Building Energy Security Through Accelerated Energy Transition

Version 2.0

May 2022

Insights briefing

Energy Transitions Commission

The Energy Transitions Commission (ETC) is a global coalition of leaders from across the energy landscape committed to achieving net-zero emissions by mid-century, in line with the Paris climate objective of limiting global warming to well below 2°C and ideally to 1.5°C.

Our Commissioners come from a range of organisations – energy producers, energy-intensive industries, technology providers, finance players and environmental NGOs – which operate across developed and developing countries and play different roles in the energy transition. This diversity of viewpoints informs our work: our analyses are developed with a systems perspective through extensive exchanges with experts and practitioners. The ETC is chaired by Lord Adair Turner, who works with the ETC team led by Ita Kettleborough (Director), and is supported by Vice-Chair Faustine Delasalle. Our Commissioners are listed on the next page.

Building energy security through accelerated energy transition was developed by the Commissioners with the support of the ETC Secretariat, provided by SYSTEMIQ. This report constitutes a collective view of the Energy Transitions Commission. Members of the ETC endorse the general thrust of the arguments made in this publication but should not be taken as agreeing with every finding or recommendation. The institutions with which the Commissioners are affiliated have not been asked to formally endorse this briefing paper.

The ETC team would like to thank the ETC members, member experts and the ETC's broader network of external experts for their active participation in the development of this insights brief.

The ETC Commissioners not only agree on the importance of reaching net-zero carbon emissions from the energy and industrial systems by mid-century, but also share a broad vision of how the transition can be achieved. The fact that this agreement is possible between leaders from companies and organisations with different perspectives on and interests in the energy system should give decision makers across the world confidence that it is possible simultaneously to grow the global economy and to limit global warming to well below 2°C. Many of the key actions to achieve these goals are clear and can be pursued without delay.

Learn more at:

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Introduction

The invasion of Ukraine has created an energy supply crisis for Europe. In response, the European Union is developing plans to reduce reliance on Russian gas, as well as oil and coal. This is driven by the desire both to enhance security of supply and to reduce the flow of money to the Russian government.

The Energy Transition Commission's primary focus is on the medium-term strategies required to build zero carbon economies across the world, limiting climate change as close as possible to 1.5°C. But the immediate crisis makes it imperative to improve European energy security and to manage the impact of high gas, electricity, and fuel prices on consumers and businesses in Europe and across the world.

- In the short run (i.e. the next 12 months) this may involve some unavoidable trade-offs versus climate objectives, as policy makers balance energy security, consumer living standards and climate concerns.
- But over the medium term (2-8 years) it is essential to address energy security and consumer living standard concerns in a way which does not delay but rather and ideally accelerates the required energy transition.

That medium-term challenge can be met: overall indeed, high and volatile gas and oil prices have improved the cost competitiveness of key zero carbon technologies and reminded businesses, consumers and policymakers of the vulnerability created by a fossil fuel dependent economy. But the opportunity will not be seized without clear strategic direction and strong public policies, which must reflect careful assessment of some climate versus energy security trade-offs.

This ETC policy brief therefore covers in turn:

1. The immediate crisis – background and short-term policy options.
2. The medium-term challenge – improving energy security while accelerating energy transition.
3. The impact on consumers – reducing exposure to fossil fuel price volatility.
4. The global impact – economic stresses and the energy transition.
5. Key future issues – implications for the ETC's work program during 2022.

A series of ETC information briefs – listed on the final page of this document – provide supporting detail on different aspects of the challenge and analysis of the alternative policy options.

1

The immediate crisis – background and short-term options

Even before the invasion of Ukraine, Europe faced soaring gas and electricity prices. Russia's invasion of Ukraine has greatly intensified the challenge by showing how dangerously dependent Europe is on Russian gas supplies; imports from Russia account for 40% of European gas consumption, 25% of oil consumption, and 30% of hard coal consumption.[1]

Gas meanwhile accounts for 10% of total Russian exports and 8% of fiscal revenues, while oil accounts for a still more important 50% of total exports and 37% of fiscal revenues.[2] In our Information Brief on 'The 2021/22 gas crisis' we describe recent developments in the global gas market, and Europe's position within it.[3]

1. Eurostat (Mar 2022) *The EU imported 58% of its energy in 2020.*
2. a) For every 1trn Rouble from gas in the Russian federal budget, there are 5trn Roubles from oil, BNEF (Oct 2021) *Russia Insight: Why Putin Can Afford to Squeeze Gas Supplies.*

   b) Revenues from oil and gas-related taxes and export tariffs accounted for 45% of Russia's federal budget in January 2022. IEA (April 2022) *Frequently Asked Questions on Energy Security.*

   c) Oil and Gas make up 60% of Russian exports in 2019. BBC (November 2021) *Will Russia ever leave fossil fuels behind?*
3. Whilst oil makes up a larger percentage of Russian export revenue there is a greater ability to shift trade flows with oil as oppose to gas, so Russia can find other buyers and Europe can find other sellers. Gas offers a more severe energy security risk, as most of Europe's imports are limited by pipe capacity, and the LNG market has very tight supply and demand fundamentals.

Two key points are that:

- Gas prices in Europe had increased by more than 250% over the year to February 2022, even before the invasion of Ukraine. One factor was a significant reduction in the flow of Russian imports into European markets for use and storage during summer 2021, but the increase also reflected multiple other coincidental developments, which changed the global supply and demand balance. This changing balance had a major impact on Europe given its increasing dependence on imports of both piped gas from Russia and LNG imports from other countries.

- The increase in the cost of gas has led to dramatic increases in the cost of electricity, exacerbating the impact on household budgets. This reflects power market designs in which increases in short-term marginal cost feed through to pervasive increases in the market price of electricity.[4]

In response to Russia's invasion, action by EU Member States and other countries has continued to evolve. The key initial EU response was a plan to reduce Europe's imports of Russian gas by two thirds within one year,[5] while the International Energy Agency has also published a "10-point plan" to reduce Russian imports by between 48 and 66 percent (Exhibit 1).[6] The details of these and other initial plans are discussed in the Information Brief on 'How far can Europe reduce use of Russian gas this year?' which outlines actions in three broad categories of alternative gas supply, alternative electricity supply, and demand reduction.

The key differences between the IEA and EU estimates lie in the following categories:

- **Increased LNG imports,** where the EU assumes that all existing technical capacity could be utilized, the IEA assumes that imports will also be limited by high prices, given competing demands from other LNG users particularly in Asia.

- **Accelerated renewable energy development,** where short term potential is constrained by limits to the speed at which projects can be completed, but where the EU makes more ambitious assumptions than the IEA.

- **Nuclear plant continuation,** where the IEA assumes that the EU can delay/cancel the closure of some existing nuclear plants, an option excluded from EU analysis.

- **Increased coal plant operations,** which the IEA considers as a possible but undesirable upside to its base case estimate.

4. It is the general feature of markets that they set prices at the margin but the crucial distinguishing feature of energy is that it is not possible to substitute and it represents a significant share of total household budgets, in particular for lower income households.

5. REPowerEU will be formally approved at the end of May and there may be some material changes, including the likely aim to phase out Russian gas by 2027 at the latest. European Commission (March 2022) *REPowerEU*.

6. IEA (March 2022) *A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas*.

The actions identified primarily seek to reduce Russian gas imports by increasing alternative sources of energy supply, but both the IEA and the EU also assume a role for demand reduction via, for instance, turning down residential heating thermostats by 1°C.

The ETC believes that all of the options in the IEA base case should be pursued.[7] In addition we believe demand reduction actions are preferable to running coal plants more, given the higher emissions which the latter would produce and the adverse impact on Europe's credibility in global climate negotiations. We estimate around 50% reduction in imports from Russia is feasible within one year without significant increases in coal burn and without additional demand reductions beyond the modest actions included in the IEA and EU scenarios (Exhibit 2).

But a 50% reduction would still leave Europe significantly dependent on Russian gas for several years, with two troubling implications. First it will make Europe more vulnerable to any Russian action to cut off gas supplies: second it would continue to provide Russia with large financial flows with which to support military aggression.

The only feasible way to avoid this is to encourage or require more significant reductions in gas demand than included in IEA and EU scenarios. These could entail encouraging or requiring residential or commercial customers to reduce thermostats further, closure of offices on specific days combined with working from home where possible, rationing of gas supplies for industrial use, and temporarily slowing down the closure of coal power plants. These measures as outlined in Exhibit 2 could reduce Russian imports by an additional 25%,[8] but would have an appreciable but still modest impact on economic output (estimates for Germany suggest a GDP decline of about 2.2%)[9]. However if combined with direct income support for lower income people could deliver a more efficient and equitable outcome than either:

- Relying solely on high prices to curtail demand, which has severely adverse economic and distributional consequences.
- Offsetting the impact of high wholesale gas prices via tax reductions, subsidies or price caps which reduce the cost (and in some cases the marginal price) of gas or electricity to end consumers. Income support delivered in this form, rather than via direct income transfers to poorer households, undermines incentives for energy efficiency and demand reduction, and provides an effective financial subsidy to the Russian government.

7. In addition there may be more opportunities to expand piped imports, for instances in countries that are flaring gas which could be otherwise used. This is reflected in the upper range of piped imports in Exhibit 2. See estimates from Capterio (2022) *North Africa can reduce Europe's dependence on Russian gas by transportation wasted gas through existing infrastructure* and Aurora Energy Research (2022) *Impact of Russia-Ukraine war on European gas markets: can Europe cope without Russian gas?*

8. Further curtailments to thermostat temperatures and industrial gas consumption could replace the remaining 25% of Russian gas imports, but these are likely to have a larger impact on standards of living and economic output.

9. VOX EU, CEPR (2022) *What if Germany is cut off from Russian Energy?*

Given naturally lower residential and commercial gas demand during the summer months, some of these actions may not be essential or have a major impact until autumn. Indeed lower demand is already feeding through to decreases in the very short-term price of gas, even while longer term prices in the futures market stay high (Exhibit 5). It is therefore essential to use the period of low demand to increase gas storage in line with the EU's stated objective.[10] And further action on demand reduction would make it possible to maximise the increase in storage levels achieved.

Europe is also seeking to eliminate imports of Russian oil: Germany has committed to achieve this by the end of 2022. Since the global market is less regionally segmented than gas, it will be easier for Europe to replace Russian oil with imports from other countries; but that also means that an embargo will have less impact on the Russian economy, since it will be easier for Russia to divert oil exports to other markets. The only way to reduce Russian oil exports in total, and to at least marginally reduce oil prices, is therefore to reduce oil demand. Given limits to the potential pace of structural changes (e.g. via accelerated penetration of EVs) this would require measures such as reduced road speed limits or measures which achieve modal shifts via for instance, increased home working, better infrastructure for bikes and microscooters, car-free Sundays and subsidies for public transport.[11]

10. The European Commission is intending to introduce a mandate that gas storage capacities in the EU be filled to 80% capacity by the beginning of November this year, ahead of the Winter heating season. European Commission (May 2022) *Member states agree on negotiating mandate for gas storage proposal.*

11. The IEA, in its 10-point plan to cut oil use, suggests that reducing speed limits on highways by 10 kmph and increased working-from-home in advanced economies reduce oil demand by 0.4 mbpd each.

Exhibit 1

Recent assessments suggest between 720 (48%) and 1000 TWh (66%) of Russian gas could be replaced over the next year

	Lever	TWh of Gas displaced in 1 year	
		IEA	European Commission
Gas supply	Ramp up **LNG imports** within existing terminal capacity constraints	195	490
Gas supply	Ramp up domestic **EU gas production, plus more pipeline imports**	100	100
Gas supply	Increased **production of biomethane** from agricultural wastes and residues	-	35
Electricity supply	Increased output from existing EU **bioenergy power plants**	90	-
Electricity supply	Accelerate the development of **new wind and solar projects**	160	220
Electricity supply	**Maximise nuclear generation**	35	-
Demand	Turn down **thermostats** by 1°C	100	100
Demand	Accelerate **energy efficiency improvements** in buildings and industry	20	40
Demand	Increase **heat pump installation**	20	15
	Total gas displaced	720	1000

NOTE: 100 TWh of renewable electricity supply was expected to be added this year. Additional potential beyond this represents opportunity for accelerated renewable additions.

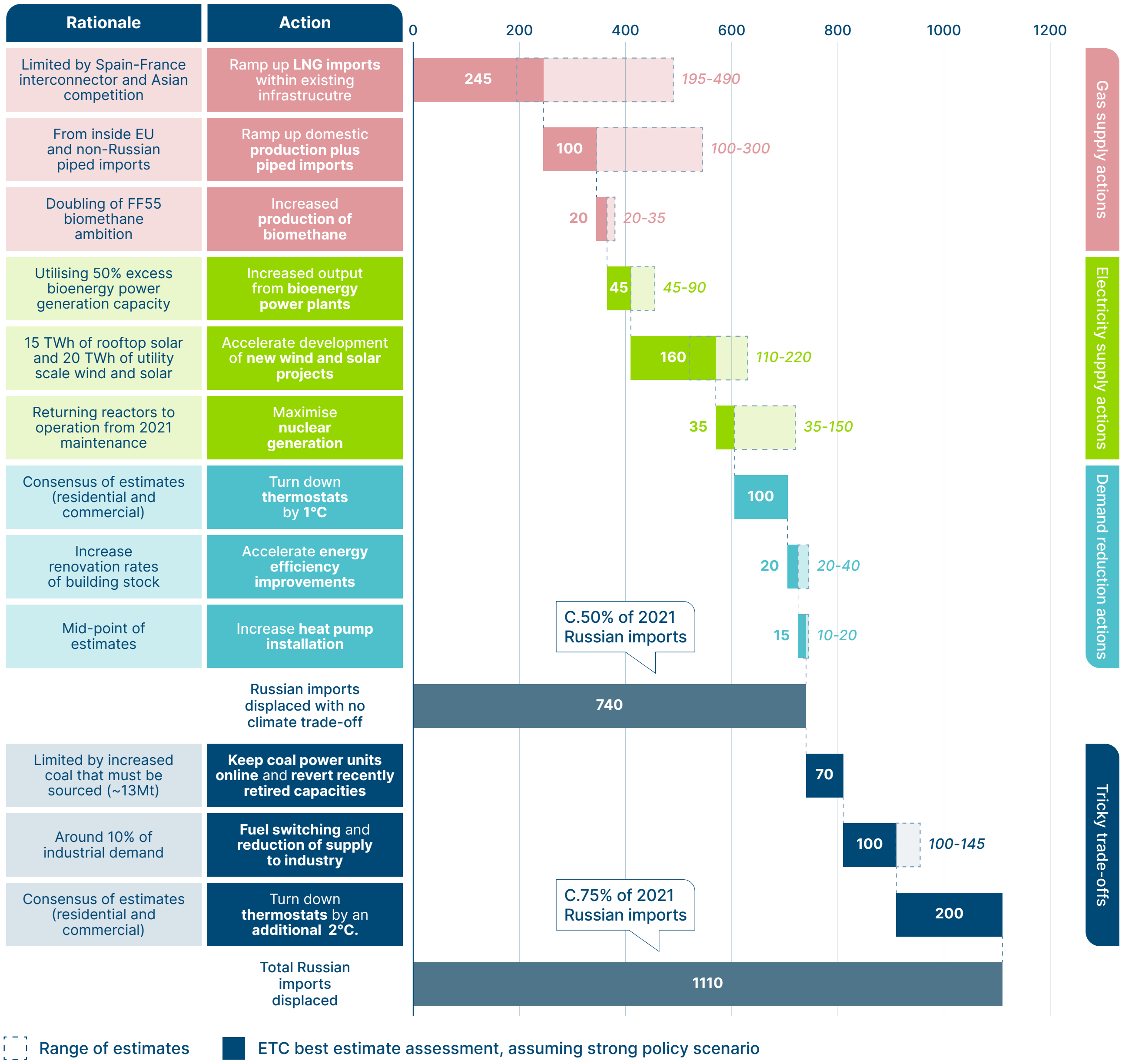
SOURCE: IEA (March 2022) *A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas*; European Commission (March 2022) *REPowerEU.*

Exhibit 2

ETC summary assessment of impact of short term actions over 1 year

ETC assessment of feasible level of European Russian gas imports which can be displaced within 1 year

TWh of gas displaced



SOURCE: IEA (March 2022) *A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas*; European Commission (March 2022) *REPowerEU*; Aurora (March 2022) *Impact of Russia-Ukraine war on European gas markets: can Europe cope without Russian gas?*

2

The medium-term challenge – improving energy security while accelerating energy transition

The EU has set the formal objective of entirely eliminating reliance on Russian gas by 2030[12] and has published an indicative plan for achieving this (Exhibit 3). Subsequently Germany has set a target of eliminating Russian gas imports by 2025, and several European countries are also arguing for early prohibition of all oil imports from Russia. The UK has already declared that it will ban Russian oil imports from the end of 2022 and the UK's plans for the Sixth Carbon Budget anticipate reduction in gas use in electricity by 25% by 2030, and the complete elimination of unabated gas by 2035.[13]

The crucial question is how to meet these energy security objectives while not delaying but accelerating the energy transition. Over the medium term this win-win can be achieved, but some potential trade-offs in the early years may need to be faced to align the response to both the energy and climate crises.

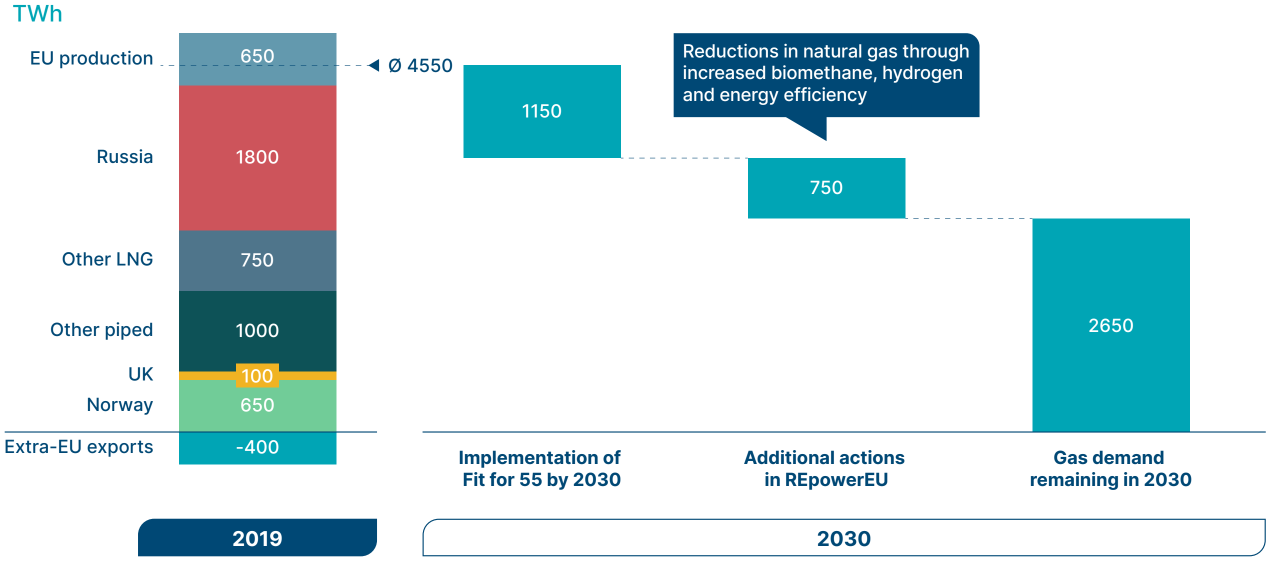
12. Recent proposals have suggested increasing this ambition to 2027.

13. CCC (2020) *The Sixth Carbon Budget*.

Exhibit 3

EU plans in Fit for 55 and additional actions announced in REPowerEU plan to eliminate Russian gas imports by 2030

EU gas consumption, 2019 and 2030 forecast



NOTE: Excludes actions in REPowerEU that increase supply of natural gas.

SOURCE: SYSTEMIQ calculations for the ETC based on Eurostat (2022) *Natural gas imports by country of origin*; European Commission (2022) *REPowerEU*; European Commission (2019) *Fit for 55*.

Two considerations set the context for policy choice and private investment decisions:

- **Timescales for impact.** The first is the relative pace at which alternative technologies can be deployed. Exhibit 4 sets out an assessment of required timelines for significant impact by technology, and of the potential to reduce existing timelines via strong policy action. Some key points are:

  – The feasible pace of ramp up for renewable electricity varies by specific technology but within 5 years forceful policy could produce a very significant acceleration in RE deployment, including for the development of green hydrogen supply.

  – Energy efficiency improvements (in particular better insulation and increased use of heat pumps) could also produce a major impact within 5 years, but only with forceful policies to create incentives or requirements for deployment and to drive the development of supply chains.

  – Building new LNG infrastructure – i.e. liquefaction plants in exporting countries and regasification plants in Europe – requires a significant lead time and will only occur if underpinned by long term contracts, but could very significantly replace Russian gas within 4-5 years. However noting that any new LNG infrastructure comes with both carbon lock-in and stranded asset risk.

- Postponing the closure of existing nuclear plants could have a significant medium-term impact, but building new nuclear, though potentially valuable in the long term, is unlikely to contribute materially to energy security or climate change objectives before the 2030s.

- Developing entirely new oil or gas fields in Europe is also unlikely to make a material difference before the late 2020s, including through fracking.

- **Expectations for future fossil fuel prices.** European gas prices had increased dramatically even before the invasion of Ukraine and have increased still further since then (Exhibit 5); whilst coal and oil prices have also increased significantly. The future evolution of prices is inherently uncertain. Prices quoted in futures markets suggest that these increases may moderate over the next 3-5 years but that prices throughout that period will remain significantly above previous expectations. Latest developments have seen a reduction of very short-term prices, but a slight increase in expectations over a 4 year period (Exhibit 5). But the very fact that oil and gas prices are currently high may stimulate a supply response which could substantially moderate prices later in the decade. Despite cost pressures in renewable energy supply which have produced temporary increases in levelised cost of electricity for the first time in over a decade (Exhibit 6), the relative cost position of renewable electricity versus gas-based generation has therefore significantly improved. The relative economics of hydrogen production within Europe have also shifted quite dramatically in favour of the green route (electrolysis of water) when using dedicated renewables[14] and against the grey route (steam methane reforming without CCS) and blue route (steam methane reforming plus CCS) (Exhibit 7).

Against this background, the ETC believes that potential actions to reduce/eliminate reliance on Russian gas imports should be placed into three categories (Exhibit 8);

- **Clearly desirable** – where policy should focus on achieving as rapid progress as possible, removing potential barriers to investment.

- **Actions involving potential trade-offs** between energy security and climate change objectives, but where careful policy design could mitigate adverse impacts.

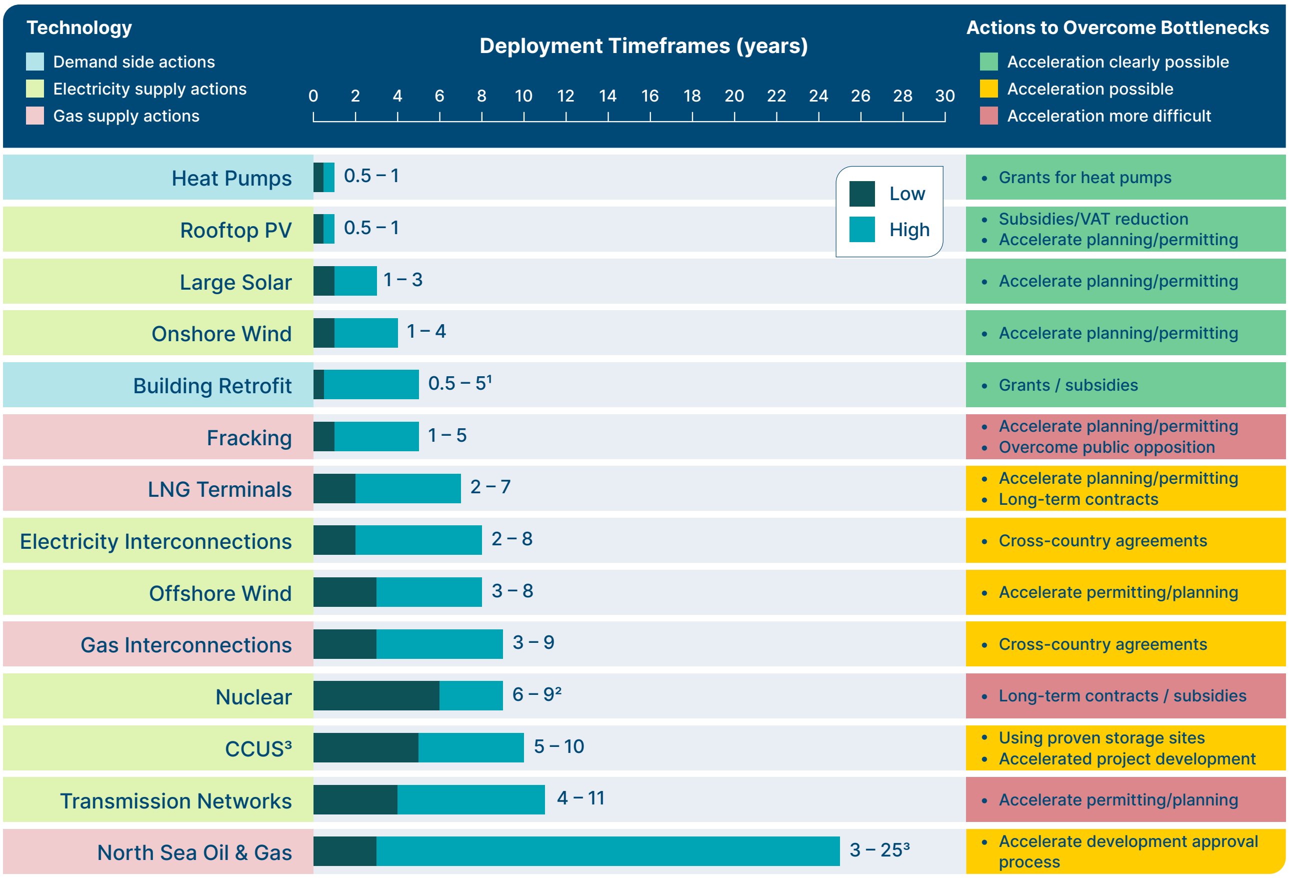
- **Clearly undesirable and unnecessary.**

14. Where green hydrogen is produced using grid electricity rather than dedicated renewable electricity supply, the cost has increased due to the increased price of electricity which the gas price increase has produced. It is also possible to use Power Purchase Agreements with certificates of origin which access renewables with the grid as the carrier.

Exhibit 4

Technology deployment timeframes vary significantly; actions can be taken to accelerate uptake by overcoming bottlenecks

Estimated deployment timeframes for different energy solutions – *Illustrative*



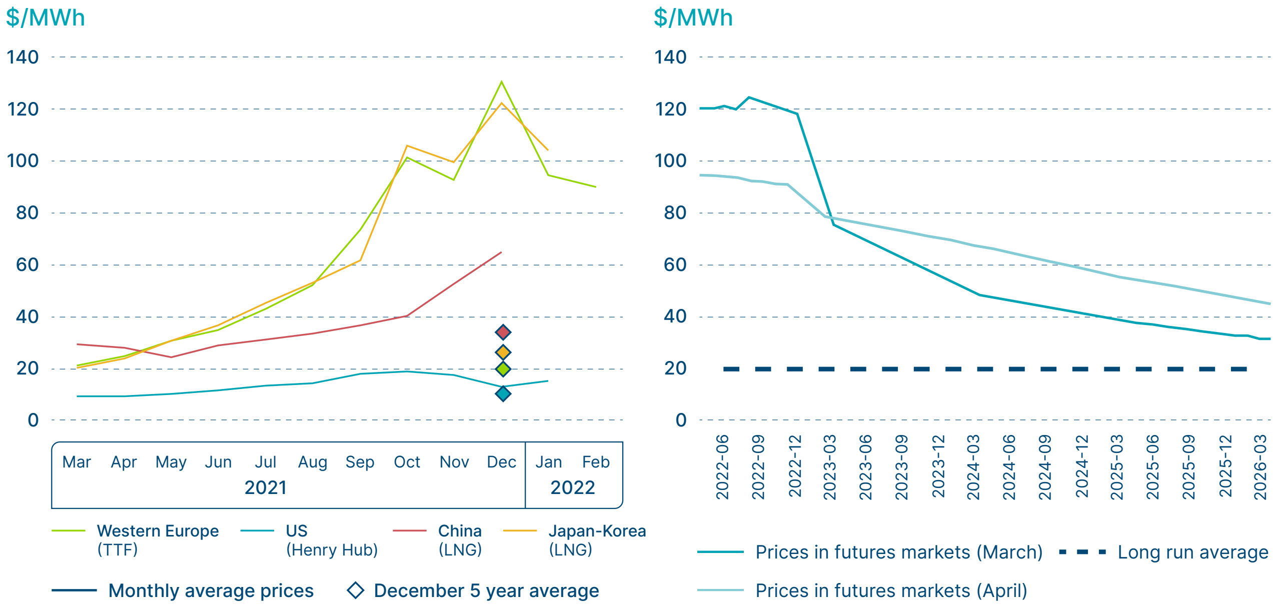
NOTES: The ratings for Actions to Overcome Bottlenecks are a judgement on whether the bottom of the range of years can be achieved, not whether or not it will occur.
[1] Efficiency gains through retrofit varies heavily, with certain actions such as insulations being relatively quick.
[2] Based on plant development timeframes in western Europe.
[3] North Sea Oil low deployment estimates refer to previously discovered fields. Note: Deployment timeframes vary by country and location. Timeframes can also vary depending on if plans are already in place.

SOURCE: SYSTEMIQ analysis for the ETC based on EIA, GTI, North Sea Link, Global Energy Monitor, Qualenergia, Iso Energy, IRENA, IEA, CCC, Eurelectric, FT.

Exhibit 5

The global gas crisis resulted in high gas prices with the worst effects felt in Europe and parts of Asia; quoted futures markets suggest that they may stay high and slowly decline towards past levels

Average wholesale gas prices | **Dutch TTF natural gas futures**



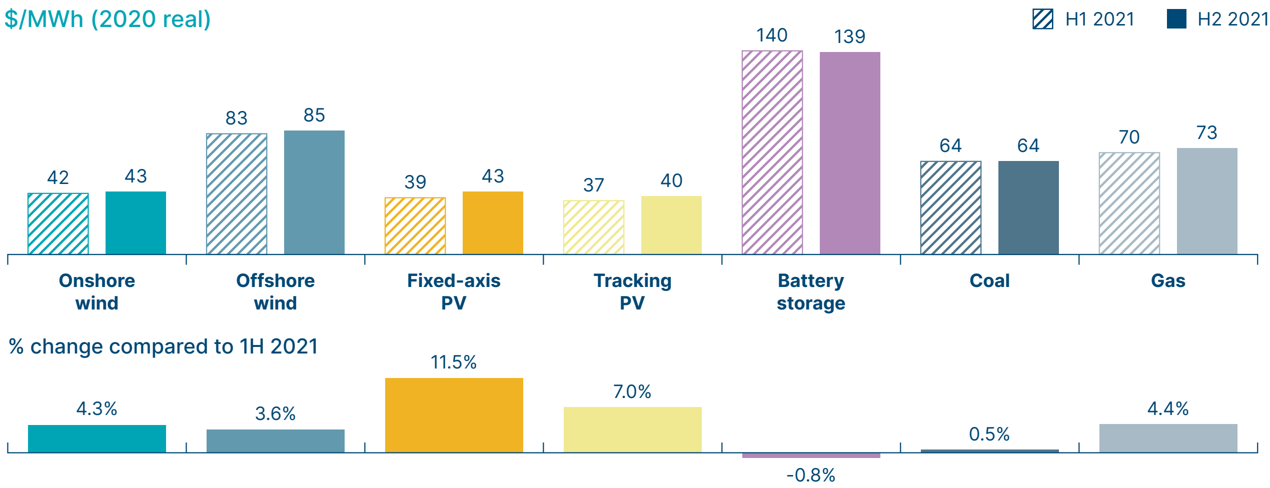
NOTE: TTF = Title Transfer Facility, the Netherlands gas trading hub. Japan-Korea and China use 2018-19 gas price averages due to limited data. Averages have been used where data gaps occurred in Chinese data.

SOURCE: BNEF (February 2022) *EU Power and Fuel Prices*; BNEF (February 2022) *APAC Power Market Monthly*; EIA (February 2022) *Henry Hub Natural Gas Spot Price*; S&P Global Platts (January 2022) *China Data: Total natural gas imports rose 20% in 2021 on strong energy demand*; Powernext (Data extracted 30th March 2022 and 26th April 2022) *Futures market data.*

Exhibit 6

Recent spikes in global energy prices and supply chain bottlenecks in some components (partially driven by COVID) have caused small increases in renewable LCOEs

Global levelized cost of electricity (LCOE) benchmarks, change between 1H and 2H 2021

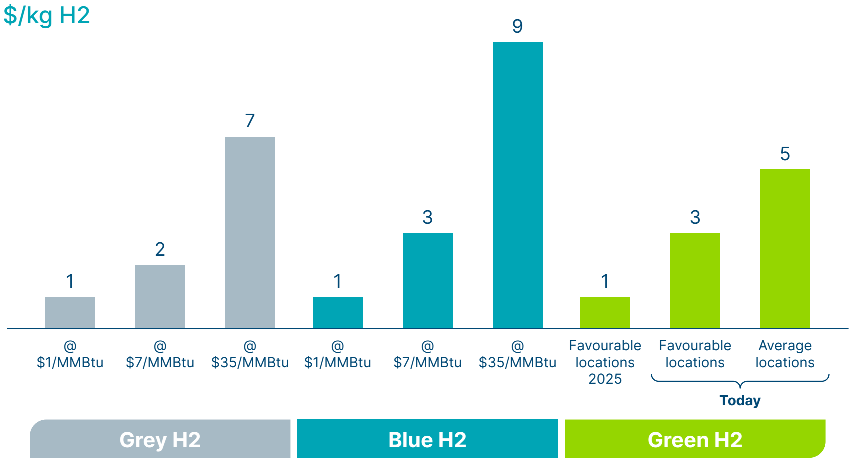


SOURCE: BNEF (December 2021) *2H 2021 LCOE Update.*

Exhibit 7

If gas prices remain high, green hydrogen will be favoured over grey

Impact of increased gas prices on hydrogen production costs



- Sustained high gas prices will tip **low-carbon hydrogen production in favour of green**. Risks of future volatile gas prices also compounds this.
- EU TTF gas prices have been above $22/MMBtu since September, and have been mostly **above $35/MMBtu** from March.
- Impact on current grey producers will largely depend on how exposed they are to short-term gas prices vs. long-term contracts.
- Low cost gas producers with low volatility (e.g. Middle East, US) **likely to still favour grey/blue hydrogen in the near-term**. Although these producers will have greater opportunity to export gas as opposed to hydrogen.

SOURCE: SYSTEMIQ analysis for the ETC based on recent gas prices and ETC (2021) *Making the hydrogen economy possible*.

Exhibit 8

The 2-8 year gas challenge: achieving a win-win for energy security and climate action

Win-wins

1) **Massively accelerate renewable energy development**
- With strong focus on building storage, flexibility and green hydrogen infrastructure
- Including diverse and dependable imports e.g. interconnection / green ammonia from Africa
- Supported by power markets which protect consumers against marginal price volatility (e.g. by reflecting total generation costs)
- Ensuring resilient metals and minerals supplies

2) **Energy efficiency and productivity**
- Insulate, plus heat pump electrification and better waste heat utilisation
- Invest in industrial energy efficiency & circular supply chains

3) **Lean on other sources of electricity generation:**
- Keep existing nuclear going – extend life if possible and safe to do so
- Utilise existing biomass generation if bio sources sustainable (trade-off with other uses of bio e.g. Sustainable Aviation Fuel)

Challenge:
Long lead times

Difficult trade-offs

Short term slowdown in **coal closure** – apply CCS?

Physical investment and contracts for **LNG imports**

Investment in **existing European gas fields** – e.g. Norway / UK?

Challenges:
Emission reduction delay and international message

Stranded assets

Methane leakage

In some cases **long lead times**

Definitely not

Dilute 2050 net zero commitments

Put back 2030 phase out date for German coal

Major long term **investment in new gas** capacity

By the 2030s we **can build the green secure alternative**

2.1 Clearly desirable actions – reducing fossil fuel demand

The clearly desirable actions are:

Accelerating renewable electricity rollout, which the EU believes could deliver a reduction of 170 BCM of gas demand by 2030[15] (equivalent to 850 TWh of electricity). This would require total EU installed capacities amounting to 480GW of wind and 420 GW of solar,[16] plus major investments in transmission, distribution and storage. For solar this would require a continuation of current installation rates which have grown rapidly over the last few years (from 4 GW in 2016, to 26 GW in 2021).[17] For wind it would require a very significant acceleration (Exhibit 9). In principle this acceleration could be achieved, and commitment to achieve it would bring down costs via scale economy and supply chain development effects. But it will only be achieved with very strong policy action to overcome deployment barriers, particularly relating to the pace of planning and permitting decisions (Exhibit 10). The recent UK Government commitment to reduce offshore wind planning and permitting timescales from 4 years to one year reflects this priority.[18]

Storage and flexibility options. Accelerated growth in the share of electricity coming from intermittent sources will hasten the need to develop storage, flexible demand, and flexible generating capacity to balance power supply and demand across hours, days and months. Significant flexibility may be provided by gas turbines continuing to burn methane but for a reducing number of hours per year. But markets for auxiliary services[19] should also be used to drive a rapid development of battery, hydrogen, pumped and other grid storage technologies. Increased interconnection between European grids should also be a priority, with significant improvements possible before 2030.

Accelerating investment in green hydrogen. As Exhibit 7 shows, increased European gas prices have dramatically increased the cost of producing grey or blue hydrogen, making green hydrogen in some cases already cost-competitive, much earlier than until recently anticipated.[20] In addition to playing a growing role in grid storage, green hydrogen could therefore substitute for fossil fuels earlier than assumed in applications such as steel or fertilizer production. Accelerated development of green hydrogen produced from dedicated renewables should therefore be a priority,[21] and

15. REPowerEU hasn't increased total EU targets for renewable electricity deployment to the grid but has increased renewable targets for 2030 by 80GW to produce green hydrogen which is expected to save an extra 25-50bcm of gas.

16. Including an additional 80GW required to produce green hydrogen.

17. BNEF (March 2022); Solar Power Europe (January 2022) *EU Market Outlook for solar power 2021-2025.*

18. This may require careful management of supply chains to ensure availability to all and prevent regional bottlenecks.

19. At present many markets for auxiliary services are focuses on shorter term needs for frequency balancing, these must develop over time to support longer term storage.

20. It is worth noting three caveats to this: 1. Given the lead times in developing new hydrogen capacity, new hydrogen production is not expected to come online at scale until the latter half of 2020s 2. Most industrial purchasers of gas utilise long-term contracts, and therefore don't face short-term contracts and prices. 3. Existing hydrogen production is already linked up to transport and storage networks, with supply chains direct to users, new green hydrogen will also need to build this infrastructure (where needed), which has further cost implications.

21. It is also possible to use Power Purchase Agreements with certificates of origin which access renewables with the grid as the carrier.

both the EU and the UK have already increased their targets for green H_2 capacity. Public policies should assist with supporting shifts towards hydrogen in potential use sectors and also focus on the development of hydrogen storage technologies and should consider the potential role of green hydrogen imports from countries which have low cost RE resources, seeking to make future energy imports more secure by ensuring a diverse supply.[22]

Extending nuclear plants lives. Even after the planned German closures at the end of 2022 European nuclear plants will be generating 800 TWh per annum, avoiding the need for 1600 TWh per annum of gas (165 bcm).[23] Recent experiences illustrates that nuclear plants may be kept going significantly longer than originally anticipated - potentially in some cases up to an additional 40 years.[24] Governments should therefore seek to keep all existing nuclear plants operating for as long as technically and safely possible.[25] Nuclear plants already under construction should be brought into operation as rapidly as possible. The role of new nuclear plants which have not yet begun construction – whether in the form of large fission, small modular nuclear, or fusion – should depend on the evolution of total system costs relative to other solutions. But timescales for deployment mean that new nuclear cannot play a significant (or indeed almost any) role in driving the shift away from Russian or other gas and in reducing emissions before 2030.

Accelerating road transport electrification. The scope to reduce oil demand via a shift to new technologies is very limited over a one-year period;[26] electric vehicle manufacturing capacity cannot be rapidly increased and supply chain constraints are already resulting in lengthy delivery delays. But over the 2-8 year period, forceful policy could significantly accelerate the electrification of passenger cars, two wheelers, vans and mid-duty trucks. Policies could include bringing forward ICE bans in countries which still allow ICE sales beyond 2030, but must also involve ensuring that charging networks and electricity distribution capacity are in place to support the rapid rollout which high oil prices are in any case likely to encourage.

Accelerating energy efficiency improvements. Energy efficiency improvement – in particular in residential heat applications – has long been identified as a key priority, but one where many countries have made slow progress.[27] Over the short term, the opportunity for faster rollout of non-gas-based heating technologies (such as heat pumps) and of improved insulation, is constrained by existing supply chain capacity and skilled workforce availability. But within 2 years forceful policies could significantly accelerate the pace of investment, making a significant difference to gas demand within five years with estimates suggesting that a further 13bcm (125 TWh) from energy efficiency measures can be obtained, in addition to the measures

22. It is worth noting that 10 Mt of the 20 Mt of hydrogen in the EU's 2030 targets is expected to come from sources outside of the EU.

23. The average efficiency of turning gas into electricity in Europe is around 50%.

24. Two nuclear reactors in the US have recently had their lifetime extended to 80 years. US Office of Nuclear Energy (2021) *What's the Lifespan for a Nuclear Reactor? Much Longer Than You Might Think.*

25. Issues relevant to these conditions include the technical limitations of increasing the life of a plant that has not received recent investments, cost incentives as developers may have to incur significant costs to extend the life of plants, the clear need to prioritise overall plant safety and reliable sourcing of sufficient fuel resources.

26. There may be more potential to reduce fuel use in cities by advocating modal shifts, encouraging households to share cars and switch their mode of transport via cutting prices of public transport, running more buses and trains, and improving public transport networks. Further gains could be made from cutting commuter journeys by encouraging continued home-working, building on programmes developed during the pandemic.

27. IEA (2019) *Energy Efficiency 2019.*

outlined in Fit for 55, by 2025.[28] In addition, energy use could be reduced by strongly encouraging changes in consumer and business behaviour (for instance in relation to the heating and cooling of offices and homes), simultaneously improving energy security, reducing emissions and cutting business and household energy costs; measures such as these achieved significant reduction in the energy intensity of the Japanese economy in the aftermath of the Fukushima nuclear accident.[29]

Ensuring resilient metals and minerals supplies. In addition to being a major producer of oil, gas and coal, Russia is also a major producer of minerals including some, such as nickel, which will play a major role in the energy transition. Transition to a deeply electrified zero carbon economy will in any case drive rapid increases in demand for key metals and minerals – such as copper, cobalt, lithium, nickel and manganese – as well as for rare earths, and if investment in mining capacity does not grow adequately ahead of demand, major price spikes could undermine the transition. Europe and other countries should therefore develop clear strategies to ensure secure, diverse and sustainable sources of future supply including scaling mining capacity and via ensuring maximum recycling. The ETC will deliver a detailed report on mineral and other resources required for the energy transition in autumn 2022 (Section 5).

Increasing sustainable bioenergy use where possible. Bioenergy applications – including biomass based power generation and the production and use of biofuels and biomethane – currently account for around 11 percent of European energy supply.[30] As the ETC's report on *Bioresources within a net-zero emissions economy* described,[31] long term strategies for bioenergy must ensure that total bioresource use does not exceed truly sustainable supply, and should focus bio resource use on applications where alternatives are missing or very expensive (e.g. on aviation biofuel rather than biofuel for light-duty road transport, where electrification provides a more efficient decarbonization vector). Strong policies to increase the use of municipal waste and of agricultural and forest residues could however make a contribution to reduced gas and coal demand within five years.[32] It is vital however, that any additional use of bioenergy does not compete with food production, especially in the aftermath of the invasion of Ukraine where there are rising global food prices.

Each of these actions would be fully compatible with current plans for the energy transition to meet climate change objectives, and indeed would help accelerate them. Together, they can more than eliminate demand for Russian gas (Exhibit 3), and to a more limited extent oil. Indeed, further reductions in gas demand by 2030 are likely possible, given the limited revisions to the EU's renewable electricity targets by 2030, relative to the opportunity of deploying more renewables at a faster pace.

28. BELLONA, EMBER, RAP & E3G (March 2022) *EU can stop Russian gas imports by 2025.*

29. Total electricity consumption in Japan decreased by 7.5% between 2011 and 2020. IEA (2021) *Key Energy Statistics – Japan.*

30. EC modelling for the Fit for 55 package available at: https://energy.ec.europa.eu/excel-files-mix-scenario_en

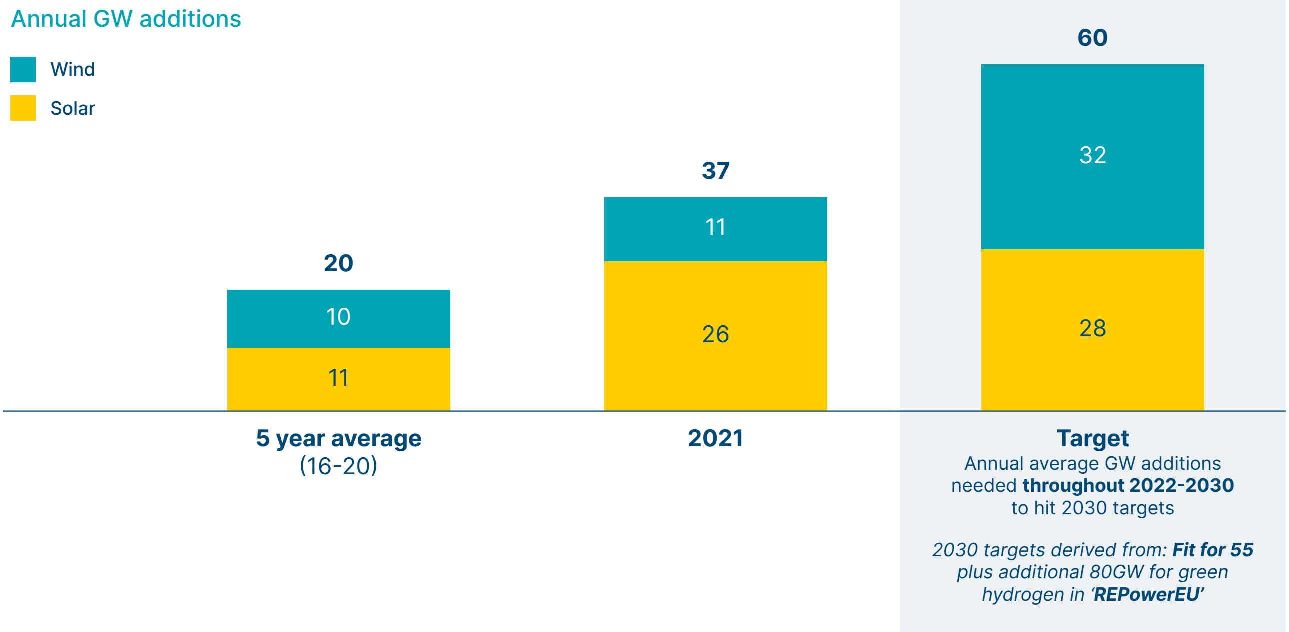
31. ETC (2021) *Bioresources within a Net-Zero Emissions Economy: Making a Sustainable Approach Possible.*

32. The EU's bioenergy strategy is currently tabled for review. This includes the capture and use of biomethane from landfill. The EU's initial response to the Ukraine crisis included targeting 17bcm of biomethane within 1 year, and 35bcm of biomethane by 2030. European Commission (March 2022) *REPowerEU.*

Exhibit 9

The EU is currently far behind the pace of renewables build needed to meet, let alone exceed, its existing 2030 targets

EU wind and solar installation targets



NOTES: 5-year average represents capacity additions from 2016-2020.

SOURCE: BNEF (March 2022) *Global Installed Capacity*; SolarPower Europe (December 2021) EU Market Outlook for Solar Power 2021-2025; Wind Europe (February 2022) *Wind energy in Europe: 2021 Statistics and the outlook for 2022-2026*; European Commission (December 2019) *Fit for 55*; European Commission (March 2022) *REPowerEU.*

Exhibit 10

Accelerating renewable deployment to 2030 is possible, by focusing on four critical actions

4 Critical Actions

Key Examples

- **Increase EU and National quantitative targets** for zero-carbon electricity in 2030 (e.g. wind and solar capacity, grid emissions intensity)

- **Appropriate power market design** (e.g. long-term contracts, appropriate short-term markets incl. ancillary services, long-term peak capacity mechanisms, flexibility enablers)
- **Annual auctions** to competitively procure new renewable capacity

- Regulatory frameworks to enable **anticipatory investment in power networks**
- **Network infrastructure** (e.g. grids, EV charging, building retrofits)
- New **Distribution System Operator capability** to manage distribution network
- Clear plans for **supply chain expansion and workforce training**

- **Integrated vision for power system and network design**
- **Streamlined planning, permitting**, and land acquisition
- **Strategic approach to zoning** development areas for renewable projects, standardized application processes, pre-approvals based on presumed permission, consolidation of regulatory bodies

2.2 Diversifying sources of fossil fuels – potential trade-offs

Complete and rapid elimination of all Russian gas imports, and a significant reduction or elimination of Russian oil imports, will however also require the development of alternative supply sources. The resulting trade-offs between improved energy security and the pace and certainty of future energy transition will require careful management.

The three key options are:

Building LNG infrastructure. As Section 1 discussed, LNG imports into Europe could certainly be increased by around 20 bcm (200 TWh) without new infrastructure investment (Exhibit 2). Importing up to an additional 50 bcm (490 TWh) this year is also possible but would require radical rerouting of the EU gas network (to overcome constraints in the size of the Spanish-French gas interconnector)[33] and would depend on whether Europe can effectively compete with Asian demand.[34] This would take total EU LNG imports from 110 bcm to at least 130 bcm per annum. Expansion of LNG imports beyond that level would require new investment in infrastructure – in particular liquefaction plants in exporting countries and re-gasification plants in Europe.[35] These investments are unlikely to occur without long-term contracts for LNG supply which have tended to last 10-20 years or more.[36]

There is therefore a danger that the development of large-scale LNG alternatives to piped gas from Russia could leave Europe with infrastructure and long-term contracts which would make it more difficult to subsequently transition beyond gas, with carbon lock-in and stranded assets a large concern. At the global level indeed, increased LNG infrastructure, together with increased gas production capacity in exporting countries, would mean an increase in the total scale of global gas capacity, since Russian production assets would still be in place and seeking alternative markets. This installed base of gas production and transport capacity would contribute not only to future CO_2 emissions but to methane leaks which must be a key area of policy focus given:

- Increased understanding of the key role which methane emissions play in climate change: the IPCC estimated that almost 40% of global warming to date derives from methane.[37]

33. This may also require reinforcement of the French gas transmission system.

34. Further considerations that are relevant to this are detailed in the accompanying ETC information brief *Importing Liquified Natural Gas (LNG)*.

35. Construction of new liquefaction and export facilities takes between 3-7 years, whilst construction of new gasification and import facilities takes 2-5 years.

36. Though some LNG operators may be able to balance risk through a combination of shorter contracts, higher prices, and expectations of future returns on the spot market.

37. IPCC (2021) WG 1 *Climate Change 2021: The Physical Science Basis.*

- Indications that the US – which would likely be a major new source of LNG[38] – is not a leader in methane leak control. Estimates are inherently uncertain but the latest figures from IEA suggest that methane emissions from production are similar in the US and Russia.[39] As a result once additional leaks from LNG transformation and transport[40] have been allowed for, LNG imports from the US could result in a higher emissions footprint than piped gas from Russia (Exhibit 11).

Despite these concerns, some increased LNG capacity will be essential if Europe is to achieve a rapid elimination of Russian gas imports. An inherent climate versus energy security trade-off must therefore be recognized and managed.

Commitment to large-scale new LNG infrastructure must therefore be combined with strong action – in particular by the US – to deliver the methane leak reductions agreed at COP 26 in Glasgow via the Global Methane Pledge. Some contracts are already reflecting this need. The recently signed 15 year deal between Engie and Houston based gas provider Next Decade provides an important example,[41] with Next Decade committing both to certify a low level of methane leaks and to apply Carbon Capture and Storage to cut CO_2 from production and processing by 90%.

Carbon lock-in and stranded asset risks could also be mitigated by via shortening asset amortisation periods, and by designing LNG related strategies to as best possible utilise existing assets and provide a bridge to the future zero carbon economy. For example, current EU LNG capacity is concentrated in Iberia with minimal interconnection to France and the rest of EU gas grid. Building new interconnectors could both ensure maximum use of existing LNG infrastructure and, if designed to be hydrogen ready, create potential for future hydrogen supply from Iberia or North Africa into northern Europe.

Governments should also pursue the other clearly desirable routes to reduced gas consumption as rapidly as possible, to minimize the risk of stranded assets.

Increasing output from existing European oil and gas fields. Any large-scale investment in new oil and gas production fields would also increase the risk of carbon lock-in and stranded assets which make the transition to net zero more difficult. But there is some potential to increase gas production from existing Norwegian, UK and other European gas fields which typically have much lower methane leakage rates. Some have estimated this potential at around 24 bcm per annum (235 TWh),[42] however others believe overall potential is severely limited, as Groningen – the largest onshore gas field in Europe – must close down to limit dangerous seismic activity, Norway is already producing at full speed, and

38. The US is expected to become the largest exporter of LNG in 2022. Reuters (December 2021) *U.S. to be world's biggest LNG exporter in 2022.*

39. Analysis by Greenmantle using IEA (2022) *Methane Tracker*, adjusted for total estimated volumes of gas methane emissions per volume of gas produced.

40. Sustainable Gas Institute (2015) *White Paper – Methane and CO_2 emissions.*

41. Financial Times (May 2022) *French utility Engie buys US natural gas as Europe looks beyond Russia.*

42. Aurora (Mar 2022) *Impact of Russia-Ukraine war on European gas markets: can Europe cope without Russian gas?*

UK natural gas production is already ramping up as much as it could to benefit from the 2021 price increases. Despite these challenges, increased piped gas would be strongly preferable to maintaining additional coal generation beyond the period of short-term emergency response. Any commitments to increase gas production should be combined with reinforced action to develop Carbon Capture and Storage.

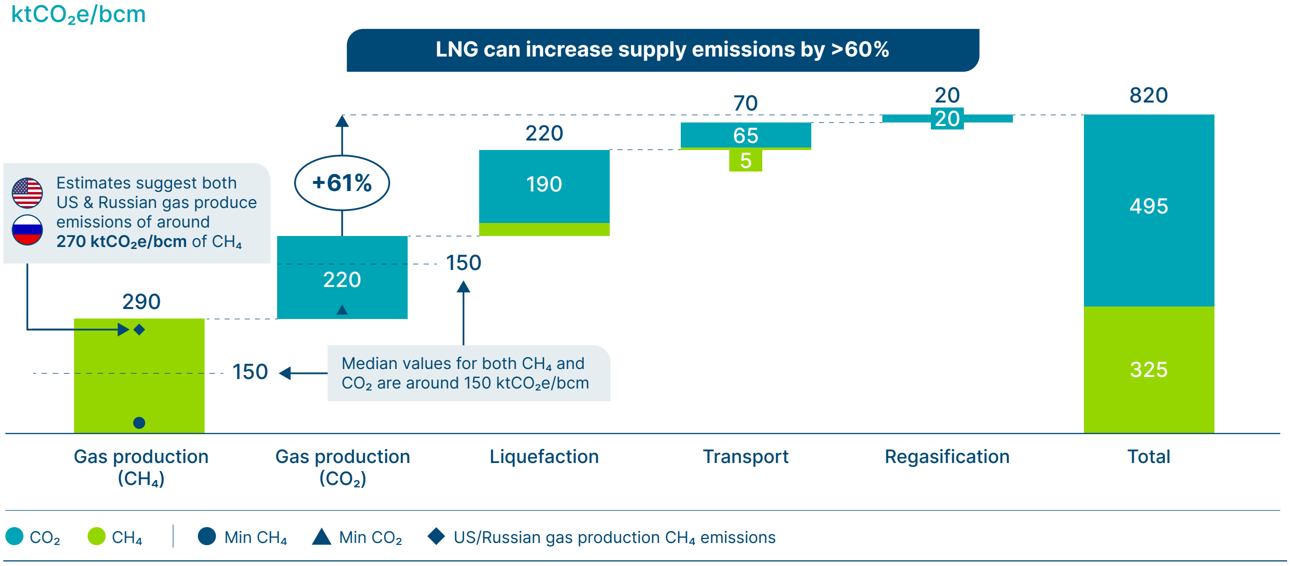
Switching from gas to coal in the power sector. Amidst high gas prices a short-term increase in the utilisation of higher-carbon coal plants in Europe is likely, though the long-term trend is a phase-out of these plants in Europe. Though in the near-term there are clear energy security benefits – given the ability to source coal from a more diverse range of sources – but a direct trade-off in terms of carbon emissions. Any significant increase in coal power generation in Europe will significantly damage the credibility of Europe in global climate negotiations, and risk a slowing down of the global phase down of coal agreed at the Global Climate Pact.

Either of the first two options would require some additional investment, highlighting the importance of investment in a managed transition to the zero carbon economy which reduces the danger of highly disruptive price swings and spikes.

Exhibit 11

Methane leakage rates from non-Russian sources may imply increased emissions; importing LNG would exacerbate this

GHG emissions across the supply chain with LNG, split into methane and CO_2 emissions



NOTES: Best in class natural gas production may result in emissions of 44 $ktCO_2e$/bcm, whereas bad practices (including high methane leakage) can reach >6,000 $ktCO_2e$/bcm according to OCI+ dataset (i.e. ~2,200 $ktCO_2e$/bcm for CH_4 and ~4,000 $ktCO_2e$/bcm for CO_2); A value of 30 for GWP100 of methane is used, 1 bcm = 35,170,000,000 MJ HHV, all numbers are rounded.

SOURCE: Sustainable Gas Institute (2015) *White Paper – Methane and CO_2 emissions from the natural gas supply chain*; SYSTEMIQ analysis for the ETC.

2.3 Undesirable and unnecessary actions

A combination of the clearly desirable actions and some limited expansion of LNG infrastructure would make it possible to eliminate all Russian gas imports well before 2030, while meeting all existing climate objectives such as the EU's 55% emissions reduction target by 2030, and the UK's NDC commitment of a 68% emission reduction for the same year. This reflects the fact that over 8 years, or indeed a considerably shorter period, a major acceleration of renewables deployment and energy efficiency improvements can be achieved.

There is therefore no need to loosen existing emissions reductions targets for 2030 or specific sectoral objectives such as Germany's commitment to cease all coal generation by that year. Whilst generating power from gas creates emissions, power generated from coal is much more carbon intensive and damaging to the planet. Pushing back the phase out dates for coal in Europe would send a negative signal to the rest of the world, especially when other, more carbon-friendly, options are available.

In addition, strategies should seek to avoid incentivising unsustainable use of bioresources. The light-duty road transport sector should not seek to reduce oil demand by encouraging an increase in road transport biofuel consumption. Available sustainable bioresources should instead be focused on by the production of bio jet fuel to drive emissions reductions in aviation and for materials uses. Bioenergy for power generation must only be used where the feedstock is sustainable, and would not be used otherwise for food production, given the ongoing global food crisis.[43]

43. Further discussion of key considerations on the optimal uses of scare bio-resources, see ETC (2021) *Bioresources within a Net-Zero Emissions Economy: Making a Sustainable Approach Possible.*

3

The impact on consumers – reducing exposure to fossil fuel price volatility

The cost of gas inputs to European electricity generation had increased by around 36 billion euros per annum even before the invasion of Ukraine.[44,45] But the total cost of electricity supplied to consumers had increased by around three times that amount (Exhibit 12).

This reflects the fact that increases in natural gas costs increase the cost of gas power generation, which in many places sets the marginal cost in power markets, this in turn often impacts the cost of all units of electricity purchased by retail consumers even if the cost of some other generation has not increased.

These effects, which vary significantly country by country, reflect the impact of power market designs and contracts at wholesale and retail level. In all power markets, increases in natural gas costs increase the cost of power generation which often sets the marginal price in wholesale markets. Depending on whether or not retail or other customers have struck long-term price agreements with suppliers this can result in either

- Increases in the cost of all units of electricity purchased by retail consumers (even if the cost of all generation has not increased).
- Power suppliers facing losses because their costs have gone above the level of fixed price promises.

As a result, this can lead to some electricity generators earning increased margins, some facing reduced margins, and some going bankrupt.[46]

44. Calculated using average TTF price levels between 2015-2019 compared to 2021, where 1050 TWh of gas was used for power generation in 2021. Prices from BNEF (2022) *EU Fuel and Power prices*. Gas use from EMBER (Feb 2022) *European Electricity Review 2022.*

45. Most large utilities are on long-term contracts or hedged, and therefore don't pay spot rates. If prices remain high over longer time periods more of these costs will filter through to consumers.

46. Many energy suppliers across the world have gone bankrupt in the last year, including Bulb Energy Ltd., in the UK, Strom AG in Germany, and Bohemia Energy in the Czech Republic. Bloomberg (2021) *Energy Supplier Collapses Go Global as Prices Keep Rising.*

The overall net result is that consumers across Europe have faced increased gas and electricity bills, with an average increase of over €750 in the past year.[47] Increases in the oil price have also fed through to rising petrol and diesel prices. While recognising that all energy markets, particularly in a period of energy transitions, are likely to generate price spikes and falls, it is essential that governments have clear strategies for managing the impact of this on household energy expenditure.

In the short term, governments have responded with an array of tax and subsidy mechanisms, and in some cases are considering so-called windfall profit taxes on gas or electricity producers.[48] These policy measures seek to protect companies and consumer living standards by reducing the impact of the price changes in gas, electricity, petrol or diesel. The downside of this approach, which in some sense amount to fossil fuel subsidies, is that this may create market distortions and reduce incentives to cut gas and oil consumption just when Europe is seeking to reduce its fossil fuel imports from Russia. Direct income support to low-income families, while leaving marginal prices of gas or road transport fuel unchanged, could in principle produce both more equitable and efficient results.

But whatever the short-term policy response, it is vital also to design in advance policies which address the medium-term challenge which the crisis has highlighted. Ideally power market design for systems dominated by zero carbon electricity supply should achieve an optimal balance between two objectives:

- Reducing the volatility of consumer bills to reflect the more stable costs which zero carbon power systems will enjoy over periods of multiple years.
- Maintaining marginal pricing in wholesale markets, and for marginal units of electricity used by retail customers, to create incentives for efficient decisions relating to investment in different types of generation mix, dispatch of flexible generating assets and time specific demands for electricity.

47. Clean Energy Wire (Feb 2022) *The energy crunch – What causes the rise in energy prices?*

48. Bloomberg (Mar 2022) *Italy to Hit Energy Companies With 10% Levy to Fund Support Plan.*

The ETC developed preliminary recommendations on these and related issues in its April 2021 report *Making Clean Electrification Possible*.[49] These recommendations included:

- Introducing appropriate long-term contract structures which can both increase revenue certainty and reduce costs of buildout.
- Appropriate design of short-term and ancillary service markets to allow all forms of generation to be competitive and deliver an increase in system flexibility.
- Long-term peak capacity mechanisms.
- Creating suitable market enablers to underpin smooth functioning and correct signals across the system.

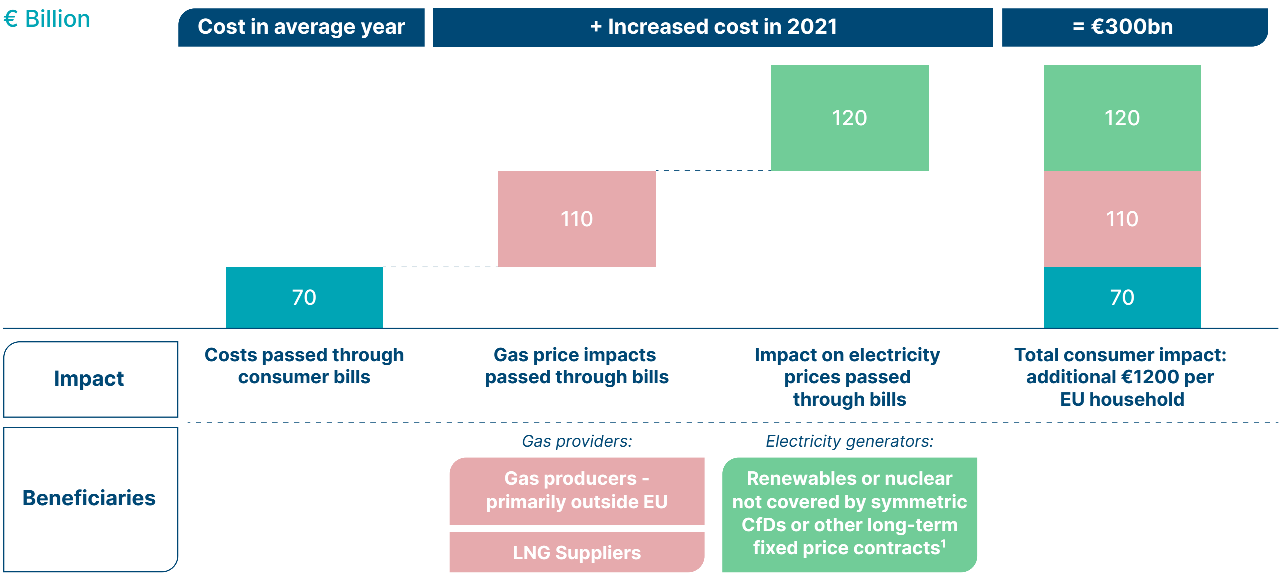
We will further refine our analysis and recommendations during 2022 in light of these issues revealed by the current crisis.

49. ETC (2021) *Making Clean Electrification Possible.*

Exhibit 12

The cost of producing gas hasn't increased, but EU consumers paid around €230 billion more in 2021 as a result of high gas prices

Impacts on EU consumers of increased gas prices in 2021



NOTES: Total consumer impact calculated by dividing additional 2021 cost by 195.4m EU households. This represents total costs passed through and not just energy bills.
[1] Feed-in-tariffs or renewable energy credits sometimes provide fixed price top-ups to variable wholesale prices. In these cases operators will benefit from high wholesale prices.

SOURCE: SYSTEMIQ analysis for the ETC based on BNEF (March 2022) *EU Power and Fuel Prices*.

4

The global picture – implications for the energy transition

Europe is determined to reduce reliance on Russian gas both to improve energy security and to reduce Russia's fossil fuel revenues. For many countries outside Europe however these objectives are not relevant: in these locations implications for the energy transition are driven primarily by price increases experienced today and changes in expectations of future prices and policies.

In the gas market, the price increase is not universal since gas markets are highly segmented. US and Canadian gas prices - which are based on domestic production – continue to be much lower, and have increased less than import-dependent countries. But all countries which depend on LNG imports will tend to face higher prices as Europe seeks to substitute LNG imports for Russian piped gas, with impacts particularly likely to be felt in the Asian market. In the oil market the price impact is more general, but with very different implications for net exporters and importers.

In much of the developing world, the net economic impact of the Ukraine crisis will be severely negative, with IMF forecasting price inflation, a significant fall in growth rates and recessions in some countries.[50] In addition dramatic increases in food prices – resulting both from interruptions to Russia and Ukrainian grain supply and increased fertilizer prices – threaten living standards among low-income people in many countries. Prices of wheat in the futures market have increased over 50% since the start of the war, and the World Bank is warning that food price increases could produce a hunger catastrophe in poorer countries.[51] The immediate policy priority is to respond to these short-term economic effects.

There is a clearly a danger that this focus could be at the expense of actions to drive the required energy transition. Whether this is the case

50. Financial Times (March 2022) *IMF cuts global growth forecast to 3.6% as Ukraine war hits neighbours hard.*

51. BBC (April 2022) *Ukraine war: World Bank warns of 'human catastrophe' food crisis.*

will partly depend on whether the gas prices in the futures market indicated in Exhibit 5 correctly anticipate higher prices over the next several years. If they do it is possible that carbon emissions may rise as the substitution of gas for coal slows in some specific locations; conversely, higher gas (and to a degree coal prices) will make low carbon technologies, including in particular renewable and nuclear electricity, and renewable derived hydrogen, more cost competitive relative to fossil fuels.

But in many countries the pace of renewable deployment (with China as a major exception) and decarbonization already falls far short of what is required to meet climate objectives (Exhibit 13). This reflects multiple barriers to the pace of development whether financial (e.g. the high cost of capital in many developing countries) or real economy related (e.g. planning and permitting systems in many countries, land purchase arrangements in some, and power market structures in others).

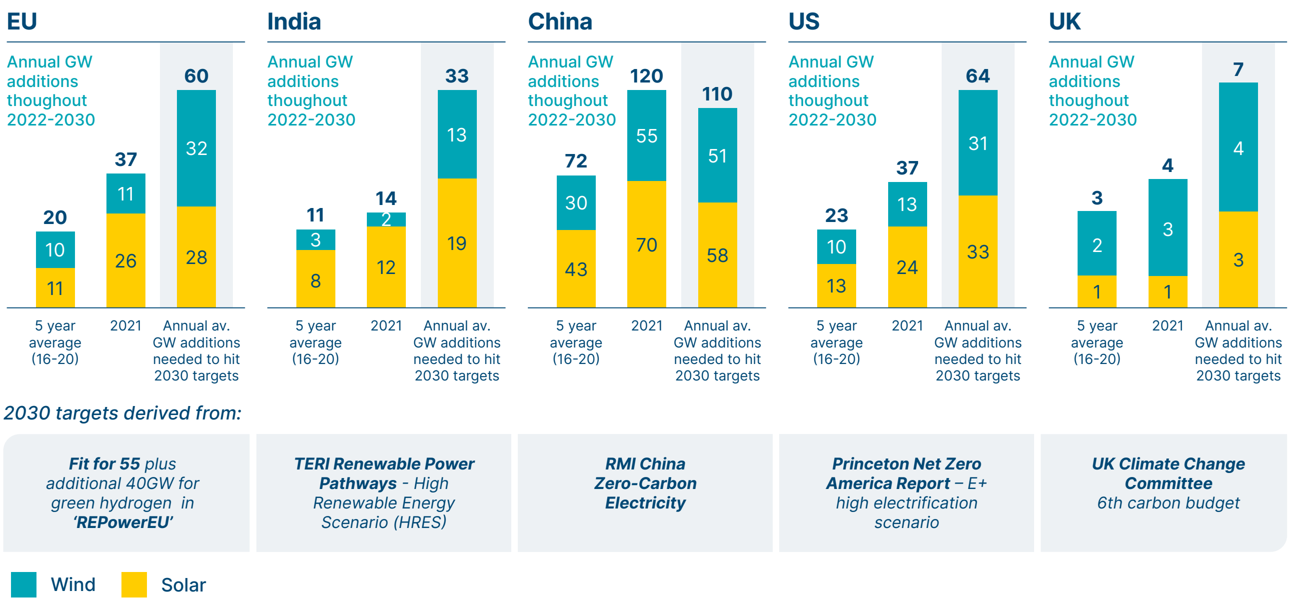
Identifying and overcoming barriers to clean electrification, in both developing as well as developed countries is therefore an even higher priority in the wake of the Ukraine crisis than it was before. In addition current economic stresses make it more important to identify whether and how far accelerated clean electrification through renewables must be combined with:

- Focussed investment on developing country gas production to help deliver affordable energy fast.[52]
- Measures to alleviate any negative employment and income effects of an accelerated energy transition (e.g. for regionally concentrated employment in coal mining).

52. As this may produce gas at a lower price than current marginal cost. However, to avoid carbon lock-in and stranded assets assistance with a 'leap forward' to clean energy would be preferred.

Exhibit 13

Most countries are currently far behind the pace of renewables build needed to meet, let alone exceed, 2030 targets



NOTE: 5-year averages are capacity additions from 2016-2020.

SOURCE: BNEF (March 2022), *Global Installed Capacity*; Renewables Now (February 2021) *UK's annual solar installs grow to 730 MW in 2021*; Wind Europe (February 2022) *Wind energy in Europe: 2021 Statistics and the outlook for 2022-2026*; CCC (December 2020) *Sixth Carbon Budget*, SolarPower Europe (December 2021) *EU Market Outlook for Solar Power 2021-2025*; European Commission (December 2019) *Fit for 55*, European Commission (March 2022) *REPowerEU*, TERI (July 2020) *Renewable Power Pathways: Modelling the Integration Of Wind And Solar by 2030*; Renewables Now (October 2021) *India installs 10 GW of solar, wind in Jan-Sep 2021*; RMI (January 2021) *China Zero Carbon Electricity Growth in the 2020s: A Vital Step Toward Carbon Neutrality*, BNEF (March 2022) *The 2022 Sustainable Energy in America Factbook*; Princeton (October 2021) *Net-zero America;* RECHARGE (April 2022) *'Made in Britain' energy strategy boosts offshore wind target to 50GW by end of decade.*

5

Key future issues – implications for the ETC's work programme

Many of the challenges involved in achieving rapid energy transition are unchanged by the current energy crisis. In general indeed high and volatile fossil fuel prices have improved the cost competitiveness of zero carbon technologies. But the current crisis has highlighted the importance of specific issues which have implications for several of the ETCs 2022-23 workstreams. These include:

- **Barriers to clean electrification**, which will identify what needs to happen to deliver investment in zero carbon power generation, transmission and distribution at the pace required to meet climate objectives. This work programme will cover multiple countries, but we will now also include a particular focus on how fast Europe could substitute clean electricity supply for Russian gas. It will also include detailed consideration of the issues relating to power market design discussed in Section 3, which are relevant in all countries. In addition this work will consider in detail the resources required to build a zero carbon economy, including in particular metals and minerals and the actions required to develop secure, resilient and sustainable supply.

- **Clean electrification in Africa** through which, building on existing work, we plan to identify how far African countries can "skip a generation" of fossil fuel power generation, rapidly developing much larger and low carbon electricity systems. The issue of how far gas developments have a role to play (whether for domestic consumption or export), has increased in importance in the current situation.

- **Energy productivity and efficiency**, on which we will focus strongly during this year. Achieving rapid improvements in this area has now become even more important in Europe but could also play a crucial role in reducing the costs of energy transitions across the world.

- **Fossil fuels in transition**, on which we intend to focus in 2023. This work programme will assess the pace at which fossil fuel production and consumption can and must decline, but also identify the level of investment needed to ensure that over-rapid decline does not trigger harmful disruption. Here the issues relating to investment in LNG infrastructure and long-term contracts, and the potential trade-off between energy security and climate objectives, will be important.

ETC Information Briefs on the aspects of the current energy crisis

This ETC Insights briefing is supplemented by a series of short explainers detailing 'what you need to know' about the following topics:

Analysis of the gas crisis

Drivers of the winter 2021/22 gas crisis.

The energy security implications of Russia's invasion of Ukraine.

How far can Europe reduce use of Russian gas this year?

Topic explainers – considering the options, both medium and short term, to reduce use of natural gas and diversify sources

How increased renewable deployment can deliver energy security.

Considering the opportunities, limits and trade-offs to using bioenergy-based power and heat to deliver energy security.

How the gas crisis has impacted green hydrogen.

Considering the role nuclear might play in supporting energy security.

How energy efficiency and consumer behaviour change can reduce demand for gas.

Importing Liquified Natural Gas (LNG).

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