ISSN 2811-6925

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SINGLE MARKET ECONOMICS BRIEFS

Economics Brief n°9

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EUROPEAN COMMISSION

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PDF	ISBN 978-92-68-14491-6	ISSN 2811-6925	Doi: 10.2873/059530	ET-BD-24-004-EN-N

Manuscript completed in April 2024

1st edition

Luxembourg: Publications Office of the European Union, 2024

The EU27's 'energy-renewables' ecosystem: Importance, dependencies and policy aspects

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Final version: 2024-03-11

Abstract:

The energy-renewables ecosystem (ERES) plays a particularly important role in the green transition. This paper analyses its relevance in EU member states and its competitiveness for the EU27 as a whole vis-à-vis other global players, and identifies structural dependencies and vulnerabilities. Several key findings emerge from the analysis. At the global level, the EU27 is the second most-important exporter after China. In 2020, the EU ecosystem depended on imports of coal and lignite from Russia (a situation that has since changed) and on a variety of other products from China (including medium- and high-tech electronic products). This points to a degree of vulnerability in the ERES supply chain that needs to be addressed by further policy initiatives.

Keywords: green transition; energy-renewables ecosystem; linkages; dependencies; policy aspects

JEL-codes: F10, F14

[1] This essay was prepared under the economic advisory programme of DG GROW of the European Commission – the 2023 DG GROW Fellowship Programme. The opinions are those of the author and should not be considered as representative of the European Commission's official position.

1. Introduction

The green transition and supporting Europe's open strategic autonomy are among the key objectives of today's industrial policy in the EU. While the relevance of these objectives was acknowledged in industrial policy documents as long ago as 2010, recent events – most notably the rising geopolitical tension between China and the US, the disruption caused by the COVID-19 pandemic and Russia's full-scale invasion of Ukraine – have magnified these concerns. The European Commission has put in place a variety of initiatives to identify strategic dependencies and to analyse the associated challenges for the green transition. Within this framework, the concept of 'industrial ecosystems' has been adopted to take account of the complementarities between economic activities and to facilitate the design of 'systemic' policies. Fourteen ecosystems have been identified, and work has been started on each to create transition pathways towards more resilient, greener and more digital ecosystems.

While all ecosystems have a role to play in making the green transition a success, the energy-renewables ecosystem (ERES) plays a vital role. Indeed, the ERES is responsible for the production of wind and solar energy, hydropower, bioenergy (including sustainable biofuels), geothermal and ocean energy, and heat pumps (European Commission, 2021). The infrastructure required by these industries (e.g. sustainable energy storage solutions, smart infrastructure technologies and energy conversion technologies) is also an integral component of the ecosystem. In a way, all other ecosystems depend on the innovativeness and performance of the ERES to transition to greener production methods.

In addition to being crucial for the green transition, this ecosystem is also indispensable when it comes to fostering the open strategic autonomy of the EU. Indeed, the ecosystem was impacted by the supply-chain bottlenecks triggered by the shutdowns during the COVID-19 pandemic (IEA, 2020). The markets most affected were the wind and solar (photovoltaic) industries, which were disrupted by the closure of manufacturing plants in Italy and Spain in April 2020, as well as in China (European Commission, 2021). Beyond the supply-chain disruptions, the rapid rise of China as a critical source of inputs and technologies for this ecosystem has created strategic dependencies and vulnerabilities, which add to the long-standing issues related to the energy dependence on certain trade partners (most notably, Russia).

This brief contributes to the current policy debate on this ecosystem by providing solid empirical evidence of its role in global value chains, its sourcing patterns and its dependencies, while at the same time taking a truly 'systemic' analytical approach made possible by the use of input-output tables. In doing so, it complements the research into and analysis of the technological challenges associated with renewable energies (European Commission, 2022a) and their uses (e.g. European Commission, 2020a, 2022b; IEA 2020).

2. Data and methodology

As currently defined, industrial ecosystems are composed of a number of industries, which at times cannot be measured with precision due to the low level of granularity of official statistics (particularly national accounts). This prompted the Commission to design a methodology to attribute data at the two-digit level to the various ecosystems, based on various weights (see European Commission, 2021). According to this methodology, the ERES consists of two main industries plus a few smaller ones. The two main industries are 'Manufacture of electrical equipment' (C27), with a share of 38%, and 'Electricity, gas, steam and air conditioning supply' (D35), with a share of 29%.

In this brief, we draw on the most recent release of the FIGARO database, a multi-country input-output database provided by the Joint Research Centre (JRC) of the European Commission and Eurostat, and covering the EU and its major trading partners. This database allows us to study the ecosystem's competitiveness and its linkages with other industries in the EU and beyond. As mentioned before, given the centrality of this ecosystem in supplying other ecosystems with green energies and technologies, it is important to understand its linkages with other industries – specifically, what it needs in terms of inputs and where it sources them. To conduct this analysis, we used the FIGARO database to construct an additional 'industry' (i.e. the ERES) for each country in the input-output table (often referred to as the MC-IOT, standing for 'multi-country input-output table'). This additional industry is the sum of the sectors that comprise the ERES (based on the definition provided in the Annual Single Market Report 2021 and weighted by the shares specified in that publication). In this way, we add the energy-renewable ecosystem as a separate industry in the MC-IOT, which enables us to calculate the various indicators usually applied in the literature.

Using this novel approach and data, this brief looks at global trade patterns and international performances based on revealed comparative advantage indicators (RCAs), before going on to explore the sourcing patterns and strategic dependencies of this ecosystem. This analysis allows us to identify the most important players in this ecosystem and, most importantly, what the ecosystem needs for it to function (i.e. its input needs), as well as the countries from which these important inputs are sourced.

3. The EU's trade performance in the global context

3.1 The major ERES players at the global level

This section looks at the status quo and recent dynamics in terms of global trade patterns and the competitiveness of global players in the ERES. It does so by drawing on export data from the FIGARO database and computing standard competitiveness measures. The dominant players in the global ERES are China (with about 30% of the global export share in 2020) and the EU27 (with about 22%) (Figure 1).[2] China has a near monopoly on mining and processing of the rare-earth elements needed for clean energy technologies. In addition, it holds a strong market position in the manufacturing segments of the ecosystem, particularly in manufacturing photovoltaics and batteries; and its market share is growing for other technologies, such as wind energy and heat pumps (European Commission, 2020b, 2022a).

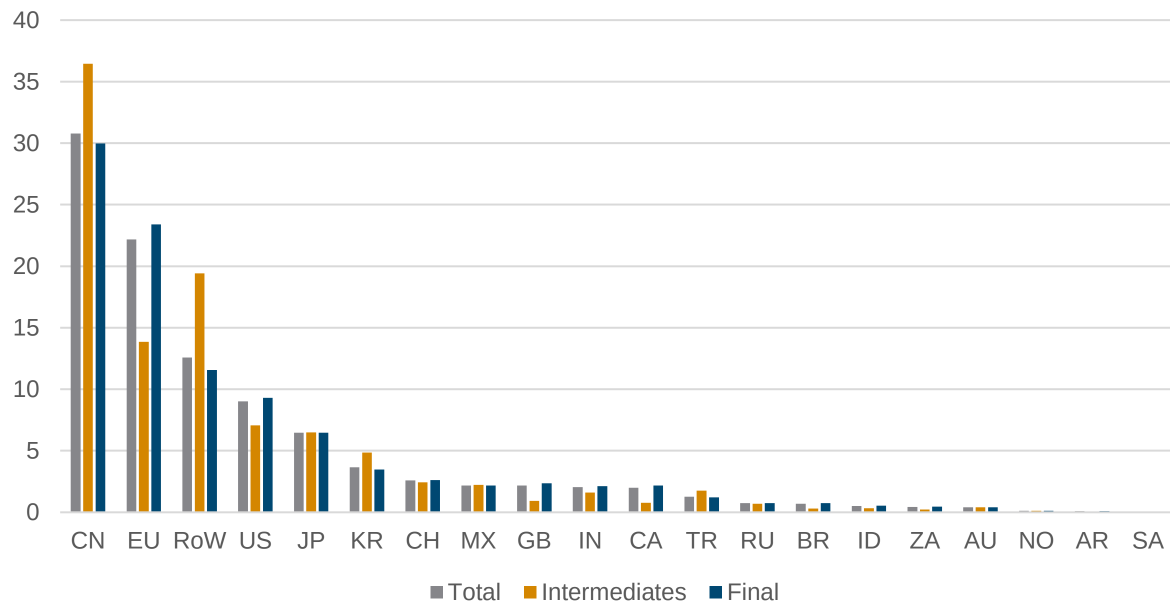
The US has a share of below 10%;[3] it is followed by Japan (with about 7%) and South Korea (with less than 5%). The market shares of all other countries are below 5%. Thus, the market is dominated by just a few big players, which collectively account for about a quarter of global exports.[4] The relevance of Asia in this ecosystem is partly explained by the strong support that the governments of Japan, China and South Korea have provided for investment in areas considered to be of strategic importance (e.g. batteries) (European Commission, 2020b).

[2] These figures are consistent with previous estimates (European Commission, 2021).

[3] While our analysis pre-dates the Inflation Reduction Act in the US, some anecdotal evidence suggests that this new policy initiative is having an impact, for example, on the capacity of renewables in the medium to longer run. These new investments might thus induce an increase in the US share of global exports in the near future.

[4] This includes the countries included in the 'rest of the world' category (RoW).

Figure 1 / World export market shares in %, 2020

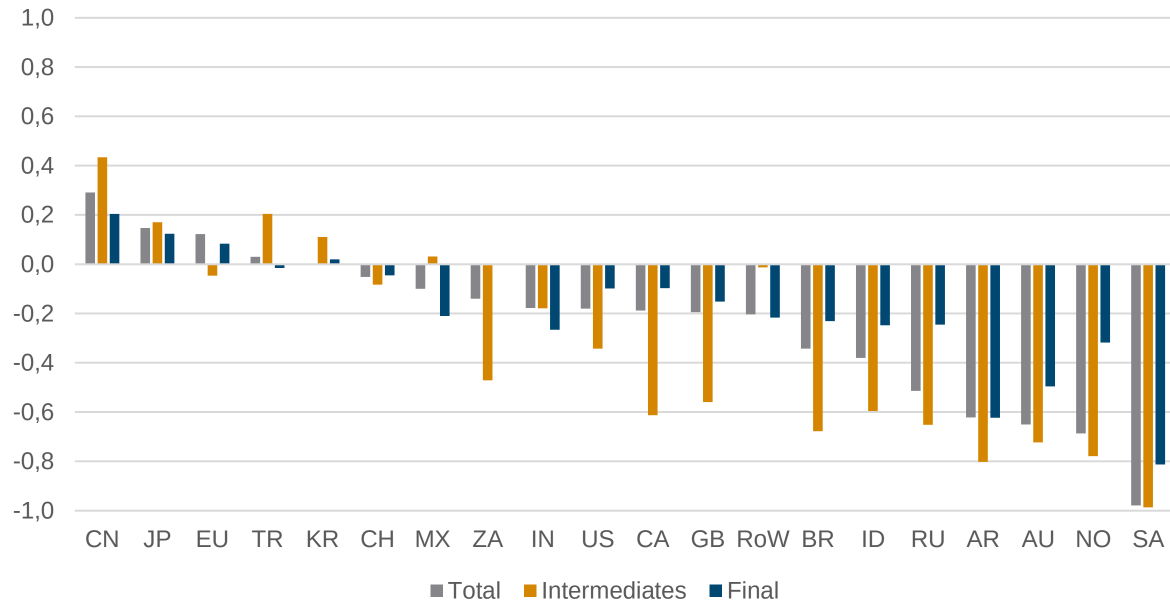


Note: Data for intra-EU trade are excluded.
Source: FIGARO; own calculations.

3.2 The international competitiveness of the EU vis-à-vis other global players

Using a country's export structures relative to the global export structures allows us to calculate the Balassa index of revealed comparative advantage (RCA). Its normalised version (ranging from -1, indicating a strong comparative disadvantage, to +1, indicating a strong comparative advantage) is presented in Figure 2. In line with the results above, one can see that China, Japan and the EU have an RCA in this ecosystem, while Turkey and South Korea are on the cusp. Other global superpowers, such as the US and India, are characterised by a negative RCA. A closer look at the EU reveals that its comparative advantage lies in final goods, while its value for symmetric RCA is negative for intermediate goods. In this respect, the EU is very different from China.

Figure 2 / Symmetric RCAs of the ERES in %, 2020



Note: Data for intra-EU trade are excluded.
Source: FIGARO; own calculations.

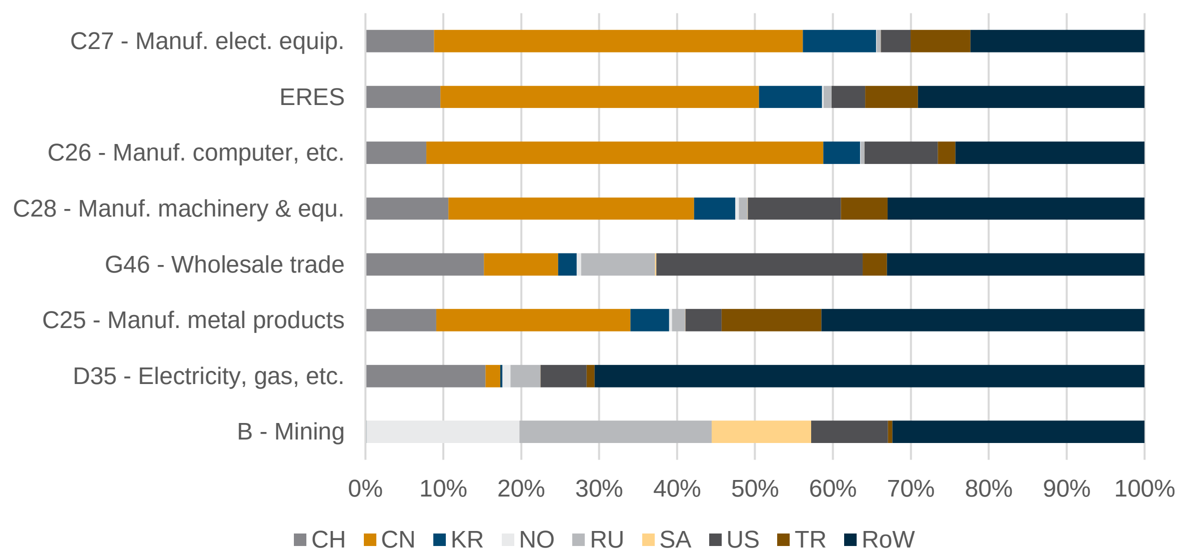
4. International interdependencies

The specific dependencies of this ecosystem are well documented, and EU initiatives seek to reduce their impact, given the need to facilitate the green transition. In this regard, our previous study (Guadagno and Stehrer, 2024) shows that by far the most critical industry from which the ecosystem sources its intermediate inputs is 'Electricity, gas, steam and air conditioning supply' (D35), followed by the ecosystem itself (intra-industry), 'Wholesale trade, except of motor vehicles and motorcycles' (G46) and 'Mining of coal and lignite' (B). The magnitude of foreign sourcing is generally small, except for intermediate inputs from the 'Mining of coal and lignite' (B) industry, where the share of foreign sourcing is 70%. As shown in Figure 3, in 2020 EU sourcing from this industry was dominated by Russia, followed by the US, Norway and Saudi Arabia.

However, what the orange bars in Figure 3 also show is that the ERES sources a significant quantity of its intermediate inputs from China, which is responsible for roughly 50% of the imports of the 'Manufacture of electrical equipment' (C27) industry. A similar sourcing structure characterises another strategic industry: 'Manufacture of computer, electronic and optical products' (C26). Furthermore, this sourcing pattern emerges in virtually all manufacturing industries (for details, see Guadagno and Stehrer, 2024). On the one hand, this evidence confirms China's role as the factory of the world. On the other, it reveals that the number of EU strategic dependencies are far more than those under the spotlight. When we look at an ecosystem with the strategic relevance of the ERES, we find that a variety of inputs is required by the ecosystem for it to function and that a wide range of them are, to all intents and purpose, sourced from a single trade partner: China.

By linking input-output tables with export data from the BACI dataset (for technical details, see Guadagno and Stehrer, 2024), we can discern how many products imported from China can be considered 'risky' products – i.e. those most vulnerable to global shocks. Applying a methodology developed by Reiter and Stehrer (2021, 2023), we classify products into 'risky' (or 'vulnerable') and 'non-risky'. The assessment is based on considerations related to market concentration, clustering tendencies, positioning of key partners in the global trade network and international substitutability.[5] Translating this analysis to the ERES demonstrates that up to 45% of the EU's ERES imports from China can be classified as risky. Concentrating on manufacturing imports of the ERES industry, Figure 4 shows that about EUR 1.4bn of imports from China are classified as risky, which is much higher than any other import volume from any other country in the world.

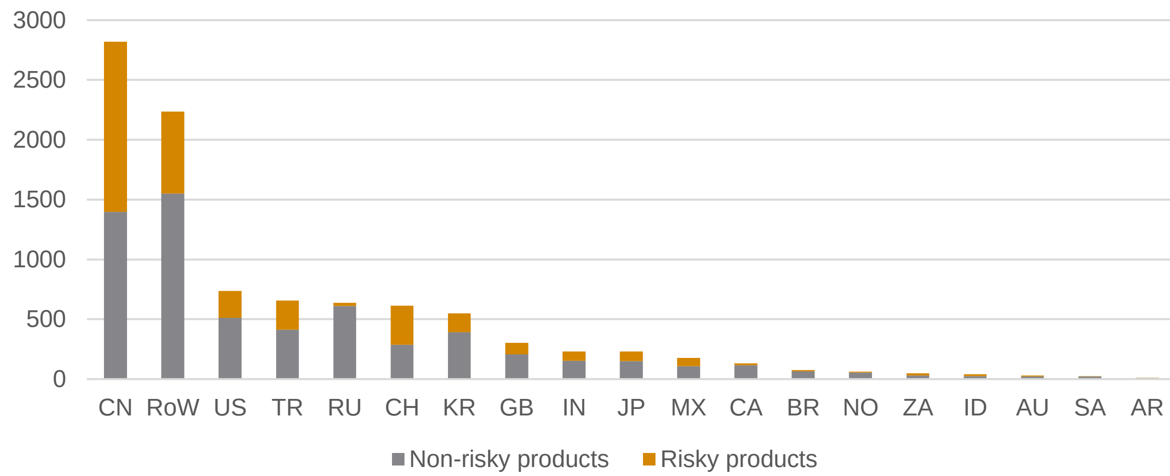
Figure 3 / Share of foreign sourcing by partner, selected industries, 2020



Note: Industries are ranked by China's share. Industries are selected on the basis either of their relevance (in terms of sourcing volumes), such as in the case of industry B ('Mining of coal and lignite'), or of China's importance as a sourcing partner (e.g. 'Manufacture of fabricated metal products' (C25)). The full descriptions of the codes are reported in Annex 1.
Source: FIGARO; own calculations.

[5] It is worth recalling here that the methodology to identify 'risky' products does not include any assessment of geopolitical risk.

Figure 4 / Share of risky products in total intermediate manufacturing inputs of EU ERES, 2020, in EUR million



Note: ‘Not classified’ represents imports of services.
Source: Own calculations.

5. Conclusions and policy relevance

The energy-renewables ecosystem (ERES) has a crucial role to play as an enabler and facilitator of the green transition, since a significant number of products and technologies that other sectors require to become greener are produced within this ecosystem. Given its strategic relevance, it is essential for the EU to bolster its competitiveness and reduce its external dependencies. In this paper, we have presented selected empirical evidence that contributes to a better understanding of the EU’s current performance in this ecosystem, as well as of its sourcing patterns and strategic dependencies.

The key findings of this paper can be summarised as follows: while China, Japan and the EU27 show a revealed comparative advantage in the products of the ecosystem, the ERES of the EU was, until recently, heavily dependent on imports related to the mining of coal and lignite, particularly from Russia. Beyond these imports from Russia (which are currently a matter of obvious concern), this study shows that the dependencies of this ecosystem are much wider in terms of industry, in that they also involve electrical equipment, computers, and electronic and optical products. These inputs are, to all intents and purposes, sourced from a single country – China. Heightening these concerns, we also demonstrate that 45% of the imports from China are products that can be considered ‘risky’ from the perspective of the global value chain. Since it is hard to find alternative sources for these vulnerable products, there are few options left beyond

China. Thus, we can gain a much more nuanced picture of the ecosystem's dependencies when we take a systemic view of the ecosystem – one that looks at all its connections and interlinkages with other products and countries.

This is a crucial finding of our analysis – and one that has important policy implications. The policy initiative that set the pace and direction of change in this ecosystem is the REPowerEU plan. This was conceived as a response to the hardships and energy-market disruptions caused by Russia's full-scale invasion of Ukraine in February 2022. Its key objectives are to end the EU's dependence on Russian fossil fuels and to accelerate the transition to a greener EU. The measures in the REPowerEU plan involve energy savings, diversification of energy suppliers and an accelerated roll-out of renewable energy to replace fossil fuels in homes, industry and power generation.

A plethora of other initiatives revolve around REPowerEU. For example, while the EU Solar Energy Strategy seeks to increase solar photovoltaic capacity, the Biomethane Action Plan sets out financial incentives to increase biomethane production (including through the Common Agricultural Policy). Various industry alliances (e.g. the European Solar Photovoltaic Industry Alliance, the Battery Alliance and the Clean Hydrogen Alliance) have also been established to promote the resilience and strategic autonomy of the ecosystem. Along the same lines, five of the eight Important Projects of Common European Interest (IPCEIs) approved so far involve products of this ecosystem (i.e. two for batteries and three for hydrogen).

While this is by no means an exhaustive list of the measures that support the ecosystem, this discussion already shows that the resilience and autonomy of the ecosystem are not left completely at the mercy of market forces. Nevertheless, a few policy considerations may be derived from the analysis conducted in this study.

Considering the reach of the dependencies of this ecosystem, REPowerEU correctly places considerable emphasis on energy diplomacy as a tool to help Europe diversify its energy sources and forge new global partnerships. In this regard, linking energy supplies to broader initiatives that promote friend-shoring of manufacturing activities relevant to this ecosystem might create win-win scenarios, especially when re-shoring is not feasible. In this regard, an observatory to trace re-shoring events – as well as new investment in installing or increasing production in these value chains – could provide valuable data to help us understand the effectiveness of these initiatives and the actual feasibility of restoring these value chains in the EU.

Finally, monitoring the ecosystem's trade linkages might help to reveal vulnerabilities that slip under the radar and to develop a more proactive (rather than reactive) approach to industrial policy making. Indeed, several of the current initiatives (including the trade negotiations with Mercosur to strike a deal on critical raw materials) seem to react to the present geopolitical scenario and other players' moves.

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Annex 1

Table A.1 / NACE Rev. 2 industry classification

NACE code	Description
B	Mining of coal and lignite
C25	Manufacture of fabricated metal products, except machinery and equipment
C26	Manufacture of computer, electronic and optical products
C27	Manufacture of electrical equipment
C28	Manufacture of machinery and equipment n.e.c.
D35	Electricity, gas, steam and air conditioning supply
G46	Wholesale trade, except of motor vehicles and motorcycles

Source: Eurostat.

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ET-BD-24-004-EN-N

Publications Office
of the European Union

DOI: 10.2873/059530
ISBN: 978-92-68-14491-6