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# The reform of the European electricity market: a triple challenge

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The energy crisis has revealed the inability of the European electricity market organisation to meet the three challenges of decarbonisation, security of supply and affordable prices. This calls for structural reforms, which this Note outlines.

Following the invasion of Ukraine and in addition to the considerable impact of gas prices on electricity prices, the crisis highlighted the cross-border effects resulting from price caps on gas by certain countries and led to questions about the gas supply in Europe. Indeed, to prevent a sharp rise in consumer bills and, in France at least, to contain inflation, governments set up urgency measures. They nevertheless constitute subsidies to fossil fuels, which are incompatible with the objective of decarbonisation. Therefore, we need to adapt them by giving priority to controlling energy demand, gradually replacing the French tariff shield with more incentive-based and targeted measures and coordinating gas purchases at the European level.

In the medium term (2030), decarbonisation requires a radical transformation of the European and French electricity sector, due to the increase in electricity needs and the ageing of our nuclear power plants. The actual daily market plays its role effectively in balancing supply and demand in the short term, but it fails to ensure the needed transformation for three reasons: the structural deficit of remuneration of decarbonised investment in the electricity sector - aggravated by the insufficient level of the carbon price -, the importance of associated technological risks and demand uncertainty.

In addition to setting a floor price for carbon in the short term, we recommend creating a new business model for decarbonised technologies. To do so, we recommend to reorganise the electricity market by developing the use of long-term contracts: the remuneration of the volumes produced is guaranteed outside the wholesale market and large buyers can also act as insurers via bilateral contracts. Suppliers should also be subject to prudential rules and hedging obligations in order to better protect consumers. They must guarantee them tariffs on part of their consumption, while encouraging them make their demand more flexible.

Finally, this new market organisation requires a redefinition of the role of the public authorities, both at national and European level. Through enhanced coordination, they sould be able to plan and monitor the development of the energy mix. To achieve this, it is essential to bring together a multidimensional expertise mastering the many uncertainties hanging over the future.



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European wholesale electricity markets are currently under pressure due to excessive and extremely volatile prices. As the European Commission launches a public consultation on the reform of the organisation of the European electricity market in the first quarter of 2023, this Note considers two time horizons: in the short term, in the context of tensions arising from the war in Ukraine on gas supply and prices, and in the medium term (2030), in the context of a reformed market and the challenge of decarbonisation.

## Responses to the crisis consistent with long-term objectives

Since the summer of 2021, energy prices have experienced unprecedented peaks and volatility, with serious repercussions for economic actors in Europe. The urgency measures were intended to protect consumers' bills from sudden and unbearable increases and, in France, to contain inflation. They constitute nevertheless subsidies to fossil fuels, which are incompatible with the objective of decarbonisation. They must therefore be adapted according to three principles: control of energy demand, European coordination for gas purchases and support to decarbonisation.

### Controlling energy demand

The price signal is a powerful mean to curb energy waste: it encourages the search for leeway and plays an accelerating role towards the necessary sobriety. While the actual decline in consumption in some sectors, industries or professions suggests that the price elasticity of electricity consumption is still poorly known, it is certainly not zero. Research conducted before the crisis suggests that consumption is highly inelastic in the short term, but that over a one-year horizon, industrial consumption and, to a lesser extent, residential consumption are highly sensitive to price and income.[1] The price signal can usefully be complemented by administrative standards,[2] information campaigns and non-monetary incentives to change behaviour. These measures must be defined and planned collectively in order to deal with the gas crisis today and to move away from dependence on fossil fuels tomorrow. In addition, social and competitiveness issues must be addressed through appropriate instruments.

#### The limits of the tariff shield

The tariff shield implemented in France[3] responded to the emergency, but the untargeted capping of regulated household tariffs does not encourage a reduction in energy demand and effective peak management. This type of untargeted policy is very costly in budgetary terms and not very effective. Its continuation in a context of lasting crisis is not sustainable.

Above all, the imperative of demand management implies not capping the price of electricity for marginal consumption. It is clear that certain vulnerable groups whose consumption is constrained must be protected from price rises by targeted and specific measures. Nonetheless depriving all consumers of the incentive effects of the price signal is damaging. In Germany, prices are protected only for a part of past consumption (80%), the rest being delivered at market prices. However, such a mechanism must be temporary as it could encourage overuse of the electricity system at peak times: constrained on the volume of their consumption, users will probably consume electricity when they need it most (e.g. 6-8 pm). This argues in favour of flat-rate rebates[4] and not per kWh subvention, and a gradual replacement of the tariff shield by more incentive-based and targeted measures, such as energy vouchers to protect vulnerable households.

#### Limits to the generalisation of the Iberian mechanism

In May 2022, the European Commission granted a derogation to Spain and Portugal on the grounds that the Iberian Peninsula is poorly interconnected with the rest of the European Union (EU). In the so-called Iberian mechanism, the purchase of gas for electricity generation is subsidised: owners of gas-fired power plants receive compensation (financed by consumers) between a cap price and the market price, and then sell their electricity at a regulated price. This limits the equilibrium price on the electricity market and the rents of other producers, and ensures gains for consumers.

However, this mechanism is ineffective in reducing gas demand (and therefore its price on the markets) as it removes the price signal of gas for electricity generation. Even if the climatic conditions in Spain partly explain it (the drought in the summer of 2022 has considerably limited hydro power), an increase in gas consumption for electricity generation has

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[1] Csereklyei Z. (2020): «Price and income elasticities of residential and industrial electricity demand in the European Union», *Energy Policy*, No. 137, February.

[2] Ban on illuminated advertising, maximum heating temperature of 19°C, control of swimming pools and sports halls, etc.

[3] The increase in the regulated electricity tariff (TRV) has been limited to 4% in 2022 and 15% in 2023.

[4] These rebates would be deducted from the supplier's invoice so that the effect on purchasing power is taken into account in the price index (i.e. the subsidy is paid to the supplier who passes it on in the invoice).

been observed,[5] which has led to increased tensions on the market and to higher gas prices for all consumers.

A generalisation across Europe would exacerbate this effect. In addition, it would create a risk of leakage of subsidised electricity to non-contributing neighbouring countries. Furthermore, in terms of financing, Member States have different capacities to contribute depending on the role of gas in their energy mix. This is why we recommend avoiding any mechanism to cap the price of gas for electricity generation. Since the electricity system is subject to gas price volatility, it seems more appropriate to establish a permanent consumer protection mechanism, inspired by insurance mechanisms.[6]

## Promoting a European gas buyer

In addition to demand reduction efforts, European coordination of gas purchases is an effective way to contain the impact of gas prices on electricity prices and to address supply issues more broadly. The lack of coordination of European purchases could lead to a price spike when all European countries will need to replenish their stocks for the winter of 2023. Therefore, the creation of a European buyer must be an objective, to increase bargaining power, avoid congestion and damaging competition between buyers.[7]

A European agency could thus help coordinate the companies, collecting information from them on their short-term orders (quantity and places of reception of gas - regasification terminals) and sharing the elements of concern with the concerned gas importers.

We also propose to set up a Joint Purchase Board to aggregate the demand of European consumers and thus have more influence in negotiations with sellers - who also have an interest in stable and guaranteed levels of demand. This board would be made up of experts (representing one or more companies) in charge of negotiating collectively. For the importing countries, the risk would be low as their capital would be returned if the negotiations failed. In order to build confidence, European governments could test this joint purchasing committee in the current low-pressure environment, for a limited quantity.

**Recommendation 1.** Coordinate gas supply plans in Europe for the 2023 stocks refilling and set up a joint purchase commission.

## The European carbon market: a key part of the decarbonisation policy

Daily wholesale markets were designed to balance electricity supply and demand before real time. High prices at certain times are a sign that these markets are doing their job: reflecting the costs of producing electricity at each moment. They thus play a positive role in ensuring that, on a European scale, electricity demand is met at the lowest production cost. However, without the internalisation of all external costs (in terms of climate, health, technologies and network security), the optimisation achieved by the wholesale markets is partial and potentially illusory. The experience of the 2010s clearly illustrates this: because the ETS carbon price was particularly low, we have seen a rise in the production of electricity from coal to the detriment of gas based production, half less polluting. In other words, for wholesale markets to provide the desired balance, market and social merit orders must be much better aligned.

In this respect, the European carbon market is an essential piece. It must resist the calls for flexibility heard during the crisis. Indeed, an appropriate carbon price encourage coherent trade-offs between the use of gas and other fossil fuels, as the most expensive (i.e. polluting) power plants are the last called. Mechanically, it discourages the use of gas when its price is excessive and, conversely, to avoid an excessive return to coal, which would run counter to the challenges of decarbonisation. Moreover, the revenues from the auctioning of carbon emission allowances are reinvested in Europe – and not used to finance the war in Ukraine.

Today, the price of carbon in Europe is still too low to properly reflect the social cost of emissions.[8] However, a predictable carbon price enables the players in the electricity system to anticipate and to direct investments towards different technologies. It is also a prerequisite for the credibility and effectiveness of the adjustment mechanism at European borders. It is therefore urgent to set a floor price for carbon by drawing lessons from the successful experiment in the United Kingdom.[9]

[5] Hidalgo Pérez M., Mateo Escobar R., Collado Van-Baumberghen N., Galindo J. (2022): «Estimating the effect of the Spanish gas price cap for electricity generation», ESADE, September.

[6] Such a mechanism should provide for pre-defined compensation payments when the gas price exceeds certain limits in return for contributions when it is low. But it must be organised in a regulatory way, since it is not based on the market and must not prevent consumers from changing supplier.

[7] See Brunnermeier M. and Chassang S. (2023), «European Gas Market: Stakes, Priorities and Potential Solutions», *Focus,* No. 93, April.

[8] In recent months, the price has been fluctuating between €80 and €100 per tonne of CO2. The socio-economic cost of carbon emissions is more likely to be between €150 and €200/tCO2. See Rennert, K. et al (2022): «Comprehensive evidence implies a higher social cost of CO2», *Nature*, 610(7933), pp. 687-692, September.

[9] Leroutier M. (2022): «Carbon pricing and power sector decarbonization: Evidence from the UK», *Journal of Environmental Economics and Management*, vol. 111, issue C.

**Recommendation 2:** Set a dynamic floor price for carbon that reflects its social cost, at least €150/tCO2 today

The proposals that emerged during the crisis to "bypass" a wholesale market based on marginal cost pricing (see Box 1), which is held responsible for the coupling of gas and electricity prices, do not address the fundamental problems that the crisis revealed: on the one hand, Europe's over-dependence on gas for electricity production and its lack of investment in decarbonised technologies, and on the other hand, the predominance of short-term price signals from the daily markets.

## The triple challenge of decarbonisation, security of supply and affordability

The prospect of a structural reform of the European electricity market must be guided by the three key objectives of the integrated climate-energy policy, defined at European level

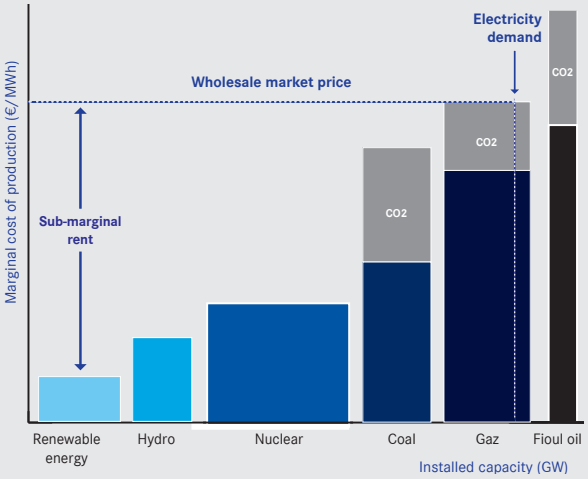
### Box 1. The functioning of electricity markets

While we often talk about the electricity market, one should stress that several markets have developed in the context of the liberalisation of the energy market carried out by the European Union since the 1990s. They have different characteristics, timeframes and ways of operating. Electricity is negotiated between the producers, who own the electricity generators, and the suppliers who buy the electricity from them on the wholesale market on an hourly or forward basis. The latter then deliver the purchased energy to households and businesses on the retail market.

Hourly markets: Due to the specificities of electricity, in particular its low storabilty, the wholesale markets are necessarily structured on an hourly basis: there must be a permanent balance between supply and demand, as an imbalance would lead to a disruption of the electricity frequency. As regards hourly reference markets, there are about ten power exchanges in Europe. One of the most important is Nord Pool Spot; Epex Spot (European Power Exchange with Germany, Austria and Switzerland) is more relevant to France. Transactions are made the day before for the next day (day-ahead) or the same day for shorter periods (intraday). These exchanges operate on the basis of producers' bids in relation to the demands expressed on the market. They are coordinated by the interconnection capacities guaranteed by the national transmission operators. This mechanism for coordinating exchanges for trade flows between countries, at the heart of the single European electricity market, is called «Market Coupling».

The spot price is the price per MWh that balances the hourly market. It corresponds to the marginal cost (variable operating cost) of the last generation unit commissioned on the market according to the merit order principle (see Figure 1). It is paid to all producers called. This price is by nature volatile, as several technologies coexist in the generating fleet. It varies very frequently, both up and down, depending on the tension between supply and demand. Each generator that has lower operating costs than the hourly price therefore receives a surplus which is called the infra-marginal rent.

Figure 1: Price formation mechanism on the wholesale electricity market




On the futures markets, electricity is bought and sold in advance at a price fixed at the date of contract negotiation. These markets are for standardised products (e.g. base load or peak load) and the price is the average of the expected spot prices over these wider time frames. These forward prices are therefore much less volatile than on the spot markets. The time horizon of the exchanges varies between a few weeks and two or three years in the French case.

Other wholesale market exchanges outside the exchanges exist, in particular intermediated exchanges via a broker or over-the-counter (the two parties trade directly).

The retail markets operate the supply of electricity to final customers. Open to competition since 2007, they bring together energy suppliers and offer two types of supply in France: market supplies with prices freely set by the suppliers and which may vary, and supplies at regulated sales tariffs (TRV) which are set by the public authorities. Not all of them are as sensitive to variations in wholesale market spot prices because they are mainly made up of costs other than energy (network transmission, commercial costs, taxes).

in 2014, and by the constraints they underpin. These objectives originate from the ecological transition and its necessary acceleration, and also represent challenges for the future electric system. Indeed, the organisation of the power system will have to deal with specific constraints in order to achieve those objectives: significant investment needs in a context of uncertainty, the increasing intermittency of electricity production and the need for greater European coordination.

## Objective 1: Decarbonising the energy mix

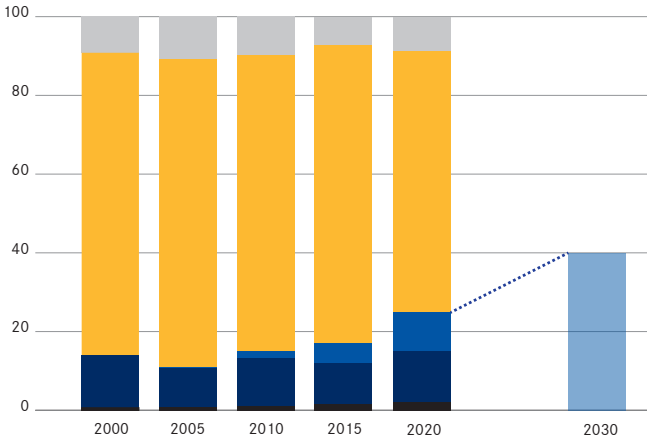
The first objective, set out in the Paris Agreement, is the decarbonisation of our way of living and producing. This means the decarbonisation of electricity production, but also the electrification of certain uses in transport (electric vehicles), housing (heat pumps) and industrial processes. This objective is linked to the necessity of energy sobriety in order to control the increase in electricity needs.

Although CO2 emissions from electricity production in the European Union have fallen by 54% since 1990, this sector remains the main emitter of CO2 (29%) along with transport. In order to achieve the 2050 carbon neutrality target, which is enshrined in the European climate law of 2021, the "Fit for 55" package plans to increase the share of renewable energies to 70% of energy production by 2030 (compared to the current 37%)[10] and to rapidly lower the carbon emission caps on the European market (the Emissions Trading Scheme). However, these two targets are only milestones in the context of the challenge to be met by 2050. Indeed, while electricity production in France is already largely decarbonised, it is not the case for the rest of Europe (Figure 2, a and b).

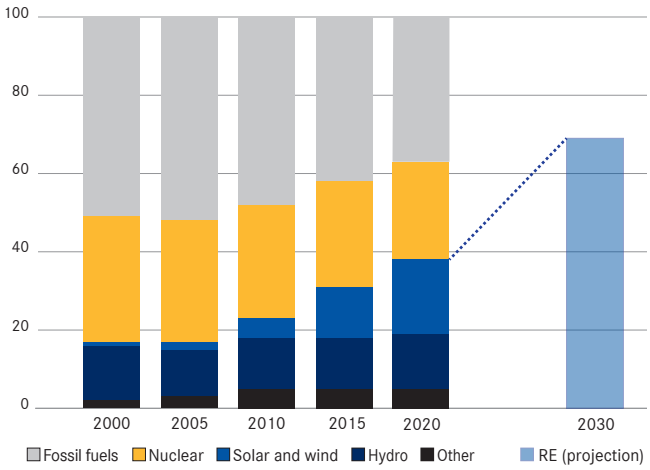
In France, the static vision of a decarbonised electricity production is also misleading. Indeed, we must anticipate the need to renew the nuclear power plant, whose average age has now reached 36 years, and at the same time take into account a significant increase in electricity demand. To illustrate, the study[11] published by the French electricity transmission system operator (RTE) in March 2022 explores different scenarios incorporating carbon neutrality. It emphasises the need for considerable investment, which must be carefully selected if electricity costs are to be kept under control: while the total cost of the electricity system is currently €45 billion per year, the RTE study envisages costs of between €60 and €80 billion.

Figure 2. Share of electricity generation sources

a. France 2000-2020 and projection for 2030




b. European Union 2000-2020 and projection for 2030




Source : Eurostat, Energy balances. For the 2030 projection in France : SNBC.For the 2030 projection in Europe : plan REPowerEU.

Reading: In 2020, solar and wind energy will account for 19% of the EU's energy mix.

## Objective 2. Ensure security of supply

Security of electricity supply means ensuring sufficient supply to meet overall demand and different uses. This objective is all the more important because with the increasing electrification of uses, production that would be too low in relation to needs will have a particularly negative impact on society and the economy. However, because electricity is not easily stored, it is all the more difficult to manage the high proportion of intermittent sources in the electric facilities. These sources require adapting the management of the electricity system and the networks, to be able to increase or decrease

[10] See the estimates produced in the document attached to the REPowerEU plan: Commission Staff (2022): «Implementing the REPowerEU action plan: investment needs, hydrogen accelerator and achieving bio-methane targets», Working document, SWD(2022)230, May

[11] RTE (2022): «Energy futures 2050: production mix scenarios under study to achieve carbon neutrality by 2050», *Prospective study*, February. This study states that energy efficiency and sobriety gains are absolutely necessary to achieve the objectives. Furthermore, the networks must be rapidly resized to make the transition from fossil fuels to electricity possible. Finally, although the control resources that the system needs to guarantee security of supply are very different according to the scenarios, there is an economic interest in increasing the control of consumption, developing interconnections and hydraulic storage, as well as installing batteries to accompany solar and wind power.

the load in conditions that ensure stability and satisfy residual demand at all times.

In the absence of large-scale storage technologies, a high penetration rate of wind and solar power is therefore inconceivable without significant complementary controllable means of production, also decarbonised (gas with carbon capture and sequestration, biogas, hydrogen, nuclear).[12]

The European scale of the electric systems should also be taken into account. The interconnection of networks and exchanges between the countries' electricity zones make it possible to respond more effectively to variations in demand. They limit the need to install important reserves in each zone. Recently, the imports of electricity from other European countries have been crucial to compensate for the lower availability of French nuclear power. It will continue to be so in the future to ensure security of supply (in December 2022, 20% of French consumption was supplied by imports from Germany). In addition, the increasingly intermittent supply creates vulnerabilities when energy policy choices are not coordinated, which further reinforces the interest of the European scale.

Moreover, ensuring energy security is not limited to managing the intermittency of renewable energies or interconnections, as the war in Ukraine has shown, revealing European vulnerabilities. In the coming years, other geopolitical events may further weaken the EU's energy security (dependence on fossil fuels from the Gulf, availability of strategic metals for transition, etc.).

**Finding 1.** Moving away from fossil fuels requires considerable investment in the electricity sector, which far exceeds the effort already made in the field of renewables and cannot be limited to them to ensure security of supply.

### **Objective 3.** Reduce price volatility and consumer exposure to shocks

The energy crisis has made this third objective all the more salient. For European countries, it is both a social issue of protecting consumers/citizens, an economic issue of competitiveness, particularly for industry, and an essential condition for encouraging investment in the energy transition.

The need to invest more in renewables for decarbonisation can be double-edged with respect to this objective. On the one hand, it increases the use of low or zero marginal cost generation on an increasing share of the electricity produced, putting downward pressure on wholesale prices. Above all, the intermittency of renewable energy production may have the direct consequence that the wholesale markets will alternate, even more so than today, between very low or even negative prices when wind turbines and solar panels are running at full capacity, and very high prices when part of the park is operating at low capacity. On the other hand, the expensive, state-of-the-art equipment used to produce the electricity needed for energy security will push prices up (see Box 1). Furthermore, during the transitional period when fossil equipment remains, the volatility of fossil prices, especially gas, will continue to affect the wholesale markets.

Achieving these three objectives is made more complex given the high level of uncertainty at all levels. It makes it more difficult to develop the business models needed to move towards a decarbonised, secure and affordable electricity system.

Uncertainties impact both supply and demand. On the supply side, they concern the costs of the various technologies (whose degrees of maturity are heterogeneous), the conditions of deployment and industrialisation (decisive for evaluating the learning curves of innovations), the technical obstacles to overcome as well as the possible scarcity constraints on raw materials.

On the demand side, uncertainties remain about the decarbonisation of mobility and buildings, and on the future of our industry. Thus, in the RTE scenarios for France, the anticipated demand for electricity varies from 555 TWh to 750 TWh, i.e. an increase of between 15% and 60% of our current consumption, which is considerable. This high uncertainty leads investors to demand high risk premiums. The transformation of the electricity sector faces the same problems as green investment in general[13]: uncertainty about the maturity of technologies or the response of markets to innovations, and the level of demand. Policy and regulatory instability further complicates the calculation of a return on investment and deter investors.

**Finding 2.** The transition of the electricity system requires a new business model taking into account the European dimension, the uncertainty related to future technologies and the evolution of needs, and the specific risks of green investments.

In order to meet the triple objective of sustainable, secure and affordable electricity while integrating the challenges posed by intermittency, uncertainty and the need for European coordination of the future electricity system, we need an in-depth analysis of the advantages and shortcomings of the current functioning of the markets (see Table 1). Although the daily

[12] It can be noted that several countries, including the UK and France, do not envisage this future without a nuclear component. In the RTE scenarios for France mentioned above, if the nuclear power station is reduced or if its relaunch is weak, it will be necessary to build new decarbonised thermal power plants with capacities approaching 30 GW (which is higher than the thermal capacities installed in France since the 1970s).

[13] See on this topic Blanchard O. and Tirole J. (dir.) (2022): «Les grands défis économiques», Report of the international commission, France Stratégie, June.

market allows supply and demand to be balanced in the short term, it fails to meet the three objectives due to cumulative failures: the structural deficit in the remuneration of investment in the electricity sector, aggravated by that of carbon investment in general, which is hampered by the insufficient level of the price of carbon, and the importance of the associated technological risks (see Box 2).

To overcome some of the failures of the daily wholesale market, several mechanisms have been put in place in most Member States. In France, various instruments exist, but they do not provide fully satisfactory solutions in the long term (see Box 3). These mechanisms appeared in the 2000s in successive layers, in a context of production overcapacity, and often had contradictory objectives. They do not meet the current challenges. Today, for example, our security of supply is ensured by the capacity mechanism (see Box 3), but this mechanism does not take into account neither the question of maintaining existing equipment in operation (particularly nuclear), which will require major investments (in refurbishment), nor the incentives to develop innovations in terms of storage and flexibility of demand.

**Finding 3.** Wholesale markets work in the short term but are inadequate in the long term to meet all objectives.

As the RTE scenarios indicate, over the next twenty-five years we must rebuild almost all of our electricity production facilities, taking into account the anticipated decommissioning of existing equipment and the objective of a totally decarbonised, competitive and safe electric fleet by 2050. To achieve this, it is necessary to combine climate policies and the regulation of the electricity sector.

Public regulation of the electricity sector must ensure that electric facilities evolve towards its desirable long-term structure, which calls for a paradigm shift: the three key objectives and the associated constraints must be incorporated into the organisation of the electricity market and its regulation. The mechanisms must be thoroughly reformed by combining the advantages of markets and public intervention. In this context arises the question of the future of Arenh, which expires at the end of 2025.

## Designing a market architecture to serve key objectives

### Develop long-term contracts to establish a hybrid wholesale market

To overcome the inability of daily wholesale markets to attract long-term investment,[14] new incentives to invest must be created elsewhere. There is a consensus on the need for more secure remuneration than the one provided by the short-term market alone, but how to achieve it is subject to debate. First of all, although there are reservations about this type of long-term contract from the point of view of competition, we consider that ordinary law is capable of managing possible abuses of a dominant position, and that the expected benefits in terms of investment for the transformation of

### Box 2. The limits of the wholesale market by 2050

The daily wholesale market is incomplete because :

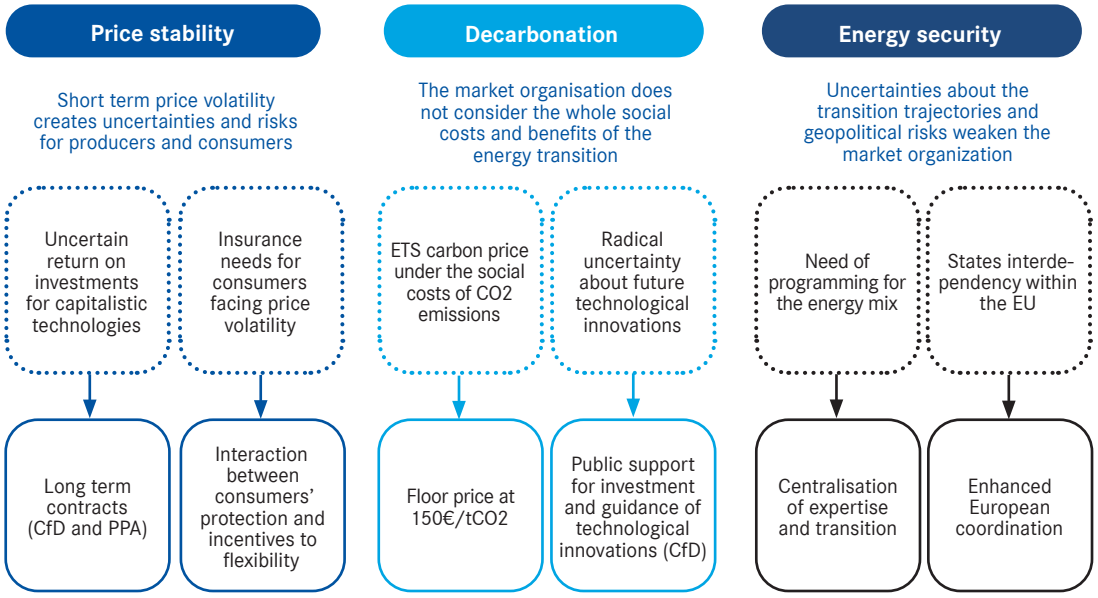
- It does not encourage investment in low-carbon technologies, as it does not produce a credible long-term signal that would ensure that investors cover their full costs for capital-intensive equipment. The disconnection between market prices (aligned with short-term marginal costs) and the full costs of equipment is the main structural problem for long-term electricity markets.
- It does not encourage the development of decarbonised electricity production capacity in facilities that secure the functioning of the system, including during peak periods. Indeed, during rare periods when demand is potentially higher than supply, the price of electricity can be very high which, in theory, should encourage producers to invest in new power plants. However, because this price is capped by the regulator to protect consumers, there is a "missing money" phenomenon[15] : the scarcity rents thus capped are not sufficient to cover the fixed costs of the power plants and encourage investment. More generally, it is difficult to cover the investment risk for these peak facilities with revenues that are subject to fundamental uncertainty: it is not known how many hours in the year these facilities will be called upon. This market failure is exacerbated by the development of renewable energies, which amplifies the volatility of prices during peak periods due to their intermittency.
- It does not limit price volatility because it reflects the fundamental characteristics of the electricity sector: low storage capacity, variable demand and very different production technologies where the share of intermittent renewable energies is growing.

This incompleteness of the wholesale market in meeting the three main objectives is also set out in Table 1, with suggestions for correcting these imperfections.

[14] The daily market price is based on short-term operating costs only, with no direct relation to the full costs (investment + operation) of a facility (see above).

[15] Hogan W. (2005): «On an 'Energy Only' Electricity Market Design for Resource Adequacy», Harvard Kennedy School Working Paper, September; and Cramton P. and Stoft S. (2006), «The Convergence of Market Designs for Adequate Generating Capacity», White Paper for the Electricity Oversight Board For a more complete overview of the Arenh and other schemes, see Cour des Comptes (2022): «L'organisation des marchés de l'électricité», Report, July.

**Table 1. Reform of the European electricity market**




our electricity systems cannot be neglected. The idea is therefore to move towards a "hybrid" wholesale market which would remain based on the short-term wholesale market but with a long-term contractual module to supplement it.

Two types of long-term contracts already exist: contracts for differences and power purchase agreements (PPAs and CfDs, see Box 3). In the case of CfDs, the guarantee of remuneration of the volumes produced lies outside the wholesale market, but it is based on spot prices as a reference for the contract. The insurer is most often a public body that directs the nature of these contracts according to the mix that the public authority seeks to establish. PPAs are a private variant of CfDs, where the price insurer is also a buyer of the output; it is often a professional consumer or supplier. Both PPAs and CfDs have the properties expected of long-term contracts for new generation investments.

In France, CfDs are already widespread in calls for tenders organising wind and solar power generation. They should be generalised to all long-term decarbonised production tools, including nuclear, as well as to flexibility sources such as storage technologies. The European taxonomy has recognised that nuclear power activities are low carbon and can make a substantial contribution to climate change mitigation objectives. This framework needs now to be the reference to measure the environmental effects of electricity generation technologies and thus to define the conditions for implementing State aid in this area. In other words, what applies today to renewable energy sources should be extended to other types of equipment that contribute to climate change mitigation. This reasoning is based on the principles of market neutrality and non-distortion: there is no justification for technologies with equivalent environmental effects not to receive the same support. We therefore recommend extending the European guidelines on State aid and making the CfD the preferred contract for a real change of scale. CfDs can indeed massify the volume of investments. They can also combine to offer a large volume at a stable price for offers to domestic consumers, small entities or companies. But the risk carried must be well calculated and hedged, because in times of very low market prices (which may even be negative), the insurer may face considerable obligations.

On the other hand, because of the high standardisation of CfDs, many specific needs of energy buyers can be overlooked. Finally, they must take into account the potential for innovation on the supply side (mix of generation and storage technologies, remuneration formulas) and on the demand side (firm and variable bands, peak and baseload flexibility, speed of response to upswings and downswings, etc.).

PPAs have the opposite characteristics: the risks are bilateral and not socialised. These contracts highly adapt to the variety of options and professional needs, and facilitate the electrification of uses. Collective insurance (private or public) can improve the contract, as well as a secondary market, or even organise the mutualisation of buyers to facilitate access for the smallest. The biggest flaw of PPAs with regard to the decarbonisation objective is their private nature: they do not guarantee a certain rate of decarbonisation. PPAs and CfDs are therefore complementary long-term contracts.

However, the construction of these contracts requires the utmost care. The incentives for long-term remuneration must not negate those necessary for the proper functioning of the electricity system in the short term, particularly at times of congestion or peak consumption. The purchase obligation often associated with these contracts - the fact that renewable energies are necessarily given priority, even in the event of congestion and when production should be reduced - will have to evolve in this sense. Another point of attention

## Box 3. Complementary mechanisms to wholesale markets

**Guaranteed prices:** this mechanism was introduced in the early 2000s in most EU countries to promote the penetration of renewable energy and to overcome the missing money problem. Renewable electricity benefits from a guaranteed remuneration price, set by the public authorities, and a purchase obligation under a long-term contract with the incumbent. This mechanism has evolved into the use of "CfD".

**Contracts for differences (CfD):** the principle is to guarantee the electricity producer a price that makes his investment profitable. The producer receives additional income from the State if the guaranteed price (for 15 to 20 years depending on the payback period) is higher than the market price, but pays it back if it is not. The French version of CfDs takes the form of remuneration supplement contracts. They apply to most renewable energy sources (hydro, photovoltaic, household waste incineration, biogas, geothermal) but not to nuclear.

**Power Purchase Agreement (PPA):** in this long-term contract, a supplier or consumer buys electricity directly from a producer (often of renewable energy) for a fixed period. The PPA allows the customer to protect itself from the risk of price fluctuations on the energy market and the producer to secure part of its investment.

**Capacity mechanism:** it ensures security of supply during peak periods. Implemented in France in 2017, this regulation implies that suppliers must hold guarantees of production or shaving capacities certified by RTE. They buy the former on the capacity market from producers who undertake to make their production resources available on demand. This system makes it possible to keep little-used power stations in operation, but essential during peak full stops. Capacity guarantees can also take the form, on the demand side, of load shedding guarantees: the supplier pays for the ability of its customers to reduce their consumption when the supply of electricity is too low.

**Regulated access to historical nuclear electricity (Arenh):** this mechanism allows electricity suppliers competing with EDF in France to buy back part of its nuclear production (up to 100 TWh) from the electricity company at a rate of €42/MWh. This mechanism was put in place as part of the liberalisation of the French electricity market, for a transitional period between 2011 and 2025, in order to promote competition against the monopoly then held by EDF. Electricity suppliers wishing to exercise their "right to Arenh" apply to the Commission de régulation de l'énergie (CRE). The Arenh system has been the subject of much criticism. In particular, EDF denounces its optional nature for alternative suppliers, while the latter are calling for an increase in the ceiling of the scheme. The negative effect of Arenh on investments in the electricity sector is also debated.

**Regulated sales tariffs (TRV):** for private individuals, the TRV is EDF's blue tariff. It is available in a basic option (uniform price per kWh), an off-peak option and a Tempo option (price varies according to the time of day and the day of the week). The TRVs are established by adding together the Arenh tariff, the cost of the electricity supply supplement (which includes the capacity guarantee, marketing costs and the supplier's margin) and the transmission costs. This calculation methodology aims to guarantee the "contestability" of these tariffs by alternative suppliers, i.e. the possibility for them to propose market offers to consumers at prices equal to or lower than the TRV. It benefits residential consumers (CRE indicates that 65% of residential sites are at the TRV on 30 September 2021) and "small professionals" (29.9% of sites) on the retail market.

concerns the fact that these contracts stimulate entry investments, i.e. the implementation of capacities with new technologies and in different territories. Does the public insurer have full control over all these dimensions? In a context of great uncertainty regarding electrical systems, technological innovations, climate shocks, and the appearance of new forms of demand driven by electrification, what part should public authorities give to private initiatives, including collective ones (communities or cooperatives), and to entrepreneurial risk-taking? At least, we recommend developing technology-specific CfDs to approximate full costs, while creating and maintaining the highly specialised skills required for informed and expert decisions by public authorities.

More generally, it is important to give market participants longer time horizons. Nowadays, the forward price market only covers small quantities with horizons of up to three years. It is therefore necessary to propose long-term contractual arrangements, but also insurance arrangements so that suppliers can sell larger volumes over longer horizons.

**Recommendation 3.** Extend the use of long-term contracts (CfDs and PPAs) to all decarbonised electricity production, develop the forward market and organise a secondary market for bilateral power purchase agreements (PPAs).

In the French case, historical nuclear power is a major issue in the reform of the electricity markets. In the context of previous reforms (liberalisation of the electricity market and European integration), a specific mechanism, the Arenh (see

Box 3), was put in place with a double objective: to ensure that consumers benefit from these facilities in terms of price and to encourage competition by allowing new suppliers to challenge EDF's historical monopoly. At that time, EDF was supposedly in a position to make a profit from the sale on the wholesale market of electricity produced by facilities that had already been amortized, the price being supposedly higher than the full costs of the installed facilities. The context has changed, and Arenh is due to end in 2025.[16] While the competition for the entry of new suppliers is less of an issue today, the first objective remains important; it could be achieved through the establishment of specific CfDs for existing nuclear power plants, based on an updated estimate of the full operating costs of the plants and projections in terms of the investments to extend their life or to decommission them. Companies and suppliers should also be able to contract directly with the incumbent producer via PPAs.

The use of CfDs on existing installations should be allowed, taking into account the following two elements

– For heavy equipment with a very long life span, the nature of the decommissioning decision is economic: it must result from a comparison of the costs of production of new vs old equipment, the maintenance costs, increasing with age (whether curative or major overhaul costs, if these can be anticipated),

– Consequently once the equipment has reached its limit age when the trade-off arises,[17] two types of investment are conceivable : in new equipment or in keeping the old one in operation. In both cases, the use of CfDs (adapted to the risks involved) is fully justified.

### Reconciling consumer protection with incentives for flexible demand[18]

With the development of long-term contracts, suppliers could be much less exposed to the volatility of the short-term markets and ultimately expose their customers less. Furthermore, because the electricity sector is a sensitive (systemic) area, it is essential to establish a system of prudential rules for electricity suppliers in the retail market, with hedging and solvency requirements similar to those in the banking sector. Compliance with these rules should be monitored annually by the Commission de régulation de l'énergie (CRE). Consumer demand, particularly in the residential sector, is not very responsive to rapid price changes, and consumers need protection of their final bill. This is why active consumers, who are ready to contribute to the needs of the electricity system, must be guaranteed a maximum monthly bill and a significant bonus for any effective hourly or daily reductions in their consumption. Appropriate equipment for active consumers will be needed to organise this market, installed by traditional suppliers or new innovative suppliers. Such fine-tuned demand flexibilities already exist in many countries and, in the United States, are part of proactive public demand flexibility programmes. These retail tariff innovations can be an integral part of electrification programmes for private and professional use (mobility and heating in particular).

Some innovative investors have developed electronic devices to monitor, or even control consumption in order to organise demand flexibility. These are aggregators whose activity is the opposite of retailers'role: the retailer buys wholesale what it fractions on the retail market while the aggregator buys, from consumers, fractions of what it aggregates on the wholesale market. Aggregators may operate in specialised markets or in local markets. By buying electricity directly from consumers, network operators can work more efficiently in congestion management, for example.

**Recommendation 4.** Introduce prudential rules for electricity suppliers and ensure that they offer contracts with fixed prices on part of the consumption, while preserving incentives to reduce marginal consumption.

## Strengthening the role of government

In view of the structural shortcomings of the organisation of the electricity markets, it is essential to redefine the role of the public authorities.

### In France, organising the expertise and monitoring of the electricity system

The organisation of the markets we propose requires to program the energy mix. It must be based on expertise from several points of view (production, transport, distribution, electrification of uses, etc.) and integrate the sector constraints and uncertainties. A steering body must also monitor this evolution of the mix, regardless of the degree of centralisation of the energy policy. In a centralised approach, this body must be able to organise the successive auctions in such a way as to meet the objectives of the programme - particularly the development of certain production technologies. In a decentralised approach, it must ensure that the obligations of the market players in terms of energy transition are respected.

There is no shortage of expertise in France, but it is hampered by its proliferation and lack of coordination; the fragmentation of institutions is an obstacle to the affirmation of French energy policy objectives, particularly in view of the rapid evolution of the issues and constraints. For example, the National Low Carbon Strategy, conceived in 2015, was

[16] In this case, the life span set out in its original operating licence.

[17] For additional analyses on the subject, see in particular Goldberg N. and Guillou A. (2023): «Décorréler les prix de l'électricité de ceux du gaz: mission impossible?», Terra Nova, Report, January.

updated in 2018 and will be updated again in Summer 2023, as will the Multiannual Energy Programming (PPE), the main tool for steering energy policy, which is reviewed every five years. However, the major public energy players have proposed their own adjustments to account for the "new world" of energy. In 2022, the electricity transporter RTE published possible trajectories for the electricity system up to 2050.[20] The public agency for ecological transition, Ademe, did the same,[19] but based on scenarios including social and territorial issues, for all energies and emissions. The major distribution network, Enedis, produced the "Prospective 2050" report in spring 2021, which is already corrected... The regulator CRE is continuing its own foresight work.

Legislation, regulation, transport, applied ecology and distribution: despite all this high-quality expertise, France still lacks a sustained, detailed and technical dialogue between all these fields. Building this dialogue and institutionalising it is a priority to renew the understanding of the issues, challenges and options. It is also essential to organise the monitoring and adjustment of operational measures in order to reduce uncertainties as they arise and to maintain flexibility in their implementation. The political economy issues are not negligible and must be studied: influence of lobbies, decision-making methods, etc.

**Recommendation 5.** In France, give a body the task of coordinating expertise, recommending investments and monitoring the evolution of the electricity ecosystem (electric facilities, networks, consumption, electrification, technologies and innovations).

## Coordinating the European level

While the sovereignty of each Member State energy policy is not at stake, the challenges of European coordination are unavoidable on three central subjects: the need for a carbon price floor (see above) and, in the long term, the management of systemic risks regarding infrastructures and supply.

Concerning the long-term objectives, because the interconnections of the European power station park create interdependencies, the risk of moral hazard with regard to the objectives of decarbonisation of the energy mix should not be overlooked. The increase in the need for decarbonised electricity requires some form of enhanced coordination, or even planning, to ensure that the effort and risk of securing European supply is shared fairly.

In addition, the increase in the share of renewable energies in electricity production creates the need for greater reactivity and better integration of the operations of network managers, due to their intermittent and more diffuse nature. Thus, due to the uncertain level of security of supply that renewable energies imply, the European scale is also the most appropriate for organising the solidarity of controllable energies.

The European level most often determines objectives, targets and some principles of action, but leaves the Member States free to implement them. This is particularly the case in the field of energy, where each State must find the ways and means to achieve the objectives set (Fit for 55-2030 Targets). Yet, there are European action or coordination instruments that could be useful for implementing the three major objectives of the new electricity system, such as the Ten Years Network Development Plan or the Adequacy Assessment (the ability of production resources to meet various future demand scenarios); but these are study plans, not investment or equipment plans. There are also funding schemes, such as Projects of Common Interest (PCIs), but these are initiated by Member States, so their scope is necessarily limited. Finally, the national energy-climate plans NECPs have still not reacted to the Covid crisis, Fit for 55 or the invasion of Ukraine, and they operate in national silos. The coherence of these four tools with all new European developments is not guaranteed.

In terms of infrastructure, the lack of dialogue is also damaging: when new European targets are designed, such as 480 GW of wind or 600 GW of solar in 2030, this should automatically lead to the formulation of new needs in terms of grid access conditions and interconnections for example.

To date, capacity markets are national tools designed and implemented at a national scale. Their European coherence is very weak and mainly defensive: it expresses above all the concern of the European authorities to avoid that all the national markets close to each other.

To succeed in accelerating its decarbonisation and in rebuilding its energy security, the European Union needs coordination of national policies. In a reciprocally open European market, national generation and transmission capacities must follow a common path. To ensure this coordination, the European Commission must strengthen its position by building a serious, ongoing, detailed and technical dialogue between sectors of expertise. Institutionalising it is a priority to renew the understanding of the issues, challenges and possible trajectories. The European Union Agency for the Cooperation of Energy Regulators (ACER) and the Joint Research Centre (EU scientific and technical research laboratory) - which would remain independent - could be tasked with jointly building this expertise. In particular, they could assess Member States' plans, conduct stress tests and make recommendations. Their studies would be able to inform more detailed Commission opinions on certain aspects of energy policy, such as the composition of the energy mix or the strengthening of security of supply.

[18] TEN: op. cit.

[19] Ademe (2021): «Transitions 2050: choose now, act for the climate», Report.

**Recommendation 6.** At European level, strengthen consultation on the choice of energy mixes and security of supply by means of expertise produced by a European authority with extended missions and appropriate resources. Coordinate national capacity markets between Member States.

The wholesale market is working for the short-term optimisation of the electricity system, but it is essential to complement it with long-term contracts to serve the three objectives of a decarbonised, secure and affordable energy. The aim is to create a business model that allows the transition to an electricity system that meets the energy challenges and protects consumers against price volatility.



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