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Poland on the map of "green" trade

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Key numbers

Around 8%	percentage of global exports made up of “green” products
USD 0.5-1.5 billion	global exports of environmentally-friendly products
Poland is 5th-largest	exporter of environmentally-friendly goods in the EU and 15th worldwide
USD 100 billion	EU “green” trade surplus in 2018
122%	increase in Polish exports of equipment used to produce electricity from renewable sources
USD 757 million	exports of the key Polish environmentally-friendly product (gas filtering devices)
98%	of the supply of rare earth elements to the EU comes from China
10-fold	possible increase in demand for rare earth elements in 2050, according to the European Commission
Poland ranks 106th	out of 130 countries in the Global Green Economy Index (GGEI)

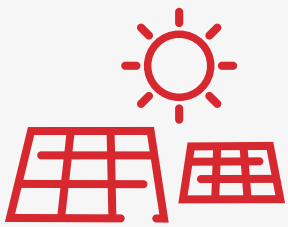
Key findings

- The low-carbon transformation and environmental protection policy have led to the rapid development of green economic sectors. The achievements so far – for example, in the development of renewable energy sources – have been the result of international trade; the decline in these technologies' prices has increased their competitiveness in relation to conventional energy. **In coming years, "green trade" will become more important thanks to investment in the low-carbon transition as part of the recovery from the crisis caused by the COVID-19 pandemic.**
- Depending on how green products are defined, exports of them amounted to USD 0.5-1.5 trillion in 2018 and accounted for 3-8% of global exports. Their value increased by 10-32% in 2010-2018. **Growth in the green economy, broadly understood, exceeded growth in total world trade, which amounted to 24.5%.**
- Factors such as an increase in photovoltaic panels' productivity and economies of scale resulted in the unit price falling by 85% in 2009-2019. Although the value of solar panel exports fell by more than 28% in 2010-2018, the volume increased by as much as 52%. **The likely slowdown in the decline in prices and the continued growing importance of renewable energy sources will lead to a new increase in the value of trade in these products.**
- This will also be influenced by political factors. Since China is the largest producer of the rare earth elements (REE) used in low-carbon technologies, among other things, there is a risk that Beijing will decide to limit the supply of them and some products made out of them. This could push up the price of many environmentally-friendly technologies and slow down the green transformation of the economy. **Independence from supplies from China is therefore one of the key goals of EU and US trade policy.** However, this is a long and expensive process, which the COVID-19 pandemic could make more difficult.
- The world's largest economies are the dominant players in the trade of green products. **The EU, China and the US account for over 60% of global exports of these products** (when EU internal and external exports are included). These economies, along with Japan and South Korea, are responsible for three-quarters of the world's exports. The EU has a positive trade balance in *green goods*, China's depends on the definition of green trade adopted and the US has a deficit in each case.
- **In 2010-2018, the value of Polish exports of environmentally and climate-friendly products doubled to USD 26 billion** – or USD 2.7 billion for the narrower list of products for generating electricity from renewable sources. In both cases, the export growth rate exceeded the total one for Polish exports, amounting to 78% and 122% respectively over the period analysed. Environmentally-friendly products accounted for 10% of Polish exports in 2019.
- **Poland ranks fifth among EU exporters in terms of the value of exports of green**

products and 15th worldwide, accounting for 2% of global trade. Poland has comparative advantages when it comes to the export of environmental goods in a broad sense; their share in Polish exports is 24% higher than their average share in global trade. For trade in products directly related to the production of electricity from renewable sources, their share in Poland's exports is 32% higher than their share in global trade. This shows that Poland has potential for the further development of exports in this group of goods.

→ **The export of green products has a positive effect on two of Poland's basic macroeconomic indicators: GDP and unemployment.** Poland should support the production of environmentally-friendly technologies and goods. This could help exporters make greater use of "green" export opportunities that have tangible benefits for the environment and the economy in the long term.

→ The structure of Polish exports shows that there are no clear export hits and that there are quite large differences between the main products, depending on the list selected. **In terms of products related to energy from renewable sources, Poland is successfully building its export potential when it comes to batteries.** Given its growing comparative advantages and the increase in these products' share in exports, Poland is well placed to attract further investment in environmentally-friendly sectors.



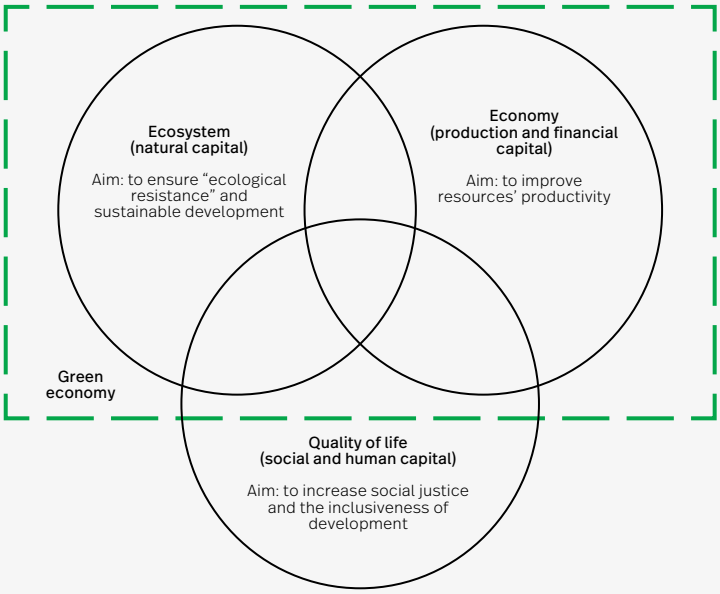
Introduction

"A green economy is defined as low carbon, resource efficient and socially inclusive. In a green economy, growth in employment and income are driven by public and private investment into such economic activities, infrastructure and assets that allow reduced carbon emissions and pollution, enhanced energy and resource efficiency, and prevention of the loss of biodiversity and ecosystem services. These green investments need to be enabled and supported through targeted public expenditure, policy reforms and changes in taxation and regulation" (UNEP, 2011). The debate on the green economy gained prominence after the financial crisis of 2008-2010, which highlighted economies' and societies' structural problems. The two key challenges for the future defined at the time encompass climate change and dependence on traditional energy resources (Szyja, 2015). The concept of the green economy was seen as a possible remedy for the multiple problems. The key features of the green economy are:

- improving material and energy efficiency (decoupling resource consumption from economic growth),
- the transition to a circular economy,
- shifting costs onto the actors responsible for pollution and greenhouse gas emissions,
- the energy transformation and replacing non-renewable sources with renewable sources (EEA, 2011).

Figure 1 presents the concept of the green economy in the context of sustainable development and identifies three main areas: the ecosystem, the economy and quality of life. In general, the green economy can be characterised by low emissions, resource efficiency and inclusiveness, understood as "social inclusion" (Szyja, 2015).

↘ Figure 1. The concept of the "green economy" in the context of sustainable development

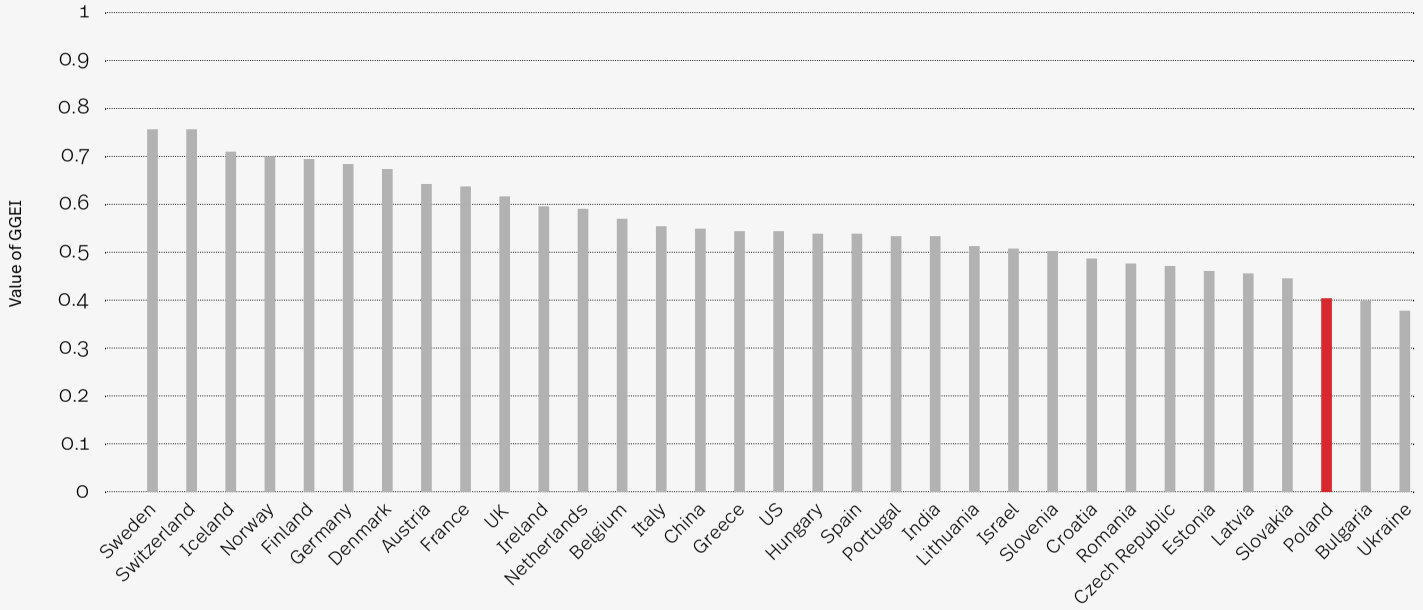


Source: prepared by PEI based on: EEA (2011).

The idea of the green economy applies to virtually all sectors and affects the functioning of all of society (including the choice of transport). This is also indicated by the Sustainable Development Goals and Millennium Development Goals (UN, 2015), which complement this concept. The Global Green Economy Index™ (GGEI) is the first index that creates a system for assessing the development of the green economy. The ranking of 130 countries contains quantitative and qualitative indicators that reflect the extent to which assumptions in four dimensions have been implemented: leadership and climate change, efficiency sectors, markets and investments, and the environment. In 2018, European countries ranked the highest in the GGEI index. Among the top ten countries, there were five Nordic ones – Sweden (1st), Iceland (3rd), Norway (4th), Finland (5th) and Denmark (7th) – along with the three German-speaking countries (DACHL): Switzerland (2nd), Germany (6th) and Austria (9th). The top 10 also included France (10th) and Taiwan (8th), which advanced the fastest compared to the previous ranking (the GGEI value increased almost 1.7-fold).

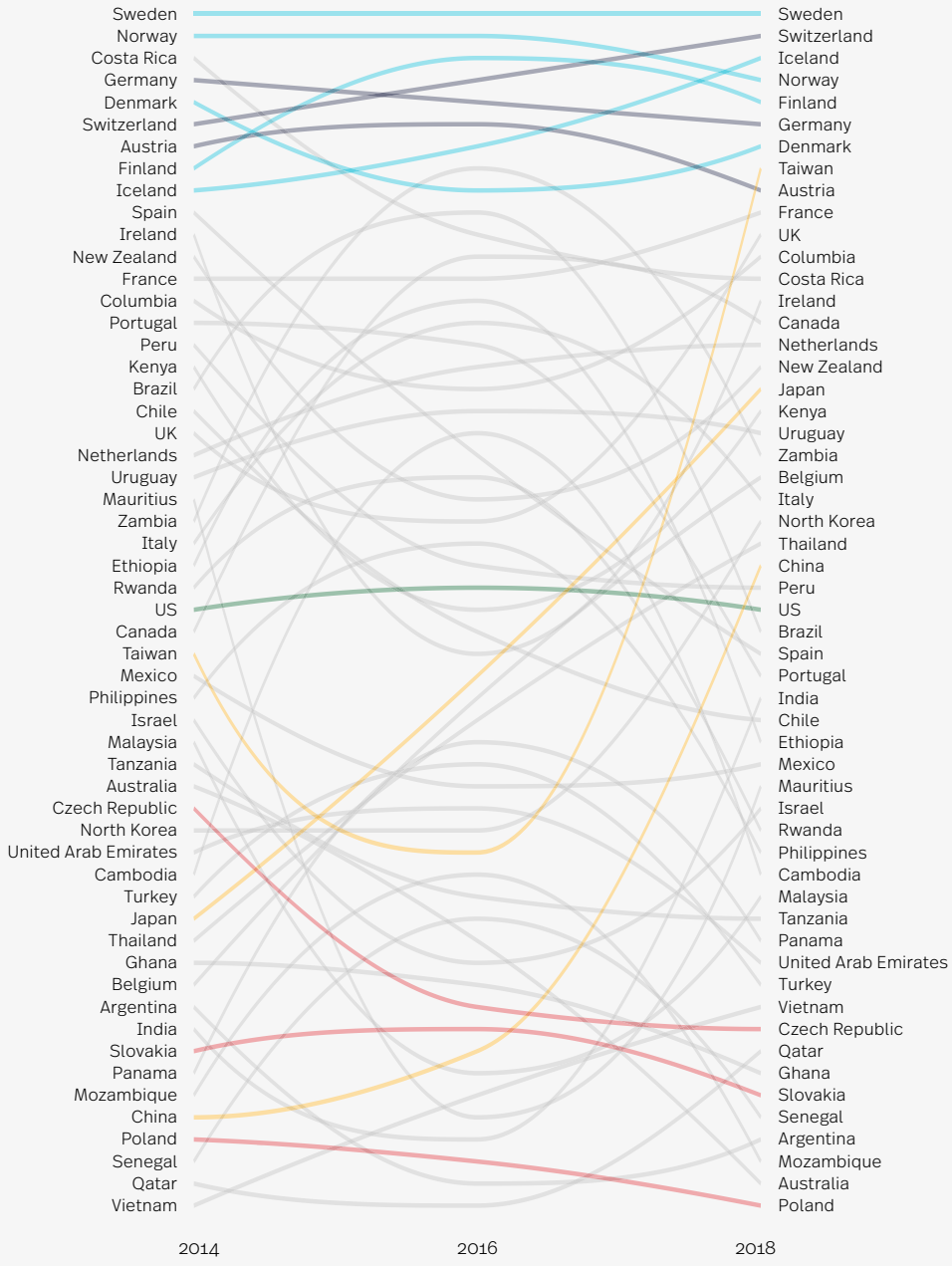
These countries are highly developed and have a relatively high standard of living. Poland ranks just 106th out of 130 countries. In Europe, only Bulgaria (107th), Serbia (115th), Moldova (118th), Ukraine (121st) and Bosnia and Herzegovina (127th) rank below it. Despite regularly falling in the ranking, the value of the index in Poland increased slightly in 2014-2018. Chart 2 shows changes in the position of 55 selected countries for which the GGEI was calculated in 2014-2018. It is worth noting that, in 2018, the United States was overtaken by China for the first time. In China, the value of the index increased by 32% in 2016-2018, compared to 6% in the US. This was the highest increase, along with Taiwan.

↘ Chart 1. Ranking of selected countries in the Global Green Economy Index in 2018



Source: prepared by PEI based on: Dual Citizen LLC (2019).

↘ Chart 2. **Changes in selected countries' position in the GGEI in 2014-2018**



Note: turquoise – the Nordic countries, dark grey – selected DACHL countries, green – the US, yellow – selected "Asian tigers", red – selected V4 countries.

Source: prepared by PEI based on: Dual Citizen LLC (2019).

International trade in environmentally-friendly products

Lists of "green" products

Trade can be a driving force in the move towards a "green" economy and sustainable development. As part of the growing importance of environmental and climate protection policies, countries are combining product exports with environmental opportunities to support economic development, and, at the moment, the economic recovery after the pandemic. Trade is a very important carrier of innovation, enabling the spread of low-emission technologies in different countries around the world (Mealy, Teytelboym, 2020).

The difficulty of defining the "green" economy affects assessments of its importance in world trade. The breadth the approach determines how many product groups are classified as goods with a positive impact on the environment and climate protection. Many "green" sectors enable the export of products, from organically grown fruit to clean and environmentally-friendly technologies (Brandi, 2012). International negotiators have been dealing with this issue since 2001 when, at the ministerial conference of the World Trade Organisation, there was an attempt to talk about customs liberalisation for trade in green products (Ambroziak, 2015). The only successful attempt to introduce facilitations so far is the list of 54 commodity codes classified in the Harmonized System (HS) that are related to environmental protection (www1). It was agreed on in 2012 at the Asia-Pacific Economic Community's APEC Forum (which will be referred to as "APEC List / Products"). The signatories undertook to reduce customs duties on these groups of goods to no more than 5% of their value. Since 2014, negotiations on an Environmental Goods Agreement (EGA) have been conducted under the auspices of the WTO (Bucher et al., 2014), but no comprehensive agreement has been reached in the WTO forum or in a narrower group of states.

Moreover, as in many other international negotiations, the main divide is between developed and developing countries' interests. While the former mainly aim to include technologically-advanced products on the list, the latter would benefit from a very broad approach to green products and the inclusion of goods that are often more environmentally-friendly substitutes for other products. This kind of list of products, sometimes called "environmentally preferred goods", would offer less developed countries greater benefits from customs liberalisation than the APEC list or the classifications proposed by developed economies as part of the EGA negotiations (www2).

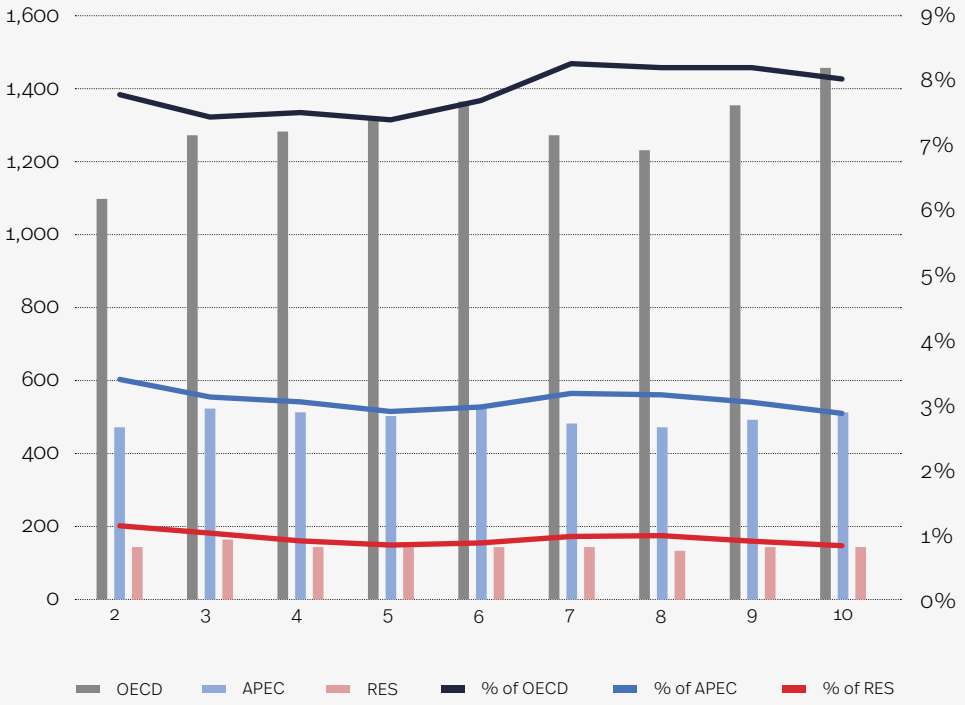
The lack of a widely-used list of environmentally preferred goods means that the APEC list is the only one associated with a political decision to classify them. For this reason, it is the focus of the research in this report. To show trends in the most recognisable branch of the green economy, the production of electricity from renewable energy sources, a list of products directly related to its production was examined, too.

The list used here was prepared by the European Commission (Pasimeni, 2017) and contains 28 HS codes (which will be referred to as "RES list/products"). However, to include many more product groups and show the scale of the "green" economy broadly understood, a list of 255 HS codes (OECD 2019) compiled by the OECD (OECD list/products) was also analysed. It is worth remembering that the estimates are based on commodity codes, which often go beyond products with a positive environmental impact. Some products, such as gas or steam turbines, serve various purposes, not just "green" ones.

Global exports

In 2018, the value of international exports of environmental products (APEC list) amounted to **USD 519.4 billion** and accounted for 2.8% of global exports. Exports of devices directly related to the production of energy from renewable sources (RES list) were worth **USD 144.7 billion** and accounted for less than 1% of global exports. For comparison, in 2018, exports of products from the widest list of 255 commodity codes collected by the OECD were worth **USD 1.461 billion**, 8% of global trade. Compared to 2010, the value of exports of these goods increased by 32%, faster than growth in all global trade (25%). Interestingly, there were other trends in "green" trade in a narrower sense. In 2010-2018, exports of products from the APEC list increased by 9.5% in terms of value, while renewable energy exports fell by 4.4%. The technological and production revolution explains this lower growth in the trade of green products from these two lists. Technical progress has made energy generation more productive, for instance, and huge demand has made it possible to use the economies of scale in production, which pushed down prices (Kavlaka, McNerneya, Trancik, 2016). One example of this kind of product are photovoltaic panels. In 2009-2019, their market price fell by around 85% (Jäger-Waldau, 2019). Their exports decreased by 28% in terms of value (to USD 52 billion in 2018), but increased by as much as 52% in quantitative terms. The export dynamics of APEC and RES products were therefore strongly shaken by these products. However, the OECD's extended list of 255 products was resistant to them.

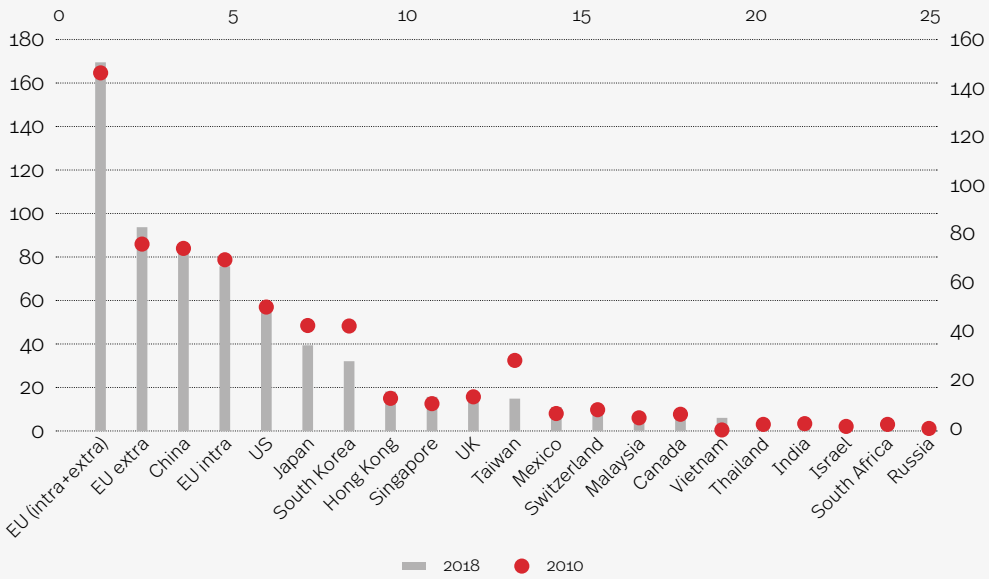
↘ Chart 3. Global exports of products from the RES, APEC and OECD lists in 2010-2018 (billions of USD and percentage of global trade)



Source: prepared by PEI based on the WITS-Comtrade (2020) database.

In 2018, the EU was the world's largest exporter of **APEC products** (both in terms of internal and external trade). Exports of them amounted to USD 170 billion. Although the value of exports of APEC products increased by 15.9% compared to 2010 (USD 146.7 billion), their share in total EU exports decreased from 3.2% in 2010 to 2.9% in 2018. The reason for the relatively low growth was the collapse of photovoltaic panel exports; their value decreased from USD 17 billion in 2010 to USD 6 billion in 2018. Exports outside the EU alone amounted to USD 94.0 billion (22.4% more than in 2010). China was the second-largest exporter of APEC products. In 2018, it exported USD 85.8 billion worth of these products (14.6% more than in 2010), 3.4% of its exports. The US was third. The value of American APEC product exports amounted to USD 56.7 billion in 2018, 11.7% more than in 2010. The share of "green" goods in US exports in 2018 amounted to 3.4%, like in China's case. For Japan and South Korea, the next two countries in terms of the value of exports, products with a positive impact on the environment were more important than for the three leading exporters of these products. Their share in total exports was 5.4% in Japan and 5.3% in South Korea (down from 9.2% in 2010).

↘ Chart 4. Top exporters of APEC products in 2010 and 2018 (billions of USD)

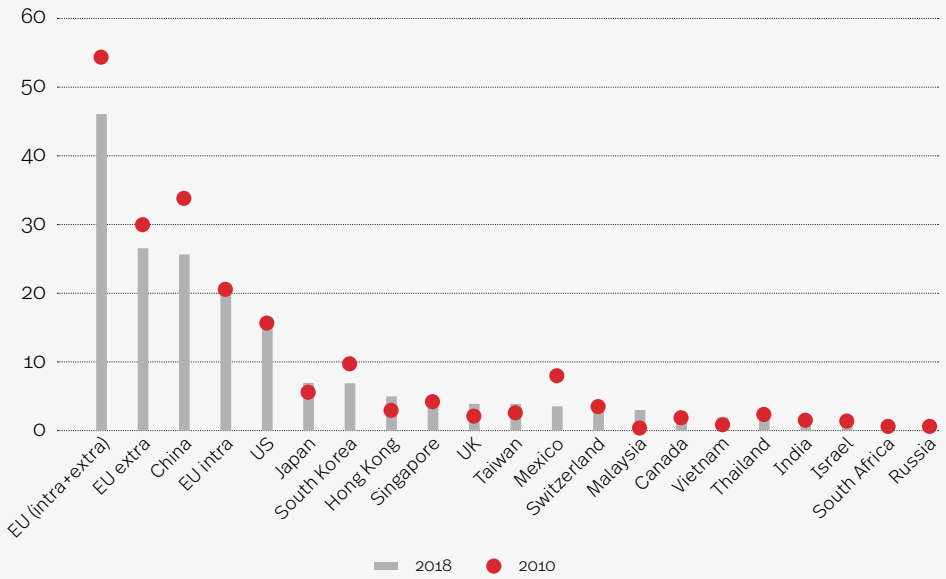


Source: prepared by PEI based on WITS-Comtrade (2020) data.

It is worth noticing two countries where the value of exports of environmentally-friendly products increased extraordinarily in 2010-2018: Macedonia (2445.6%) and Vietnam (1194.5%). In 2018, Vietnam was the 14th largest export of APEC products and Macedonia was 24th. The former has specialised in products related to solar energy, while the latter has specialised in air filters (not for the EU market). Although this big increase results from the low value in 2010 (Macedonia: USD 29 million, Vietnam: USD 477 million), it seems likely that this trend will continue, especially in the case of Vietnam.

In terms of combined internal and external exports, **the EU is also the largest exporter of goods used to generate renewable energy.** In 2018, the value of EU renewable energy exports amounted to USD 46.3 billion. The value of exports to other EU countries (EU intra, USD 25.8 billion) exceeded the value of exports to third countries (EU extra, USD 20.5 billion). Compared to 2010, EU exports (intra+extra) of this type of product decreased by 15.1%. There was a larger drop in the value of exports to other member states (-24%) than to those outside the EU (just -0.7%). The share of RES products in total EU exports also decreased, from 1.2% in 2010 to 0.8% in 2018. Taking into account only exports outside the EU, China was the largest global exporter; exports of RES products from there amounted to USD 26.7 billion in 2018 and decreased in value by 11.5% compared to 2010. In the US, exports amounted to USD 16.6 billion and were the only ones to increase by 5.7% compared to 2010. Other major RES exporters in 2018 included South Korea (around USD 7.0 billion), Japan (USD 6.9 billion) and Malaysia (around USD 5 billion).

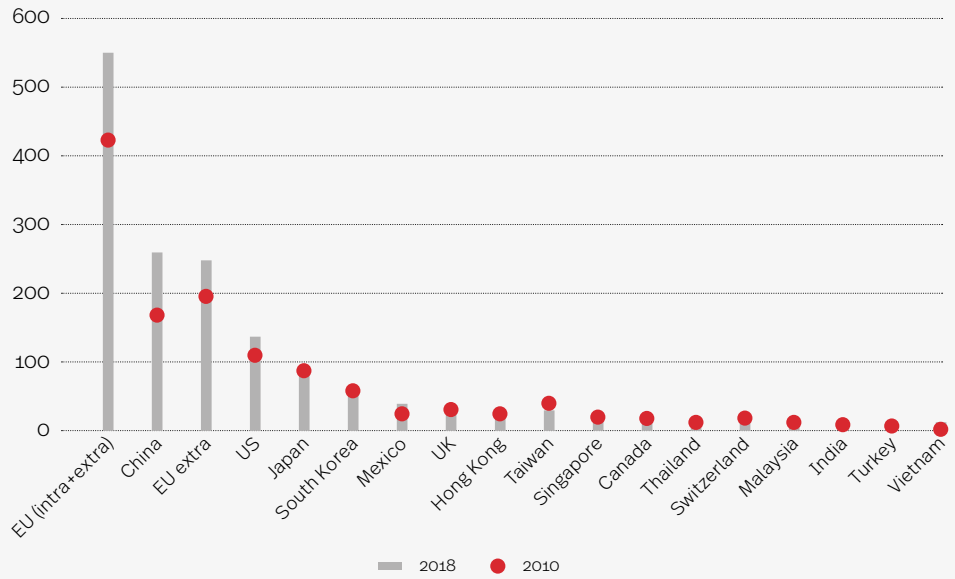
↘ Chart 5. **Largest exporters of RES list products in 2010 and 2018 (billions of USD)**



Source: prepared by PEI based on WITS-Comtrade (2020) data.

The geographical structure of exports of products from the OECD list is similar. Here, too, combined internal and external EU exports were the largest, accounting for 38% of global trade in these products. In terms of external trade only, which was worth USD 249 billion in 2018 and accounted for 18% of global exports, the EU came second, after China (USD 260 billion, 18%). The value of EU trade in *green goods* from the OECD list increased by 30% in 2010-2018, while the value of Chinese trade doubled. Interestingly, the export of these goods is equally important for both entities; it accounted for slightly over 10% of all their exports in 2018. The US's significance in the export of environmentally-friendly goods from the OECD list is falling. In 2018, exports of them were worth USD 138 billion (9% of global exports). These goods also made up less of US exports – just 8 per cent. All the groups of "green" goods are characterised by a strong concentration of exports. The five largest export markets (EU, China, the US, Japan and South Korea) account for three--quarters of global exports of these products.

↘ Chart 6. **Largest exporters of goods from the OECD list in 2010 and 2018 (billions of USD)**



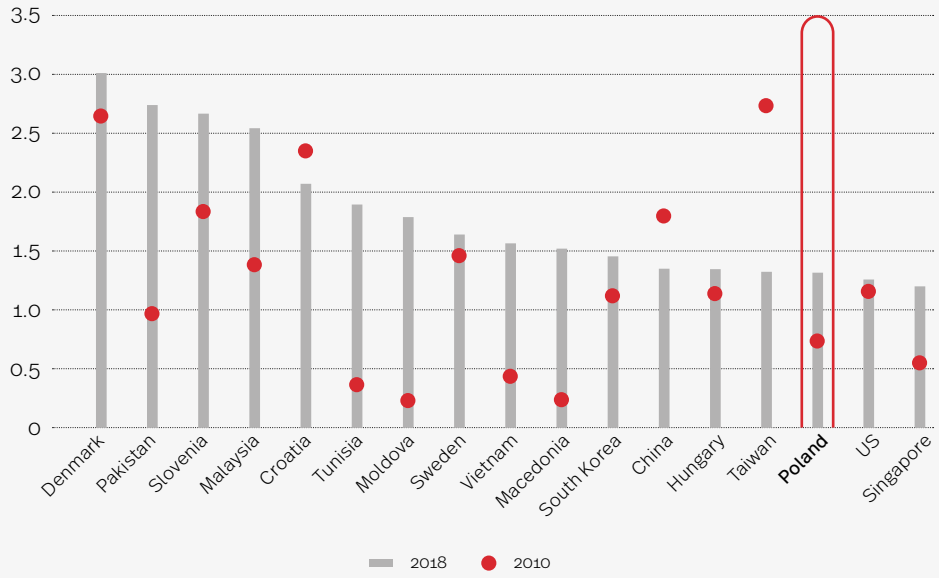
Source: prepared by PEI based on WITS-Comtrade (2020) data.

In 2018, the highest positive balances in trade in environmentally-friendly products from the APEC list were recorded by the EU (USD 65 billion, of which Germany accounted for USD 41 billion), Japan (USD 23 billion) and South Korea (USD 14 billion). The highest negative balances were recorded by the Russian Federation (USD 20 million) and India (USD 8 million). The largest surplus in trade in renewable energy products was recorded by China (USD 15 billion), the EU (USD 12 billion), Malaysia and South Korea (USD 3 billion each), while the largest deficits were recorded by India and Turkey (USD 4 million).

Similarly, in terms of trade in OECD products, China came first in terms of positive balance in 2018 (USD 110 billion). The EU came second (USD 100 billion) and Japan third (USD 52 billion). The US recorded the highest deficit in trade in these products (USD 58 billion).

An important measure of countries' competitive position is the revealed comparative advantages (RCAs) indicator. There is an advantage when a given product's share in a given country's exports is higher than its share in global exports. The RCA indicator points to an advantage when it is higher than one. The countries with the highest comparative advantages in trade in renewable energy products are Benin, Denmark, Pakistan, Slovenia and Malaysia. The top ten also includes Croatia, Tunisia, Moldova, Sweden and Vietnam. Poland ranks 17th, with a score above one for RES products. Their share in Polish exports is 32% higher than their share in global exports.

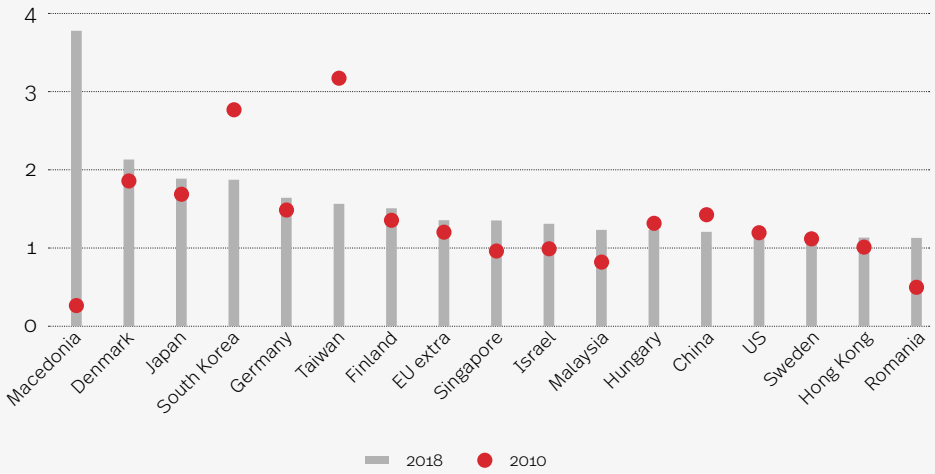
↘ Chart 7. Comparative advantages when it comes to RES products in 2010 and 2018



Source: prepared by PEI based on WITS-Comtrade (2020) data.

The situation is different when we consider the wider range of environmentally-friendly goods on the APEC list. Macedonia has the largest revealed comparative advantage; the share of APEC products in its exports is four times higher than their share in the total global exports. When it comes to exports of these products, Bermuda and Denmark's share is double their respective share in global exports. The top ten also includes Japan, South Korea, Germany, Taiwan, Finland and Benin. Poland has no revealed comparative advantages in this product category, but – as in the case of RES – this indicator improved in 2010-2018.

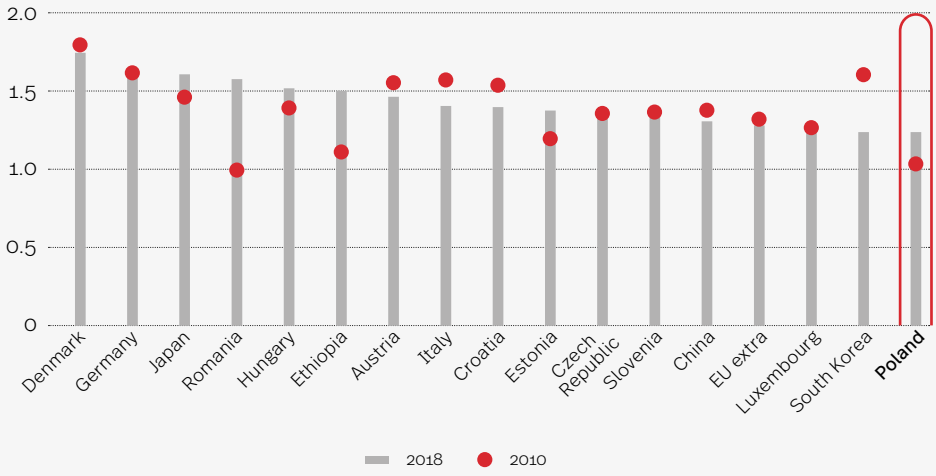
↘ Chart 8. **Comparative advantages when it comes to APEC products in 2010 and 2018**



Source: prepared by PEI based on WITS-Comtrade (2020) data.

Apart from the small states with very high RCAs, Denmark, Germany and Japan had the highest comparative advantages for products on the OECD list. Romania, Hungary and Ethiopia's share in exports of these goods was also over 50% higher than their share in global exports. Poland's advantage was the same as South Korea's (24%), with an increase of 20 pp. in 2010-2018.

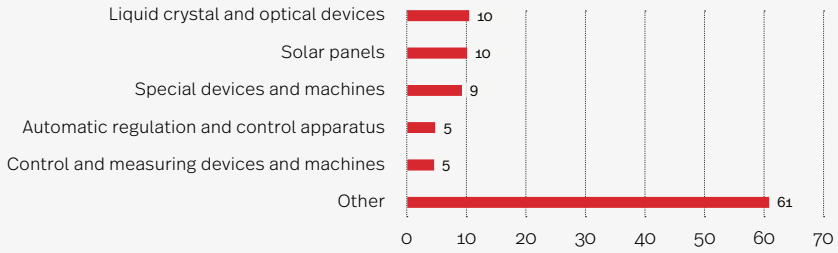
↘ Chart 9. **Comparative advantages when it comes to OECD products in 2010 and 2018**



Source: prepared by PEI based on WITS-Comtrade (2020) data.

The product structure of global exports reveals the leader in "green" trade: products related to solar energy, despite a 30% decrease in value in 2010-2018. In the broader APEC list, the most important export products are optical, liquid crystal and similar devices (code 901380), including heliostats used in the construction of concentric solar power plants. Their global exports were worth USD 54 billion in 2018. However, it is worth noting that such a high value for heliostats seems excessive; other optical or liquid crystal devices probably dominate in this product category. The second most important export goods in terms of value are photovoltaic panels and modules, as well as other photo-sensitive semiconductor elements (code 854140), which were worth USD 52 billion. The next two export products on the APEC list are machinery and equipment related to sorting, filtering, purifying, compressing waste (code 847989, USD 47 billion), and instruments and apparatus for automatic regulation or control (of electricity, pressure or humidity), which improve devices' energy efficiency (code 903289, USD 24 billion).

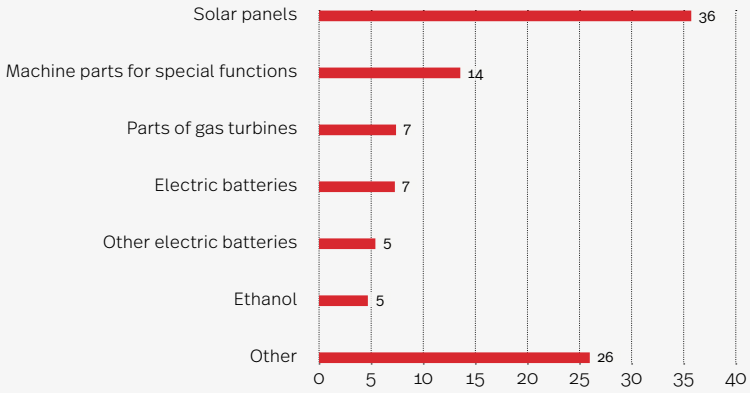
↘ Chart 10. **Structure of APEC product exports in 2018 (%)**



Source: prepared by PEI based on WITS-Comtrade (2020) data.

In the export of goods from the RES list, photovoltaic panels came first again (USD 52 billion). Gas turbines for producing electricity from clean coal and gas (code 841199, USD 20 billion) were second and energy storage in the form of lead-acid batteries (code 850720, USD 11 billion) were third. Exports of RES commodities are much more concentrated: the four largest product groups account for 56% of exports. For the APEC list, the top eight product groups account for 51% of exports.

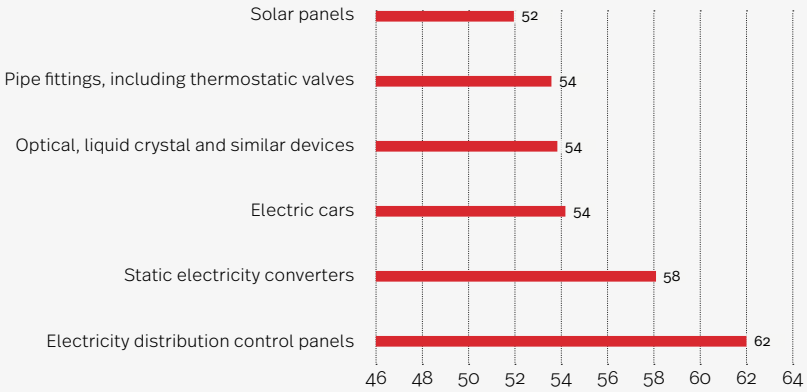
↘ Chart 11. **Structure of RES product exports in 2018 (%)**



Source: prepared by PEI based on WITS-Comtrade (2020) data.

The leader when it comes to exporting panels and optical devices is China (accounting for 40% of the market); for waste and regulation and control devices, it is Germany; for gas turbines, it is the US; for batteries, it is South Korea. A broad approach to green trade product lists changes the top export goods. They are: control panels for the distribution of electricity not exceeding 1000V (code 853710, USD 62 billion), static electricity converters (code 850440, USD 58 billion) and electric cars for passenger transport, for example, at airports (code 870390, USD 54 billion). Extending the list to 255 products diversifies it considerably. Unlike with the RES or APEC list, the top ten products account for just 31% of exports of goods from the OECD list.

↘ Chart 12. **Top goods exported from the OECD list in 2018 (billions of USD)**

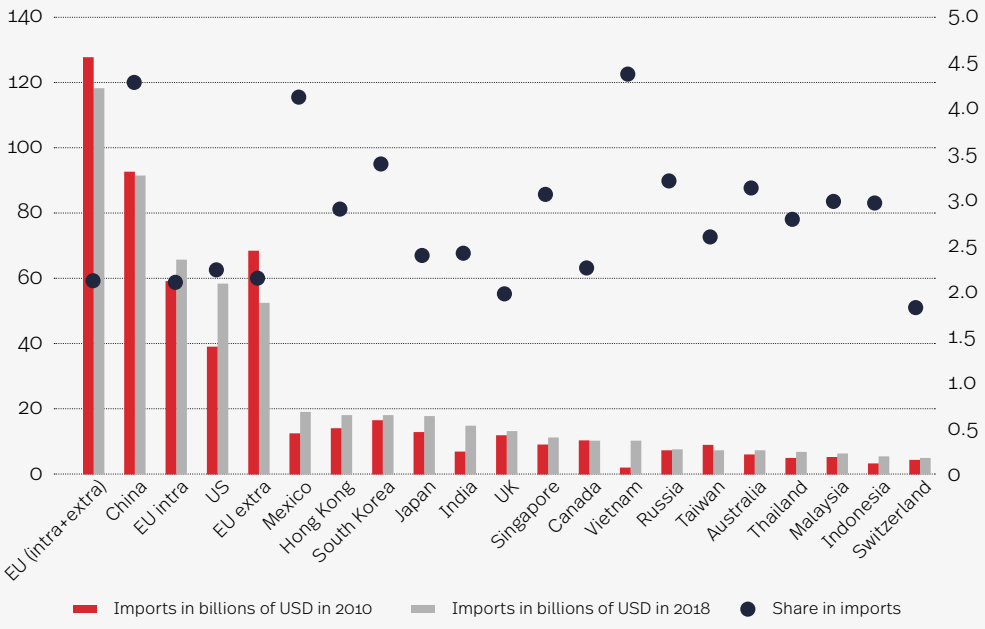


Source: prepared by PEI based on WITS-Comtrade (2020) data.

Global imports

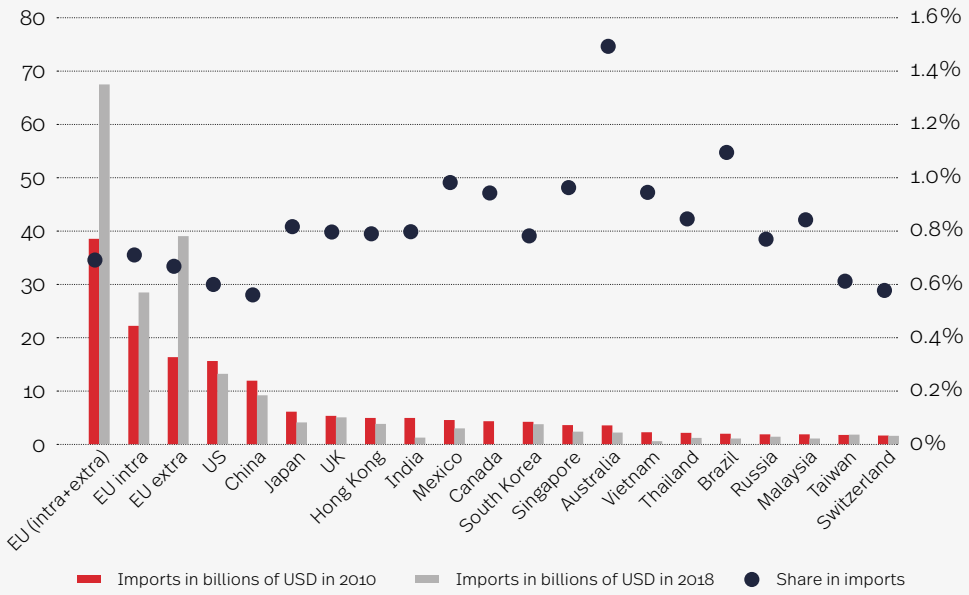
In imports, there was no decrease in value in 2010-2018, although the specific nature of the sector meant that the increases were slow. Imports of RES products increased by 2% and APEC ones by 14%. **The EU is also the leader when it comes to the import of "green" goods**, in particular renewable energy; imports of it to the EU account for 12% of global imports (28% if imports from other EU countries are included). The US is second with a share of 11% and China third with 9%. For the wider APEC list, the situation is similar. The EU is only the largest importer when it includes also supplies from other EU countries. In 2018, EU imports accounted for 24% of global ones. However, those only from outside the EU accounted for just 11%. In the latter case, China (18%) is the largest importer. For the broadest, OECD list of green products, the EU was again the largest importer in terms of intra-EU supplies. If only imports from outside the EU are considered, the US is first with a 14% share, China second (11%) and the EU only third. Significantly, the geographic differentiation of global imports of these goods is increasing. In 2010, three entities were responsible for 66% (RES) and 60% (APEC) of global imports. In 2018, this was 47% and 54 %.The geographical variation is similar for imports of goods from the OECD list; the top three countries account for 54% of global imports.

↘ Chart 13. Top importers of goods from the APEC list in 2010 and 2018



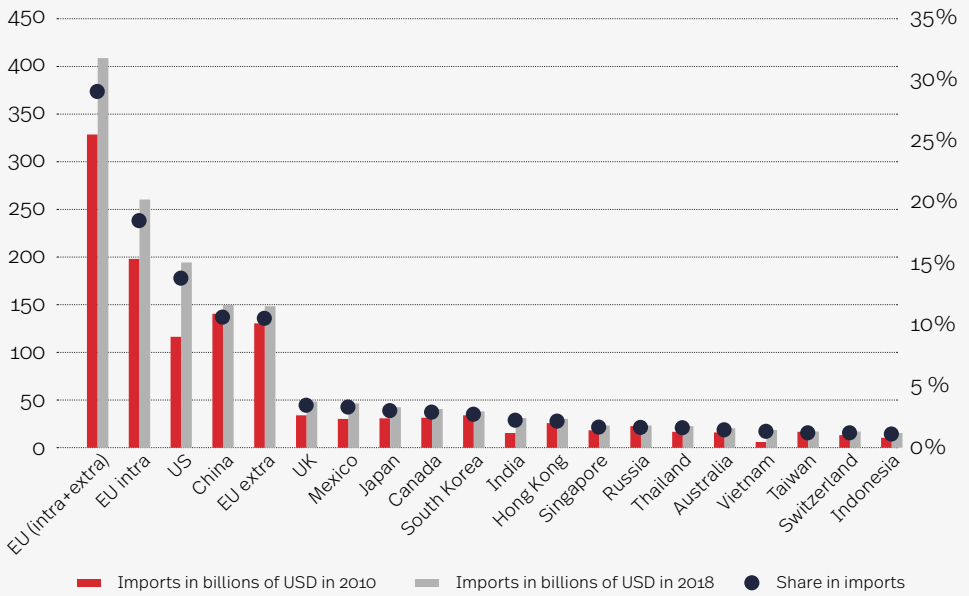
Source: prepared by PEI based on WITS-Comtrade (2020) data.

↘ Chart 14. Top importers of goods from the RES list in 2010 and 2018



Source: prepared by PEI based on WITS-Comtrade (2020) data.

↘ Chart 15. Top importers of goods from the OECD list

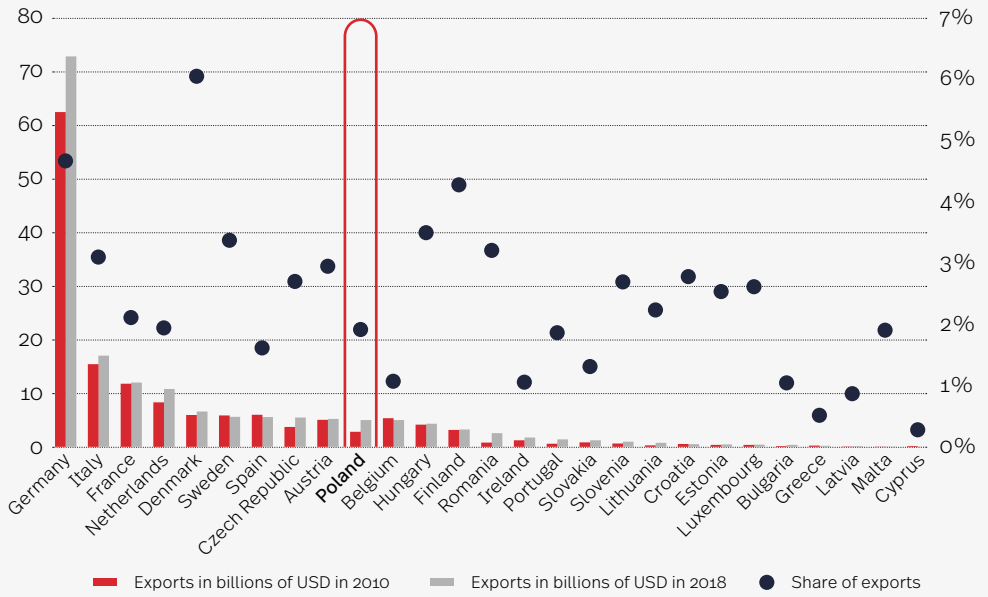


Source: prepared by PEI based on WITS-Comtrade (2020) data.

The EU

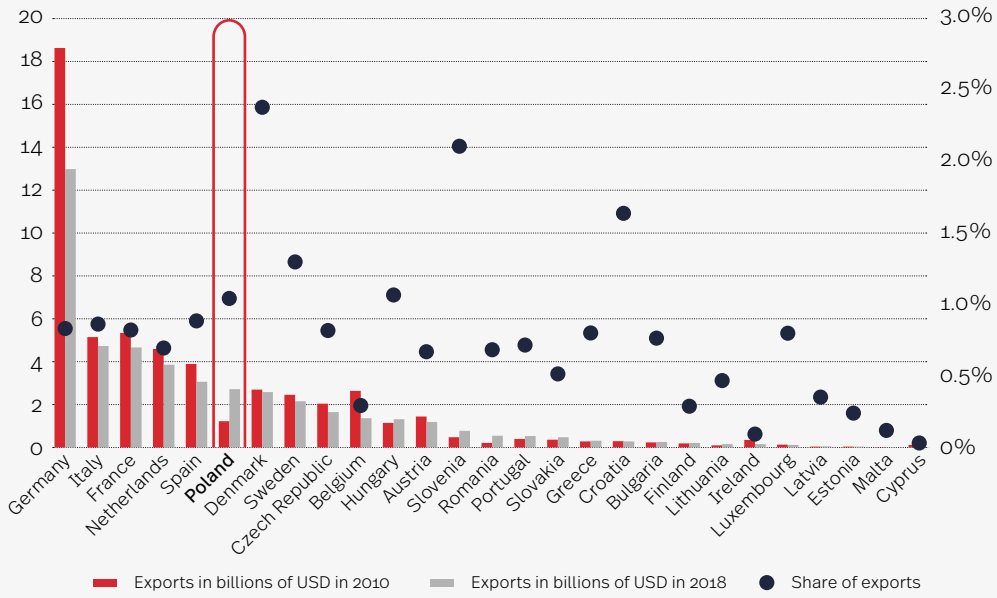
Among EU member states, Germany is the undisputed leader in the export of RES and APEC products. In 2018, the value of exports of products from the APEC list amounted to USD 73.1 billion, an increase of 16.6% compared to 2010. These goods account for 4.7% of Germany's total exports. The country's RES product exports amounted to USD 13.0 billion, 30.3% lower than in 2010, which also translated into a decrease in their share from 1.5% to 0.8% in 2018. The resulted from the collapse of solar panel exports due to falling prices and competition from Asia, mainly China. Other major EU exporters of "green" goods are Italy, France, the Netherlands, Spain and Denmark. Among EU member states, green product exports are of the greatest significance for Denmark's exports; their share in the country's total exports in 2018 was 2.4% for RES products and 6.1% for ones on the APEC list.

↘ Chart 16. **Exports of goods from the APEC list in the EU in 2010 and 2018**



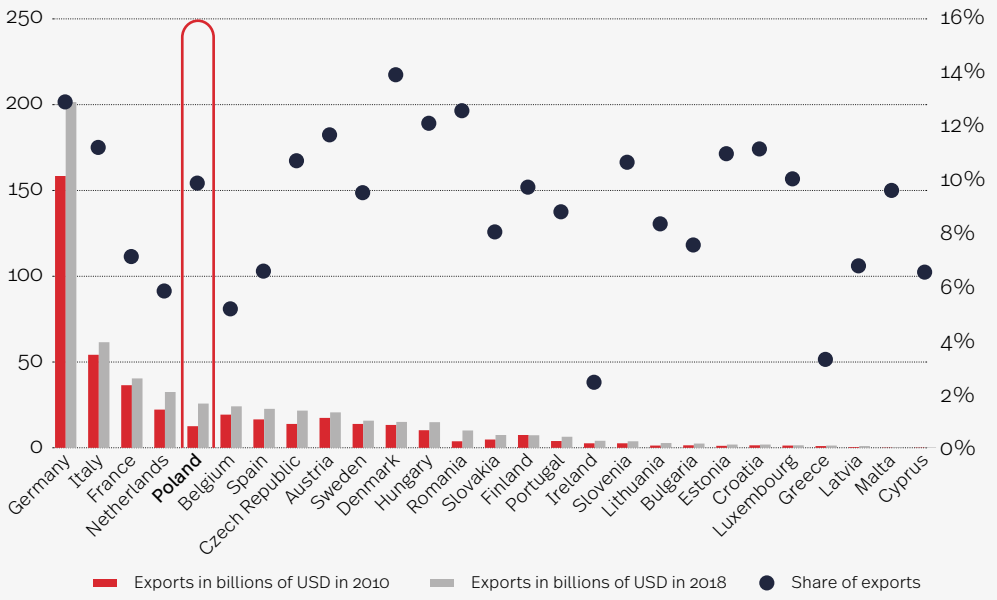
Source: prepared by PEI based on WITS-Comtrade (2020) data.

↘ Chart 17. Top exporters of RES products in the EU in 2010 and 2018



Source: prepared by PEI based on WITS-Comtrade (2020) data.

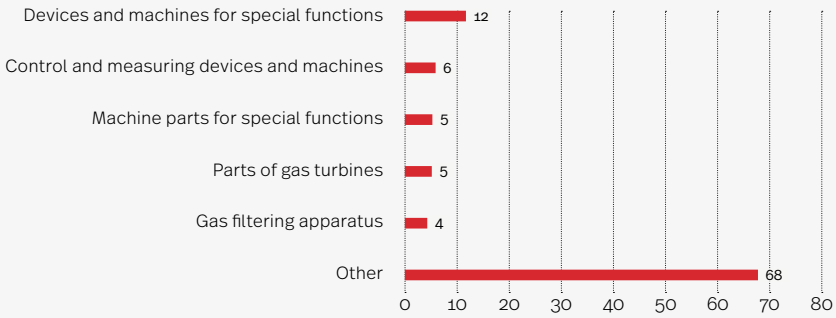
↘ Chart 18. Top exporters of products from the OECD list in the EU in 2010 and 2018



Source: prepared by PEI based on WITS-Comtrade (2020) data.

The structure of EU exports from the APEC list points to the dominance of machines and devices for sorting, filtering, cleaning and crushing waste (code 847989, USD 11 billion). Their value is twice that of the second group of goods, air measurement devices (code 903180, USD 6 billion). Export of specialised equipment, including for ensuring air humidity or compacting waste, and gas turbine exports, are worth slightly less (USD 5 billion).

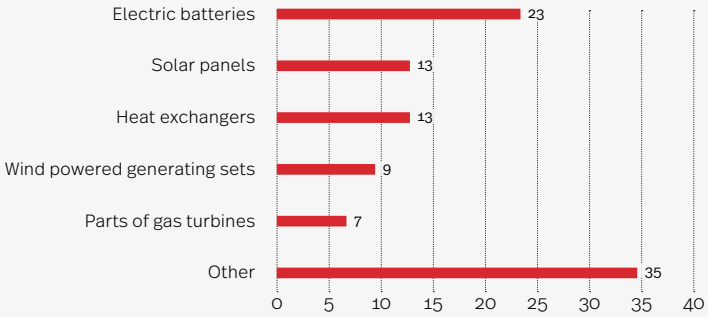
↘ Chart 19. **Structure of goods on the APEC list exported outside the EU in 2018 (%)**



Source: prepared by PEI based on WITS-Comtrade (2020) data.

The latter product is also the main product on the RES list exported outside the EU (code 841199.5 billion USD). In this product group, generators used by wind farms are in second place (code 850231, USD 3 billion), followed by heat exchange units (code 841950, USD 3 billion).

↘ Chart 20. **Structure of goods on the RES list exported outside the EU in 2018 (%)**

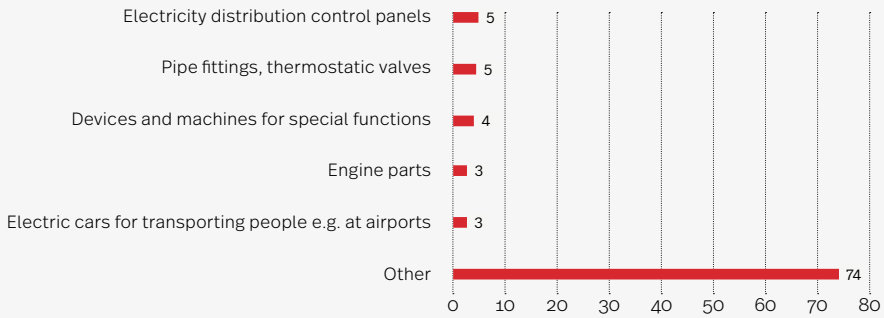


Source: prepared by PEI based on WITS-Comtrade (2020) data.

As in the case of global exports, among OECD products exported from the EU, control panels for electricity distribution (code 853710, USD 13 billion) and pipe fittings, including thermostatic valves (code 848180, USD 11 billion) come first. The third product in terms

of export volume is the first on the APEC list: machinery and equipment for filtering, sorting and crushing (code 847989, USD 11 billion). Extending the list to 255 products makes it much more diverse. Unlike for the RES or APEC lists, the top ten products account for just 31% of exports of goods from the OECD list, which results from the list's much wider scope.

↘ Chart 21. **Structure of goods on the OECD list exported outside the EU in 2018 (%)**



Source: prepared by PEI based on WITS-Comtrade (2020) data.

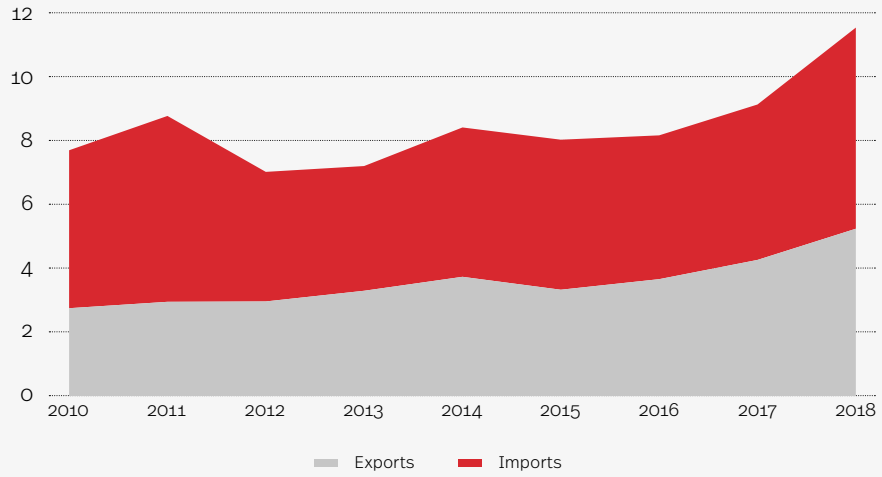
In intra-EU trade, the top products on the RES list were photovoltaic panels (USD 4 billion) and lead-acid batteries (USD 3 billion). The top product imported from outside the EU on both the APEC and RES lists are photovoltaic panels. In 2018, exports of them were worth USD 6 billion. The second product in terms of export value is machinery and equipment related to sorting, filtering, cleaning and crushing waste (code 847989, USD 4 billion). Gas turbines are third (USD 4 billion).

Poland

In 2010-2018, **the value of Polish exports** of RES products increased by 122.1%, to USD 2.7 billion. Exports of products from the APEC list grew slightly more slowly (77.9%), to USD 5.0 billion. The growth rate for both was higher than that for Polish exports overall, which amounted to 66.7% over the period analysed. For this reason, the share of these products in Polish exports increased. For RES products, it increased from 0.8% in 2010 to 1.0% in 2018. For products from the APEC list, it increased from 1.8% to 1.9%. Poland ranks 6th among EU exporters in terms of the value of exports of RES products and 10th in terms of the value of APEC products. From a global perspective, Poland is the 18th and 23rd largest supplier of these goods globally. For "green" products in the broadest sense, those on the OECD list, Poland did best in 2018: it is the 5th largest exporter of these goods in the EU and 15th globally. Exports of these products doubled in 2010-2018, to USD 26 billion. The exports of goods on the OECD list grew more slowly than that of RES goods, but exceeded that of Polish exports overall. Since 2012, Poland has recorded a positive balance in trade in these goods in 2018. The wider scope of the list means that these

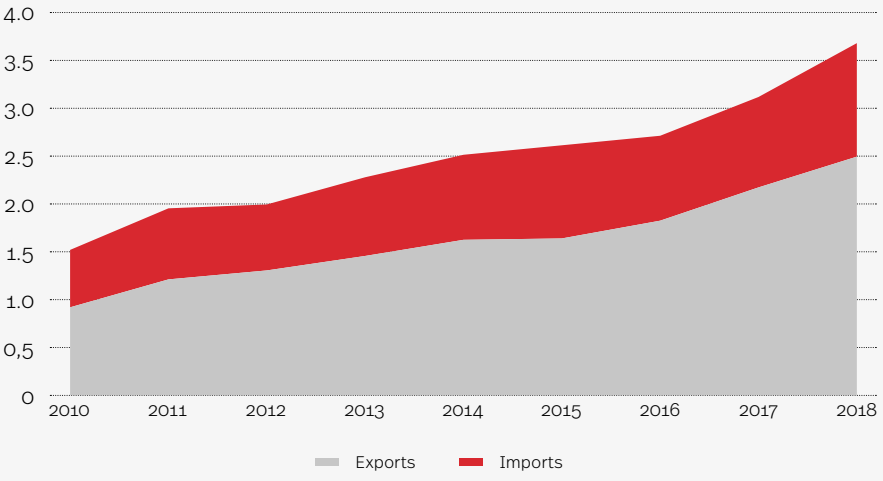
products' weight in Polish exports is much greater; it increased from 8% in 2010 to 10% in 2020. As the 15th largest exporter, Poland is responsible for 2% of global exports of these products.

↘ Chart 22. Poland's trade in goods from the APEC list in 2010-2018 (billions of USD)



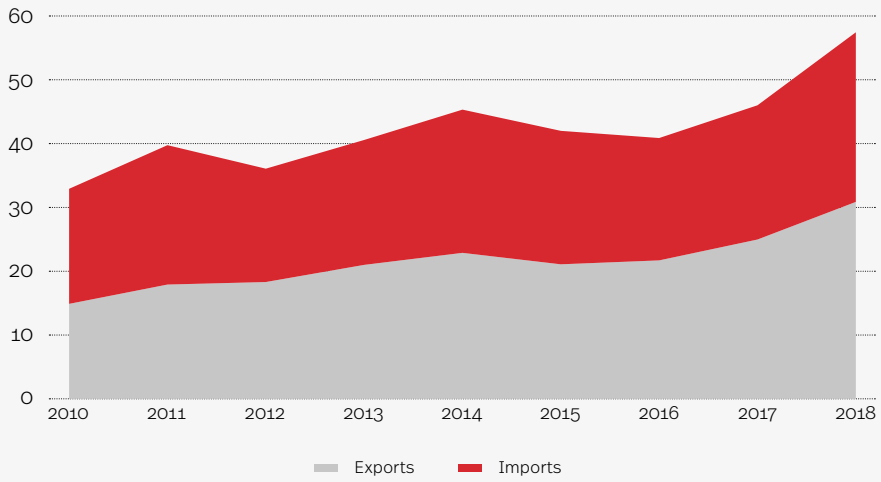
Source: prepared by PEI based on WITS-Comtrade (2020) data.

↘ Chart 23. Poland's trade in goods from the RES list in 2010-2018 (billions of USD)



Source: prepared by PEI based on WITS-Comtrade (2020) data.

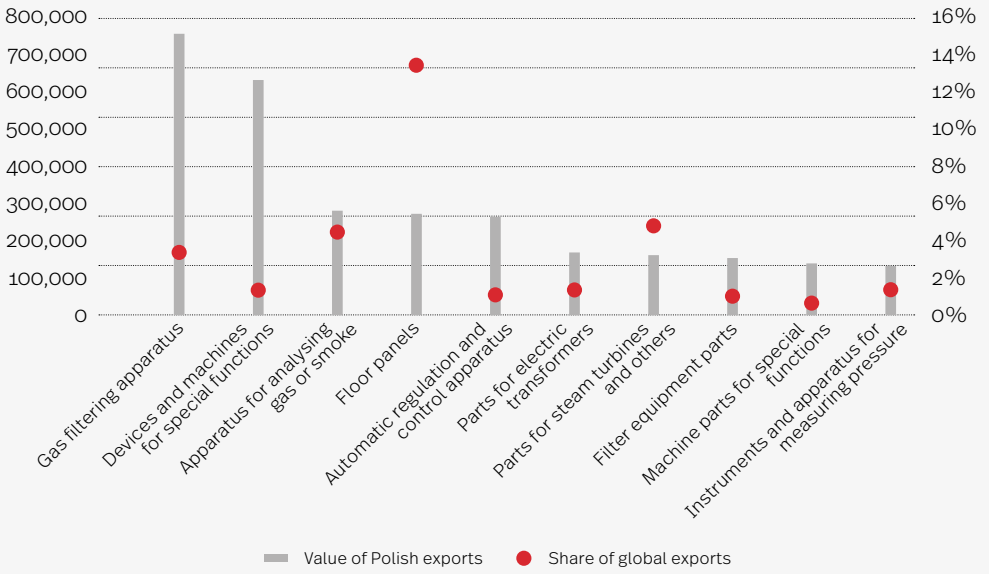
↘ Chart 24. **Poland's trade in goods from the OECD list (billions of USD)**



Source: prepared by PEI based on WITS-Comtrade (2020) data.

Poland has revealed comparative advantages (RCAs) in trade in products from the RES and OECD lists, but not the APEC one, although RCA for all three product lists improved compared to 2010. Analysis of the commodity structure of Polish exports confirms greater competitiveness when it comes to RES and OECD goods. The top Polish export goods on the APEC list are gas filtering devices (code 842139, USD 757 million), waste sorting and compacting devices (code 847989, USD 633 million) and equipment for analysing gas or smoke (code 902710, USD 282 million). The following products had the largest share in global exports: wooden floor panels, whose eco-friendliness is based on the use of bamboo with a shorter renewable cycle (code 441872, 13%), parts for steam turbines and others (code 840690, 5%), and, at 4% each, equipment for analysing gas or smoke, non-electrical devices for heating water, and electric furnaces for the heat treatment of materials.

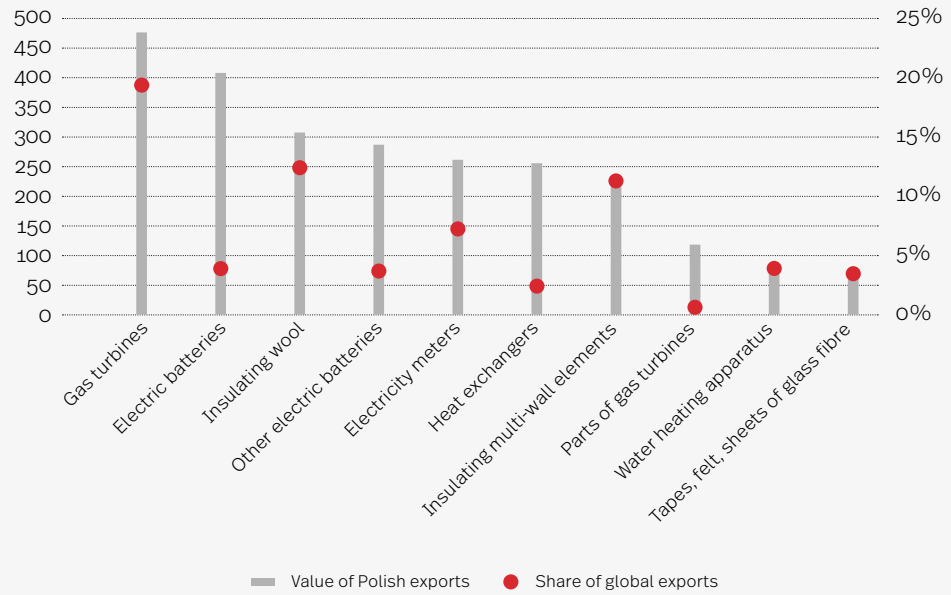
↘ Chart 25. **Polish exports of products on the APEC list in 2018**



Source: prepared by PEI based on WITS-Comtrade (2020) data.

Analysing the Poland's specialness in exports of RES products points to a greater share of the global market, which may be associated with the country's strong revealed comparative advantages that point to these products' high competitiveness in exports. The most important export goods on this list are gas turbines with a capacity of less than or equal to 5,000 kW. In 2018, Poland exported USD 475 million worth of goods of this type, which accounted for 18% of global exports. In terms of value, lead-acid electric batteries (USD 408 million, 4% of global exports) were second and insulating wool – slag, rock and other similar mineral ones – ($ 307 million, 12%) third. Poland also had a significant 11% share of global exports of multi-wall insulating glass (USD 216 million) and a 7% share for electricity meters (USD 261 million).

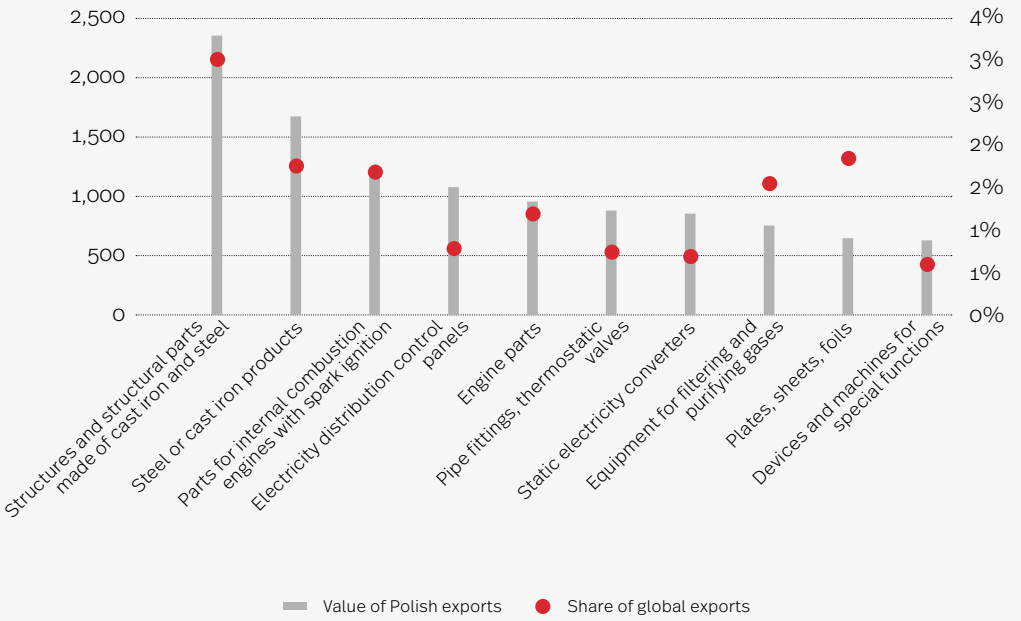
↘ Chart 26. **Polish exports of products on the RES list in 2018**



Source: prepared by PEI based on WITS-Comtrade (2020) data.

For exports of products from the OECD list, of which Poland is the fifth-largest exporter in the EU, other goods were the most important. Structures and structural elements made of cast iron and steel were first (code 730890, USD 2.363 million, 6% of global exports), followed by other steel or cast iron products (code 732690, USD 1.680 million, 4%), and parts for combustion engines with spark ignition (code 840991, USD 1.196 million, 4%). USD 1 billion worth of electric energy distribution control panels (code 853710, USD 1082 million, 2 percent), a global export hit, were exported. In terms of share of global exports, the top products, as in the case of the RES list, are gas turbines (18%), train and tram cars (14%, but an export value of just USD 89 million) and the already-mentioned insulating wools (12%). The commodity structure of Polish exports is slightly more focused on these products compared to that of EU exports. The top seven goods in terms of the value of exports accounted for 35% of exports from Poland. In the case of the EU, this was 25%.

↘ Chart 27. Polish exports of products on the OECD list in 2018



Source: prepared by PEI based on WITS-Comtrade (2020) data.

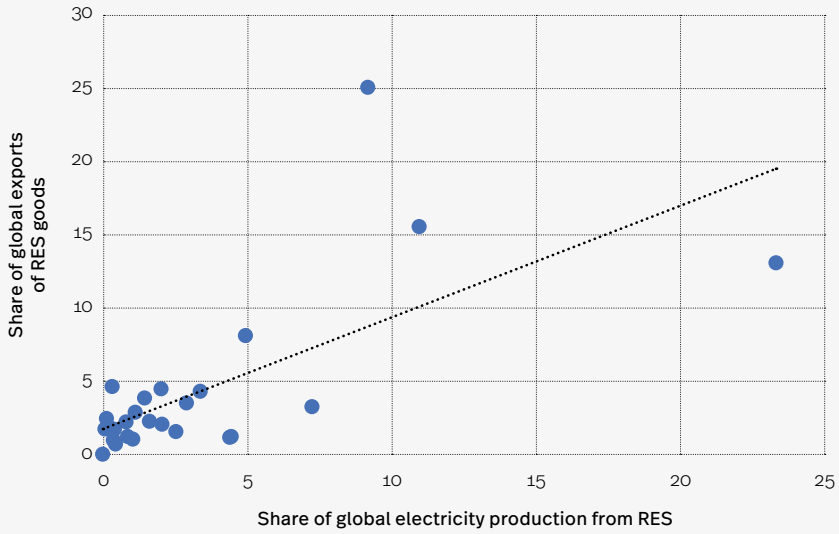
Analysis of the commodity structure of Polish exports points to a lack of unequivocal export hits and quite large differences among the main products, depending on the list selected. **The narrowest collection of RES products shows Poland's effective efforts to build batteries' export potential.** With its growing comparative advantages and the increase in the share of these products in Polish exports, Poland seems ready to attract further investment in environmentally-friendly sectors.

The relationship between electricity production from RES and the value of exports of products from the RES list

The transformation of the energy mix is also conducive to the export of environmentally-friendly goods. There is a correlation between the value of a country's exports from the RES list and production of electricity from renewable sources. We examined the relationship between RES products' share in exports and the share in the global production of electricity from renewable sources. The Pearson correlation coefficient, which checks the relationship between variables, was 0.77 in 2010. The values of the coefficient may range from -1 to 1. Values close to 0 mean no dependence; they closer they are 1 or -1, the stronger the dependence. The more electricity is

produced from renewable sources, the greater the value of exports from the RES list[1]. Of course, this is also related to the size of the economy, which makes it possible to expand the capacity installed in RES. In 2015, these relationships became stronger: the Pearson coefficient was 0.91. These dependencies show that the volume of electricity produced from RES has a positive impact on the development of the green economy in the renewable energy sources segment and, in this case, on the export of RES-related products. Among large economies, the US is an example of lower exports of RES products than the potential resulting from the share of electricity produced from RES. Meanwhile, in 2010, China's share in exports of goods from the RES list was significantly higher than its share in the global production of electricity from RES. However, these imbalances decreased in 2015, when the production of electricity from renewable sources increased significantly in China, while, in the US, the share in the global production of this energy decreased markedly and more than export of related goods.

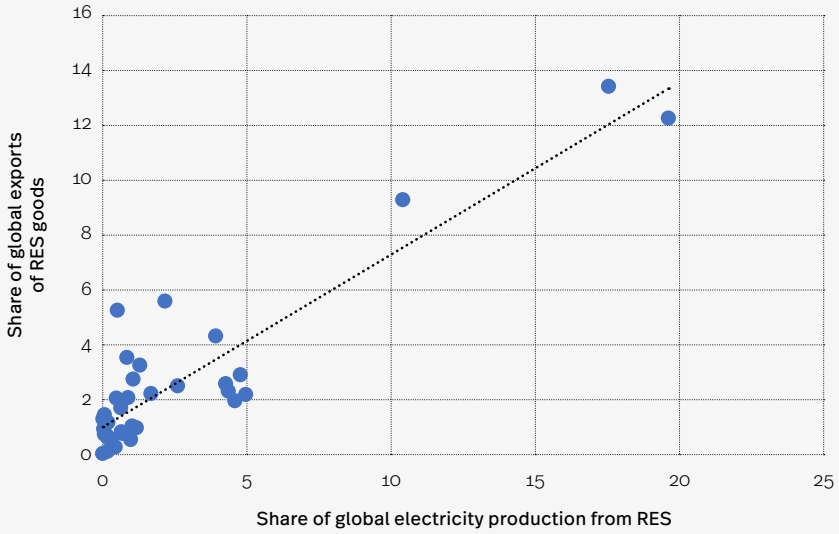
↘ Chart 28. **Ratio between exports of RES goods and electricity produced from RES in 2010 (%)**



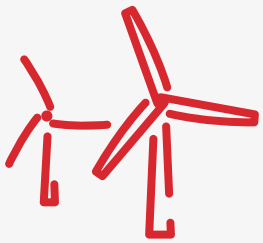
Source: prepared by PEI based on WITS-Comtrade (2020) and World Bank (2020) data

[1] The R-square determination coefficient, which determines the significance of the factor examined in determining the second variable's value, was 0.59, and 0.84 in 2015.

↘ Chart 29. Ratio between exports of RES goods and electricity produced from RES in 2015 (%)



Source: prepared by PEI based on WITS-Comtrade (2020) and World Bank (2020) data.



The importance of the export of "green" products for the economy

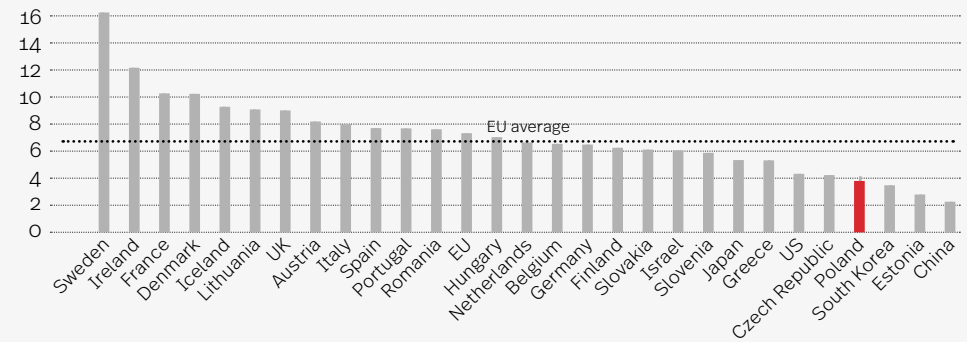
The advantages of "green" sectors in the economy

According to the World Bank, industrial production accounts for up to 16.8% of global GDP. At the same time, the industrial sector is responsible for 24.2% of global CO_2 emissions (Ritchie, Roser, 2018). The aim of climate and environmental protection policy is to reduce the use of natural resources in the production of finished goods; for example, by developing more energy-efficient production processes and reducing greenhouse gas emissions. Working towards this concept requires the involvement of entities at every stage of the production cycle and supply chain. It is worth noting that, in addition, an improvement in resource efficiency can lead to a competitive advantage and sustainable growth.

For the areas in the "green" economy identified earlier, we prepared a summary of green growth indicators (OECD, 2011). Chart 30 presents selected countries' productivity in relation to emissions, expressed as GDP generated per unit of carbon dioxide emitted (USD/kg CO_2). Poland's result is clearly below the EU and Visegrad Group average. The reasons include how Poland has the lowest variation in energy sources in the EU and the lowest share of energy from RES among the V4 countries in 2018.

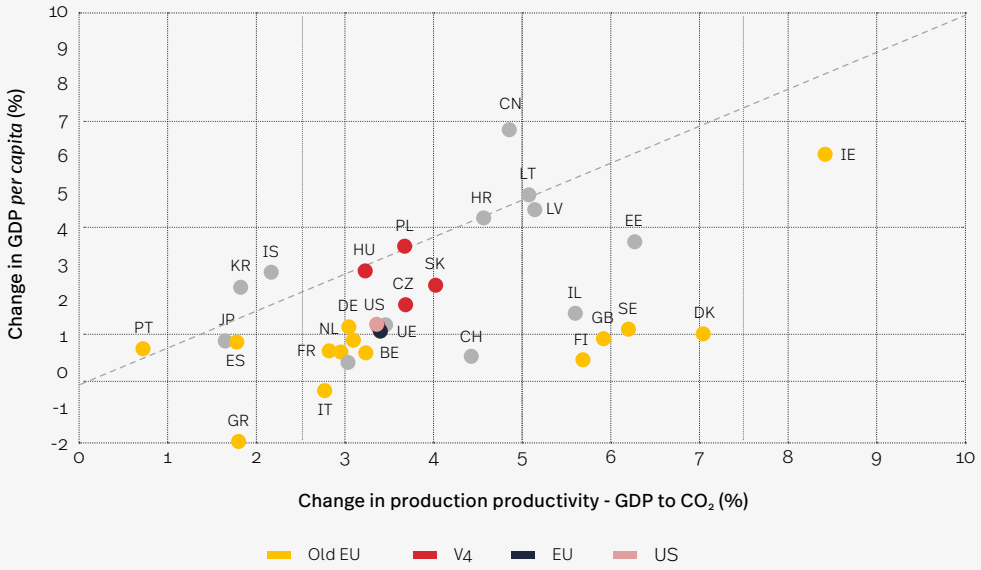
In addition, Poland is characterised by a lack of nuclear energy, as well as lower consumption of hydropower and natural gas (Rokicki, Perkowska, 2020). Among the selected countries, only South Korea, Estonia and China recorded a lower result. Chart 31 shows the ratio between the growth in productivity growth and growth in GDP *per capita* in 2010-2018. Highly developed countries are characterised by a gradually high change in the ratio of GDP to CO_2 with low economic growth. Examples include the Scandinavian countries, where "green" production has developed the fastest, alongside Ireland, Estonia and Israel.

↘ Chart 30. **Productivity per unit of energy-related CO_2 emissions in 2018 (USD/kg CO_2)**



Source: prepared by PEI based on the OECD Green Growth Indicators (2020) database.

↘ Chart 31. Ratio of change in GDP *per capita* to change in productivity per unit of energy-related CO_2 emissions in 2010-2018 (%)



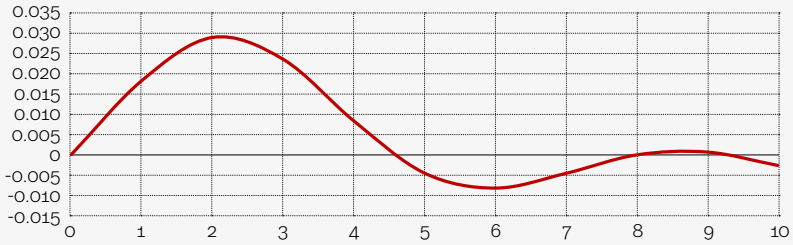
Source: prepared by PIE based on the OECD Green Growth Indicators (2020) database.

Changing how people think about greening the economy requires in-depth analysis of the flow of benefits. According to research into the development of renewable energy and improving energy efficiency, it helps create many more new jobs than the development of the fossil fuel industry – almost three times more per million dollars spent (Garrett-Peltier, 2017). For example, low energy efficiency and the falling price of low-carbon technologies could stimulate changes in the US energy system, which could reduce greenhouse gas emissions in the economy by 80% by 2050 compared to 2015. This scenario also provides for an increase in employment, in which, for 550,000 new jobs, over 75% are in construction and production (Ackerman et al., 2015). Analysis of input-output (I-O) flows for Africa suggests a similar potential for job creation through the development of renewable energy – the implementation ambitious greenhouse gas emission reduction scenarios may be associated with a potentially lower average cost of creating a job (Cantore et al., 2017). Because initiatives concerning policies that reduce greenhouse gas emissions indirectly lead to the creation of a large number of jobs, it is reasonable to view them as potential foundations for the development of industry (UNCTAD, 2019). It is worth remembering that a significant part of the jobs created in the "green" economy are local; in construction, installation and assembly, and in the production of massive components, as in the case of wind turbines, which are too expensive to transport far (MOP, 2018).

The impact of trade in "green" products on macroeconomic indicators

Poland is a country that should support the production of environmentally-friendly technologies and goods. This will help exporters to take greater advantage of "green" trade opportunities. In the long term, this could have tangible benefits for the environment and the economy. The potential impact of trade in *green goods* in Poland was assessed using the impulse response of exports of *green goods* to GDP and the unemployment rate (in Charts 32 and 33, we systematised green products according to the Asia-Pacific Economic Community (APEC) and, in Charts 34 and 35, according to OECD) with the help of the stimulus response function based on the Vector Error Correction Model (VECM) model over a ten-year period. Chart 32 shows the potential impact of green product exports from the APEC list on GDP. The stimulus response function shows that the increase in GDP already occurs one year after a unit increase in the value of green product exports. The impact is highest in the second year. It then declines and is negligible from the fifth year.

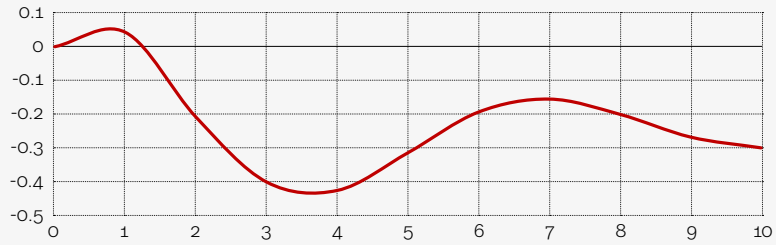
↘ Chart 32. Potential impact of exports of *green goods* on GDP (APEC classification)



Note: the chart shows the impulse response of exports of *green goods* (as classified by the APEC) to GDP and the unemployment rate using the stimulus response function based on the VECM model, assuming three stable cointegrating relationships and one lag order. The impulses are unitary, not cumulative.

Source: prepared by PEI based on OECD data.

↘ Chart 33. Potential impact of exports of *green goods* exports on unemployment (APEC classification)



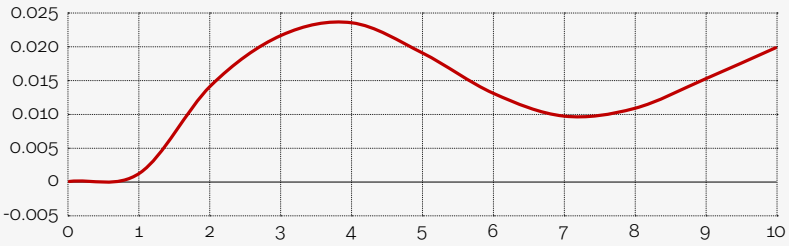
Note: see Chart 32.

Source: prepared by PEI based on OECD data.

Chart 33 shows the impact of exports of green products from the APEC list on unemployment. In the first year, there is a negative reaction to the stimulus. During the remaining period, an increase in exports of green products is associated with an increase in employment; the maximum impulse occurs during the third and fourth year.

Chart 34 shows the impact of exports of green products, as categorised by the OECD, on GDP (the cumulative volume is greater than that for APEC goods). The stimulus response function reaches the highest value in the fourth year and the impact increases again from the seventh year. The impact of the trade of OECD goods on the unemployment rate is similar to that of APEC goods: the situation on the labour market deteriorates in the first year and employment increases in subsequent years. The impulse is the highest in the fourth and fifth years after the increase in exports of green products.

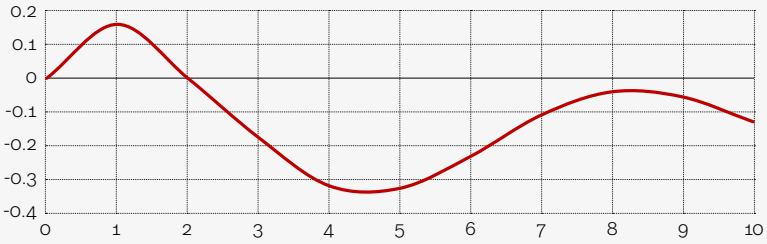
↘ Chart 34. Potential impact of exports of *green goods* on GDP (OECD classification)



Note: the chart shows the impulse response of exports of *green goods* (as classified by the OECD) to GDP and the unemployment rate using the stimulus response function based on the VECM model, assuming three stable cointegrating relationships and one lag order. The impulses are unitary, not cumulative.

Source: prepared by PEI based on OECD data.

↘ Chart 35. Potential impact of exports of *green goods* exports on unemployment (OECD classification)



Note: see Chart 34.

Source: prepared by PEI based on OECD data.

The export of "green" products has a positive effect on two of Poland's basic macroeconomic indicators: GDP and the unemployment rate. By financing trade, Poland should support the production of environmentally-friendly technologies and goods. This can help exporters make greater use of "green" export opportunities, which will lead to tangible environmental and economic benefits in the long run.

Security of supply chains for "green" trade – Rare Earth Elements

The green economy is susceptible to being influenced by political conditions and the availability of raw materials. The technology war between the US and China and limiting access to, for example, CPUs will also affect the environmental and climate sector. Part of the trade in products that limit humans' negative impact on the environment is particularly sensitive to turbulence related to the supply of raw materials. These include products manufactured with the use of Rare Earth Elements (REE), which are used in the fastest-growing fields related to green technologies: when creating solutions in the field of energy, especially wind energy, and in modern energy-saving solutions, such as in the production of LEDs. REE is the collective name for 17 elements. In the context of green technologies, the most important ones used to produce magnets, batteries and catalysts are: neodymium, dysprosium, holmium, praseodymium, lanthanum and cerium. These elements and their alloys are also needed in the electronics (for example, in the production of smartphones) and automotive (for example, in electric cars) industries, as well the precision, optical and defence ones. These industries' growing importance and the technological revolution mean that the demand for REE has been growing very rapidly since 1990.

Deposits of REE are relatively abundant and located in many countries. However, extracting them is a complex process and involves high environmental costs. The extraction and refining process is toxic and the exploitation of these metals, if carried out in an uncontrolled manner, can generate lasting pollution, because strong acids are used at different stages of separation. Moreover, REE are often found with radioactive substances. The cost of securing production in this area can be passed on to the producer – or the natural environment and local communities. As a result, although the supply of REE has been growing for years, it cannot change sharply, which means that their prices are subject to periodic fluctuations.

It is likely that, in the near future, technological changes in the energy sector – the transition from traditional to renewable energy sources and the rising popularity of electric vehicles – will be responsible for the increased demand for REE in an especially clear way. It is estimated that, with the current rate of extraction, the deposits will last for about a hundred years (Zhou, Li, Chen, 2017). According to forecasts published by the European Commission in 2020, the EU will need up to 60 times more lithium and 15 times more cobalt. Meanwhile, "demand for rare earths used in permanent magnets, e.g. for electric vehicles, digital technologies or wind generators, could increase tenfold by 2050" (European Commission, 2020, p. 5).

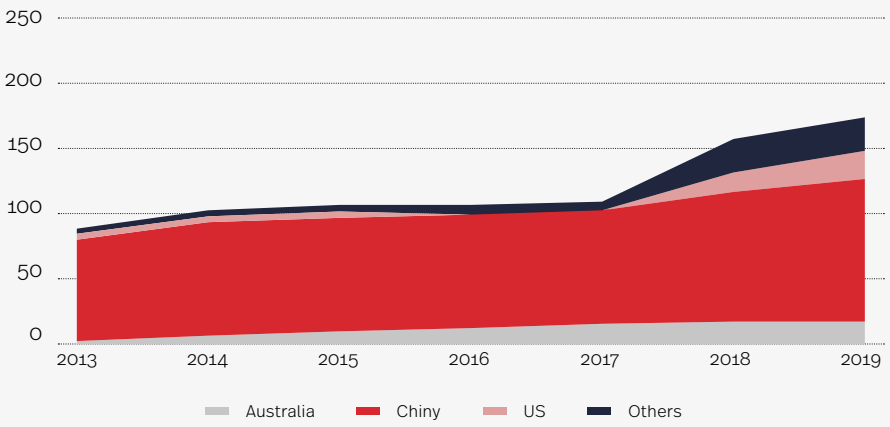
There is a risk that the availability of REE could become a barrier to the development of the electric vehicle market. Its rapid development means that future demand for certain metals (neodymium, dysprosium and praseodymium), which are used in the vast majority of engines

in electric vehicles, may be many times greater than today's production. In addition, the electric vehicle market also needs to compete for access to critical metals with several other applications. This is likely to be a stimulus for the more frequent use of technologies in electric vehicles that do not use REE (such as motors without neodymium magnets).

China's dominant role

The countries that extract the most REE are China, Australia and the US. Before 1990, the main producer of these raw materials was the US, which is currently responsible for a small share of global production. China has maintained its very dominant position since the start of the 21st Century. According to official data, China is currently responsible for over 70% of world production; its actual dominance is likely to be even greater due to the large volume of illegal trade in REE. The EU's dependence on supplies from China is even greater: the country is responsible for 98% of the supply of REE to the EU. The scale of extraction in China is mainly associated with low labour costs and very liberal environmental standards. In addition, Beijing controls most of the world's processing plants, which means that even metals mined elsewhere are sent to China for refining.

↘ Chart 36. **Production of REE in 2010-2019 (thousands of tonnes)**



Source: prepared by PEI based on U.S. Geological Survey.

Such a high concentration of production makes REE particularly vulnerable to supply disruptions. In the past, China has used its dominant position in the REE market as a tool for political pressure. In 2010, due to a territorial dispute with Japan, it limited the export of some raw materials to that country. Although Beijing introduced export quotas for REE, it turned out that the restrictions are often bypassed by producers (www3). Illegal production and smuggling may account for as much as 15-30% of official Chinese production (Hwa Ting, Seaman,

2013). However, these events contributed to a significant increase in prices. In 2014, the WTO found that Beijing had BUS breached free trade rules by introducing export quotas. As a result, China withdrew its restrictions (Gholz, 2014).

China's goal seems to be to expand and serve the domestic manufacturing industry, as well as to attract foreign investors in return for access to REE and other raw materials. The effective use of export quotas by China would give domestic producers of advanced technologies a cost advantage over foreign competitors. Beijing's strategy includes strengthening its position in the renewable energy sector's global value chains. Its clearly dominant position enables China to create problems for individual countries, especially in the short term. A certain barrier to using REE as a long-term tool for putting pressure on others is their fairly common occurrence in various countries. Introducing permanent restrictions would probably lead to investments in new extraction projects and would result in higher prices.

The sudden suspension of Chinese REE exports to Japan in September 2010 opened a new front in the international competition for natural resources and compounded the debate on excessive dependence on suppliers from China. Further stimuli of this type are the US-China trade war and the global trade crisis caused by the COVID-19 pandemic. The fact that REE exports could be used as an argument in the dispute with the US and other countries is visible in the Export Control Law adopted by China in October 2020, which introduces the possibility of banning the export of strategic and advanced technologies to specified foreign companies (www4).

The growing tensions in relations with China and concerns over the resilience of the supply chain in the aftermath of the COVID-19 pandemic have also given a new impetus to American efforts to rebuild its REE production potential, which are important for the US defence industry. On 30 September 2020, Donald Trump signed a decree assuming an increase in the country's production of rare earth minerals critical to military technology, while reducing the country's dependence on China (www5). Joe Biden's election as US president could slightly soften the tone of America's diplomacy towards Beijing, but there is bipartisan agreement in Washington regarding a more assertive policy towards China. Everything indicates that the new administration will continue its efforts to become independent of Chinese supplies in strategic sectors.

The escalation of the trade war with China could disrupt the supply of REE and products made using them to Europe, too. The key role of REE in many goods that can reduce humans' negative environmental impact means that decoupling from China could also hinder the green transformation, as China not only dominates the REE market, but also those of many products made using them due to price competitiveness. The development of low-emission technologies depends to a large extent on the low price of photovoltaic panels, among other things. An increase in the prices of these products will probably mean a slower transition to low-carbon technologies globally.

Security of REE supplies to the EU

Due to political issues, becoming independent from supplies from China is one of the most important goals in the trade policy of both the EU and the US. The growing demand for REE has led to a global search for new sources of these elements, so that supply chains for new technologies can be secured. For years, exploration projects have been carried out around the world (including in Kazakhstan, India, Australia and at the bottom of the Pacific Ocean), which EU countries are involved in, too. Rising labour costs and a growing environmental awareness in Chinese society mean that China is also participating in mining projects in other countries.

It currently seems unlikely that China will impose an embargo on REE exports to the EU. However, cooperation between the EU and the US on an assertive trade policy towards Beijing will leave the EU more exposed the EU to this kind of situation. In a communiqué on resilience when it comes to critical raw materials published in September 2020, the European Commission stressed that Europe should aim for strategic autonomy in the field of REE, and that achieving security requires action to diversify supplies. The challenge, in the context of the EU's efforts to achieve climate neutrality, is to ensure that dependence on fossil fuels purchased mainly from Russia is not replaced by dependence on other raw materials, most of which are obtained in China and that are subject to increasingly clear global competition.

The European Commission's plan provides for efforts to diversify supplies, because – even in the long term – the EU will be forced to acquire raw materials from third countries. From the EU's point of view, it is crucial to ensure unimpeded access to global raw material markets and, for this purpose, develop strategic partnerships with resource-rich countries, such as Australia and Canada. In opting for a green transformation, the EU is also trying to reduce its dependence on REE by introducing solutions that do not require their use in photovoltaic panels, energy storage or wind turbines.

Since REE can be recovered (for example, from waste electronic equipment), the EU should also strive to save resources and introduce a circular economy. Although the EU is focusing on the recycling REE, the percentage of secondary production is currently negligible, mainly due to the complicated technology needed to recover them and the high costs (in the case of some products and elements, major losses of the recovered raw materials are difficult to avoid). However, due to technological progress in the field of REE recycling, the Commission believes that the transition to a circular economy could create 700,000 jobs in the EU by 2030 (European Commission, 2020).

Poland does not have significant deposits of REE but some have been found in the Sudetes and in the Białystok area (Całus Moszko, Białecka, 2012). The most promising development in Poland, in terms of the possibility of obtaining REE, seems to be the deepening of research and the development of technology for recovering lanthanide from used electronic equipment and power plant waste. The waste from hard coal combustion has been found to contain some REE. The dominant ones are: erbium, lanthanum, neodymium and yttrium (Latacz, 2017). However, technology for the efficient recovery of REE from mining waste is still being developed.

Summary

Escalating global trade tensions and the COVID-19 pandemic have left European supply chains vulnerable to threats. This also applies to products that reduce the humans' negative impact on the environment. The Strategic Review developed by the European Commission emphasises that the crisis has created a threat to the further dynamic growth of "green" trade. At the same time, it has highlighted the EU's over-dependence on third countries for the raw materials that are crucial to the technologies needed to achieve climate neutrality. REE, which are key to wind energy and some energy-saving technologies, were identified as the most at risk of interrupted supply chains.

The crisis could be an impulse to transform the economy into a low-carbon and less environmentally harmful one. It is estimated that this will create jobs: 1 million in the EU, according to the European Commission, and 24 million worldwide, according to the International Labour Organization. This will be fostered by the huge EU funds for helping rebuild countries' economies after the pandemic crisis, which are largely geared towards stimulating a "green transition". Moreover, many countries' commitment to achieving climate neutrality by the middle of the century create demand for products linked to renewable energy sources, energy efficiency, emission-free transport and environmental protection. As a result, an increase in the importance of trade in the environmentally-friendly products sector is to be expected.

Poland is in a favourable position for the further development of this sector and an increase in share in the global export of goods linked to the "green" economy. With its strong links in global value chains with Germany, the largest EU exporter of these goods, Poland can benefit indirectly from rising global imports, too. The EU has adopted the most ambitious low-carbon transformation plans in the world. This makes it an attractive market for "green" goods, which Poland can also benefit from. This is already the case in some areas, such as the production of batteries for electric vehicles.

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List of figures and charts

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