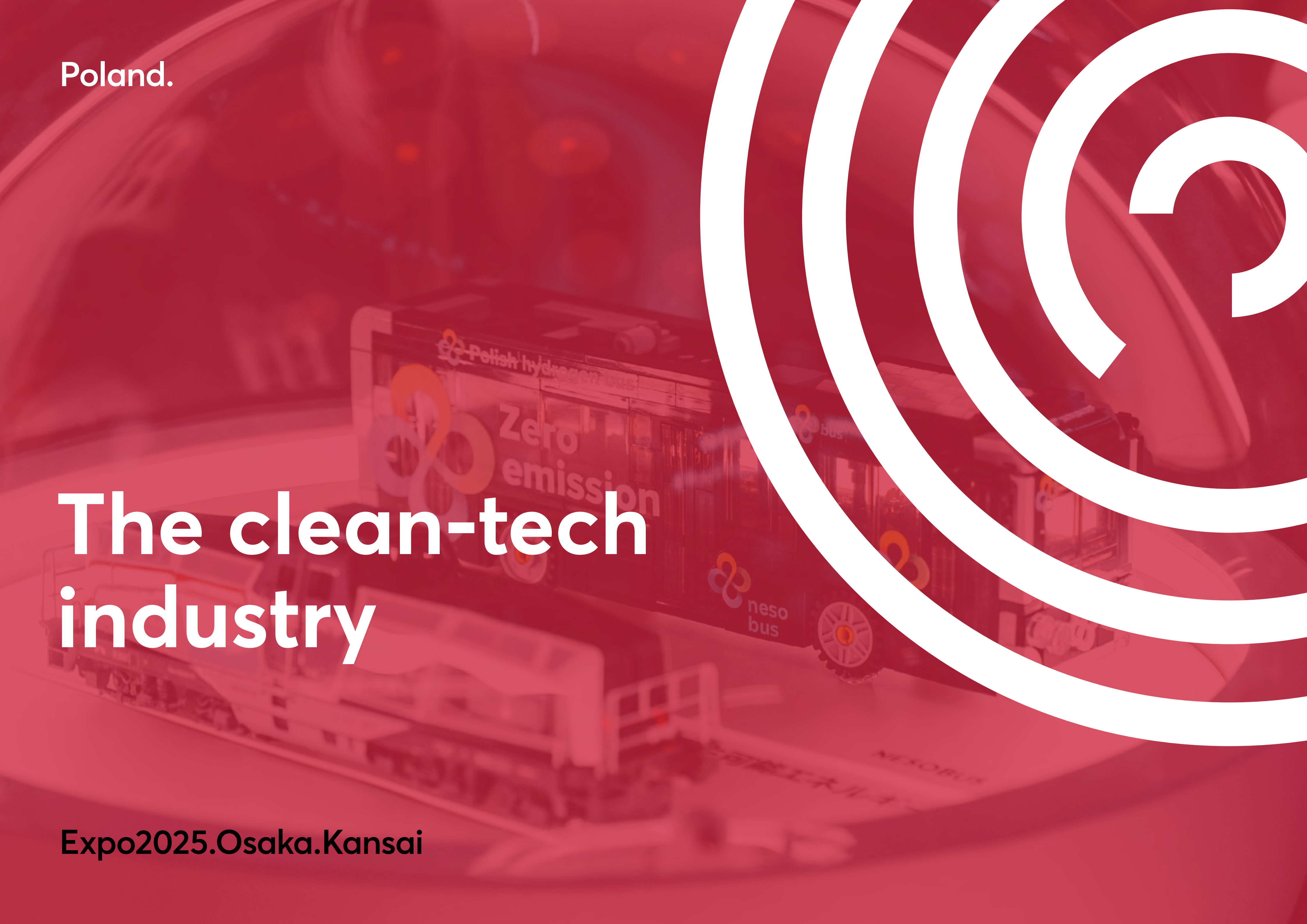
Poland.

The clean-tech industry



Expo2025.Osaka.Kansai

Green technology is an area of prospective technological development for many countries, including Poland. The transformation towards low-carbon economies, as part of the recovery from the crisis caused by the COVID-19 pandemic, will force countries to invest in green technology. As such, "green trade" can be expected to increase in prominence in the coming years. Regardless of how green products are defined, it is estimated that their exports in 2018 amounted to between USD 0.5 and 1.5 trillion and accounted for between 3 and 8% of global exports. The value of green exports increased by 10-32% in the years 2010–2018. At the same time, the dynamics of green exports exceeded the dynamics of world trade during this period – estimated at 24.5%.

With regard to the value of green exports, Poland ranks fifth among EU exporters and fifteenth in the world with a 2% share of global trade. Poland, with a comparative advantage in green exports, has a 24% higher share of these products in Polish exports than their average share in world trade. As for trade in products directly related to the production of electricity from renewable energy sources (RES), their share in Polish exports is 32% higher than their share in global trade. This shows that Poland has the potential to further develop exports in this group of goods.

At the same time, Poland and Japan share ambitious plans to decarbonise their economies, which heavily depend on fossil fuels. As part of its commitment to the United Nations Convention on Climate Change, Japan has pledged to reduce its greenhouse gas (GHG) emissions by 26% by 2030 (compared to 2013). As announced by the Prime Minister in 2020, Japan is expected to become a net-zero economy in terms of GHG emissions by 2050.In turn, Poland, as a member state of the European Union (EU), should reduce net GHG emissions by at least 55% by 2030 compared to 1990 levels. In addition, the European REPower EU introduced in 2022, partly as the Community's response to Russia's aggression against Ukraine, aims to make the EU completely independent of Russian fossil fuels while increasing the pace of the Community's energy transition. The accelerated decarbonisation of European economies is also a result of the directives implemented by the EU. One of the directives, concerning renewable energy (Renewable Energy Directive, RED III), seeks to increase the share of RES in total EU energy consumption to at least 42.5% in 2030 (intended 45%) collectively by all Member States.RED III sets an obligation of 49% target for renewable energy share in buildings. This target is to be achieved by facilitating investment in smaller photovoltaic or heat pump installations. Additionally, to arrive at a more thorough decarbonisation of transport, RED III introduces an obligation to reduce greenhouse gas emissions by 14.5% by 2030 through the use of renewable energy sources in transport. This goal is to be achieved by increasing the share of biofuels and so-called green hydrogen – derived from renewable sources. RED III came into force on 20 November 2023, and Member States have 18 months after the directive's entry into force to transpose its provisions into national law.

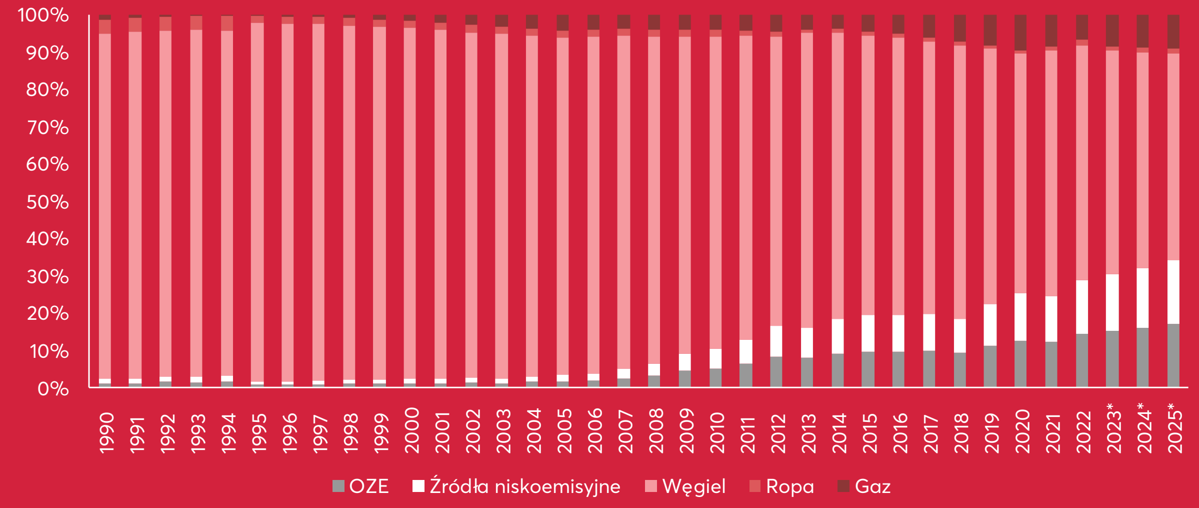
Development of the clean-tech industry in Poland

This section of the chapter aims to present the trends of the clean-tech industry inPoland and Japan in the years 1990–2022, to compare them, and to estimate the possible directions of the clean-tech industry in these countries in the coming years.

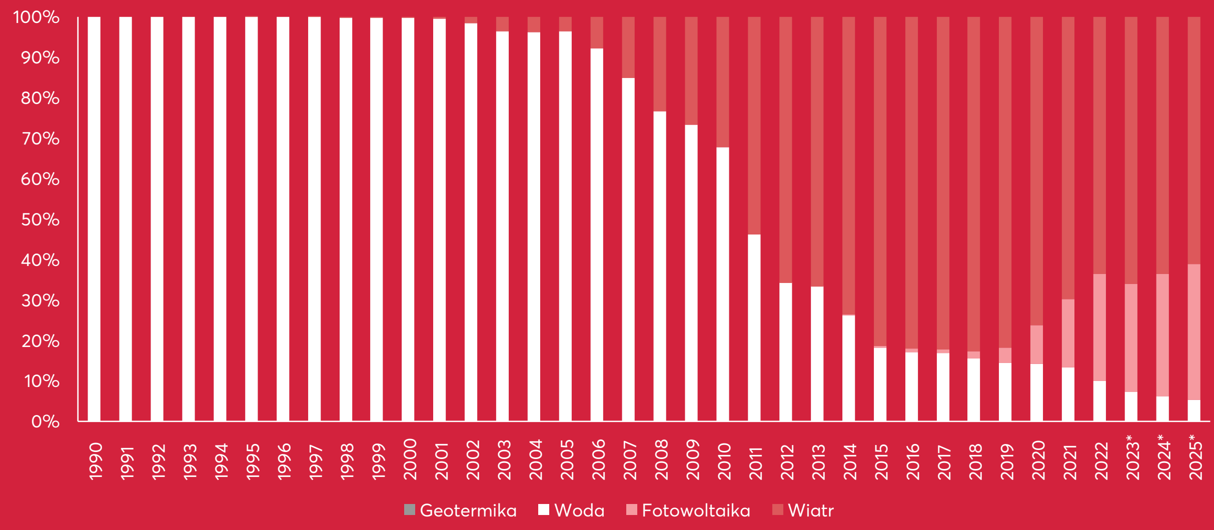
In the years 1990-2022, the share of renewable sources in Poland increased from 1.30% to 16.70%, while the use of fossil fuels as energy sources (i.e., coal – from 93.20% to 73% and oil – from 3.90% to 1.60%) was significantly reduced. An exception to this trend is natural gas, whose share increased from 1.20% to 7.80%.

In Poland, as in Japan, the use of hydro energy for electricity production declined in the years 1990–2022 (especially after around 2008), and the share of wind and solar energy increased

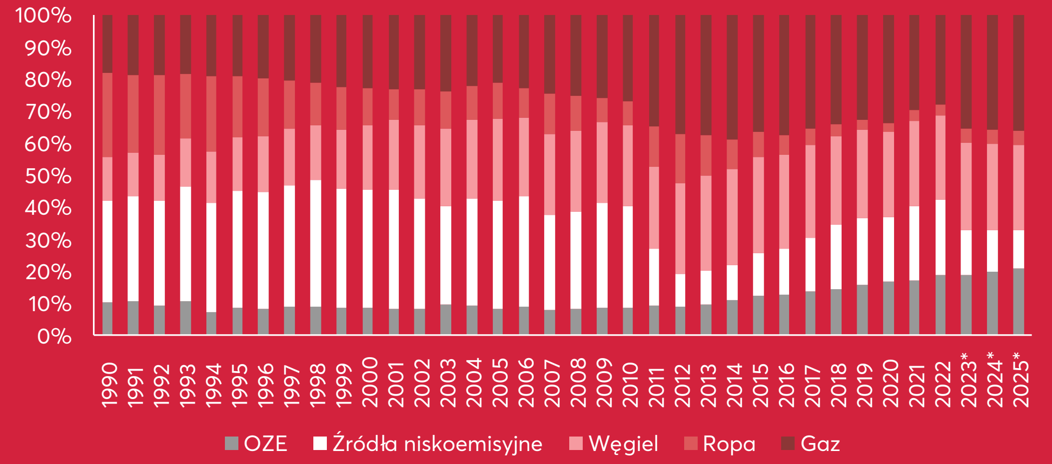
Share (%) of RES, low-carbon sources, and fossil fuels in Poland's energy production in the years 1990–2025 (projected values – * – for the years 2023–2025)



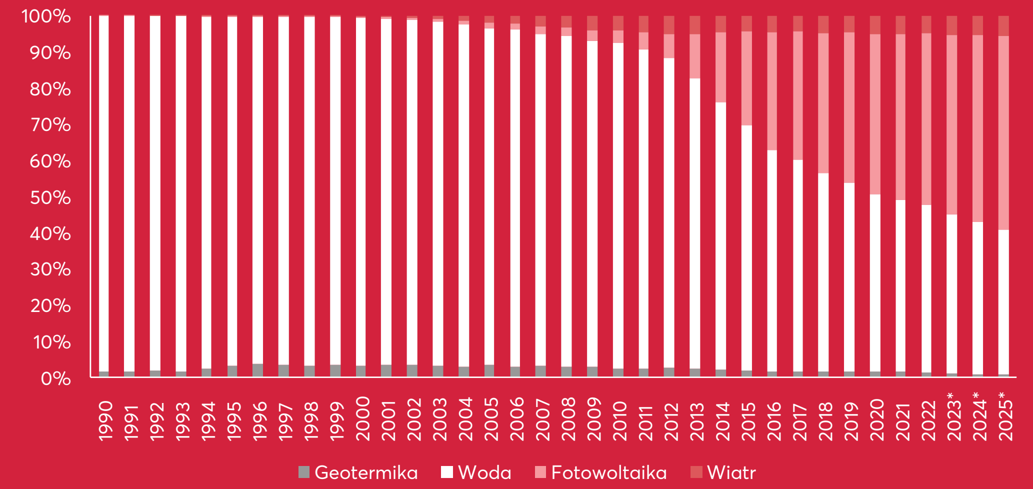
Share (%) of RES in Poland's energy production in the years 1990–2025 (projected values – * – for the years 2023–2025)



Share (%) of RES, low-carbon sources, and fossil fuels in Japan's energy production in the years 1990–2025 (projected values – * – for the years 2023–2025)



Share (%) of RES in Japan's energy production in the years 1990–2025 (projected values – * – for the years 2023–2025)

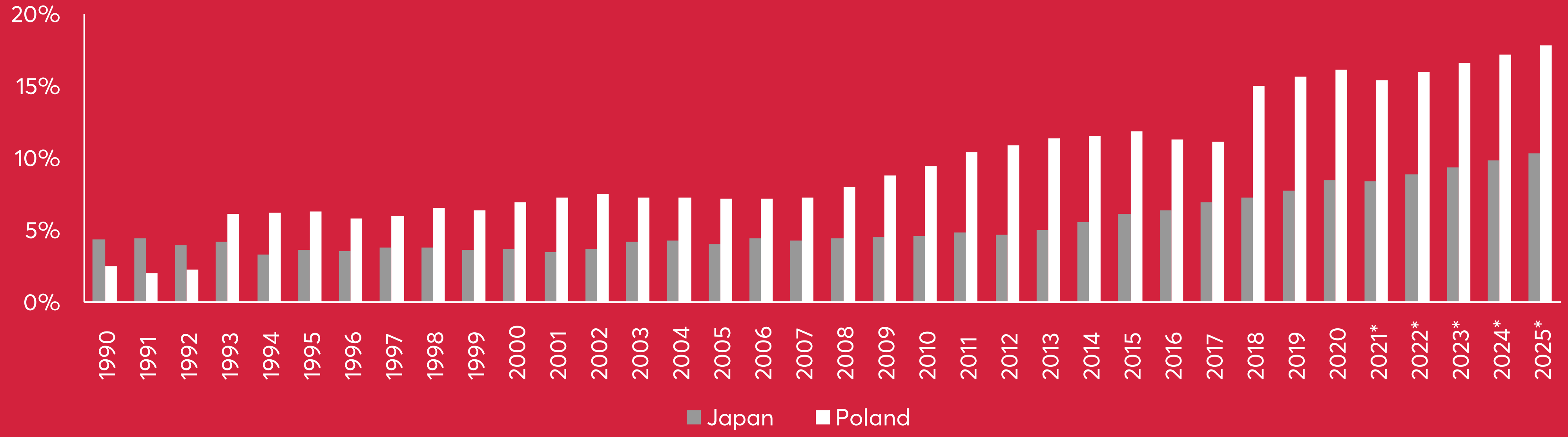


Development of the clean-tech industry in Japan

Japan has a relatively diverse energy mix. Over the 1990–2022 period, in the energy production process, there was a significant increase in the share of gas (from 19.50% to 33.30%), and there were twofold increases in the share of coal (from 14.50% to 30.90%) and renewable sources (from 11.30% to 22.50%). At the same time, the share of low-carbon sources decreased (from 34.70% to 28%), and the use of oil was significantly reduced (from 38.90% to 4%).

The key RES used for electricity production in Japan is water, which has been steadily replaced by photovoltaics and (minimally) wind since around 2012.

Share (%) of RES in energy consumption in Japan and Poland in the years 1990–2025 (projected values – * – for 2021–2025)



Comparative analysis of clean-tech industry development in Poland and Japan

- Both Japan and Poland are increasingly including RES in their energy mix (Graph 5). While in 1990, only 4.33% of the energy used in Japan came from renewable sources, by 2020, this share almost doubled (8.45%).
- An even greater change was recorded in Poland, where renewable energy sources accounted for as much as 16.13% of energy consumption in 2020, more than six times the share recorded 30 years earlier (2.50%).
- The fact that the share of RES in energy consumption is growing in importance much faster in Poland than in Japan is also confirmed by the average annual changes. In Poland, the share of RES in energy consumption grew by an average of 0.40 pp per year between 1990 and 2020, while in Japan, it grew by less than half as much, i.e. by 0.17 pp. This difference, as a result of the compounding percentage, explains the significant variations in the described energy mixes between the analysed economies in 2020.

Growth prospects for the clean-tech industry in Japan and Poland

- Provided that current trends continue, in 2025, Japan – thanks to a significant change in trend in 2012 – will catch up but not overtake Poland in terms of the share in question (10.37% – Japan, 17.83% – Poland
- Although Japan is currently employing RES more intensively in energy production, Poland is making a more dynamic energy transition using RES, as confirmed by projections for the years 2023–2025.
- If the trends observed in the data from 1990 to 2022 continue, photovoltaics will account for more than half of Japan's electricity generation after 2023.
- In Poland, apparent trends suggest that the use of wind and water for electricity generation will steadily (but, in the case of water, more slowly than before) decline in favour of photovoltaics.

Projection of RES shares in the energy mixes of Japan and Poland for the years 2021–2025

Year	1990	...	2020	2021*	2022*	2023*	2024*	2025*	R^2 (%)
Japan	4.33	...	8.45	8.43	8.88	9.36	9.85	10.37	96.24
Poland	2.5	...	16.13	15.4	15.99	16.59	17.20	17.83	90.06

Projection of shares (%) of RES, low-carbon sources, and fossil fuels in energy production in Japan and Poland for the years 2023–2025

	Year	1990	...	2022	2023*	2024*	2025*	R^2 (%)
Japan	RES	11.3	...	22.5	22.33	23.69	25.10	91.96
	Low-carbon sources	34.7	...	28	16.34	15.34	14.34[a]	53.63
	Coal	14.5	...	30.9	32.17	32.22	32.23	95.64
	Oil	28.9	...	4	5.35	5.30	5.29	95.64
	Gas	19.5	...	33.3	41.79	42.60	43.42[b]	79.03
Poland	RES	1.3	...	16.7	17.69	18.96	20.28	96.79
	Low-carbon sources	1.3	...	16.7	17.69	18.96	20.28	96.79
	Coal	93.2	...	73	69.9946	68.06	66.06	98.35
	Oil	3.9	...	1.6	1.4381	1.496	1.560	78.25
	Gas	1.2	...	7.8	9.7647	10.27	10.79	90.46

a Value underestimated due to the trend reversal to an upward trend in 2012. b Value overestimated due to the trend reversal to a downward trend in 2014.

Projection of shares (%) of RES used for electricity production in Japan and Poland for the years 2023–2025

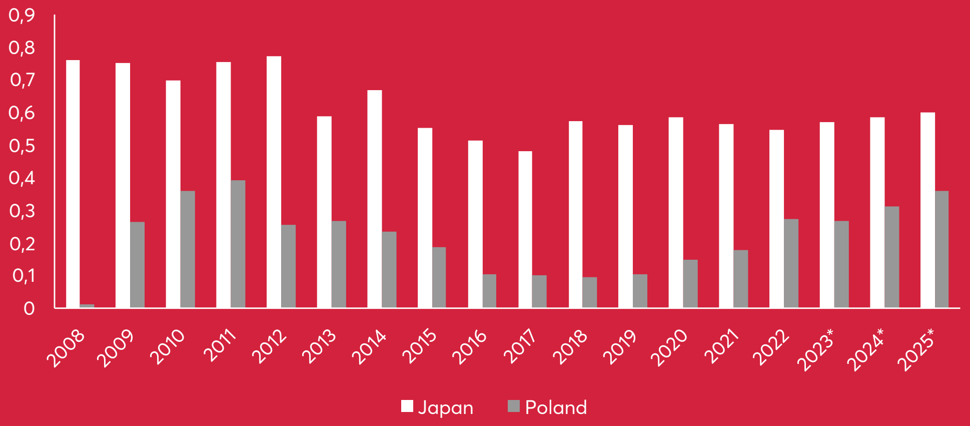
	Year	1990	...	2022	2023*	2024*	2025*	R^2 (%)
Japan	Geothermal source	1.76%	...	1.48%	1.11%	1.00%	0.90%a	28.70
	Water	98.17%	...	46.44%	44.11%	42.02%	40.04%	21.52b
	Photovoltaics	0.07%	...	47.29%	49.46%	51.59%	53.61%	94.20
	Wind	0.00%	...	4.79%	5.31%	5.39%	5.46%	94.20
Poland	Geothermal source	–	...	–	–	–	–	–
	Water	100.00%	...	9.86%	7.28%	6.21%	5.33%	51.70
	Photovoltaics	0.00%	...	26.58%	26.66%	30.27%	33.51%	89.39
	Wind	0.00%	...	63.55%	66.06%	63.52%	61.16%	96.71

a Value underestimated due to trend reversal in the last years of the analysis.

b The low value of the determination coefficient is due to the very high dynamics of the process in question, which is moving in a relatively stable sideways trend.

– No data available.

Expenditure (per 1,000 units of GDP) on energy R&D in Japan and Poland for the years 1990–2025 (projected values – * – for the years 2023–2025)



Projection of expenditure (per 1,000 units of GDP) on energy R&D in Japan and Poland for the years 2023–2025

Year	2008	...	2022	2023*	2024*	2025*	R2
Japan	0.76	...	0.55	0.57	0.58	0.60	72.38
Poland	0.01	...	0.27	0.27	0.31	0.36	62.55[a]

[a] Projection based on the years 2009–2022 due to the very low and forecast-distorting value recorded in 2008.

Development trends in the clean-tech industry and the potential for developing cooperation between Poland and Japan

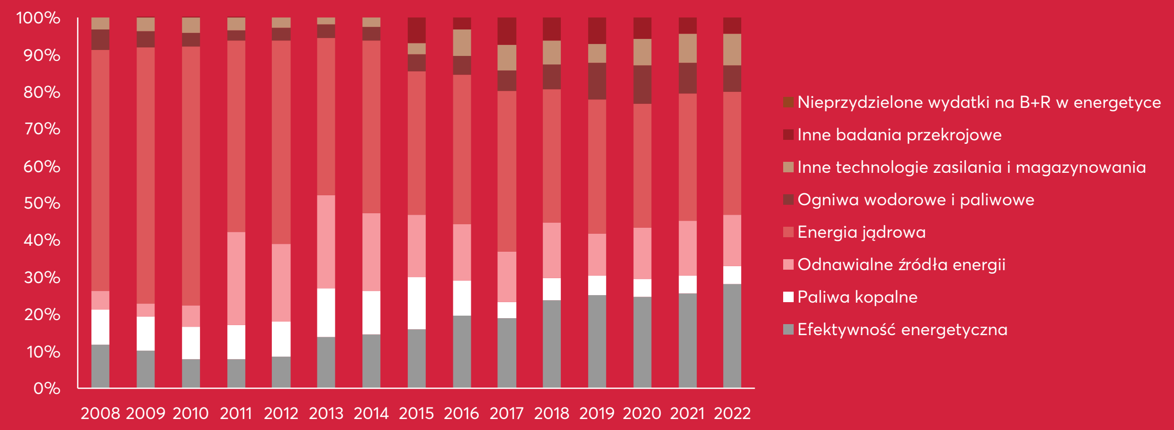
In both Japan and Poland, the energy R&D budget as a proportion of GDP in the years 2008–2022 resembles a parabolaIt is very interesting to observe that for both economies, the turning point was in 2017/2018. While it is Japan that spent more (in relation to GDP) on energy R&D over the entire period under review, it is Poland's budget that had a much faster growth rate. If the observed trends continue, the level of energy R&D expenditure in Poland will surpass the one in Japan in 2030/2031.

When it comes to the energy R&D budget allocation in Japan, the key expenditure category has continually been nuclear power (65.21% in 2008 and 33.20% in 2022), which is successively being pushed out by investments in other areas – primarily general energy efficiency (11.70% and 28%, respectively) and RES (5.01% and 13.81%, respectively). Fossil fuels have been steadily losing importance (2008 – 9.45%; 2022 – 5.01%). In the analysis of the above changes, it is important to note that for some categories, key tipping points were observed, with shifts in fund allocation policy. For example, the share of fossil fuels in the budget in question fell significantly between 2015 and 2017 (from 13.94% to 4.50%), followed by a stabilisation lasting until 2022. R&D related to renewable energy sources started to grow in importance from the perspective of this budget in Japan in the years 2020–2011 (jumping from 5.88% to 25.07%), but just two years later, the share of funding allocated to this category started to decline.

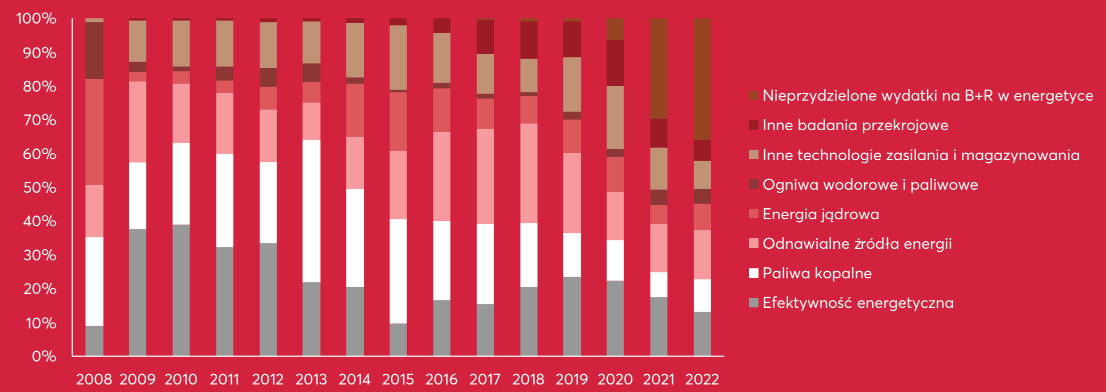
In the case of Poland, the share of fossil fuels in the analysed budget was reduced by more than half during the period under review (from 26.48% in 2008 to 9.72% in 2022), but nuclear energy lost its importance to a greater extent (falling from 31.48% to 7.73%) Compared to the above changes, the share of RES in the R&D budget fell slightly (i.e. from 15.26% to 15.58%). The category that saw the largest increase (from 0% in 2008 all the way up to 35.85% in 2022) was the unallocated R&D expenditure in energy.

As in the case of Japan, specific turning points regarding the allocation of the energy R&D budget can also be identified in Poland. For fossil fuels, such a turning point occurred after 2013 (from 42.05% to 7.44% in 2021 and to 9.72% in 2022), when the share of funds allocated to RES significantly increased (from 11.13% to 29.46% in 2018). Unfortunately, after 2018, R&D in the field of renewable energy sources lost ground from a funding allocation perspective (decline and subsequent stabilisation of the share in question to 14.38% in 2020). The above examples suggest that energy R&D in Japan and Poland tend to be characterised by short-term spurts that do not necessarily continue in subsequent years.

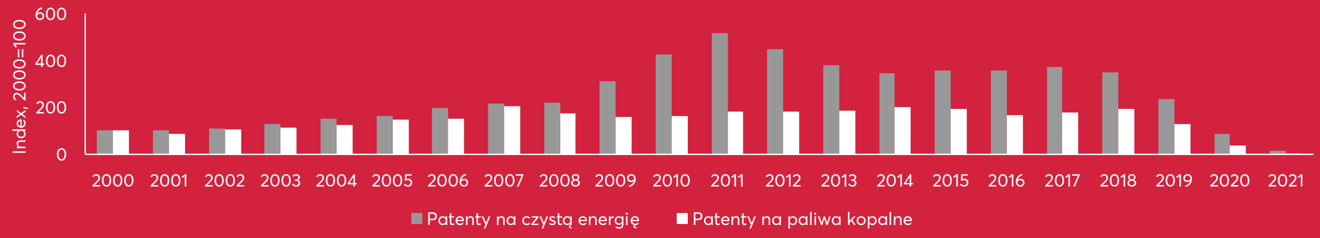
Share (%) of R&D budget by technology group in Japan for the years 2008–2022



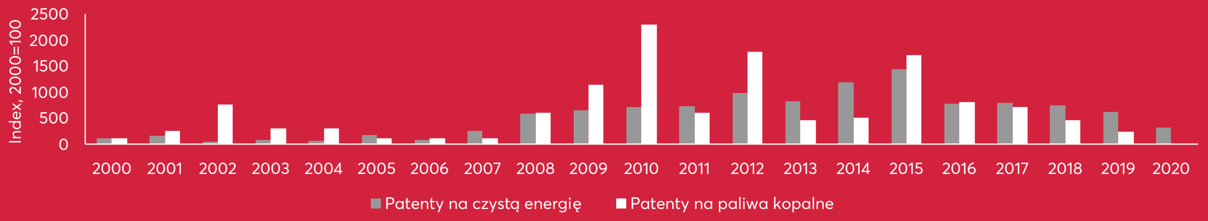
Share (%) of R&D budget by technology group in Poland for the years 2008–2022



Patent dynamics in the fields of clean energy and fossil fuels in Japan in the years 2000–2021 (index, 2000=100)



Patent dynamics in the fields of clean energy and fossil fuels in Poland in the years 2000–2020 (index, 2000=100)



Poland is more dynamic than Japan when it comes to fossil fuel patents and patents in the field of clean energy.On the other hand, while fossil fuel patents prevail in the case of Poland, activity in the area of clean energy patents is definitely at the forefront in the case of Japan.

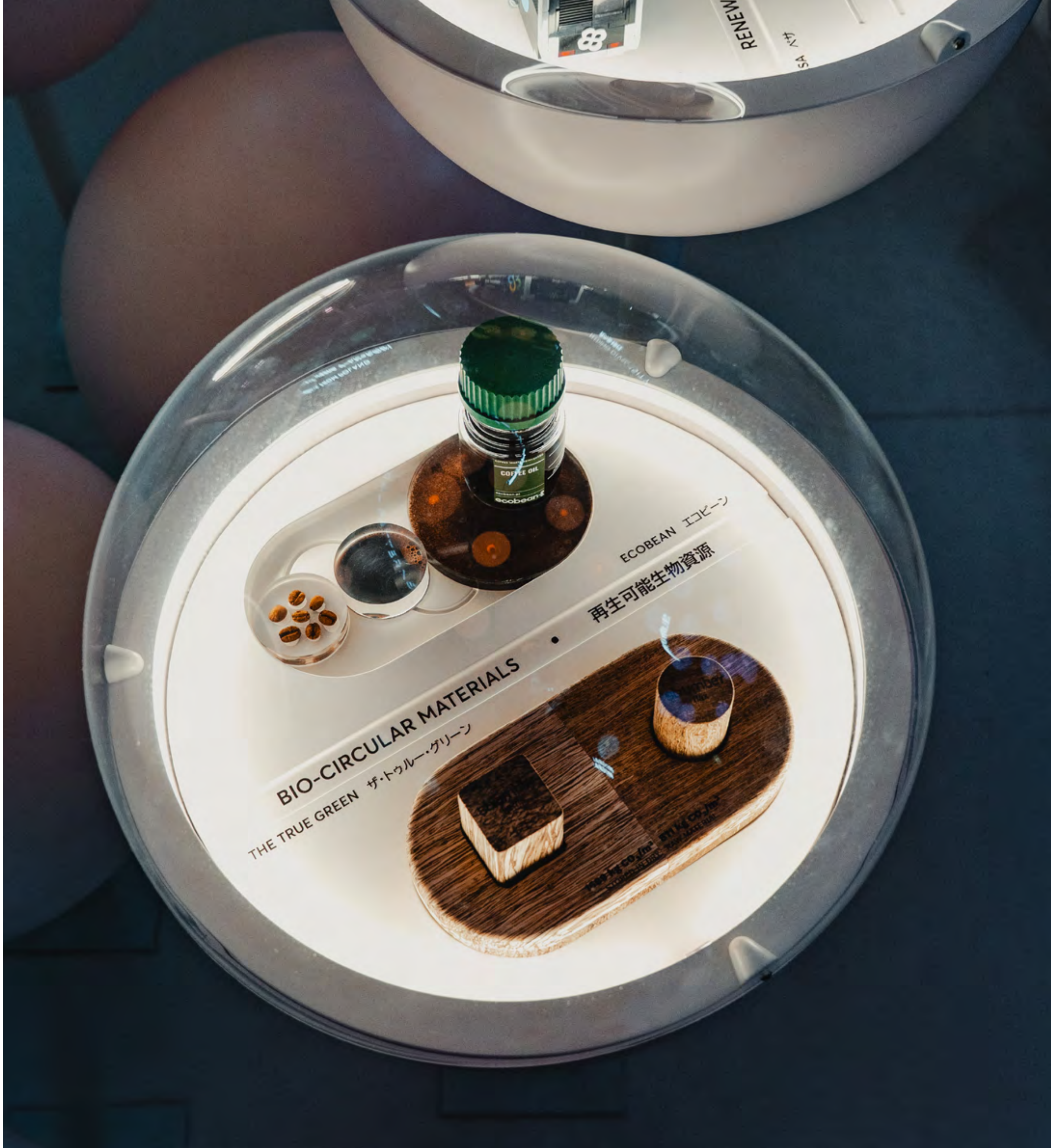
Polish companies in the broadly defined green technology sector are present in the Japanese market in diverse forms, ranging from the presence of a locally branded product with Japanese distributors to maintaining the company's representation in Japan.

Looking ahead to the next few years, the Japanese market, particularly for the green technology industry, may prove to be promising not only because of its conditions regarding the need for decarbonisation, but above all because of the EU-Japan Green Alliance established in 2021. It is an initiative that is based on five areas of cooperation between the EU and Japan. They concern cooperation at political, business and research levels in the fields of RES, hydrogen, the circular economy, and others. The programme is expected to start operating in the third quarter of 2024. Such an initiative creates a favourable climate for bilateral clean-tech ventures.

A directory of Polish companies already partially present in the Japanese market or that are potential "candidates" for overseas expansion is provided below. The main criteria for selecting companies for the directory included the uniqueness of their technology, as well as the company's international experience to date. Some of the companies shown in Table are winners of Greenevo's Green Technology Accelerator competitions, such as Seedia, Symbiona, the Institute of Power Engineering – National Research Institute, Asket, Dagas, Prote, Izodom 2000, System 3E, Ekoenergetyka polska [Polish ecoenergetics] and PPHU Agata. Other companies such as Anwil, Azoty and ORLEN are some of the largest producers of (grey) hydrogen in Poland, while also possessing significant know-how in chemical synthesis.

The group of companies with unique technologies/ products includes hiPower Energy, Hydrogenium Prosta Spółka Akcyjna [Joint Stock Company], PAK-PCE Polski Autobus Wodorowy [the Polish Hydrogen Bus], Asket, Dagas, Prote, Izodom 2000, System 3E, Ekoenergetyka polska [Polish ecoenergetics] and PPHU Agata. Some of these companies already have experience in expanding into foreign markets (including Asia) and some combine Asian and Polish know-how (hiPower Energy and Hydrogenium Prosta Spółka Akcyjna [Joint Stock Company]).

In addition, research and development institutions with a significant track record in green technology are highlighted in the compilation. This group includes the Institute of Power Engineering – National Research Institute and the New Chemical Synthesis Institute (in Puławy). The first institution has developed an innovative method of generating hydrogen or electricity/thermal energy, recognised in the Greenevo Green Technology Accelerator. The aforementioned solid-oxide electrochemical cell stack technology enables the generation of electricity, heat or hydrogen. The technology is characterised by high efficiency and a wide range of industrial applications (including transport, chemicals, petrochemicals, and electricity). The second institution is assessed by experts as having the world's greatest know-how in the synthesis of green ammonia. Both institutes therefore have significant potential for R&D cooperation.



Selected Polish green technology companies in Japan – incumbents and potential investor

No.	Company	Area of activity	Exports – geographical destinations (continents/countries)	Foreign representation
Companies present in various forms in Japan				
1	**Hynfra** sp. zoo ul. Smolna 40 00-375 Warsaw	Developer of integrated green hydrogen projects	A broad spectrum of cooperation in the region of North Africa, Asia (including Japan), Middle East, Europe	Foreign representation in Japan: Hynfra Japan Representative Office 1-24-1301 Higashihakushimacho Nakaku Hiroshima 730-0004 Japan
2	**PESA** S.A. Pojazdy Szynowe Pesa Bydgoszcz S.A. ul. Zygmunta Augusta 11 85-082 Bydgoszcz	Rail transport – SM42 6Dn hydrogen locomotive (Non-carbon hydrogen shunting locomotive)	Bulgaria, Kazakhstan, Lithuania, Germany, Czech Republic, , Romania, Ukraine, Italy	
3	**Saule** Technologies S.A. ul. Danish 11 54-427 Wrocław	Renewable energy sources – perovskite cells	Japan, among others	Japanese investor: H.I.S (Hideo Sawada) Securing the entire supply chain from foreign partners. An international team of staff/engineers (from Korea, Malaysia, UK, Singapore and Japan).
4	**Seedia** sp. zoo ul. Stork 22 31-231 Kraków	RES – solar urban furniture	Saudi Arabia, Greece, Spain, Canada, Moldova, Monaco, United Kingdom	Cooperation with a distributor in Japan
5	**Symbiona** sp. zoo ul. Agatowa 12 03-680 Warsaw	Circular economy	Africa, South-East Asia, Middle East, Europe (including Hungary)	Foreign offices: - Malaysia: Symbion APAC Sdn. Bhd. 6th Floor, Block A, Kelana Centre Point, Jalan SS7/19, 47301 Petaling Jaya Selangor, Malaysia - UK: Symbiona UK Ltd. 71-75 Shelton Street, Covent Garden, London United Kingdom WC2H 9JQ Tel. +44 20 80 770 980

Potential investors in the Japanese market

Hydrogen technologies

6	**Anwil** S.A. (ORLEN Group) ul. Toruńska 222 87-805 Włocławek	Chemical synthesis know-how	Austria, Belgium, , Croatia, Denmark, Estonia, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Portugal, Czech Republic, Romania, Slovakia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom	
7	**Azoty (Group)** Grupa Azoty S.A. ul. Eugeniusza Kwiatkowskiego 8 33-101 Tarnów	Chemical synthesis know-how	Europe (including Belgium, France Germany, United Kingdom, Czech Republic, Italy), South America, Asia	Collaboration with: COMPO EXPERT GmbH Krögerweg 10, 48155 Münster, Germany
8	**hiPower Energy** S.A. ul. Marszałkowska 111 00-102 Warsaw	Hydrogen technologies, including Europe's first hydrogen recycling dedicated to semiconductor manufacturing	Philippines, Malaysia, Taiwan	
9	**Hydrogenium Prosta** S.A. ul. Gliniana 5/35 20-616 Lublin	Innovative plasma biomass gasification technology for biohydrogen production		
10	**Institute of Power Engineering – National Research Institute** ul. Mory 8 01-330 Warsaw	Solid oxide electrochemical cell (SOC) stack as a device for hydrogen or electricity generation (R&D)	International cooperation within research networks and programmes, international projects (e.g. Horizon 2020)	Presence at international events as part of the Greenevo competition
11	**New Chemical Synthesis Institute Łukasiewicz Research Network – New Chemical Synthesis Institute** al. Tysiąclecia Państwa Polskiego 13A 24-110 Puławy	(Advanced) Know-how in the synthesis of green ammonia (R&D)	Implementation of research/development results in Denmark, Lithuania, the Netherlands, Hungary, among others. In addition, the Institute is part of the Łukasiewicz Research Network – one of the largest research networks in Europe.	
12	**ORLEN** S.A. ul. Chemists 7 09-411 Płock	Experience and R&D in hydrogen projects	Austria, Belgium, Bulgaria, France, Germany, Hungary, Italy, Latvia, Lithuania, Spain, Czech Republic, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine.	Orlen Lietuva AB | Orlen Baltics Retail AB Orlen Unipetrol Slovakia | Orlen Unipetrol A.S. Orlen Unipetrol Rpa S.R.O | Orlen Unipetrol Doprava S.R.O. Orlen Asfalt Ceska Republika S.R.O. Unipetrol Rpa Hungary Kft.
13	**PAK-PCE Polski Autobus Wodorowy** Sp. z o.o. ul. 45 Kazimierska Street 62-510 Konin	Hydrogen bus (Nesobus)		

Circular economy				
14	**Asket** ul. Forteczna 12a 61-362 Poznań	Technology for converting local biomass (straw, hay, etc.) into high-quality fuel briquettes	Africa, Australia, Asia, Europe	Distribution with foreign partners: - Finland: Ab Integrado Oy - Romania: Panagroteh Service SRL - Serbia: Agrogas d.o.o. - Sweden: Glommers Miljöenergi AB - Ukraine: AmeliArt Ukraine - Hungary: Erdogepker Kft.
15	**Dagas** sp. z o.o. ul. Gośniewska 46 05-660 Warka	Wastewater treatment technology (plus other green technologies)	Asia	
16	**PROTE Technologies for the Environment** Sp. z o.o. ul. Franciszka Firlika 26 60-692 Poznań	Technology for biomonitoring water	Lithuania, Moldova, Oman	
Ecoconstruction				
17	**Izodom 2000 Polska** sp. z o.o. ul. Ceramic 2A 98-220 Zduńska Wola	Construction technology for passive and highly energy-efficient buildings using foamed plastic formwork	Austria, Belgium, Bosnia and Herzegovina, Denmark, Estonia, France, Latvia, Luxembourg, Czech Republic, Russia, Romania, Slovakia, United Kingdom	
18	**System 3E** S.A. ul. Rondo ONZ 1 00-124 Warsaw	Wall construction system for all types of buildings without mortar and insulation	Asia	
Other green technologies				
19	**Ekoenergetyka Polska** S.A. ul. Nowy Kisielin – Rozwojowa 7A 66-002 Zielona Góra	Charging stations for electric cars (also plug-in hybrids), research and development into the use of hydrogen in transport	France, Germany	Regional representative/distributor in Albania, Austria, Bosnia and Herzegovina, Belgium, Bulgaria, Croatia, Montenegro, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Iceland, Italy, Latvia, Lithuania, Luxembourg, North Macedonia, Moldova, Monaco, the Netherlands, Norway, Portugal, Romania, Serbia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom.
20	**PPHU Agata** Kuczki Kolonia 11 26-634 Gózd	Technology for hydrodynamic coating of dusty surfaces with a flexible, reinforced liquid coating.		

The Polish Investment and Trade Agency

The Polish Investment and Trade Agency's mission as a Government Agency is:

- To enable small-and medium-sized companies to reach their full potential in exporting their products and services around the world
- To support potential investors in Poland by providing comprehensive and up-to-date information services regarding legal and tax aspects, location and human capital, as well as on the available financial incentives
- To promote 'Poland as a Brand'

How we can help

The Agency's experienced team of experts with a hands-on approach and excellent understanding of the needs of entrepreneurs will ensure that your projects will move as fast and smooth as possible.
www.paih.gov.pl

Poland at Expo 2025 Osaka, Kansai

The Polish Investment and Trade Agency is the institution responsible for preparing Poland's presence at the World Expo 2025 Osaka, Kansai. The Agency carries out this task under the supervision of the Ministry of Economic Development and Technology.
www.expo.gov.pl