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How Can the European Energy Crisis Reshape the Power Sector Reform Endeavors of GCC Countries?

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Abstract

Energy prices in Europe have been soaring, and policymakers are trying to find solutions to immediately contain the energy prices for end-consumers and to enhance the market design in the longer term. This paper discusses some of the current events that are facing the power sector in Europe and some challenges that may face the industry more generally in the future. Then, we propose policy recommendations in the context of Gulf Cooperation Council (GCC) countries by contrasting the power sector design in place in this region with that in the European region.

Our findings include four main lessons for the GCC. First, policy intervention should be appropriate and well timed to foster a conducive environment that encourages investor participation. Second, combined with targeted and timely policy interventions, well-regulated vertically integrated utilities (VIUs) can bring significant advantages in realizing the future aspirations of the power sector, especially its aspirations regarding the global deployment of renewable energy (RE). Third, long-term contracts can play a key role in managing costs and achieving energy transition goals, but competitive auction mechanisms and well-designed contracts are key to their success. The GCC region should consider various contract types to benefit from these agreements. Finally, energy security remains a top priority, and the GCC has an advantage in fuel supply and management.

Highlights

Europe has experienced a significant rise in wholesale electricity prices since mid-2021. The main identified drivers are on the supply side, with the increase in natural gas and carbon prices in Europe and relatively low availability of specific technologies.

The crisis has encouraged the European Commission to allow member states to implement short-term and temporary solutions to contain the crisis. It has also opened the debate on reforming the European electricity market design.

GCC countries are in the process of reforming their power sectors. The current European energy crisis can help to better shape these reforms.

Abbreviations

GCC	Gulf Cooperation Council
PPA	power purchase agreement
PV	photovoltaic
VIU	vertically integrated utility

1. Introduction

Historically, power systems have been organized in several ways, from vertically integrated utilities (VIUs) to fully liberalized markets. Since the 1990s, the power sector in Europe has evolved toward a fully liberalized structure. Electricity markets have been introduced as the core mechanism to coordinate short-term operations and provide investment signals. These markets have been progressively integrated at the European scale with market coupling mechanisms. The emphasis has been on harmonizing the functioning of short-term electricity markets across European countries and facilitating cross-border exchanges. In 2019, the last energy package released by the European Commission also added a focus on empowering consumers through decentralized generation ("prosumers"), energy communities, and dynamic price contracts (European Commission 2019a).

In parallel with the liberalization and harmonization of the European power system, the energy transition has resulted in a focus on renewable deployment through specifically dedicated financial mechanisms. Every European country has designed and implemented a combination of mechanisms to facilitate the uptake of renewable technologies such as wind power and solar photovoltaics (PVs). These mechanisms include feed-in tariffs, feed-in premiums, auctions, green certificates, net metering, and tax incentives. As a result, the share of electricity produced by wind and solar in Europe has increased from 5.5% in 2010 to 22.3% in 2022 (Ember 2023). The deployment of intermittent and variable renewables has also raised the question of how renewables will impact the European power system, particularly its reliability and flexibility (Huber, Dimkova, and Hamacher 2014; Zappa, Junginger, and Van Den Broek 2019).

Since the summer of 2021, Europe[1] has been facing an energy crisis with soaring natural gas and electricity prices. This crisis has refocused the European debate on energy security and has raised the question of whether European electricity markets should be reformed. In response to this crisis, European policymakers have taken multiple actions. These actions include short-term mechanisms to contain the crisis (more specifically, to protect consumers from high energy prices) and, in the longer term, potential (debated) market reforms.

To contain this energy crisis, one of the first European actions was to reduce its dependency on gas imported from Russia as part of the new European strategy called "REPowerEU" announced in March 2022 (European Commission 2022b). Second, European energy regulators pursued and are pursuing solutions to reduce energy prices for European citizens (Council of European Energy Regulators 2022). These solutions, which are being undertaken at the national level and are being coordinated and regulated at the European level, include reducing electricity consumption, limiting energy bills for some or all citizens, and collecting and redirecting extra revenues earned by some energy producers. Third, European energy stakeholders have started to review and discuss options to enhance the functioning of their gas and electricity sectors in the longer term. The crisis and actions in Europe can inform and provide lessons for power systems worldwide.

In Gulf Cooperation Council[2] (GCC) countries, the electricity sector is largely dominated by oil and gas sources and is predominantly operated by state-owned VIUs. Exploiting their weather conditions, GCC countries have also started to transition to renewable energy (RE), with a particular focus on solar energy. In parallel, many reforms have been implemented, and others are currently being implemented or are under discussion. These reforms aim to trigger investments (in generation capacity and networks) and better reflect electricity costs to consumers. In particular, discussions are addressing whether to introduce competition on the generation side or, otherwise, to increase efficiency. The two goals of transitioning to renewables and reforming power sectors that the GCC is pursuing still need to be reconciled and consistently addressed (Poudineh, Sen, and Fattouh 2021). These reform endeavors observed in the GCC can benefit from worldwide experiences such as the recent European energy crisis.

This paper focuses on the European electricity sector in the context of the ongoing energy crisis. It analyzes the current responses of European policymakers to the energy crisis and proposes key lessons relevant to the GCC. The remainder of the paper is organized as follows. Section 2 briefly describes the European power systems and how the sector is structured around electricity markets. Section 3 presents the ongoing European energy crisis that started in 2021. Section 4 discusses the solutions implemented or considered in Europe to mitigate the energy crisis. Section 5 presents the power systems of the GCC, highlighting their similarities to and differences from Europe. Then, the paper suggests key lessons for the GCC from the European experience before finally concluding in section 6.

2. Overview of European Electricity Markets

2.1 European Electricity Markets at a Glance

The European electricity sector has been progressively liberalized since the first liberalization directives adopted by the European Commission in 1996 (the so-called "First Energy Package"). The current European electricity sector is structured around two primary elements: (1) wholesale electricity markets where electricity is traded from year ahead to intraday and (2) a retail market where end-consumers buy electricity from the electricity supplier of their choice.

Pricing in wholesale electricity markets in Europe and other parts of the world follows the marginal price principle. In theory, hourly electricity prices computed by the power exchanges align with the system's marginal cost of producing electricity at every hour.

In wholesale markets, generators and suppliers can trade at various time horizons. In Europe, the day-ahead market (also called the spot market) follows a pay-as-clear mechanism for a given electricity product traded at a given date and hour (the same electricity price is paid and received by all market participants). Offers are submitted to the power exchanges by 12:00 am the day prior to delivery. For most European countries, the day-ahead market considers implicit cross-border allocation computed by the power exchanges through their market coupling algorithm (NEMO Committee 2020). In most European countries, the day-ahead market follows regional pricing, with one price being defined for each country as a whole and for each hour (Italy, Norway and the Netherlands are exceptions to the regional pricing).

European electricity futures markets are continual wholesale markets where trading takes place up to six years before the delivery year. Their liquidity is minimal if trading takes place more than three years ahead. In theory, the future electricity price of a baseload product[3] aligns with the average hourly marginal price that can be forecasted by market participants for the delivery year.

European retail prices follow a different pattern. As in almost all power systems across the world, retail tariffs are set for an extended period, typically six months to several years, and they are independent of the hour during which electricity is consumed.

2.2 More Than an Energy Market

In addition to the energy market described above, which is the market mainly discussed and debated within the electricity sector, there are layers in Europe that make the operation of the electricity markets even more complex. These additional layers include ancillary markets, a capacity market in some countries, and the European carbon market (European Union Emissions Trading System (EU-ETS)), which applies to the power sector.

In some European countries (e.g., France, the UK, Italy, and Poland), a capacity market has been implemented for resource adequacy purposes. The capacity price can vary significantly depending on whether the system needs to maintain the operation of existing assets or invest in new assets (Petitet, Finon, and Janssen 2017). In the first case, when resource adequacy can be ensured by maintaining existing assets, the capacity price theoretically is aligned with the "short-term" missing money, i.e., the gap between revenues and the annual operation and maintenance costs of the assets required to ensure resource adequacy. In the second case, when resource adequacy requires new assets, the capacity price is aligned with the classical (long-term) missing money, i.e., the gap between revenues and the investment cost of the new asset. Despite the ongoing renewable deployment, Europe tends to observe increasing capacity prices due to the need for new assets to ensure resource adequacy and to deal with the need for flexibility. For example, the last four-year-ahead capacity price in the United Kingdom 2022 auction (known as the T-4) cleared at a record price of £63/kW and was significantly higher than expected. This rise in the UK capacity price triggered by flexible capacity could become a trend in the future (Tan 2023).

2.3 Renewable Energy in Europe

The European Union (EU) is considered a progressive region in regard to renewables. In 2020, nearly 20% of electricity in the EU-27 countries was produced by solar and wind, and the total generation contribution of all renewable technologies (i.e., bioenergy, hydro, solar, wind, and others) was approximately 38%. The total demand in 2020 was lower than that in 2019 due to the COVID-19 pandemic. Figure 1 shows the renewable installed capacity deployed by eight European countries.

The deployment of renewables poses challenges in the European power sector in at least three dimensions: the functioning of electricity markets with renewables, the maintenance of the reliability and stability of the power system, and the financing of the energy transition.

First, with the advent of renewables and, in particular, with the increased shares of renewables in power generation, the current energy market model has faced some challenges and criticisms (e.g., Blazquez et al. 2018; Joskow 2019; Peng and Poudineh 2019). These challenges include the following:

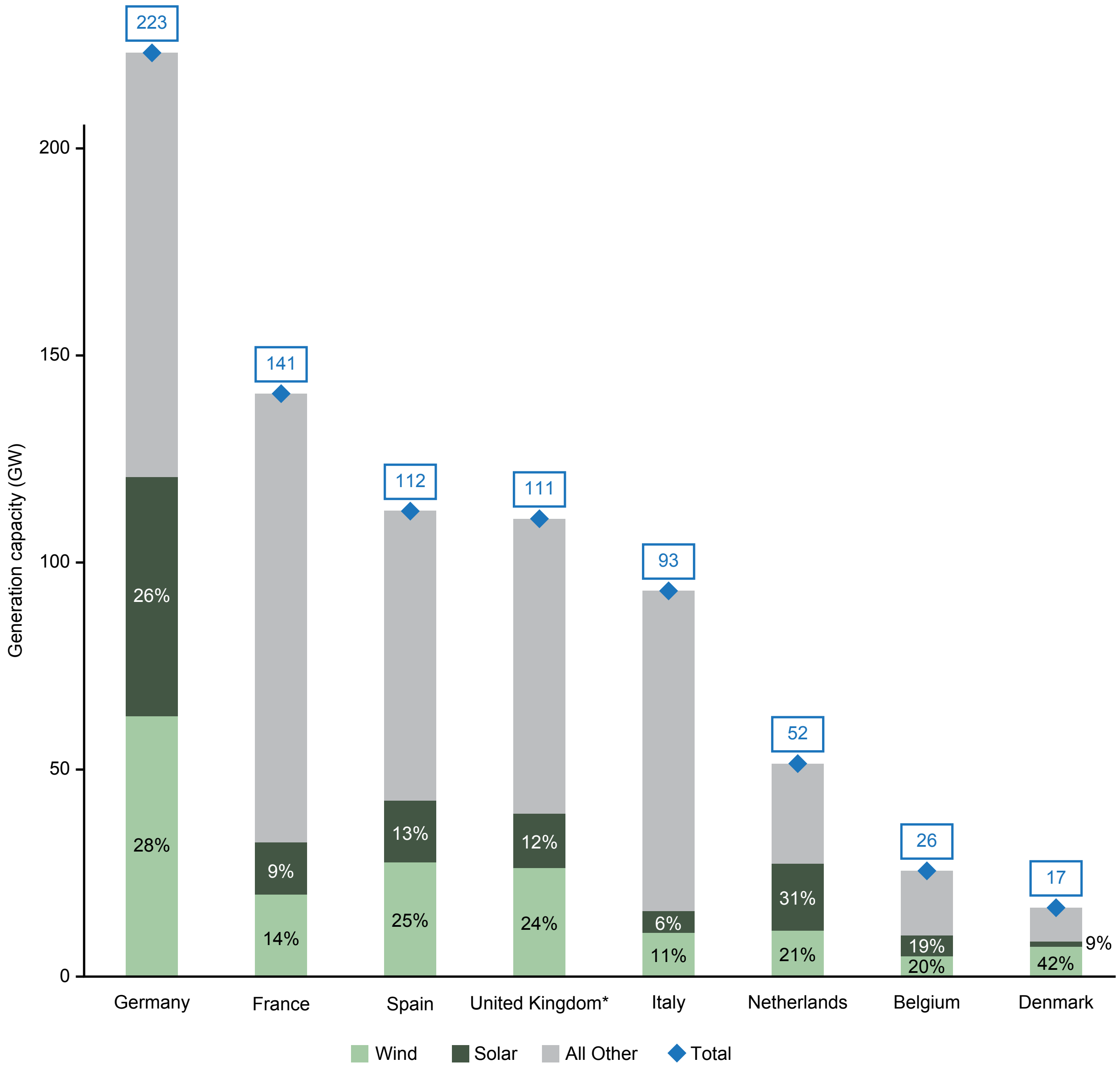
(1) A decrease in wholesale electricity prices when generation from renewables increases. This effect is common to all technologies but is particularly exacerbated in the case of nondispatchable renewables, given that the generation of a given technology is highly correlated. Consequently, the average wholesale price received by renewables decreases when more renewables are added to the system, hence resulting in a decrease in profits from renewables. This phenomenon is known as the cannibalization effect (Brown and Reichenberg 2021; Prol, Steininger, and Zilberman 2020).

(2) Zero or negative[4] wholesale prices when generation from renewables is high compared to electricity demand. Depending on the renewable support scheme in place, renewables may be subject to curtailment during times of zero or negative prices.

To address these issues, first, most European countries have reformed their incentive mechanisms for renewables to switch from feed-in tariffs to auctioned premiums (Melliger and Lilliestam 2021). This evolution toward market-based support mechanisms for renewables is part of the guidelines defined by the European Commission (European Commission 2013). Under the feed-in tariff scheme, renewables were receiving a fixed price for every MWh injected into the grid for a contracted period (typically 20 years). Renewables that had been under feed-in tariffs faced a remuneration that was completely "out of the market" and not aligned with current wholesale prices. Under the reformed feed-in tariff scheme, renewables are exposed to wholesale market prices: they sell their generation on wholesale markets (just like any other technology) and receive a premium when the market price is

2. Overview of European Electricity Markets

Figure 1. Total installed generation capacity and the installed capacity share of solar and wind in selected European countries as of 2022.



Source: Authors; data from ENTSO-E Transparency.
Note: *2021 data for the United Kingdom.

below the contracted reference. These feed-in premiums, which have been designed in a context of low wholesale prices, generally include specific rules in case of zero or negative price situations that incentivize renewables to curtail their energy during these events (the premium is suspended when the wholesale price is zero or negative).

However, more recently, the current energy crisis in Europe has raised a new challenge for renewable support schemes: renewables have experienced high windfall profits when the marginal generator has a high marginal cost of generation (e.g., gas units), resulting in profits significantly larger than renewable costs.

Second, the increase in the share of renewables adds a reliability and stability challenge to the power grid. The additional supply variability caused by renewables requires additional resources and operational adjustments compared with a system comprising only (or mostly) dispatchable thermal generation, which comes at a cost. These additional resources stem from, for example, the need to invest in the storage, transmission, and additional backup of dispatchable (mostly thermal) generation.

3. European Electricity Markets in 2022

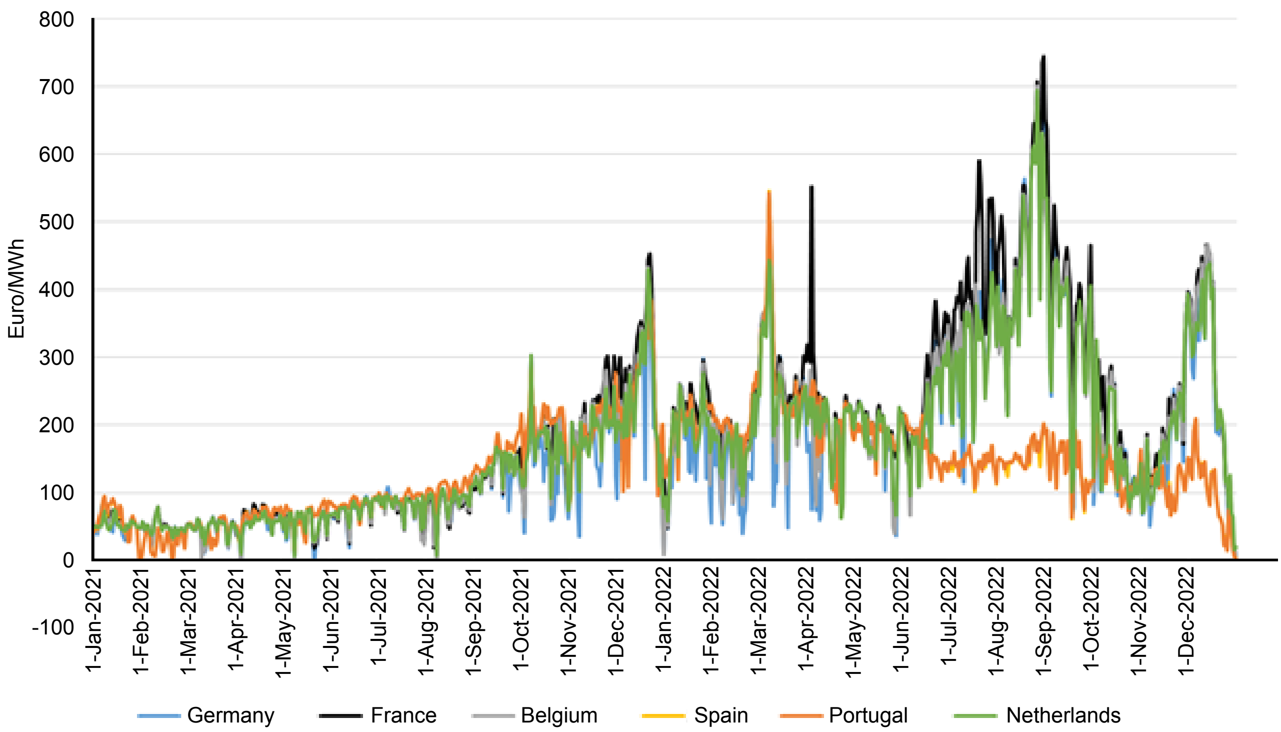
3.1 Electricity Prices

Since 2021, the EU has been facing an unprecedented and unexpected energy crisis that has impacted natural gas and electricity prices (Al-Balawi and Belaid 2023; Petitet and Belaid 2021). Since the summer of 2021, European wholesale electricity prices have increased significantly, as shown in Figure 2. Although the six European countries presented in Figure 2 (Germany, France, Belgium, Spain, Portugal, and the Netherlands) had similar wholesale prices from January 2021 to May 2022, we identify a clear change from June 2022, where prices in Spain and Portugal remained close but were significantly lower than those in the other countries. These lower wholesale electricity prices observed in the Iberian Peninsula are the consequence of a cap on the gas price for electricity producers implemented in Spain and Portugal (see section 4 for more details).

In the six European countries presented in Figure 2, the average wholesale price increased by 183% and 495% in 2021 and 2022, respectively, compared to the 2018-2019 period. Due to the price cap implemented in the Iberian Peninsula in June 2022, the average wholesale price was limited to 168 euro/MWh in 2022 in Spain and Portugal versus 249 euro/MWh in Germany, France, Belgium, and the Netherlands.

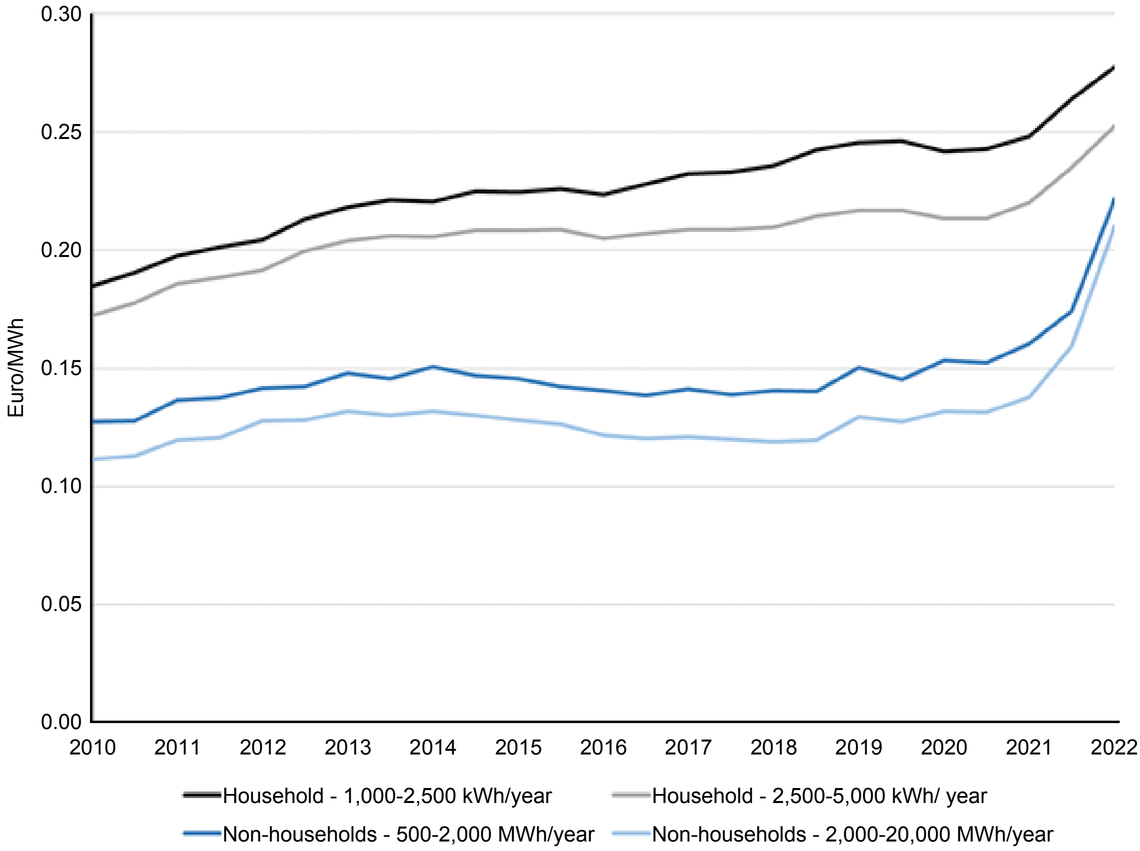
Because of the increase in wholesale electricity prices observed in Europe in the 2021-2022 period, retail prices are also expected to increase. Figure 3 presents Europe's biannual average retail price for household and nonhousehold consumers since 2010. It shows that the price increase has been reflected in the retail market since the second half of 2021 and is particularly significant in the first half of 2022. Notably, however, the increase in retail prices has been of a lower magnitude than the increase in

Figure 2. Daily average of wholesale day-ahead electricity prices in Germany, France, Belgium, Spain, Portugal and the Netherlands in 2021 and 2022.



Source: Authors, based on data from ENTSO-E Transparency

Figure 3. Average retail electricity prices in Europe for household and nonhousehold consumers, 2010-2022 (first half).



Source: Authors, based on data from Eurostat (datasets NRG_PC_204 and NRG_PC_205)

wholesale prices observed during the same period. From 2020 to 2022, the average European retail price increased by 16% for household consumers and 52% for nonhousehold consumers. This increase in retail electricity prices occurred despite the price regulation reforms undertaken in different European countries to contain the crisis. These reforms include reducing the electricity tax and setting a cap on retail electricity prices.

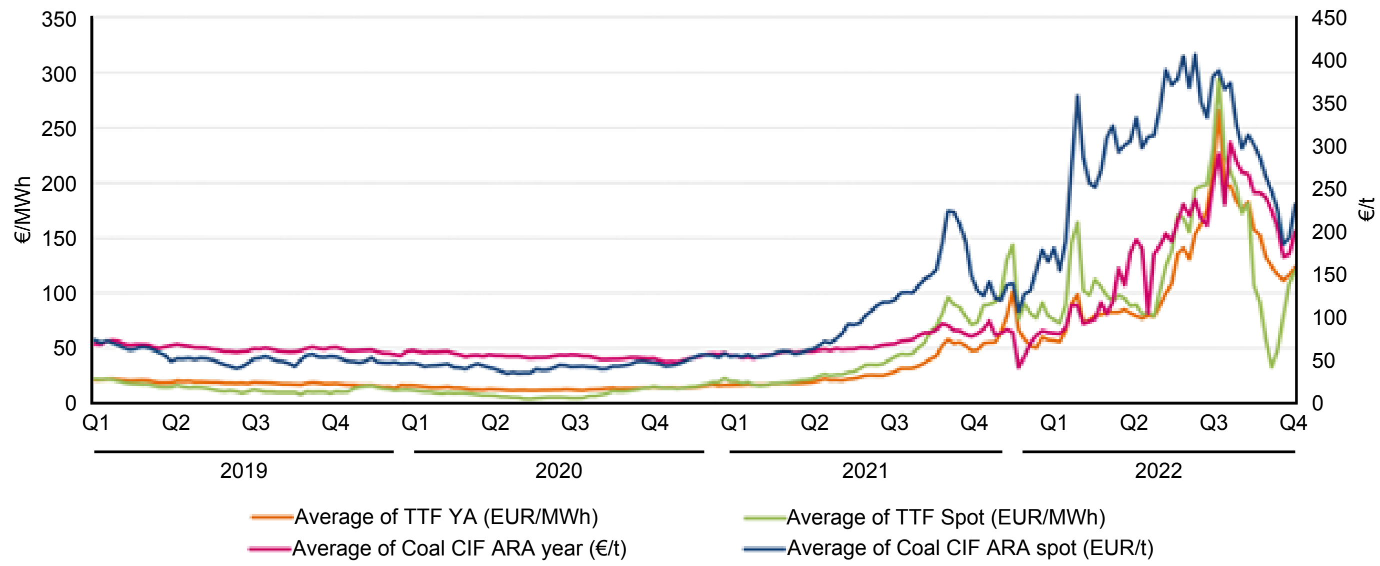
3.2 Drivers of the Crisis

The current situation in Europe has been widely discussed and analyzed to understand whether these unprecedented wholesale electricity prices (see Figure 2) should be attributed to poorly functioning electricity markets. This section highlights three critical drivers from the supply side. The primary driver is the shock in the European gas price that started in 2021 and continued in 2022 due to the Russian–Ukrainian conflict. Two other drivers were electricity generation from renewables and the French nuclear fleet.

Supply and its economic fundamentals have played a vital role in the current situation. At least three major supply events can be identified as the root cause of the current European electricity crisis.

First, the gas price has significantly increased in Europe, as shown in Figure 4, due to the gas supply shortage caused by the Russian–Ukrainian conflict. An increase in the gas price directly impacts the marginal cost of gas-fired power plants, which

Figure 4. Weekly evolution of spot and year-ahead gas and coal prices in Europe, 2019-2022.



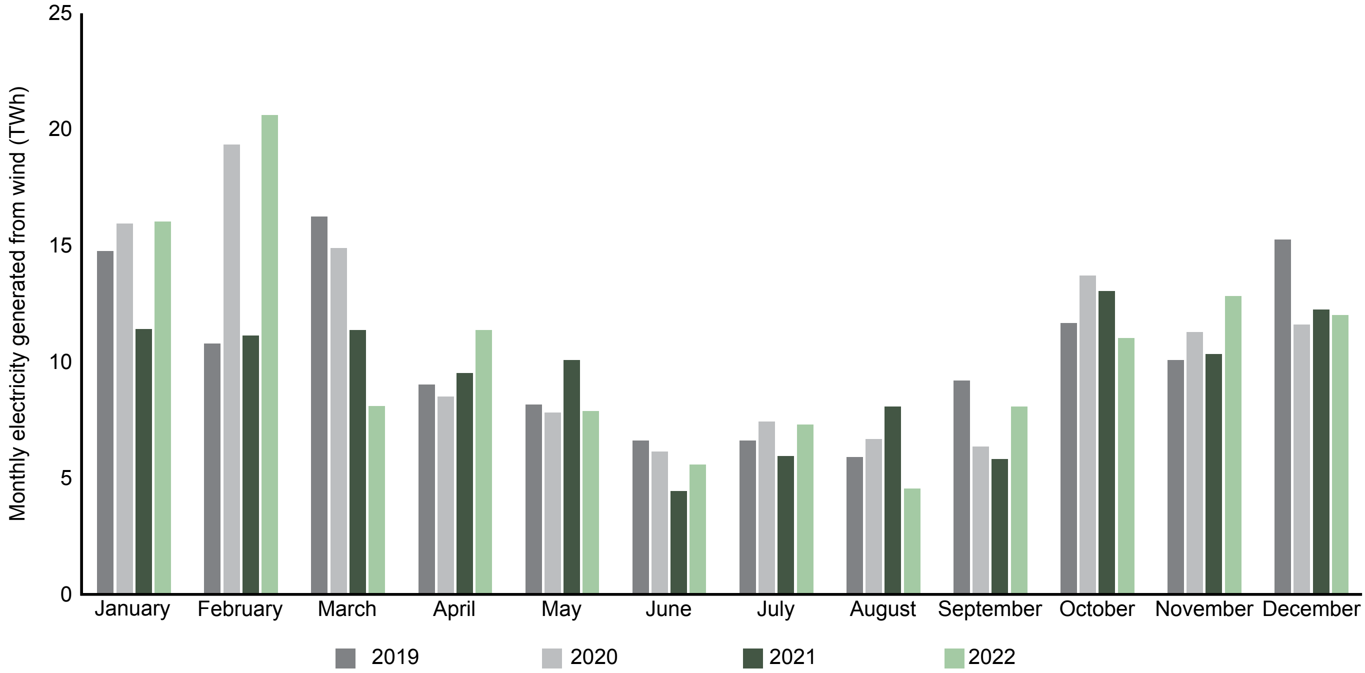
Source: European Commission (2022a). *Quarterly Report on European Electricity Markets*. 15, no. 3. Market Observatory for Energy. DG Energy. https://energy.ec.europa.eu/system/files/2023-01/Quarterly%20Report%20on%20European%20Electricity%20markets%20Q3%202022.pdf
Note: The gas price shown in the figure is the title transfer facility (TTF) price, which is traded in the Netherlands. The coal price shown in the figure is the cost insurance and freight (CIF) price traded in Amsterdam, Rotterdam and Antwerp (ARA).

is then reflected in an increase in the wholesale electricity price when gas units are marginal (i.e., the last technology necessary to meet electricity demand). This effect would have occurred whether renewables were in the energy mix or not; however, renewables may exacerbate this effect, as we discuss shortly. This first identified driver is only due to the marginal technology being gas or being indexed to gas prices, which is often the case in Europe. Based on data published by the French regulator (Commission de Régulation de l'Energie 2022), gas prices influenced the French day-ahead wholesale electricity price approximately 80% of the time in 2021.[5]

In addition, the 2021-2022 period has experienced a significant increase in the coal price in Europe, as shown in Figure 4. This increase has also contributed to increasing wholesale electricity prices, particularly in European countries with a significant share of coal in their energy mix, such as Germany and Poland.

Second, low electricity production from solar and wind in some periods could increase European electricity wholesale prices if the variation is significant enough to influence the marginal technology and, thus, the wholesale price. Figure 5 presents the annual electricity generated by wind in Germany from 2019 to 2022, showing that German wind generation was relatively low in June and July 2021 and August 2022. Weather analyses of 2021 (Bär and Kaspar 2022; Copernicus Climate Change Service 2021) have pointed out that Germany has experienced negative anomalies in wind and PV generation, up to –12% in the annual capacity factor for onshore wind compared to the 1991-2020 period. The low wind level observed in Germany and Europe in 2021 has influenced the European electricity mix. Nevertheless, it is

Figure 5. Monthly electricity volume generated by wind power (onshore and offshore) in Germany, 2019-2022.



Source: Authors; data from ENTSO-E Transparency.

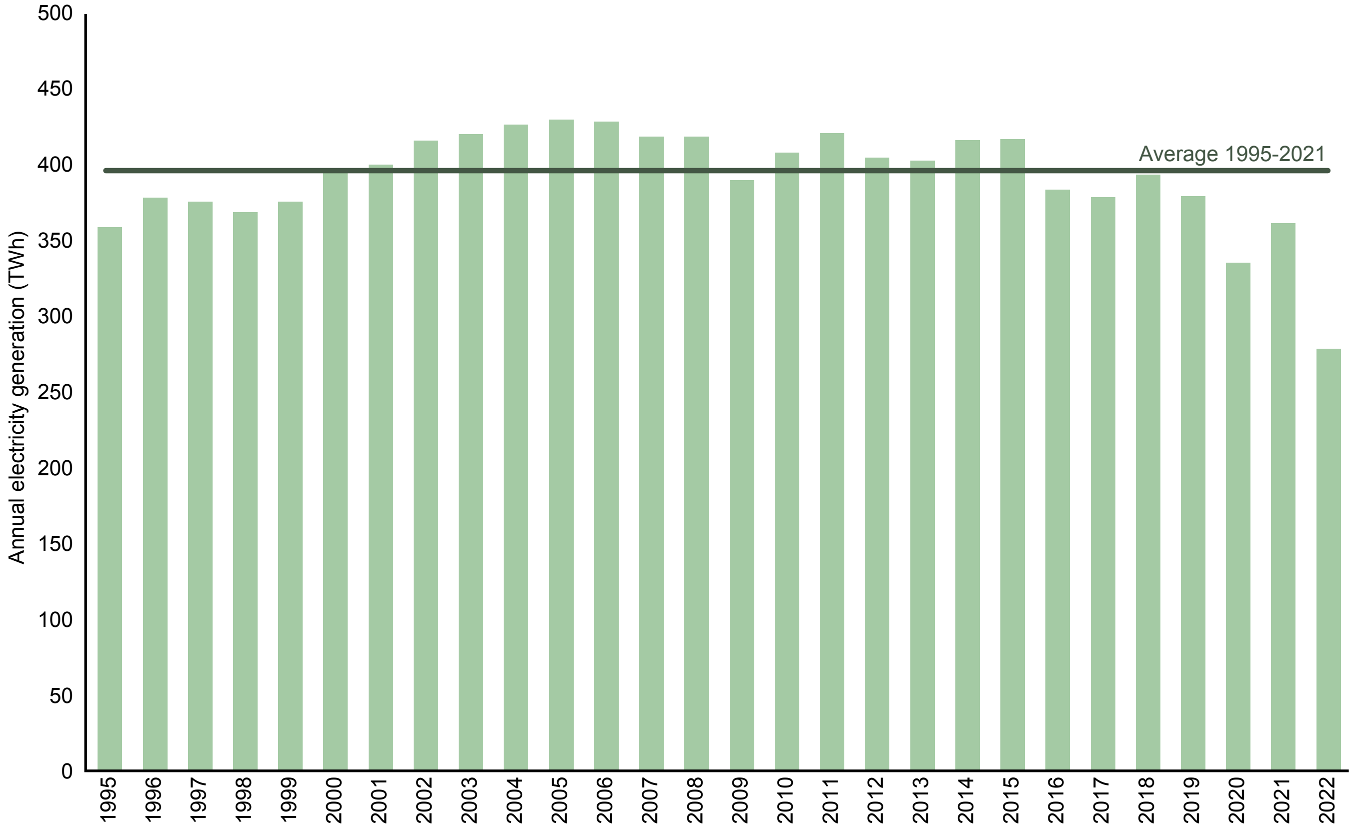
not sufficient to determine its effect on wholesale electricity prices since renewables are not often the marginal technology in Europe. A recent analysis of the relationship between European wholesale electricity prices and renewables concludes that the dampening effect of renewables is still limited, with an average decrease of 0.6% in wholesale prices for an increase of 1% in electricity generated from renewables (Cevik and Ninomiya 2022).

Third, the stress on European electricity supply has been further exacerbated by an unprecedented low availability of the French nuclear fleet in 2022. As presented in Figure 6 below, French nuclear generation was only 279 TWh in 2022, which corresponds to a decrease of 30% compared with the average over the 1995-2021 period (396 TWh). This decrease in nuclear generation is coincidental and not due to the poor design or functioning of European electricity markets. Instead, the decrease was caused by the need to shut down more nuclear generators than usual for their 10-year maintenance plans and for preventive corrosion controls (Tellier 2022).

In light of the facts above, electricity markets in Europe were operating exactly how they were expected to operate, and the current electricity crisis is explained by changes in supply. Indeed, when the input fuel price increases for the marginal generator, then electricity prices increase. If supply decreases, then electricity prices increase. These two implications are not a “shortcoming” of the wholesale market but, rather, a feature of this market. While we do not accuse “markets” of being the cause of the energy crises, we can still question whether the crisis could have led to different outcomes if the European energy sector followed another sector structure (e.g., a vertically integrated model or competition with a single buyer).

3. European Electricity Markets in 2022

Figure 6. Annual electricity volume generated by the French nuclear fleet, 1995-2022.



Source: Authors; data from Réseau de Transport d'Electricité (2023).

Designing and implementing a market design take time, and the market design cannot be changed instantly. Thus, the European energy crisis has led to finding short-term adjustments to contain electricity prices and to reopen the debate on the European electricity market design.

4. Levies to Contain the European Energy Crisis

The response of policymakers to the current European energy crisis was multifaceted. One of the first European actions was to reduce its dependency on gas imported from Russia as part of the new European strategy called "REPowerEU" announced in March 2022 (European Commission 2022b). Its key pillars are ***diversifying*** energy sources and suppliers, ***saving*** energy through energy efficiency and enhanced consumer behavior, and ***accelerating*** the energy transition to renewables. The "REPowerEU" strategy has also introduced many mechanisms to contain the crisis. As part of the solutions, Europe decided to use its Recovery and Resilience Facility, a financial instrument introduced in 2020 in the aftermath of the COVID-19 pandemic.[6] It includes precrisis funds and additional funds from the stability market reserve of the EU-ETS.

Second, European energy regulators are looking for solutions to limit energy prices for European citizens (Council of European Energy Regulators 2022). These solutions are being undertaken at the national level and are being coordinated and regulated at the European level. They include consumed electricity consumption, limiting energy bills for some or all citizens and collecting and redirecting extra revenues earned by some energy producers. Third, European energy stakeholders have started to review and discuss options to enhance the functioning of their gas and electricity sectors in the longer term.

4.1 Short-Term Adjustments to Contain the Crisis

To deal with the very high energy prices, European energy regulators are looking for quick and efficient solutions to contain energy prices for European citizens (Council of European Energy Regulators 2022). Some of the implemented and discussed measures directly affect the functioning of electricity markets. Short-term interventions, which some have been called "temporary relief valve" mechanisms (Agency for the Cooperation of Energy Regulators 2022), could remain part of the toolbox to respond to future energy crises in Europe or elsewhere (Agency for the Cooperation of Energy Regulators 2022; Hogan et al. 2022). Europe is not the first to consider such short-term interventions in electricity markets. For example, policies based on a similar logic are already in place in Texas ("peaker net margin" mechanism) and Australia ("cumulative pricing threshold" mechanism). This section briefly summarizes the short-term adjustments of electricity markets that some European countries have adopted since the start of the current energy crisis. Specifically, we focus on the impacts of the energy crisis on European electricity markets.

In Europe, these short-term interventions to contain the energy crisis have been decided at the state level but within the guidelines provided by the European Commission in October 2021 in its so-called "energy prices toolbox" (European Commission 2021). This toolbox focuses on (1) reducing the financial consequences for some or all consumers while avoiding grid disconnections; (2) reducing tax rates for specific consumers and shifting the taxation of renewables to nonelectricity products; and (3) facilitating and accelerating long-term contracts (under bilateral power purchase agreements (PPAs) or state auctions) to better hedge electricity prices for consumers and promote renewables. In the same document, the European Commission reaffirmed that accelerating the energy transition would solve this crisis and that deeper reforms of the European electricity markets (if any) would be carried out at the European level.[7]

In the following, we detail the two major short-term adjustments considered in Europe, namely, price caps and taxation of windfall profits. We intentionally focus on measures that directly impact wholesale market prices or revenues, and we do not discuss the other measures that provide direct financial support to consumers (e.g., introducing a one-time or regular financial help to all or specific consumers, reducing the tax on retail prices).[8] Clearly, most of the measures implemented to contain the crisis come with an additional cost borne by governments.

4.1.1 Price Caps on Wholesale Markets or Retail Prices

Imposing price caps on electricity prices has been discussed as one of the options to contain the consequences of the current energy crisis in Europe. Such price caps would help protect consumers from high electricity prices; however, lowering the wholesale electricity price cap is contrary to the European trend observed in recent years. Indeed, drawing on "energy-only" theory, there is neither a maximum nor a minimum limit[9] to the wholesale electricity price as per Article 10 of Regulation (EU) 2019/943 (European Commission 2019b). In this context, despite the energy crisis, no price cap on the wholesale electricity markets has been introduced at the European level. While pursuing the same goal of containing electricity prices, price caps have been discussed and implemented in the electricity retail market and in the gas wholesale market.

To limit the crisis and keep electricity affordable for end-consumers, retail price regulation through price caps or their equivalent has been implemented in almost all European countries (see Sgaravatti et al. [2023] for a review). For example, in November 2022, Germany approved a cap on the retail electricity price for 70%-80% of electricity consumption. Effective from 2023, the German retail electricity price cap is set at 400 euro/MWh for households for up to 80% of their 2022 consumption and to 130 euro/MWh for industries for up to 70% of their 2022 consumption (Wehrmann 2022). Retail price regulation also includes reducing the tax on electricity. For example, France has reduced one[10] of the taxes on household electricity prices from 22.5 euro/MWh to 1 euro/MWh (Article 64 of law 2022–1726) for the 2022-2024 period, which is the minimum tax level imposed by European legislation.

Another option is to impose a price cap on the wholesale gas market rather than the electricity market. Having a cap on the gas price would also automatically limit prices on wholesale electricity prices, given that the gas price is capped for electricity generators and gas is typically the marginal fuel. The cap could apply to all gas in Europe, and it could also be limited to Russian gas (Ehrhart and Schlecht 2022; Weder di Mauro and Martin 2022). Alternatively, it could apply only to the gas used for electricity generation (Roeger and Welfens 2022).

Since the beginning of the crisis, Spain and Portugal have been in favor of imposing a gas price cap on electricity generators. The European Commission approved the temporary gas price cap (the so-called "tope al gas") imposed in these countries in June 2022 for a maximum duration of one year (European Commission 2022c), with an initial price cap set at 40 euro/MWh for the first six months and linearly increasing to 70 euro/MWh. With this price cap, the Spanish government has agreed to compensate power generators for any losses that they may incur due to the price cap. Because of the price cap, electricity wholesale prices have remained low in the Iberian Peninsula compared with other European countries, as illustrated in section 2. However, this market intervention in the Iberian Peninsula was probably made possible by the low level of interconnections between this region and the rest of Europe, where the measure is not implemented but would bring subsidy leakage issues[11] if applied at a larger scale (Maurer and Hirth 2022; Schlecht et al. 2022).

Later, a gas price cap on the European gas hub was decided at the European scale. In December 2022, the European Commission agreed to implement a price cap of euro 180/MWh on the TTF gas market. The cap implemented starting in mid-February 2023 and will remain in place for a year.

4.1.2 Taxing Windfall Profits

Beyond price caps, policymakers can adapt their taxation of companies' profits to collect part of the profits considered windfall due to the crisis. Whereas a price cap affects the price that consumers pay and, therefore, their consumption at the margin, a windfall tax retains the high marginal price incentives. The windfall tax can be rebated to consumers and thus improves consumers' utility. Taxing windfall profits has been discussed in Europe for so-called "inframarginal" electricity generators, i.e., those generators that are not setting the wholesale price (renewables, nuclear, coal, etc.).

In December 2022, Germany approved a law to collect 90% of earnings above a threshold defined in euro/MWh applicable to inframarginal technologies (solar PVs, wind, nuclear, coal lignite and oil). The German windfall tax applied for 10 months, backdated to start in September 2022 and could be extended to the end of 2024 (Delfs and Kowalcze 2022). Table 1 presents the thresholds above which the German windfall tax is applied. For renewables, the threshold has been set to cover a cost benchmark plus a margin of 30 euro/MWh. This measure is likely to dampen hedging and thus negatively impact forward electricity markets and the PPAs whose prices are above the threshold (Montel 2022).

When renewables first entered the power sector, many governments provided them with generous financial support and other types of support. Financial incentives included investment credits and feed-in-tariffs, while other forms of support included dispatch priority to minimize energy curtailment and/or dumping. These support mechanisms encouraged investors to enter this market. With this cap under consideration, the appetite for investment in renewables could be negatively impacted. The targets for RE penetration in all international scenarios are ambitious, and the private sector is a crucial contributor to these targets. Hence, any cap should be carefully chosen to support the global transition.

Table 1. Earnings threshold above which the German windfall profit tax is applied for electricity producers.

Technology	Threshold above which the 90% tax is applied
Solar PVs	130 euro/MWh
Wind	130 euro/MWh
Nuclear	130 euro/MWh
Coal lignite	82 euro/MWh
Oil	280 euro/MWh

Source: Data from Delfs and Kowalcze (2022).

4.2 Reform of the European Market Design

European energy stakeholders have started to review and discuss options to enhance the functioning of their gas and electricity sectors in the longer term. Since the beginning of the European crisis, a flourishing academic literature has proposed various options to enhance or reform the European electricity market design (Ambec et al. 2023; Anatolitis, Azanbayev, and Fleck 2022; Batlle, Schittekatte, and Knittel 2022; Glachant 2022; Newbery 2023; Pollitt et al. 2022; Schittekatte and Batlle 2023). While there is a consensus on the need to keep short-term electricity markets to optimize electricity dispatch, economists have proposed various long-term contracting mechanisms. This idea of long-term contracts is not new to the literature. For example, it was discussed by Roques and Finon (2017) under the wording "competition *for* the market," to be added to the existing "competition *in* the market." However, if this discussion was motivated mainly by the need to better allow investments in electricity generation similar to the motivations for capacity mechanisms, the emphasis has shifted to enabling longer-term hedging to better protect consumers from price volatility.

On the implementation side, in January 2023, the European Commission launched a public consultation on its electricity market design (European Commission 2023b). In March 2023, the European Commission released the outcome of this consultation in its proposed "reform of the EU electricity market design to boost renewables, better protect consumers and enhance competitiveness" (European Commission 2023a). This document confirms the lessons learned from the European crisis, leading to some enhancements in the current electricity market design; however, it does not propose deep changes to the market design.

Following the same trend as precrisis, the proposed reforms are guided by a consumer-centric approach, where retail competition is maintained but complemented by additional measures to decouple the retail price from wholesale prices. More importantly, the document does not favor any options debated by academics and policymakers. Instead, it lists the different options and lets member states select what seems most suitable to them. Consequently, we can expect to see various long-term market designs emerging in Europe similar to the various capacity markets in place. However, every mechanism will continue to be assessed under the European State Aid legislation and guidelines. The main market design reforms being considered in Europe include hedging obligations for suppliers, enhancing contracts for differences for renewables and facilitating long-term PPAs. The debate is particularly heated regarding whether long-term contracts should arise from a central entity or be left to private bilateral negotiations.

5. What Can We Learn From the European Energy Crisis for the GCC?

The reforms discussed or proposed in Europe can be used to learn several lessons for the electricity sector globally. One lesson that has been reaffirmed is the crucial notion of security of supply.[12] Lessons from the European energy crisis can be tailored to every type of power system, whether liberalized or not. After briefly describing the power system structure in GCC countries, we present key focus points for the power sector reforms pursued in this region specifically.

5.1 Overview of the Power Sectors in the GCC

Historically, the power mix of the GCC heavily relied on liquid fuels, and it still does. In 2020, the share of electricity produced from fossil fuels (oil and gas) was more than 95% in Saudi Arabia, the United Arab Emirates and Kuwait (International Renewable Energy Agency 2022a). However, GCC countries have started to develop renewables, mainly solar, and have announced ambitious renewable targets for the future. In 2021, wind and solar installed capacity reached 3.5 GW in the GCC (International Renewable Energy Agency 2022b). For 2030, GCC countries have set targets to increase renewables up to 50% of their electricity mix: 50% in Saudi Arabia, 44% in the United Arab Emirates and 30% in Oman (Al-Sarihi and Mansouri 2022).

Contrary to Europe, most power sectors in the GCC are structured around a state-owned VIU. As in all countries with or without electricity markets, the electric utilities established in the GCC use optimization models to decide how to use existing generation units. These models follow the merit order principle just like liberalized electricity markets do but with administratively set fuel prices. To maintain the reliability and stability of the power system, the merit order also considers physical constraints such as transmission, must-run generators, reserves, and the ramping of generators.

For the sake of cost efficiency, most GCC countries have also established independent regulatory authorities. For example, in Saudi Arabia, the regulatory authority in charge of the power sector was created in 2001 (Hasan, Al-Aqeel, and Peerbocus 2020). GCC countries have also started to reform their power sector by adopting a single-buyer market structure and introducing independent power producers to compete on electricity generation (Poudineh, Sen, and Fattouh 2021). Oman has gone a step further in the liberalization process and launched the first electricity spot market in the GCC in January 2022 with the aim of increasing its efficiency of electricity procurement (Reuters 2022).

However, GCC countries can still design their power systems in line with their renewable ambitions and other goals (e.g., liquid fuel displacement, rural electrification, electricity trade, financial health and economic diversification) while necessarily deregulating their electricity sector. For example, they can implement hybrid structures by combining short-term coordination through single-buyer or spot markets with long-term contracts (Poudineh, Sen, and Fattouh 2021). While Europe and other Organisation for Economic Co-operation and Development (OECD) countries have faced challenges incorporating decarbonization goals after having liberalized their electricity sector, GCC countries can learn from worldwide experience to better plan their reforms and their energy transition at the same time.

5.2 Key Focus Points for the Power Sector Reform Endeavors of the GCC

The ongoing European energy crisis has reverberated in the GCC. Notably, GCC countries are still in the process of reforming their power sectors. We propose four main lessons for the GCC in its process of reforming power sectors while achieving an energy transition.

First, strategic and well-timed policy intervention is essential for fostering a conducive environment that encourages investor participation and boosts market confidence. Furthermore, any policy intervention should ideally rectify the current challenges faced and, simultaneously, not impact previous policies enacted. In many instances, a policy intervention occurs as a response to an inefficiency, a bottleneck, or a major incident that occurs. When this intervention happens, policymakers should adopt appropriate and targeted measures and ensure that any previous policies enacted will not be impacted (or impacted to the lowest extent possible). Here, the challenge arises from the possibility that every policy intervention may lead to unforeseen technological or market developments at a later stage. As a result, policymakers can find themselves in a cycle of continuously enacting policies to fix the implications of previous policies (Hoppmann, Huenteler, and Girod 2014). Liberalized power systems, such as the European system, can easily fall into the trap of continuously changing policies, which is detrimental to investors and electricity cost optimization.

Second, if regulated correctly, VIUs, as they exist in the GCC, could provide regulatory leeway and a central planning advantage to realize the future aspirations of the power sector. Specifically, the literature and examples are not clearly conclusive on the strong relationship between a sector's structure and its efficiency (Chao, Oren, and Wilson 2008; Delmas and Tokat 2005; Kaserman and Mayo 1991), and thus, VIUs should not be underestimated in achieving efficiencies compared with completely liberalized models. Hence, a well-regulated vertically integrated model could enhance efficiency and minimize price fluctuations, depending on the country's specificities and its policy objectives. Such a vertically integrated structure can also facilitate the central coordination of generation and network planning, which constitutes a key enabler of the success of energy transitions. Additionally, VIUs can help in managing risks and uncertainties. Indeed, the European crisis has raised the question of whether its power system and how its electricity markets work could have been better prepared and could have been made more resilient to supply shocks. These extreme events can include shocks to electricity supply (e.g., unavailability of generation units), shocks to fuel (e.g., fuel availability or fuel price), extreme weather events, and cyberattacks. GCC countries can foster a conducive electricity sector that encourages investor participation even without deregulation.

Third, long-term contracts for power generators can continue to play a key role in the GCC to serve the interests of both consumers and investors. Such long-term agreements help in managing costs and achieving the energy transition objectives defined in a country's vision, but competitive auction mechanisms and well-designed contracts are key to their success. Additionally, long-term contracts effectively fix prices for extended periods, making an efficient pricing mechanism crucial. The ultimate goal is for PPAs to protect consumers from price spikes and to simultaneously secure a reasonable return for investors. On the other hand, PPAs may prevent investors from earning potential higher revenues and consumers from benefiting from potential lower prices.

Today, GCC countries mainly implement PPAs through contracts signed with a national entity and awarded through auctions. However, there are many types of long-term and shorter-term contracts that can be used for new or existing assets. There are also numerous approaches to designing these contracts (e.g., various auction types, "open-window" programs, private bilateral agreements). The GCC could benefit by implementing one or a combination of available contracts. Specifically, PPAs between power generators and private industries could be further developed and would help in accelerating the pace of the region's energy transition. They may also allow industries to decarbonize their energy mix based on their ambitions while simultaneously helping to reach national goals. To do so, regulations and financing conditions should be adapted or enhanced to allow and facilitate private PPAs.

Long-term contracts should be developed with an efficient contract design from the auction process (if any) to the contract definition. Such contracts should trigger investments while ensuring cost efficiency. The European experience highlights that contract design is not necessarily easier than market design. Both private PPAs and centralized PPAs auctioned at the national level should articulate the rules to be applied in each possible future situation. For example, PPAs corresponding to a market premium given in addition to wholesale prices should deal with high or low wholesale prices. Long-term contracts should also be defined based on the proper product, i.e., MW or MWh, with the relevant time profile to meet the goals of investors and customers. They can also include a hybrid portfolio of technologies (for example, solar PVs combined with storage).

Fourth, the energy transition must maintain an adequate level of energy security that is not to be compromised. While energy security (and fuel supply security) has always been a priority, the European crisis has made the topic of energy security even more important. The European experience also suggests that energy security, from a practical perspective, has taken precedent over environmental aspirations. Energy policies should enable energy diversification to enhance reliability. All viable options should be considered, such as renewables, nuclear power, the carbon capture of emissions from power plants, the digitalization of the power system, behavioral-based information, incentives to reduce demand, and the acceleration of energy innovation. Fuel supply management should be carefully considered, even if renewables account for a large share of electricity. To that end, the GCC, whose countries produce a sufficient fuel supply, has a crucial advantage. Given their abundant fuel supplies, these countries can plan and transition at a pace and a scale that make sense for them, given their climate commitments, the evolving trajectory of renewable and storage costs, and their economic development objectives, including the localization of energy transition-related industries.

6. Conclusions

The EU is facing an energy crisis that has caused a significant increase in natural gas and electricity prices since 2021. Wholesale electricity prices have surged, and retail prices have also started to reflect this trend. In response to this crisis, European policymakers have taken multiple actions. EU member states have already implemented immediate solutions to reduce energy prices for their citizens, including reducing electricity consumption, limiting energy bills for some or all citizens, and collecting and redirecting extra revenues earned by some energy producers. In parallel, supported by the European Commission, energy stakeholders have started to review and discuss options to enhance the functioning of European gas and electricity sectors in the longer term.

As the countries of the GCC continue to reform their power sectors and transition to clean energy, there are several lessons that can be learned from the European experience. Specifically, the current energy crisis has relaunched the debate on electricity market design, and several lessons can be identified. First, policy intervention should be appropriate and well timed to foster a conducive environment that encourages investor participation and boosts market confidence. Second, combined with targeted and timely policy interventions, well-regulated VIUs can bring significant advantages in achieving the future aspirations of the power sector, especially its aspirations regarding the global deployment of RE. In other words, GCC countries can foster a conducive electricity sector that encourages investor participation with PPAs and other market mechanisms, even within the existing framework of VIUs. Third, long-term contracts can play a key role in managing costs and achieving energy transition goals, but competitive auction mechanisms and well-designed contracts are key to their success. The GCC region should consider various contract types to benefit from these agreements; benefits could be achieved while simultaneously striking the right balance between investors and off-takers. Finally, energy security remains a top priority, and the GCC has an advantage in fuel supply and management while also progressing on the emission reduction front.

To successfully reform the power sector while achieving an energy transition, policies and regulations should be adapted or enhanced, and investments should be triggered through efficient long-term contracts. In summary, the GCC has a unique opportunity to learn from the European experience and implement policies and structures that will make its power sector more efficient, reliable, and resilient.

To conclude, power systems can operate in several ways, and their design can evolve. Their functioning is a means of achieving policy objectives such as low costs, economic development, energy security, and environmental improvements. The overarching lesson is that countries should pursue the type of power system structure that corresponds with their circumstances with complementary policies to help achieve their objectives.

Endnotes

[1] The United Kingdom is also experiencing an energy crisis. In response to it, the United Kingdom has undertaken solutions on its own that are not part of the solutions developed by the European Commission.

[2] The GCC includes six countries in the Arabian Peninsula: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates.

[3] A baseload product corresponds to electricity that is delivered for each of the 8,760 hours of a given year. For example, a calendar baseload product of 1 MW corresponds to 1 MWh being delivered each hour and, thus, 8,760 MWh being delivered over the year.

[4] A negative price reflects the need to shut down one or several conventional power plants to balance consumption and generation. Shutting down a power plant for a few hours can incur significant costs for generators.

[5] The 80% arises from the combination of three situations identified in the report: (1) gas technology is the marginal one in France, (2) reservoir hydrogeneration is marginal in France – its opportunity cost is indexed on the gas price, and (3) the price in France is set by a generation unit abroad, which is most likely to be a gas unit.

[6] Part of the "next Generation EU" plan, the Recovery and Resilience Facility includes grants and loans available to all EU member states to support investments and reforms with a focus on COVID-19 pandemic recovery and resiliency in general. More information can be found at: https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en.

[7] For an overview of the interventions proposed by policymakers and academics, see Heussaff et al. (2022).

[8] A tentative summary of all measures undertaken in the EU, the United Kingdom and Norway to tackle the energy crisis can be found in Sgaravatti et al. (2023). Their total cost estimates reach 657 billion euro for the EU, among which 265 billion euro is for Germany.

[9] In practice, there is a 3,000 euro/MWh limit on the electricity day-ahead market, with an automatic increase in the limit when reached based on the methodology defined by nominated electricity market operator (NEMO). The 2021-2022 energy crisis has led to a review of this methodology to limit the frequency of the cap increase, and a new version was approved in January 2023.

[10] This tax is called "taxe intérieure sur la consommation finale d'électricité."

[11] Indeed, when electricity flows from Spain to France, France may benefit from the subsidies implemented in the Iberian Peninsula to compensate generators that may face losses due to the price cap.

[12] This point can be exacerbated when there a large share of intermittent and variable electricity generation from renewables without sufficient energy storage. Indeed, electricity generated from wind and solar may change significantly from day to day, month to month or year to year.

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Notes

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About the Project

This paper is part of the “Innovations in electricity markets, network regulations, low-carbon investments and technologies” project under KAPSARC’s Energy Transitions and Electric Power program. This project aims to provide insights into the transformation of the Saudi electricity sector. This transformation is characterized by a willingness to increase the share of renewables and to replace liquid fuels with natural gas. It must also ensure fiscal balance, expand electricity exports, produce green hydrogen and diversify the Saudi economy through localization. This project provides insights into this transition by discussing and learning from electricity markets worldwide.

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