

# Electricity in the energy transition

## Preface

**Agnès Pannier-Runacher**, Minister of Energy Transition

## Introduction

**Ivan Faucheux**, Member of the college of the Commission de régulation de l'énergie

## The future major balances of the (European?) electrical system

### A look back at Energy Futures 2050

**Thomas Veyrenc**, Executive Director in charge of strategy, foresight and evaluation at Réseau de transport d'électricité (RTE)

In October 2021, and again in February 2022, RTE published the results of the major "Energy Futures 2050" study undertaken two years earlier to determine possible paths to carbon neutrality and to reflect on the electricity system of tomorrow. The various scenarios proposed have since been widely used in the energy debate; they have been taken up by many players and political forces and have fed into the strategy for decarbonizing France presented in February 2022 in Belfort by the President of the Republic. One year after the publication of the main results of this study, we return in this article to the conditions of its elaboration and to some of its main lessons in the light of the energy crisis that has since grown in Europe.

### The contribution of renewable energies to the balance of the electricity market in Europe: the experience of Vattenfall

**Yara Chakhtoura**, Managing Director of Vattenfall Wind

The European energy market has been in crisis for almost two years, highlighting the urgent need to accelerate the transition to a fossil-free world within a generation. To achieve carbon neutrality by 2050, while ensuring our energy security, the massive and rapid deployment of renewable energies in the electricity mix is now essential and implies the implementation of strong simplification and acceleration measures, based in particular on real planning. Vattenfall, a European energy company and one of the leaders in offshore wind energy worldwide, shares its vision of the challenges of such a deployment.

### The challenge of creating long-term electricity markets

**Antoine Dereuddre**, Chief Economist at the French Energy Regulatory Commission (CRE)

Never have electricity prices on the French wholesale market been so high. Our neighbors, despite having a more carbon-intensive fleet, are selling us electricity that they produce at lower cost. This bitter, seemingly aberrant situation is in stark contrast to past years, when French prices were among the lowest in Europe.

We will not dwell here on the immediate causes of the crisis as they are so obvious. Without denying the urgency of the current situation, it nevertheless seems useful to examine some possible avenues for long-term reform of market mechanisms.

The starting point of our reflection is based on the hypothesis that a liquid market for long-term contracts is as necessary for the proper functioning of the system as the short-term markets.

Starting from the observation that the market is still incomplete, where long-term contracts do not develop spontaneously, we consider the premises of a prudential regulation by quantities.

### The need to change the European electricity market model

**Boris Solier**, ART-Dev, University of Montpellier, CIRAD, CNRS, Paul Valéry University Montpellier 3, University of Perpignan Via Domitia, Montpellier

The energy crisis and soaring electricity prices in Europe have led a number of observers and policy makers to question the current market model based on marginal costs. Among the many reform proposals that have been put forward, two in particular have attracted attention: 1) capping gas prices for power generation in the short term (the Spanish option); or 2) introducing a dual market model in the medium term, combining a merit order based on marginal costs for fossil fuels with high variable costs, and long-term contracts based on average costs for low-carbon producers with high fixed costs (the Greek option). The debate is all the more intense because rising energy costs are the main driver of inflation in Europe, which reached more than 10% year-on-year in October 2022. This situation is weighing on the competitiveness of the euro zone vis-à-vis its main trading partners, which are often less severely affected by the energy crisis.

## Electricity sectors moving towards a hybrid regime combining market and planning

**Dominique Finon**, Emeritus Director of Research at the CNRS, associate researcher at the "European Electricity Markets" Chair (Paris Dauphine)

The resurgence of public intervention in the electricity sector raises the question of how best to adapt market design to meet the investment challenge associated with the objectives of security of supply and decarbonization. The evolution towards a hybrid market regime seems inevitable, whether in Europe or in the United States, as soon as intermittent renewable energies are introduced outside the market and, with a zero marginal cost, distort all existing coordination. This system is based on two forms of regulation: on the one hand, planning that is linked to competition "for the markets" aimed at developing new capacities based on different techniques, and on the other hand, competition "in the market" limited to the realization of economic dispatching. The current crisis linked to the increase in electricity prices should accelerate this change, giving new weight to the search for alignment of sales prices with system development costs.

## The electricity market, the engine of the energy transition

**Davide Orifici**, Director of Public and Regulatory Affairs and Communication of the European Power Exchange Epex Spot

The energy price crisis puts pressure on households, businesses, and policy-makers alike. A "malfunctioning" or "inadequacy" of the EU power market has quickly been identified as culprit in the public debate – Rightfully so? The answer is: no. Even if currently under fire, the pan-European power market is not only what enables the energy transition on the continent, but what drives it forward. Thanks to reliable and transparent price signals that adequately reflect supply and demand, generation assets are activated to satisfy demand at the lowest possible cost, renewables are integrated efficiently, the use of infrastructures is optimised, and supply is secured across borders. Furthermore, many market-based instruments are available to lower the costs of the energy transition, to involve the end-consumer in decarbonisation efforts – In short, to pave Europe's way to net-zero.

## The consumer

### From perplexity to mistrust among consumers

**Françoise Thiebault**, Coordinator of the energy sector of the CNAFAL

The opening of the energy market has been concurrent with the deconstruction of public services and a poorly-controlled digital revolution. Private consumers, still attached to the old monopolistic model and the mis-

sions of public service, have been targeted by suppliers whose potentially unscrupulous practices found reinforcement in an independent administrative authority more focused on market opening than consumer protection. In a context of unmet commitments and rocketing global prices, the consumers' bafflement has turned to sheer distrust. How can they now be encouraged to embrace change and reform their attitudes – A key-prerequisite for achieving the goals of energy transition?

## Accelerating the energy transition in a context of crisis:

### a perspective on the associated challenges

**Andreas Rüdinger**, Coordinator for Energy Transition France at the Institute for Sustainable Development and International Relations (IDDRI)

France and Europe are going through an unprecedented energy crisis, which began in September 2021 before being considerably amplified by the war in Ukraine. This crisis is a painful reminder of our dependence on imported fossil fuels (which cover 65% of final energy consumption in France and 70% in Europe). For the time being, the political response to this crisis focuses mainly on short-term management of the economic and social emergency, and therefore neglects the necessary acceleration of low-carbon transition policies, which are nevertheless our main lever of resilience in the face of current and future crises.

Starting from an overview of the current crisis and its political management at the French level, we give in this article an overview of some issues related in particular to the acceleration of the development of electric renewable energies in France, by insisting on the issue of a better appropriation and territorial integration of the projects considered.

## The consumer, an actor of energy sobriety?

### A sociological approach

**Stéphane La Branche**, Independent climate and energy sociologist, scientific coordinator of GIECO/IPBC – International Panel on Behaviour Change

Following more than thirty research projects in the field of climate and energy sociology in different sectors, the article presents some major elements for understanding the interactions between individuals and energy, in order to better explain what it means to make behavioral efforts on a daily basis. Sobriety is much more complex than common representations lead one to think and it is also more difficult to implement. It must also be distinguished from efficiency and management because these three aspects do not refer to the same behavioral and cognitive drivers of change and non change. At the end of the text, we propose socio-energetic profiles.

### Coordinated management of consumption to achieve the energy transition

**Pierre Bivas**, Co-founder of Voltalis

The energy transition is accompanied by a Copernican revolution in electricity: with more and more renewable, intermittent and decentralized production, ensuring the balance between production and consumption at all times now requires consumption to be controlled. This is the purpose of a new business line that consists of optimizing the consumption of millions of electrical appliances in real time by controlling them remotely and in a coordinated manner.

The energy transition is calling for major changes in consumption, in particular due to the "electrification of uses", notably the spread of heat pumps and electric vehicles. This is creating new opportunities in terms of control, to the benefit of consumers. This control is already proving to be very valuable in the current crisis, as it has an enormous impact in terms of price moderation.

### Nuclear and renewable energies: is public debate conducive to their acceptability?

**Chantal Jouanno**, Former Minister

Imposing energy transition projects in the name of the climate emergency would be democratic suicide, given the immense stakes involved in this transition. It would be ignoring our history. Public participation in decisions impacting the environment is a citizen's conquest that has become the international and constitutional standard of democratic development. However, public debate is not the tool of acceptability, it is only the tool for identifying the conditions of feasibility of a project. The issue is all the more important because nuclear power has a history of conflict and because renewable energies bring with them new issues of land use. For a project to be acceptable, decision-makers must listen sincerely to what the public has to say and translate what they learn from it. The effectiveness of a public debate depends less on its method than on the decision-makers' adherence to the fundamentals of participatory democracy.

### The second wave of electrification

**Hélène Macela-Gouin**, Vice President of Secure Power activities at Schneider Electric France and member of the company's Executive Committee

In the energy world of the Twenty-first century, three major disruptions are on-going en parallel: decarbonation, decentralization and digitalization. But probably because the French electric grid was seen as a reference in the world of the twentieth century, the essential transformations are long to emerge. This prospective document summarizes the main disruptions going-on and the rationale around this absolute need to accelerate our energy transformation. Like a reality check, the present crisis in energy production painfully highlights the limits of our current system: It's time to catch the second wave of electrification!

### The industrial competitiveness challenges of the electric transition

**Hoang Bui**, General Secretariat for Investment, under the authority of the Prime Minister

France must meet the challenge of decarbonizing its economy, and its efforts will be all the more important if it wants not only to maintain but also to develop its industry.

Some of the sectors that are most affected are also the most strategic for our sovereignty and are also major providers of jobs.

One of the main levers for decarbonizing industrial companies is electricity, either for direct use or through the hydrogen vector.

In 2030, France will need 680 kt of hydrogen to decarbonize its industry and heavy mobility, which implies having at least 6.5 GW of electrolysis capacity installed and connected to the electricity grid.

Hydrogen production projects are part of a constrained timeframe: if hydrogen does not arrive in time, its main industrial customers will not be able to decarbonize according to the planned schedule, with the risk that major modernization investments will eventually be abandoned or relocated. This would mean that a whole sector of French industry would be doomed in the medium to long term.

If we consider the very large water electrolysis projects planned in France, some of which are several hundred MW in size, most of them will require connection to the electricity transmission network as early as 2026 or, at the latest, in 2027. However, there are currently strong concerns among industrialists, because the announced deadlines for these connections suggest several years of delay.

Thus, the difficulty of connecting to the transmission grid is proving to be a potentially critical obstacle in the path of major decarbonization projects in the industry.

In an environment that is increasingly complex and crowded, stimulated by the appetite of hydrogen entrepreneurs who want to be the first, while the markets are not yet mature and the offers sometimes seem redundant, it could be tempting to wait before investing in reinforcing the electrical system.

However, waiting means losing part of our industry, which must negotiate difficult technological and climatic changes within a constrained timeframe. This industry could therefore be tempted to move to countries offering a more responsive and competitive electricity system. In addition, there are tensions over the supply of the equipment needed to make these connections: we must therefore act without delay to avoid being the last to be served.

It is urgent that stakeholders, starting with the government and the grid operator, work on taking into account all the factors that make our electricity system competitive and share a common vision of the industry's needs and the projects to be carried out.

### Long-term nuclear contracts: a major challenge for carbon neutrality

**Philippe Darmayan**, President of the UIMM (2018-2021) and in charge of a ministerial mission on long-term electricity contracts

Viewed from both producers and consumers stand point, it appears that the current electricity market will not allow carbon neutrality to be achieved in time. There is an urgent need to rethink the market design: by strategic planning of needs and uses, and by setting a long-term price signal based on the average cost of actual and future production.

One part of this transformation process concerns large energy-intensive consumers, whose very long-term needs are not met. We must create the conditions for a long-term market which would put all electricity suppliers on an equal footing and which would allow manufacturers to group together in purchasing structures to buy capacities or production ribbons, which they would finance, either themselves or through partners (suppliers or infrastructure funds). These long term contracts already exist for renewable energies. It should be extended to the French nuclear production through the development of long-term contracts consistent with the challenges of decarbonizing their processes.

## Energy networks at the heart of transformations

### The challenges of digitization for distribution network operators

**Sébastien Jumel** and **Pierre Mallet**, Enedis

All over the world, the public electricity distribution network is at the crossroads of many environmental, technological, digital, economic and societal transitions.

We are moving from a centralized electricity system to a partially decentralized system based on intermittent and therefore much less controllable means of production. Distribution will be optimized at various levels, increasingly local. And flexibility, enabled by intelligent use of data, will be the key to the system. These transformations will rely heavily on the electricity distribution network, which is becoming the backbone of the current ecological transition.

Solutions based on data processing are essential to implement these transformations, as they open up prospects for major improvements in our performance and the development of services.

The Linky smart meter is a central link in this digitalization. With it, Enedis is moving into the world of Big Data. Linky paves the way for dynamic management of usage, facilitates the development of self-consumption and makes it possible to offer many new services. It is also a formidable tool for improving the performance of network management.

Of course, this transformation will not happen overnight, but it will accelerate, requiring an increasingly sustained

pace of innovation. And we will only be able to meet this challenge if we have a high-performance ecosystem, an appropriate regulatory framework and the mobilization of all our company's employees.

### Electricity and gas markets in Europe: what is the right architecture between monopolies and energy only?

**Édouard Sauvage**, Executive Vice President of Engie, in charge of worldwide infrastructure activities (gas transmission, distribution and storage, electricity transmission)

The current energy crisis caused by a brutal reduction in energy supply reveals a profound dysfunction of the gas and electricity markets in Europe. But how to respond to the challenges of prices, energy sovereignty, energy transition and consumer protection?

- Urgent measures are needed to get out of the trap of energy prices that are much higher than their values in other continents while ensuring the security of gas supply in Europe (capping gas prices by a fixed value or indexed to other energies, recreating depth in the market...).
- A structural reform of the energy markets is essential to trigger the investments necessary for the energy transition, a response to the challenges of climate change but also of energy sovereignty and energy costs. Europe and its Member States must assume a political energy planning and investments through competitive tenders. This planning must imperatively include significant safety margins guaranteeing security of supply even in extreme scenarios and partial but rapid substitutability between different vectors in order to avoid tension on the price of an energy vector.

### Local planning tools in the context of the energy transition

**Claude Arnaud**, President of Efficacity

The successful energy transition of our cities, i.e. the abandonment of oil in favor of various decarbonized energy sources, is schematically conditioned by three indispensable actions: a massive investment in renewable and recuperated energies (RE&R); an overall reduction in our consumption through the use of more efficient equipment and more responsible permanent behavior; and coordinated planning of the work to be carried out in order to optimize both the technical efficiency and the judicious spreading of investments and financing.

In this article, we focus on planning tools, both existing and under development. The Efficacity Institute for Urban Energy Transition has developed a software suite adapted to the development of new or renovated urban districts and territories. These tools have been tested on numerous concrete cases and provide political decision-makers with the technical and financial elements that enable them to make the best choices in terms of energy solutions and their management, and thus to build their climate and energy program through operational plans for multi-year implementation.

## Miscellany

### The history of the electric motor

**Iarion Pavel**, Chief Mining Engineer - General Council of the Economy

The electric motor has its origins in the 18<sup>th</sup> century in the experiments of scientists. The first industrial development took place in the 1830's with a view to transport applications, but it ran into difficulties due to the cost of alternative solutions. Then, it became established thanks to innovations in other fields (telegraphs, detonators, lighting...), before coming back in force in transportation (tramways and subways) at the end of the 19<sup>th</sup> century, as well as in electric vehicles. The energy density of gasoline made it unusable for private vehicles for a long time, while electrical applications multiplied in weak currents (household appliances, music, telephony, electronics), but also in strong currents (turboalternators, public transport), throughout the 20<sup>th</sup> century. In France, these industries went from a few thousand to more than a million employees in a century. Electric vehicles are making a strong comeback at the beginning of the 21<sup>st</sup> century in the triple context of rising fossil fuel prices, increasing scarcity of fossil fuels and the challenges of the greenhouse effect. In this article, we retrace the major stages of these developments, with their failures and successes.

### Non-energy mineral commodities in metropolitan France as seen through the prism of mining titles (1811-2020)

**Aurélien Reys** and **Yann Gunzburger**, UMR 7359 GeoRessources (University of Lorraine), **Alain Liger**, Billiton Mining and Metallurgical Group plc (now called BHP Billiton), and **Rémi Galin**, Ministry of Ecological Transition and Territorial Cohesion – Office of Non-Energy Mineral Resources Policy

Mining rights offer an original approach to map the concentrations of mineral substances that aroused the interest of investors. Their location is consistent with the geological map of France and they can be used to follow the evolution of the intensity of mining in the country over the last two centuries. In this regard, they highlight the intensity of the decline of mining in the 1980s-1990s and illustrate the failure of the desired revival during the last decade. With technological progress and the recent reform of the Mining Code aimed at attracting new investors, mining rights could be used more extensively to monitor the interest of economic agents for mining resources in France.

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