low-cost renewables, Portugal has two key factors for the development of competitive net-zero value chains. However, a lack of scale in industry and government support as well as a focus on low-added value uses such as exporting hydrogen and exporting mined and refined lithium, leads to missed opportunities for Portugal regarding higher value activities such as the manufacturing of batteries and electrolysers[668].

The increasing share of renewables causes short-term challenges related to grid capacity which could impact the scaling up of clean-tech manufacturing facilities that rely on stable energy supplies[669].

For batteries, the extraction of much-needed resources has been slowed down by local communities due to uncertainties regarding environmental impacts and socio-economic benefits. Public resistance has slowed down projects and could continue being a bottleneck if there is no value added to these communities.

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential

[662] IEA (2021), Portugal 2021, IEA, Paris https://www.iea.org/reports/portugal-2021, Licence: CC BY 4.0
[663] E3G (2023) Making Clean Technology Value Chains Work For EU Economic Convergence. A Case Study On Portugal. See here.
[664] Ibid.
[665] European Court of Auditors (2023) The EU's industrial policy on batteries. New strategic impetus needed, available here.
[666] Marta Vidal, 11 December 2023, A lithium 'gold mine' is buried under one of Europe's last heritage farming systems, see here.
[667] See the above descriptive statistics for Portugal on its RCA growth.
[668] E3G (2023) Making Clean Technology Value Chains Work For EU Economic Convergence. A Case Study On Portugal. See here.
[669] European Commission (2024), 2024 Country Report - Portugal, available here.

Country Factsheet Romania

Key findings

Manufacturing capacity:[670] Romania's manufacturing capacity amounts to between 100 and 250 MW/y (1% of EU capacity) for solar PV and between 0 and 200 MWh/y (a negligible share of total EU capacity) for battery and storage technologies. At the same time, however, Romania appears to be ramping up its manufacturing capacity in the battery and storage industry.

Industrial production:[671] Romania's three largest industrial Net-Zero sectors by value are grid technologies, with a production amounting to EUR 812 million (1% of total EU production), EUR 485 million (a negligible share) for wind, and EUR 282 million (a negligible share) for solar energy.

International positioning:[672] Romania is a competitive exporter of three key Net-Zero technologies: grid technologies, heat pumps, and solar PV. For solar PV technologies, Romania has an estimated untapped export potential of EUR 447 million for electric static converters, however, China's RCA is significantly higher than Romania's. In the wind turbine sector, Romania holds EUR 438 million in untapped export potential for wind turbine structures and has higher RCA than China and the USA. For grid technologies, Romania is competitive in exporting relays and electricity supply production meters, outperforming both China and the USA. These grid components also have low export market saturation rates. Romania is also a competitive exporter of heat pump components, such as automatic thermostats and heat exchange units, with an estimated untapped potential of nearly EUR 220 million.

Policy framework: Currently, Romania's Industrial Strategy 2023-2027 (under institutional endorsement) outlines a national vision for industrial policy, focusing on digital and green transitions, and expanding domestic production in strategic and high-tech sectors. The strategy mentions the NZIA in the context of increasing energy efficiency for high-energy-intensity sectors like chemistry and metallurgy and highlights the growing importance of environmentally friendly technologies.

Industrial permitting: The industrial permitting process for any industrial facility in Romania involves obtaining a construction permit and urban certificate from local authorities, and an environmental permit, including an Environmental Impact Assessment, from the National Agency for Environmental Protection, typically taking about 6 months. The Industrial License Office acts as a one-stop shop to streamline, simplify, and digitize these procedures.

Incentive instruments: In Romania, the National Plan for Recovery and Resilience (Planul Național de Redresare și Reziliență) allocates €199 million in grants for projects involving batteries and solar cells/panels. The intervention aims to promote investments in production, assembly, and recycling capacities for batteries (at least 2 GW) and photovoltaic cells/panels (at least 200 MW), with a maximum annual budget of €150 million. Various skills programmes are also available.

[670] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[671] Industrial production refers to total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[672] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in Romania[673]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[674]	Import dependence (extra-EU)[675]
	100 – 250 MW/y[676] *(1% of EU capacity)*	1200 - 6500 MW/y	13000 - 14000 MW/y	«Negligible share of EU production» *(Disclosure: 78%)*	0.21
	No facilities identified[677]	-	-	«Negligible share of EU production» *(Disclosure: 79%)*	0.14
	0 – 200 MWh/y[678] *(a negligible share of EU capacity)*	1750 - 2000 MW/y	22000 - 50000 MWh/y	«Negligible share of EU production» *(Disclosure: 100%)*	0.65
	No facilities identified [679]	-	-	«Negligible share of EU production» *(Disclosure: 65%)*	0.34
	No facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 84%)*	0.10
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 89%)*	0.24
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 90%)*	0.17
	N/A	N/A	N/A	1% *(Disclosure: 74%)*	0.21
	⊖	⊖	⊖	✓	✓
	⊖	⊖	⊖	✓	✓

Technologies

	Solar photovoltaic and solar thermal		*Onshore wind and offshore renewables*		*Batteries and storage*		*Heat pumps and geothermal*		*Electrolysers and fuel cells*
	Sustainable biogas/ biomethane		*Carbon capture and storage*		*Grid technologies*		*Data coverage*		*Data reliability*

Romania's main production facilities include Prime Batteries Technologies in Cernica, with an estimated capacity of 0 - 200 MWh of Li-ion cell-to-systems, and Karpat Solar's PV manufacturing facility in Transylvania with an estimated capacity of around 50 - 100 MW. In addition, Altius Fotovoltaic has a facility of 150 – 200 MW capacity in solar PV modules. Announced manufacturing facilities include factories by ABEE (Avesta Battery and Energy Engineering) and Prime Batteries Technologies, with expected outputs of 22 GWh and 7.8 GWh (of which 1.8 GWh in 2024 and 6 GWh in 2026) respectively.

[673] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[674] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[675] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[676] Manufacturing capacity is provided exclusively for solar photovoltaic and does not include capacities for solar thermal manufacturing. The current capacity is focused only on modules, yet the announced facilities after 2025 also include wafer and cell facilities.
[677] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[678] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[679] Manufacturing capacity data in MW is typically not available for facilities producing biogas and biomethane; grid technologies; CCS; and heat pumps. For heat pumps, manufacturing data is typically expressed in terms of sold equipment.

Evolution of Romania's international positioning

As illustrated in Figure 1, Romania is indicated by trade data to be a competitive exporter in key Net-Zero technologies, including grid, heat pumps, and solar PV.[680] However, there is an observed discrepancy between the trade data and the actual manufacturing landscape, based on desk research. While Romania shows a significant untapped export potential in these sectors—particularly with EUR 447 million in export potential for electric static converters in solar PV—the dominance of countries like China, which held nearly 40% of the global export market share in 2022, suggests Romania's role may be smaller than implied by trade figures alone. Consequently, as shown in Figure 2, China's RCA for exporting electric static converters is substantially higher than Romania's.[681]

In the wind turbine sector, Romania is identified as having EUR 438 million in untapped export potential for wind turbine structures (such as towers), with a significant increase in its RCA (by 150%) between 2015 and 2022. However, a closer examination of manufacturing capacity suggests that the scale of domestic production may not fully align with these figures. Romania's competitiveness, as highlighted by the RCA index, should be interpreted as indicative of its relative advantage within a niche rather than a reflection of large-scale manufacturing activities when compared to larger players like China and the USA.

For grid technologies, Romania appears competitive in the export of relays and electricity supply production meters, showing an untapped export potential of nearly EUR 440 million in 2022. While trade data suggests Romania outperforms China and the USA in these categories, it is essential to consider that this advantage could stem from particular production or assembly activities rather than a comprehensive domestic manufacturing presence across all components. The relatively low export market saturation for these goods indicates that there are opportunities for Romania to increase its share, although the country's actual capacity to capitalise on this may be limited. A similar observation applies to automatic thermostats and heat exchange units.

---

[680] Figures 1 and 2 present Romania's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Romania's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand.
This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Romania's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Romania could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Romania could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.

[681] Figure 2 builds upon this by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Romania's trade strategy. Taken together, these figures provide a nuanced understanding of Romania's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

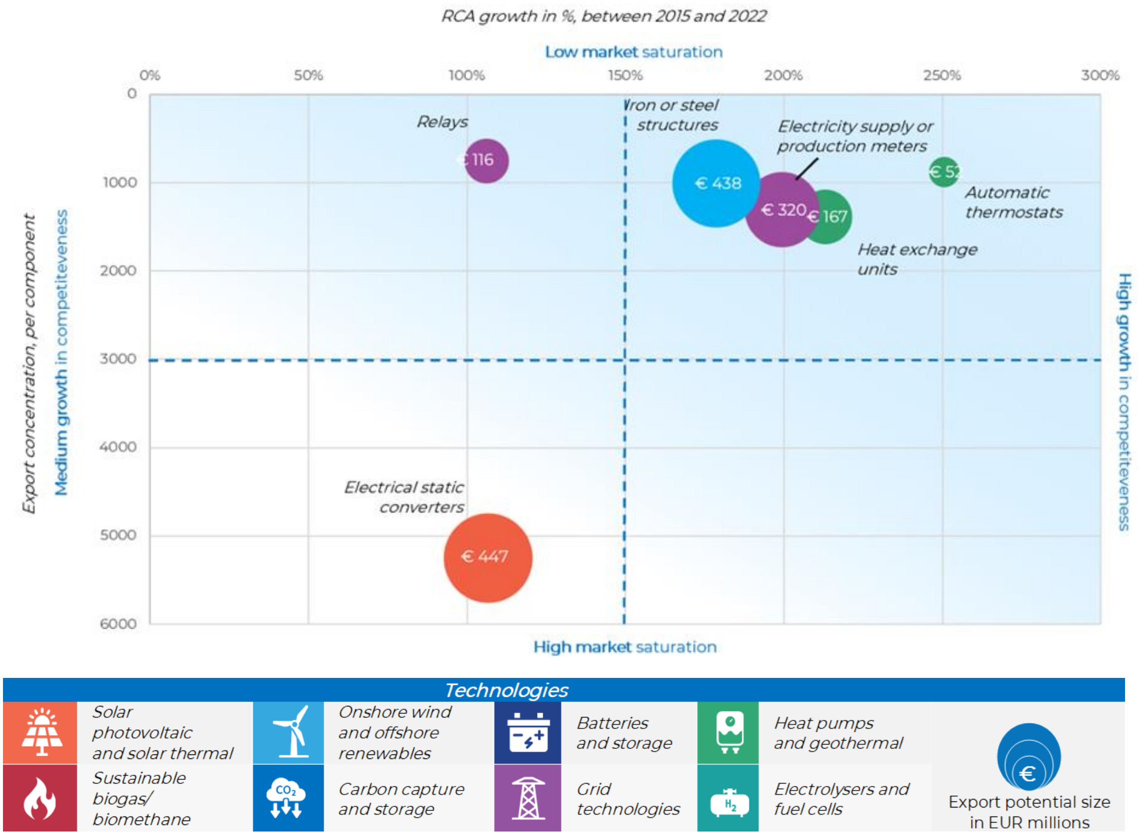
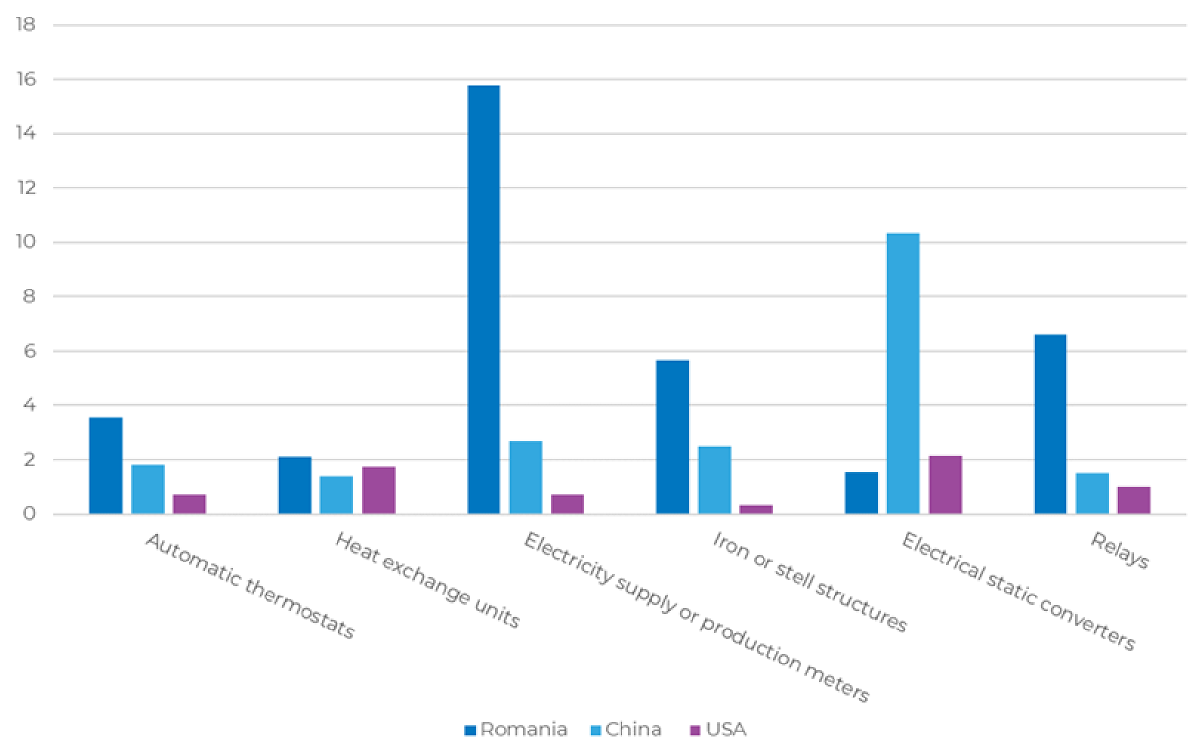


Figure 2: Absolute value of RCAs of Romania, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

[The Industrial Strategy of Romania 2023-2027](#) (in the process of institutional endorsement) outlines a national vision for industrial policy, by referring to the European and international context, and proposes interventions to support the industrial sector's adaptation to the digital and green transitions. The strategy mentions the NZIA in the context of the EU's legislative framework, specifically increasing energy efficiency for large consumers, with Romania's high energy intensity sectors being chemistry and metallurgy.

There are six general objectives. Objective 1.1 "*Promote the adoption of advanced technologies in all industrial sectors*" highlights that adopting advanced technologies is crucial for modernising Romania's economy. It emphasises the growing importance of environmentally friendly technologies and responsible procurement in reshaping long-term business strategies.

Objective 6.1 focuses on expanding domestic production and increasing the national share of value chains in strategic and high-tech sectors. This objective aims to identify and promote sectors with high growth and innovation potential, such as advanced technology, digital industry and sustainable sectors. The aim is to amplify the impact of these sectors on the national economy, thus contributing to the sustainable and competitive development of Romania and reducing strategic vulnerabilities in supply chains. The objective takes into account *the risks determined by the transformations taking place in the economy, the dynamics of innovation and the impact of new technologies, as well as the strategic directions imposed by the reindustrialization strategy at the European level*.

The proposed actions include strengthening industrial supply chains, conducting bilateral discussions with strategic partners to reduce dependencies and increase resilience, and supporting strategic investments to reinforce vulnerable chains and minimize strategic dependencies.

The Strategy also highlights the concept of "reindustrialization of Romania", which can be operationalized also through innovative low-carbon technologies and processes in energy-intensive industries. This includes replacing high-emission products and adopting solutions like carbon capture and use (CCU) and carbon capture and storage (CCS).

Scope of the policy framework

Industrial permitting

Average duration[682]	Approximate duration of 6 months for all authorisations.[683]	**One-stop shop for permitting**	The Industrial License Office serves as a one-stop shop for obtaining necessary permits, streamlining, simplifying, and digitising the procedures for granting

[682] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.

[683] Based on an interview with the Ministry of Environment

			a single industrial license.[684]

Brief summary of the permitting processes[685]

The permitting process for any industrial facility follows standard procedures, including obtaining a construction permit and urban certificate from local authorities, and an environmental permit from the National Agency for Environmental Protection. The environmental permit process also involves conducting an Environmental Impact Assessment.

The Single Electronic Contact Point (PCUe) acts as an online platform designed to digitalise and simplify the interaction between businesses and public authorities in Romania, especially for obtaining the necessary permits for economic activities. The PCUe will be replaced by Romania's Single Digital Portal (PDURo). The portal, currently being developed by the Authority for the Digitalization of Romania, is part of the investment for "*Implementation of the Governmental Cloud infrastructure*", within Component 7 of the National Recovery and Resilience Plan[686].

Procurement

As far as public procurement is concerned, there are only general rules on procurement covered by the NZIA Regulation. For the procurement of innovative solutions in the field of the NZIA, contracting authorities and entities may apply the Innovation Partnership, a procedure regulated both in national public procurement legislation and in the relevant EU Directives.

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

National plan for Recovery and Resilience (Planul Național de Redresare și Reziliență)

2024-2026	**Grant**	**Total funding available: €199 million**
Technologies: Batteries and storage technologies and Solar technologies.	**Eligibility:** the project must be implemented on Romanian territory, and should be implemented by June 2026	**Available support:** If the value of the projects submitted under the call for proposals exceeds the budget allocated in the respective year, the amounts allocated in the following years are used in advance, without exceeding the ceiling of €150m annually

Description: The plan includes the construction of new facilities for the production, assembly, and recycling of batteries for a capacity of at least 2 GW/year. This encompasses any combination of the following activities:
- Production of electrodes and/or their components and batteries.
- Assembly of electrodes into batteries, testing/conditioning of batteries, including recycling activities.

Additionally, it involves establishing new capacities for the production, assembly, and recycling of photovoltaic cells and/or panels capacity of at least 200 MW/year, including:
- Production of polysilicon and wafers.
- Assembly of photovoltaic cells and modules, including the recycling of photovoltaic panels or their components.

Professional training of human resources to acquire skills in the field of green energy (Formarea profesională a resursei umane pentru dobândirea de competențe în domeniul energiei verzi)

[684] Source available here
[685] Information in this section primarily comes from interviews with relevant authorities. Other sources can be found here, and here.
[686] Romanian Government (2024), available here

2023-2026	**Skills programme**	**Type of programme:** up-skilling and re-skilling
Technologies: Solar technologies, Wind technologies, Electrolysers and fuel cell technologies and heat pumps and geothermal energy technologies	**Description:** The plan includes a €10 million investment in professional training for human resources to acquire skills in green energy. The specific objective is to provide accelerated certification in renewable energy skills, aligned with the latest labour market developments, through nationally recognized training programs that include initiation, qualification, improvement, and specialisation courses. The investment aims at the mapping of training needs at the national level and the training of 4000 specialists necessary for the exploitation of green energies.	
Renewable Energy School of Skills (RESS – Academia pentru Surse Regenerabile de Energie)		
At least since 2016	**Skills programme**	**Type of programme:** re-skilling
Technologies: Solar and wind technologies	**Description:** While no training has been identified that directly targets skills in manufacturing, the initiative can benefit the labour force with transferable and relevant skills in the Net-Zero industry.	
RenewAcad Academy of Counseling and Professional Training for Renewable Energy Sources (RenewAcad Academia de Consiliere si Pregatire Profesionala pentru Surse Regenerabile de Energie)		
At least since 2016	**Skills programme**	**Type of programme:** up-skilling and re-skilling
Technologies: Solar and wind technologies	**Description:** While no training has been identified that directly targets skills in manufacturing, the initiative can benefit the labour force with transferable and relevant skills in the Net-Zero industry	

Opportunities and challenges

Opportunities

General

Romania has lower than EU average electricity prices[687] and has ample renewable energy resources in wind, solar and hydropower[688]. Leveraging these resources can help Romania reduce energy costs and increase the availability of energy for net-zero manufacturing.

Furthermore, the tax burden[689] and labour costs are relatively low in Romania[690] while productivity has been growing though less so for the industry[691]. Combined with a strong presence of industry and manufacturing including automotive companies this could allow Romania to develop industrial clusters focused on net-zero technologies such as batteries.

Technology-specific

The current manufacturing capacity for battery and energy storage technologies is comparatively low, however, announcements for new manufacturing facilities by Prime Batteries Technologies[695] could be an impetus for further development. There is also a proposed project by Rock Tech Lithium for a plant to refine lithium-bearing rock into high-purity lithium hydroxide[696]. However, there have not been any updates since its announcement in 2022. Nevertheless, there is great potential for Romania to follow suit with its Hungarian neighbour and become a European battery manufacturing hub[697].

For solar PV manufacturing, legislative reforms and grants provided through Romania's National Recovery and Resilience Plan[698] have

Challenges

General

Romania's net-zero technology sector is fragmented and lacks scale as well as established ecosystems supporting local supply chains and innovation[692]. Combined with a prevailing skills shortage[693] this is a serious hurdle that Romania needs to overcome to scale up its net-zero manufacturing capabilities.

The regulatory environment in Romania poses challenges for net-zero companies. Complicated and lengthy licensing processes, lack of regulatory stability, and insufficient support for clean-tech investments make it difficult for companies to operate and scale. However, improvements have been made with the establishment of the Office for Industrial Licensing which acts as a one-stop-shop and has the goal to simplify and digitalise industrial licenses[694].

Technology-specific

The decision by ABEE to abandon its collaboration with Romania to build a EUR 1.4 billion battery manufacturing plant raises some concerns over the prospects of establishing a battery manufacturing hub in Romania considering also other developments such as the Rock Tech Lithium plant are slow to materialise. It is unclear why ABEE abandoned its planned Li-ion battery factory, but it seems that state aid and investments were too slow to materialise[701] and that the company has started engaging with other countries[702].

Public acceptance of CCS technologies is a challenge for Romania, mainly driven by a lack of

---

[687] Based on 2024 data, see: Electricity price statistics, Eurostat, 2024, available here.
[688] Explain Romania, Renewable Energy in Romania, available here.
[689] Heritage Foundation, Economic Freedom Country Profile, 2024 Index, Romania, available here.
[690] Following Bulgaria, Romania had the lowest hourly labour costs in 2023 in the EU. However, Roman also experienced the strongest increase in labour costs (+16.4%) in the first quarter of 2024. See, Eurostat, Hourly labour costs and Labour cost index - recent trends.
[691] Based on AMECO data on growth in productivity, available here.
[692] McKinsey & Company (2022) Bridging the gap: Transversal technologies to boost Romania's resilience, available here.
[693] European Commission (2024), 2024 Country Report – Romania, available here.
[694] TPA Group, 27 December 2022, 'The single industrial licence – the simplification of administrative procedures', available here.
[695] See Battery Industry, 10 July 2023, 'ABEE & Romanian government announce ROMVOLT project', available here; and Balkan Green Energy News, 16 November 2022, 'Romania-based PBT teams up with EIT InnoEnergy in major battery production project', available here.
[696] PSPA (2023). Europe runs on Polish lithium-ion batteries. The potential of the battery sector in Poland and the CEE Region, available here.
[697] EY, 30 May 2023, 'Europe can benefit from the battery crisis and Romania has the chance to become an important partner in pan-European alliances', available here.
[698] There are two calls, one supporting investments in the development of electricity storage capacities and the other supporting recycling capacities for photovoltaic cells and panels. See here.
[701] Alex Ciutacu, 23 September 2024, 'De ce a pierdut România investiţia de 1,4 miliarde de euro a belgienilor de la ABEE pentru o fabrica de baterii la Galaţi, dacă autorităţile locale anunţau în 2023 că formula ajutorului de stat a fost finalizată?', available here.
[702] ABEE, 07 June 2024, 'Avesta Holding Announces Plans for a new 20 GWh LFP Battery Cell Gigafactory', available here.

accelerated Romania's transition[699] and have led also to strengthened interest from investors in setting up manufacturing and recycling plants for solar power equipment[700].	understanding and its association with the use of fossil fuels.[703] A potential bottleneck for scaling up solar PV and battery manufacturing in Romania is the dependency on critical raw materials and components from third countries, particularly China. For batteries and energy storage technologies, already 65% of Romanian imports are from non-EU countries. If no alternative sources are found then this dependency will only increase with scaling up production creating potential supply chain vulnerabilities.

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

[699] South-East European Industrial Market, 19 March 2024, 'Romania's solar power sector', available here.
[700] Balkan Green Energy News, 18 August 2023, 'Five firms apply for subsidies in Romania for solar panel factories', available here.
[703] Miu, L., Nazare, D., Cătuți, M., Dudău, R., Postoiu, C., & Bălan, M. (2021), Assessment of current state, past experiences and potential for CCS deployment in the CEE region – Romania. Available here.

Country Factsheet Sweden

Key findings

Manufacturing capacity:[704] Sweden's Net-Zero manufacturing capacity amounts to between 15.5 and 16 GWh/y (7% of total EU capacity) for battery and storage technologies; between 120 and 250 MW/y (1% of EU capacity) for solar PV modules and between 0 and 25 MW/y (a negligible share of total EU capacity) for wind power. Moreover, Sweden is home to at least 13 factories that specialise in the manufacturing of heat pumps. Metacon, a key European producer of electrolysers is also based in Sweden.

Industrial production:[705] Sweden's three largest industrial Net-Zero sectors by value are grid technologies, with a production amounting to EUR 1.8 billion (3% of total EU production), EUR 1.7 billion (7% of EU production) for heat pumps and geothermal, and EUR 0.7 billion (1% of EU production) for wind power.

International positioning:[706] Sweden is a competitive exporter of various Net-Zero technologies, including grid technologies, heat pumps, geothermal, and sustainable biogas technologies. Regarding heat pump technologies, Sweden excels in exporting heat pumps, centrifugal pumps, and heat exchange units, outperforming both China and the USA in terms of RCA for all three components. In the grid technologies sector, Sweden is competitive in exporting insulated electric conductors and devices for protecting electrical circuits.

Policy framework: Currently, Sweden's climate action plan foresees around 70 action points, including incentives for CCS and battery production. The plan, along with the Swedish NECP and the Recovery and Resilience Plan, provides high-level support through grants and funding for batteries, CCS and hydrogen/electrolysers production, but sets no specific manufacturing capacity targets. The Swedish government supports large battery factory establishments through coordinated efforts by Business Sweden (2023-2025).

Industrial permitting: Environmental permits in Sweden, issued by different authorities depending on the risk level, include land use and may require a specific Natura 2000 permit if near protected areas, taking 12-16 months for first-time applications and 25-33 months for appeals. Building permits, change permits, and assessments for chemical substances may also be necessary.

Incentive instruments: Sweden offers various incentive instruments, including the Industrial Leap scheme, which provides grants for biofuels, batteries, and hydrogen/electrolyser projects from 2018 until 2031. Additionally, The Swedish National Debt Office offers credit guarantees for large green investments.

[704] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[705] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[706] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides details on each indicator.

Key descriptive statistics for Net-Zero technologies in Sweden[707]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[708]	Import dependence (extra-EU)[709]
	120 - 250 MW/y[710] *(1% of EU capacity)*	100 - 200 MW/y	500 - 600 MW/y	«Negligible share of EU production» *(Disclosure: 54%)*	**0.40**
	0 – 25 MW/y [711] *(a negligible share of EU capacity)*	-	-	«Insufficient data coverage» *(Disclosure: 37%)*	**0.17**
	15500 - 16000 MWh/y[712] *(7% of EU capacity)*	24000 - 25000 MW/y	60000 - 150000 MW/y	«Negligible share of EU production» *(Disclosure: 77%)*	**0.42**
	At least 13 facilities identified	-	-	7% *(Disclosure: 59%)*	**0.31**
	No facilities identified	-	700 - 800 MW/y	1% *(Disclosure: 68%)*	**0.03**
	N/A	N/A	N/A	1% *(Disclosure: 78%)*	**0.27**
	N/A	N/A	N/A	1% *(Disclosure: 70%)*	**0.20**
	N/A	N/A	N/A	3% *(Disclosure: 38%)*[713]	**0.30**
	−	−	−	−	✓
	−	−	−	−	✓

Technologies				
Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Sweden's main production facilities include NorthVolt AB's battery factory in Skellefteå, with an estimated capacity, according to Northvolt itself, of 60 GWh/y[714] and Renewable Sun Energy Sweden AB solar PV module facility in Arvika with an estimated capacity of 120 MW. Announced manufacturing facilities include the Novo facility (spearheaded by NorthVolt AB and Volvo AB), which is estimated to be able to produce 50 GWh of lithium nickel manganese cobalt oxide (NMC) batteries by 2026. Sweden is also a key supplier in the grid industry, owing to Hitachi and NKT, which produces HVDC equipment and cables.

[707] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[708] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[709] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[710] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[711] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[712] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.
[713] This estimate should be seen as a minimum due to the low disclosure rate. The total value is expected to be higher.
[714] Northvolt, Europe's first homegrown gigafactory, available here.

Evolution of Sweden's international positioning

As illustrated in Figure 1, Sweden has established itself as a competitive exporter of components across various Net-Zero technologies, including grid, heat pump, geothermal, wind turbine, and sustainable biogas technologies.[715] In the realm of heat pump technologies, Sweden excels in exporting heat pumps, centrifugal pumps, and heat exchange units. These three components alone are estimated to hold nearly EUR 1.8 billion in untapped export potential for the country. Notably, Sweden outperforms both China and the USA in terms of RCA for all three heat pump technology components (see Figure 2). Remarkably, Sweden's RCA for finalised heat pump products is six times larger than that of China.

In the grid technologies sector, Sweden is competitive in exporting insulated electric conductors and devices for protecting electrical circuits. These components collectively have an untapped export potential of EUR 440 million. This signifies a substantial opportunity for Sweden to expand its presence in the global market for these critical components as the export market saturation rate is considerably favourable.

Furthermore, Sweden shows strong competitiveness in the wind turbine sector, particularly in exporting steel structures for wind turbines. The country holds an estimated EUR 488 million in export potential for these components. However, Sweden's RCA for these steel structures does not surpass that of China (Figure 2).[716]

[715] Figures 1 and 2 present Sweden's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Sweden's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Sweden's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Sweden could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Sweden could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.
[716] Figure 2 builds upon this by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Sweden's trade strategy. Taken together, these figures provide a nuanced understanding of Sweden's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

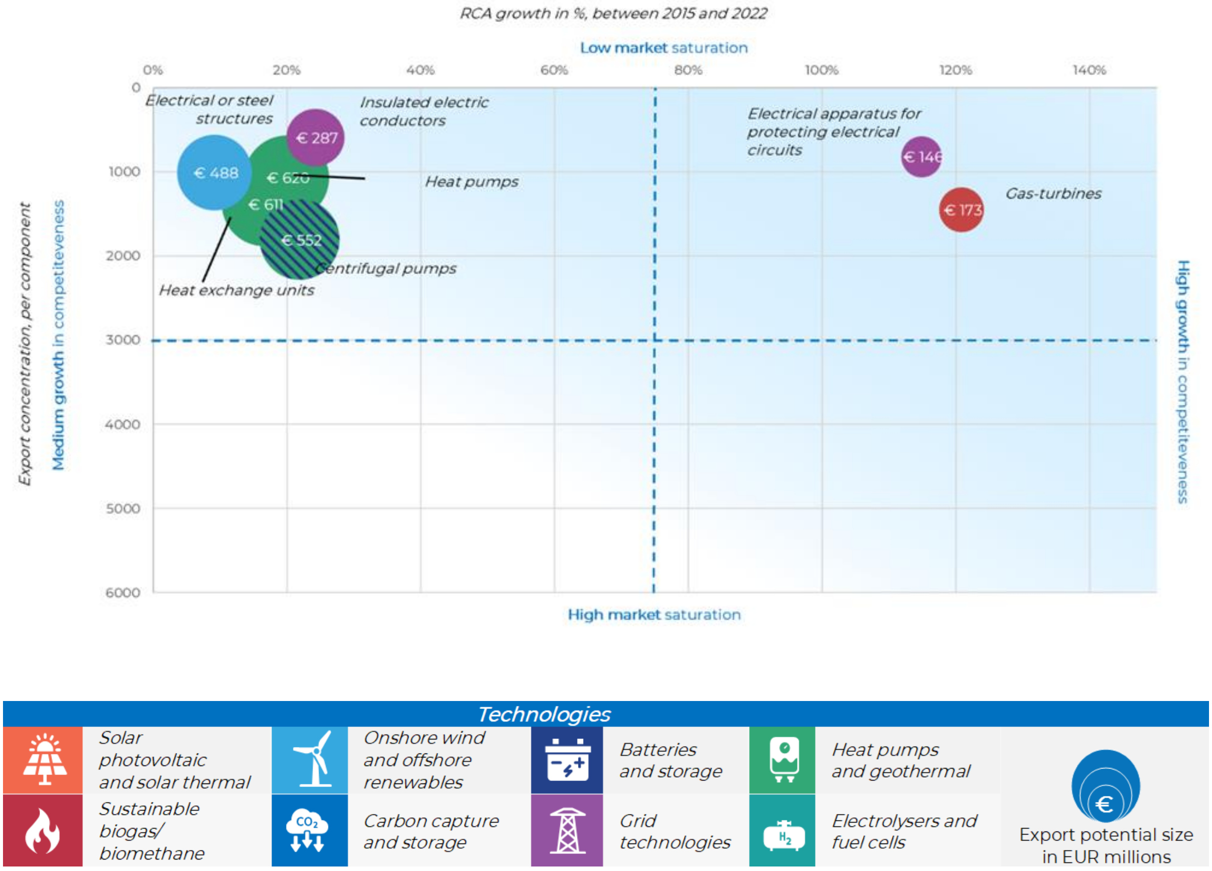
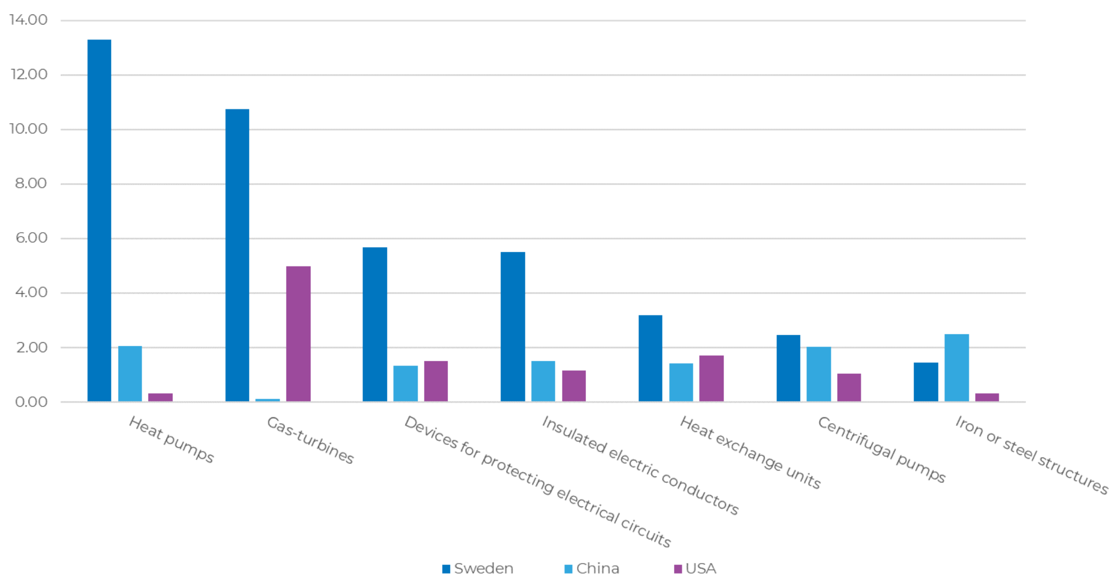


Figure 2: Absolute value of RCAs of Sweden, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

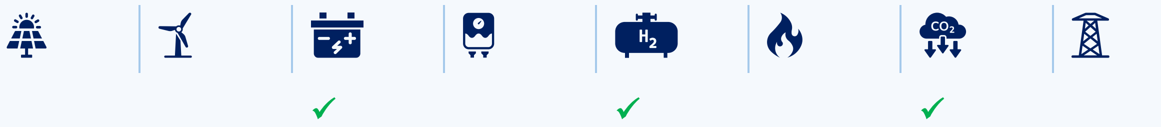
The Swedish climate action plan (Regeringens klimathandlingsplan – hela vägen till nettonoll), published in 2023, contains around 70 action points (continuation of current measures and proposals) for emission reductions in all sectors, with the overall target of reaching climate neutrality by 2045. It specifically includes measures to incentivise manufacturing capacities within CCS (and bio-CCS) and battery production, though it remains a high-level plan with brief descriptions. For CCS, measures include grants and funding of early-stage development (from the grant scheme 'Industriklivet' and 'Climate Leap', for both bio-CCS and fossil CCUS) and a proposal to exclude energy used for CCS from the energy tax (pending EU law compliance and impact assessments). For batteries, the plan includes grants and funding of early-stage developments for battery production (from grant scheme 'Industriklivet') and support to improve the coordination of large battery factory establishments in Sweden, but no targets on manufacturing capacity are defined.

The Swedish NECP (Sweden's draft updated National Energy and Climate Plan) lists measures to increase domestic battery production and hydrogen/electrolysis technology development (through the grant scheme 'Industriklivet'). The plan is high-level but provides examples of grants approved for a pilot plant for large-scale battery manufacturing (from grant scheme 'Industriklivet') and for a pilot plan to produce fossil-free steel, which also includes improving hydrogen production capacity. No targets are set.

The Swedish Recovery and Resilience Plan also includes grants (grant schemes 'Industry Leap' and 'the Climate Leap') which support battery production, CCS and hydrogen/electrolysis technology development. It is, however, a high-level plan and most items are described only briefly. No targets on manufacturing capacity are set.

In 2023, the Swedish government asked the Export and Investment Council (Business Sweden) to strengthen the **coordination of efforts for large establishments of battery factories across Sweden**. The coordination assignment shall contribute to creating good conditions for realizing the vehicle manufacturers' key investments. Through consultations with key stakeholders from the business side, research institutions, and in coordination with relevant regions (Västra Götaland and Stockholm region), the organisation is tasked to identify obstacles and challenges and provide a final report to the government by September 2025. These efforts are supported by up to about EUR 300,000.[717]

Scope of the policy framework



Industrial permitting

Average duration[718]	Environmental permitting for hazardous and water activities takes approximately 12-16 months for first-time applications and 25-33	**One-stop shop for permitting**	No one-stop shop for permitting has been identified.

[717] See here.
[718] Our research reveals that permitting times can vary significantly across and within countries due to several factors. Project size and the nature of the economic activity are key determinants of the scope and type of permits required. Activities with higher emissions or greater environmental risks, such as battery production, often undergo more comprehensive permitting processes, which can extend timelines. Projects requiring an environmental impact assessment typically experience even longer delays. Moreover, additional factors can significantly prolong the permitting process, such as litigation, multiple requests for supplementary investigation and information by authorities, or when a preliminary screening decision is needed to determine whether an environmental impact assessment is required. In some countries, permit decisions may be challenged by the applicant or the public, with appeal stages further lengthening the overall process. Therefore, processing times may vary depending on which steps are included in the calculation. As a result, estimates of permitting times and cross-country comparisons should be approached with caution, as they are highly context-specific.

Brief summary of the permitting processes[719]

Environmental permit: permitting in accordance with the Swedish Environmental Code varies by the potential environmental risk from the operations, with responsibilities handled by municipalities, counties, or national authorities. The permit for land use is included as part of the environmental permit. If operations are close to a Natura 2000 area, a specific Natura 2000 permit is required.

Approval is required under the Swedish Planning and Building Act if a building permit is needed. For extending or modifying existing facilities, a "change permit" (Swedish: ändringstillstånd) is necessary. A common challenge for these permits is determining the assessment scope, with businesses seeking to limit it and authorities aiming to expand it. Operations handling large quantities of chemical substances are also evaluated against Sweden's adoption of the “Seveso” regulation (Regulation 2008/1272 - Classification, labelling, and packaging of substances and mixtures).

Some steps have been taken to digitalise the procedure (e.g., the possibility to send and sign forms digitally), but no digital interactive platform has been established. One explanation is that the Swedish county boards are responsible for the permitting. As there are 21 county boards in Sweden, there is limited central governance to address and improve digitalisation, and thereby facilitate the permitting process. Recently, one country board (Västerbotten) received additional funding to explore how permitting processes can improve.

The number of correction rounds/complementary information needed in the permitting application is a critical part. The sensitivity of the location is another factor - highly sensitive areas (ecosystem services etc.) increase the risk of appeal. The level of resources at relevant authorities has been flagged as a concern. The stakeholder consultation activities play a major role in whether the permitting process is smooth or lengthy. Further, about 1/4 of all cases are appealed. The total time for appealed cases is on average around 750-1000 days. No alternative dispute resolution procedures exist.

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	Sweden’s Innovation Agency (Vinnova) is exploring options to fulfil the requirements regarding regulatory sandboxes in the NZIA.[720]

Key incentive instruments

Industrial Leap (Industriklivet)

2018-2031 (could be prolonged)	**Grant**	**Funding disbursed in 2024: EUR130 million; total funding disbursed to date: EUR635 million[721] between 2018 and 2022**
Technologies: Biogas and biomethane technologies, batteries and storage technologies, electrolysers and fuel cell technologies, CCS technologies	**Eligibility:** Any projects within the three areas covered by the support scheme, running until 2031. The share of the total project cost covered by support is determined on a case-by-case basis.	**Available support:** N/A

Description: Under the Industrial leap, support can be achieved for either scaling up and commercialisation (close to market projects) or research and innovation projects in the following three areas 1) process industry/hard-to-abate sectors, 2) solutions that lead to permanent negative emissions, and 3) so-called strategically important initiatives such as new technology or innovations including batteries, biofuels and

[719] Information in this section primarily comes from interviews with relevant authorities. Other sources can be found here, here, and here.
[720] More information available here.
[721] Since 2018, see here.

recycling. The so-called technology tracks that have received the most financial support so far are hydrogen, electrification, recycling and CCU. Until September 2024, support has been approved for 171 projects, mobilising a total of EUR 635 million from the instrument, and EUR 7.6 billion in co-financing.[722] The industrial life scheme is part of the Next Generation EU.		
Credit guarantees for green investments (Kreditgarantier för gröna investeringar)		
Since 2021	**Loan Guarantee**	**Funding available in 2024: EUR6.95 billion**
Technologies: All[723]	**Eligibility:** To receive a guarantee, the loan must amount to at least SEK 500 million. Applicants need to show that the investment meets environmental criteria, for which the Swedish National Debt Office relies on the EU taxonomy.	**Available support:** Minimum EUR43 million per project. The guarantee covers up to 80 percent of the loan. The credit guarantees can be issued in Swedish kronor, euros or dollars.
Description: Government credit guarantees are offered for new loans that companies take out from credit institutions to finance large industrial investments in Sweden and that contribute to the achievement of the goals in the environmental target system and the climate policy framework. Northvolt (batteries manufacturing) and Stegra, previously H2 green steel (low-carbon steel production), are among the companies that have received loan guarantees. A guarantee is granted for up to 15 years.		
Strategic investment in research and educational environmental in electrification and battery technology (Satsning på forsknings- och utbildningsmiljöerna inom elektrifiering och batteriteknik)		
2024-2029	**Skills programme**	**Type of programme:** post-secondary education programme
Technologies: Batteries	**Description:** The Swedish government has initiated a strategic investment of SEK 45 million (approx. EUR4 million) in research grants annually, starting in 2024, intending to strengthen the research and educational environments in electrification and battery technology at Uppsala University, Lund University and Chalmers University of Technology. Through this investment, the government quickly creates the conditions for the universities to be able to recruit more researchers and teachers with key skills in an area where international competition is high. Until 2029, about EUR17.5 million (SEK 200 million) will be invested to train and expand civil engineering programmes at the universities.	

[722] See here.
[723] The scheme supports 'green' investments, which thus might cover all Net-Zero technologies explored by the study.

Opportunities and challenges

Opportunities

General

Sweden is a key player in the EU's raw materials supply, with significant mining capacity for minerals like iron, zinc, and copper.[724] The country could also exploit additional resource deposits, including nickel, cobalt, graphite, and rare earth elements, amongst others, essential for battery and wind technologies.[725]

Sweden's innovation leadership, along with its high share of affordable clean electricity,[726] can drive investments and support sustainable manufacturing of net zero technologies.

Technology-specific

Sweden hosts important production facilities in battery manufacturing, including the Skellefteå gigafactory, which runs on 100% renewable energy.[728] With a strong focus on recycling and a high share of fossil-free electricity, the country is well-positioned for sustainable battery production. Sweden also excels in R&D and can leverage its potential in innovative sodium-ion batteries. This technology can be produced from locally sourced materials, reducing the reliance on traditional battery value chains.[729] Additionally, the availability of critical raw materials, such as rare earth element deposits, is another opportunity for reducing dependencies with China.[730]

Sweden could benefit from growing domestic demand for renewable heating, alongside its high comparative advantage compared to the USA and China, and a nearly EUR 1.8 billion estimated untapped export potential in heat pump technologies.[731]

Challenges

General

While Sweden excels in innovation and research, the limited availability of skilled workers in science, technology and engineering could affect investments and slow down innovation in net-zero technologies. However, the country's upskilling and reskilling efforts could help mitigate this issue.[727]

Technology-specific

Despite Sweden's potential in battery manufacturing, the Swedish (and the European) battery industry faces challenges to scaling up. One key issue is the slower-than-expected growth in EV demand in the short term, which is hindering expansion efforts. Northvolt, a leading Swedish company, has struggled to meet its targets and had to cancel plans for a cathode materials battery plant, leaving it reliant on imports. The company has also lost orders due to delays and announced layoffs in response to the challenges.[732]

The high costs associated with CCS projects, and the corresponding need for more investment in infrastructure and skilled labour could pose a challenge to the Swedish CCS industry.[733]

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

[724] European Commission (2024), 2024 Country Report – Sweden, SWD(2024) 627 final, available here.
[725] Innovation Norway, Business Finland, Business Sweden, and the Swedish Energy Agency (2023), The Nordic Battery Value Chain, available here.
[726] See the website of Business Sweden, available here.
[727] European Commission (2024), '2024 Country Report – Sweden, SWD(2024) 627 final, available here.
[728] See the website of Northvolt, available here.
[729] See Northvolt, 21 November 2023, 'Northvolt develops state-of-the-art sodium-ion battery validated at 160 Wh/kg', available here & Swedish Energy Agency, 'The future of battery technology in Sweden looks promising', available here.
[730] Innovation Norway, Business Finland, Business Sweden, and the Swedish Energy Agency (2023), The Nordic Battery Value Chain, available here.
[731] See the above descriptive statistics for Sweden and the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[732] See Rida Rambli (2024), Europe caught in the crosshairs between Chinese and US battery manufacturing & Northvolt, 23 September 2024, 'Northvolt outlines revised scope of operations in Sweden', available here.
[733] Beiron, J., & Johnsson, F. (2024). Progressing from first-of-a-kind to Nth-of-a-kind: Applying learning rates to carbon capture deployment in Sweden. International Journal of Greenhouse Gas Control, 137, 104226. Available here.

Country Factsheet Slovakia

Key findings

Manufacturing capacity:[734] Slovakia's manufacturing capacity amounts to between 5 and 5.25 GWh/y (2% of EU capacity) for battery and storage technologies and between 50 and 150 MW/y (0-1% of EU capacity) for solar PV modules. Additionally, there are at least 12 facilities in Slovakia dedicated to the production of heat pumps.

Industrial production:[735] Slovakia's three largest industrial Net-Zero sectors by value are grid technologies, with a production amounting to EUR 696 million (1% of total EU production), EUR 573 million (1% of EU production) for solar PV and thermal energy, and EUR 535 million (2% of EU production) for heat pumps and geothermal.

International positioning:[736] Slovakia is a competitive exporter of various Net-Zero technologies. The country has shown a notable increase in its competitive position in the heat pump sector, including heat exchange units, outperforming both China and the USA for these components in 2022. Slovakia is also a strong player in the export of grid technology components, including insulated electric conductors and liquid dielectric transformers. For both categories, its RCA is higher than that of China and the USA.

Policy framework: Currently, Slovakia does not have a policy framework for Net-Zero technologies in place.

Industrial permitting: General information on the industrial permitting of new production facilities for Net-Zero technologies is not available. However, typically, an Environmental Impact Assessment (EIA), amendments to territorial planning, and land/zoning procedures are required before obtaining a construction permit.

Incentive instruments: In Slovakia, a EUR 1 billion state aid scheme under the Temporary Crisis and Transition Framework was approved by the European Commission in December 2023 to support investment projects in strategic industrial production sectors for the transition to a net-zero economy, including the production of batteries, solar panels, wind turbines, heat pumps, electrolysers, carbon capture equipment, key components for these technologies, and the production or recovery of related critical raw materials.

[734] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[735] Industrial production refers to total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[736] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheets provides detail on each indicator.

Key descriptive statistics for Net-Zero technologies in Slovakia[737]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[738]	Import dependence (extra-EU)[739]
[Solar photovoltaic and solar thermal]	50 - 150 MW/y[740] *(1% of EU capacity)*	500 MW/y	-	1% *(Disclosure: 76%)*	**0.33**
[Onshore wind and offshore renewables]	No facilities identified[741]	-	-	«Negligible share of EU production» *(Disclosure: 58%)*	**0.31**
[Batteries and storage]	5000 – 5250 MWh/year *(2% of EU capacity)*[742]	6750 - 7250 MW/y	28000 - 60000 MW/y	«Negligible share of EU production» *(Disclosure: 77%)*	**0.67**
[Heat pumps and geothermal]	At least 12 facilities identified	-	-	2% *(Disclosure: 82%)*	**0.30**
[Electrolysers and fuel cells]	No facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 84%)*	**0.00**
[Sustainable biogas/biomethane]	N/A	N/A	N/A	1% *(Disclosure: 83%)*	**0.13**
[Carbon capture and storage]	N/A	N/A	N/A	1% *(Disclosure: 80%)*	**0.11**
[Grid technologies]	N/A	N/A	N/A	1% *(Disclosure: 47%)*	**0.34**
[Data coverage]	−	−	−	✓	✓
[Data reliability]	−	−	−	−	✓

Technologies

Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Slovakia's main production facilities include the Agora Solar A.S. in Vranov nad Topľou, with an estimated capacity of 150 MW. Agora Solar announced that they will expand this facility to 500 MW in 2024. Gotion High-Tech x InoBat has announced the opening of a lithium-ion battery manufacturing of 20 GWh, scaling up to 40 GWh by 2027.

[737] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
[738] The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[739] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[740] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[741] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[742] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.

Evolution of Slovakia's international positioning

As illustrated in Figure 1, Slovakia demonstrates significant competitiveness as an exporter across various Net-Zero technologies.[743] The country has shown a notable increase in its competitive position in the heat pump sector, including heat exchange units. Between 2015 and 2022, Slovakia's RCA for these components grew by approximately 30%, with a combined untapped export potential estimated at around EUR 300 million. Notably, Slovakia is found to be a more competitive exporter than both China and the USA for these components in 2022, as shown in Figure 2.[744]

In addition to heat pumps, Slovakia is also a strong player in the export of grid technologies. This includes components such as insulated electric conductors and liquid dielectric transformers. Collectively, these grid components hold an estimated EUR 440 million in untapped export potential. For both categories, Slovakia's RCA surpasses that of China and the USA. These components reflect Slovakia's capacity to expand its market share should trade barriers ease or demand in international markets increase.

Furthermore, Slovakia has emerged as a key exporter of gearboxes used in the nacelle of wind turbines. The RCA for these components has increased by 45% over the same period, with an estimated untapped export potential of EUR 257 million. For policymakers and businesses, this untapped potential is actionable—it suggests that targeted export promotion strategies could translate into measurable increases in export volumes.

---

[743] Figures 1 and 2 present Slovakia's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Slovakia's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Slovakia's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Slovakia could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Slovakia could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.
[744] Figure 2 builds upon this by mapping the RCA index for each component relative to the EU's main global competitors—China and the USA. Only components with a positive RCA (above 1) are shown, reflecting that these components indicate a comparative advantage. The exclusion of components with RCA < 1 reflects their lack of competitiveness, aligning the analysis with the focus on actionable insights for Slovakia's trade strategy. Taken together, these figures provide a nuanced understanding of Slovakia's growth potential, revealing areas for strategic focus amidst competitive pressures and untapped markets.

Figure 1: Austria's RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

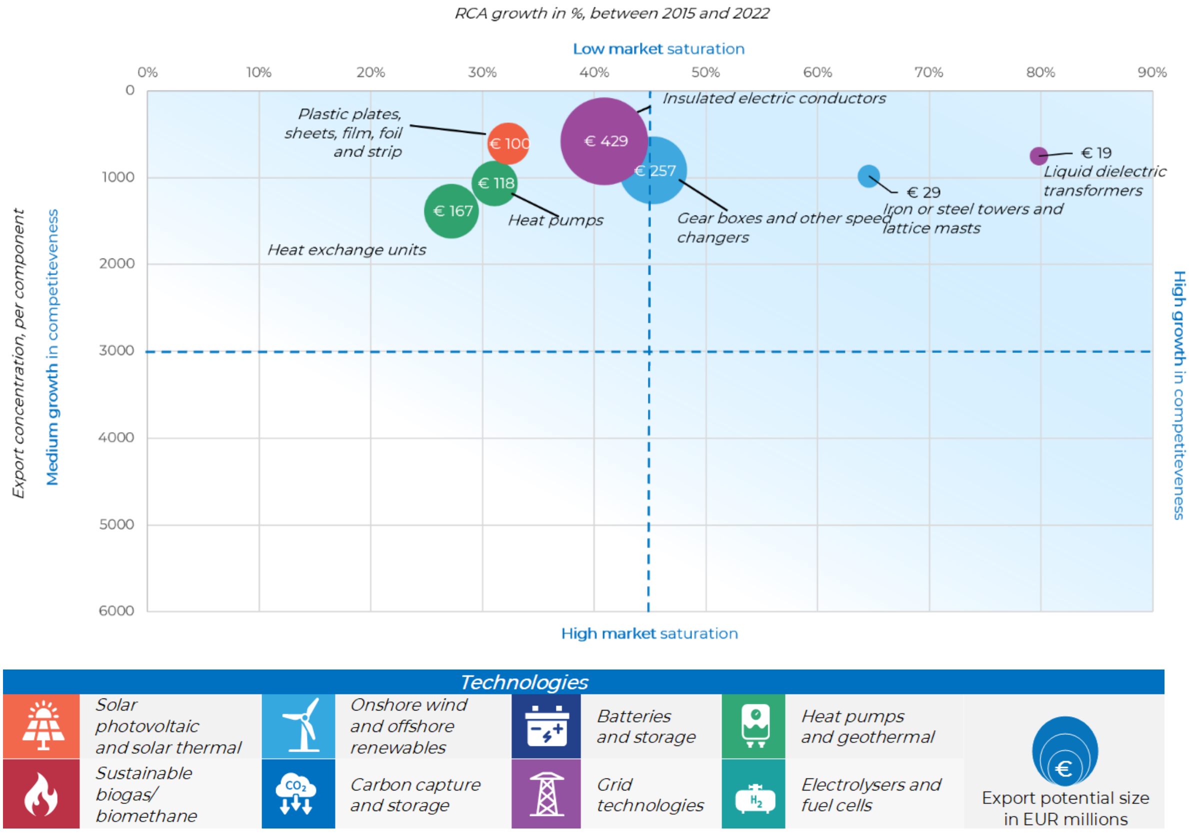
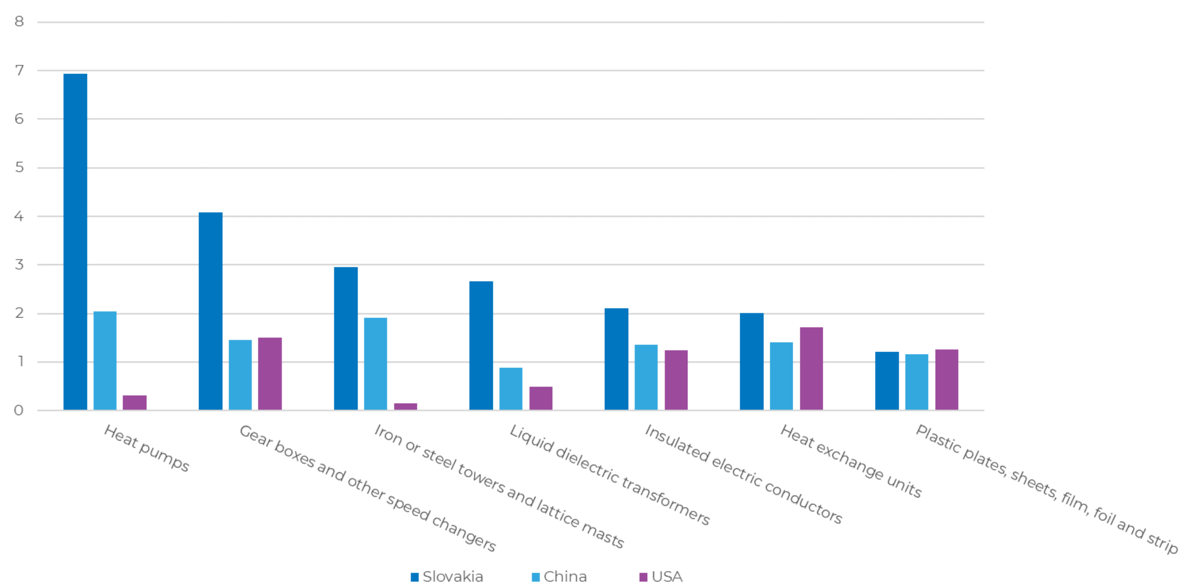


Figure 2: Absolute value of RCAs of Slovakia, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

No relevant strategies or legislation have been identified.

In December 2023, the European Commission approved a **state aid scheme** in Slovakia in the scope of the Temporary Crisis and Transition Framework for up to EUR 1 billion supporting investments for the production of equipment for Net-Zero technologies. The support will take the form of grants, income tax relief and transfers or leases of immovable property for a price below market value.

Industrial permitting

Average duration	No average duration has been identified	**One-stop shop for permitting**	No one-stop shop for permitting has been identified

Brief summary of the permitting processes[745]

According to the Act on EIA, the competent authority must issue a valid decision or final opinion from the Environmental Impact Assessment (EIA) process, confirming that the proposed activity meets EIA requirements. Also, amendments to the territorial plan of the respective municipality/region may be required. While the EIA and territorial planning processes are ongoing, the project proponent can prepare documentation for the construction permit. Once the EIA, territorial planning and land/zoning procedures are completed, the building permit process can begin.

There is a new "strategic investment" law in the pipeline in Slovakia, but it has not been adopted yet and is currently stuck in the legislative process. This may have implications for investments in Net-Zero technologies.

There are ongoing efforts to streamline and speed up the permitting process through digitalisation. Other notable initiatives include the Action Plan to implement the National Hydrogen Strategy which foresees the development and approval of legislative intentions to simplify permission processes for hydrogen technologies.

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

Extraordinary investment aid

2024-2025	**Mixed[746]**	**Total funding available: EUR 1 billion[747]**
Technologies: Batteries and storage, solar, wind, heat pumps, electrolysers and fuel cell and CCS technologies	**Eligibility:** The minimum investment is EUR 20 million in the Bratislava region, or EUR 10 million in other districts of	**Available support:** 15-20% in Bratislava, 35-40% in other parts of Slovakia

[745] Information in this section primarily comes from interviews with the ministries of the Environment and Economy. Other sources can be found here and here.
[746] Direct grants, income tax relief and transfers or leasing of immovable property at a price lower than market value
[747] Available here.

	Slovakia. Share of new technologies: 60% across Slovakia. Eligible costs are investment costs for acquiring fixed assets, including land, buildings, machinery, devices, and equipment, as well as costs for acquiring intangible fixed assets, such as industrial rights, know-how, and licenses.	
Description: From 2024 to the end of 2025, extraordinary investment aid will be granted under temporary EU state aid rules to support investment projects in strategic industrial production sectors for the transition to a net-zero economy. These sectors include the production of batteries, solar panels, wind turbines, heat pumps, electrolysers, carbon capture equipment, key components for these technologies, and the production or recovery of related critical raw materials.		
Action Plan for the successful implementation of the Hydrogen Strategy - Education and knowledge transfer		
2024-2026	**Skills programme**	**Type of programme:** Post-secondary education programme
Technologies: Electrolysers and fuel cell technologies	**Description:** The initiative aims to support hydrogen economy education at secondary and vocational schools, motivate higher education institutions to create study programs in hydrogen technologies, develop lifelong learning programs, and enhance international knowledge transfer, without a specific focus on manufacturing. Collaborating institutions include various Slovak ministries, higher education institutions, employers, and professional organizations, with a financial allocation of EUR 1.5 million from EU funds, the Slovakia Program, and the Recovery and Resilience Plan.	

Opportunities and challenges

Opportunities

General

Slovakia is a significant producer of raw materials like magnesite, magnesium compounds, and manganese ferroalloys in the EU. Additionally, barite, a critical raw material, is currently being mined in Slovakia[748]. Other materials such as rare earth deposits have been found in Slovakia[749]. There is an opportunity for Slovakia to build on its tradition of mining and metallurgy to develop value chains for critical raw materials to help reduce strategic dependencies[750].

Technology-specific

Already several investments in battery manufacturing are taking place in Slovakia. The country's large number of primary metal producers combined with the closeness to automotive manufacturers, shifting to electric vehicles, creates potential in battery manufacturing. Additionally, Slovakia's focus on STEM and engineering education, as well as the country's engagement in R&D activities could support the up-take of the industry[753].

Slovakia could tap into an unlocked export potential of over EUR 250 million for heat exchange units for its heat pump industry. Additionally, jointly with Czechia and Poland, enhancing cross-border collaboration to leverage a rich industrial ecosystem and develop a local skilled workforce offers an opportunity.[754]

Challenges

General

Public and private investment in energy research and innovation is very low in Slovakia with an R&D intensity of just below 1% in 2022[751]. This limits Slovakia's ability to develop and deploy advanced clean technologies. The private underinvestment in R&D combined with a lack of cooperation between industry and academia, and a shortage of startups and innovative ventures is also reported to hinder Slovakia's battery industry[752].

Technology-specific

While generally a producer of raw materials, Slovakia lacks significant mining capacity for battery materials[755]. Already, we see a high import dependency for batteries and energy storage technologies with 67% extra-EU imports. This dependency could be a future bottleneck for expanding the Slovak battery industry.

Slovakia faces an unfavourable electricity-to-gas ratio as gas is three times cheaper than electricity in the country which is unfavourable to its heat pump industry as it reduces domestic demand for heat pumps.[756]

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

---

[748] Šimková, Zuzana & Pavolová, Henrieta & Bednarova, Lucia. (2021). Evaluation of exploiting barite, the critical raw material in Slovakia, and benefits of its mining. Mining of Mineral Deposits, available here.
[749] See: Raw Materials News, 26 December 2023, Prospech Targets Rich Base Metals with First-Ever Drilling at Historic Slovak Mine, available here.
[750] Pavolová, Henrieta & Šimková, Zuzana & Seňová, Andrea & Gabriel, Wittenberger (2019). Macroeconomic indicators of raw material policy in Slovakia. E3S Web of Conferences, available here.
[751] Eurostat, 1 December 2023, EU expenditure on R&D reaches €352 billion in 2022, available here.
[752] PSPA (2023). Europe runs on Polish lithium-ion batteries, available here.
[753] Ibid.
[754] Euractiv (2023), Europe's 'heat pump valley' takes root in the East, available here
[755] Ibid.
[756] European Heat Pump Association (2024), Pump it down: why heat pump sales dropped in 2023. Available here.

Country Factsheet Slovenia

Key findings

Manufacturing capacity:[757] Slovenia's manufacturing capacity amounts to between 700 and 800 MW/y (4% of EU capacity) for solar PV modules. The country also hosts at least five battery production facilities and at least six facilities dedicated to the production of heat pumps.

Industrial production:[758] Slovenia's current industrial production amounts to EUR 531 million (1% of total EU production) for wind; and EUR 52 million (a negligible share of EU production) for biogas.

International positioning:[759] Slovenia is a competitive exporter of grid technologies components, including automatic circuit breakers, relays, parts of electrical boards, devices for protecting electrical circuits, and liquid dielectric transformers.

Policy framework: Currently, Slovenia does not have a policy framework for Net-Zero technologies in place.

Industrial permitting: General information on the industrial permitting of new production facilities for Net-Zero technologies is not available. However, to operate an industrial facility typically, two permits are required: an industrial permit and an environmental permit, with the overall process taking roughly 5 months. A one-stop shop is currently under development, aiming to simplify the application process online, although the specific steps are still unclear.

Incentive instruments: In Slovenia, one skill programme relevant to Net-Zero technologies has been identified.

[757] Manufacturing capacity refers to the annual maximum theoretical output of facilities that produce clean energy technologies. It is expressed either in energy generation capacity (megawatt); or energy storage capacity (megawatt hour).
[758] Industrial production refers to the total annual output of selected components and end-use products within each clean technology's value chain. It is expressed in monetary terms. The figures reported here are based on a selection of relevant components and end-use products. The selection is reported in the Main Report.
[759] International positioning is based on trade flows in selected components relevant to clean technologies (see footnote above on the selection of components). We use the following indicators: import dependence, Revealed Comparative Advantage (RCA), Export market concentration and Export Potential. The methodological note at the end of this factsheet provides details on each indicator.

Key descriptive statistics for Net-Zero technologies in Slovenia[760]

	Manufacturing Capacity (% of EU-27 capacity)	Additional announced capacity 2024-25	Additional announced capacity 2026 onwards	Industrial production % of EU-27 (component disclosure rate)[761]	Import dependence (extra-EU)[762]
	700 – 800 MW/y[763] *(4% of EU capacity)*	-	-	«Negligible share of EU production» *(Disclosure: 61%)*	**0.40**
	No facilities identified[764]	-	-	1% *(Disclosure: 53%)*	**0.56**
	At least five facilities identified[765]	950 - 1050 MW/y	-	«Negligible share of EU production» *(Disclosure: 77%)*	**0.79**
	At least six facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 59%)*	**0.29**
	No facilities identified	-	-	«Negligible share of EU production» *(Disclosure: 74%)*	**0.00**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 83%)*	**0.24**
	N/A	N/A	N/A	«Negligible share of EU production» *(Disclosure: 85%)*	**0.32**
	N/A	N/A	N/A	Insufficient data coverage *(Disclosure: 38%)*	**0.37**
	–	–	–	–	✓
	–	–	–	–	✓

Technologies				
Solar photovoltaic and solar thermal	*Onshore wind and offshore renewables*	*Batteries and storage*	*Heat pumps and geothermal*	*Electrolysers and fuel cells*
Sustainable biogas/ biomethane	*Carbon capture and storage*	*Grid technologies*	*Data coverage*	*Data reliability*

Slovenia's main production facilities include the BISOL Group's solar PV modules factory in Prebold, with an estimated capacity of 700 – 800 MW. TAB produces over 4 million lead-acid batteries a year. Announced manufacturing facilities are factories by TAB with expected outputs of around 1 GWh of lithium-ion batteries.

[760] Manufacturing capacity data is provided for solar PV, wind turbines, battery technologies and electrolysers (but not fuel cells). Manufacturing capacity data is not available for the other Net-Zero technologies. For heat pumps and for the four technologies above for which no data is available in specific countries, we report the number of current production facilities that we could identify. Manufacturing capacity data is typically not available for facilities producing biogas and biomethane; grid technologies and CCS, and therefore outside the study scope. See the section on "Data sources and methodological notes" at the end of this Annex for information on the underlying data used; calculations of indicators; and limitations.
761 The disclosure rate represents the proportion of components for which PRODCOM data is available within each technology.
[762] Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket.
[763] Manufacturing capacity is provided exclusively for solar photovoltaic modules and does not include capacities for solar thermal manufacturing.
[764] Manufacturing capacity relates only to the production of wind turbines, including blades, towers and foundations; and nacelles and their components, including gearboxes.
[765] Manufacturing capacities are primarily related to the production of battery cells and/or packs of various types (li-ion, zinc-air, lead-acid, etc.), and battery components such as cathodes, anodes and separators.

Evolution of Slovenia's international positioning

As illustrated in Figure 1, Slovenia stands out as a notably competitive exporter of grid technologies.[766] This encompasses components such as automatic circuit breakers, relays, parts of electrical boards, devices for protecting electrical circuits, and liquid dielectric transformers. Collectively, these five components hold an estimated export potential of around EUR 250 million as of 2022. Notably, Slovenia's RCA for liquid dielectric transformers rose by nearly 100% between 2015 and 2022, while the RCA for devices protecting electrical circuits increased by 85%.

As shown in Figure 2, Slovenia's competitiveness surpasses that of major competitors like China and the USA. [767] Across the board for grid components, Slovenia exhibits a higher RCA than both China and the USA. This underscores Slovenia's potential to expand its footprint in the global export market for grid components.

[766] Figures 1 and 2 present Slovenia's position within the global landscape of Net-Zero technologies, focusing on key components with an RCA above 1. Figure 1 plots these components using the Revealed Comparative Advantage (RCA) index to capture Slovenia's export performance over 2015-2022. This index is used as an indicator of a country's relative specialisation, reflecting its ability to export specific components competitively. However, RCA should not be equated with cost-based competitiveness but viewed as an outcome of various factors, such as comparative efficiency, trade interactions, and international demand. This is juxtaposed with the global export market concentration (measured by the Herfindahl-Hirschman Index, HHI), which reflects market saturation levels for each component. Higher concentration (higher HHI) indicates more saturated markets, implying potential challenges for further market entry, while lower HHI suggests open markets with growth potential. The purpose of highlighting market saturation is to provide an understanding of where Slovenia's competitiveness might face constraints or where new opportunities may emerge in less concentrated global markets.
Export potential is calculated using a gravity model, reflecting the hypothetical value Slovenia could achieve if trade barriers were removed and other competitive conditions aligned. This is critical for identifying untapped opportunities: the figure demonstrates where Slovenia could potentially enhance its exports, even if existing trade conditions do not yet fully support it. This analysis aids in guiding national policies by identifying which components offer the highest reward for targeted trade facilitation and export strategies.
For more detailed information on the methodology and sources used in the estimation and creation of these figures, please consult the data sources and methodological notes at the end of this Annex.

Figure 1: RCA growth of selected components (2015 - 2022, in %), their export potential (2022, in millions of EUR), and the export market saturation

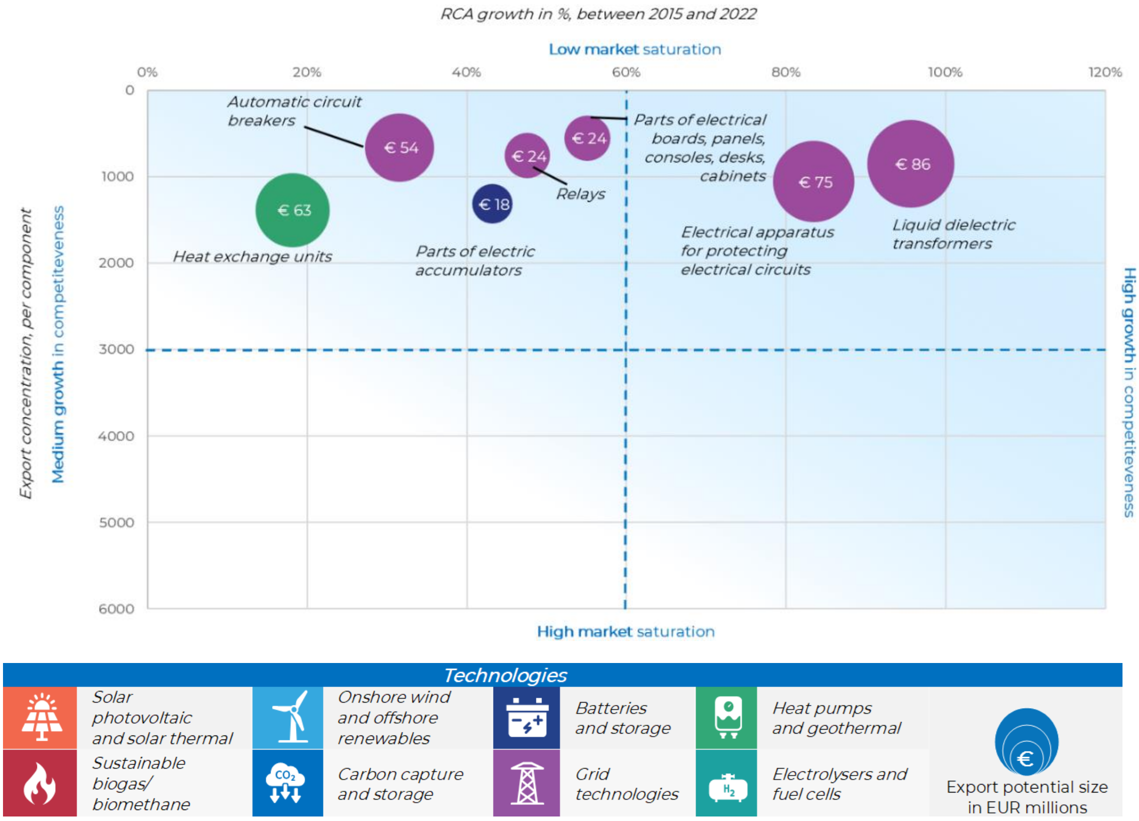
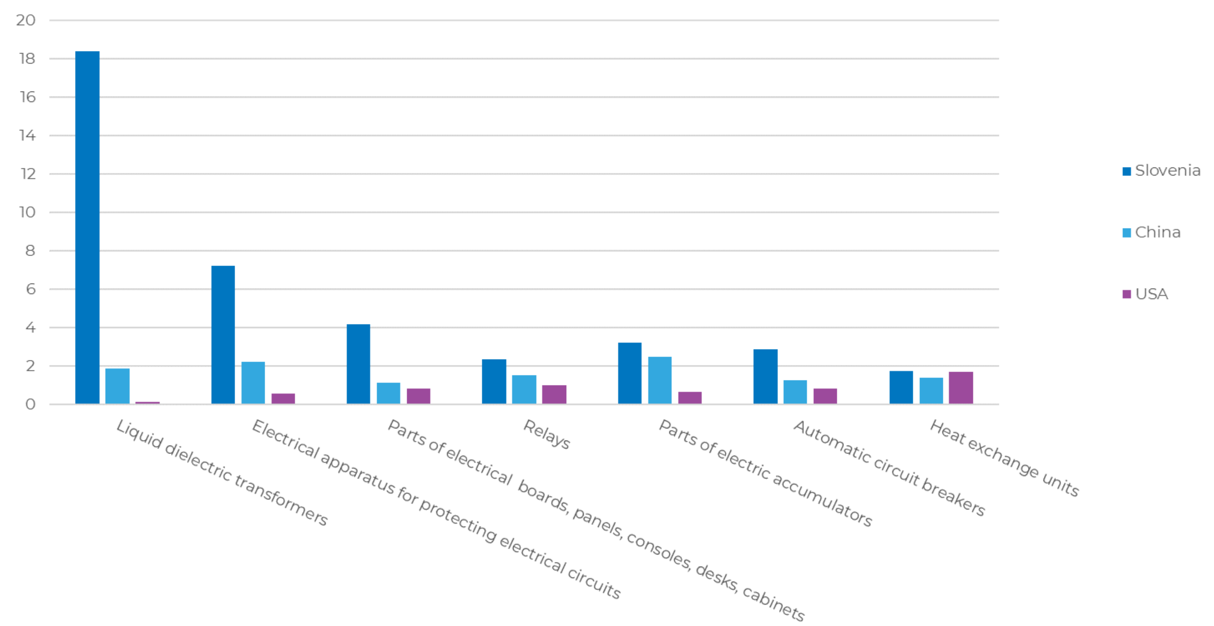


Figure 2: Absolute value of RCAs of Slovenia, China and the USA, 2022



Regulatory and incentive landscape

Policy framework

No relevant strategies or legislation have been identified

Industrial permitting

Average duration[768]	An integral building permit, including the environmental permit, takes roughly 5 months while excluding it takes 3 months. However, the actual process is longer due to the time required for companies to gather the necessary documents.	**One-stop shop for permitting**	The OSS is currently under development and will be integrated into the e-building platform. While the steps are still unclear, the application process is expected to be available online, aiming to simplify permit applications.[769]

Brief summary of the permitting processes[770]

To operate an industrial facility, sometimes two permits are needed: an industrial construction permit from the Administrative Unit or the Ministry of Natural Resource and Spatial Planning, and for a big industrial facility an integral permit is issued by the Ministry of Natural Resource and Spatial Planning and an environmental permit from the Ministry of the Environment, Climate and Energy. When the OSS (the e-building platform) is operational, permit applications should also be fully digital. As of the time of writing, the permitting platform already exists, but is operational only in parts of Slovenia.[771]

Reforms within the Slovenian Recovery and Resilience Plan (RRP)[772] aim to tackle issues related to permitting procedures and are expected to provide an opportunity to further improve the business environment.

Procurement

No relevant procurement rules have been identified

Regulatory sandboxes

Existing sandboxes	No relevant regulatory sandbox has been identified	**Plans for regulatory sandboxes under the NZIA**	No plans for a relevant regulatory sandbox have been identified

Key incentive instruments

Carbon-Free Technology Demonstration and Training Centre in Zagorje ob Savi

[768] Our research suggests that the permitting time can vary considerably across and within countries. The project size is among the key factors, partly determining the scope and type of permits needed. Another factor is the nature of the economic activity. Activities that create greater emissions or bear a higher risk of negative environmental externalities (e.g. battery production) usually need to follow a more comprehensive permitting process, which may increase the overall permitting duration. Generally, evidence suggests that projects that need to perform an environmental impact assessment see increased permitting times overall. Some interviewees also pointed to the quality of the documentation submitted by the economic operator as a determining factor of the duration of permitting processes.
[769] Based on interviews with the Ministry of Economy, Tourism and Sports. The OSS is expected to be set up under the e-building platform.
[770] Information in this section primarily comes from interviews with relevant authorities. Other sources can be found here, here, and here.
[771] Based on interviews with the Ministry of Economy, Tourism and Sports.
[772] For example through the "De-bureaucratisation Act" in 2022, see European Commission (2024), 2024 Country Report - Slovenia, available here.

From 2025	**Skills programme**	**Type of programme:** training centre
Technologies: Batteries and storage, electrolysers and fuel cell, CCS technologies	**Description:** Implemented by the National Chemical Institute, the centre will develop and provide training for both students and experts in batteries, hydrogen and CCS technologies. With an investment value of €32 million (85% funded by the Just Transition Fund), the centre is set to open in 2025.[773]	

[773] See here for more information on the scheme.

Opportunities and challenges

Opportunities

General

Slovenia has seen improvements in government efficiency managing to reduce administrative burden, simplify business processes and modernise public procurement through digitalisation in business and public administration. However, long procedures and a lack of predictability of the business environment and legislation remain an issue[774]. Reforms within the Slovenian Recovery and Resilience Plan (RRP)[775] aim to tackle these issues providing an opportunity to further improve the business environment.

Slovenia needs to ensure a fair transition in its coal regions. This brings also new economic opportunities through investments and skill transfers for net-zero technologies supported by the Just Transition Fund[776].

Technology-specific

Regarding batteries and energy storage technologies, Slovenia has several plants producing lead-acid and lithium-ion batteries and a gigafactory for lithium-ion energy storage systems has been announced to be opened in 2024[778]. There are opportunities for further growth if investments can be maintained.

Slovenia has experienced a strong uptake in the deployment of solar PV. This benefits the domestic manufacturing industry which includes solar module manufacturers such as BISOL Group and specialised companies such as ETI Group producing fuses, circuit breakers and other switchgear.

Slovenia could tap into an estimated EUR 250 million export potential for grid components. The country's high RCA indices combined with its strong manufacturing sector provide an opportunity to expand its footprint in the global export market for grid components.[779]

Challenges

General

Slovenia faces a tight labour market with a high employment rate and significant labour shortages in various sectors, including manufacturing. This lack of skilled labour, particularly in digital and green skills, is a major constraint and the ageing workforce is adding further strain. Productivity growth is also below the EU average while labour cost increases were higher than the EU average, particularly in manufacturing[777]. This has widened the gap between Slovenia and its trading partners and is a challenge in regard to Slovenia's competitiveness.

Technology-specific

There is already a very high import dependency for batteries and energy storage technologies with 79% extra-EU imports. This dependency could be a future bottleneck for expanding the Slovenian battery industry as much of the components, materials and machinery need to be imported.

Slovenia's grid stability needs to be enhanced through smart energy systems alongside investments in infrastructure is crucial to support the increasing share of renewable energy and to ensure a stable energy supply[780]. However, significant investments have already been made through the RRP and Projects of Common Interest.

Note: This is not a comprehensive assessment of the country but an overview of key findings drawn from our research on Net-Zero technology manufacturing in the EU. We focused on technologies based on their current relevance and future potential.

[774] IMAD (2024) Development Report 2024, available here.
[775] For example through the Debureaucratisation Act in 2022, see European Commission (2024), 2024 Country Report - Slovenia, available here.
[776] European Commission, 16 December 2022, EU Cohesion Policy: More than EUR 258 million for a just climate transition in Slovenia, available here.
[777] IMAD (2024) Development Report 2024, available here.
[778] TAB, 24 October 2023, First Gigafactory in Slovenia, available here.
[779] See the above descriptive statistics for Slovenia on its international positioning.
[780] World Energy Council (2024). Slovenia Energy Issues Monitor 2024. Available here.

Data sources and methodological notes

Data on manufacturing capacity was collected at the level of individual companies and then aggregated at the country level. Often, more than one data point exists for each company. We report ranges rather than individual data points for each country and technology to reflect the uncertainty. Capacity data comes from proprietary databases and desk research. Capacity data reported in the Key Descriptives table above was gathered at the end of April 2024 and is therefore based on available data as of the end of 2023 unless otherwise specified. Data from proprietary sources only provides data on solar and wind power; batteries; and electrolysers. Data on industrial production was collected at the 8-digit product level for a selection of components, equipment, and end-use products from Eurostat's PRODCOM database. Data on international trade is from the CEPII BACI database.

Import dependence is calculated as the ratio of EU to non-EU imports in a Member State's import basket. Import dependence indices are marked as green when they are below 0.5, meaning that less than 50% of a country's imports originate from outside the EU; amber when they are between 0.5 and 0.75; and red when they are above 0.75, indicating that over 75% of a country's imports originate from outside the EU.

Revealed comparative advantage (RCA) indices are computed following Balassa's formulation, as follows:

$$RCA_{ij} = \frac{\frac{X_{ij}}{\Sigma_i X_{ij}}}{\frac{\Sigma_j X_{ij}}{\Sigma_j \Sigma_i X_{ij}}}$$

Where:

- $\Sigma_i X_{ij}$ are the total exports of country *j*.
- X_{ij} are the exports of goods *i* of a country *j*.
- $\Sigma_i X_{ij}$ are the total exports of country *j*.
- $\Sigma_j X_{ij}$ are the world's exports of product *i*.
- $\Sigma_j \Sigma_i X_{ij}$ are the total world exports.

When a country's RCA in a given product is higher than 1, it can be considered a competitive producer and exporter of that product relative to all other countries in the world that produce and export that same product at or below the world average.

Export market concentration indicators measure the degree of market saturation for a particular component by evaluating how market share is distributed among exporting countries. This is done by squaring each country's share of the global export market for that component and summing these squared values. A higher value of this sum indicates a higher concentration and thus a more saturated market.

The formula for calculating export market concentration is:

$$\text{Export Market Concentration} = \sum_{i=1}^{n} (\text{Market Share of Country } i)^2$$

A high concentration value suggests that the export market is dominated by a few countries, reflecting a saturated market. Conversely, a low value indicates a more evenly distributed market with less dominance by any single country.

The ITC Export Potential indicator[781] uses a gravity model approach to estimate and visualise a country's untapped export potential for various components. This model assesses export potential based on the economic size of countries and the distance between trading partners, providing a more tangible understanding of global trade dynamics. The key steps in calculating export potential using this model include:

[781] Available via the following link

$$Export\ Potential_{ij} = \frac{GDP_i \times GDP_j}{Distance_{ij}}$$

Where:

- $Export\ Potential_{ij}$ is the estimated export potential value from country i to country j.
- GDP_i and GDP_j are the gross domestic products of the exporting country i and the importing country j, respectively.
- $Distance_{ij}$ represents the geographical distance between the two countries.

Estimation of Untapped Potential: The export potential for each country-component pair is estimated by comparing the actual trade flows with the predicted values from the gravity model. This difference reveals the potential for additional exports.

We report an assessment of data coverage (or availability); and reliability. Data is categorised as having low, medium, or good levels on both dimensions. For coverage, data included in the scorecard is evaluated based on the following criteria:

- Low coverage (marked in red) is reported when over 50% of data is missing, due to issues of unavailability or confidentiality. Data availability is the main issue with regard to information on manufacturing capacity. Data confidentiality issues impact data in PRODCOM.
- Medium coverage (marked in yellow) is reported when between 30% and 50% of data is missing due to availability and confidentiality.
- Good coverage (in green) is reported when less than 30% of the data is missing, and when our findings have either been validated or have not been challenged directly by interviewees, experts, or findings from the desk research.

With regard to reliability data is categorised according to the following criteria:

- Low reliability is reported in those instances where findings from the data analysis are in direct conflict with either our desk research; or findings from the interviews; and experts' inputs.
- Medium reliability is reported in two instances:
  - (1) When findings from interviews, experts' inputs, or desk research do not, partially or wholly, validate the findings from our data analysis – these instances are also highlighted in the factsheets using footnotes;
  - (2) Indicators are computed based on trade data for countries where re-exports are estimated to represent at least 20% of total exports.
- Good reliability is reported when findings from the data analysis have been validated by either desk research; or inputs from interviewees or experts.

P.O. Box 4175
3006 AD Rotterdam
The Netherlands

Watermanweg 44
3067 GG Rotterdam
The Netherlands

T +31 (0)10 453 88 00
F +31 (0)10 453 07 68
E netherlands@ecorys.com

Registration no. 24316726

W www.ecorys.nl
EUROPEAN COMMISSION

Directorate-General for Energy
Energy Platform Task Force
Unit TF2 Relations with Member States and Energy Community
Email : ENER-TF2-STUDY@ec.europa.eu

MJ-01-25-008-EN-N

Publications Office
of the European Union