Investment Managers

Investment Institute *Sustainability*

The impact of the Ukraine crisis on climate change

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What the impact of war means for the race to net zero

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Key points

- Russia's invasion of Ukraine has significantly disrupted energy markets and accelerated the EU's ambition to reduce its dependence on Russian fossil fuels.
- The European Commission plans to accelerate its already ambitious renewable technology implementation plans, which should raise the average emissions reduction pace to -5.0% per annum, from -4.8%.
- However, we are sceptical of Europe's ability to pivot away from Russian gas as quickly as planned, and of its goals to grow renewable technology, particularly wind, at the envisaged pace. Even as planned, we estimate Europe will remain vulnerable to any interruption of gas supplies until 2024 – in practice this could be longer.
- The expected gas shortfall is likely to be met by existing fossil fuel capacity, including an increase in coal-fired generation. This will likely raise emissions to a range that is likely to be higher over the coming decade than either 'Fit for 55' or the EU's new plans suggest.
- The 1970s marked a key turning point in oil intensity usage. The current crisis could mark a similar turning point for energy markets ushering in a range of new technologies to lower emissions output.

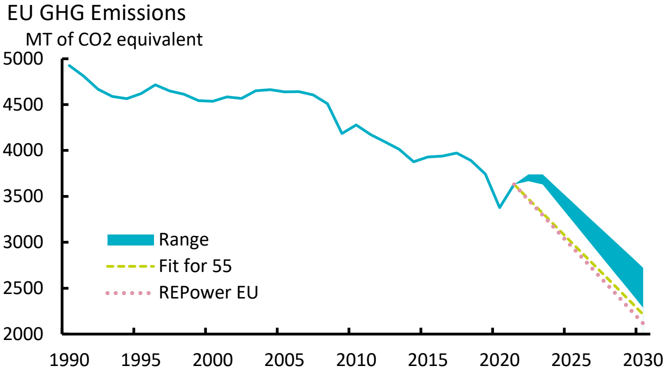
War in Ukraine will impact the battle against climate change

There are no doubt multiple factors that led to Russia's decision to invade Ukraine. One was likely to have been a calculation that European dependence on Russian fossil fuels – particularly gas – would limit the severity of any resulting sanctions on Russia from the West. Such a judgement would have considered low European gas inventories, elevated inflation pressures and the fact that Europe's Fit for 55 climate action plan envisaged a gradual reduction of gas imports over the coming decade in a bid to reduce greenhouse gas (GHG) emissions by 55% of 1990 levels by 2030. Such an analysis would have suggested some leverage of Russian gas supply now, but that would be likely to fade over time.

Such a calculation now appears misplaced. The sanctions against Russia have been deeper, more far-reaching, and more unified than many had expected. Moreover, the consequence of the inevitable increase in energy prices – particularly for European natural gas – has been for the European Commission to propose an even quicker shift in gas imports to reduce Europe's dependency on Russian supply. Europe has already banned Russian coal, but it is now considering sanctions on Russian imports of oil and even gas.

In this paper, we look at Europe's plans to reduce its dependency on Russian gas. We calculate the likely impact on the EU's GHG emissions if Russian gas supplies to Europe were halted – requiring substitution, and higher-emitting fuels, to be used for generation capacity to temporarily fill the breach. However, in the medium term the swifter shift to non-fossil fuel generation would likely see emissions fall faster. We then critically assess the plausibility of these assumptions. Exhibit 1 illustrates our estimates of the impact on GHG emissions of the EU's new plans, and an estimated range of a likely path of emissions.

Exhibit 1: GHG emissions estimates under different scenarios



Source: European Commission and AXA IM Research, March 2022

We also consider the implications beyond Europe, noting that for some of the world's largest economies, this is likely to involve a rearrangement of energy supplies, but one which might just prove to be a merry-go-round for gas supply – although such a rearrangement will take time.

Finally, we consider what the price shock might mean for renewable energy supplies. Oil suffered a similar shock in the 1970s and the surge in prices led to a material change in its use. Although demand subsequently rose to ever-higher levels, oil intensity peaked in 1973 and has fallen ever since. We consider what the latest energy price shock will mean for renewable technology and whether it will add to arguments for an accelerated decline in gas intensity.

REPowerEU: Shaking off Russian influence

As part of a much broader response to Russia's invasion, the European Commission published REPowerEU – a joint European action plan for more affordable, secure and sustainable energy. A strategy document was published in March, followed by a more comprehensive implementation document in May. The documents describe the feasibility of ending Europe's dependence on Russian gas "well before the end of the decade". The strategy involves a joined-up approach including diversification of gas supplies, increased energy efficiency (reducing demand), greater renewable energy generation and addressing infrastructure bottlenecks.

To put the task in perspective, some 40% of Europe's gas network is provided by Russia. In 2021 this totalled 155 billion cubic meters (bcm)[1].

The Commission assumes it will be able to achieve 60bcm of gas supply from alternative sources this year. This includes 10bcm of pipeline diversification and 50bcm of liquified natural gas (LNG) diversification, of which the US has already committed to provide a minimum of 15bcm this year.

Europe's 'Fit for 55' climate action plan already planned to reduce gas consumption by 100bcm by the end of the decade. REPowerEU proposes a combination of gas supply diversification and measures to reduce demand for natural gas to accelerate this drop. Exhibit 2 provides the measures proposed by the Commission and the estimated reduction in gas demand.

Exhibit 2: REPowerEU proposals for gas reduction

Measure	FF55 Ambition (bcm)	Post Ukraine Proposals	
		By end 2022 (bcm)	By 2030 (bcm)
Biomethane production	17	3.5	18
Renewable hydrogen production	9-18.5	-	25-50
Energy efficient measures	38	13	10
Solar rooftops	(inc. in 170 below)	2.5	26
Heat pumps	35	1.5	frontloaded
Wind and solar capacities	170	20	26

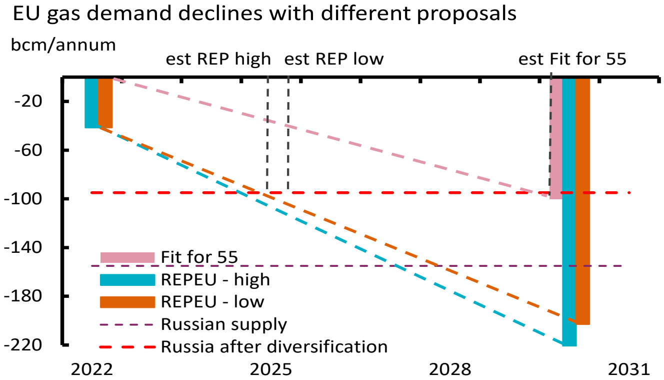
Source: European Commission and AXA IM Research, March & May 2022

The Commission's proposals suggest it can reduce demand this year by 41.5bcm. To assess the potential impact over the rest of the decade, we made some assumptions. First, we assume that Fit for 55 would have delivered the 100bcm in reduced demand gradually over the decade. Second, we consider the additional longer-term reduction estimated in the March report – estimated to total 53-78bcm by 2030 – also occurs gradually. Finally, we allow for the increase in projected solar capacity to 600GW from 420GW in May's more detailed release. Exhibit 3 illustrates the projected reduction in gas demand. Subject to the simplified assumptions, this would suggest that EU gas demand could eliminate Russian dependency by around 2025. This suggests that this year and next will be when the EU is most vulnerable.

This also shows that the EU is likely to face a shortfall of gas without Russian supplies before then. Based on our assumptions, this would equate to around 55bcm this year, 30bcm in 2023 and 5bcm in 2024. At this point in time there is nothing to stop the EU continuing to draw down this remainder of Russian gas, in which case the impact on emissions would be relatively limited. However, if these flows stopped, reflecting differences over currency payments, voluntary import bans or supply interruptions, the EU would have to make up this difference.

[1] "REPowerEU: Joint European Action for more affordable, secure and sustainable energy", European Commission, 8 March 2022.

Exhibit 3: Projected decline in gas consumption



Source: Eurostat, United Nations and AXA IM Research, 2020 data

How the EU would do this depends on how it uses gas. One-third of gas is used by the energy sector in electricity and heat generation; one-quarter is used by households; and one-tenth has commercial and public uses – both largely for heating space. For these users, the gas shortfall will be replaced by other fuels, such as electricity production using alternative generating fuels, with end-users substituting with additional electricity. The remainder – just over one-quarter – is used by industry. We assume some industry will be able to substitute gas use for electricity – for example for low temperature heating, although this may require replacement capital which would itself take some time. Other parts of industry will not be able to substitute in the medium term, either because they use gas directly (for example the chemical industry) or use high-temperature furnaces which would require more fundamental capital refinancing, for example iron and steel works. We estimate a little under 20% of natural gas use is for non-substitutable industrial use.

A shortfall of 55bcm of gas this year implies an electricity equivalent of 266TWh of electricity in 2022 (about 10% of EU total consumption), 150TWh in 2023 and 25TWh in 2024[2]. The impact that this shortfall will have on supply, pricing and thus demand is complex. However, we assume that one-quarter of this is met by reduced demand – reflecting increased energy efficiency, elevated costs, or non-substitutability. We also assume that none of this additional output could be met by additional renewable capacity – that being already accelerated in the REPowerEU assumptions.

Looking at electricity generation, we observe that nuclear-powered generation was 33TWh lower in 2021 compared with 2019 output, in part reflecting ongoing problems at reactors owned by Électricité de France (EDF) – Europe's largest nuclear power generator[3]. However, we assume scope for rebound in nuclear output beyond this year and expect that nuclear-generated electricity could recover to 2019 levels.

Coal-fired generation has also fallen sharply, down 188TWh from 2017. This drop more likely represents a strategic withdrawal, rather than operational difficulties. Some of this coal-fired generation capacity would have been decommissioned since then – making a pick-up in output more difficult. However, we expect that coal-fired generation would be capable of regaining 2017 output levels through a combination of returning mothballed plants and temporarily running at higher load factors. Indeed, in May the Commission added that "existing coal capacities might also be used longer than initially expected".

Estimating that a fall in demand accounts for one-quarter of the gas shortfall, returning nuclear and coal-fired output should address the equivalent rise in electricity demand. However, if demand does not fall back sufficiently – perhaps as governments subsidise the rising cost of energy – more explicit demand-management practices are likely to be required.

The great gas merry-go-round

Our analysis suggests higher-emission coal-fired electricity generation could be increased in the short term to account for a short-term drop in lower-emission gas supply. However, a deeper consideration of the LNG market suggests additional complexity.

The REPowerEU project is also aiming to get the EU to diversify away from Russian gas imports by increasing LNG by 50bcm this year. The size of the global LNG market in 2020 was 488bcm[4].

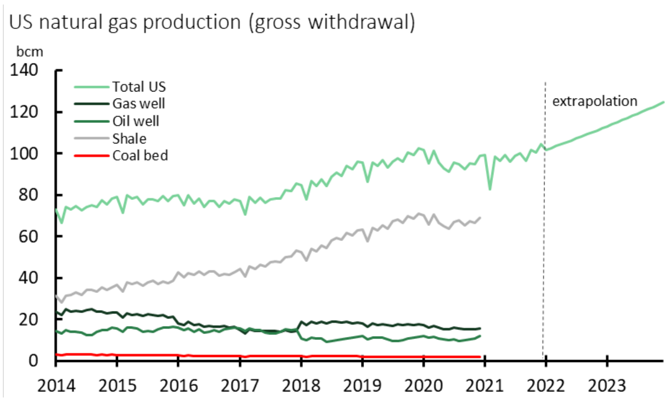
[2] The International Energy Agency (IEA) cites a ratio of 10.28TWh per 1bcm of gas as the pure energy transfer. Allowing for the efficiency rate of gas power plants of 45-57%, the IEA cites 7.24 cubic feet of gas/1kWh of electricity produced or 4.96 TWh/1bcm.

[3] EDF has suggested that it will produce between 295 and 315TWh in 2022, and between 300 and 330TWh in 2023, down from >400TWh pre-2015

[4] "Statistical Review of World Energy 2021", BP, July 2021.

REPowerEU therefore suggests a switch of over 10% of the total LNG market this year. In what follows we consider some of the risks to that assumption and the consequences of such a shift.

Exhibit 4: Direct trade links with Russia/Ukraine



Source: Eurostat, United Nations and AXA IM Research, 2020 data

There are questions as to whether the EU can achieve this level of diversification. The EU appears to have the capacity to increase LNG imports by 50bcm. Total EU LNG import capacity is 157bcm[5] – almost the same amount as Russian gas imports. In 2021, 13 EU countries imported 80bcm of LNG. On average, this suggested around a 50% capacity usage. In December 2021, capacity usage rose above 60%. To import an additional 50bcm in 2022 capacity usage would need to average around 83% for the year, exceeding the previous peak of 70% seen in Q2 2020.

Yet some of the EU's current spare LNG capacity is in the 'wrong place'. Most notably about 34bcm of it is in Spain and there is only a 7.5bcm pipeline connecting the country to France. Upscaling the connection between Spain and the rest of the continent would be a necessity to make this spare capacity practical instead of theoretic. None of these obstacles are insurmountable, but they may add to the challenges of increasing capacity this year.

Over the longer term, LNG import capacity is set to expand. Germany has commissioned two new LNG terminals, for Brunsbüttel and Stade, and France is reported to be considering a floating terminal in Le Havre. However, all will require time; the German terminals are planned for 2024 and 2026, while the French network operator will need two years to connect the floating terminal[6].

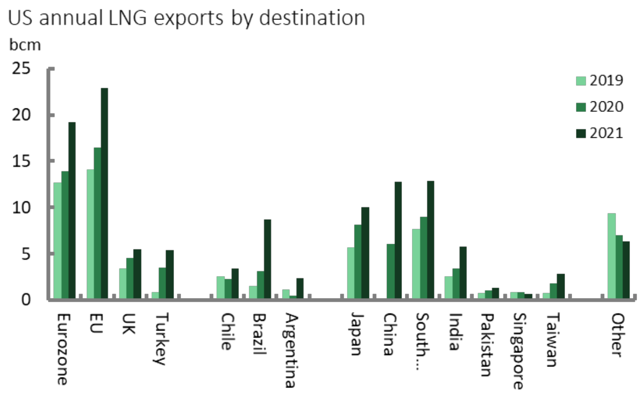
So, who will supply additional LNG? The US is the most obvious candidate. After all, it has one of the world's largest reserves of natural gas, in 2020 it was the world's largest producer (40% more than Russia) and by the end of 2022 is expected to have the world's largest LNG export capacity, overtaking both Australia and Qatar. On 25 March, US President Biden announced the US would increase gas supply of 50bcm to Europe, but only by 2030. This year the US has pledged a minimum of 15bcm.

In the short term 15bcm is a significant contribution but also represents a marked rise in US production. Total US gas production (gross withdrawal) has started to rise again, having dropped during the pandemic (Exhibit 4), with shale recently providing the additional output. An extrapolation of the current trend suggests that total gas production could comfortably produce an additional 15bcm, albeit subject to concerns that supply chain issues, labour and climate legislation had dampened the sector's response to higher prices.

Yet being able to provide an additional 15bcm of LNG exports this year is different. US LNG export capacity is scheduled to rise again this year, with peak capacity suggesting an increase to around 140bcm (from around 100bcm in 2021) – although LNG plants have faced planning and construction delays in recent years. Moreover, this assumes no transit constraints including pipeline capacity from shale fields to LNG terminals and LNG vessels.

If the US struggles to produce an additional 15bcm of exports, it may simply reroute current supply from other destinations. Exhibit 5 shows the US's recent LNG exports by destination. However, a reduction in LNG supply to Asia, for example, to boost deliveries to Europe could simply result in Asian economies suffering gas shortages. In turn this could force others to resort to higher-emission fuels for electricity generation. This was certainly the case for China last year when power shortages saw it increase coal production and usage, despite the impact this would have on its longer-term emission reduction goals.

Exhibit 5: US LNG exports



Source: EIA and AXA IM Research, April 2022

An additional 15bcm in exports from the US would still be less than one-third of the EU's overall need for this year. If Qatar and Australia were both able to match that, this would still not

[5] "Liquified natural gas", Eurostat, February 2022.

[6] French plans for a floating LNG regasification terminal - GRTgaz – 9 March 2022

fulfil the EU's hopes of 50bcm this year. But these exporters may also face difficulties in terms of producing, shipping and exporting natural gas, which could see them re-routing gas exports and in turn creating shortages elsewhere.

Ironically Russian gas supply itself might alleviate this pressure. Before the war, China's President Xi Jinping and Russian President Vladimir Putin announced several business and energy agreements, including a new deal to increase Russian gas supply to China by 10bcm per annum. This is the latest in a series of deals and follows a 2014 agreement which resulted in the construction of the Power of Siberia pipeline, to deliver a contracted 38bcm to China by 2025. Russia is constructing capacity for this initial pipeline to deliver up to 44bcm. The new deal will take Russian supply to China to 48bcm.

Live from the markets

According to the International Energy Agency IEA[7], European LNG imports have already increased by 18bcm during the first quarter of 2022 and the agency expects an overall increase of 25bcm for the full year.
Europe captured both new volumes and market shares, notably as demand from Asia declined due to high prices.

Russia has also been looking to connect the Yamal Peninsula fields, which currently supply Europe, to China via a pipeline through Mongolia, estimated to be around 50bcm[8]. This has not been officially agreed. Initially, this would have allowed Russia a stronger negotiating hand with both Europe and China as delivery from this large gas province could have been switched to either. If Europe is accelerating its reduction of Russian gas, China may now be able to secure a better deal. However, with China's own ambitions for emissions reduction high, its demand for gas is likely to grow quickly while global supply and prices will be less attractive.

China is unlikely to be the only buyer. India is reported to be buying heavily-discounted Russian oil and gas and other Asian economies may also be interested. Sanctions will play an important role. For now, Russian energy exports are not sanctioned. However, long-term contracts require confidence that this will remain the case. Recent events show a risk that future Russian actions could result in sanctions being expanded. Moreover, Western appetite to exclude Russian energy from broader sanctions is already fading and may do so more once it has successfully weaned itself off Russian supply. Countries may therefore risk secondary sanctions, or suffer reduced energy supply if they choose to disengage in the future – a risk that is likely to be implicitly included in the price of any long-term contract.

In the longer-term there is much more scope to achieve a reorganisation of international gas supply. The US's longer-term commitment to a 50bcm increase to Europe looks manageable by 2030. Over that time it is also possible that Russia will have contracted additional supply elsewhere. Overall, a big merry-go-round of gas production could take place: Russia may reduce sales to the West, but increase to the East; the East may have reduced demand for LNG from the US and the US may increase its exports to Europe. This would likely suggest rising gas supply, to meet rising demand and reducing dirtier energy production in other parts of the world. This could ultimately leave final levels of gas consumption similar to where they would have been pre-war. But this must allow for pragmatic hurdles including striking long-term contracts for supply, increased LNG terminal capacity and the building of new pipelines.

Hence over the longer term a reorganisation of global gas supply is plausible. However, this creates the likelihood of an adjustment phase that could easily last three to five years. During this adjustment phase many economies, not just the European economy, could be faced with tighter gas supplies and rising energy costs. In turn, this could increasingly lead them to resort to immediately available higher-emission electricity generation, even while plans to accelerate clean energy investment are put in place.

[7] Gas Market Report, Q2-2022, April 2022

[8] "Russia and China Expand Their Gas Deal: Key Implications", The Oxford Institute for Energy Studies, March 2022.

The impact on the GHG emissions outlook

The climate implications and impact on emissions due to the potential shifts in the EU's primary energy supply and power mix are fundamentally linked to the carbon content of the fuels. Burning coal is inherently much more carbon-intensive than burning natural gas, but all gases are not equal.

The following tables present the relative carbon intensities of electricity generation and the carbon footprint of natural gas by origin (Exhibit 6):

Exhibit 6: Carbon intensity of power generation

g C02e / kWh	Emissions	Source
Coal	760	IPCC
Coal	1 014	US EIA
Lignite	1 010	Coaltrans
Coal	1 094	RWE
Natural Gas	370	IPCC
Natural Gas	414	US EIA
Natural Gas	424	RWE
Natural Gas	366	Ibe rdrola

Source: IPCC, EIA, Coaltrans, RWE, Iberdrola and AXA IM Research, May 2022

Exhibit 7: Carbon intensity of piped natural gas and LNG delivered to France, before combustion

g C02e / kWh	Emissions	Type
Norway	9	Pipeline
Norway	23	LNG
Russia	40	LNG
Nigeria	52	LNG
Qatar	58	LNG
Russia	59	Pipeline
Algeria	66	Pipeline
Algeria	80	LNG
USA	85	LNG

Source: Carbone 4 and AXA IM Research, May 2022

A shift from gas to coal is significantly negative for carbon emissions. Real-life emissions from coal power plants are more than twice as high as for gas power plants. Producing 1kWh from coal instead of gas results in additional emissions of 0.67 kg of CO_2, based on actual intensities from German utility RWE. If EU coal-fired production increases by 188TWh to replace lower gas supplies, then CO_2 emissions would be increased by 126MT, a 3-4% increase in greenhouse gas emissions for the entire EU.

Even if the EU is successful in migrating an additional 50bcm of Russian gas to alternative LNG, this also has implications for GHG emissions. Russian gas is piped to the EU. While Gazprom is not the most GHG-efficient when it comes to transporting gas through pipelines[9], piped gas is typically less emission-intensive than LNG. The IEA's 2018 study[10] of these issues concluded that the average intensity of piped gas was 95.5kg of CO_2 equivalent per barrel of oil equivalent, while the average for LNG was 118.3kg. This difference stems from the energy required for liquefaction, shipping, and re-gasification of LNG. Therefore, shifting from piped gas to LNG would also have negative global climate consequences, although the additional emissions would not occur in the EU, but mostly where the gas is produced and liquefied.

Moreover, there are large differences in the carbon footprint of gases depending on their origin. The key differentiator is the level of methane emissions, especially in the production and transportation phases. This matters as methane, the main component of natural gas, is a potent GHG having around 80 times the impact of carbon. Exhibit 7 shows this variation, which is largely a reflection of operating practice quality, distance travelled, and methane leaks. Norway is a well-known paragon of efficiency while Russian and US operations are known to leak large quantities of methane[11]. Exhibit 7 suggests that using US LNG to partially replace Russian gas would increase global emissions, even if the emissions were attributed in the US rather than EU.

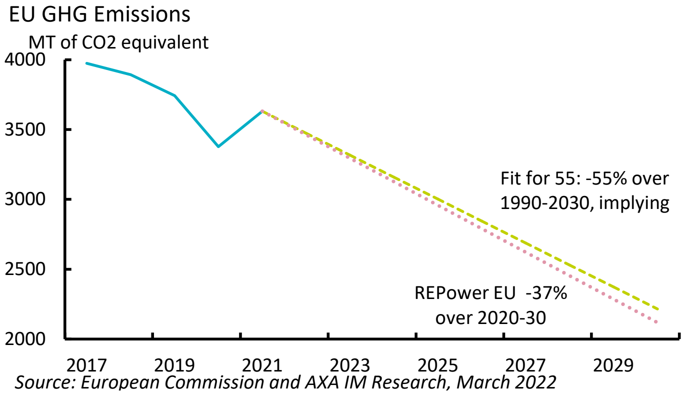
That said, we should keep things in perspective. Going on available data, a gas-to-gas shift from Russian pipelines to US LNG leads to an increase of 26g CO_2/kWh; a gas-to-coal shift would lead to an increase of 670 g CO_2/kWh i.e. 25 times more. Although it matters to have as clean as possible a gas supply, it is more important for the EU to avoid burning more coal.

[9] https://www.bloomberg.com/news/articles/2021-06-18/gazprom-admits-to-massive-methane-leaks

[10] World Energy Outlook 2018

[11] Eugene, O., "A climate change conundrum: Is there a sweet spot for natural gas in the energy transition?", AXA IM Research, September 2021.

Exhibit 8: GHG path of REPowerEU



Source: European Commission and AXA IM Research, March 2022

Exhibit 8 considers the REPowerEU plan and estimates the likely GHG emissions path variation – relative to the baseline Fit for 55 pathway – allowing for the projected shift in energy use and power mix. While the Commission says that REPowerEU "does not modify the headline ambition", we estimate that it adds to an already-demanding ambition, but to a limited extent as some large emitting sectors, such as transportation, are not impacted by this new initiative. Yet the scale of change is worth highlighting; emissions declined by 31% between 1990 and 2020 and the current goal is to reduce emissions by more than this in a third of the time. Finally, for the sake of simplicity we present a linear adjustment; however, an acceleration in the second half of the decade is more likely.

The pragmatic realities of the EU's ambitions

The key finding above is that while emissions are likely to be higher in the coming few years as the EU adjusts its energy mix, they should fall sharply in the latter half of the decade, as a function of the accelerated investment in renewable energy generation with an expected impact of 170bcm by 2030. A shortfall of renewable capacity would thus lead to either higher GHG emissions as more fossil fuels would be burned and/or to more demand-management measures. We next consider how realistically feasible this accelerated pace of investment will prove.

Fit for 55 already planned to deploy 900GW of renewable electricity capacity, with 380GW in wind and 420GW in solar and to have renewables growing to 40% of the EU's primary energy consumption, double the current level. The REPowerEU plan is pushing further by targeting a 45% level and an additional 160GW of capacity, mostly in solar, now expected to reach almost 600GW of capacity. This in practice means a more than trebling of the installed capacity by 2030, and average annual levels of new installation of more than 55GW for wind and more than 65GW for solar. To provide a scale, global 2021 installation in wind and solar were respectively 94GW and 168GW.

Looking at industry association outlooks[12], projected installations for wind between 2022 and 2026 are 21GW per annum while for solar the pace is expected to grow from 26GW per annum in 2021 to 50GW by 2025 and 80GW by 2030. The solar industry appears on track to meet both the intermediary 2025 target of 320GW and the 2030 EU target. Wind on the other hand is lagging significantly.

Renewable (green) hydrogen[13] is also presented as a means to replace 25-50bcm of Russian gas. The plan mentions up to 10 million tonnes (MT) of regional production and up to 10MT of imports. While not stated in EU documents, this appears to be to introduce hydrogen into the natural gas network, mixing hydrogen and natural gas so that less of the latter is needed, similar to the way ethanol is blended with gasoline to reduce gasoline volumes. Although burning pure hydrogen instead of natural gas in certain industrial applications is conceivable, it is not necessarily practical in the short term as the equipment must be adapted or changed. More broadly we contend that the electricity requirements to produce green hydrogen do not make it the most efficient substitution in all but a few specific applications. However, we also argue that the EU's ambition is high, but stretched, and conclude it is unlikely to be met.

REPowerEU also plans for a greater use of biomethane with a target to add 35bcm by 2030, with 3.5bcm this year. According to the European Biogas Association (EBA), biogas and biomethane[14] production in Europe (including the UK and Switzerland) reached just 19bcm in 2021, with biomethane accounting for close to 3bcm. The EBA counted 1,023 biomethane production plants, an increase of almost 300 units over 18 months and it advertises a potential to reach 1,000TWh of biogas and biomethane or 95bcm by 2050. In a study published in 2021, Engie goes further and mentions 1,700TWh as a potential for biomethane, including 462TWH from intermediate energy crops if they are developed[15].

[12] Windeurope-Wind-energy-in-Europe-2021-statistics.pdf
EU Market Outlook for Solar Power (solarpowereurope.org)

[13] Produced through the electrolysis of water using renewable electricity

[14] Biogas is a mix of biomethane (usually 50% to 70%) and other gases, notably CO_2. Biomethane is obtained through purification of biogas

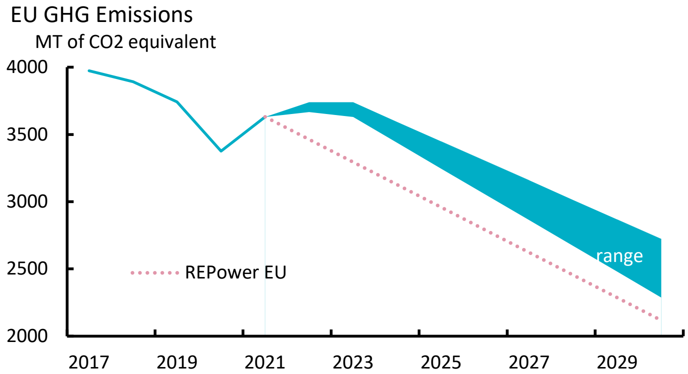
[15] ENGIE_2021_June_Biogas_potential_and_costs_in_2050

As such, the EU target 2030 of 35bcm appears ambitious but achievable. However, the target to add 3.5bcm in 2022 alone, in essence more than doubling the EU current capacity, is much more challenging.

Finally, achieving this ambitious transformation will need greater EU-wide coordination. The EU Green Deal is a step in the right direction, but more needs to be done to harmonise rules and practices. The Russian invasion of Ukraine is acting as a spur to better coordinate actions and the recent REPowerEU plan update[16] demonstrates a clearly stronger intent to change the rulebook. Specifically, we welcome the priority given to speeding up permitting for wind and solar, and the push for declaring renewable energy as an "overriding public interest". Common rules are a steppingstone, but individual countries' actions will be needed to change rhetoric to reality, and it is likely that there will be clashes between the broad EU strategy and local politics. 2030 is only eight years away and accelerating the pace is a necessity, especially for wind. Unless many projects are greenlighted in the next three to four, it will be too late. More broadly, the EU ought to work alongside its neighbours, including the UK, Switzerland, and Norway to develop common European rules. Notably, it was positive to see that the UK government, in its new energy strategy presented on 6 April 2022, aims to reduce planning approval time for new offshore wind farms from four years to just one.

We view it as unlikely that the EU can fulfil all of its ambitions for accelerated renewables investment – with wind generation a particular concern. A shortfall in renewables output would require either further demand management, or electricity produced by other means – likely a continued use of fossil fuels. In a study published in 2020[17], the Enel Foundation estimated that a 1% increase of renewable energies in the primary energy mix translates into a reduction of 77MT of GHG if it replaces coal and 32MT if it replaces natural gas. As stated, Fit for 55 and REPowerEU bank on a 25-percentage point increase for renewables in this decade. In addition, the potential for a temporary increase in coal use to replace Russian gas supply would increase emissions, something that is clearly considered in Germany[18]. As such, in Exhibit 9 we show a forecast range of what we consider the likely path of actual emissions – compared to our assessment of the what the REPowerEU plan would mean for emissions.

Exhibit 9: Emissions likely to remain higher for longer



Source: European Commission and AXA IM Research, March 2022

Our estimates suggest that GHG emissions are unlikely to fall between 2022-2023, pushed up by the post-pandemic rebound and return to coal generation – at least in Germany amidst the accelerating, but still too slow, deployment of renewables. Over subsequent years, we expect a decline in emissions, but at a slower pace than the EU is aiming for, particularly given our concerns for wind.

Fundamentally we do not consider the governance, visible industrial developments and investment flows to yet match the EU's ambition for either Fit for 55, nor REPowerEU. The most recent announcements are however positive in the sense that they are about changing the rules, promoting cooperation and innovation, and financing. As such, we would not be surprised to see an acceleration in the second part of the decade.

EU emissions declined by 1.2% per annum on a compound annual growth rate (CAGR) between 1990-2020. Over the previous decade, the CAGR was -2.3%, but only -1.5% if the sharp COVID-19 drop of 2020 is removed. Fit for 55 factors in a CAGR of -4.8% per annum between 2020-30, with emissions up by more than 7% in 2021, and we estimate that REPowerEU would mean a steeper -5% average annual drop. We see a range of the likely path between -2.8% and -4.5% per annum, lower than the EU ambition but

[16] "REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition", European Commission, 18 May 2022
[17] Circular Europe: how to transition from a linear to a circular economy - enelfoundation.org
[18] German operators prepare for extending runtime of decommissioned coal plants | Clean Energy Wire

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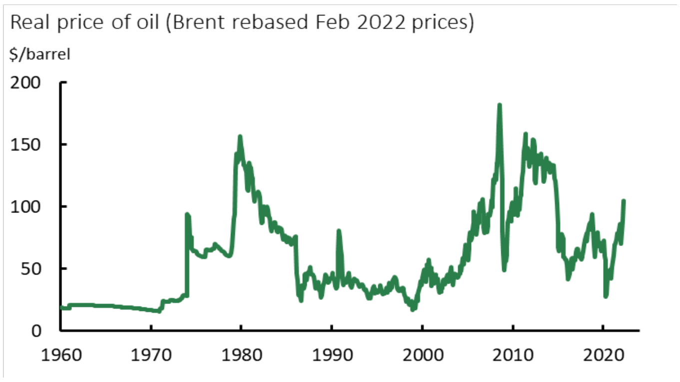
still significantly faster than during the past 30 years. We acknowledge significant uncertainty around this outlook and will watched for more announcements in the coming months. We will also closely follow the changes in permitting rules as we see this as the most critical enabler of the EU ambition.

Lessons from the 1970s and technology adoption

More broadly, we can see some obvious similarities with the oil shocks of the 1970s. Exhibit 10 shows oil prices in real terms and shows the clear surge in prices associated with the oil shocks in 1973 and 1979. Oil prices in real terms have exceeded levels reached after both shocks – although the abruptness of the change was exceptional.

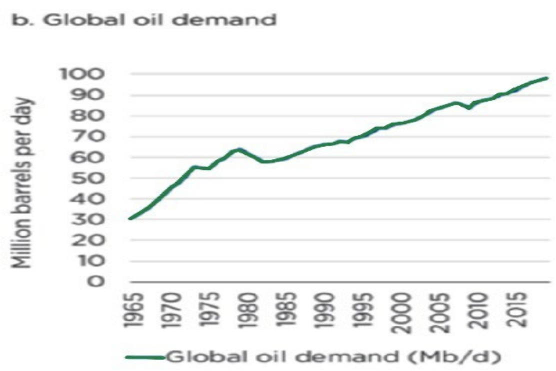
Exhibit 10: The 1970s changed perceptions of oil



Source: Refinitiv and AXA IM Research, April 2022

Yet the oil price shocks of the 1970s changed attitudes to oil, from what had previously been a reliable, cheap and non-volatile source of fuel. Exhibit 11 illustrates that, after a brief period where actual oil consumption fell, the elevated levels of pricing did not stop the level of oil demand from rising (although it did so at a markedly slower pace).

Exhibit 11: Demand continued to rise

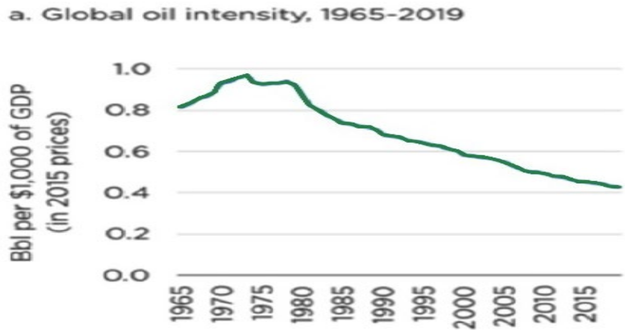


Source: BP Statistical Review of World Energy 2021, April 2022

Yet Exhibit 12 illustrates that from that point the intensity of oil usage continued to decline. This is all the more noteworthy given the relatively complex use of oil, which like natural gas provided fuel for heating and electricity but was also integral in transport fuel and plastics.

It is certainly conceivable that the current shock provides a similar marker for natural gas markets. Emissions reduction targets around the world will likely keep demand for gas rising, as a transition fuel from heavy-emitting fuels, before non-fossil fuel production can completely eliminate this need. This may even mean that gas intensity continues to rise. However, the rise in gas prices, their volatility, and renewed concerns about the security of supply are likely to additionally accelerate the transition to renewable technology.

Exhibit 12: Oil intensity has continually fallen

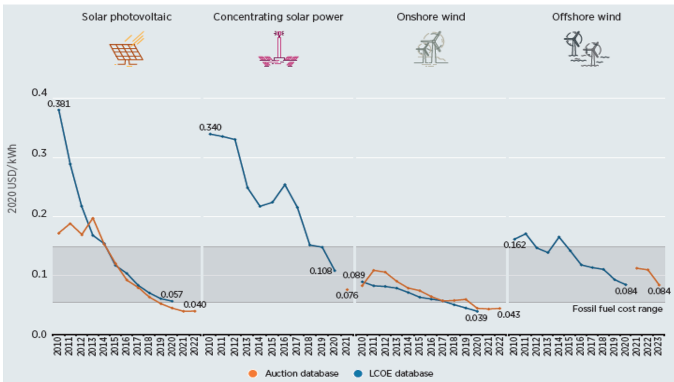


Source: BP Statistical Review of World Energy 2021, April 2022

More renewable tech becomes competitive

More broadly, we can see some obvious similarities with the oil shocks of the 1970s. Many studies have shown that renewable electricity sources have become extremely competitive and do not need subsidies anymore. The International Renewable Energy Agency (IRENA) publishes a cost analysis on a regular basis (Exhibit 13).

Exhibit 13: Levelised cost of renewable electricity



Source: "Renewable power Generation,- Costs in 2020", International Renewable Energy Agency (IRENA) - Cost Database, June 2021

Regional differences exist, depending on local conditions and local value chain developments, but renewables ought to become the default choice ahead of fossil fuel-based generation technologies. Renewable competitiveness becomes even greater if a carbon cost is included. And the current energy crisis in Europe is only reinforcing this conclusion.

However, it is insufficient to consider production costs of renewables. Wind and solar are inherently intermittent sources of electricity, while nuclear provides constant levels of output and coal and gas-based generation produces power on demand. As renewables gain market share, power networks start to function differently, requiring modifications. Hence additional system costs also need to be considered in addition to marginal generation costs.

Many studies have covered this subject[19], concluding that at some point increased renewable power will require additional investment in the network, specifically in interconnection and storage. System costs are lower in flexible systems, where the power network is well maintained, there are many nodes and there are buffers to manage supply swings. Fossil fuel-based electricity does not incur those additional costs but has to bear an additional carbon cost that renewables avoid. A fair comparison would hence require a comparison of additional system costs for renewables and carbon costs for fossil fuel plant per kWh.

Moreover, wind and solar power provides an additional advantage of energy independence – although this is difficult to put a price on.

Over the longer term, we would also consider other decarbonisation technologies, such as water electrolysis or heat pumps, as likely to benefit from the shock as their relative cost improves. More broadly, the price shock coupled with the political shock of the war in Ukraine are likely to create opportunities and new conditions where innovation can thrive. There are additional technologies and solutions that have been around for a long time that may finally find their place in the sun, including green hydrogen and carbon capture and storage technologies. Other technologies, at still earlier stages of development, may also be catalysed by recent developments to emerge as contenders.

The current Ukraine crisis may yet fuel the animal spirits of decarbonisation - and the EU should look to drive this.

[19] UK Energy Research Centre – Intermittency Report – February 2017
Projected Costs of Generating Electricity – IEA & OECD – 2020

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