Regaining Europe's Energy Sovereignty

15 Priority Actions for RePowerEU

IMPULSE

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253/04-I-2022/EN
Version 1.3
March 2022

Dear reader,

Russia's full-scale invasion of Ukraine on 24 February 2022 massively escalates its illegal war of aggression that began in 2014 and that has unleashed terrible suffering on the Ukrainian people. The war also presents a historical turning point for European energy and security policy as it casts a harsh spotlight on the EU's current reliance on Russian fossil gas imports.

On 11 March 2022, EU heads of state agreed to phase out EU dependency on Russian fossil fuel imports as soon as possible. To this end, the European Commission will prepare a "RePowerEU" plan by the end of May 2022.

First ideas on RePowerEU give little consideration to reducing fossil gas demand and remain vague on scaling renewable energies. This is regrettable, as actions to meet EU climate targets also reduce fossil gas consumption, and are therefore worth taking, no matter what the future may hold.

The fifteen priority actions on energy efficiency and on renewables developed in this report should thus be at the heart of Europe's efforts to regain its energy sovereignty.

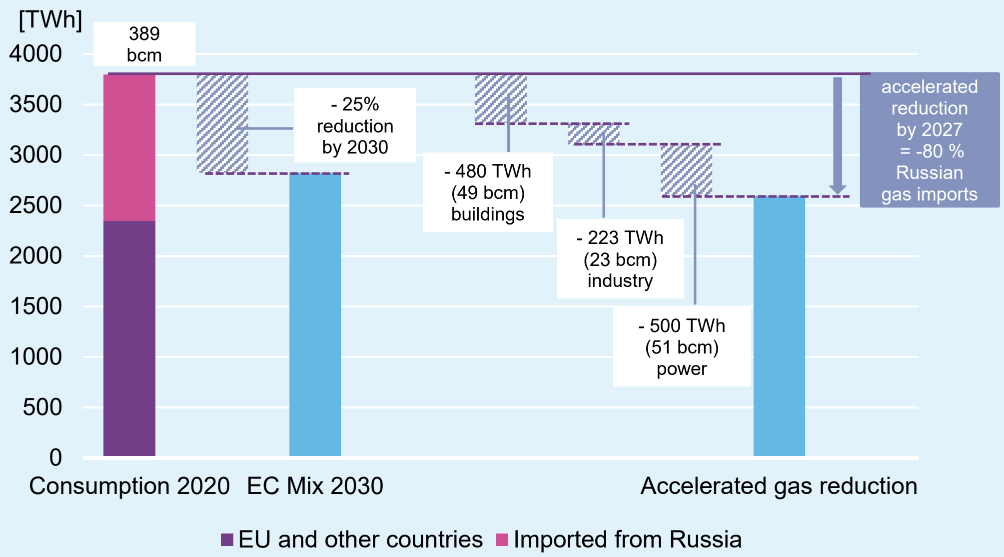
Sincerely yours,

Matthias Buck
Director Europe, Agora Energiewende

Key findings

1	**The escalation of Russia's war against Ukraine has created a fossil energy crisis and has exposed the EU's dependency on fossil gas imports. If the EU fully mobilises all available means to reduce energy demand and switch to renewable energy, Europe can regain its energy sovereignty by 2027.** Energy efficiency in buildings and industry as well as a fast ramp up of wind and solar PV can permanently reduce fossil gas demand by 1200 terrawatt hours in the next five years, allowing to avoid 80% of today's Russian gas imports and enabling a 100% displacement when combined with alternative supplies such as LNG.
2	**Climate protection and energy security go hand in hand, as actions to meet the EU climate targets also reduce fossil gas consumption.** Until 2027, energy efficiency, district heating and a heat pump revolution can save 480 TWh in buildings; efficiency and electrification in low and medium temperature heat processes can provide for 223 TWh savings in industry, and a ramp up of wind & solar PV combined with more system flexibility will contribute 500 TWh in the power sector.
3	**Regaining Europe's energy sovereignty by 2027 requires a collective European effort based on joint commitments and solidarity.** The RePowerEU plan needs to mobilize the reductions identified in this study. Similar to the COVID recovery efforts, the plan must be embedded in a strong political framework overseen by the European Council to ensure its swift and full implementation. Helping Ukraine build back better after the war should be part of the efforts.
4	**A new EU Energy Sovereignty Fund, modelled on NextGenEU and equipped with 100 bn EUR until 2027, should be set up as part of a dedicated investment framework to deliver RePowerEU.** The framework also needs to ensure that existing EU funds are re-purposed wherever possible and governments smartly combine price signals and protection for poor households and industry.

EU-27 fossil gas consumption and reduction potentials



Results EC mix scenario 2030 and Agora calculations based on Artelys, TEP, Wuppertal Institute

15 Priority Actions for REPowerEU

Buildings

1. Introduce an EU-wide Check & Act campaign and mobilize a Civilian Energy Corps
2. Make the training of skilled professionals for the energy transition a key priority
3. Stop installing new gas boilers
4. Rapidly scale up the production and installation of heat pumps
5. Rapidly scale up building renovation
6. Connect more homes to district heat networks and make them greener and more efficient

Industry

7. Don't regulate industrial gas and energy prices, let the demand signal work.
8. Take emergency measures to avoid irreversible reduction in EU industrial and agriculture production
9. Accelerate the uptake of renewable solutions for low and medium-temperature industrial heat
10. Regulate industry to ensure all cost-effective energy savings measures are taken
11. Rapidly scale material efficiency and enhanced recycling of energy-intensive materials

Power

12. Pull all stops for renewables deployment and manufacturing in Europe
13. Mandate solar rooftops, solar on the built environment and maximize PV self-consumption
14. Fully and ambitiously transpose existing electricity market rules to enhance power system flexibility
15. Strike a smart balance between direct electrification and green hydrogen production

Content

1 Reducing gas demand to eliminate Europe's dependence on Russian gas and regain energy sovereignty

In 2014, Russia started an illegal war of agression against Ukraine by annexation of Crimea and continued low-scale warfare in the Donbas region in Eastern Ukraine. On 24 February 2022, Russia launched a full-scale invasion of Ukraine that shocked the world community and unleashed terrible suffering on the Ukrainian people. The war has cast a harsh spotlight on Europe's current reliance on Russian fossil gas, coal and oil imports.

As part of a broader discussion concerning European energy and security policy, EU leaders have vowed to phase out Russian energy imports as soon as possible. To this end, the European Commission will prepare a "RePowerEU" plan by the end of May 2022.[1]

While oil and coal are globally traded commodities that can be sourced from other countries, it will be far more difficult for Europe to procure fossil gas from alternate sources. Over the last twenty years Europe has increased its structural and economic dependence on pipeline gas from Russia, which today accounts for 40% of fossil gas consumed in Europe, with some countries (including Estonia, Finland, Bulgaria, Latvia) almost entirely reliant on Russian gas. Accordingly, addressing Europe's dependence on pipeline gas imports from Russia will necessarily play a central role in the RePowerEU plan.

The European Commission has already sketched out initial ideas for the RePowerEU plan, and has invited Member States to begin a dialogue on the most suitable projects and reform measures at the national, regional and EU levels.[2]

Concrete measures proposed by the Commission to date include substituting Russian gas with shipborne LNG imports and alternative sources of pipeline gas (e.g. from Azerbaijan). The Commission has also proposed increasing the 2030 production target for biomethane from 17 to 35 bcm. However, the Commission has been much less specific regarding measures to permanently and structurally reduce fossil gas consumption in industry and in buildings, and for accelerating the expansion of renewable energy capacity. Prioritising reduction of gas demand is, however, necessary since fossil gas cannot anymore be considered as a 'bridge fuel'.

Additional attention must be devoted to these topics during the further development of the RePowerEU plan. Rapidly reducing demand for fossil gas will not only strengthen European energy security, but also help the EU to meet its climate targets for 2030.[3] Furthermore, reducing fossil gas consumption is far preferable to replacing one fossil fuel dependency with another.

A supplementary benefit of reducing fossil gas consumption will be to reduce expenditures on fossil gas imports. The estimated 1200 TWh reduction in gas consumption by 2027 would save an estimated 127–318 billion euros between now and 2027, and generate additional savings going forward (see Table 1).

1 Versailles Declaration of 10 and 11 March 2022, para. 16., available at https://www.consilium.europa.eu/media/54773/20220311-versailles-declaration-en.pdf.

2 COM (2022) 108 final of 8 March 2022.

3 In 2020 the Commission projected that reaching the EU's 2030 climate target would imply reducing fossil gas use in Europe by 25% by 2030 relative to 2020 levels.

Table 1: Cumulative savings from reducing fossil gas consumption by 1200 TWh up to 2027

Fossil gas price	Savings
Future prices for 2023 to 2027*	127 billion euros
Current average price over last 6 months of 80 EUR/MWh	318 billion euros
Current maximum price of 200 EUR/MWh	795 billion euros

* TTF Prices from Feb 28th, rounded. To calculate cumulative savings we assume linear reduction of fossil gas consumption up to 2027 year over year and multiply the overall amount saved by the gas price

This report focuses on measures to permanently reduce Europe's structural dependency on fossil gas within the next five years. Section 2 describes current fossil gas demand in Europe. Section 3 quantifies the main options for reducing fossil gas use in buildings, industry, and the power sector from now up to the end of 2027. Sections 4–6 develop potential elements of the RePower EU plan, including its political framework, priority actions, and investment measures. Section 7 describes associated trade, employment and economic effects.

2 Status quo of fossil gas use in the EU

In 2020, the EU-27 consumed approximately 3800 terawatt hours of fossil gas, 90% of which was imported. By far the largest share of imports comes from Russia (~40%), followed by Norway (~20%) and North Africa (~10%). The domestic production share fell by half over the past decade to approximately 10% of demand,[4] such that the EU is now more dependent on Russian gas than it was in 2014, when Russia illegally occupied Crimea and invaded the Donbas region of Eastern Ukraine.

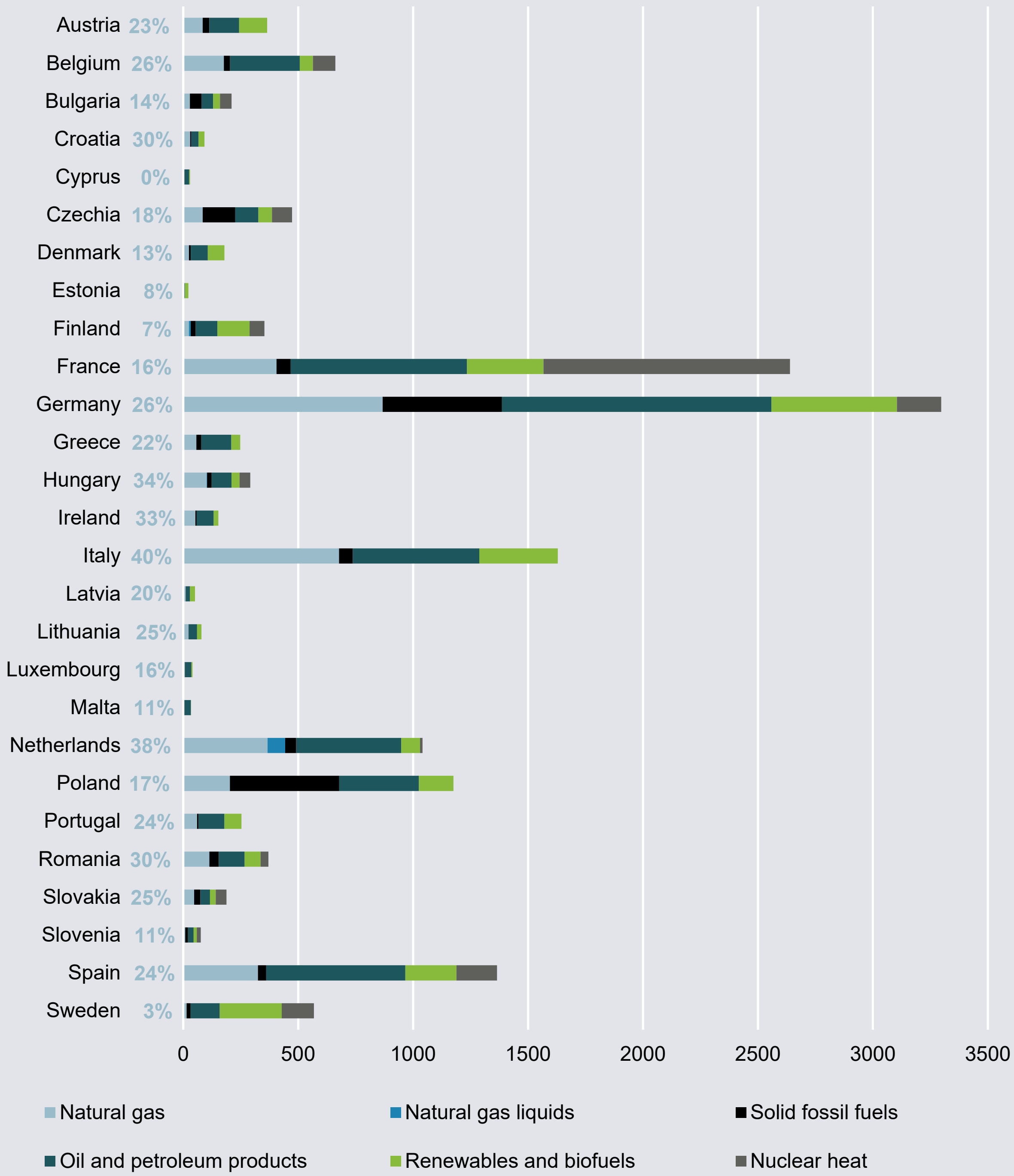
European countries diverge considerably in their reliance on fossil gas as an energy source. Germany and Italy are the largest absolute consumers of fossil gas, while in the Netherlands, Hungary, Croatia, Germany and Romania, fossil gas covers the highest shares of total energy demand (see Figure 1 below)

Fossil gas plays an important role as an energy source for heating buildings and as a feedstock and source of energy in industry. In some countries, the power sector is also strongly reliant on fossil gas (see Figure 2 below)

In this way, efforts to rapidly reduce fossil gas demand will pose divergent challenges for each European country, based on their current consumption patterns. Furthermore, as fossil gas can no longer be considered a "bridge fuel", some countries will need to re-assess plans to achieve climate neutrality.

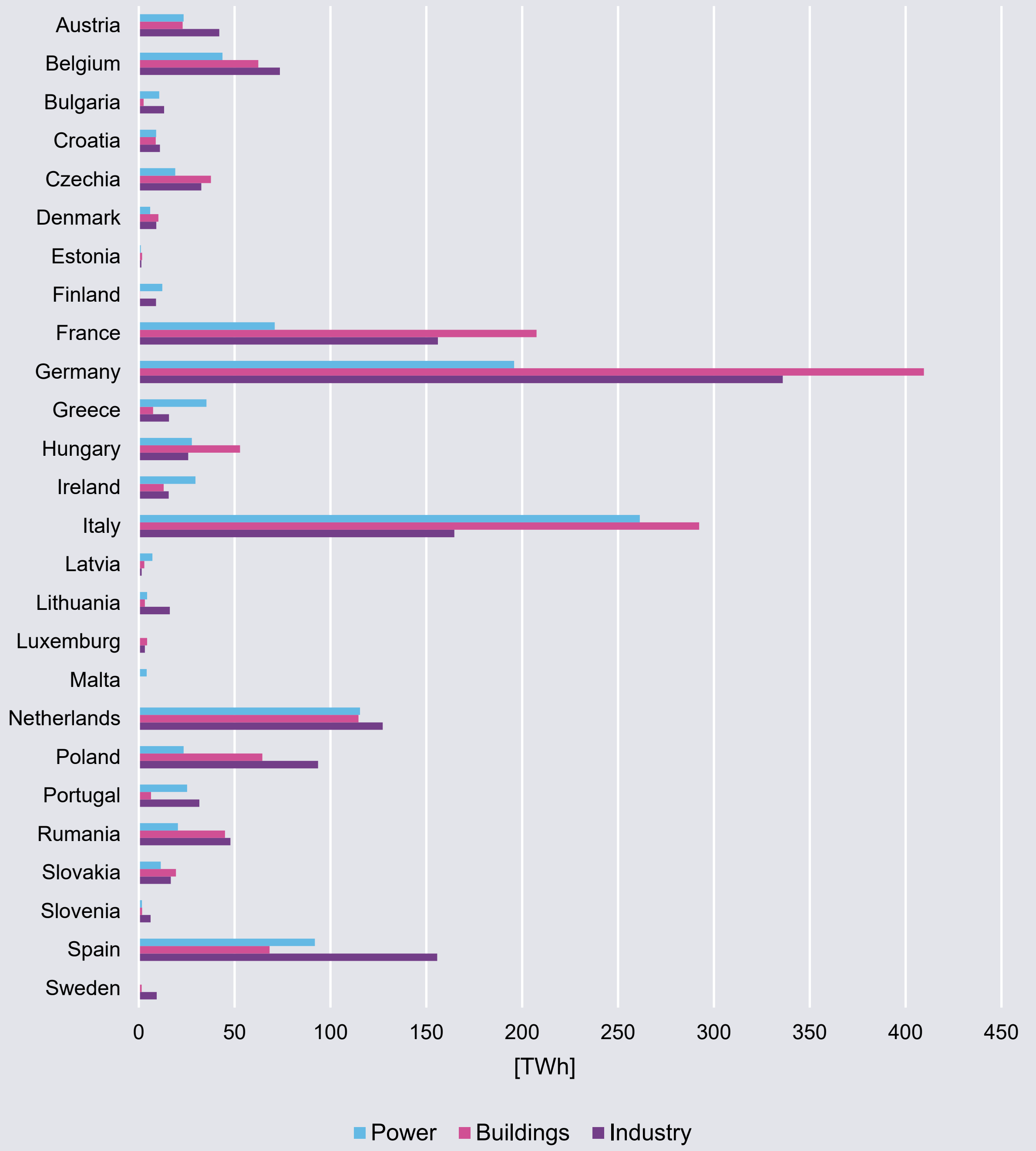
4 See https://www.acer.europa.eu/gas-factsheet

Figure 1: Total available energy in EU member states in terawatt hours and fossil gas share in % for 2020



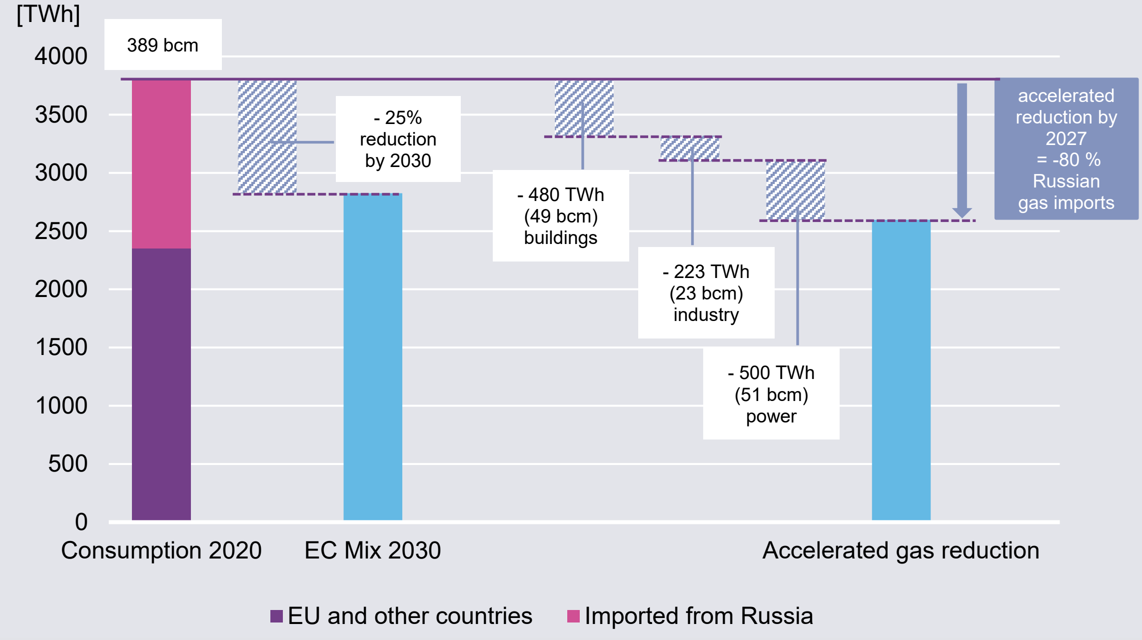
Source: Eurostat (2022)

Figure 2: Fossil gas consumption by sector in EU member states in 2020



Eurostat (2022). Numbers converted to terawatt hours from terajoule (gross calorific value).

Figure 3: EU-27 fossil gas consumption and reduction potentials



Source: Results from the EC mix scenario 2030 and Agora calculations based on Artelys, TEP, Wuppertal Institute

3 Achieving a structural reduction in fossil gas demand by 1200 TWh by 2027

In 2020, fossil gas consumption in the EU-27 stood at 3800 TWh. As part of current EU planning for a 55% reduction in greenhouse gas emissions by 2030, fossil gas consumption is projected to decline 25% between 2020 and 2030. However, Russia's war on Ukraine makes it essential to reduce fossil gas consumption in Europe even faster. But how quickly can fossil gas demand be reduced? And how do we avoid merely replacing one dependency with another?

Based on modelling performed for Agora Energiewende by Artelys, TEP Energy and the Wuppertal Institute and discussions with experts, we estimate that the EU-27 could reduce fossil gas consumption by 1200 TWh up to the end of 2027. This reduction would avoid 80% of today's Russian gas imports, enabling a 100% displacement when combined with alternative supplies such as LNG reduction. This figure is based on modelled fossil gas reduction pathways for the industry, buildings and the power sector in line with the EU's 2030 and 2050 climate targets.

Importantly, the estimated reductions would be of a *structural nature* and *thus permanently reduce fossil gas consumption in Europe*, irrespective of where fossil gas is sourced. It should be noted that this discussion of how to reduce structural dependency on fossil gas over the mid-term is distinct from the issue of immediate measures to reduce fossil gas consumption in order to prepare for winter 2022/23 and a potential interruption of the gas supply from Russia (see Infobox 1).

As shown in Figure 3, the largest potential for reducing demand exists in the power sector (-500 TWh). This is followed by the buildings sector (-480 TWh) and by industry (at least -223 TWh and up to -410 TWh).

These estimates of fossil gas reduction potential pertain to the EU-27 as a whole. We have not yet broken them down to the country level. However, it is evident from Figure 2 that each EU country has a divergent reduction potential, and that the attendant challenges will be different for each country.

The modelling underpinning our estimates nevertheless provides a robust indication of priority measures that should be developed as part of the EU's RePowerEU plan.

The remaining part of this section describes the technical reduction potentials, including the main levers for reducing and/or substituting fossil gas in industry, buildings and the power sector. We also provide an estimate of investment needs and identify challenges to reducing demand.

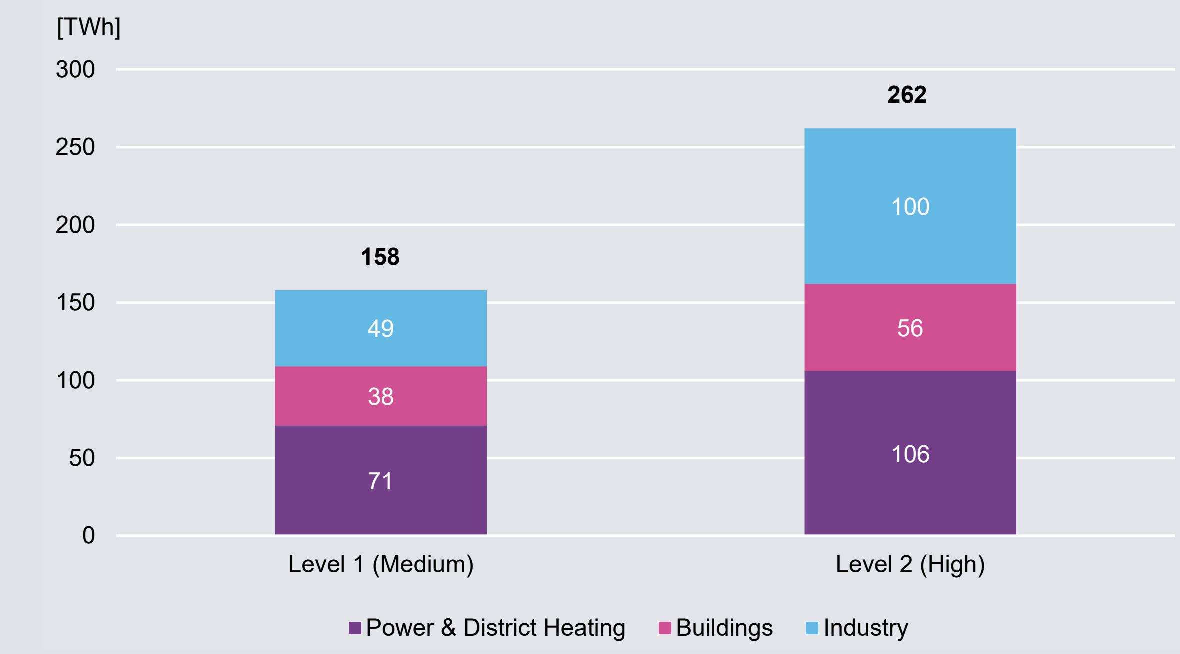
INFOBOX 1. Immediate actions to reduce fossil gas consumption in run-up to winter 2022/23

Any reduction in fossil gas consumption before winter 2022/23 leaves the EU in a better position with regards to storage levels, demand pressure on gas markets, and other impacts from potential supply disruptions resulting from Russia's war against Ukraine. Our recommended immediate actions to reduce fossil gas consumption in the run-up to winter 2022/23 include:

1. Fuel switching in the power sector, district heating and buildings (e.g. use of oil in gas CHP plants).
2. Short-term operational efficiency improvements for wind turbines and biomass plants.
3. Encouraging citizens and business owners heating with gas to save energy, e.g. by turning off heating in unused spaces, reducing room temperature by 1-2°C (~10 bcm for each degree of reduction) or installing smart heating controls, at cost of normally less than €250.
4. A broad campaign to invest into low-cost and highly beneficial energy savings measures, e.g. attic, roof or top floor ceiling insulation, draught-proofing of windows and doors, reflective radiator panels, water tank and heating pipes insulation, water-efficient showerheads, and energy-efficient LED light bulbs and household appliances.
5. An initiative to incentivise industry to save and substitute fossil gas in low temperature heat applications of 100°C or less, which currently constitute 40% of industrial gas usage, e.g. rapid installation of higher temperature heat recovery units and the adoption of industrial heat pumps, e-boilers, geothermal and solar thermal solutions.

A recent analysis by Agora Energiewende and Prognos estimates that between 158 and 262 TWh in fossil gas can be saved in Germany with such short-term measures.

Short-term gas savings potential in Germany across different sectors (in TWh)



Agora Energiewende (2022) und Prognos (2022)

Buildings: Reducing fossil gas use by 480 TWh by 2027 through energy efficiency and a heat-pump revolution.

The fossil gas consumption in the buildings (residential and tertiary) sector could be reduced by 480 TWh from around 1400 TWh today.

Improving the efficiency of existing gas boilers (-15% or 72 TWh): Significant gas savings can be achieved by optimising the operation and installation of existing gas boilers so that they achieve their full technical efficiency potentials. Modern condensing gas boilers often have rated efficiencies of higher than 90%, but rarely achieve these values in practice. Measures that can be taken to improve the performance of gas boilers include reducing set temperatures for boilers to no-higher than 60°C, avoiding the installation of oversized boilers, installing load or weather compensation as well as occupancy controls and performing a hydronic balancing to optimise system pressure hydronic (water-based) heating and cooling systems. In non-residential buildings the operation of ventilation systems can also be significantly improved by adjusting set-points and adopting occupancy controls (e.g. based on CO_2 concentration), improving health and well-being.

Building renovation (-15% or 72 TWh): It is estimated that roughly one-third of the EU's building stock was built before energy performance requirements were introduced into building codes (from 1970s onwards). As requirements in the next decades were fairly low, the vast majority of buildings are currently energy inefficient. However, both the weighted EU renovation rate and the rate of new construction are estimated at roughly 1%, far below the rate of 2–3% required to achieve the EU's 2030 climate target. Accelerated and targeted building renovation with low-investment-cost solutions can reduce fossil gas demand significantly in the next five years. Achieving these reductions will first and foremost require significant improvements in the thermal envelope of buildings in order to reduce heating and cooling losses and minimise investment costs associated with the electrification of heating & cooling. Associated refurbishment measures include improving roof, ceiling and wall insulation, draught-proofing and the installation of efficient windows and doors to create an airtight enclosure of the building shell.

Replacing existing gas boilers with renewable heating technologies (-65% or 312 TWh): In 2017, an estimated 59% of installed capacity for individual heating systems in the EU relied on fossil gas, nearly two-thirds of it is either older than the technical lifetime (11%) or in the 2nd half of its technical lifetime (47%).[5] More than half of existing gas boilers are relatively inefficient.[6] The EU is thus in the midst of a significant refurbishment cycle that could either help significantly reduce the EU's gas consumption or lock it in for decades to come. In 2021, German households alone installed an estimated 929,000 new heating appliances, of which 653,000 were new gas boilers – an increase of 5% compared with the year before.[7] At the same time, alignment with ambitious decarbonisation and fossil gas phase-out scenarios will require all systems aged more than 15 years to be replaced by non-fossil alternatives in the upcoming years. Significant reductions in fossil gas consumption could thus be achieved through an accelerated replacement of the existing stock of gas heating systems older than 15 years with heat pumps, district heating and, to a more limited extent, biomass:

5 (Forthcoming) Fraunhofer ISI, Öko Institute, TU Wien: Description of the heat supply sectors of individual EU Member States Space heating market summary 2017- European Union (EU-27)

6 ECOS (2020) Five Years Left: How ecodesign and energy labelling can decarbonise heating.

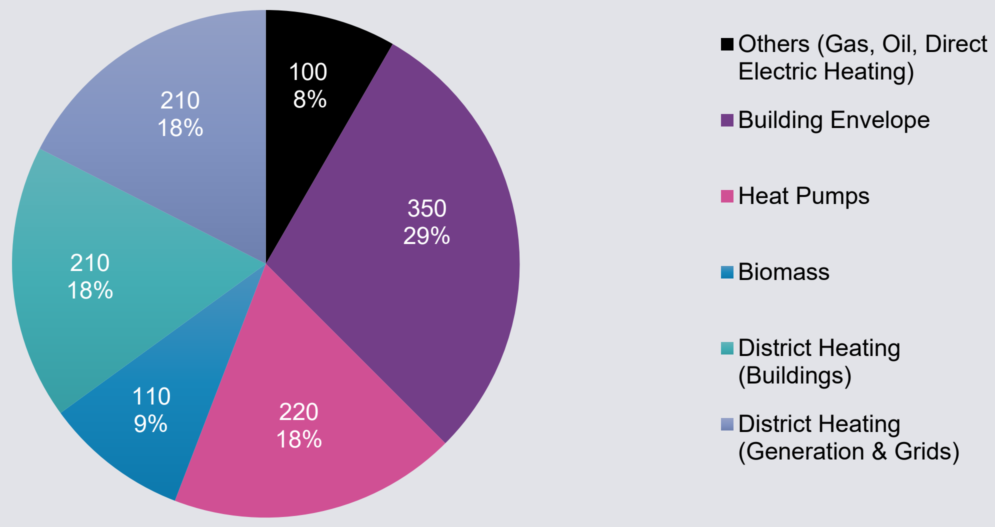
7 BDH (2022): Marktentwicklung Wärmemarkt 2021

- **Heat pumps (~140 TWh):** Small-scale heat pumps for space and water heating in residential and commercial buildings are inherently more efficient than fossil gas boilers, and can convert 1 kWh of electricity into between 2.5 and 5 kWh of useful heat depending on the climate, heat pump technology and the performance of the technical heating system. On average, the installation of a heat pump will lead to reductions in fossil gas consumption, even in cases where the power used by a heat pump is fully generated by a fossil gas power plant. The electrification of heating also allows heat pumps to achieve reductions in fossil gas consumption through fuel switching to alternative energy sources (e.g. renewables, nuclear, oil, coal). As a result, roughly doubling the stock and floor area supplied by heat pumps between 2022 and 2027 could help to significantly reduce overall fossil gas consumption.
- **District heating (~125 TWh):** District heating and cooling networks provide roughly 10% of heating and cooling in buildings in the EU, serving some 70 million EU citizens, including more than half of the population in Latvia, Denmark, Estonia, Lithuania, Poland, Sweden and Finland. While roughly one-third of these sales are supplied by fossil gas, district heating systems are generally more efficient than individual fossil gas heating systems and enable a fuel switch to both alternative fossil fuels, as well as renewables and waste heat. District heating systems could thus help to significantly reduce fossil gas demand through densification (i.e. new connections to existing grids), the spatial expansion of existing grids to service new customers and the building of new district heating networks. Combined, these measures could increase the floor area supplied by district heating by ~50% between 2022 and 2027, while only increasing energy demand in district heating by ~30%. Even if this growth in demand increases fossil gas consumption in district heating slightly in the short-term, it is still projected to reduce fossil gas consumption in buildings overall by displacing significantly more fossil gas in individual fossil gas boilers. This significant switch to district heating is achieved while decreasing emissions by: (1) phasing-out coal, (2) significantly increasing the supply of renewable energy and waste heat sources and (3) implementing short-term operational energy-efficiency measures, i.e. by decreasing supply temperatures, managing costumers needs and dismantling inefficient boilers and co-generation systems.
- **Biomass and biogas (~47 TWh):** Additional individual biomass and biogas heating systems can also help to reduce the fossil gas demand in both the short and medium term. However, their installation must be weighed against significant concerns about the limitations on the sustainable supply of biomass.

Switching fuels in existing gas boilers (~5% or 24 TWh): Additional reductions in fossil gas consumption can also be achieved through the use of heating oil or LPG in existing boilers (mainly large non-residential buildings).

Required investments: The investments for a faster decarbonisation of the buildings sector are around 1200 billion euros. This implies the replacement of gas heating systems after 15 years and should be compared with a base scenario where gas boilers are replaced at the end of their technical lifetime (after 20–30 years), which already requires spending 840 billion euros. Investments can be complemented with enhanced maintenance and efficiency improvement measures (10 to 15 billion euros per year, about 65 billion more than in 2027). Most investment must go into district heating, the building envelope and heat pumps (see Figure 4).

Figure 4: Investments between 2022-2027 in the EU27 in buildings sector in billion Euros, including district heating. Biomass includes solid and gaseous biomass.



TEP Energy (2022)

Key challenges:

- **Labour and skills shortages:** A sharp rise in demand for heating replacements – roughly one-quarter of all gas and oil boilers need to be exchanged in the next 5 years – combined with the need to optimise the remaining gas heating systems and accelerate insulation improvements, presents a real challenge for the availability of skilled labour. The biggest challenge is likely to be the rapid expansion of heat pumps, which will require a doubling of both the current stock and the annual installation rate over the next five years.
- **Price effects:** The rapid increase in demand will also lead to price effects for the planning, installing and purchasing of heating systems, as well as for all other renovation works.
- **Integrated planning:** The accelerated phase-out of gas boilers will require a rapid development of integrated local heating and cooling plans to identify priority targets for building renovation and heating replacement, zone areas for district heating and synergies with other infrastructure investments (e.g. electricity grids) to reduce infrastructure investment costs.
- **Existing buildings and heating systems:** The efficiency of the building stock and the performance of existing technical systems could be a bottleneck for both the deployment of heat pumps and the expansion of new and existing district heating and cooling networks.
- **Stranded assets:** Many heating systems and gas grid investment won't reach their technical lifetime, leading to financial losses for building and gas-grid owners.

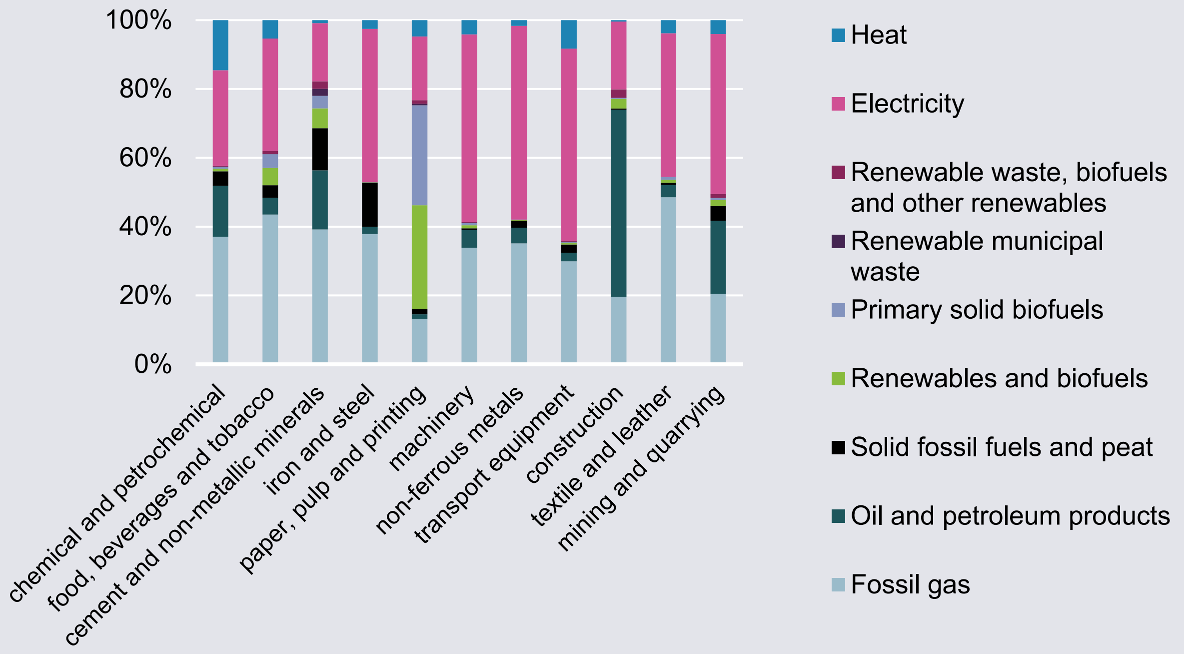
→ **Growing demand for biomass and fossil fuels:** Without guardrails, the EU's new climate targets could push demand for bioenergy beyond sustainability limits and jeopardise the EU's 2030 climate target by increasing coal and heating oil consumption in heating & cooling.

Industry: Reducing fossil gas use by at least 223 and up to 411 TWh by 2027

Industry is responsible for around 20.5% of annual EU fossil gas use as energy (around 860 TWh in 2019). This figure rises to 25% if gas use as a feedstock is included (1060 TWh in 2019). Some 84% of industrial fossil gas is used as an energy source for heat and for steam production, while 16% is used as a feedstock for non-energy purposes (e.g. in the chemicals and petrochemicals sectors). Gas reduction strategies must tackle both of these usages. As shown in Figure 5, in all of these sub-sectors there is fuel switching potential to either heat, electricity, renewables or even light petroleum products as a temperature solution.

Low-temperature heat (up to 150°C): The largest short-term potential to reduce fossil gas demand in industry is from energy savings and fuel switching for low-temperature heat applications. In 2018, 40% of industrial gas use (343 TWh) was used in fossil gas boilers for temperature levels of 100°C or lower (i.e. space heating, hot water supply and steam). A further 10% was used for steam and low-grade process heat up to 200°C (86 TWh). Given robust – but not

Figure 5: Share of gas in final energy consumption by industrial sub-sector in 2020



Eurostat, Energy Balances, Energy Flow statistics (2020 data). Notes: The main consuming industrial sub-sectors are: Chemicals and petrochemicals production (21% of industrial gas energy consumption), food beverages and tobacco (14%), cement and non-metallic minerals (14%), steel production (8%), pulp paper and printing (7%) and machinery manufacturing (6%).

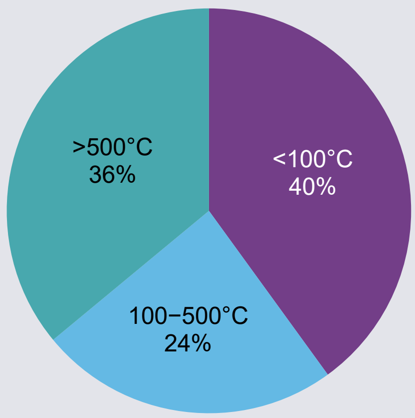
impossible – policy ambition, up to 75% of this gas for temperatures below 150°C could plausibly be replaced within 5 years. Depending on the extent to which this goal is achieved, this could create direct gas demand reduction savings of 170 to 283 TWh under the best case scenario.

The main measures available to industry are:

- Widespread deployment of industrial heat pumps
- Better insulation of industrial buildings
- More efficient recovery of waste heat from high temperature processes
- Fuel switching to electricity and other renewables for steam and low-process heat production, including to solar thermal and geothermal.

These measures would reduce gas consumption and total primary energy consumption in industry.

Figure 6: Share of industrial gas use as energy, by heating temperature (2018)



Agora Energiewende and AFRY Management Consulting: No-regret hydrogen (2021)

Medium temperature heat (150-500°C) accounts for a further 19% of industrial gas use for energy. Significant potentials also exist here to structurally reduce gas demand. This gas is used both for steam, medium temperature process heat and in combined heat and power (CHP) units. We estimate that fossil gas demand could be reduced in medium temperature industrial heat use by 30–80TWh by 2027 under a best case scenario.

Key levers to reduce gas consumption in these categories include:

- Replacing gas boilers with high temperature industrial heat pumps (most efficient)
- Installing small-scale concentrated solar thermal power units (most efficient)
- Replacing gas boilers with e-boilers in hybrid systems
- Reducing electricity production in CHP from fossil gas
- Switching gas for light fuel oil in existing gas boilers

Constraints: An important constraint on some medium temperature heat processes, such as e-boilers, is that they are less energy efficient than heat pumps or local renewable solutions. Thus, if they draw grid power, they must be operated during times when they do not induce net increases in total system-wide energy and fossil fuel demand. In member states where coal or gas is still used at the margin in the power market, electrified solutions such as e-boilers should thus be part of hybrid systems where their use is either limited to certain load hours where gas is not used at the margin, or else they must be integrated into real time power markets.

High temperature heat (>500°C): Around 36% (308 TWh) of energetic fossil gas used in industry in the EU is used in high temperature heating applications, such as cement kilns, in steel production and in crackers in the chemicals sector. Key levers to reduce gas consumption for high temperature energy use in these categories include:

- → Expanding high-temperature direct electrification solutions (e.g. replacing gas-based naptha crackers with e-crackers in the chemicals sector, increasing existing Electric Arc Furnace and high-quality scrap recycling capacities, investments into induction furnaces, resistance furnaces, electric ovens, and other electric heating systems)
- → Replacing fossil gas with solid biomass waste (e.g. in paper, glass, lime, foundries and ovens) or biogas and biomethane (e.g. in the chemicals or steel sector)
- → Replacing fossil gas with non-recyclable mixed solid waste (e.g. in cement kilns)
- → Expanding chemical and mechanical recycling of plastics
- → Increasing enhanced copper and alloy sorting and separation technologies for closed loop recycling of primary steel and aluminium

Constraints and potentials: The fossil gas reduction potential in the area of high temperature heat in is much more limited in the short term than for low and medium temperature heat. For high temperature heat, solutions must be tailored to the sector and to individual sites. Broadly applicable requirements are therefore more difficult to formulate. In some sectors, such as steel, an increase in gas use will potentially be needed to accompany the transition to hydrogen, making total reductions of gas consumption in this segment more difficult to estimate. Thus gas use in this segment may increase in some industries and decline in others. Our estimate is of potential savings of 3–20TWh by 2027; which represents only 1-5% of the total estimated potential.

Replacing fossil gas used as a feedstock via circular economy, material efficiency and substitution measures: Around 16% of fossil gas demand in industry is for use as a feedstock, most notably in chemicals production. The following options must be pursued as part of the transition to climate neutrality and could be accelerated during the next 5 years:

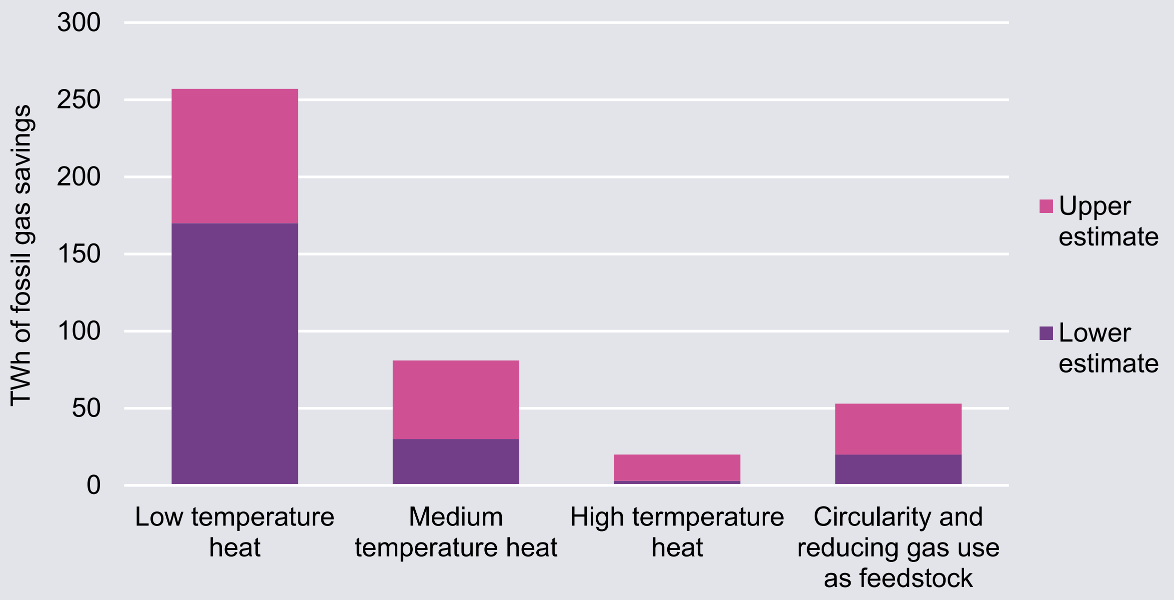
- → Reduce consumption of virgin plastics (especially single-use plastics). By 2030, up to 149 million barrels of oil equivalent worth of naphtha and 2.7 billion cubic meters of gas-derivative feedstock inputs into plastics could be saved. For gas, this would be roughly equivalent to 28 TWh of fossil gas in terms of energy content.[8]
- → Prioritise clean and fossil free hydrogen as an alternative to grey or blue hydrogen. 50% of gas used for grey hydrogen to produce ammonia could be replaced by 2030, according to the European Commission. A 20% replacement of gas-based ammonia with electrolysis by 2027 and a 50% replacement would be equivalent to savings of 9.6 TWh and 24 TWh of fossil gas by 2030.
- → Increase the use of alternative organic fertilisers. Replacing 10% of industrial fertilisers with organic fertilisers could save around 3.8 TWh of fossil gas currently used for EU ammonia production.
- → Reduce wasteful ammonia-based fertiliser consumption. Up to a 5% reduction could be incentivised by allowing for higher prices for gas-based ammonia fertilisers in a short time frame. This would be equivalent to a 1.9 TWh of gas savings within the next 1-5 years.

Summary of industrial potentials: In total, we estimate that the industrial sector in the EU has the potential to reduce fossil gas consumption between 223 and 411 TWh up to 2027. The wide range of this estimate reflects uncertainties surrounding the strength of policy incentives, the effectiveness of

8 Since here the majority of the inputs saved are fossil gas derivatives, they are not direct substitutes for fossil gas for all end-usages. Nevertheless, total fossil gas consumption in the EU's regional market and EU imports of fossil gas and its derivatives would be saved by such measures, thus helping to ease overall supply and demand constraints.

policy implementation, and the creation of sufficient economic incentives for the supply and installation of necessary technologies within the required timeframe. The vast majority of this potential pertains to total fossil gas demand (including non-fossil gas). The main exception would be the expanded use of hydrogen as a feedstock in the steel and ammonia sectors. We estimate that this increase in *non-fossil* gas demand could be met based on the hydrogen quota of 50% for Renewable Fuels of Non-Biological Origin that is discussed as part the Update of the EU Renewable Energy Directive, with production reaching 32.6 TWh by 2027 and 81.5 TWh by 2030.

Figure 7: Potential fossil gas demand savings of 223–411 TWh in industry across the four main categories of measures



Agora Industry (2022)

Power: Reducing fossil gas use by 500 TWh through ramping up wind & solar PV faster, reducing the share of gas in baseload and increasing system flexibility

From 350 to 900 GW within 8 years – a true European industry project. Scenarios that achieve climate neutrality by 2050 typically feature a carbon-neutral power system by 2035, mainly based on wind and solar. A decarbonised power system is also a key element to reduce fossil gas dependency, because clean power can go a long way in decarbonising the areas where fossil fuels are still dominant.

The current EU ambition set out in the Fit-for-55 package would see Europe reach 427 GW of installed wind power capacity and 383 GW of installed solar power capacity by 2030. The RePowerEU Communication raises these figures by a further 90 GW to 480 GW of wind capacity and 420 GW of solar capacity by 2030, with 80 GW earmarked for additional green hydrogen production. In 2021, the EU had 192 GW of wind power capacity and 158 GW of installed solar power.[9]

The new targets under RePowerEU would more than double (by a factor of 2.5) installed capacity by 2030, reaching in 2027 approximately 377 GW of installed wind capacity and approximately 329 GW of solar PV. We estimate that this share of renewable power in the mix would lead to a corresponding reduction of fossil gas for power production by 500 TWh by 2027 (see Infobox 2) .

Notably, the wind capacity deployment projected by the Commission is consistent with what the wind

Figure 8: Historical and projected deployment rates for wind (onshore and offshore)

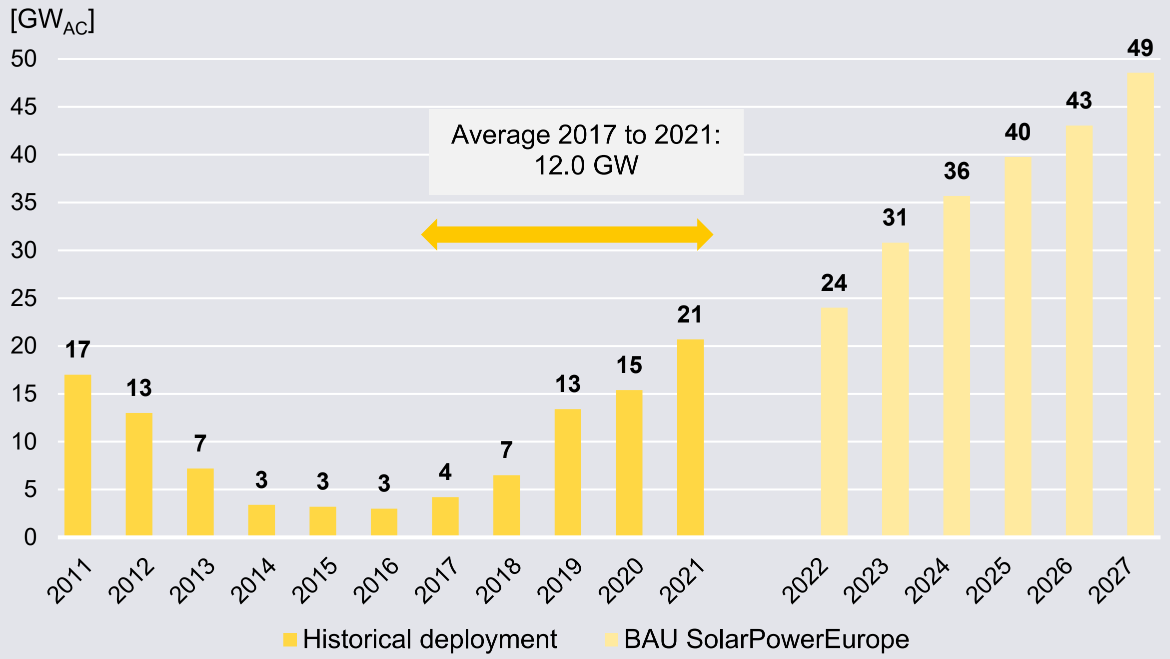
Adapted from the European Commission (2021) and WindEurope (2022) industry considers feasible (see Figure 8) , whereas the solar PV figures projected by the Commission remain below what market see in the current project pipeline and far below what the industry believes is feasible with the right conditions in place (see Figure 9).

Technical feasibility: The updated wind power installation target of 480 GW by 2030 is aligned with the industry's estimates for the end of the decade, provided an enabling regulatory framework and favourable funding conditions are in place. Around 80% of the new wind turbines will be built onshore, the rest offshore. **However, an instant and real gear-shift in scaling new wind turbines is needed to reach the projected deployment pathway.**

While the RePowerEU target for wind reflects the upper end of industry's potential, the solar PV industry could see Europe reach an installed solar capacity of around 600 GW by 2027 under its "accelerated high scenario" – assuming that the EU were to follow an ambitious high policy support regime mirroring China's approach to solar PV expansion.

For example, much more than the 15 GW additional rooftop PV featuring in the RePowerEU strategy seems achievable because more than 90% of European rooftops suitable for PV deployment are still unused.[10] Other options include early re-powering of existing solar installations with more efficient modules. In addition, solar PV could be expanded to new areas along transport corridors, other unused built environments and as agrivoltaics. Unlike biogas, agri-

Figure 9: Historical and projected deployment rates for solar PV



Solar Power Europe (2022); numbers in AC converted from DC numbers with a factor of 1.25

voltaics would allow the continued use of the land for harvesting, avoid additional pressure on soils and provide an additional income source for farmers.

Investment needs and public support

A research project by Aurora Energy Research for Agora Energiewende estimates that the solar and wind power installations added to meet the Fit for 55 ambition by 2030 (hence not yet the additional ambition of RePowerEU) will need support of circa 118 billion euros. This is the amount needed to make the new installations investible and stabilise their revenue streams. The support would be disbursed over the lifeteime of the installation, to a large extent after 2030. Support contracts can be financed through either levies or government budgets. This estimate significantly depends on future gas, ETS, wholesale and capture prices and future power demand. Commitments could be as low as 30 billion or as high as 285 billion euros. The bulk of support would be required for offshore wind, where investment sums and project risks are high.

With only 20 billion euros committed in all recovery plans for renewables support, it is clear that additional funding at both the EU level and the national level will be required to meet the EU's higher ambition on renewables. Notably, the faster scaling of offshore wind energy also means that more than 6.5 billion euros projected in the EU's offshore strategy for upgrading ports to become offshore hubs and for transmission network capacity are needed.

For PV, the amount of support needed also depends on the type of capacity installed – i.e. rooftop PV or more innovative PV such as PV integrated into buildings or agriPV, which is still more costly.

Another factor determining necessary support levels is the effect of very high shares of renewable electricity on market revenues. Depending on the extent of power system flexibility periods of low or even negative prices are reduced.

A high share of renewables however reduces wholesale prices overall to the benefit of all power users.

Electricity Grids: Power cables, not pipelines will constitute the backbone of the future energy system. Numerous studies have shown that renewables expansion and the growing electrification of buildings, industry and transport will need strengthened and modern power grids. The bulk of these investments will occur at the distribution grid level. Transmission and distribution grid investments were not modelled as part of this analysis. Based on various scenarios (Goldman Sachs, McKinsey, Eurelectric and EC modelling), estimates range from 0.9 billion euros to 3 billion euros of grid investments per additional GW of RES in the EU, resulting in 470–1650 billion euros of cumulative grid investments for this decade. This compares to 130 bn between 2011-2020 according to Commission data.

INFOBOX 2. Renewables and fossil gas consumption in the power sector

The amount of fossil gas displaced in the power sector is estimated to be 500 TWh. This estimate is subject to assumptions on renewables deployment, fossil gas prices, coal prices, ETS prices and their relations. With increasing volumes of renewables, the additional amount of fossil gas displaced decreases, because the full load hours that fossil gas power plants operate are expected to decrease: From 2800h in 2018 to around 1400h in 2025. Fossil gas power plants will mainly run during hours when renewable production is low or to provide balancing and system services. Renewable electricity on the other hand will power additional electricity demand from electrolysers, heat pumps, electric vehicles, electric industry applications and also replace mainly coal, lignite and nuclear generation.

Flexibility, demand response and security of supply

Our modelling indicates that overall gas turbine capacity in the power sector will remain almost constant until 2030. However, as renewable electricity continues to penetrate the market, the use pattern will increasingly shift to peak supply with an average of 1400 full-load hours in 2025 and further decreasing thereafter. In view of the policy objective – a climate-neutral power system by 2035 – any new gas-power investment needs to be 100 % hydrogen-ready by the end of this decade.

Safeguarding system adequacy is an increasingly dynamic issue. It is not only about the quantity of capacity installed, but also about the kind. Similarly, cross-border system integration lowers the costs of achieving a reliable power system. The recent rejection of the first EU system adequacy assessment by ACER – which argued that achievable market revenues were underestimated and the value of demand-side response is not fully captured in ENTSO-E's modelling – suggests that more is possible with measures that avoid adding new cabling.

Demand response will need to get more attention amid reduced dependency and increased industrial electricity demand. Technically it would be possible in many cases to shift demand by a few hours, adapt production accordingly and, increasingly, add storage capacity for intermediate products and hot air. Similarly, the retail sector can shift power demand by, say, controlling store heat or cold for short periods of time. Such peak shaving together with further deployment of storage ensures that peak gas use in the power sector remains as low as possible. Finally, heat pumps and EVs can contribute to balancing supply and demand in power grids. However, current buildings, electric vehicles and charging stations often lack the technical systems required to fully exploit such potential.

Battery storage: Although battery costs have significantly declined in the past years (-89 % since 2010), Lithium-ion batteries are not cheap enough to profitably store power. This said, the Commission projects that deployment of large-scale stationary batteries will increase from 3 GW today to more than 11 GW in 2026.[11] But that would not be enough: Our modelling suggests that 27 GW of stationary batteries will be needed in 2027 for RePOwerEU. This comes with an investment of ~11 billion euros per year. Goldman Sachs estimated that annually around 8 billion euros need to be invested for battery storage to support grid flexibility in Europe by 2030. Unlike hydrogen, batteries have not been present in RRFs so far.

Renewable hydrogen: Finally, more electrolyzers will also add flexibility capacities to the power system. The REPowerEU communication places a strong focus on hydrogen over other flexibility options. It envisions an increase of the EU's hydrogen production to 20 million tonnes by 2030, which represents 15 million tonnes to in addition to the 5.6 million tonnes projected to be produced under the Fit-for-55 package. These are very ambitious objectives, indeed, and with blue hydrogen no longer available (see Infobox 3 below), larger quantities of renewable hydrogen will thus be needed and they will be needed a lot earlier than previously assumed. Our calculations suggest the need for 22 GW of electrolyzer capacity by 2027, which seems to align with the Commission's objective of 6 GW of installed electrolyser capacity by 2024 and 40 GW by 2030 and plans of Member States announced in their economic recovery plans. Three things are now more important than ever: Steering green hydrogen only to applications that cannot decarbonise

11 See https://energy.ec.europa.eu/system/files/2019-06/report-_battery_storage_to_drive_the_power_system_transition_0.pdf

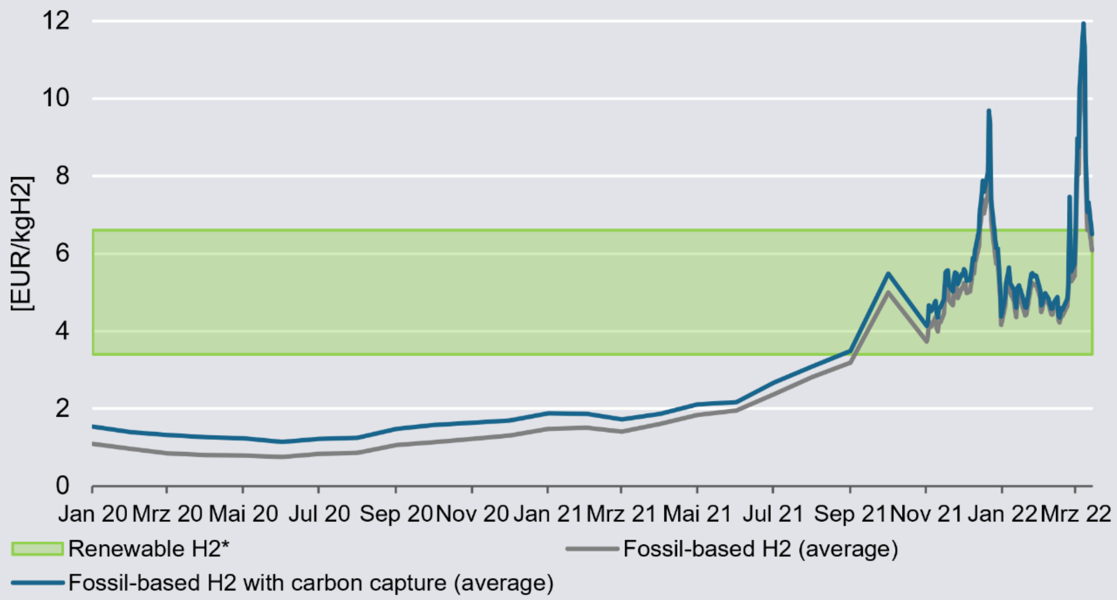
INFOBOX 3. The changing economics and geopolitics of blue hydrogen and the even higher pressure on green hydrogen to emerge

'Blue' hydrogen produced from fossil gas with carbon capture and storage plays a prominent role in many decarbonisation scenarios, in particular as a transitional fuel until 'green' hydrogen produced from renewable electricity becomes widely available. Considering the current objective of reducing Europe's dependence on (Russian) fossil gas, fossil gas-based hydrogen can no longer be considered part of the solution. On the contrary, next to concerns over its compatibility with net-zero ambitions, the inevitable conversion losses in the production process of blue hydrogen means that its scaling would tend to increase the EU's reliance on fossil gas in a time of great market scarcity. Prevailing gas prices have also decidedly undermined the business case for blue hydrogen while significantly enhancing the competitiveness of green hydrogen (see figure below).

With blue hydrogen unlikely to feature as a viable and competitive alternative for the foreseeable future, renewable hydrogen will be in increasingly scarce supply relative to growing demand, especially for applications that currently rely on fossil gas and fossil hydrogen, and which cannot achieve climate neutrality with alternative pathways such as direct electrification. Therefore, an accelerated deployment of renewable hydrogen must be accompanied by an equally strong commitment to prioritise and target deployment of renewable hydrogen in no-regret applications (e.g. steelmaking, basic chemicals, aviation and shipping), to abandon ideas for inefficient applications (e.g. grid-based blending) and to emphasise the additionality of renewable electricity production when hydrogen is supported.

Failing to achieve this prioritisation and reorientation would put parts of EU industry at considerable risk of offshoring, not least those already reliant on hydrogen produced with fossil gas (e.g. ammonia). Uncertainty regarding the sufficient availability of renewable hydrogen could also risk reinvestment in fossil technologies with considerable lock-in effects, in particular in industries (such as steel) facing significant reinvestment cycles over the next decade.

Cost of renewable H2 and fossil-based H2 with carbon capture 2020-2021



Agora Energiewende and Guidehouse (2022)
* Renewable H2 production based on RES direct connection / RES PPA

with other means (industry, high-temperature uses, maritime and aviation), prioritising green hydrogen across all Fit-for-55 areas, and adhering to state aid rules as long as provisions for low carbon hydrogen are not yet fully defined.

Key challenges

Permitting: Long, complex and uncertain permitting processes for both new and repowered wind and solar PV projects are a serious obstacle across Europe.[12] Better staffing and training of planning and permitting authorities and some restrictions on legal challenges against renewable energy projects, considering the overriding public interest in ramping up renewables as fast as possible, are the most important levers to accelerate.

Spatial planning for renewables: Another problem is the currently insufficient designation of areas for developing renewables in spatial planning, resulting in lack of available land. Available seaspace is also a major issue for offshore wind projects.

Grid-related issues: Several aspects of grid planning and policies stand in the way of faster renewables uptake. There is still a significant amount of uncertainty around the awarding of grid connections. In around half of EU Member States, the costs of grid connection are also an issue. Infrastructure development is not fast enough and often unpredictable whether it will happen and by when. Moreover, infrastructure planning often does not factor in future consumption and production centers.

Revenue stabilisation, de-risking and funding volumes: The projected massive scaling of new solar and wind capacities to regain energy sovereignty in Europe constitute an energy and industry project comparable in scale and ambition to the expansion of nuclear power in Europe in the 1960s and 70s. It will require substantial investment volumes, including for grid expansion. Renewable energy companies will not be ready to invest at the required scale unless governments offer a robust investment framework in the form of revenue stabilisation and de-risking investments.

Supportive legislative environment: Not all discriminations for wind and solar have been removed from EU legislation and the Fit-for-55 proposals, such as renewables heating not being based on bioenergy. Clear rules are also needed for hydrogen deployment. In particular, the EU needs fully prescribed standards for low-carbon production based on lifetime emissions. These standards must underlie state aid and the EU budget and rules for green hydrogen that minimise fossil gas use in production.

Supply chain issues: Even if the dependence on input material for wind and solar is only an issue during the manufacture of generation equipment – in contrast to fossil fuels, where dependency occurs throughout the operation period – the scale of the ramp-up will put pressure on supply chains. Steel, copper, aluminium and raw materials will need careful monitoring. In the case of solar energy, a full re-establishment of solar manufacturing is a possibility, as was laid out by the Fraunhofer institute in 2020.[13]

12 See https://resmonitor.eu/en/

13 See https://www.ise.fraunhofer.de/de/veroeffentlichungen/studien/sustainable-pv-manufacturing-in-europe.html

4 RePowerEU must be developed as a European political project based on joint commitments and solidarity

The European Council has entrusted the Commission with developing a RePowerEU plan by the end of May 2022. It is critical that this plan becomes a European project based on joint commitments and solidarity, underpinned by the necessary political, human and financial resources to fully see through the implementation of the plan.

There are two main reasons why this is critical:

Widely differing dependencies and means: As shown above, the specific challenges of rapidly reducing fossil gas consumption differ widely between countries in Europe. The share of households depending on fossil gas for heating whose energy bills are impacted by rapidly rising prices is much higher in some countries than in others. And similarly, the necessary investments for replacing fossil gas for heating are very unevenly spread across countries, many of which have below-average GDP per capita. Europe's uneven dependence on fossil gas will become even more visible should gas imports from Russia be interrupted by the EU or by Russia due to the sanctions.

If phasing out dependency on Russian gas is a common political objective of the EU, Member States with particular exposure to Russian gas (e.g. the Baltic countries) and with lower-than-average GDP and fiscally fragile countries will need support.

Need to anticipate Russian interference: In the run-up to and during its full-scale invasion of Ukraine, the current Russian leadership has used Europe's dependency on Russian gas as a political and economic weapon. Based on this experience, we cannot expect the Russian leadership to stand by idly over the course of five years while we gradually eliminate our dependence on Russian fossil fuels – and thereby eliminate large parts of the revenue base that keep the regime alive.

The EU-27 countries have shown remarkable unity when putting in place the sanctions package against Russia. However, the widely differing impacts of the energy security and energy price crisis resulting from the war already pose a challenge to maintaining political unity. European unity will also be put to the test after the war, when the Russian leadership will try to achieve an early lifting of the sanctions.

A robust governance framework to deliver RePowerEU

The challenge of maintaining unity is arguably greater than during the COVID-19 pandemic. But important lessons can be learned:

Joint commitments in the RePowerEU plan must be concrete and actionable, they must be embedded in a dedicated process that drives full and effective delivery, and it must be supported by a dedicated investment framework.

- → Policy direction by EU heads of state and government is essential. The European Council in June 2022 should formally launch the RePowerEU plan. Thereafter, heads of state and government should regularly take stock of progress and set new priorities moving forward.
- → EU Energy and climate ministers as well as EU Finance ministers should regularly discuss the challenges in implementing RePowerEU and agree on concrete steps to resolve them.
- → Senior officials of energy and climate ministries of Member States, supported by the Commission, should cooperate on the exchange of information and experience and offer support.
- → The Commission should establish a dedicated Energy Sovereignty Task Force modelled on the EU Recovery Task Force with the sole task of supporting Member States in delivering their planned national contributions to RePowerEU.

- The European Parliament's ITRE, ENVI and BUDG committees should regularly organise hearings on the state of RePowerEU and its implementation.

Solidarity also means helping Ukraine build back better

While writing this report, the Ukrainian people are fighting a heroic battle for their freedom as the Russian army not only targets the Ukrainian military, but also deliberately kills civilians and destroys energy and industrial infrastructure.

After the war ends, countries in the European Union owe it to the Ukrainian people to help them rebuild. This commitment should be an explicit component in the RePowerEU plan.

5 Fifteen priority action areas for RePowerEU

In the following, we propose 15 priority action areas for the RePowerEU plan: six for buildings, five for industry, four for power.

Each of these priority action areas highlights a key technological, regulatory or behavioural lever for achieving the gas savings described in this report, as well as some concrete actions that policymakers can take to harness them. Some of the actions require EU-level action others need a firm national commitment. All should be addressed as potential priority actions for inclusion in the national contributions to the RePowerEU plan.

With energy prices at record levels and the EU's energy sovereignty in jeopardy, governments must act swiftly and with determination to protect their citizens and companies. Yet it would also be a failure not to recognize the power of exactly these price signals to reduce fossil gas consumption. Governments should therefore smartly use price signals to reduce gas demand and mobilize the needed private investments in clean technologies, while protecting vulnerable households and critical parts of the industry with targeted support.

Priorities for the buildings sector

Action Area 1. Introduce an EU-wide 'Check & Act' campaign and mobilise a Civilian Energy Corps

- Launch a large 'Check & Act' media & communications campaign to promote energy saving measures and mobilise citizens to take action on reducing gas consumption supported by communication material to promote energy savings, introduce free online energy savings consultations in all EU languages and create a platform to share best practices in communication on energy savings. The campaign should include communication activities that help bust common myths about heat pumps.
- Require utilities, district heating companies and providers of thermal billing services to identify clusters of buildings with high thermal demand via a central data platform in order to identify buildings to be targeted for priority demand reduction and boiler replacement.
- Develop and launch Citizen Energy Corps that support cities and regions across the EU in quickly training and mobilising teams of professionals, students, apprentices and civil service volunteers to help citizens in achieving energy savings. Trained members of the Citizen Energy Corp should be provided thermal imaging cameras to go door to door to identify cold spots and help install simple energy savings measures, set heating and boiler controls and provide information on cost-effective 'do-it-yourself' measures.
- Where possible, train members of the Citizen Energy Corps to identify the relative suitability of the roofs of the buildings they are visiting, as well as provide information on the benefits of so-

lar rooftop PV and support programs available in the community (see Action Area 13).
- → Launch a campaign to install thermal insulation in all attics and roofs in the next 5 years.
- → Help towns, regions and cities by bulk-ordering energy saving materials and equipment and helping to finance energy audits, vouchers and green technology showcase events.
- → Adopt energy efficiency obligations for commercial and public sector office buildings and aim for the adoption of energy management systems in all commercial and public sector buildings heated by fossil gas in the next two years, supported by public grants and loans.

Action Area 2. Make the training of skilled professionals for the energy transition a key priority

- → Develop national plans and training programs to ensure that enough trained and qualified energy auditors, electricians, construction workers, engineers and installers are available to meet the accelerated deployment pathways for the key clean technologies needed to reduce the EU's dependence on Russian gas, especially in the areas of wind, solar, building insulation, heat pumps and district heating.
- → Establish an annual EU "skills summit" to make sure that all Member States address the number and level of skilled workers. The summit should serve as an event for stock-taking and best practices exchange, focused on both training and making maximise use of existing capacities.
- → Use the EU Citizen Energy Corp as an opportunity to introduce citizens of all ages, and especially all genders, to professions relevant for the decarbonisation of buildings, power and industry and for which there are labor shortages.
- → Support training programs for heating appliance installers to ensure that the remaining gas boilers that are installed between now and 2025 are properly sized and fitted to ensure maximum efficiency.
- → Explore ways to improve installation capacities through the optimisation of processes, including the synergistic effects between the installations of PV, heat pumps, batteries and charging points.
- → Enhance national quality control measures to ensure that the fast deployment of building efficiency measures, heat pumps and rooftop solar does not come at the expense of lower energy performance and the failure to deliver promised outcomes.

Action Area 3. Stop installing new gas boilers

- → Revise the proposed Ecodesign and Energy Labelling rules for space and water heating appliances to remove all heating appliances with an efficiency below 110% as early as 2024, effectively banning non-hybrid oil and fossil gas boilers from the EU single market.
- → Immediately act to remove all remaining subsidies for boilers operating on fossil gas and introduce bonus-malus schemes that tax the installation of non-hybrid oil and gas boilers and use the revenues to support the uptake of clean heating technologies.
- → Immediately prohibit the installation of new oil and gas boilers in all new buildings.

Action Area 4. Rapidly scale up the production and installation of heat pumps

- → Introduce a CO_2 standard for heating appliance manufacturers modelled on CO_2 standards for cars (max. CO_2 emission per kWh of thermal heat provided) for which heat pumps would be given a zero rating. This policy would help to ensure that boiler manufacturers operating on the EU market sell a minimum share of heat pumps in line with this trajectory and send a clear political signal to industry leaders to scale their associated supply chains to the needed levels.
- → Introduce an EU Heat Pump Accelerator, similar to the EU Clean Hydrogen Alliance, that coordi-

nates strategic policy actions for scaling heat pump manufacturing and installation and serves as a one-stop-shop for information sharing.
- Increase financial support for the installation of heat pumps in line with the accelerated pace of installation via upfront grants, subsidised loans, a temporary elimination of the VAT on heat pumps and other renewable heating technologies for the next 5 years and an accelerated depreciation of heat pump investment costs for businesses.
- Take immediate measures to balance electricity and gas prices in favour of heat pumps and ensure that heat pumps are, on average, cheaper to operate than fossil gas boilers in terms of operating costs (by, say, reducing electricity taxes and funding support programs for renewables).

Action Area 5. Rapidly scale up building renovation

- Quickly establish a 'Renewables Ready' building standard for existing buildings that defines the measures and operational performance needed to enable the efficient and flexible operation of renewable heating systems such as heat pumps and low-temperature district heating.
- Quickly adopt minimum energy performance requirements for existing buildings and aim to renovate the lowest-performing 25% to the 'Renewables Ready' Standard by 2027 and all buildings by 2030.
- Commit to achieving an average annual renovation target of 3% over the next five years for all public-sector buildings (including healthcare, education and public housing) and develop building renovation action plans in line with this goal.
- Introduce a comprehensive roll-out of energy audits and building renovation passports accompanied by a campaign to train emergency experts (i.e.: architectural/construction engineering students), who could issue building renovation passports under the supervision and guidance of professional experts.
- Require all building owners with a gas or oil boiler older than 15 years to undergo a free energy audit and develop a building renovation roadmap within the next five years.
- Launch a new initiative to support the rapid creation of industrial-scale building renovation programmes by providing special financial assistance to the first 100,000 housing units renovated before 2027.
- Ensure that all building owners required to carry out renovations for meeting new building standards are eligible for state aid, while linking the level of eligible costs to the depth of renovation, choice of heating technology, early action and use of low-GHG-intensive building materials.

Action Area 6. Connect more homes to district heat networks and make them greener and more efficient

- Municipalities with a population higher than 20,000 should immediately start developing local heating and cooling plans. These plans are needed to identify local renewable energy and waste-heat potentials, establish zone areas for future heat supply via district heating and prepare the orderly phase-out of fossil fuels in buildings by no later than 2040, including the decommissioning of existing gas grids.
- Provide dedicated funding to local governments to support the development of local heating and cooling plans (in the form of, say, per-capita support payments) and to regional governments to develop the capacity of regional energy agencies for heating and cooling plans.
- Provide a dedicated financial support programme to help district heating companies develop plans for achieving full decarbonisation (100% renewables and waste heat) by 2040 within strict sustainability constraints (e.g. biomass potential).
- Develop and strengthen existing financial support programs for the modernisation and growth of existing district heating grids, the development of new low-temperature district heating

networks and the accelerated deployment of investments in renewables (e.g. large heat pumps, geothermal, solar thermal), thermal heat storage and industrial waste heat.

→ Accelerate the deployment of geothermal in power and district heating by streamlining regulatory and permitting frameworks and developing a European financial risk mitigation framework that helps to de-risk the deployment of large-scale geothermal projects for local authorities and private investors.
→ Take into account all major sources of waste heat (e.g. data centres, metro stations, supermarkets and waste-water treatment plants) when developing local heating and cooling plans and require them to feed into district heating systems wherever cost-efficient.

Priorities for the industry sector

Action Area 7. Don't regulate industrial gas and energy prices; let the demand signals work.

→ Allow higher gas prices to work through the industrial sector value chain in order to incentivise efficient fuel switching, virgin material reductions, substitutions and demand decreases. For sites using large amounts of energy, for consumers of products rich in fossil gas as a feedstock (such as agricultural usages of fertiliser), and for reducing excess plastic use in packaging, etc, price signals are the most effective way to incentivise the rapid curtailment and switching to more circular and more materially efficient solutions.
→ When caps must be placed on gas, power or fertiliser prices, ensure they are sufficiently high so as to send industry strong price signals before they kick in.
→ Ensure that all medium- and high-temperature heat consumers with electric heating systems have real-time price incentives and variable price contracts for responding to demand. Real-time incentives for demand response on the wholesale power market can encourage medium- and high-temperature industrial heat consumers to install e-boilers and other electric systems alongside existing fossil-fuel-based units and to avoid drawing on power from the grid at times when gas (or coal) is used at the margins.

Action Area 8. Take emergency measures to avoid irreversible reductions in EU industrial and agricultural production

→ Grant liquidity support and state aid for energy-intensive industries to temporarily curtail (but not shut down) production as a temporary measure during the next 12–24 months to assure provisions for the coming winter. Similar aid should be granted to vulnerable agricultural producers.
→ Accept a temporary increase in imports over the next 1–2 years to limit inflation and shortages in critical materials; and assess potential structural measures to take in the event that energy prices remain persistently high so as to limit the financial burden on the state while protecting the domestic production of critical raw materials.

Action Area 9. Accelerate the uptake of renewable solutions for low- and medium-temperature industrial heat

→ Require a full phase-out of fossil gas for all industrial applications using heat levels below 200C within 3 years (i.e. by 2025).
→ Require the implementation of either full-electric or hybrid-electric and fossil-fuel systems for all industrial heating applications below 500C by 2027.
→ Provide accelerated depreciation, zero-interest loans and capex aid to accelerate payback periods on investments in direct electrification, renewables, hydrogen and enhanced recycling technologies and ensure that price and regulatory signals translate into speedy investment.

- Streamline permitting for new sites, site extentions and fossil-free energy infrastructure linked to industries aiming to reduce fossil gas consumption.

Action Area 10. Regulate industry to ensure that all cost-effective energy savings measures are taken

- Immediately ramp up all existing national energy efficiency savings targets to raise the value of across-the-economy energy savings.
- Require all energy-intensive companies to undergo (renewed) energy audits and implement all energy savings measures with a payback period of 10 years or less.

Action Area 11. Rapidly scale material efficiency and enhanced recycling of energy-intensive materials

- Require all plastic, steel and aluminium sellers to increase the minimum content of recycled materials in their products by 3% per annum by 2025.
- Immediately implement deposit refund schemes for plastic and aluminium recycling.
- Require all recyclers of energy-intensive materials to adopt best-available techniques for ex-post sorting, separating impurities, and recycling scrap.
- Immediately introduce a ban on the export of scrap and plastic in energy-intensive sectors outside of the EU/EFTA region.

Priorities for the power sector

Action Area 12. Pull all stops for renewables deployment and manufacturing in Europe

- Encourage Member States to re-orient planned spending in RRF, CAP, cohesion spending, etc. towards wind and solar and away from bioenergy. Push Member States to pay into the EU Renewables Financing Mechanism, even when it comes to unused RRF.
- Identify minimum staffing levels and ensure sufficient capacity in public authorities responsible for RES planning and permitting to manage the anticipated increase in additional permits sought. Fast-forward permitting for repowering.
- Make the scaling of domestic solar PV manufacturing a core focus of the EU's upcoming solar strategy. This should include a target of at least 20 GW of PV production by 2025, covering the entire value chain from polysilicon to modules.
- Establish industrial initiatives modelled on the EU Battery Alliance for solar PV manufacturing and floating offshore wind and for the launch of a green critical raw material strategy, including recycling for key inputs to renewables technologies.
- Establish a Renewables Investors Group following the successful example of the Energy Efficiency Financial Institutions Group (EEFIG), as well as a de-risking instrument for emerging renewables technologies under InvestEU.
- Enable and make use of financing from the EU's Common Agricultural Policy for deployment of agrivoltaics and green ammonia production. Establish a target of 5 GW of agrivoltaics in the EU by 2027 to be co-financed through CAP.
- Ensure that 'windfall profits' obtained in the energy market through the high prices set by expensive gas power plants are re-invested into scaling renewables deployment in accordance with the new Commission guidance on the matter.
- Make operational the legal principle to consider renewable energy projects and related infrastructure as in the overriding public interest to accelerate renewables permitting, whilst ensuring that public support and other environmental aspects do not suffer.
- Update EU public procurement guidelines for electricity contracting so as to support municipalities and companies in contracting green elec-

tricity from additional wind and solar projects without the need for guarantees of origin.
- → Apply additionality principles for all EU and MS investments in hydrogen.

Action Area 13. Mandate solar rooftops, solar on built environments and maximise PV self-consumption

- → Introduce solar rooftop obligations requiring all building owners in case of new construction and major rooftop renovations to either install solar PV or solar thermal by a set date, or enter the rooftop into a lease register that allows others to exploit the potential.
- → Provide additional incentives (e.g. subsidised loans) to ensure that the rooftop area of each building is exploited to maximum extent, as well as sanctions (e.g. penalties once a certain number of offers are rejected) to ensure obligated parties do not circumvent the obligation. Consider PV deployment along transport corridors, including via CEF.
- → Mandate manufacturers of PV inverters to provide a communication interface to heat pumps, batteries and EV chargers to maximise the consumption of PV energy on each respective building or lot.
- → Review and adapt national laws to enable renters to install micro scale solar modules.

Action Area 14. Fully and ambitiously transpose existing electricity market rules to enhance power system flexibility

- → Issue an ACER/Commission guidance for ENTSO-E on how to better reflect the now even higher value of demand response and flexibility and actually available capacity for cross-border trade in the European Resource Adequacy Assessment (ERAA) to correctly depict the state of play and outlook for security of supply.
- → Carry out a comprehensive stocktaking and re-evaluation of capacity mechanisms approved so far and their performance and develop minimum criteria to be respected to allow for proper demand-side, storage and renewables participation in capacity mechanisms.
- → Ensure an ambitious transposition of all wholesale electricity market flexibility provisions to ensure improved integration of renewables and minimized need for fossil gas based balancing energy, e.g. reduced cross-border intraday gate closure times, integrating the liquidity from the replacement reserves market in intraday, remove exceptions from procuring all balancing capacity volumes in the day-ahead timeframe and 15-minute products on the day-ahead market.
- → Require hourly cross-border intraday auctions to correctly depict the value of cross-border flows and optimise the utilisation of available cross-border transmission capacity
- → Fully transpose the demand-side flexibility provisions of the Electricity Directive, establish minimum flexibility requirements (e.g. bi-directional charging for EVs) and consider common standards for communication with flexible assets (e,g, EVs, aggregated heat pumps) . Consider mandatory installation of smart electricity meters and smart thermostats for all consumers.
- → Establish rules in the forthcoming renewable hydrogen delegated act to ensure that electrolysers are operated in view of power system flexiblity needs (rather than exacerbating bottlenecks) that will increase with the faster than anticipated ramping of renewable power production.

Action Area 15. Strike a smart balance between direct electrification and green hydrogen production

- → Immediately review the EU and national hydrogen strategies, EU spending programmes, the Fit-for-55 package and the EU's gas and hydrogen package to remove all incentives for inefficient applications of hydrogen outside of no-regret sectors.

- Adapt state aid rules to prohibit support for hydrogen in inefficient applications, including the provision of low-temperature industrial heat and fossil-based hydrogen production.
- Re-establish the priority on green hydrogen from the 2021 Hydrogen Strategy and introduce it the Gas Package, the Energy Taxation Directive and the application of state aid rules. Establish a phase-out date for grey hydrogen by 2030.
- Ensure that all Member States integrate investments in flexibility, batteries, industrial and residential heat pumps and district heating into cohesion spending and RRF.
- Complement the prioritisation of hydrogen applications in the Renewables Directive with a sunset clause for gas in low temperature uses below 200 C and a sunset clause for grey hydrogen by 2030.
- Establish a planning process for hydrogen infrastructure, steered by the future users and producers of hydrogen, that integrates hydrogen and electricity planning as well as local heat plans. Ensure that national, regional and local heating and cooling plans take into account the limited sustainable potentials of hydrogen and biomass.
- Implement renewable additionality rules for publicly funded hydrogen investment, ensuring that 3-4 MW of RES-E are developed for each MW of green hydrogen.

6 An investment framework for RePowerEU based on European solidarity

The necessary investments in Europe's clean-energy sovereignty must occur at a time of increased military spending, aid to Ukrainian refugees, and rising costs of energy and food hitting poor households.

The mobilisation of the required investment in renewable energy, infrastructure and energy efficiency will not happen without a robust policy framework that combines regulation with public grants and other kinds of public financial support. Moreover, a just transition with public ownership of key assets will require a high degree of public financing.

Table 2 shows our assessment of the public share of the investment needs for the identified RePowerEU priorities. The figures only cover grants and not repayable instruments or guarantees. It is clear that, in spite of the presence of the Next Generation EU (incl. RRF) complementing the EU budget, the lion's share of public financing will need to come from national budgets.

The RePowerEU plan increases ambition for all Member States, while not expanding the resources available for EU support. The starting point is a situation in which investments in national Recovery and Resilience Plans (RRPs) where already insufficient to significantly advance the EU economy towards the 2030 climate targets.[14]

Public finances of many Member States are constrained by high public debt levels, that increased significantly during the Covid-19 crisis. Before the

Table 2: Public funding needs of the 15 priority actions

bn EUR (2022–2027)	Public funding needs (total)	Public funding needs (per year)	National budgets	EU funds (EU budget, RRF, other)
Power sector and H2	103	11	31	72
District heating	210	35	176	34
Building and heating renovations	337	56	253	84
Industry	30	5	4	26
TOT	**680**	**113 (0.81% EU GDP)**	**464**	**216**

Agora Energiewende (2022)
Note: includes only RRF funding in the 22 plans approved by the Council. Percentage of 2019 GDP

14 See our analysis published on Social Europe, accessible at https://socialeurope.eu/building-back-greener.

war, the debate on EU fiscal reform had highlighted the need for more EU solidarity to support pre-defined green spending in fiscally fragile countries.

Green golden rules leave the burden of financing the necessary public spending on national governments, not helping when a country has little fiscal space. The public spending gap from the 2030 EU climate targets is at least 1% GDP in the EU[15] and the RePowerEU plan increases the bill by frontloading green investment. At the same time, high energy prices reduce the space for carbon pricing, the main source of fresh revenues for governments.

Leaving Member States to their own devices when financing bolder EU-wide ambitions increases the likelihood that they will fall to achieve common targets and increases the risk of widening sovereign spreads in the euro area and another severe public debt crisis. Moreover, the common benefits of the RePowerEU plan, both environmental and geopolitical, are another reason for more European solidarity, including through common borrowing.

It thus critical that RePowerEU be complemented by an investment framework that can stand up to these challenges. Such a framework must:

- → confirm political targets for clean energy investments under RePowerEU;
- → commit governments to re-assess national spending plans under the RRF and the EU budget (incl. the Common Agricultural Policy) to maximise the use of existing funds for investing in clean energy sovereignty;
- → establish a European Energy Sovereignty Fund equipped with at least 100 billion euros to support investment needs not covered by existing EU funds, especially in fiscally fragile Member States;
- → update investment needs estimates by the European Commission to reflect high commodity prices, the sanctions on Russia and the concrete clean energy investment targets of RePowerEU;
- → commit governments to smartly combine price signals with measures to protect low-income households and energy-intensive industries;
- → update Commission guidance on energy markets interventions, on protecting vulnerable consumers and industry and on state aid;
- → launch new Important Projects of Common European Interest (for heat pumps, serial renovation, district heating, etc.); and
- → establish a dedicated Energy Sovereignty Task Force in the European Commission, modelled on the EU Recovery Task Force, to help governments leverage all available EU-level tools for delivering the RePowerEU plan.

15 See Agora Energiewende, 'How to align the EU fiscal framework with the Green Deal', 2022.

Table 3: Employment in the gas, clean energy and heating equipment sectors

Sector	EU27 employment, thousands (*)
	Fossil gas (2018)
Extraction of gas	15
Manufacture of gas	12
Distribution and trade of gas and gaseous fuels	104
Electricity generation[17]	28
Total natural gas	159
	Clean energy (2019)
Energy efficiency	1,104
Renewables	617
Renewables (direct and indirect employment, 2020)[18] Of which: solar and wind power	1300 453
Heating equipment manufacturing (2018)	
Manufacture of central heating radiators and boilers	56
Heat pumps (direct and indirect employment, 2020)[19]	319

Eurostat, IRENA, EurObserv'ER and Agora Energiewende (2022)
(*) Direct employment otherwise stated.

7 Effects of RePowerEU on trade, employment and economic activity

Regaining energy sovereignty in Europe in the next five years requires a full-scale mobilisation of efforts in the industrial, buildings and power sectors to cut energy waste and rapidly scale investments in clean-energy technologies – heat pumps and renewables, first and foremost.

The effort will be huge, but its economic benefits stand to be real, large and enduring. And they are preferable to paying many billions of euros every year to autocratic regimes to purchase and burn fossil fuels.

Effects on trade

A 32% reduction of fossil gas consumption by 2027 through energy efficiency and renewable energy technologies will have a sizable effect on the EU trade balance. Thanks to the reduced consumption, savings worth 130–320 billion euros are likely to accrue in the 2022–2027 period – the same amount could finance the full renovation of 3 to 8 million homes.

Europe depends on international value chains for solar photovoltaics and storage technologies, but the value of such imports would be far lower than what the EU currently spends on gas imports. From 2019 to 2021, the import content of solar PV capacity additions was 0.44 billion euros per GW.[16] In 2021, 25.9 GW of new solar PV capacity were added to the grid; between January and November, imports of components and panels totaled 10 billion euros. The import content of wind turbines is significantly lower. In fact, the EU has a trade surplus in that market.

16 This calculation is based on data from Solar Power Europe and Eurostat.

Overall, the shift from fossil gas to renewable energy will benefit EU trade and its strategic position. While the reliance on foreign production for essential metals and intermediate goods for clean-energy capital expenditures still poses security of supply risks, the EU economy will be less dependent on foreign inputs for normal business operations and residential heating.

Effects on employment and economic activity

The gas industry directly employs 159,000 people across the EU, most of them in the areas of distribution and trade. The renewable energy sector already today employs almost four times as many people (617 thousand), with 1.3 million jobs supported directly and indirectly in the EU. Activities related to the conservation of energy, such as building renovations, directly employed more than 1 million people in 2019. this figure has likely increased as building renovations over the past two years have scaled up.

Investing in renewable energy and energy efficiency has the potential of boosting employment in Europe.[20] We estimate that adding 418 GW of solar and wind power can create 418 thousand new jobs (FTE) in the construction of new plants and 46 thousand new jobs in operation and maintenance by 2027. Investing 350 billion euros in the renovation of building envelopes over the 2022–2027 period can support 1 million jobs per year across the EU.[21]

Moreover, thousands of jobs can be created with the investment in power grids, district heating and the replacement of millions of fossil fuel boilers with heat pumps. Job losses in the gas industry will be concentrated in the area of distribution and trade, as in our modelling the installed capacity of gas-fired power plants stays largely unchanged throughout this decade. These workers could find new employment in the expanding areas of the buildings and energy industry, for instance among the rapidly increasing number of district heating technicians and heat pump installers or in activities related to hydrogen and biogas.

Phasing down gas consumption across sectors will have the benefit of reducing the exposure of households and firms to fluctuations in international fuel prices, reducing the risk of disruptive energy price shocks. Bijnens et al. (2021) find a negative impact of electricity and gas prices on employment in European manufacturing. Their results indicate that a power price increase of 20%, well below what Europe has experienced during the recent gas crisis[22] puts at risk around 3% of the employment in key manufacturing

17 This figure was estimated using employment factors for O&M from Malik et al. (2021) and EU27 installed capacity for gas power in 2019 from Eurostat.

18 See IRENA (2021): Renewable Energy and Jobs: Annual Review..

19 See EurObserv'ER.

20 See for instance Fragkos and Paroussos (2018): Employment creation in EU related to renewables expansion; McKinsey (2020): Net Zero Europe; Cambridge Econometrics (2022): Modelling the socioeconomic impacts of zero carbon housing in Europe.

21 This estimate is based on results from the analysis by BPIE, "Building renovation: a kick-starter for the EU recovery", 2020.

22 The gas price increase in 2021 was the main determinant of the steep rise in power prices in Europe. According to the European Commission's communication "Tackling rising energy prices: a toolbox for action and support", published in October 2021, "the effect of the gas price increase on the electricity price is nine times bigger than the effect of the carbon price increase", which occurred during the same period.

sectors.[23] Other jobs are lost with the direct effect of higher gas prices on industrial production. Investing in renewables and energy efficiency is more effective in addressing this concern than switching from Russian gas to LNG from other countries.

8 Conclusions

Russia's war against Ukraine has brutally exposed Europe's high dependence on fossil-fuel imports. And it is absolutely critical that we not simply replace our dependency on fossil fuels from Russia with dependency on fossil fuels from elsewhere.

Efforts to regain Europe's energy independence must prioritise the reduction of fossil gas consumption as fast and as much as possible. This means cutting energy waste and substituting fossil gas mostly through direct electrification. If Europe is to regain its energy sovereignty, the efficiency and electrification investments needed to reach Europe's 2030 climate targets must be accelerated.

This report proposes fifteen priority actions that should be included in the RePowerEU plan. When combined, these actions would eliminate 1200 TWh of fossil gas consumption by 2027, which is 80% of the fossil gas currently imported from Russia.

RePowerEU should also include dedicated measures to help Ukraine rebuild its destroyed energy infrastructure after the war.

RePowerEU should be embedded in a robust policy framework to oversee and steer the implementation of the actions. This framework would help ensure that EU funds are used to facilitate the necessary investments in a spirit of solidarity.

RePowerEU is a tool to maintain and deepen the sense of togetherness that Russia's invasion of the Ukraine has created in the European Union. It will help to make sure that, if all goes well, in five years' time, EU citizens and the Ukrainian people will be in a better place than they are today.

23 We calculate that this corresponds to ca. 141 thousand jobs in the sectors and countries analysed in the paper. They are the paper, chemical, machinery, metals, computer and pharma industries in Belgium, Germany, France, Italy and the Netherlands (the UK is excluded here).

9 Annex: Potential fossil gas savings in buildings, industry and power

Table 4: Potential savings of fossil gas in buildings, industry and power

Sector	Minimum potential (TWh)
Buildings	**480**
Improve energy efficiency of existing gas boilers	72
Renovate buildings	72
Replace gas boilers with heat pumps	140
Replace gas boilers with district heating	125
Replace gas boilers with biomass	47
Switch fuels for existing boilers	24
Industry	**223**
Install heat pumps for low temperature heat (<150°C)	170
Install hybrid electricity/fuel systems for medium temperature heat (150-500°C)	30
Switch fuels for high temperature heat processes (>500°C)	3
Reduce and replace natural gas as feedstock in fertilisers and plastics	20
Power	**500**
Increase wind onshore deployment	160
Increase wind offshore deployment	212
Increase solar roof deployment	64
Increase solar ground deployment	63

Agora Energiewende (2022)
Note: These potentials were estimated based on modelling by Artelys, Wuppertal Institute, and TEP Energy for Agora Energiewende that takes 2018 as base year. Nevertheless our estimates relate to gas consumption in 2020 (Eurostat Code [NRG _CB_GAS - IC_OBS]), as overall gas consumption in 2018 and in 2020 differed by less than 1%. From a modelling perspective some reduction potential will have been captured between 2018 and 2020.

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