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The green transition in the shadow of the war

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Key numbers

41%

increase in the period of 2018-2022 of the EU target for the share of energy from RES in gross final energy consumption in the EU in 2030 (raised from 32% to 45%)

EUR 288 billion

amount needed to carry out additional investments as part of REPowerEU plan in the run-up to 2030

EUR 100 billion

EU's potential annual savings if it stops using Russian fuels completely

315%

increase in TTF gas prices in Q2 and Q3 2022, compared to the same period in 2021

34.5 TWh (12%)

increase in electricity production at coal-fired power plants in the EU in the first three quarters of 2022, compared to the same period in 2021. In Poland there was 6% decrease.

56.5 TWh (13.3%)

increase in energy produced from RES (photovoltaics, wind energy, biomass) in the EU in the first three quarters of 2022 compared to the same period in 2021

59 TWh (22%) and 24.3 TWh (50%)

decrease in energy produced at nuclear power plants in France and Germany respectively in the first three quarters of 2022 compared to the same period in 2021

Key findings

- **The EU was largely dependent on energy commodity imports from Russia.** 44% of coal, 45% of natural gas and 25% of oil imported by the EU in 2020 came from this country. Russia's invasion of Ukraine and manipulations on commodity markets contributed to the sharp increase in the prices of energy raw materials. In the Fit for 55 package and proposed energy transition model, natural gas was meant to serve as a transition fuel. However, with the escalation of the war in Ukraine and the difficult situation on energy markets, this model is changing. On 18 May 2022, the European Commission published REPowerEU plan, which assumes a departure from Russian gas, diversifying gas supplies, increasing energy production from RES, and the development of the hydrogen and biofuel market.

- **In the first three quarters of 2022, EU countries increase energy production from hard coal by 17.2 TWh (13%) compared to the same period in 2021.** The largest increase took place in Germany – 11.9 TWh (35%), Italy – 6.29 TWh (70%) and Spain – 3.21 TWh (102%). **In contrast, Poland decreased energy production from hard coal by 3.5 TWh (-6%). Energy production from RES rose too, especially in the case of** solar energy – 29.5 TWh (27%) and onshore wind farms – 26 TWh (11%). **In the case of nuclear power, energy production fell by 84 TWh (16%) despite the crisis on European energy markets.** This was primarily the result of nuclear power plant shutdowns in Germany and France.

- **In this policy paper, we consider four scenarios of the impact of the war and energy crisis on EU climate policy.** "Fast and furious to Fit for 55", assumes the acceleration of the energy transition and the toughening of climate targets. In the next scenario, "Green reengineering", policy-makers will accelerate the process of issuing permits for investments in RES, thereby increasing installed capacity, while member states continue to move away from fossil fuels. In the "Climate Compromise" scenario, we assume that EU member states will decide to temporarily return to coal and nuclear power to balance the system, but that the climate targets will be maintained. The "Coal Strikes Back" scenario assumes the suspension or abandonment of climate targets and a long-term return to producing energy from coal. The final scenario, The first and fourth scenario are the least likely and could damage the EU’s cohesion. Based on the possibility of these four scenarios being implemented, we present joint recommendations for EU policy in response to the war in Ukraine and the energy crisis triggered by Russia. The actions we propose have three different time horizons:

- short term – the upcoming heating season, the winter of 2022. Key actions will focus on ensuring energy security during the approaching winter by filling gas storage facilities, improving energy efficiency, diversifying fossil fuel supplies, and continuing to produce energy from coal and nuclear power;
- medium term – the next three years. Key actions will focus on developing RES technology and energy storage, further improvement of energy efficiency, diversification of fossil fuel supplies, and starting talks on a departure from the policy of closing nuclear power plants, and even building new units;
- long term – more than three years. Further development of RES and energy storage, investment in hydrogen technology and infrastructure.

Introduction

Russia's invasion of Ukraine and the prospect of a long-term energy crisis (rising commodity prices and the risk of problems balancing European power systems) are forcing Europe to rethink the direction of its energy transition. In this policy paper, we analyse four scenarios for the EU's climate policy, including the fate of the Fit for 55 package. In the first chapter, we discuss the EU's climate targets. In the second, we focus on plans and changes in the main trends in climate policy triggered by the war. In the third, we present the scenarios, followed by SWOT analysis and recommendations for EU countries.

The emissivity of gas is half that of coal (KOBiZE, 2021), which is why it was treated as a good transition fuel that would ensure the green transition's stability. The relatively low emission of greenhouse gases and lower emission of pollutants in the combustion process meant that, for years, natural gas was seen as the optimal transition fuel during the transition in Europe's energy sector. This increased the EU's dependence on Russian gas. According to Eurostat, in 2014-2021, the EU's gas imports rose by almost 13%. According to ENTSOG data, exports of Russian gas via pipelines grew by at least 9% over this period, increasing European companies' and economies' dependence on the Russian fuel. Russia's invasion of Ukraine has led to changes in the EU's approach to the security of commodity supplies and the energy transition. Russia's manipulations, including restricting gas supplies and not filling Gazprom's storage facilities, and the hot summer contributed to the increase in energy commodity prices on international markets. In addition, the EU decided to broaden its economic sanctions significantly to limit Russia's budget revenues and prevent it from further financing the war. The import of Russian coal, oil and all its components was banned, subject to certain transition periods (EC, 2022). The limited supply of commodities further pushed up gas prices. At their peak in August 2022, they reached over EUR 340/MWh, 20 times the average price in 2016-2019, leading to sharp increases in households' and companies' bills.

In the report, we analysed four scenarios outlining possible changes in EU climate policy:

- **"Coal Strikes Back"** assumes the suspension or abandonment of climate targets (the existing targets are potentially maintained, but merely declarative and not enforced), a return to generating energy from coal, and focusing by member states on their own, individual interests.
- **"Climate Compromise"** describes a situation in which member states decide to temporarily return to generating energy from coal and nuclear power to balance the system. The climate targets are maintained.

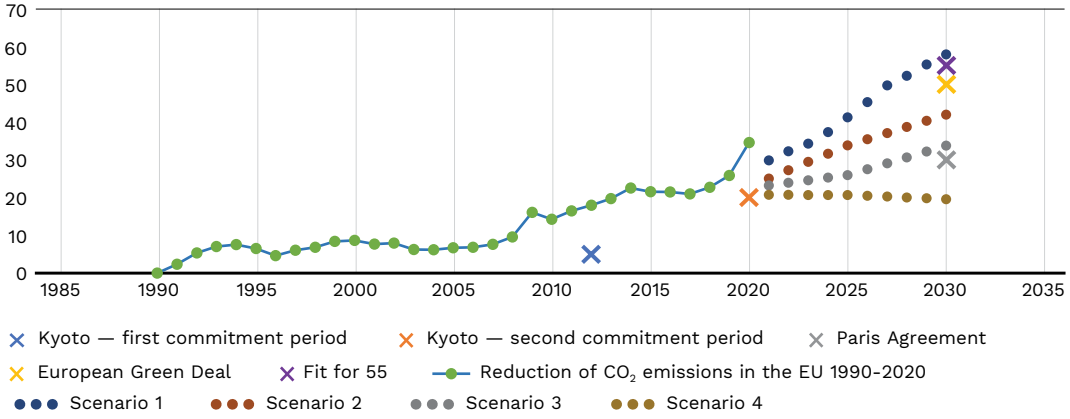
- **In the "Green reengineering"** scenario – like in the second one – the climate targets remain unchanged. The EU focuses on improving the efficiency of the legal side by accelerating the process of issuing permits to invest in RES and reducing the red tape in the investment process.
- **"Fast and furious to Fit For 55"** assumes the acceleration of the energy transition, more ambitious climate targets and increasing energy production from RES.

The climate targets before the war and after the announcement of REPowerEU

On 14 July 2021, the European Commission announced the Fit for 55 package, a collection of legal acts that create a coherent legislative framework for the climate targets in the European Green Deal. The package's main objective is to reduce CO_2 emissions by 55% compared to 1990 (EC, 2022). This is an intermediate target on the path to climate neutrality by 2050. Reducing emissions affects most areas of the economy, including electricity, heating, agriculture, forestry, construction and industry.

The first plan to reduce greenhouse gas emissions in the EU was agreed on in 1997 with the adoption of the Kyoto Protocol. It sought to reduce CO_2 emissions by 5% in 2008-2012. Then, during the second commitment period of the protocol (2013-2020), the target was increased to 20%. At the same time, most countries in South America, Africa and Asia did not adopt any binding targets. Research organisations, including the Intergovernmental Panel on Climate Change (IPCC), warned of the advancing climate change and highlighted the need for further actions to reduce CO_2 emissions. The Paris Agreement – the first ever universal and legally binding climate deal – was adopted in December 2015. It included the following target: reducing CO_2 emissions by 40% compared to 1990 by 2030 (www5). Every five years, the parties need to present updated national emission reduction plans. In 2020, the EU exceeded the reduction target set for that year, reducing emissions by 34%. This result was affected by the COVID-19 pandemic, during which energy production fell sharply by 7% and transport emission intensity by almost 12%. The 2020 commitment to reduce emissions by 55% was inscribed in the European Green Deal and Fit for 55 package the following year.

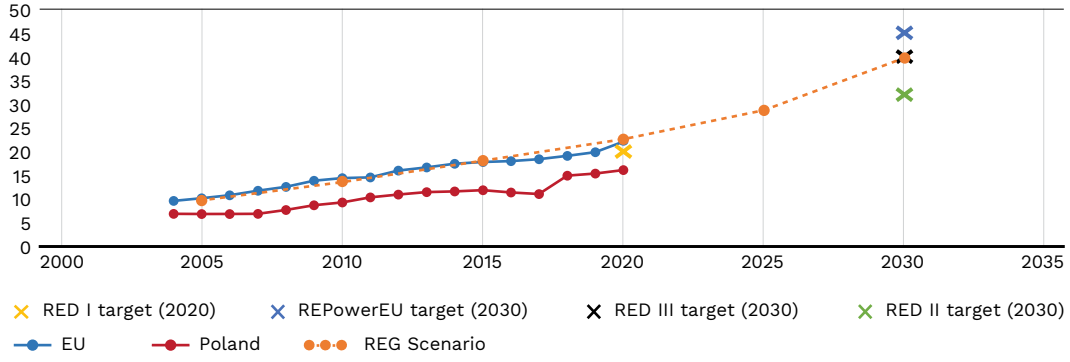
Chart 1. The EU is not yet on its way to meeting the "Fit for 55" targets
Reduction in CO_2 emissions and reduction targets in 1990-2030 (%)



Source: prepared by PEI based on European Commission data and scenarios developed by Climate Action Tracker.

The energy sector's transition is a key step in the process of reducing greenhouse gas emissions. In REPowerEU plan, the European Commission proposed to increase the share of RES in 2030 from the 40% proposed in the Fit for 55 package to 45%. Initially, the target for 2030 in the revision of the RED Directive in 2018 was 32%. Meanwhile, the much less ambitious target for 2020 set in 2007 – a 20% share of RES – was achieved in the past year and amounted to around 22%.

Chart 2. The share of RES in 2030 is meant to amount to 40%, according to "Fit for 55"
Share of RES in gross final energy consumption in 2004-2030 (%)



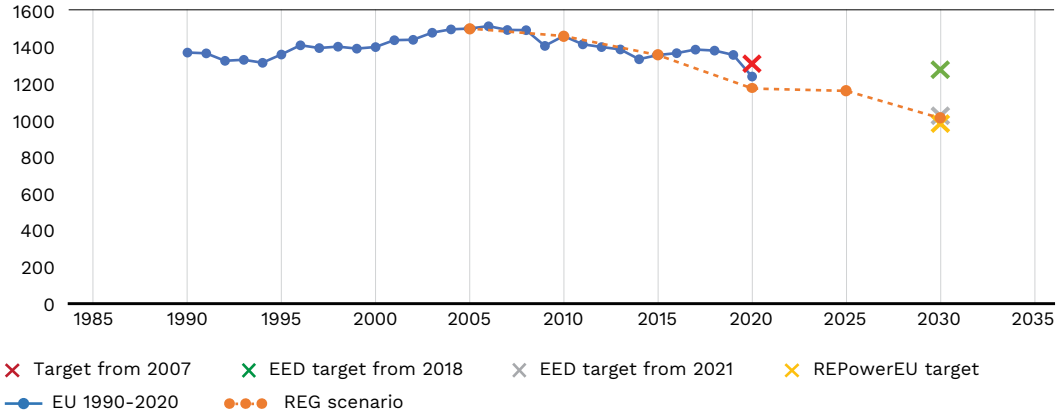
Note: The REG scenario, developed by the EC, assumes intensified energy policies to meet the objectives of the European Green Deal in the absence of a separate EU ETS for buildings and transport.

Source: prepared by PEI based on European Commission data.

The EU has been reducing energy consumption since 2007, when the first energy consumption reduction target was set out in the climate and energy package (the "3x20" package). The Commission introduced the following target: a 20% improvement in energy efficiency. Energy consumption in the EU decreased in 2007-2014, but increased in 2014-2017 due to good economic performance, low oil prices and colder winters. High economic activity, fuelled by low commodity prices, has increased emissions' intensity. In addition, hot summers and cold winters have forced households and businesses to consume more energy through the increased use of air conditioning and heating systems.

As part of the 2018 revision of the energy efficiency directive, the reduction target for primary energy – that is, energy obtained directly from natural resources – for 2030 was raised to 32.5%, which corresponds to reducing consumption to 1,273 Mtoe (EC, 2021). Due to the solutions implemented and the COVID-19 pandemic, energy consumption decreased to 1236 Mtoe in 2020 (EC, 2021), which enabled the EU to achieve the target set for 2020. In 2021, as part of the Fit for 55 package, the Commission proposed to increase the target again to 39%; that is, 1023 Mtoe. The directive will include an increase in the energy saving target and a reduction in energy consumption in the public sector; that is, in the areas of transport, buildings and street lighting. In May 2022, in the REPowerEU plan, the Commission proposed to increase the energy efficiency target for 2030 to 980 Mtoe (EC, 2021).

Chart 3. The EU has been reducing energy consumption since 2007
Primary energy consumption reduction targets (Mtoe) in 1990-2030



Note: The REG scenario, developed by the EC, assumes intensified energy policies to meet the objectives of the European Green Deal in the absence of a separate EU ETS for buildings and transport.

Source: prepared by PEI based on European Commission data.

The climate policy model in the face of the Russian invasion

Challenges

In 2020, the EU was 25% dependent on energy commodity supplies from Russia (Lipiński, Maj, Miniszewski, 2022). Replacing such a significant amount of raw materials requires global changes in value chains and the EU's energy system. The REPowerEU plan is the Commission's response to the conflict in Ukraine and the need to end the EU's dependence on Russian fuels. The plan covers four main areas: diversifying supplies, developing the biofuel and hydrogen market, improving energy efficiency, and developing RES.

Ensuring that there are enough energy commodities for the approaching heating season is one of the key challenges for countries in the EU. The EU is 83.5% dependent on gas imports (Ambroziak, Arak, Baszczak et al., 2022). In 2020, 44% of coal, 45% of natural gas and 25% of oil imported by the EU came from Russia (Lipiński, Maj, Miniszewski, 2022). In 2021, natural gas consumption within the EU grew by 4.3% compared to 2020, and imports from Russia amounted to 155 billion m^3, around 45% of total imports (Ambroziak, Arak, Baszczak et al., 2022). According to the Commission's calculations, the REPowerEU plan will enable the EU to do without 110 billion m^3 of gas, around 71% of the gas imported from Russia by the EU in 2021 (EC, 2022a). To secure enough gas before the winter, in the REPowerEU plan, the Commission introduced a minimum level at which gas storage facilities must be filled by 1 November 2022 of 80%. At the same time, an EU Energy Platform, which will enable voluntary joint purchases of gas, LNG and hydrogen by member states, was established.

The target of a 45% share of RES in gross final energy consumption in the REPowerEU plan means that the EU must ensure that it has enough raw materials to produce, assemble and operate the equipment used in low-emission energy sources. Producing wind turbines, solar panels and batteries requires raw materials that have been classified as critical for the development of the EU economy (including chromium, magnesium, niobium, borate, rare earth metals, germanium, cobalt and indium). For the 11 raw materials listed, the EU's dependence on imports exceeds 85%. For example, 93% of magnesium and 99% of rare earth metals are imported from China, and 98%

of borate from Turkey (Ambroziak, Arak, Baszczak et al., 2022). In addition, the Commission estimates that the demand for critical raw materials will continue to grow: by 2030, the demand for lithium and cobalt, which are needed for battery production, may increase 18-fold and fivefold, respectively. With the high dependence on imports of critical raw materials and high concentration of supplies, there is a risk of disruptions and the energy transition being delayed (Ambroziak, Arak, Baszczak et al., 2022).

The Commission estimates that EUR 288 billion will be required by 2030 to carry out investments as part of the REPowerEU plan, including EUR 113 billion for investments in RES and hydrogen infrastructure, EUR 56 billion for improving energy efficiency, EUR 41 billion for modernising industry, EUR 37 billion for biomethane production, EUR 29 billion for modernising the power grid, and EUR 12 billion for infrastructure for gas transmission and ensuring oil deliveries. At the same time, the Commission estimates that the departure from Russian fuels will provide savings of around EUR 100 billion per year (EC, 2022a).

Dominant trends

REPowerEU is the EU's response to the Russian invasion of Ukraine and destabilisation of the commodity market. The plan assumes an acceleration of the energy transition towards green sources of energy, which will enable a faster departure from fossil fuels, make it easier for the EU to end its dependence on Russian fuels and, with time, lower electricity prices. Solar energy is meant to be the main technology due to its short installation time and the ability to rapidly increase installed capacity. As part of its Solar Strategy, the Commission has set a target of increasing installed capacity in solar panels to around 320 GW by 2025 and to 592 GW by 2030 (EC, 2022a) (an over fourfold increase compared to 2020). According to the Commission's calculations, to achieve this target, 45 GW need to be installed per year, on average (EC, 2022a).

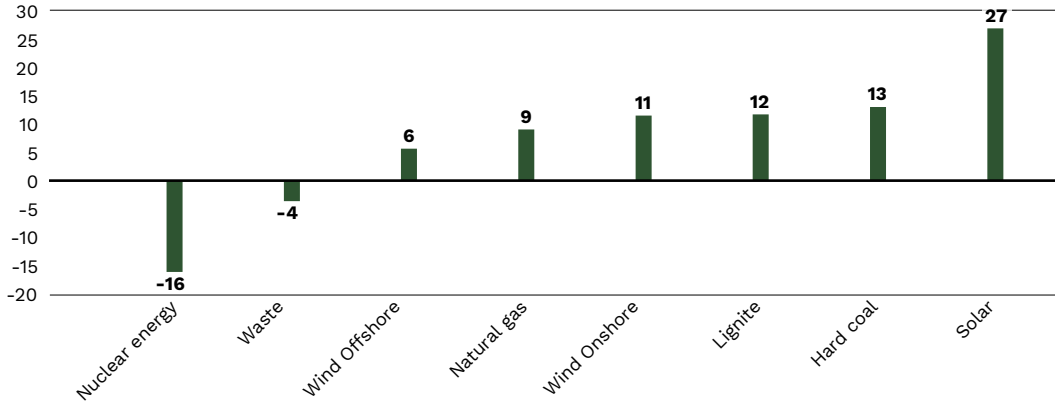
Box 1. Europe is accelerating solar power development

The European Solar Rooftops Initiative makes it mandatory to install PV panels on the roofs of all residential buildings by 2029 and all existing public and commercial buildings with a floor area of over 250 m^2 by 2027. At the same time, the EU proposes to reduce the time it takes to issue permits for rooftop solar installations to one month (3 months in REPowerEU plan).

Reducing energy use is the cheapest way to become less dependent on Russian fuels. The EU proposes to increase energy savings through short-term changes in consumer behaviour, such as lowering indoor temperatures in the winter, reducing the use of air conditioning, turning off unnecessary lighting, and use of public transport. At the same time, the EU is urging member states to launch information campaigns targeting industry and households to encourage energy savings. The Commission estimates that the introduction of these solutions would reduce the demand for oil and gas by 5% (EC, 2022a).

On 20 July 2022, the Commission proposed an emergency "Save Gas for a Safe Winter" plan, referring to the complete cutoff of Europe from Russian gas. The plan's main component is a proposal to reduce gas consumption in member states by 15% by 2023, compared to the average for 2016-2021. In addition to short-term behavioural changes, including reducing the heating temperature in buildings to 19°C and cooling to 25°C, the Commission allows for a temporary return to coal and nuclear energy in the event that gas-based technology cannot be replaced by RES (EC, 2022b).

Chart 4. The EU increase solar energy production by almost 30% in 2021-2022
Change in electricity produced in the EU from various sources in 2021-2022 (%)



Source: prepared by PEI based on ENTSOE data.

Bioenergy and renewable hydrogen are meant to play the main role in the strategy of moving away from Russian fuels. According to the REPowerEU plan, by 2030, there should be 20 million tonnes of renewable hydrogen and 35 billion m^3 of biomethane on European markets. This is a significant increase compared to previous documents, which contained a target of 5.6 million tonnes for renewable hydrogen and 17 billion m^3 for biomethane (EC, 2022a). Currently, less than 2% of energy in Europe is produced

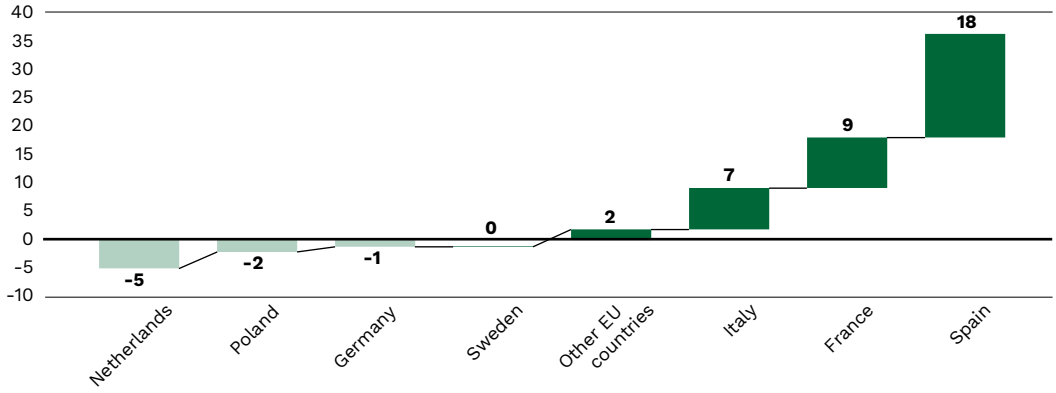
using hydrogen (EC, 2022a). It is mainly used to produce plastics and fertilisers. In addition, 96% of the hydrogen in the EU is so-called grey hydrogen, produced with the use of natural gas, characterised by high emission intensity.

Member states are implementing their own solutions alongside EU plans. There are plans to suspend the closure of coal and nuclear units. These aim to reduce the pressure on gas infrastructure following the increase in gas prices due to Russia's manipulations. In the EU, there are plans to shut down coal-fired units with a total capacity of 35 GW by 2025 – the process could be suspended for 25 GW of capacity (ECF, 2022). Some countries are increasing their own extraction of selected raw materials; for example, Hungary has announced an increase in gas production, while Poland and Romania plan to increase coal production.

Comparing ENTSOE data on electricity production in the EU in Q1, Q2 and Q3 2022 to that in 2021, there has been a noticeable increase in energy produced from both fossil fuels and RES. At the EU level, energy production from hard coal rose by 13%, that from lignite by 12%, and that from natural gas by 9%. At the same time, the development of RES translated into a higher share of solar (an increase of 27%) and wind energy (an increase of 6% for offshore and 11% for onshore wind farms).

Chart 5. Poland has reduced the use of gas in electricity production by 2 TWh

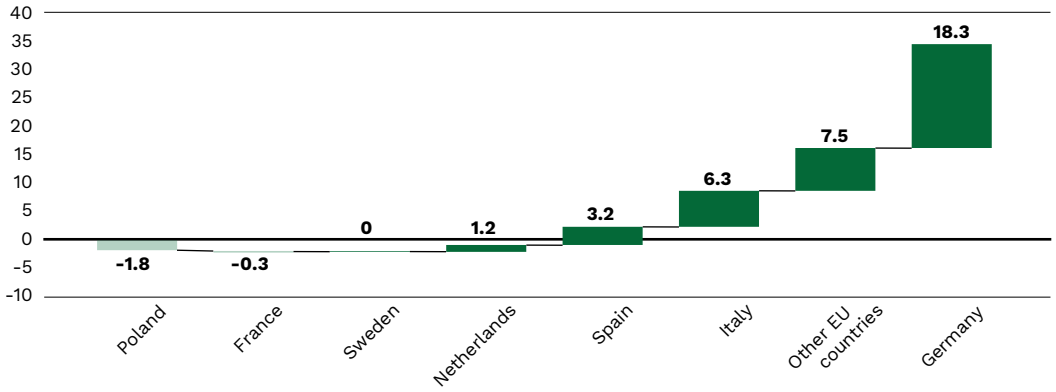
Change in electricity generated from natural gas in selected EU member states in January-September 2022, compared to the same period in 2021 (TWh)



Source: prepared by PEI based on ENTSOE data.

Chart 6. The EU has increased electricity production from coal by almost 35 TWh

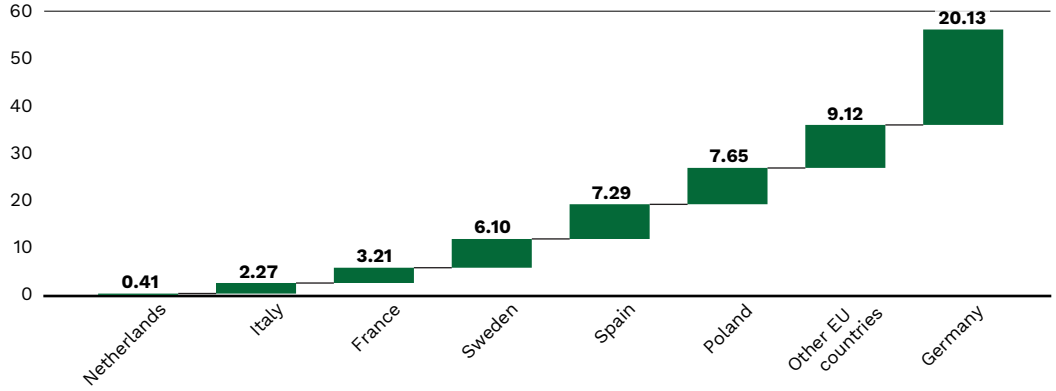
Change in electricity generated from hard coal and lignite in selected EU member states in January-September 2022, compared to the same period in 2021 (TWh)



Source: prepared by PEI based on ENTSOE data.

Chart 7. In 2022, the EU increase electricity production from RES by over 55 TWh

Change in electricity generated from RES (photovoltaics, wind energy and biomass) in selected EU member states in January-September 2022, compared to the same period in 2021 (TWh)



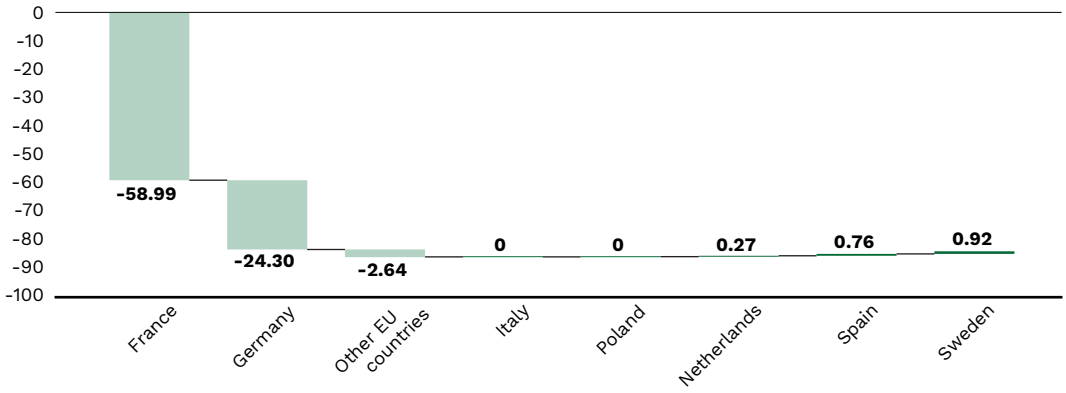
Source: prepared by PEI based on ENTSOE data.

In 2022, Poland was the only of the top seven producers of electricity in the EU that, despite the energy crisis, was able to lower electricity production at coal-fired power plants, reduce gas consumption, and develop RES rapidly. The other countries either used gas to replace nuclear power shortfalls or replaced gas with coal. Spain's six functioning LNG terminals, which led to much lower gas prices at the country's PVB gas hub than elsewhere in Europe, also enabled it to increase electricity production from gas

(by 37%), mainly for exports to France. The situation in Sweden was exceptional, too: its clean energy mix based on nuclear energy and RES mean that it did not have to reduce gas consumption and therefore increase coal-based energy production.

Chart 8. Electricity production at nuclear power plants decreased by 85 TWh in 2021-2022

Change in electricity generated at nuclear power plants in selected EU member states in January-September 2022, compared to the same period in 2021 (TWh)



Source: prepared by PEI based on ENTSOE data.

In 2022, France and Germany combined produced 82.3 TWh less electricity at nuclear power plants than in 2021. This is 59 TWh less than the increase in energy produced from photovoltaics, wind energy and biomass in these two countries. Despite the unstable energy situation and high risk of shortfalls in energy supplies, the amount of energy generated at nuclear power plants in the EU decreased by as much as 81.6 TWh, or 16%. The main reasons for this significant decline during the energy crisis were political decisions made in France and Germany in 2011-2021. In France, the 58.99 TWh (22%) decrease was caused by individual units' poor technical condition, resulting from the lack of consistency in the development of nuclear energy, among other things. In Germany, the closure of 50% of the country's nuclear power plants resulted from the plan to move away from nuclear power triggered by socio-political upheaval after the Fukushima nuclear disaster in 2011. The decision to abandon nuclear power meant the need to seek other, more emissive and environmentally harmful sources: coal and gas, as well as importing energy from other EU countries.

Scenarios for the development of climate policy

Over the past 50 years, the world has faced many energy crises, which unambiguously influenced changes in energy policy. The oil crisis of 1973 forced the richer countries in Europe and the US to build nuclear units and invest large amounts in seeking new sources of energy to reduce their dependence on fossil fuels. In 2022, Europe faces an energy crisis again – this time due to Russia's invasion of Ukraine. To analyse its impact on current climate policy, we developed four scenarios for changes in the Fit for 55 package at the Polish Economist Institute.

Scenario 1. "Coal Strikes Back"

Scenario description

In the "Coal Strikes Back" scenario, we considered the suspension or reduction of climate targets in connection with the energy crisis, Russia's invasion of Ukraine and the economic consequences of the COVID-19 pandemic. Advancing anti-climate polarisation and the economic, social and environmental costs of the war make it difficult or impossible to reach an EU consensus on climate policy. Due to gas availability problems, member states revert to coal technologies that will delay or halt the energy transition. In the medium and long term, this also means higher investment outlays for the modernisation of old conventional power units.

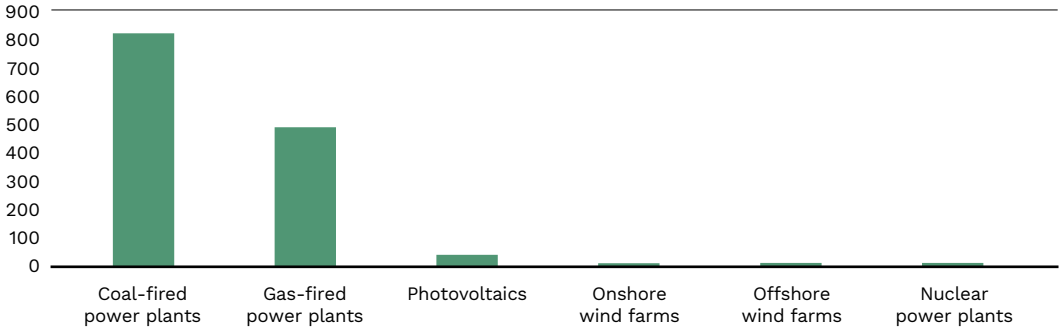
Scenario's assumptions and development

The war in Ukraine, rising energy prices and the unstable situation on the gas climate result in a change in the EU's priorities. Energy security and member states' day-to-day interests are more important than distant climate goals. The countries decide to suspend or abandon the EU ETS, slow down the development of RES in favour of modernising coal-fired units, and abandon technological requirements for energy installations. Stabilising the power system and protecting citizens from energy shortages is key. The abandonment of climate targets implies a return to high-carbon

technologies. Suspending the closure of coal-fired power plants and increasing energy production from fossil fuels increases greenhouse gas emissions and pollution. Emissions from coal-fired power plants are roughly twice as high as those from gas-fired power plants.

Chart 9. Coal leads to 70% more emissions than natural gas

Carbon dioxide equivalent emissions over a given technology's lifespan (g/kWh)



Source: prepared by PEI based on IPCC data.

In the short term, the return to coal and abandonment or suspension of the ETS reduces energy production costs. The main reason is the lack of fees linked to greenhouse gas emission allowances. In the future, the need to increase investments in the modernisation of energy infrastructure, both generation and transmission, will increase. The average lifetime of a coal-fired power plant is 50 years (Cui, Hultman, Edwards et al., 2019), while the average age of coal-fired power plants in the EU is 44 years (www2). Research shows that the CAPEX increases with a coal-fired power plant's age. For desulphurisation plants 1-10 years old, this value is USD 22.8/kW per year; for power plants 60-70 years old, it is USD 30.4/kW per year (EIA, 2019). This means that the older the power plant, the greater the investment outlays for repairs or modernisation. Higher operating costs will translate into higher electricity prices on the wholesale market, which will increase the burden on households.

In this scenario, domestic extraction and the search for near coal deposits is once again viable due to increased demand and high coal prices. In 2018, the mining industry in the EU provided 185,000 jobs, and coal-fired power plants 53,000 jobs (JRC, 2018). In 2022, average employment in the hard coal mining sector in Poland was 79,000 (www3). These posts will be preserved. At the same time, the energy price is heavily dependent on the raw material market due to the growing share of conventional power plants in the energy mix. Moving away from solidarity mechanisms and focusing on individual states' interests hamper cooperation within the EU. The lack of a common position worsens its negotiating position and increases the costs

of importing raw materials from outside the EU. Countries with relatively low import volumes are exposed to higher prices, which will especially hit those most at risk of energy poverty.

Table 1. Return to coal will be costly in the long term
SWOT analysis of the "Coal Strikes Back" scenario

Strengths	Weaknesses
• Short-term lack of increase in infrastructure costs, • Short-term fall in energy production costs caused by abandonment of EU ETS, • Maintains jobs in fossil fuel sector.	• Failure to meet climate targets, delaying of the transition, • Further dependence on fossil fuels, • Polarisation on climate issues, • High refutation cost of moving away from current climate policies • Higher modernisation costs for energy infrastructure, • Loss of position on the new technology market, • Deterioration of economic cooperation on the EU internal market.
Opportunities	**Threats**
• Development of fossil fuel mining industry, • Ensuring continuity of energy supplies.	• Increase in competition for resources between member states, • Further climate change and its consequences, • Institutional problems in the EU, • Maintaining high costs for households in the long term, • European companies producing green technologies become less competitive • EU countries become more dependent on China and Russia • Increased dependence of EU countries on China and Russia.

Source: prepared by PEI.

Challenges

Replacing Russian coal and meeting additional demand will require alternative suppliers, such as Australia, Indonesia, the US or South Africa. In 2021, hard coal consumption in the EU exceeded 166 million tonnes. Production fell by almost 80% in 1999-2021 – to 57 million tonnes. Hard coal imports from Russia amounted to over 51 million tonnes on average in 2015-2020; that is, around 36% of total imports. Further import potential is limited by global production and port throughput. In addition, summer heatwaves reduce the water level in reservoirs and watercourses, preventing raw materials from being transported power plants by river.

New supply chains bypassing Russia will require that ports be prepared to receive larger amounts of coal. A change in the directions of supplies – using freed-up coal from South Africa or the US – is a logistical challenge that will occupy part of the commercial fleet. Sea transport will become the bottleneck in these processes: coal will be transported from Asia to Europe, and from Russia to Asia. The demand for ships will increase and the routes will lengthen, too. In Europe alone, the price of coal distribution has increased eight-fold due to the drought, to over USD 200 per tonne – the Rhine was at its lowest in 15 years (Bloomberg, 2022). In October 2022, the cost of a tonne of coal in the ARA (Amsterdam-Rotterdam-Antwerp ports) was around USD 260.

A policy of subsidies will be difficult to maintain. Providing households with subsidies will be expensive if there is no income threshold. Support should target the poorest and most at risk of poverty. According to OECD, IMF and EC experts, maintaining pricing policy programmes or subsidies without earnings thresholds is much more expensive than an income-based policy.

Scenario 2. "Climate Compromise"

Scenario description

In the compromise scenario, we assumed a temporary return to generating electricity from coal and nuclear power, while maintaining current RES capacity. The climate targets set out in the Fit for 55 package remain unchanged. This scenario is currently being implemented by EU member states.

Scenario's assumptions and development

Europe returns to its coal-based past for the duration of the crisis. There are currently 199 hard coal and lignite-fired power plants operating in the EU. 105 of the power plants have a set closing date (www4). Delaying planned closures enables the EU to increase electricity production and make up for

shortfalls caused by instability on the gas market or unfavourable weather conditions. Germany, the Netherlands, France and Austria have postponed closures and even decided to reopened certain coal-fired power plants. Bringing existing generation infrastructure back into use allows power shortfalls to be compensated for relatively efficiently: the use of coal-fired units in the above-mentioned countries will produce an additional 13.5 GW. This will have climate consequences: emissions will increase by 30 million tonnes of CO_2, or 1.3% of total EU emissions (Brown, 2022).

Table 2. Halting the closure of coal units gives more time to make further decisions
SWOT analysis of the scenario "Climate Compromise"

Strengths	Weaknesses
• Possibility of reaching a compromise at EU-level, • Relatively low cost of ensuring energy security – using existing power generation infrastructure, • Possibility to use the nuclear and coal energy sector's experience – no increase in infrastructure costs.	• Temporary increase in greenhouse gas emissions, • Increase in electricity generation costs while maintaining the EU ETS, • Postponement of investment in RES technology.
Opportunities	**Threats**
• More time for energy-intensive industries based on fossil fuels to prepare for the transition. • Short-term fall in electricity prices due to high gas prices.	• Sending ambiguous market signals could disorient entrepreneurs, • Potential polarisation when it comes to climate policy, • Delaying in advancement of the energy transition.

Source: prepared by PEI.

Despite rising coal prices, producing energy from coal is a suitable solution in times of high gas prices. In 2021, the marginal cost for coal-fired power plants was USD 37-46 per MWh; for gas-fired power plants, it was USD 19-29 per MWh (www7). This refers to the variable costs, mainly fuel costs, needed to increase production capacity if there is a temporary increase in demand for electricity. In Q2 and Q3 2022, the gas price increased more than fourfold compared to the same period in 2021 (IRENA, 2022). In August 2022, prices were as much as 14 times as high as those in January 2021. The limited gas supply and high demand due to heatwaves will keep prices high on European markets. This could lead to the alignment of the short-term marginal costs of coal and gas technologies.

Halting the closure of coal-fired power plants will limit the fall in employment in the sector. This argument appeared in the previous scenario, too. Transforming mining regions is a long-term, expensive process, so postponing the departure from fossil fuels gives policymakers, staff and companies more time to reach a satisfactory deal between the parties and adapt the power industry to the just transition.

Challenges

Substitution, reduction and diversification. A short-term increase in energy production from coal and nuclear power plants, while continuing to invest in RES, are part of current policy. Reducing primary energy consumption in the face of the energy crisis, which has led to a sharp increase in the price of all the raw materials, remains key. Supply diversification should be based on finding alternative supply chains, first for fossil fuels, which are still needed, and then for the critical raw materials needed for RES projects.

Nuclear energy could be a low-carbon response to energy stability. Halting the closure of three nuclear power plants in Germany and two nuclear units in Belgium (Doel 3 and Tihange 2) is being considered. The loss of low-carbon electricity generation capacity would require increased use of fossil fuels. In contrast, nuclear energy ensures a stable electricity supply with low emission intensity.

Investment in infrastructure is key to a secure, green future. The priority should be to prepare the power grids to receive power from numerous RES installations. The growing risk of higher costs in the future should accelerate the move towards green energy. Steps that can be taken now include maintaining the targets set out in climate policies and building the electricity grid in a way that makes it ready to receive energy from new sources that are less readily available and less predictable.

Scenario 3. "Green reengineering"

Scenario description

In the "Green reengineering" scenario, we assumed the launch of investments (mainly green ones), along with the acceleration and simplification of the process of issuing environmental permits and RES certification. The climate targets remain unchanged; in addition, the EU institutions are considering increasing them gradually. Fit for 55 is updated and adapted to more rapid changes in the development of RES. The acceleration of procedures and the limiting of bureaucracy first require logistical preparation by member states, and then, in the short term, effective checks to prevent potential abuse.

Scenario's assumptions and development

Green investments will help achieve climate targets. Over the past decade, the EU has allocated 3.9% of GDP on fighting climate change in the form of public spending. At least 30% of the combined EU budget and NextGenerationEU instrument, which seeks to help repair the economic and social damage brought about by the COVID-19 pandemic, has been allocated to climate goals (Amiot, Bovino, 2021). This is 12% of the amount that the EU needs to invest to implement the Fit for 55 package (EC, 2020a; 2020b) and just 9% of the amount needed to be on the 1.5°C pathway set out in the Paris Agreement. Launching the investments requires increasing financial outlays from the planned USD 4.5 billion to as much as USD 7 billion by 2030.

Legal facilitations support RES production potential. According to the IEA, RES installed capacity in the EU amounted to 507.5 GW in 2020. Experts forecast that it will increase to 752.3 GW by 2026 and, in the fast-track scenario, to as much as 814.8 GW; that is, 62.5 GW more than in the baseline scenario (IEA, 2021). To achieve such a big increase in installed capacity, additional investments are being carried out and administrative barriers abolished. According to a report by Windeurope, the main obstacles to the development of wind energy in Europe are supply chain problems and the long, complicated process for issuing permits (Komusanac et al., 2022). The time it takes to issue permits for RES projects in the EU varies between member states – it can range from 2 to 10 years for wind energy projects, and from 9 months to 4.5 years for ground-mounted solar installations (EC, 2022c). Shortening this process would increase investment in RES.

Financial outlays on green energy are becoming more profitable and costs are falling. The European Commission proposes that the development of renewable energy be deemed an "overriding public interest", the introduction of "regulatory sandboxes" (safe legal environments for testing new projects and services), and the simplification of the grid connection procedure. Reducing bureaucracy and making the process of issuing permits more

efficient will reduce the additional costs caused by investment delays. A seven-year delay in the construction of a 35 MW onshore wind farm cost EUR 4.85 million, and the two-year permitting process to build a 360 kWp photovoltaic installation increased costs by EUR 25,000, 10% of the project's total cost (www5).

Table 3. Accelerating the process of obtaining environmental permits and RES certification as an opportunity to end dependence on fossil fuels
SWOT analysis of the scenario "Green reengineering"

Strengths	Weaknesses
• Increasing the share of RES in the energy mix, • Lowering average energy prices on the wholesale market due to low marginal costs of producing energy from RES, • Increasing the pace and predictability of investing in RES at the central, local, and business level.	• It requires the reform of ways operation of EU member states' institutions, • Lower environmental protection during the investment process, • Lack of immediate solutions securing energy supplies for the approaching winter.
Opportunities	**Threats**
• Growing number of RES investments, increasing the likelihood that climate targets will be achieved, • Fall in cost of investing in RES, • Decrease in time it takes to build RES installations provides an additional incentive for investors, • Gradual fall in dependence on fossil fuels due to faster and cheaper construction of RES.	• Greater threat to protected areas, • Potential social conflicts linked to the investments' unforeseen environmental consequences, • Increase in dependence on imports of critical raw materials used in the production of wind farms and solar panels accelerates.

Source: prepared by PEI.

Increased availability of land for wind and solar investments. The Commission proposes that member states designate specific onshore or offshore sites suitable for RES installations. Zones in which RES cannot be developed due to their proximity to residential buildings, protected areas or military zones are reduced to a minimum. In addition, the Commission has proposed to simplify the requirements for environmental impact assessments. A direct impact on individual wild birds or protected species should not constitute an obstacle to investment in RES (EC, 2022c). The introduction of these regulations increases the availability of land for RES investments.

Environmental activists are sceptical about the new regulations. They have doubts about the changes concerning environmental decisions, which could result in a more lax approach to pollution and damage to protected areas. According to activists, this leads to the degradation and even devastation of the natural environment.

The liberalisation of the rules concerning RES lowers electricity prices on the wholesale market in the long term. However, the lack of investment in additional conventional capacity may pose a risk of energy shortages in the short term. In addition, rising fossil fuel prices during the upcoming winter increase consumers' bills, posing a challenge for the households most at risk of energy poverty. Support for the poorest households is needed. Meanwhile, additional investments in thermal modernisation ensure that RES capacity is used more efficiently and reduce future energy consumption significantly.

Challenges

The liberalisation of rules concerning RES should be accompanied by further, intensive investment in the electricity grid. Adding power from newly-built wind farms or solar panels requires appropriate preparation. In Poland in 2021, nearly 4000 requests to connect energy-producing installations to the grid were refused. 90% of them concerned RES, mainly photovoltaics. In 2015-2020, there were a total of 6,000 refusals (Client Earth, 2022). The lack of an optimal electricity grid in Norway has led to extreme differences in the purchase price of 1 MWh between the north and south of the country – they can amount to several hundred euros (Financial Times, 2022).

To ensure electricity supplies without substitution using coal and gas, the phase-out of nuclear power plants needs to be halted. In addition, keeping nuclear power plants in operation is compatible with raising climate targets. Nuclear energy is a low-carbon source that can provide a stable alternative to coal-fired power plants.

Europe must prepare for potential shortfalls in electricity supplies. The limited number of conventional units, increasing load on the power grid in connection with the liberalisation of RES rules, and weather anomalies increase the risk of energy shortages. The solution could be a solidarity policy regulating the joint use of gas storage facilities and the transmission of energy between EU member states.

Scenario 4.
"Fast and furious to Ff55"

Scenario description

In the scenario speeding up the actions in the Fit for 55 package, the development of RES becomes a fundamental priority that unites the EU and a response to emerging internal and external problems. In this scenario, the EU mobilises the maximum available funds to achieve its more ambitious climate targets. Member states face severe penalties for failure to achieve the targets.

Scenario's assumptions and development

Europe gets closer to achieving the Paris Agreement targets, including limiting the increase in the average global temperature to 1.5°C. The more ambitious climate targets and increase in RES installed capacity reduces greenhouse gas emissions in the power industry. Dependence on fossil fuels decreases. In the long term, a decrease in electricity generation costs is expected.

Rising commodity costs during the energy crisis increase the viability of RES projects. The unstable situation on the gas market and increase in the price of CO_2 emission allowances pushed up electricity generation costs at gas-fired power plants by 645% in 2021 compared to 2020. While conventional power plants are exposed to sharp increases in fuel prices, the development of RES technology in recent years has resulted in a fall in the levelized cost of electricity (LCOE) of 88% for the construction of solar installations and of 68% for onshore wind farms compared to 2010 (IRENA, 2022). According to the Fraunhofer Institute, in 2021 the LCOE at existing conventional power plants became equal to the LCOE at new units based on RES, and in 2040 – due to rising CO_2 emission allowance prices – the LCOE at RES units will be lower (Fraunhofer ISE, 2021). The rapid growth in commodity prices is speeding up this process. In 2021, the marginal cost of generating electricity from new installed capacity in wind and solar energy was 4-6 times lower, on average, than that of generating it from fossil fuels (IRENA, 2022). In June, the presence of solar power in Poland's energy mix reduced the residential customer equivalent (RCE) price by as much as 75% during the day (IJ, 2022).

As with fossil fuels, ensuring the supply of raw materials and semi-finished products for RES requires diversification. The EU's high dependence on imports of critical raw materials, together with increased demand, are increasing the production prices of photovoltaic modules and wind turbines. More than 66% of all the critical raw materials imported by the EU come, including 98% of rare earth metals and 93% of magnesium, come from China (JRC, 2017). The Democratic Republic of Congo accounts for 68% of cobalt and Chile for 78% of lithium (PEI, 2022). The renewable energy sector's fragmented supply chain leads to higher transport prices due to rising fossil

fuel prices. In the short term, these factors increase the cost of electricity production.

RES projects take less time than building conventional infrastructure. On average, it takes 2-7 years to build a wind warm and 1-3 years to build a solar farm. Faced with gas shortages on the market, the EU is seeking quick solutions to ensure energy security. The first RES investments could already provide benefits during the next heating season, but the lack of an immediate increase in energy production leads to interruptions in supply. The increased share of RES in the EU's energy mix and phase-out of conventional power plants may lead to problems with balancing the power system during daily peaks – in particular, during the winter in countries relying on photovoltaics, and during the summer in countries the mainly use wind farms. The high dependence of energy generation on weather conditions and the lack of global storage solutions make the system less flexible and affect energy security.

Table 4. Emphasis on RES threatens the EU's stability
SWOT analysis of the scenario "Fast and furious to Ff55"

Strengths	Weaknesses
• A clear and stable signal for EU citizens and investors – consistent action increases the EU's credibility.	• Polarisation on climate issues within the EU, • Increase in anti-EU sentiment, • Short-term increase in electricity generation costs, • Electricity system becomes less flexible, • Difficult to balance energy supply and demand at any given moment.
Opportunities	**Threats**
• Acceleration of the energy transition, • Fall in greenhouse gas emissions, • Lower electricity prices for households in the long term, • EU becomes less dependent on fossil fuels, • Development of innovative industries.	• Potential obstacles to the development of RES technology, • EU institutions operate less efficiently.

Source: prepared by PEI.

The more ambitious climate targets and introduction of penalties for member states' failure to meet obligations lead to divisions within the EU. The conflict is between countries where fossil fuels make up most of the energy mix and those with a larger share of low-carbon energy sources. This leads to polarisation on climate issues and an increase in anti-EU sentiment as entrepreneurs face higher costs and households' financial situation deteriorates due to rising electricity bills.

Challenges

RES investments require consistent and multifaceted planning. The public institutions extensive involvement in building RES installations enables accurate planning, preparation, and provision of transmission grid infrastructure. Energy companies should actively identify the greatest needs from a business perspective, taking into account green development scenarios. Coordinating multi-level cooperation between entities that often have different goals – which is necessary for this scenario – may be a challenge for many member states.

Focusing EU action on climate targets requires institutional support. Additional funds should be directed towards approved and necessary RES provides. With the high energy costs in the short term and accelerated fall in energy produced from fossil fuels, there is a growing need to support people at risk of energy poverty and help people previously employed at coal-fired units and in mining change industry. The sense of a lack of a just transition may be associated with strong social resistance.

An accelerated transition should take into account differences within the EU. Countries with a high share of fossil fuels in their energy mix should not be prevented from using nuclear and gas energy, as agreed on in the new proposed EU taxonomy (Bloomberg, 2022a). In view of the potential instability of the RES systems currently being built, the role of nuclear energy in the entire EU should be considered in a broader context, beyond the current regulatory framework.

Summary and recommendations

The scenarios presented in the policy paper vary in terms of their costs and environmental impact. The EU energy sector should be considered from three main angles: ensuring a stable energy transition that guarantees security of supply, reducing greenhouse gas emissions, and protecting households at risk of energy poverty and European economies' competitiveness. In the context of the energy crisis linked to the increased cost of gas and electricity, finding a solution that will be broadly accepted by the public and will ensure a lasting international consensus is key to EU solidarity and cohesion.

Table 5. Assessment of the scenarios' climate, social, budgetary and political impact
Scenarios' impact in selected areas

Scenario	Reducing emissions	Cost for households (short term)	Cost for households (long term)	Cost for member states' and EU budget (short term)	Cost for member states' and EU budget (long term)	EU solidarity
"Coal Strikes Back"	Absent or low	Medium	Very high	Low	High	Low
"Climate Compromise"	Medium	Medium	Medium	Medium	Medium	High
"Green reengineering"	High	High	High	Low	Medium	Medium
"Fast and furious to Ff55"	Very high	High	High	High	Medium	Low

Source: prepared by PEI.

The extreme – and least likely – scenarios involved a return to coal or accelerated roadmap to achieving the Fit for 55 targets could have a negative impact on EU cohesion. In the former, policymakers practically abandon the achievement of climate targets. In the latter, they burden consumers with hefty bills at the initial stage of the accelerated transition. Liberalising the rules on RES investments, which can increase installed capacity in green energy at a relatively low cost, may seem like a favourable solution.

An additional challenge linked to the development of RES and achievement of climate targets will be developing the electricity grid in a way that reduces the impact of a decrease in generating units' availability on the supply system and end users' security.

The scenarios present have common features that the EU should consider when responding to the consequences of the war in Ukraine and the energy crisis triggered by Russia. The actions have three different time horizons:

- short term – the upcoming heating season, the winter of 2022-2023,
- medium term – the next three years,
- long term – three years or more (Atlantic Council, 2022).

In the short term (this winter already), policymakers will face energy shortfalls and high electricity bills, which will hit the poorest households. The overriding goal is to ensure that gas storage facilities in Europe are filled to the highest level possible, in view of the need to fill them to 90% of capacity each time before the winter of 2022-2023 and the winter of 2023-2024. In this context, it is crucial to keep the nuclear power plants in Germany and Belgium operational. This power is essential to system's stability. Meanwhile, households and enterprises should reduce their energy consumption. Reducing the heating of households in the EU by just 1°C would save 14 billion m^3 of gas, over 10% of the gas imported from Russia (PEI, 2022). Governments should already invest in energy efficiency, including the thermal modernisation of buildings. Currently, 30% of single-family houses in Poland do not have any external wall insulation. Increasing energy efficiency could save 4-6 million tonnes of coal (around 50% of households' consumption) (IBS, 2022). Solidarity between member states will be essential, too, especially in crisis situations. In the short term, new infrastructure cannot be added, so the solidarity-based use of existing interconnectors, especially in the countries of Central Europe, will reduce the potential shortfalls for protected recipients in the event of extremely low temperatures during the winter.

In the medium term, the priority is building a new, low-carbon, European power industry. It is crucial to plan and begin investments developing the power grid and RES. Energy efficiency projects should be continued with subsidies and incentives for heat pumps, which reduce energy consumption by more than 70% compared to standard systems. According to the Atlantic Council, from a strategic point of view, the Baltic States should be connected to the European network and Ukraine to transatlantic energy security infrastructure – Europe could also benefit from this by storing gas win Ukraine.

In the long term, Europe needs to keep developing clean energy technology. In addition, it should expand and modernise the transmission network, further increase energy efficiency and develop energy storage technologies. Maintaining nuclear power and its expansion remains key. The hydrogen economy should be developed, especially with the use of gas infrastructure, the usefulness of which will decrease over time. As the European Hydrogen Backbone points out, existing gas transmission infrastructure – the Baltic

Pipe gas pipeline, the Poland-Lithuania gas pipeline, and the Yamal gas pipeline – could be converted to make it suitable for hydrogen transmission. The potential date for these investments is 2040, after the current Baltic Pipe futures contracts expire at the end of 2037.

Yet until an efficient hydrogen production chain, market and infrastructure are created, the EU will be forced to use fossil fuels. In almost all the net zero scenarios prepared by the European Commission, hydrocarbons continue to play a key role in the energy system until 2050 and beyond. Until then, Europe will have to seek alternative suppliers of fossil fuels, expand and modernise storage infrastructure, adapt transmission infrastructure to new supply directions, and raise public awareness about energy efficiency and savings, gradually building genuine energy security in the context of Europe's continued sustainable development.

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The Polish Economic Institute

The Polish Economic Institute is a public economic think tank dating back to 1928. Its research primarily spans macroeconomics, energy and climate, foreign trade, economic foresight, the digital economy and behavioural economics. The Institute provides reports, analyses and recommendations for key areas of the economy and social life in Poland, taking into account the international situation.

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