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Competition in Energy Markets – Background Note

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The opinions expressed and arguments employed herein do not necessarily reflect the official views of the Organisation or of the governments of its member countries.

More documentation related to this discussion can be found at:
www.oecd.org/competition/competition-in-energy-markets.htm

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Competition in Energy Markets*

Energy is a vital input for all economic activities and everyday life. Modern economies globally rely on the extensive use of fossil fuels, the main contributor to climate change. Energy markets are facing the long-term challenge of moving towards a net zero future. In the past year, conditions in energy markets worldwide have been unprecedented. Driven by COVID-19 and Russia's invasion of Ukraine, increased demand and shortages in supply have led to record energy commodity prices, the impact of which has been felt worldwide. High natural gas and electricity prices have had a significant impact on inflation, economic growth, living standards and wider policy goals such as decarbonisation. This paper explores the longer- and shorter-term challenges of the energy markets and their competition policy implications. It considers why wholesale natural gas and electricity prices have risen so much and the public policy responses to high energy prices.

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Introduction

1. Energy plays a vital role in modern society: from heating people's homes to powering industrial processes. Modern economies globally have industrialised following the discovery and extensive use of non-renewable energy sources such as coal, crude oil, and natural gas. Whilst the use of renewable energy has increased in recent years, economies still rely on these energy sources.
2. In the past year, conditions in energy markets worldwide have been unprecedented. Driven by COVID-19 and, more recently, Russia's full-scale invasion of Ukraine, shortages in supply and excess demand have led to record energy commodity prices, the impact of which has been felt worldwide. High natural gas and electricity prices have had significant impacts on inflation, economic growth, living standards, and wider policy goals such as decarbonisation.
3. This background paper explores the interaction between energy prices, particularly natural gas and electricity, and competition. Using this lens, it considers why wholesale natural gas and electricity prices have risen so much following Russia's full-scale invasion of Ukraine, the impact of high energy prices on competition as well as the impact of the competitiveness of energy markets on prices, and implications for competition authorities.
4. The first section of the paper provides an overview of the wholesale natural gas and electricity markets. It explains the uses of natural gas and electricity, their fundamental features and how this has an impact on competition and price formation. It also outlines which parts of the market are competitive and which are not. This section also briefly covers the crude oil market.
5. The second section examines the impact of the COVID-19 pandemic and Russia's full-scale invasion of Ukraine on energy supply and demand as well as how these events have contributed to record high prices during the last year. It also looks at how governments and policy makers have responded to record energy prices, considering the impact of prices on supply security, inflation and competition.
6. The third section discusses how the global energy system will be overhauled as a result of the transition to a decarbonised power system and economy by 2050 (the 'Net Zero' transition). It discusses issues that may arise as mass decarbonisation accelerates, that governments and regulators should be aware of.
7. The final section considers the issues that have arisen from current energy crisis and the significant structural changes arising from the transition to Net Zero. It discusses the tools competition authorities have typically used in energy markets and their interaction with the role of sectoral regulators, and offers thoughts on how competition authorities could engage with governments and regulators on competition issues.

1. Global market structure

1.1. Natural gas

1.1.1. Overview of natural gas markets

8. Natural gas forms an important part of the global energy system. It accounts for 24% of primary energy demand as of 2021, up from 16% in 1973. In 2021, the world's largest producers of natural gas were the US, Russia, and Iran (Investopedia, 2022^[1]). By export volume, Russia is the leading supplier of natural gas, followed by the US and Qatar (Statista, 2022^[2]). By a large margin, China is the largest importer of natural gas (149.4bcm), followed by Japan (95bcm) and Germany (84bcm) (Enerdata, 2022^[3]).

9. The export of natural gas has two main forms (Ritz, 2019^[4]). First, natural gas transported by pipeline, for example, Russian exports to Europe. State-owned producer Gazprom is the world's largest supplier of pipeline gas, with a legal monopoly in Russia over exports of piped gas. Second, natural gas transported as seaborne liquefied natural gas (LNG), notably Qatar's exports to Asia, dominated by state-owned producer QatarEnergy.

10. Pipeline and LNG increasingly compete head-to-head, particularly in Europe. However, there are key differences: pipeline exports are physically bound to a particular route, with no alternative use; LNG in contrast is exported by tanker and can be transported to a choice of markets. In 2021, LNG accounted for just over half of all inter-regional trade of natural gas (BP plc, 2022^[5]).

1.1.2. Regional markets

11. There are three main regional natural gas markets: Europe, Asia, and North America (US Energy Information Administration, 2022^[6]). Regional segmentation arises due to transportation difficulties, differences in regional price formation, and regulatory factors. Natural gas is more difficult to transport than crude oil. If the distance is too large to bridge via pipelines, natural gas must be transformed into LNG for transportation, for which infrastructure is very costly. Price formation mechanisms are also different between regions, which can limit the scope for competition (more details on price formation are provided below).

12. In Europe, most natural gas imports are transported via pipelines from Russia, while LNG plays a balancing role in the market. Most Asian markets, by contrast, lack pipeline connections, e.g., Japan and South Korea import 100% of their natural gas as LNG. The US was disconnected from global trade until around a decade ago, but, following the shale gas 'revolution' and major investment in LNG infrastructure, has become the world's largest producer and second largest exporter of natural gas.

13. The share of LNG in inter-regional gas trade has risen significantly in recent years, due to investment in LNG infrastructure as well as more competitive LNG prices. LNG has connected once-regional markets – relaxing physical and market infrastructure constraints – and increasingly acts as a virtual pipeline between continents (Intercontinental Exchange, 2022^[7]). In light of the conflict in Ukraine, there is currently an ambitious program of investment in LNG infrastructure in Europe, to reduce the continent's dependency on Russian gas.

1.1.3. Price formation mechanisms

14. From the 1960s until the liberalisation of North American and European natural gas markets in the early 2000s, natural gas prices were linked to the price of crude oil known as oil-indexation (IEA, 2021^[8]). Crude oil provided a reference price in long-term contracts underpinning large-scale infrastructure investment. Oil-indexation was used because natural gas was not yet a mature market, and due to linkages between the two commodities on the supply- and demand-side.

15. On the supply side, price linkages are driven by the direct competition for drilling resources, as the equipment needed is largely the same and most fields can produce both oil and gas. Suppliers can extract: oil with natural gas as a by-product; only natural gas; or natural gas with natural gas liquids. The decision of suppliers on how to allocate capital and resources to development of oil and gas depends on the return on investment, and price signals may prompt suppliers to prioritise one fuel source to maximise profits. On the demand side, price linkages exist because electricity generators and some industrial users can substitute between crude oil and natural gas. Substitutability on both supply and demand-side meant that the value of the two commodities tended to move in parallel, which meant indexing the price of gas to that of oil gave a good enough approximation of true value.

16. However, the relationship between natural gas and crude oil reached an inflection point in 2008 and has since largely decoupled – for reasons including contraction in demand for crude oil for electricity production (due to retirement of petroleum power plants), an increase in gas-fired generation, and higher demand for gas for environmental concerns (CME Group, 2018^[9]). As a result, the correlation between crude oil and natural gas prices has weakened.

17. The use of oil-indexation meant natural gas prices did not reflect the supply-demand fundamentals of the natural gas market itself. Liberalisation in the US, UK, and EU in the last three decades has led to a gradual move away from oil-indexation to “gas-on-gas” competition, where prices are determined directly by the supply-demand dynamics in natural gas markets (as opposed to being linked to competing fuels e.g., crude oil). Between 2005 to 2020, the share of gas-on-gas competition in global gas consumption rose from 31.3% to 49.3% (International Gas Union, 2021, p. 22^[10]).

18. With gas-on-gas competition, natural gas prices are a function of supply and demand (US Energy Information Administration, 2021^[11]). Supply-side factors which affect prices include: the amount of natural gas production, level of natural gas in storage, and volume of natural gas imports and exports. Demand-side factors which affect prices include: variations in weather, level of economic growth, and the availability and price of other fuels (particularly those used for power generation). In the short-run, demand for natural gas is highly price inelastic. Therefore, increases in demand or reductions in supply can cause significant fluctuations in prices, especially in the winter when demand is highest.

19. Gas-on-gas competition has also been supported by the gradual move away from long-term contracts (between 10 to 30 years) towards more trading on the spot and short-term market (IEA, 2021^[12]). With natural gas abundant and liquid spot markets, buyers with variable demand were increasingly reliant (pre-crisis) on spot markets, as these allow volumes to be flexibly adjusted with potential for price improvements. Buyers with inflexible, long-term natural gas demand may still use long-term contracts (typically take-or-pay contracts)¹ to eliminate volume risk. Price risk largely remains as long-term contracts typically do not fix prices, though price volatility may be reduced through moving averages. The terms of long-term contracts e.g., pricing are typically subjects to non-disclosure agreements, thus transparent pricing on spot markets has allowed firms to negotiate long-term contracts which are more competitive and cost reflective. Producers tend to favour long-term contracts as they provide a floor in terms of price and volume – which allows financing to be secured for large projects with large upfront costs and long payback periods e.g., developing a new field or LNG terminals. Long-term contracts signal the long-term viability of projects to lenders and facilitate the expansion of global natural gas production and infrastructure investment.

20. Natural gas hubs are the central pricing point for regional markets and form the centre of the spot gas market, trading for within-day or day-ahead delivery.² The world's biggest natural gas hub is the Henry Hub in the US. In Europe, the Dutch Title Transfer Facility (TTF) and British National Balancing Point (NBP) are the key hubs. Prices at gas hubs are used as benchmarks for natural gas supply contracts traded outside the hubs.

21. Natural gas trading takes place over-the-counter (OTC), i.e., bilaterally between counterparties, or on-exchange (Columbia SIPA Center on Global Energy Policy, 2018, p. 18_[13]). Exchanges, such as the New York Mercantile Exchange, emerged as central points where liquidity is centralised, and market participants can trade natural gas with either physical or financial settlement, depending on the contract. This includes both spot and futures trading, and more complex financial instruments e.g., options and swaps. In addition to reducing counterparty and credit risk, exchange trading typically improves price transparency as transactions are publicly reported.

22. Benchmarks³ play a key role in the natural gas and other commodity markets by providing market participants access to a reliable and accessible price in markets where there is little price transparency. Market participants can opt to use these benchmarks to ease the process of agreeing transactions, in particular for OTC physical transactions, rather use other mechanisms (e.g., direct negotiations or requesting bids). Therefore, it is important for the efficient functioning of the market that benchmarks accurately reflect market prices. Over time, there have been several investigations into and findings of benchmark manipulation by authorities across jurisdictions.⁴ Price assessments which rely on voluntary submission of market information, e.g., Platts Market-on-Close, may be vulnerable to manipulations as firms can make selective or false submissions to artificially move price assessments to benefit a larger transaction (e.g., the price of a related derivative contract).

1.1.4. Price correlations between regions

23. Typically, natural gas prices tend to be highest in the Asian market, followed by Europe and then North America. From 1999 to 2017, the average “Asian premium” over European natural gas prices was 36% (Ritz, 2019, p. 7_[4]). The rapid growth of LNG markets has led to a convergence in regional prices as producers and traders take advantage of regional differences by re-routing LNG tankers to regions with higher prices i.e., from Europe to Asia, provided there is capacity available at LNG terminals. As a result, natural gas prices have increasingly become more correlated across regions. The correlation between TTF and Asian LNG spot prices (East Asia Index) increased from 0.86 in 2019 to 0.95 in 2020; similarly, the correlation between Henry Hub and TTF, and Henry Hub and Asian spot prices increased to 0.81 and 0.76 respectively (IEA, 2021, p. 13_[12]).

24. This trend of price convergence is likely to hold in the long-term. Higher levels of flexible LNG volume and the evolution of supplier marketing strategies towards optionality – whereby suppliers trade and continuously optimise their portfolios to take advantage of arbitrage opportunities (e.g., adjusting where they deliver their cargo to) – support price convergence. Further, increased liquidity in spot markets has pressured natural gas suppliers to move away from oil-indexation, particularly in the years following 2008 (The Economist, 2012_[14]), and to remove restrictive clauses in long-term contracts (ECB, 2013, p. 1_[15]), e.g., destination clauses which restrict the re-export of natural gas. The removal of such restrictions supports price convergence in the long-term.

1.1.5. Competition in the natural gas industry

Upstream production

25. Competition in the production of natural gas, whether for export via pipelines or LNG, differs between countries. There are two main types of actors involved in the natural gas industry: state-owned companies and privately-owned entities.

26. State-owned companies play an outsized role in energy markets. For example, in Russia, production of natural gas is dominated by Gazprom, which accounted for 68% of Russian natural gas production in 2021 (IEA, 2022^[16]). As a result of multinational companies being forced out of Russian projects (e.g., Sakhalin 2 project in 2006 and TNK-BP in 2007) (The Wall Street Journal, 2010^[17]), Gazprom became the world's largest producer of natural gas, with rights to about 25% of the world's known natural gas reserves. Equinor, the state-owned energy company of Norway, is also a major exporter of natural gas to Europe.

27. State-owned companies also dominate production and other activities in other jurisdictions. QatarEnergy operates all oil and gas activities in Qatar, including exploration, production, refining, transport, and storage (Wikipedia, 2022^[18]). The company's revenues amount to 60% of Qatar's GDP. In China, natural gas production is dominated by the China National Petroleum Corporation and China Petroleum & Chemical Corporation (Investopedia, 2022^[19]).

28. In other jurisdictions, there is more competition in the upstream and midstream supply chain.⁵ In the US, privately-owned and UK-listed BP plc is the largest natural gas producer, followed by ConocoPhillips (Natural Gas Intelligence, 2022^[20]). In the UK, Harbour Energy is the largest oil and gas producer, followed by TotalEnergies and BP (Financial Times, 2022^[21]). In these jurisdictions, governments auction oil and gas drilling leases to allow private firms to extract oil and gas.

29. There is significant vertical integration in both state-owned companies and privately-owned firms: for example, QatarEnergy is vertically integrated into the extraction, liquefaction, and transportation via LNG tankers; and BP is vertically integrated into production, processing, trading, marketing, logistics and risk management. Vertical integration can offer certain advantages such as reducing the cost of acquiring natural gas for midstream or upstream operations; capturing wider margins between the sale of natural gas and the sale of refined products; and it can operate as a hedge as downstream and upstream operations typically operate on inversely correlated revenue cycles (Mercatus Energy Advisors, 2022^[22]).

Concentration on the supply markets

30. Across countries which import natural gas, concentration in the supply markets differs significantly, depending on factors such as domestic natural gas production, number of pipelines, and LNG import facilities.

31. In Europe, the market share of the largest natural gas producer and/or importer differs significantly between countries (Eurostat, 2022^[23]). In 2020, the largest firm produced and/or imported 100% of natural gas in Estonia, Malta, and Sweden, whereas the largest firm in Spain had a 25% market share. Between 2013 and 2020, the market share of the largest importer and/or producer decreased in 13 member states but increased in three states. In the UK, market concentration, as expressed by the Herfindahl-Hirschman index, has fallen significantly since 1986 when the market was liberalised (BEIS, 2021, pp. 1-2^[24]).

32. In Asia, natural gas imports are becoming increasingly concentrated amongst a small number of producers (IEA, 2021, p. 72^[25]). The share of OPEC and Russia (and their state-owned energy corporations) in developing Asian economies is expected to rise, according to the IEA projections, from around 30% to between 40-50% across their projections (IEA, 2021, p. 72^[25]).

Distribution and transmission networks

33. Natural gas distribution and transmission networks are natural monopolies. The high upfront costs and significant economies of scale of building and operating networks represent large barriers to entry for potential competitors. As a result, there are typically very few network operators and, in jurisdictions where regional infrastructure is privatised, operators are subject to regulation to prevent uncompetitive outcomes.

34. Access to distribution and transmission networks is essential for competition in the production of natural gas as well as competition in the sale of natural gas to domestic and non-domestic consumers. Where a firm controls the network and is involved in competitive segments of the supply chain (e.g., production), it has an incentive to limit or deny access to competitors. There are a number of ways to ensure non-discriminatory access to network infrastructure, from structural remedies (i.e., prohibiting companies from participating in both competitive activities and monopoly networks) through to third party access provisions. In the UK (Ofgem, 2022^[26]) and Europe (ACER, 2022^[27]), network operators are required to develop and maintain transparent charging methodologies which are non-discriminatory and cost reflective. Network operators may also be required to partially unbundle, for example undertaking competitive and network activities in separate functional or legal entities (European University Institute, 2020^[28]).

1.2. Electricity

1.2.1. Overview of the electricity system

35. The electricity supply chain comprises four stages:

- **Generation:** the process of generating electrical power from fossil fuels, nuclear power, and renewable sources. The generation market is competitive in most jurisdictions.
- **Transmission:** networks that carry electricity from generating sites to substations at high voltages. Due to the high fixed costs of laying transmission lines, transmission tends to be a natural monopoly and is not competitive, though there may be competitive tendering for the construction of substantial new projects (e.g., connecting new windfarms).
- **Distribution:** networks that carry electricity from the transmission system to end consumers at lower voltages. Due to the high fixed costs of laying distribution lines, distribution also tends to be a natural monopoly and is not generally competitive.
- **Retail** (also known as supply): The final sale of electricity to end consumers. This process is sometimes integrated with distribution, but otherwise is typically competitive – especially for larger industrial and commercial customers.

36. Electricity can be generated from different fuel sources and by different technologies: fossil fuels (natural gas, oil, and coal); nuclear; and renewable energy (wind, solar, hydro, wave, and biomass). The generation mix varies significantly across countries, e.g., in 2021, France generated 69% of its electricity from nuclear and 22% from renewables, whereas the US generated 61% of its electricity from fossil fuels, 19% from nuclear and 20% from renewables (BP plc, 2022, p. 55^[5]).

37. Capital costs tend to be low for gas and oil power plants, moderate for onshore wind turbines and solar plants, higher for coal-fired plants, and even higher for wave and tidal, offshore wind, and nuclear. Once constructed, ongoing costs are very low or zero for most renewables (except biomass) and low for nuclear plants, but high for fossil fuels and biomass. The cost of energy generation in natural gas and oil-fired plants is significantly affected by short-term fluctuations in fuel prices, as seen from the recent energy crisis. By contrast, the cost of electricity generated from wind and solar power plants is almost entirely independent of fuel prices.

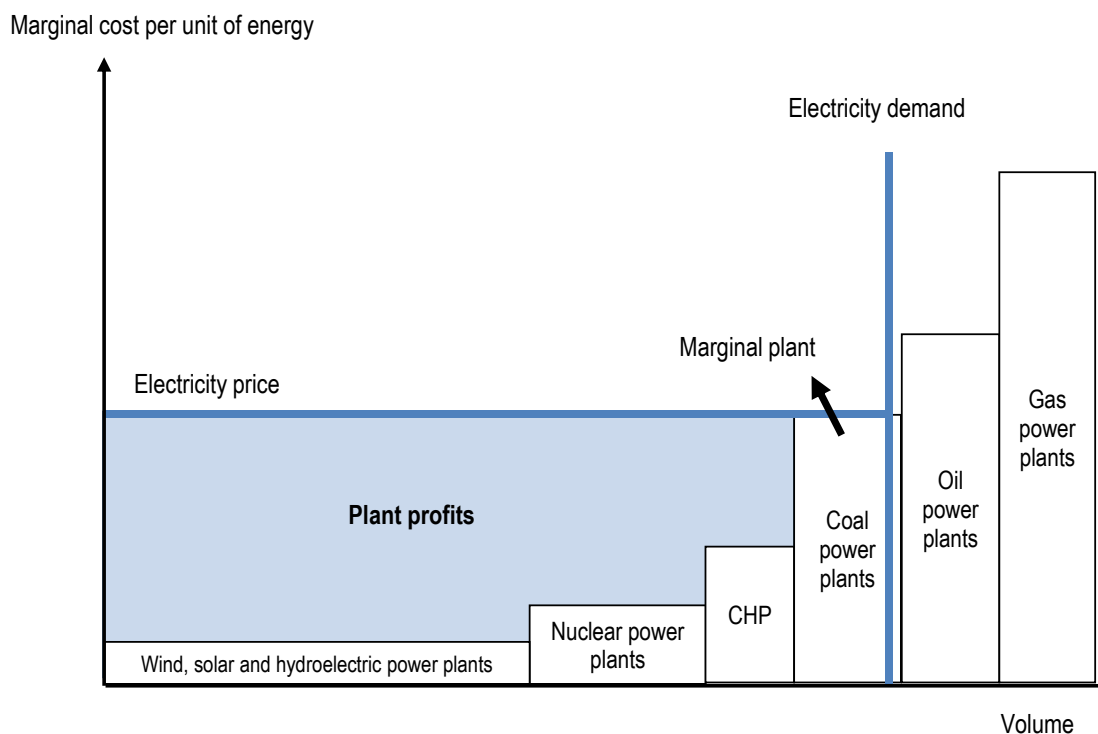
38. Historically, vertically integrated firms – state-owned, privately-owned or a combination of both – provided all stages from generation to retail. Since the 1990s, many countries have liberalised the electricity market by unbundling the generation and transmission business from the distribution business to different extents (Nagayama, 2009^[29]). Separation of generation from network and sales required the introduction of wholesale electricity markets. While generation firms still own the transmission grid in many countries, the process of liberalisation means that transmission grids are generally operated by independent Transmission System Operators (TSOs),⁶ so other generation firms can access the transmission grid on equal terms and participate in wholesale electricity markets.⁷

1.2.2. Price formation mechanisms

39. Physically, electricity is a fully homogenous product. One crucial feature of electricity is that it cannot be easily stored, so most of it has to be produced and delivered instantaneously through the grid.⁸ The need to balance supply and demand instantaneously, combined with inelastic demand, means electricity prices strongly fluctuate and can get very high at times of peak demand (typically weekday evenings).

40. A transparent wholesale spot market, coordinated by an independent entity, forms the foundation of a competitive generation market. Generators submit offers to the system operator based on marginal cost of production and the amount of electricity they want to sell on the day-ahead market, the financially binding schedule for the purchase and sale of electricity for every hour of the next day.⁹ The system operator arranges all the supply offers in ascending order, to create a supply curve (“merit order curve”). Typically, units are dispatched in this order (starting with lowest cost) until energy demand is satisfied (see Figure 1 below).

Figure 1. Merit order dispatch in electricity markets



Source: Based on Bahar, H. and J. Sauvage (2013), “Cross-Border Trade in Electricity and the Development of Renewables-Based Electric Power: Lessons from Europe”, OECD Trade and Environment Working Papers, No. 2013/02, OECD Publishing, pg. 42

41. However, dispatch in the merit order curve is subject to technical constraints (e.g., network congestion) which may mean the System Operator is not able to dispatch the next-lowest cost generator and must call upon a generator with a higher marginal cost. The System Operator also considers different technical attributes of generators, such as speed of response, reliability, and longevity of the action.

42. There are three different models of wholesale electricity markets: a single national price, zonal pricing, or nodal pricing.

- **Single national price:** there is one price for electricity across the country. For each settlement period¹⁰ in a national wholesale market, the wholesale price of electricity clears as a uniform price across the entire geographical area. In each trading period, this provides a single wholesale price to all market participants regardless of their location on the network.
- **Zonal pricing:** the transmission system is split into several pre-determined zones, with a uniform price in each zone. For each settlement period in a zonal wholesale market, the wholesale price of electricity clears as a uniform, separate price for each zone. Zones are usually defined by transmission constraints, or where transmission links are most likely to be congested
- **Nodal pricing (also called locational marginal pricing):** the network is divided into hundreds or thousands of nodes, each with their own unique wholesale price. Nodes are usually where generation comes on to the system or where demand takes from the grid. Each node's price represents the cost to serve one additional unit of energy at that node. The wholesale electricity price typically varies between each node for each trading period.

43. Nodal pricing is theoretically the most economically efficient pricing system. Nodal pricing internalises the cost of network congestion and signals local grid constraints. Generators have stronger signals on where to invest in generation and storage, leading to more efficient network development. Consumers also have enhanced price signals, which could enable greater demand-side response. However, nodal pricing introduces an added degree of complexity, as it requires the management and calculation of prices at a larger number of nodes and may decrease the predictability of short-term prices. From a competition perspective, generators have increased market power under nodal pricing. Within a smaller geographical area, generators are more likely to be pivotal and able to exercise unilateral market power, particularly if there are no other generators able to meet locational needs. As such, the potential for market power abuse is higher and there is more need for market monitoring and enforcement.

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¹ The settlement period is the half-hour trading period for balancing supply and demand.

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Box 1. Wholesale market clearing mechanisms

Most electricity markets operate a **pay-as-clear model**, where all electricity generators receive the same price for the electricity sold in each settlement period, with the price determined by the 'marginal generator' i.e., the generator with the highest production costs called to produce electricity. This price represents the system's marginal cost. Pay-as-clear results in economically efficient outcomes and transparency as generators have no incentive to bid above their marginal cost.

Alternately, system operators can operate a **pay-as-bid model**, where generators are paid according to their bids, rather than the system marginal price. Pay-as-bid can deliver a lower (average) price if generators bid at (or not significantly above) their marginal cost. But generators would have an incentive to bid strategically towards the system marginal price. Thus, both models produce similar or same results. However, the pay-as-bid model is less transparent because bids do not necessarily reflect costs, which obscures the merit order curve and may lead to less efficient dispatch.

1.2.3. Price correlations between regions

47. The extent to which electricity prices are correlated between regions depends on transmission constraints. With no transmission constraints between zones, price differences can be fully arbitrated which results in a uniform price. With transmission constraints, prices between regions can differ a lot.

1.2.4. Regional markets

48. **Europe's** electrical grid is divided into four synchronous areas (areas with interconnected TSOs and common system frequency) and two isolated systems (Cyprus² and Iceland). Electricity is priced using

² Note by Türkiye: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Türkiye recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Türkiye shall preserve its position concerning the "Cyprus issue".

Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Türkiye. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

a zonal approach, where market participants can trade without capacity allocation. Zones are “coupled” through cross-border allocation mechanisms, covering 19 countries.¹¹ If there is enough interconnection capacity, electricity prices across the zones converge. Europe aims to increase inter-zonal exchange capacity to achieve a more integrated energy market. There is also interconnection with non-EU members including the UK and Norway.

49. The **United States**’ mainland electricity system is divided into three regional markets: the Western Interconnection, the Eastern Interconnection, and the Electric Reliability Council of Texas Interconnection. There is little electricity flow between the interconnections, and electricity markets do not cross the boundaries. Within each interconnection, how electricity is traded depends on whether the market in that state is traditionally regulated or liberalised. Many states have regulated monopolies (e.g., Florida), but some states deregulated their markets in the 1990s, which led to the creation of independent energy suppliers and system operators (ISOs) or regional transmission organisations (RTOs) who operate transmission facilities. All deregulated states use locational marginal pricing.

50. **Japan** has two main synchronous grids. The two grids are connected by high-voltage connections, but the interconnection capacity is severely limited due to technical factors. This led to blackouts in parts of Japan following the Fukushima nuclear disaster, as there was insufficient capacity to transfer electricity between the grids. The electricity grids were once operated by 10 vertically integrated monopolies, though since 1995 Japan has gradually liberalised its electricity sector.

51. **South Korea’s** electricity sector continues to be dominated by the state-owned, vertically-integrated former monopoly, Korea Electric Power Corporation. The South Korean government implemented initial reforms in 1999, however, political backlash in 2004 stopped the restructuring process. Today, there are 17 independent power producers in South Korea.

1.2.5. Competition in the electricity industry

52. Generation and supply to consumers tend to be competitive markets, while transmission and distribution tend to be natural monopolies. The mode of regulation differs for each of these four markets. Transmission and distribution companies typically have regulated prices. Generation and retail supply of electricity are generally less regulated as they are competitive processes, although some countries retain some controls on the retail price of energy. For example, in the UK, the regulator Ofgem sets a price limit on what retail consumers can be charged for their electricity and gas consumption. The price cap is designed to be cost-reflective and is updated every three months to reflect changes in wholesale energy and other costs.

53. Competition in generation is widely accepted as important, because it spurs cost reductions in generation, which is the biggest component of electricity bills, and innovation in new technologies, such as solar and wind power. Competition in retail supply has been less universally adopted because the merits are less clear cut but can include reduction in retailing costs (admittedly the smallest component of bills) and innovation in areas such as time-of-use tariffs and demand-side management. These topics are dealt with below.

1.3. Crude oil

54. Crude oil and its derivatives (e.g., transport fuel) are not a focus of this paper. However, given the number of references to crude oil markets when discussing natural gas and electricity and its significance as an energy source, this background paper provides a brief overview of the global market structure.

1.3.1. Global supply and demand dynamics

55. The largest producers in the world are the US, Russia, and Saudi Arabia. State-owned entities play a significant role in crude oil markets and collectively control more than 75% of all production (The Wall Street Journal, 2010^[17]).

56. The crude oil market is more complex than may initially appear. There are hundreds of different varieties of crude, or ‘grades’, produced worldwide (US Energy Information Administration, 2012^[30]). Each individual crude grade is valued according to its characteristics, such as the sulphur content (whether the crude is sweet or sour) and the API gravity (whether the crude is heavy or light) (Focus Economics, 2016^[31]). Light crude oil tends to be priced at a premium as it is easier to refine and produces a greater quantity of gasoline or diesel fuel. Heavier crude oils are more difficult to refine and require more advanced methods and technologies for refinement.

1.3.2. Price formation mechanisms

57. Crude oil is a highly fungible commodity, holding the grade of crude constant, and prices are largely determined by global supply and demand. Spot prices, the price to purchase or sell oil immediately rather than on a set date in the future, are influenced by the level of production of crude oil globally, the amount of crude oil and refined products in inventories, and refined product inventories. There is also a highly developed market for trading of crude oil on futures markets, which make a significant contribution to price discovery (US Energy Information Administration, 2022^[32]).

58. Crude oil is typically priced using crude oil benchmarks. The most widely used crude oil benchmarks (US Energy Information Administration, 2014^[33]) are Brent and West Texas Intermediate. Other grades of crude oil are compared to these benchmarks with a mutually agreed-upon differential (so-called “quality spreads”). In addition, price differentials also arise due to “location spreads”, transportation costs from production areas to refineries, and regional supply and demand conditions (The Balance, 2022^[34]).

1.3.3. Crude oil cartels

59. Since 1960, several large oil-producing nations have acted collectively under the auspices of the Organisation of the Petroleum Exporting Countries (OPEC). The stated objectives of OPEC are to: coordinate and unify petroleum production policies among member countries; secure fair and stable prices for petroleum producers; secure an efficient, economic and regular supply of petroleum to consuming nations; and secure a fair return on capital to investors in the industry (OPEC, 2022^[35]). A significant motivation for the cartel is to reduce excessive volatility (“boom-bust” cycles) in the crude oil industry, and to smoothen oil exports revenues. There is also a geopolitical aspect to OPEC decisions.

60. As of June 2022, OPEC had a 30% share of global crude oil production (OPEC, 2022^[36]). To counteract OPEC’s declining market share, OPEC+ was created in 2016 through a Declaration of Cooperation with 10 non-OPEC producing countries, including Russia. However, with the US now a major exporter thanks to the shale revolution – and one based on competing private companies rather than national monopolies – the ability of even OPEC+ to control world oil prices is waning (Knowledge at Wharton, 2022^[37]).

61. Nonetheless, OPEC policies can have a substantial impact on oil prices. OPEC members are typically the only producers who maintain spare production capacity (production which can be brought on within 30 days and sustained for at least 90 days) (US Energy Information Administration, 2022^[32]). Given the inelasticity of demand in the short-run, spare capacity has a large impact on oil prices. The extent to which OPEC members utilise their spare production capacity is an indicator of tightness of global oil markets and how much upward pressure on prices OPEC is exerting.

2. Current energy crisis

62. There are two main contributing factors to the current crisis in energy prices and security, which is particularly acute in Europe but poses challenges worldwide. These are the aftermath of the Covid-19 pandemic, and the conflict in Ukraine.

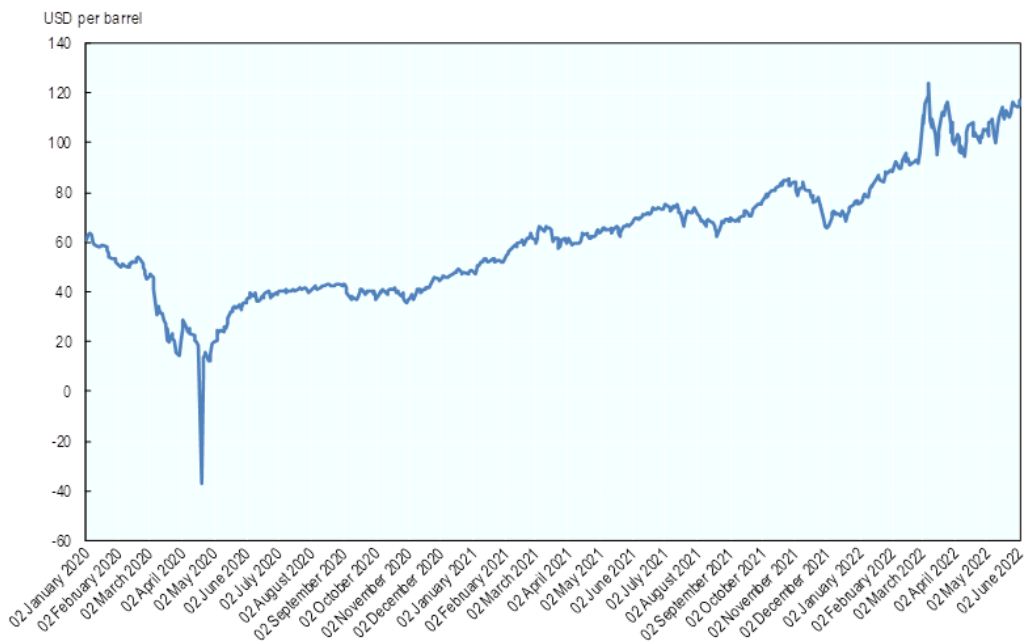
2.1. COVID-19

63. Energy prices were particularly volatile in 2020 and 2021, driven by the significant economic contraction in 2020 due to the widespread lockdowns across the world, followed by the subsequent economic recovery in 2021 when the restrictions were lifted (World Bank, 2022^[38]).

2.1.1. Impact of national lockdowns on commodity prices

64. Energy prices dropped considerably at the onset of the COVID-19 pandemic in March 2020, due to an unprecedented fall in economic activity and transport. Commodity prices fell quite broadly in this period, including the price of crude oil and natural gas, which declined 75% and 44% respectively between February and April 2020 (ECB, 2022^[39]). The decline was most pronounced for WTI crude oil futures (see Figure 2 below) (U.S. Energy Information Administration, 2022^[40]). On 20 April 2020, the price fell below zero for the first time in history, reaching -USD37.63 per barrel (Financial Times, 2020^[41]). Prices went negative because WTI futures require physical delivery and there was insufficient storage capacity at the settlement point (Cushing, Oklahoma), meaning financial investors (who did not have the physical infrastructure to store or transport crude oil) unwound their positions at any price to avoid physical delivery (Nagy and Merton, 2020, p. 3^[42]). Nonetheless, the episode illustrates the scale of the collapse in demand for crude oil.

Figure 2. WTI Spot Price



Source: Based on Thomson Reuters, <https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RWTC&f=D>.

65. Crude oil prices also declined so significantly because supply is slow to adjust to sharp falls in demand due to technical constraints. Turning off an oil well can cause damage (e.g., water blockage) and permanently reduces future productivity of the oil field, particularly for shale formations. Other facilities, e.g., pipelines and refineries, require a minimal level of production to be kept in operation, so oil producers may be willing to continue production for some time, even if prices are below long-run average costs (Resilience, 2020^[43]).

2.1.2. Economic bounce back

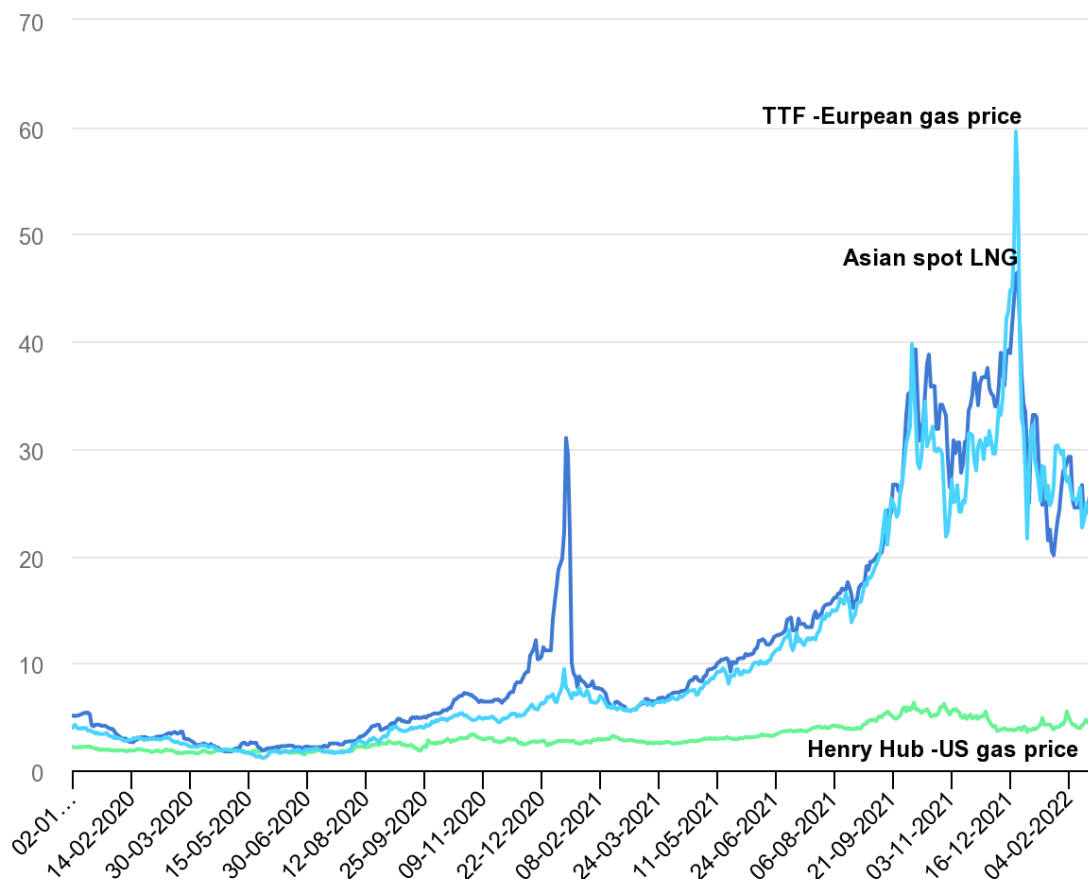
66. In the second half of 2021, there was a rebound in energy prices, driven by the resumption of economic activity and travel. Both oil and natural gas prices surpassed pre-pandemic price levels, with European natural gas prices reaching all-time highs, causing record-high wholesale electricity prices. The increase in natural gas prices led to spill overs in demand for other energy sources, including crude oil and coal, as substitutes for natural gas in electricity production and heating. For example, European coal prices more than doubled (Bloomberg, 2021^[44]).

67. There were several factors which drove European natural gas prices to record highs (IEA, 2022^[45]). Following Germany's refusal to certify Nord Stream 2, pipeline deliveries from Russia declined by 25% year-on-year in Q4 2021. Gas consumption by power plants increased significantly due to lower generation from other types of power plant e.g., due to low winds in the summer months of 2021. Higher consumption and lower imports of natural gas depleted European storage facilities, which were 28% below their five-year average levels (IEA, 2022^[45]). Storage sites owned or controlled by Gazprom had particularly low storage levels, accounting for half of the storage deficit.

68. During this period, European gas prices closely tracked and even exceeded Asian spot LNG prices, particularly towards the end of H2 2021 (see Figure 3 below). This was atypical as natural gas prices in Asia are usually priced at a premium compared to Europe. The price of natural gas at the Henry

Hub remained remarkably stable in this period; although the US is now a major gas exporter, capacity constraints at LNG export facilities still limit US natural gas exports, preventing price convergence.

Figure 3. Natural gas prices in Europe, Asia and the United States, Jan 2020-February 2022



Source: IEA, Natural gas prices in Europe, Asia and the United States, Jan 2020-February 2022, IEA, Paris <https://www.iea.org/data-and-statistics/charts/natural-gas-prices-in-europe-asia-and-the-united-states-jan-2020-february-2022>, IEA. License: CC BY 4.0

69. Supply-side responsiveness has been limited despite high energy prices. Between 2019 and 2021, investment in oil and gas production fell by 23% (International Energy Forum, 2021^[46]), as producers used record free cash flow to reward shareholders (Financial Times, 2022^[47]). Several factors have driven this trend. The collapse of commodity prices in 2014-15 and 2020 impacted producers severely and decreased risk appetite for new long-term projects (IEA, 2021^[48]). This effect is compounded by existing constraints, e.g., government regulation and costly infrastructure, which have prevented the development of shale projects in Europe. The transition to Net Zero has reduced appetite for fossil fuel projects, as government carbon-reduction policies become more ambitious and technological developments reduce fossil fuel demand (Bloomberg News, 2022^[49]). As a result, investment in fossil fuel production has in some cases been redirected to renewable energy. For example, in 2017, DONG Energy sold off its oil and gas business in 2017 and transitioned to renewable energy, renaming itself Ørsted A/S. Ørsted is now the world's largest developer of offshore wind power. Global energy investment is set to increase by 8% in 2022, driven mainly by renewables (IEA, 2022^[50]). The International Energy Forum¹² has warned that insufficient upstream investment could result in further price volatility.

2.2. Russia's full-scale invasion of Ukraine

70. Tight energy markets due to the economic recovery and mounting tensions over a possible invasion of Ukraine led to very volatile energy prices in late 2021 and 2022. On 24 February 2022, following months of tension, Russia launched a full-scale invasion of government-controlled territories in northern, eastern and southern Ukraine. This aggression prompted a set of sanctions against Russia. There are wide-ranging restrictions on trade and investment, which prohibit investment in or financing of the Russian energy sector and government, as well as sanctions in the financial sector e.g., decoupling Russian banks from SWIFT, the international payments system.

71. Initially, sanctions did not directly target Russian commodity exports due to fears of the inflationary impact, but later commodity-specific sanctions were introduced (Reuters, 2022^[51]). For example, on 3 June, the EU banned the import of Russian oil and certain petroleum products, although with some exceptions, notably for imports of crude oil by pipeline into member states with specific dependence on Russian supplies. On May 8, the US banned the import of Russian crude oil and certain petroleum products, LNG, coal, and other energy imports (White House, 2022^[52]). The same day, the UK committed to phasing out imports of Russian oil and oil-products by the end of 2022.

72. In the last decade, Europe's reliance on Russian natural gas has increased, with Russia's share in meeting European natural gas demand rising from 25% in 2009 to 32% in 2021 (IEA, 2022^[45]). In parallel, the importance of Ukraine as a transit country for Russian natural gas decreased after construction of new pipelines, in particular Nord Stream 1. The share of Russian pipeline deliveries transiting Ukraine decreased from 60% in 2009 to 25% in 2021 (IEA, 2022^[45]). This suggests that the reduction in Russian flows of gas to Europe since the start of the conflict is a conscious decision by Russia, rather than an operational consequence of events in Ukraine.

2.2.1. Reduction in natural gas exports

73. Russia has curtailed natural gas exports in response to geopolitical events in the past. Russia restricted natural gas flows to Europe as part of disputes with Ukraine in 2005, 2009 and 2017 (The Guardian, 2022^[53]). During the certification process of the Nord Stream 2 pipeline by German regulators in 2021, Gazprom reduced natural gas exports through the Yamal pipeline, which caused natural gas prices to spike (Politico, 2022^[54]). In October 2021, to prompt certification of the pipeline, Putin noted that Russia can only export more natural gas if regulators approve Nord Stream 2.

74. Following the invasion and widespread sanctions, Gazprom unilaterally amended existing natural gas contracts to require payment for natural gas in Russian rubles from "unfriendly countries." (Politico, 2022^[55]) Following refusal to pay in ruble, Gazprom halted natural gas deliveries to Poland and Bulgaria on April 26, and several other countries and firms in the following months. Deliveries via the Nord Stream I pipeline, the largest pipeline to move Russian natural gas to Europe, was completely stopped in September 2022, which Russian authorities initially claimed was due to sanctions on a turbine, an explanation refuted by European authorities.¹³ Russian natural gas flows to the EU have decreased by more than 75% compared to 2021 (Energy Monitor, 2022^[56]).

75. As a result of reduced natural gas supplies, natural gas and electricity prices rose to record levels in Europe. At over EUR 343 MWh, the price of natural gas was equivalent, in energy terms, to almost USD580 a barrel of crude oil (Financial Times, 2022^[57]). While natural gas prices have risen across Europe, the degree of increase in electricity prices has varied across countries. Countries relying on natural gas for (peak) electricity generation and with more limited electricity interconnections (e.g., Spain) have seen the largest price increases. Countries less reliant on natural gas power plants and having more electricity interconnections (e.g., Nordic countries) experienced smaller price increases (IMF, 2022, p. 8^[58]). A higher gas dependency means natural gas is more frequently the marginal price setter, while limited interconnection capacity constrains the ability to import electricity from areas with lower prices. It should

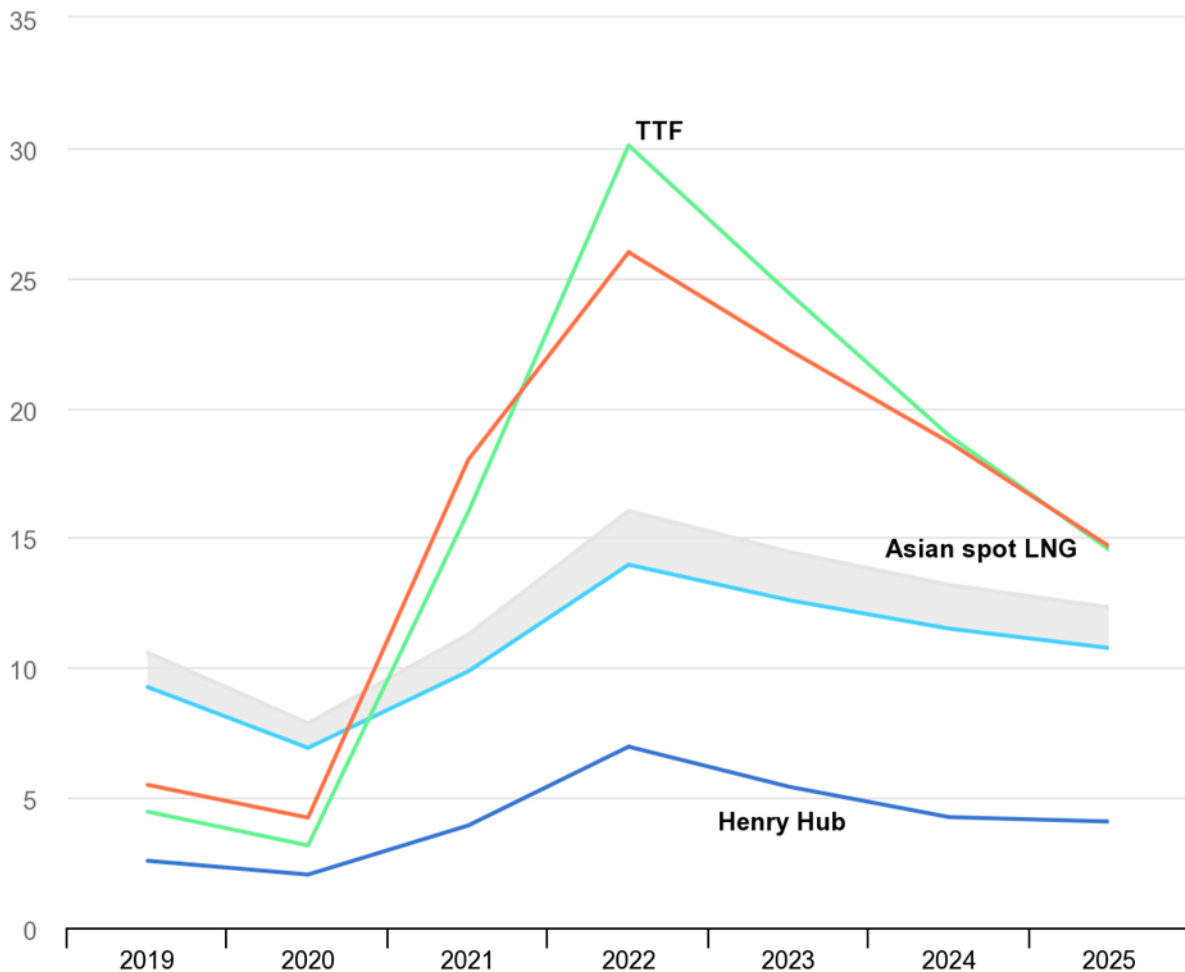
be noted the passthrough of wholesale gas prices to electricity prices may also be influenced by other factors.¹⁴

76. Divergences have also emerged in the natural gas prices between countries. Typically, NBP and TTF gas prices have moved together. However, since April 2022, high imports of LNG into the UK and limited capacity to export natural gas via pipelines to Europe drove down wholesale prices in the UK (NBP) and led to a record discount relative to TTF prices (IMF, 2022, p. 7_[58]).

77. Europe has sought alternatives to Russian supplies such as LNG from the US. In 2022, for the first time, the US supplied more natural gas to Europe than Russia sent by pipelines (Bloomberg, 2022_[59]). Further, due to weak energy demand, China has resold surplus LNG cargoes to Europe to take advantage of higher natural prices in Europe. Total Chinese LNG cargo resold amounted to 7% of European imports in H1 2022 (Financial Times, 2022_[60]). The large increase in LNG imports has allowed Europe to substantially increase the amount of natural gas in storage. This has eased concerns of shortages in the winter and, as a result, prices have fallen from their peak (Financial Times, 2022_[61]).

78. Energy markets expect natural gas prices to remain elevated. As far out as 2025, the price of natural gas in Europe (as measured by TTF) and Asia (as measured by Asian spot LNG) will remain significantly higher than the price levels before the COVID-19 pandemic and Russia's full-scale invasion of Ukraine (see Figure 4 below) (IEA, 2022_[62]). Prices are expected to remain around USD15/Mbtu in 2025, almost three times higher than the price in 2019.

Figure 4. Natural gas price assumptions, 2019-2025



Sources: CME (2022), Henry Hub Natural Gas Futures Quotes; Dutch TTF Natural Gas Month Futures Settlements; EIA (2022), Henry Hub Natural Gas Spot Price; ICE (2022), JKM-Japan Korea Marker LNG Future; ICIS (2022), ICIS LNG Edge (subscription required); Powernext (2022), Spot Market Data.

79. In October 2022, OPEC+ agreed to reduce collective output of crude oil by 2mn b/d, which caused significant geopolitical pushback due to the inflationary impact of higher oil prices amid the current cost-of-living crisis (Financial Times, 2022^[63]). As some OPEC+ members are producing below their output quotas, the actual cut to supply is predicted to be closer to 1mn b/d. As of October 2022, Brent crude oil futures are in backwardation (ICE Futures Europe, 2022^[64]), which means the price for the delivery of crude oil is cheaper in the future than it is for immediate delivery and indicates market participants think the crude oil market will become less tight in the coming months and drive down prices.

2.2.2. Self-sanctioning and changing trade flows

80. Self-sanctioning (where firms curtail Russian business ahead of or despite no applicable sanctions) has had an impact on the Russian oil and gas sector. Companies avoided engaging with Russian entities due to a cautious approach on sanctions or to avoid public criticism. For example, banks have refused to open letters of credit (Global Trade Review, 2022^[65]), and following intense criticism of its decision to purchase discounted Russian crude oil, Shell announced it would stop buying Russian crude

oil on spot markets and start a phased withdrawal from Russia (Shell, 2022^[66]). This caused the price of Russian commodities to fall relative to non-Russian commodities. Urals crude, Russia's flagship crude oil, was discounted by USD 33.52 per barrel against Brent crude in August 2022 (CME Group, 2022^[67]).

81. The discount on Russian commodities led to significant re-direction in global flows. Whilst Russian crude oil exports to Europe fell by 554,000 b/d, exports to Asia increased by 503,000 b/d. However, while seaborne trade in oil is well established, facilities to transport LNG are still developing, meaning it is much more difficult to re-direct natural gas to non-European markets. In the long-term, Russia plans to expand its LNG capacity and build new pipelines to Asia (e.g., Power of Siberia 2 pipeline).

82. The re-routing of flows had initially mitigated financial losses, with crude oil and natural gas production remaining resilient (Financial Times, 2022^[68]) and - despite the Urals discount - Russian government revenues were similar to pre-invasion levels (Bloomberg, 2022^[69]). However, the sharp decrease in crude oil and natural gas exports in August have begun to take their toll, with oil and gas revenues falling 18% year-on-year over the January to August period (Financial Times, 2022^[70]). Gazprom's production fell by 15% year-on-year.

83. Going forward, the European embargo on Russian crude oil, which will be implemented in December 2022, and oil-products, which will be implemented in February 2023, will likely have a significant impact on Russian exports (Bloomberg, 2022^[71]) and government revenues, given crude oil accounts for 37% of total Russian exports by value (natural gas accounts for 13% of exports) (CRS, 2022^[72]). Combined, oil and gas accounted for 36% of Russian government revenues.

2.3. Policy responses to the energy crisis

84. The energy crisis has exacerbated already rising level of inflation in many countries. This has raised fears of a cost-of-living crisis and prompted governments to implement measures to ease the burden on consumers. Politically, governments are under pressure due to the distributional impact of high energy prices - poorer consumers spend proportionately more of their income on energy and transport fuels (IMF, 2022, p. 16^[58]). Measures implemented in some countries and regions are briefly described below, accurate as of October 2022. As the crisis unfolds, governments are considering what additional support is needed, therefore new measures may be implemented.

2.3.1. Household support

85. Many developed countries have provided direct payments to households. Fiscal transfers can be targeted at low-income households or, to save the time to administer targeted payments, given to all households.

86. Given the scale of the crisis in Europe, several EU Member States have provided direct support to households. The ECB estimated fiscal transfers of between 0.2-0.3% of euro area GDP in 2022 (ECB, 2022^[73]). While the political rhetoric has focussed on the importance of providing support to hard-pressed households, only 12% of the measures implemented by European governments were targeted towards low-income households, whilst 54% were untargeted. The UK government announced a GBP 15bn partially-targeted package (HM Treasury, 2022^[74]), which provides support to all households and additional help to low-income households.

2.3.2. Price caps

87. Some countries have introduced mechanisms to cap the price of natural gas and electricity paid by consumers, with different methods of implementation. The fiscal cost of price caps has been much

higher than anticipated, largely because energy prices have been more expensive and for longer than anticipated.

88. In Europe, France (The Local, 2022^[75]), the UK (BEIS, 2022^[76]), and Germany (Financial Times, 2022^[77]) capped retail electricity and gas prices, paying suppliers the difference between capped and wholesale prices. France limited the increase in price to 4% in 2022, at a cost of EUR 8 billion to the French government (The Guardian, 2022^[78]) (EDF suffered an EUR 8.4 billion loss and was nationalised), and 15% in 2023 at a cost of EUR 45 billion. The UK announced it would cap the unit price of natural gas and electricity for households for two years and businesses for six months, but – concerned about fiscal impact – later limited the household commitment to six months. Germany has subsidised a given amount of gas and electricity for consumers and businesses at a cost of EUR 200 billion. The Spanish and Portuguese governments capped the price of natural gas used for electricity generation until May 2023, at a cost of EUR 8.4 billion. The measure aims to reduce the price of electricity.

2.3.3. Indirect taxes

89. To reduce energy prices, governments reduced indirect taxes and levies on energy bills. In Asia, India has cut excise duties on gasoline and diesel (S&P Global, 2022^[79]). The UK, Austria, Italy, and Germany (Federal German Government, 2022^[80]) removed levies which support renewable generation.

2.3.4. Subsidies

90. Countries have provided subsidies to support businesses. In Europe, 34% of fiscal transfers were provided to businesses (ECB, 2022^[81]), e.g., Spain provided support to gas intensive businesses (La Moncloa, 2022^[82]). Japan increased subsidies to oil wholesalers to curb increases in prices of gasoline and other fuels at a cost of JPY 1tn (Nippon, 2022^[83]). Indonesia tripled its energy subsidy budget to USD34bn to maintain the price of subsidised gasoline, diesel, and certain power tariffs (Refinitiv, 2022^[84]).

2.3.5. Liquidity support

91. The sharp increase in energy prices has caused liquidity issues for firms which trade on financial markets. Firms typically use futures markets for risk management. For example, a utility may sell electricity a year in advance to guarantee its profit margin, if its input costs (notably natural gas) are contractually fixed. The relationship between spot and futures prices are influenced by factors including physical arbitrage between spot and future contracts, liquidity and transaction costs (Timera Energy, 2014^[85]). Physical arbitrage provides the strongest link between spot and futures prices, thus markets with limited storage (e.g., electricity) tend to have less developed futures markets.

92. When trading futures and other financial instruments, firms must deposit collateral ('margin') with the exchange or counterparty to limit the exchanges or counterparty's credit exposure to the firm. Margin requirements are determined by factors including the value of contracts and the level of volatility in the market. Rising energy prices, which increase the absolute value of contracts, combined with extreme levels of volatility caused margin requirements to rise substantially, which led exchanges and counterparties to demand over USD 1.5tn in margin calls across the industry (Bloomberg, 2022^[86]).

93. The cash impact on firms is most pronounced in liberalised markets, where market participants are typically smaller (compared to state-owned utilities) and thus have less capacity to meet higher margin requirements (Financial Times, 2022^[87]). Where firms cannot meet margin requirements, they have sought additional funding, e.g., via revolving credit facilities at banks, or been forced to reduce trading activity. Recognising the impact on the liquidity positions of commodity traders, overall market liquidity and the possibility of contagion due to firm failure, countries including Finland, Sweden, Germany, Austria, and the UK (Financial Times, 2022^[88]) have arranged emergency liquidity support schemes to help otherwise viable firms meet collateral requirements in recent months.

2.3.6. Windfall taxes and revenue caps

94. Given the extraordinary profits made by oil and gas producers and electricity generators, some governments have introduced windfall taxes. In Europe, the EC endorsed windfall taxes, which could raise EUR 200bn to partially offset higher energy bills (EC, 2022^[89]). To prevent market distortions, the EC imposed conditions on the windfall taxes e.g., they should be time-limited and not affect wholesale price formation. Spain, Italy (Freshfields, 2022^[90]) and the UK (HM Revenue and Customs, 2022^[91]) have introduced windfall taxes.

95. In September, the EC proposed a cap on market revenues for the generation of electricity from so-called 'inframarginal' technologies (e.g., renewables, nuclear, and lignite) – essentially technologies that do not burn gas and therefore are benefitting from high power prices while not suffering from high input costs. The EC set an ex-post cap on revenues of EUR 180 per MWh (EC, 2022^[92]).

2.3.7. Demand-side measures

96. In Europe, regional measures were introduced to reduce natural gas consumption. The schemes were successful in reducing European demand – a key policy aim to support filling natural gas storage facilities before winter 2022. In May 2022, the REPowerEU Plan was introduced, which provides EUR 210bn to rapidly reduce the EU's dependence on Russia and fast forward the green transition (EC, 2022^[93]). In July, the 'Save Gas for a Safe Winter' plan was introduced. EU states set voluntary targets to reduce natural gas use by 15% until next spring, with mandatory targets in the event of severe natural gas shortage or exceptionally high demand. It also encouraged public awareness campaigns to promote reductions in heating and cooling, and other short-term saving measures. For example, the Spanish government prohibited air conditioning below 27 degrees Celsius and heating above 19 degrees Celsius (Bloomberg, 2022^[94]). In September, the EC proposed EU states reduce overall electricity consumption by 10%, with an additional target to reduce consumption during peak hours by 5%.

97. In the UK, the system operator is preparing to pay households to reduce electricity demand in peak periods during the winter, to reduce the need to burn gas for electricity generation.

98. High natural gas prices have triggered substitution away from natural gas. Countries with oil-generation power capacity (e.g., Pakistan and Bangladesh) increased imports of crude oil (Bloomberg, 2022^[95]). Germany increased its use of coal in electricity generation, from 27% in 2021 to 31% in 2022, whilst natural gas fell from 14% to 12% (Financial Times, 2022^[96]).

2.3.8. Supply-side measures

99. While the supply of natural gas is inelastic in the short-run, several measures have been implemented which aim to increase supply.

100. European countries have made investments to increase imports of LNG. In September 2022, two floating LNG terminals were set up in the Netherlands to allow LNG to be pumped into onshore networks (Bloomberg, 2022^[97]). Germany has chartered seven floating LNG terminals, three of which will begin to operate in 2022. Investments will also be made to improve pipeline infrastructure within Europe (Financial Times, 2022^[98]). Much of Europe's LNG import capacity is on the Iberian Peninsula, but limited pipeline capacity to Central and Northern Europe prevents further LNG imports and thus diversification of supplies. In June 2022, the EU required all states to have adequate natural gas storage and to fill underground natural gas storage to at least 80% capacity before winter 2022, and 90% by winter 2023. While the regulation has successfully filled natural gas storage facilities, it triggered additional demand for natural gas which increased prices and resulted in distortions to the typical shape of the forward price curve (summer prices became higher than winter prices) (ING, 2022^[99]).

101. In the US, the government released 180 million barrels of crude oil from its Strategic Petroleum Reserve over six months (DOE, 2022_[100]), in coordination with IEA partners who released 60 million barrels.¹⁵ The US Treasury estimated it lowered domestic gasoline prices by 17-42 cents (US Department of the Treasury, 2022_[101]). In August 2022, the Senate passed the Inflation Reduction Act which provides USD369bn for investment in Energy Security and Climate Change (US Senate, 2022_[102]). This aims to lower costs for consumers, increase clean production and reduce carbon emissions by 40% by 2030.

2.3.9. Effectiveness of policies and impact on competition

102. The International Monetary Fund has published a working paper on the appropriate design for support measures for households and firms, and how actual measures taken so far measure up (IMF, 2022, pp. 17-24_[58]).

Household support

103. The paper argues that price signals should be retained in any policy measure, to provide incentives for consumers and firms to reduce energy use (or substitute to other energy sources if possible), and to suppliers to increase production. Temporary policy measures which delay the pass-through of wholesale energy prices can be justified where the price shock is short-lived, but policy measures which mute price signals should be wound-down as soon as possible.

104. Price-suppressing measures (e.g., subsidies, tax reductions, and price controls) are seen as inefficient tools to protect economically vulnerable consumers as they inhibit demand adjustments, such as energy-conserving behaviour and energy-efficiency investments. The supply of natural gas and energy sources is very inelastic in the short run; it is therefore important demand adjusts to find a reasonable equilibrium price.

105. The paper recommends measures that provide vulnerable households with income support, which do not distort the marginal price of energy. If price-suppressing measures are implemented, they should be limited to a small number of consumers or infra-marginal energy use, to reduce the distortionary impact on price formation.

106. In practice, both price-suppressing measures and income support are politically difficult to withdraw. This means that even if designed to be a temporary response to a short-lived price shock, both may be difficult to unwind in practice. Furthermore, Governments are struggling to design well-targeted measures in time for winter, thus pragmatism around feasible implementation is driving policy responses ahead of winter.

Subsidies to business energy consumers

107. Policy measures have been implemented to help firms cope with rising energy costs, including tax relief, energy subsidies, and guaranteed loans. As above, the paper argues temporary measures may be justified where viable firms are liquidity constrained and cannot borrow to weather a temporary shock. However, with a persistent increase in energy prices, such measures may impede the necessary reallocation of demand and production towards less energy-intensive activities.

108. Where support is provided to firms, it should be time-limited and well-targeted to incentivise firms to reduce energy use. Measures should be directed towards viable firms, although (as the experience of supporting businesses through the pandemic has shown) identifying these is highly challenging in practice. Larger firms are more likely to have access to sufficient working capital to absorb losses or sufficient market power to pass-along increased costs to consumers; small- and medium-sized firms are more likely to be liquidity constrained or price-takers and thus more likely to need support. If implemented unevenly, state

aid can distort competition – e.g., it may unfairly provide some firms with better access to capital than their rivals.

109. The paper noted special consideration should apply to firms that play a critical role in importing and distributing energy e.g., trading firms and suppliers. The high cost of trading has squeezed market participants out of commodity markets and caused a significant drop of liquidity. Illiquid markets tend to be more vulnerable to market manipulation, as even small trades in illiquid markets can cause large price movements. To prevent liquidity issues resulting in solvency issues, firms may need liquidity support or other measures to allow firms to pass increased costs to end-users.

Windfall taxes

110. As windfall taxes are levied on past profits and do not impact marginal costs or demand, firms should not, in theory, change their behaviour in response to windfall taxation. However, this assumes windfall taxes are not pre-announced and that firms believe the tax is one-off (National Institute of Economic and Social Research, 2022^[103]). In practice, limiting the potential upside of profits in the energy sector (and increasing uncertainty in tax policy) can have a dampening effect on new entry and reduce competition in the medium- to long-term. In practice, therefore, a tax which is perceived to be genuinely exceptional and targets an older generation of players is less likely to damage entry. For example, the UK revenue cap (similar to a windfall tax) targets older renewable and nuclear generators, which have benefitted from the period of high power prices. Newer generators have Contracts for Difference (CfDs)¹⁶ so are not making exceptional profits and are not affected by this tax.

111. The IMF paper also notes that windfall taxes should be designed to preserve investment incentives, as firms may react to a real loss of income by reducing investment. Taxes should only be imposed on excess profits, allow producers to recover operating costs and earn a fair return on investments, and retain some excess profit.

112. In terms of fairness, windfall taxes may be justified as extraordinary profits did not arise from factors of production or entrepreneurship. However, the level of profit deemed 'extraordinary' may be politically rather than economically judged. Ultimately, a windfall tax is a redistribution in income from firms' shareholders to the wider population.

113. Governments have also explored moving existing generators to CfDs. However, this is complicated as generators may have forward contracts and hedges in place, possibly lasting years, which could be very difficult to unwind. Generators may also prefer a windfall tax as it only applied to actual profits, whereas CfDs would limit revenue without regard for profitability.

3. Challenges ahead

3.1. The Transition to Net Zero

114. The Net Zero transition will raise competition and policy issues which need to be addressed by competition and regulatory authorities and governments. Below, we provide an overview of transition plans, renewable generation sources and some potential issues which may arise during the transition.

3.1.1. Net Zero Transition plans

115. The UN Climate Change Conference (COP21) in 2015 was a focal point for international cooperation on climate change. The Paris Agreement, signed by 193 parties, is a legally binding treaty which commits countries to reduce their carbon emissions to limit global temperature rises in this century to 2 degrees Celsius and work together to adapt to the impacts of climate change (United Nations, 2022_[104]).

116. Following COP21, over 70 countries (including the largest polluters, China, the US, and the EU) set net-zero target covering 76% of global emissions (United Nations, 2022_[105]). More than 1,200 firms, 1,000 cities, and 400 financial institutions made pledges to halve global emissions by 2030. Climate Action Tracker estimated in 2014 the world was heading for 4 degrees Celsius of warming by 2100. As of 2021, it estimated, if binding long-term targets are met, warming could be limited to 2.1 degrees Celsius (Climate Action Tracker, 2022_[106]).

117. Whilst there has been significant progress globally in the Net Zero transition, it is widely agreed that more needs to be done. The energy sector is the source of three quarters of greenhouse gas emissions and critical to averting the effects of climate change (United Nations, 2022_[105]). Global energy demand is expected to grow 47% in the next 30 years, due to population and economic growth. Whilst much progress has been made in transitioning energy systems to renewables in recent decades, challenges lie ahead.

3.1.2. Electrification and low carbon technologies

118. To meet Net Zero, large parts of the economy must transition away from fossil fuels and undergo 'electrification'. According to some estimates, electrification may double electricity demand by 2050, driven by electrification of transportation, residential and industrial heating, and industrial production (Climate Change Committee, 2020, p. 10_[107]).¹⁷ This can be achieved through increased renewable generation; however, it presents challenges in terms of investment, innovation (e.g., in battery storage), supply chain readiness, and willingness of customers to adopt new technologies, e.g., electric vehicles and heating. The share of renewables in global electricity generation has risen rapidly in recent years, rising from 20% in 2010 to 29% in 2020 (IEA, 2022_[108]). This growth looks set to continue, with almost half of the global increase in capacity driven by China, followed by the US, EU, and India (IEA, 2021, p. 22_[109]). There are different types of renewable generation, the main ones are briefly described below.

119. **Hydropower** generates electricity using elevation difference of water flowing from one side to the other (Office of Energy Efficiency & Renewable Energy, 2022_[110]). Hydropower is the largest renewable

source of electricity, generating 4,418 TWh of electricity globally in 2020 – more than all other renewables combined (IEA, 2021^[111]). **Wind power** is generated using land-based or offshore wind turbines. Globally, 1,592 TWh of electricity was generated from wind installations in 2020, a 12% increase from 2019, with the majority produced by onshore turbines (IEA, 2021^[112]). **Solar technologies** convert sunlight into electricity through photovoltaic (PV) panels or through mirrors which concentrate solar radiation (Office of Energy Efficiency & Renewable Energy, 2022^[113]). Worldwide, solar PV generation increased by 23% to reach 821 TWh in 2020.

120. There has also been an increase in **decentralised renewable generation**, small-scale solar and wind generation units which deliver electricity to individual consumers or local grids. While centralised renewable generation, e.g., large-scale wind farms, can benefit from economies of scale, decentralised generation can contribute towards security of supply and reduce demands on the national grid.

121. In the last decade, the cost of renewable energy has fallen substantially, driven by incremental improvements in technologies, economies of scale, competitive supply chains, and improving developer experience. A main metric for cost comparisons is the levelized cost of electricity (LCOE), which is the average revenue required per unit of electricity generated to recover the costs of building and operating a generation plant over its lifetime. Between 2010 and 2020, the global weighted-average LCOE for solar PV fell by 85%, onshore wind fell by 56%, and offshore wind fell by 48% (IRENA, 2021, p. 11^[114]). Renewable generation is becoming more competitive and, in some cases, cheaper than new and existing fossil fuel generation capacity. In 2020, 162 GW of new renewable generation capacity had costs lower than the cheapest source of new fossil-fuelled capacity, which amounts to approximately 62% of the net increase in global renewable power generation (IRENA, 2021, pp. 28-29^[114]).

122. **Hydrogen** can also play a role in transitioning sectors which are inherently difficult to decarbonise as they cannot be easily electrified, e.g., long-haul transport, airplanes and industrial production of steel (IEA, 2019^[115]). In addition, hydrogen is a promising option for storing excess energy from renewable generation where output is not well-matched with demand. Natural gas is the primary source of hydrogen ('grey hydrogen'), releasing carbon dioxide in its production. To enable decarbonisation, emissions can be captured if natural gas is used ('blue hydrogen') or hydrogen can be produced using dedicated renewable or nuclear power ('green hydrogen'). Hydrogen can be transported as a gas by pipeline or as a liquid like LNG, and transformed into electricity, methane or fuel.

123. Despite the progress made, there are still challenges in transitioning to Net Zero, which governments and policymakers will need to address. These are briefly described below.

3.2. Challenges in the transition to Net Zero

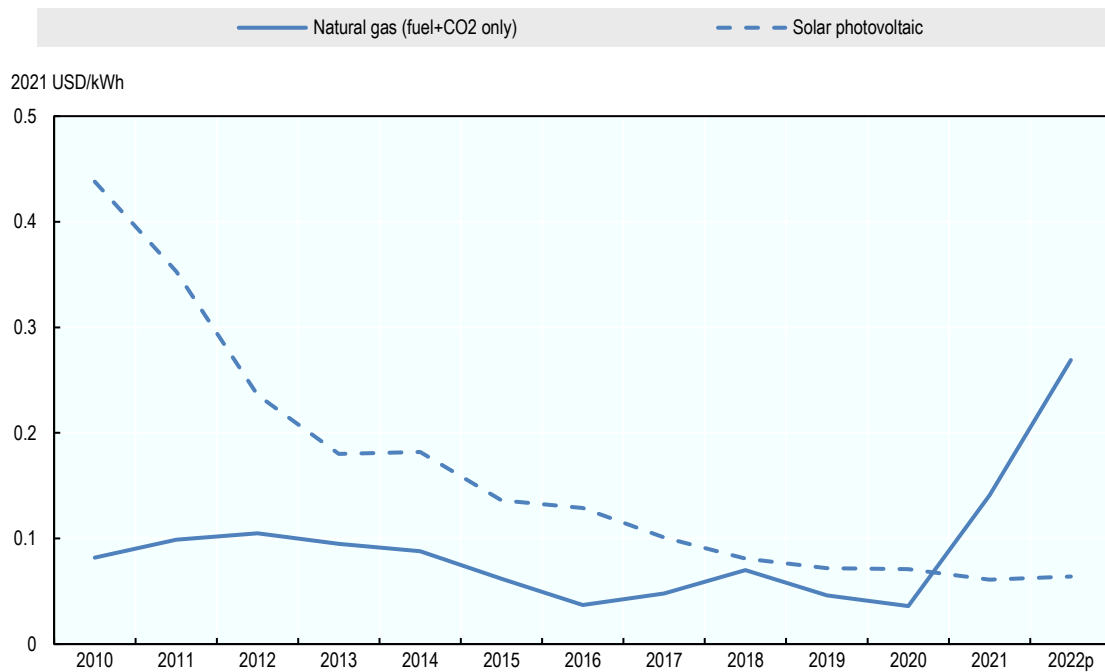
3.2.1. Competitiveness of renewable energy

124. As noted above, the cost competitiveness of renewable generation has improved in the last decade. Governments provided subsidies and incentives to encourage the development of the sector – e.g., CfDs (Financial Times, 2022^[116]) and feed-in tariffs (PV Magazine, 2022^[117]) which provide a fixed price for electricity, and investment tax credits (Office of Energy Efficiency & Renewable Energy, 2022^[118]) which provide tax credits against upfront capital costs. Subsidies were designed to increase supply in the nascent industry, allow firms to develop economies of scale, and move through the learning curve more quickly. Subsidies also protected the infant renewables industry from competition from lower-cost, non-renewable energy producers. This has, very successfully, allowed the industry to scale and push down costs.

125. COVID-19 and the energy crisis has caused the cost of industrial materials and freight to rise significantly. In 2021, the price of plastics used in solar panels rose by 400%, aluminium by 80%, and

freight by 600%. This has put upward pressure on the cost on renewable infrastructure (which is energy-intensive to produce) and reversed the long-term trend of decreasing costs (IEA, 2021^[119]), e.g., the price of wind turbines and solar PV rose by 10-25%. However, despite the recent increase, higher natural gas and coal prices have improved the competitiveness of wind and solar PV further (please see the Figure 5 below) (IRENA, 2022^[120]). In Europe, the cost of electricity produced from solar PV increased from 0.061 USD/kWh in 2021 to 0.064 USD/kWh in 2022. By contrast, the cost of electricity produced from gas increased from 0.141 USD/kWh in 2021 to 0.269 USD/kWh in 2022.

Figure 5. The weighted average LCOE of utility scale solar PV compared to generation from natural gas in Europe, 2010-2022



Note: 2022 values are possible outcomes and not yet a forecast.

Source: (IRENA, 2022^[120])

126. At current prices, the need for subsidies is clearly declining. However, withdrawing subsidies too quickly could undermine the investment needed to meet Net Zero targets. Investment in renewable energy have substantial lead-times and require a longer payback period than fossil fuel projects – driven by factors including large upfront capital costs and lower load factors. As a result, current high fossil fuel prices may be insufficient to stimulate investment. Investment decisions are more likely to be influenced by investor expectations of electricity prices in the next 10-20 years.

127. Renewable projects face other obstacles unrelated to costs, e.g., many people oppose the building of onshore wind turbines in surrounding areas driven by concerns about how they look and the sound they make. Renewable energy also has an impact on the local environment, which can create obstacles in the application process for renewable infrastructure. For example, wind turbines can cause death to birds via collisions, or displacement via loss of habitats.

128. Even if these issues are resolved, and the rollout of renewable generation proceeds at pace, there are other issues which policymakers need to consider to successfully integrate a much greater volume of renewable energy into existing systems.

3.2.2. Price formation in electricity markets

129. As the proportion of renewable energy in the generation mix increases, the marginal pricing model may no longer be feasible. Governments have begun to consider how the issues with pricing can be resolved.

130. The first issue is ‘price cannibalisation’ (Cornwall Insight, 2018^[121]). The absence of fuel costs means solar PV, wind, and hydropower have near zero marginal cost, and are extremely competitive in wholesale markets when they operate. Currently, most wholesale electricity markets set clearing prices that reflect the short-run marginal cost of the last plant dispatched in the merit order; this is typically a gas, coal, or oil-fired generator. With more renewable energy, renewables will more often be the marginal plant leading to low and sometimes even negative wholesale power prices. Prices can go negative as it may be cheaper for the grid operator to encourage extra demand than reduce electricity generation, particular as baseload power is often inflexible (e.g., nuclear power). Should low and negative prices occur for extended periods of time, renewable generators will not be able to generate enough income to cover the cost of their initial investment.

131. The second issue is the ‘squeezing out’ effect on capacity from higher marginal cost conventional plants. The intermittency of renewables means even systems with plentiful renewable capacity need conventional generating capacity on standby, to avoid blackouts when the wind does not blow, or the sun does not shine. There is a significant market design challenge around how to ensure remuneration of such capacity.

132. In terms of existing tools, one approach being considered is to extend CfDs, or equivalent schemes e.g., feed-in tariffs, to all renewable generators. In the UK, CfDs are auctioned to the lowest bidder, discovering the minimum price needed to bring forward new investment (BEIS, 2022^[122]).

133. CfDs would eliminate price cannibalisation, as renewable generators would receive a fixed price for their output. Provided this is fixed at a price above the renewables long-run marginal cost, it would ensure renewable generators receive sufficient payments to remain viable and stimulate further investment in renewable generation. CfDs can provide renewable generators with sufficient price stability to recoup their initial investment, incentivise investment in renewable energy, and prevent windfall taxes (Financial Times, 2022^[123]).

134. Another existing approach is the use of capacity markets. Some countries have introduced capacity remuneration mechanisms, which provide additional payments to firm capacity providers (e.g., fossil fuel generators). This incentivises firms to maintain existing capacity and invest in new capacity, preventing ‘squeezing out’. This mechanism could play an important role in ensuring the stability of the electricity grid during the transition to a decarbonised electricity system.

135. There are also discussions of more radical options to reform electricity markets to take into account the increase in renewable generation. There is significant academic work on new price formation mechanisms, but few of these theoretical models have been tested in real-life.¹⁸

136. There are also discussions of more radical options to reform electricity markets to take into account the increase in renewable generation. There is significant academic work on new price formation mechanisms, but few of these theoretical models have been tested in real-life.³

137. In the UK, the government opened a consultation in July 2022 to identify reforms to transition to a decarbonised, cost-effective, and secure electricity system (BEIS, 2022^[124]). One of the proposals discussed is to create separate markets for renewable and firm generation capacity. The renewable power market (‘as available’ market) would be based on long-run marginal costs of production. The firm power market (‘on demand’) would remain similar to the current electricity system, principally based on the short-

³ For examples of theoretical models, see (European University Institute, 2017^[137]).

run marginal costs of fossil-fuel production. This would insulate each market from the drivers of volatility of the other (i.e., intermittency and high input fuel costs). This proposal goes further than extending CfDs to all renewable generation (see above) as it would incorporate demand into the split market approach. Consumers could participate in both markets, but those who more able to adjust their demand could purchase a higher proportion of their electricity from the 'as available' market, whilst consumers would pay a premium for firmness of supply in the 'on demand' market. For example, consumers might be offered cheaper retail tariffs if electric vehicles are charged with 'as available' power. Suppliers are already starting to offer more flexible tariffs to customers who have a 'smart' (i.e., time of use) meter.

3.2.3. Stranded assets risk

138. A significant challenge to the Net Zero transition is stranded assets – assets which, at some point prior to the end of their economic life, are no longer able to earn an economic return (Carbon Tracker, 2017^[125]). It has been estimated stranded assets could total USD900bn *if* governments move to restrict the rise in temperatures to 1.5 degrees Celsius.¹⁹

139. Divestment and further consideration of financial risk may have caused the cost of capital for new investment in fossil fuel assets to increase: loan spreads for coal mining increased 54% in the last decade, although the picture is mixed for oil and natural gas (Zhou, Wilson and Caldecot, 2021, p. 5^[126]). By contrast, the cost of capital for renewable assets has fallen substantially.

140. However, while asset managers and fossil fuel producers have divested some non-renewable assets, firms which do not face the same political or investor pressure or have a higher willingness to take financial and reputational risks, have been willing to purchase them (Financial Times, 2021^[127]). Such firms include unlisted energy producers, private equity owned energy producers, energy traders, and national oil companies. Partly for this reason, there is significant debate as to whether divestments lead to emission reductions in practice, or whether the better strategy for investors is to hold assets and engage with company management to drive action to decarbonise operations.²⁰

3.2.4. Link between domestic renewable and global fossil fuel prices

141. Higher levels of renewable energy in domestic electricity generation should reduce the link between domestic energy prices and global energy prices – and reduce energy dependence on exporting countries. In the longer run this could alleviate some of the geopolitical tensions experienced to date in connection with fossil fuels.

142. Renewable endowments are more plentiful and more evenly spread geographically than fossil fuels. But the potential for different renewable technologies depends on geographic characteristics, which vary across regions and countries. For example, coastal countries with shallow seabeds have advantages in building offshore wind farms, while countries with plentiful sunshine can develop solar power plant. There is a strong economic case for interconnection between countries with complementary renewables capacity. Many countries already use interconnectors which allow them to trade power internationally.

143. Looking ahead there is an increasing need on improving cable technology so that power can be transported over greater distances, for example to import solar energy from North Africa to Europe. Renewable energy can also be used to manufacture hydrogen, which can then be shipped internationally. There is growing interest in hydrogen for a range of industrial and commercial uses, and potentially domestic heating. Greater movement of renewably-sourced energy internationally by wire or ship means that some of the geopolitical tensions experienced to date in connection with fossil fuels could in theory re-emerge in connection with renewable resources; fortunately, renewable endowments are more evenly spread geographically.

4. Competition and regulation in energy markets

144. The last three decades have seen substantial reform and restructuring in energy markets. Traditional, state-run monopolies have been dismantled in many jurisdictions, and wholesale and retail markets have been liberalised – although energy remains amongst the most heavily regulated sectors of the economy. When wholesale and retail energy markets were liberalised, countries deployed a combination of structural measures (e.g., separation between monopoly and competitive activities), regulatory measures (e.g., transfer pricing rules) and competition law to safeguard competition in these markets, ensuring that new players could enter and compete effectively with incumbent firms.

145. The trend for deregulation and increased competition may have slowed in recent years, for instance with increasing interventions in wholesale markets (e.g., to support renewables) and reintroduction of price regulation (e.g., the UK retail price cap). This trend back towards greater intervention in energy markets may accelerate considering the COVID-19 pandemic, the ongoing energy crisis, and the transition towards Net Zero.

146. In this section, we discuss the role of competition authorities, the application of competition law in energy markets, and areas of concerns for competition authorities in the energy crisis and, looking forward, the Net Zero transition.

4.1. Sectoral regulators

147. In the energy sectors, market participants are subject to sectoral regulation as well as economy-wide competition law, similar to sectors such as telecoms and financial services (OECD, 2019^[128]). Sectoral regulators may have different roles to competition authorities, but there is often some overlap in responsibilities and objectives. For example, some energy regulators have a formal role in merger control in the energy sector, while others have an informal or advisory role or no involvement at all.

148. Energy regulators' remits tend to address a broader array of issues than competition authorities, and they have broader powers to intervene in markets. For example, in addition to pursuing competition, the French Commission de régulation de l'énergie seeks to ensure consumers have access to services at a fair price, establish harmonised rules for energy networks and markets between EU member states, and guarantee independence for system operators. The European Union Agency for Cooperation of Energy Regulators seeks to promote security of supply. The UK regulator Ofgem seeks to support the Net Zero transition, by ensuring the right investment can come forward in renewable electricity generation and infrastructure to support the use of electric vehicles, heat pumps and heat networks.

149. Where energy regulators have remits or objectives concerning competition, the powers to address competition issues tend to be different to those of competition authorities. Sectoral regulators typically have the ability to establish standards and regulations in segments of the industry. This arises from the ability to restrict activities in the sector to licence holders (i.e., firms are not permitted to provide certain services

unless licensed), which are conditional on obligations and responsibilities incorporated into the standards expected of licence holders.

150. Application and enforcement of the standards allows energy regulators to achieve a degree of ex ante control of the sector. Standards can include general arrangements for treating consumers and businesses fairly, measures to ensure continuity of supply, and prudential requirements. This provides an additional route to tackle structural barriers to competition and market failures, where competition law or self-regulation may not be effective. Tailored, sector-specific regimes also mean energy regulators can reach and implement certain decisions on a faster timeline than competition authorities – for example authorities in Europe typically find it easier to enforce against market abuse using the EU Regulation on Wholesale Energy Market Integrity and Transparency (REMIT) regime than using competition law.

151. Where energy regulators have a legislative objective to promote competition, their work can be complementary to the work of competition authorities. Energy regulators typically have ex-ante powers to address the extent of market power in the sector, while the competition authority has ex-post powers to tackle use of market power, via abuse of dominance and cartel enforcement. For example, energy regulators can introduce (or threaten to introduce) price regulation as a ‘remedy’ to competition concerns, which competition authorities may not have the authority to do. There tend to be few conflicts between ex ante regulation and ex post competition enforcement, however conflicts may arise where energy regulators have wider policy goals. For example, energy regulators could hypothetically encourage consolidation in the interest of security of supply – given larger entities are better able to source energy on competitive, long-term contracts. Regulatory barriers to entry, for example rules on financial resilience, also illustrate the tension between competition and other objectives.

152. Sectoral regulators are typically responsible for market monitoring, promoting transparency and detecting market abuse, which includes market manipulation and insider trading. The concentration of energy-specific expertise, network of relationships across the sector, and specific regimes for complaints and whistleblowing means that sectoral regulators may be better placed to identify market abuse than generalist competition authorities. Where sectoral regulators tend to have the ability to impose punishment for breaches, the role of competition authorities in both identifying and enforcing punishment against market manipulating tends to be minimal. However, competition authorities can provide advice to governments and sectoral regulators on how such regimes should be structured, drawing on their knowledge from across sectors.

Box 2. Remit of OECD sectoral regulators

European Union: Under the Third Energy Package, energy regulators across Europe must cooperate to promote: competition, the opening-up of the market, and efficient and secure energy systems. It also ensures that regulators must be independent from industry and government, able to issue binding decisions and impose penalties, and able to require firms to provide accurate information. European regulators typically have market monitoring powers.

United States: The Federal Energy Regulatory Commission (FERC) is an independent agency which regulates interstate transmission of electricity, natural gas (including LNG) and oil. FERC seeks to ensure just and reasonable rates, terms and conditions; safe, reliable and secure infrastructure; and facilitating trust and understanding of FERC’s activities. Its remit extends to reviewing mergers and acquisitions, market monitoring and monitoring interstate transmission systems.

Australia: The Australian Energy Regulator (AER) regulates wholesale and retail energy markets and energy networks. The AER’s strategic objectives are to protect vulnerable consumers; deliver efficient regulation of monopoly infrastructure and incentivise networks to become platforms for energy services;

regulate competitive markets through monitoring, reporting, enforcement; and using its expertise to inform debate about Australia's energy future and support the energy transition.

Korea: The Electricity Regulatory Commission aims to create an environment of fair competition in electricity markets; to protect consumers' rights and interests; resolve disputes between electricity firms and/or consumers; and to monitor for unfair market practices and abuses of market power.

4.2. Competition policy tools

There are four main areas where competition authorities utilise competition law to safeguard open and competitive energy markets. Competition law enforcement can be complemented with more general investigations of markets conditions in form of market studies or market inquiries.

4.2.1. Cartels and other horizontal conduct issues

153. Energy production and upstream markets are susceptible to cartel behaviour, for two main reasons. First, they exhibit many of the characteristics which tend to facilitate collusion: a small number of competitors; little to no market entry, for reasons including high fixed costs or regulatory barriers; stable market conditions, with a constant and predictable flow of demand; identical products or services; few, if any, substitutes available; and comparatively little technological change in the industry, which facilitates maintaining an agreement over time. Second, market forces can drive boom-bust cycles – a period of high prices encouraging excess entry, followed by a price crash and destruction of businesses. These cycles, with unstable prices and occasional periods of scarcity, create market disturbances affecting both producers and consumers. OPEC claims that its policy aims to “ensure the stabilization of oil markets” rather than maximising profits from oil production (OPEC, 2022^[129]). Even if that claim was true, OPEC did not have much success in preventing price volatility. Cartel behaviour may thus be motivated by profit maximisation and/or price stabilisation. National monopolies may be granted for similar reasons – to capture resource wealth for the nation, and to stabilise prices for the benefit of producers and consumers.

154. Many national oil and gas companies are given legal monopolies in their respective countries (e.g., QatarEnergy). On the international stage, OPEC is an overt cartel and is accepted at a geopolitical level, in part for the stabilising role it plays during periods of extreme price fluctuation. There are other examples of overt or state-sponsored cartels in oil markets. In many jurisdictions, anti-trust exemptions are given for private export cartels, export subsidies, or state trading through public monopolies – on the basis firms require protection from competition in order to compete with cartels internationally. Competition authorities have a role in weighing up the case for such arrangements, in granting approvals where the benefits are clear, or in advocating for greater liberalisation of markets where vested interests are at play.

155. Active antitrust enforcement is also important to tackle covert cartels and other horizontal agreements in the energy sector. For example, in 2009, the EC imposed fines of EUR 553m each on E.ON and GDF for market-sharing agreements in the French and German gas markets. When E.ON and GDF jointly built the MEGAL pipeline across Germany to import Russian gas into Germany and France in 1976, the two firms agreed not to sell gas transported over this pipeline in each other's home markets. They maintained the agreement until 2005.

4.2.2. Vertical integration and abuse of dominance

156. It is very common to find vertical integration in commodities production. Vertical integration can, at times, be pro-competitive especially in the early stages of the development of an industry. In natural gas, many countries have under-developed infrastructure for handling LNG. Infrastructure owners may not invest in infrastructure until they know there will be sufficient volumes to justify the expense, but large-

scale production cannot commence without the necessary infrastructure (the ‘chicken and egg’ problem). It is therefore common for a producer to vertically integrate across all stages of the production process, particularly if there are economies of scale.

157. However, once a firm is vertically integrated and the industry matures to the extent that other competitors seek to enter the industry, control of critical infrastructure could enable anticompetitive conduct. Without access to critical infrastructure such as distribution networks or pipelines, it is difficult for competitors to take proven reserves into production and distribution.

158. Competition policy is therefore critical to ensure third-party access to critical infrastructure is non-discriminatory and that incumbents are prevented from abusing their dominant market position to deter market entry by potential competitors. For example, the EC intervened against abusive use of infrastructure in the RWE, E.ON, ENI, CEZ and Svenska Kraftnet cases. In 2011, the EC launched an antitrust case against Gazprom over accusations of anti-competitive practices towards smaller gas-importing countries in Eastern Europe. Gazprom was accused of pursuing an overall strategy to partition natural gas markets along national borders to enable Gazprom to charge higher prices. In 2018, the EC imposed constraints on Gazprom’s behaviour, by removing restrictions on cross-border resale, to enable the free flow of gas at competitive prices.

4.2.3. Anticompetitive mergers

159. Merger control ensures that mergers and acquisitions do not result in markets that are too concentrated, enabling market participants to exercise market power either unilaterally or in a coordinated fashion. As noted above, the scope for substitution in energy markets is often low, meaning demand is price inelastic. There is considerable scope therefore for a monopolist to raise prices resulting in an increase in revenues.

160. In natural gas, the US FTC has scrutinised mergers including EnCap Investment’s acquisition of EP Energy, El Paso Energy Corporation and The Coastal Corporation, and Anadaroko Petroleum’s acquisition of Nuevo Midstream LLC. Interestingly, the US DOJ required S&P Global to divest three of IHS Markit’s price reporting agencies to resolve antitrust concerns, given the importance of price reporting agencies to price discovery in commodity markets and the concern that the proposed merger might have resulted in higher prices and lower quality.

161. In electricity generation, there are considerable barriers to entry, given the high upfront investment costs needed to establish generation assets (e.g., an offshore wind farm), which are more easily borne by incumbents with large balance sheets than new entrants. Competition authorities need to carefully scrutinise mergers to ensure that mergers do not lead to excessive market concentration – particularly when markets already have oligopoly characteristics. The EC examined the acquisition of Uniper by Fortum, and E.ON’s acquisition of RWE’s Innogy. The UK’s Competition and Markets Authority also investigated the mergers and acquisitions between SSE Energy Services and OVO, SSE Retail and Npower, and Npower and EON.

4.2.4. Other forms of abuse and dominance

162. As electricity is difficult and expensive to store and the grid must be balanced at all times, electricity markets present quite unique challenges in terms of firms having occasional market power and scope for abuse.

163. In markets with nodal or zonal pricing, generators may have market power when there are transmission constraints, which shrink the size of the geographic market in which the generators compete. During certain system conditions, a single generator may be the only one able to meet a given locational energy need; making it a monopolist facing completely inelastic demand with no market constraint on the price it can charge. In these circumstances, the System Operator is usually authorised to cap bids of plants

that it considers possess local market power. For example, in the US, in the PJM, New York and New England electricity markets, the regulator allows the ISOs to implement mitigation mechanisms that limit the potential harm to consumers from local market power. In the PJM scheme, if the ISO determines that a particular unit possesses significant local market power, it can limit the bids of this unit to their variable cost plus 10%.

164. However, it is impossible for the regulator and system operator to perfectly counter the potential for such abuses through such ex-ante regulation; there remains a role for ex post enforcement of both competition law and related law on market abuse. For example, in 2016, InterGen sent misleading signals to UK National Grid, falsely claiming some of its power stations would not be generating during the 'darkness peak' evening period when demand is highest. The misleading signals pushed National Grid into paying InterGen high prices to generate during those hours through a second market, the balancing mechanism. Ofgem fined InterGen GBP 32.7m for breaching the wholesale energy market abuse regime.

4.3. State aid and competition

165. State aid has played an important role in how jurisdictions decarbonise their economies, in particular through subsidies for renewable and nuclear energy. Competition policy governing state aid is important for ensuring the proper functioning of competition in the energy sector, as state aid schemes may contribute to unfair competition between types of renewable energy or within single markets. State aid can take many forms such as tax relief and credits, guarantees of loans on favourable terms, or capital transfers. While state aid is designed to over-ride market signals in certain circumstances and for particular policy ends (for example to decarbonise energy supply in the absence of a carbon price), it can also distort competition in damaging ways, for example supporting inefficient firms at the expense of more competitive ones.

166. State aid was required to establish the renewables industry in the early days, as technologies for renewable energy generation were still developing and mostly too expensive to compete with fossil fuel power plants (in the absence of a carbon price that reflected the likely costs of climate change). Recognising this market failure in Europe, the EC intervened rather lightly and allowed Member States considerable freedom in choosing support schemes to promote the adoption of renewable energy. In recent years, however, technology cost improvements mean that renewable electricity production is becoming increasingly competitive, and the need for subsidies is reducing. In 2014, new State Aid Guidelines (replaced in 2022 with new Guidelines on State Aid for Climate, Environmental Protection and Energy) started a process to limit options for Member States in terms of renewable energy support schemes. In 2017, the German electricity regulator approved construction of the first offshore wind farms that depend entirely on market prices instead of government subsidies.

167. Another state aid mechanism relating to the Net Zero transition is the use of Capacity Remuneration Mechanisms (CRMs). The output of renewable power plants varies with weather conditions (e.g., wind, sun, rain) which means they cannot provide a stable supply of electricity. To safeguard security of supply, sufficient firm (conventional) generation capacity is required to balance the grid. This has led some countries, e.g., France and the UK, to introduce CRMs, which pay firm capacity providers to maintain existing capacity or invest in new capacity – even if it is not called upon to run very often. As CRMs are only available to certain generation technologies, most CRMs are subject to state aid rules.

4.4. Areas of concern for competition authorities in the energy crisis

168. How the energy crisis evolves in the coming months, and possibly years, will affect how much of a focus energy markets become for competition authorities and what tools they may have to use. The early stages of the energy crisis have already raised issues, some which are discussed below.

169. As a result of tight market conditions, state-owned or private oil and natural gas producers with spare production capacity will have very significant pricing and negotiating power. Producers may leverage their increased market power to pressure importers, in a way which could undermine future competition, e.g., producers may offer only very long-term contracts without flexibility or introduce territorial restrictions which could be anticompetitive. Several European governments have signed long-term deals to safeguard natural gas supplies for this and next winter, possibly on unfavourable terms (Bloomberg, 2022^[130]). Competition authorities may be called upon to investigate whether parties are making excessive margins. For example, the UK's CMA investigated the road fuel market, and launched a market study to investigate refinery spreads (CMA, 2022^[131]). However, the exercise of pricing power in a tight market is not necessarily a breach of competition law (where the behaviour is exploitative rather than exclusionary, and not "excessive") and, in such circumstances, the main public policy response to companies making extraordinary profits may be a windfall tax.

Box 3. Austrian sector inquiry into fuel markets

Against the background of sharply rising prices at petrol stations, the Austrian Federal Competition Authority (AFCA) launched a sector inquiry into the Austrian fuel market on 21 March 2022.

After Russia's full-scale invasion of Ukraine, diesel and petrol prices significantly increased at Austrian filling stations. This triggered a lively public debate as to whether this could be fully explained by the development crude oil prices.

The sector inquiry concludes that the main drivers of fuel price increases were crude oil prices and refinery margins. On the other hand, filling station margins were not a systematic contributing factor.

AFCA found that gross refinery margins on diesel and gasoline have roughly tripled on average. However, this was not caused by a systematic reduction in production or utilisation rate of refineries relevant for Austria.

Overall, AFCA found no evidence for anticompetitive behaviour by these refineries. The most likely reason for the high margins was a global scarcity of refinery capacity.

Source: (Bundeszweitswettbewerbshörde, 2022^[132])

170. Depending on how the crisis evolves, there may be an increase in the number of firm failures. This may be due to factors such as commercial pressures (e.g., in sectors that use a lot of energy such as hospitality) and policy or regulatory pressures (e.g., in the power generation sector where producers had long-term contracts with Gazprom that are not being honoured). Firm failures may reduce competition in energy intensive sectors if firms exit the market (for example, energy intensive manufacturing in Europe), drive consolidation where firms can be more competitive at a larger scale (e.g., 'failing firm' mergers) and/or lead to an increase in state aid (e.g., liquidity support for power generators).

171. As a result of current market conditions, governments and regulators may introduce (albeit temporary) market reforms which eliminate market-based price formation or dull price signals to consumers. While such measures may meet other policy goals, e.g., to protect vulnerable consumers or industries, the weakening of market-based mechanisms may sacrifice economic efficiency – which could

have significant, longer-term impacts. Therefore, even under challenging conditions, it is important such signals are retained. For example, in the event of rationing of natural gas, competition authorities could advocate for auction platforms to incentivise industrial users to reduce demand and provide gas only to those producers who most need and can most efficiently use it.

4.5. Areas of concern for competition authorities in the Net Zero transition

172. Whilst the Net Zero transition is primarily a matter of energy policy rather than competition policy, competition authorities have a role to play in advising policymakers on how competition can facilitate the transition, and on how tensions between the goals of promoting Net Zero and competition may be resolved.

173. In certain instances, competition law may hinder firms or industries from moving towards Net Zero. Firms have noted that a lack of clarity on what is, and is not, a breach of competition law can hinder their ability to work towards sustainability goals. Firms may look to lessen the environmental impact of their sector by pooling resources or expertise with other firms, for example developing common standards for electric vehicle charging, or transitioning (re)insurance underwriting portfolios to Net Zero (Net-Zero Insurance Alliance, 2021^[133]). Competition authorities can support firms in this transition by providing more clarity and reducing uncertainty about the application of competition law in these circumstances (OECD, 2020^[134]). For example, competition authorities can provide letters of comfort or derogations from competition law to allow certain types of co-operation between competitors, introduce legislative amendments to provide increased legal certainty, and even allow private co-operation agreements between competitors where environmental or climate benefits are clear and consumers receive a fair share of the resulting benefits.

174. Competition authorities should also advocate for competition where it can be most useful, for example in driving down costs of new technologies or developing consumer propositions (e.g., time-of-use tariffs) which facilitate the transition to Net Zero. Competition authorities could identify what factors prevent competition and advocate for policy or regulatory change to drive innovation. Together with letters of comfort or derogation from competition law, competition authorities can advise the government and other authorities to balance the need for co-ordination and/or central planning (particularly as the timelines for the Net Zero transition are rather short) and leaving market forces to find the appropriate solutions and drive down costs.

175. Due to future market dynamics arising from the Net Zero transition, governments and regulators may introduce changes to price formation mechanisms and market structure, for example separating renewable and firm power markets, or a move to nodal pricing. Competition authorities should advocate for market structures which retain market-based price formation and promote competition.

176. Finally, as the Net Zero transition progresses and the use of fossil fuels declines, many non-renewable energy assets will cease to be economically viable (i.e., stranded assets). However, certain energy assets may be viewed as 'essential' until there is a full transition away from fossil fuels, for example the gas grid. Authorities may need to take a view on whether state aid is needed to keep such assets operational until the point they can be switched off, e.g., coal-fired power stations, or (in time) the supply of natural gas for home heating. In the context of a general decline in fossil fuel markets, there may be consolidation which drives an increase in market concentration, starting with fossil fuels which are most polluting and/or least cost-competitive with renewable energy, e.g., coal. Competition authorities may need to take a view on mergers in the context of a declining sector and be on the lookout for anti-competitive behaviour by firms who are struggling or failing.

5. Conclusion

177. Wholesale energy markets are highly interconnected and global, and market participants comprise a mixture of privately-owned and state-owned or state-sponsored enterprises. The unique characteristics of energy markets can make it a challenging area for competition authorities to intervene, even under normal circumstances.

178. The causes of the current energy crisis are mainly geopolitical in nature, triggered by the COVID-19 ‘bounce back’ and greatly exacerbated by Russia’s full-scale invasion of Ukraine. In response, governments have implemented a range of measures from short-term tactical measures to dampen the effects of high prices, to long-term strategic measures to diversify sources of energy and to reduce reliance on fossil fuels. The energy crisis has created challenging trade-offs between policy goals, e.g., security of energy supply, and competition, which governments and policymakers will have to manage.

179. Looking forward, the transition to Net Zero will likely have a profound impact on global energy markets and completely overturn existing value chains. Electricity from renewable sources will increasingly supplant demand for fossil fuels, but it will generate demand for a different set of commodities which enable renewable generation, e.g., nickel and aluminium. The characteristics of renewable generation will have implications for how wholesale energy markets are designed and how companies compete, both domestically and internationally. There will also be major transitional effects – vast parts of the energy industry will be eliminated, resulting in stranded assets, and the economy as a whole will need a vast amount of investment to transition away from fossil fuels via electrification and/or green hydrogen.

180. Competition authorities have a role in advocating for market-based policy solutions and ensuring that governments and policymakers are cognisant of the competitive consequences of non-market solutions – highlighting where trade-offs may exist and how they can be mitigated. In the current energy crisis, competition authorities have a role in being alert to opportunistic anti-competitive behaviour. Looking forward, competition authorities will oversee competition in energy markets which – having been mature and stable for several decades – are increasingly either nascent (e.g., renewable technologies) or declining (e.g., coal power stations or possibly the entire gas grid). Competition authorities will need to ensure they build up the required technical expertise and knowledge of these new markets and technologies to identify anticompetitive conduct and remain effective enforcers of competition law.

Endnotes

¹ Take-or-pay contracts obligating the buyer to take and pay for the volume of natural gas delivered, or otherwise pay an agreed price for any natural gas not taken. They also can include flexibility mechanisms to allow adjustments to contracted volumes. The price obligations are typically pegged to a benchmark (e.g., daily, monthly, quarterly or annual spot prices) or may fix prices for a period (e.g., three years) with periodic price reviews to reflect market conditions.

² Hubs can be “virtual” or “physical”, though both serve as meeting points where parties can buy or sell natural gas with title transferring. Virtual hubs do not have an exact physical location, e.g., NBP and TTF represent all of the UK and Netherlands’ natural gas transmission systems - as natural gas enters the systems, it is “at” NBP or TTF until it exits the systems. Physical hubs, e.g., Henry Hub, are at the heart of natural gas infrastructure networks, e.g., pipelines, LNG terminals and storage sites. For further information, please see (Columbia SIPA Center on Global Energy Policy, 2018, p. 15^[13])

³ The methodology used to produce prices can differ between benchmarks. For example, Argus publish price assessments for TTF daily. The price assessment is informed by market information received from market participants which is non-public, e.g., OTC transactions, bids/offers. Argus’ methodology aims to produce a reliable and representative price from the market data it voluntarily receives. By contrast, the settlement price for TTF futures traded on ICE Endex are determined by the exchange directly using transactions conducted on the central limit order book (CLOB). The daily settlement price is used to determine the amount payable under financial instruments or contracts.

⁴ For example, see CFTC investigations Glencore, Total Gas and Power North America, Amaranth Advisors LLC, Reliant Energy Services Inc, CMS Marketing & Trading, and Total SA. Ofgem also published an open letter on the [prohibition of market abuse under EU regulation](#).

⁵ Upstream refers to the exploration and production of natural gas. Midstream refers to the transportation and storage of natural gas, including pipelines and other infrastructure. Downstream refers to the final step in the value chain, whereby usable products are delivered to end-consumers.

⁶ For example, the EU's Third Energy Package (2009) forced ownership unbundling in Europe.

⁷ Also called independent system operators (ISOs) or regional transmission organisations (RTOs).

⁸ There are nascent storage technologies, e.g., battery energy storage systems, thermal energy storage, and mechanical energy storage. These long-duration storage technologies are increasingly important as intermittent renewables form a larger proportion of the energy mix.

⁹ A merit order curve can be viewed on any short-term electricity markets. For example, please see epeXspot [DE-LU Day-Ahead prices](#). The displayed aggregate curves include all orders submitted to the nominated Electricity Market Operators in the concerned bidding zone.

¹⁰ The settlement period is the half-hour trading period for balancing supply and demand.

¹¹ Originally, transnational electricity trading and allocation of interconnection capacities were two separate markets. Under market coupling, the two trading mechanisms are combined into an integrated electricity market in “implicit auctions”, where electricity is sold together with interconnection capacity – interconnection capacities are allocated at the same time as the market clears on the electricity markets.

¹² The International Energy Forum is an inter- governmental organisation which aims to facilitate open dialogue on energy and promote energy security and transparency. Its participants include both producing (OPEC) and consuming (IEA) nations, covering more than 90% of global oil and gas supply and demand.

¹³ For a breakdown of the reduction of exports to Europe by pipeline, please see (The Economist, 2022_[140]). Since publication, exports via Nord Stream 1 have halted.

¹⁴ The pass-through of wholesale gas prices to wholesale electricity prices is determined by multiple factors, e.g., the share of gas in marginal generation and the market power of gas generators. The pass-through rate is close to 100% in the UK, Germany, and Norway and shows significant cost-reflectivity. By contrast, the pass-through rate in Italy and the Netherland are far from 100% and do not indicate strong cost-reflectivity. For further discussion, please see (Ofgem, 2018_[139]).

¹⁵ The International Energy Administration was set up under the framework of the OECD and its role is to provide recommendations, analysis, and data on the global energy sector. Each member must hold oil stocks equivalent to 90 days of net oil imports, which can be released in extreme supply disruptions.

¹⁶ A CfD is a contract that in effect offers a generator a fixed price for energy generated – when market prices are low the generator receives a subsidy; when they are high the generator gives the excess back. For further explanation of how CfDs work in practice, please see (HM Treasury, 2014, pp. 19-20_[138]).

¹⁷ The Climate Change Committee estimates electricity demand in the UK will double by 2050, from 300 TWh in 2018 to between 550 to 680 TWh in its range of scenarios (Climate Change Committee, 2020_[107]).

¹⁸ For examples of theoretical models, see (European University Institute, 2017_[137]).

¹⁹ This reflects that total fossil fuel reserves on company balance sheets far exceed the maximum future fossil fuel consumption consistent with climate targets (Financial Times, 2020_[136]).

²⁰ For example, (Financial Times, 2022_[135]).

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