ESCP
BUSINESS SCHOOL

IT ALL STARTS HERE

BERLIN | LONDON | MADRID | PARIS | TURIN | WARSAW

LIGHTS - Eco/Geopolitics

The European electricity market: Past crisis and future prospects - What lessons to draw?

ESCP Impact Paper No.2024-37-EN

Hamed GHIAIE & Olivier LABORDE
ESCP Business School

ESCP RESEARCH INSTITUTE OF MANAGEMENT (ERIM)

ESCP Impact Paper No.2024-37-EN

The European electricity market: Past crisis and future prospects - What lessons to draw?

Hamed Ghiaie*
Olivier Laborde**

ESCP Business School

Abstract

Following the energy shock triggered by the invasion of Ukraine, the European electricity market experienced a surge in prices, exacerbating inflation and penalizing the economy. This period of instability revealed various dysfunctions inherent in the electricity market's architecture. Through this article, we will analyse the limitations of the current market and put into perspective the strategy pursued by the European Union. Finally, we will explore how to promote better price competitiveness in the current system and in a thoroughly reformed one.

Keywords: Electricity Market; Energy crisis; Energy transition; Electricity architecture; Gas and Geopolitical sensitivity

* Professor of Economics and Public Policy, ESCP Business School

**Alumni of ESCP Business School, promotion 2023

The European electricity market: Past crisis and future prospects - What lessons to draw?

The sharp increase in European electricity prices, starting from mid-2021 and amplified in 2022, has constituted a genuine wake-up call, repositioning the European electricity market at the center of future inquiries and challenges. This "crisis" in electricity prices marked a turning point compared to decades of cheap electricity and exposed the vulnerabilities of the European electricity market. However, electrification emerges as the primary means of decarbonizing the European economy by 2050, reaffirmed as a priority objective by the European Commission.

At the core of environmental issues, the electricity market also intertwines with decisive geo-economic concerns for the coming decades. Europe's ability to ensure stability and competitiveness in its access to electricity is vital for the economic sustainability of the continent. While electricity prices are currently experiencing a slowdown, it would be perilous to forget that many of the vulnerabilities evidenced by the energy crisis persist.

What lessons can be drawn from the past crisis, and what coherent electricity strategy can be devised to address multiple challenges and strengthen the stability and competitiveness of electricity in Europe?

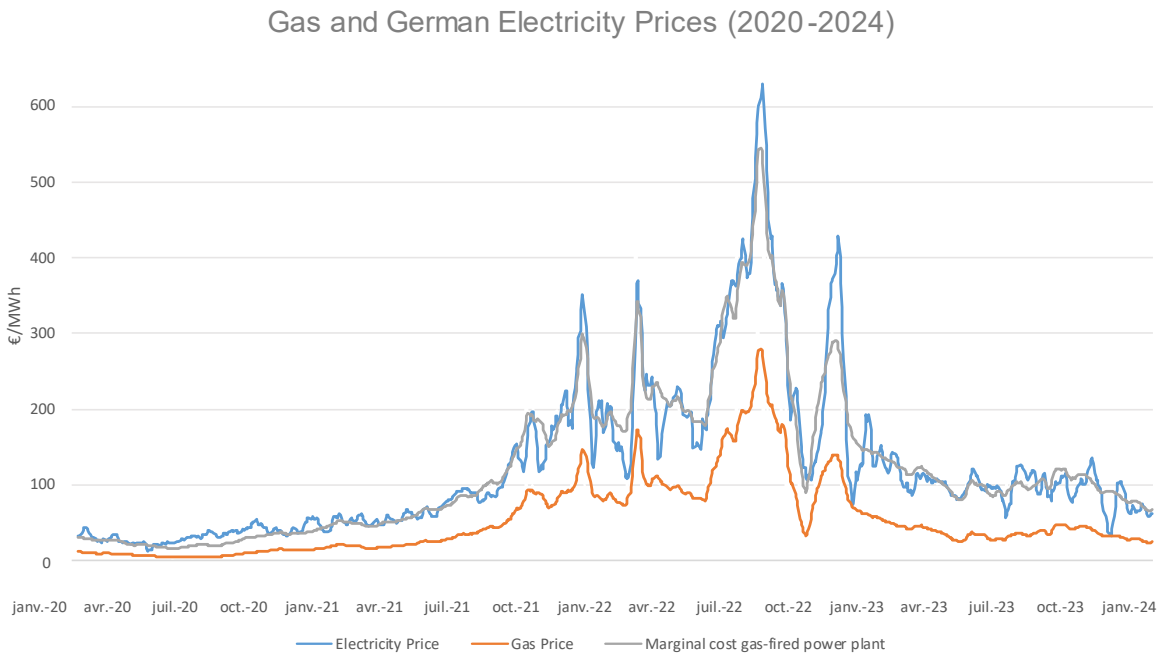
An electricity market tied to gas prices

Historically, gas and electricity experienced a period of low prices (contained below the €25 to €50/MWh range between 2010 and 2020), somewhat obscuring the relationship between these two markets. The European energy crisis, from its onset in June 2021 until the winter of 2022, starkly revealed the strong correlation between gas and electricity prices in Europe. Under the pressure of reduced gas supply from Russia and limited availability of other electricity production methods, electricity prices soared to stratospheric levels. Overall, electricity market prices more than tripled in France and Germany between 2020 and 2021 and multiplied by approximately 7.5 and 8.5 respectively between 2020 and 2022.

This economically unsustainable situation for both households and businesses prompted states to implement numerous "price shields" on electricity, as Germany did at an estimated cost of €13 billion for the year 2023 alone.

Between 2021 and 2022, the correlation between gas and electricity prices was nearly perfect, with respective correlation rates of 0.92 and 0.94 for Germany and France (daily correlation between day-ahead ENTSOE-E electricity price & TTF, Refinitiv). The European Council's findings indicated that in over two-thirds of cases (from 2021 to 2022), the entire electricity market reflected the cost of natural gas because it was determined by the marginal cost of a gas-fired power plant.

This phenomenon of gas prices affecting electricity prices stems from the structure of the European electricity market, which combines two fundamental elements: the merit order and the strong interconnection of electricity networks between European countries. The merit order tends to align electricity prices with the marginal cost of the last plant used (which is also the highest of the mix used), often gas-fired plants, which play a crucial role in balancing supply and demand. The strong interconnection of electricity networks leads to price convergence across countries.



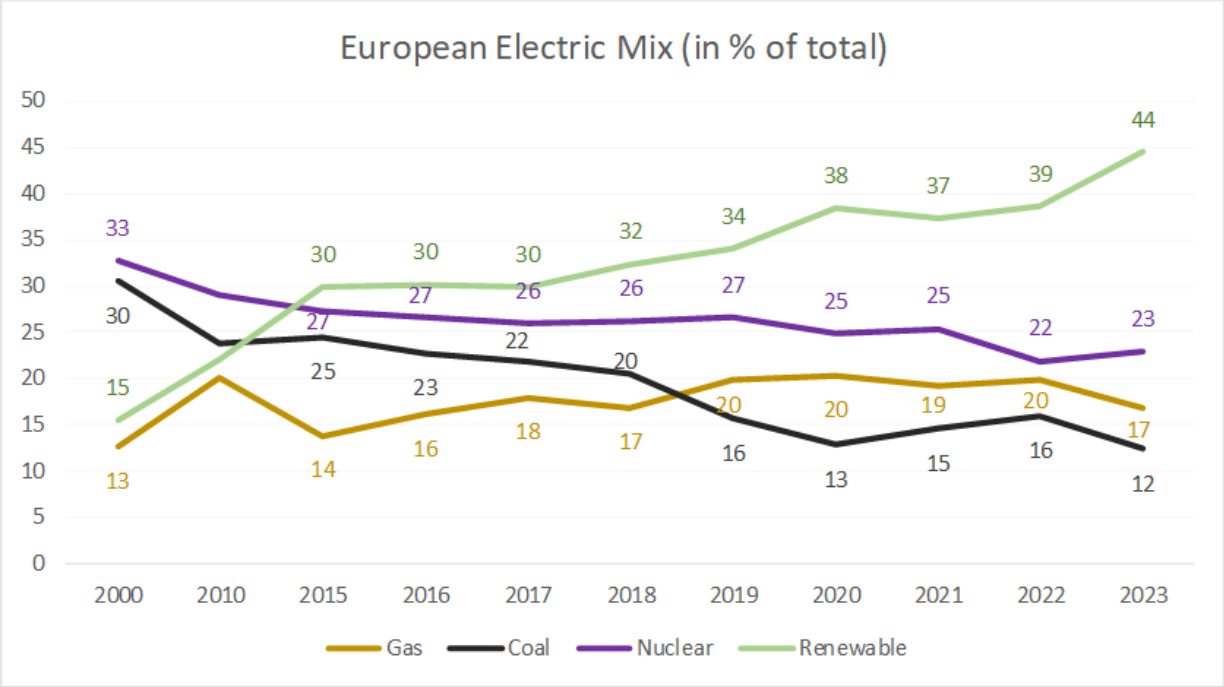
Note: Day-ahead electricity prices from ENTSO-E & Gas Price (TTF, Refinitiv). Daily fluctuations smoothed using a 7-day moving average. Marginal Cost computed using an average emission factor of 0.4T/MWh and an electricity generation efficiency from gas of 55%

Between 2023 and early 2024, the correlation between gas and electricity prices decreased due to increased nuclear production, reduced electricity demand, and greater use of renewable energies. However, gas prices continue to strongly influence electricity prices. In 2023, the decline in gas prices (TTF index) to around €40/MWh on average, compared to over €125/MWh in 2022, was accompanied by a significant drop in electricity prices, roughly halved over the period (in France and Germany). Furthermore, since the beginning of 2024 (1st quarter), the further decline in gas prices has led to unprecedentedly low electricity market prices since 2021 (around €65–70/MWh on average between January and March 2024).

The European Union's strategy

The long-term strategy pursued by the European Union has primarily relied on an objective of renewable energy development. It has been based on three main pillars:

- Creating large interconnected electricity markets through gradual liberalization and enhancing electricity exchange capacities between countries, facilitating more efficient integration of intermittent renewable energies into the electricity mix.
- Massive support for renewable energy development enabled by "off-market" guaranteed remuneration through fixed tariff systems (guaranteed purchase of electricity) or Contracts for difference (CfD).
- Introducing CO2 emissions allowances applicable to fossil fuel power plants, increasing their marginal costs. For example, with a €80/t CO2 emission allowance, the marginal cost of a coal-fired power plant increases by approximately €75–80/MWh and by €32–35/MWh for a gas-fired combined cycle plant.



Note: Data sourced from Ember Climate open-data

Regarding the electricity mix, these measures have had a significant impact, with intensified installation and production of wind and solar electricity across Europe. In 2023, renewable energies accounted for 44% of the electricity generated in the EU, with solar and wind contributing 27%. Concurrently, the share of carbon-based electricity decreased from 37% to 33% between 2020 and 2023 in the EU.

The emphasis on renewable energy and the phasing out of coal nevertheless entail an implicit trade-off: the reliance on gas-fired power plants to address the intermittency of solar and wind energy. Presented as a transitional energy source, gas serves as a crucial cornerstone for grid balancing, and is expected to remain indispensable for numerous years.

In terms of competitiveness, opting for gas exposes the price of electricity to the volatility of global markets and geopolitical instabilities, exemplified by the Ukraine invasion. Furthermore, the increased reliance on liquefied natural gas (LNG), accounting for 37% of EU consumption in 2023 compared to 19% in 2021, to compensate for the decline in Russian gas imports, results in a premium associated with transportation, processing, and infrastructure costs. Europe currently incurs higher electricity costs compared to its direct competitors. For instance, in 2023, electricity was traded at an average of approximately €60/MWh *(ICE historical wholesale market data)* in the United States versus €96/MWh in Germany.

What is the trend for electricity consumption in Europe?It's noteworthy that electricity demand has reached historically low levels over the past two years. In the European Union, electricity consumption decreased by 6.4% between 2021 and 2023, with even steeper declines of 8.1% in France and Germany.

This decrease primarily stems from three factors:

- A significant reduction in industrial production, particularly in electro-intensive industries such as chemicals, petrochemicals, steel, paper, and pulp, largely due to high

energy costs. According to the IEA's 2024 report, electricity prices in the EU remained approximately 50% higher than in China or the United States for electro-intensive industries. For instance, 30% of primary aluminum production lines have been halted in Europe since 2021 as electricity accounts for 40% of its production costs.

- Increased energy efficiency and savings efforts promoted by governments due to concerns about energy supply (winter 2022-2023) and rising electricity prices.
- Milder winters (2023 was the second warmest year ever recorded in Europe).

While some of these factors may persist, electricity demand is expected to stabilize before increasing again due to industrial recovery. Furthermore, increased electrification will start a new era of rising electricity consumption. While still at its beginning, the substitution of thermal engines with electric motors in transportation, followed by the electrification of the most polluting industries, and the ever-growing demand for data centers, are expected to increase electricity usage. The example of the electrification of one of France's most polluting sites is characteristic: in Dunkirk, ArcelorMittal's steel plant will replace a coke (coal) blast furnace with an electric furnace, nearly tripling the site's electricity capacity from 300MW to 800MW, almost equivalent to the power output of an average nuclear reactor.

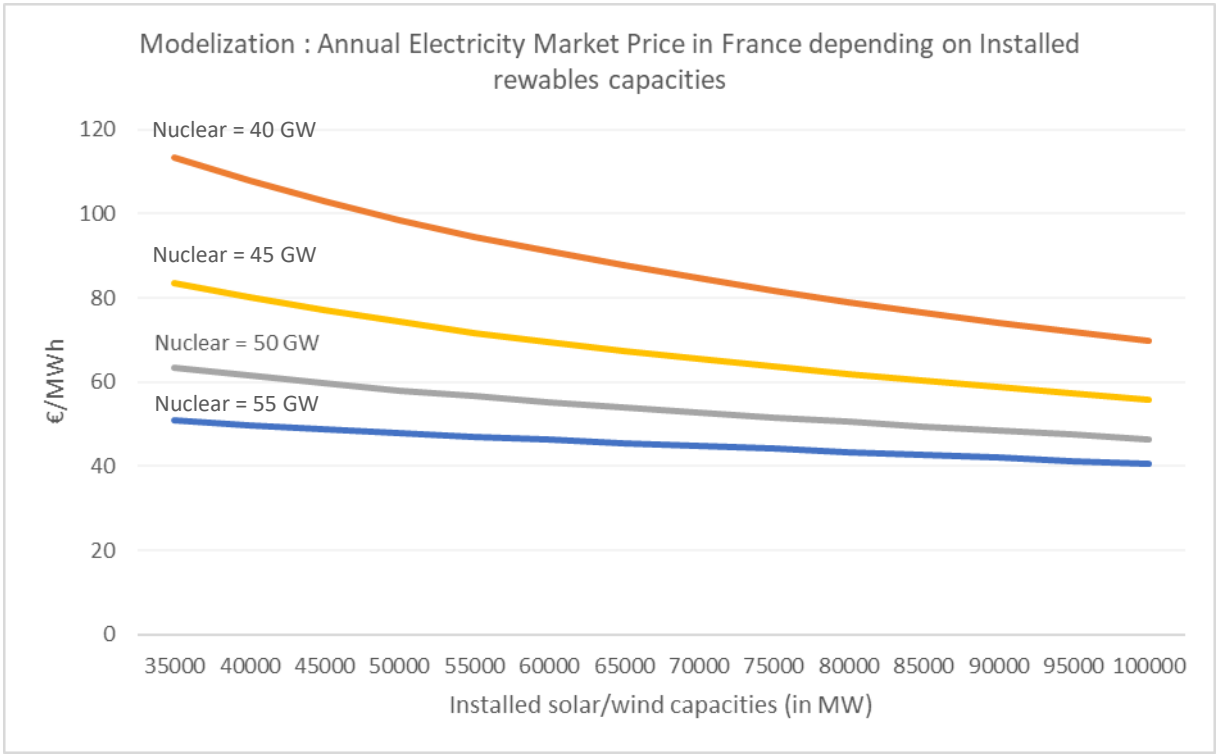
If Europe is willing to retain its key industries and achieve its energy transition, it cannot hope for a long-term decline in electricity consumption. Instead, it must ensure abundant, decarbonized, and affordable electricity in the medium to long term to promote the transition to electric power over traditional fossil fuels.

How to enhance the competitiveness of European electricity?

As in the current model, the price of electricity is determined by the marginal cost of the last unit required, there are schematically few means to lower the price of electricity. This involves reducing the use of units with the highest marginal costs by either decreasing electricity consumption or increasing the supply of units with the lowest marginal costs.

This last point entails an accelerated modification of the electricity mix by favoring sources with the lowest marginal costs, namely renewable energy and nuclear power. Modeling studies indicate that expanding solar/wind capacity and nuclear power reduce market prices but in different proportions. Indeed, the impact of nuclear power on market price reduction is significantly more substantial, given its dispatchable nature, allowing for the substitution of gas/coal-fired power plants throughout the year. In contrast, solar/wind units merely decrease the average utilization of gas/coal-fired plants, with the latter remaining necessary at numerous intervals to address their intermittency.

In this regard, increasing nuclear production alongside renewable energy sources emerges as a priority to enhance Europe's electrical competitiveness and reduce sensitivity to gas prices. The urgency of bolstering nuclear capacities becomes increasingly apparent in light of the aging nuclear power plants across Europe and the impossibility of indefinitely extending their lifespans. In the broader context, the long-term energy security of Europe is at stake, with the capacity to address both periods of renewable energy underproduction and geopolitical threats impacting commodity prices.



Note: Simulation based on end-of-2022 French Electricity Mix stand-alone. Annual Price corresponds to the hourly monthly simulated price weighted by consumption. Price is determined by the marginal cost of the last unit used to balance hourly demand. Emission factors from ADEME. Hypothesis of average solar & wind power based on actual annual average. Market Prices hypothesis applied to calculate Marginal Costs of fossil plants

Parameters	Market Prices
Gas	36 €/MWh
Coal	121 €/t
Fuel oil	700 €/t
EU Carbon price	85 € t/CO_2

Moreover, a comprehensive reform of the European market must be undertaken in the long term. The current pricing model creates a distortion between the cost of electricity production and its price. In the perspective of a complete transition away from fossil fuels, it seems inconceivable for electricity prices to continue to be influenced by an increasingly smaller proportion of fossil fuels. What coherence is there for a wind or solar energy producer to have their electricity market price indexed to that of gas/coal and paradoxically to the carbon price? The decoupling between electricity market prices and the actual production costs for renewable energies (and soon nuclear) also compels public authorities to guarantee revenues (and compensate losses) for these producers. And the lower electricity market prices drop, the heavier the burden on public authorities becomes. The generalization of CfD contracts clearly demonstrates the market's inability to provide decarbonized electricity and prepare for the future without government support.

These factors represent arguments for a return to a more planned and, dare we say, regulated electricity market in which the cost of electricity is based on its production cost. All means of production are necessary (wind, solar, nuclear, gas, etc.), and the final price paid

by the consumer must reflect the cost of all means and not just a decreasing fossil proportion.

Conclusion

The structure of the European market has led to a double contagion effect: the transmission of fossil fuel market prices to the electricity market and the interconnection-induced contagion among national electricity markets. In practice, electricity market prices remain heavily influenced by gas prices, thus exposing economic agents to global price volatility and contributing to a disadvantageous electricity price compared to their competitors.

The European strategy has long been based on full support for renewable energies. However, renewables cannot fully replace carbon-based energies due to their intermittency, and implicit reliance on gas-fired plants. Under these conditions, the increase in nuclear production demonstrates the most significant effects in terms of lowering market prices to enhance Europe's electrical competitiveness. In this regard, the current reform of the European market unlocks the resurgence of nuclear power by facilitating the financing of new reactors.

In the longer term, reform appears necessary to align the price of electricity with the average production cost of all means in order to both enhance price competitiveness and reduce sensitivity to fossil fuel prices.

References

CEA. (2023). *Projet de réforme du marché de l'électricité*. https://www.cea.fr/Documents/positions-cea-UE/2023-02-reforme-marche-electricite.pdf

EMBER. (2023). *European Electricity Review 2023*. https://ember-climate.org/insights/research/european-electricity-review-2023/

EMBER. (2024). *European Electricity Review 2024*. https://ember-climate.org/app/uploads/2024/02/European-Electricity-Review-2024.pdf

Fabra, N. (2023). *Reforming European electricity markets: Lessons from the energy crisis* https://www.sciencedirect.com/science/article/pii/S0140988323004619?ref=pdf_download&fr=RR-2&rr=872d52bc2a53020c

Faucheux, I. (2023). L'électricité dans la transition énergétique. *Revue de l'énergie*. https://www.annales.org/re/2023/re-janvier-2023-introduction.pdf

Ferrand-Trotignon. (2023). *La crise énergétique bouscule l'économie de l'Europe et de la France*. https://www.cairn.info/le-demeter-2023--0011662119-page-185.htm

Fortin, P. (2024). *Comment ArcelorMittal va décarboner la plus grande aciérie de France à Dunkerque ?* https://www.lesechos.fr/weekend/planete/comment-arcelormittal-va-decarboner-la-plus-grande-acierie-de-france-a-dunkerque-2083352

Guillou-Goldberg. (2023). *Décorréler les prix de l'électricité de ceux du gaz. Terra Nova*, 9. https://tnova.fr/economie-social/finances-macro-economie/decorreler-les-prix-de-lelectricite-de-ceux-du-gaz-mission-impossible/

IEA. (2022). *World Energy Outlook*.
https://www.iea.org/reports/world-energy-outlook-2022

IEA. (2024). *Electricity 2024. Analysis and forecast to 2026*

https://iea.blob.core.windows.net/assets/18f3ed24-4b26-4c83-a3d2-8a1be51c8cc8/Electricity2024-Analysisandforecastto2026.pdf

Laborde, O. (2023). *Le prix de l'électricité en Europe, dépendance au gaz et impact des énergies renouvelables* (on demand)

Solier, B. (2023). La nécessité de faire évoluer le modèle du marché européen de l'électricité. *Revue de l'électricité*.
https://www.annales.org/re/2023/re109/2023-01-06.pdf

Wholesale Electricity and Natural Gas Market Data
https://www.eia.gov/electricity/wholesale/