

# Chapter 3

## Phasing out coal in the French energy sector

Andrzej Jakubowski

### Introduction

In November 2018, the French government (2018a) published a revised version of the French ‘National Low-Carbon Strategy’ (SNBC; *Stratégie Nationale Bas Carbone*), which targets climate neutrality by 2050. To achieve this ambitious objective, the project sets out a wide range of measures targeting cuts in emissions of greenhouse gases (GHG), including the closure of the last four remaining coal-fired power plants in France. These power plants, however, which employ a little over 1,000 workers, account for only a small share of the country’s electricity production and CO<sub>2</sub> emissions.

Despite this, the closure of the plants remains a sensitive issue due, on the one hand, to the specificities of the French electricity production system but also, on the other, to the social concerns they have raised. According to the trade union CGT, the plants support a total of more than 5,000 direct and indirect jobs. Subsequent to the closure announcement, several strikes and protests have been organised by workers since December 2018. To address these concerns, the French government announced, also in 2018, the initial inclusion of the four sites into the pilot phase of the newly-created environmental transition contracts (ETCs) programme, which aims at implementing green economic diversification measures and social transformation schemes in regions touched by the negative effects of the transition.

This chapter will address the main challenges, policies and debates related to the phasing-out of coal in the French energy sector. Section 1 introduces the framework of the French national ‘low carbon strategy’, while section 2 describes the situation of the last four remaining coal-fired power plants in the country. Section 3 turns to the environmental transition contracts programme that aims to cushion the economic and social impacts of the transition and section 4 examines alternative projects that target the conversion of three of the remaining plants to biomass-fired units that have been developed with the support of workers and trade unions. Section 5 finally concludes.

### 1. The French national low-carbon strategy (SNBC)

Thanks to its largely decarbonised electricity mix, France ranks among the lowest greenhouse gas emitting countries in the European Union (Climate Transparency 2017). To achieve its 2050 objectives, the French SNBC targets the complete decarbonisation of the electricity production sector which, according to Eurostat, now accounts for around seven to eight per cent of France’s total GHG emissions.

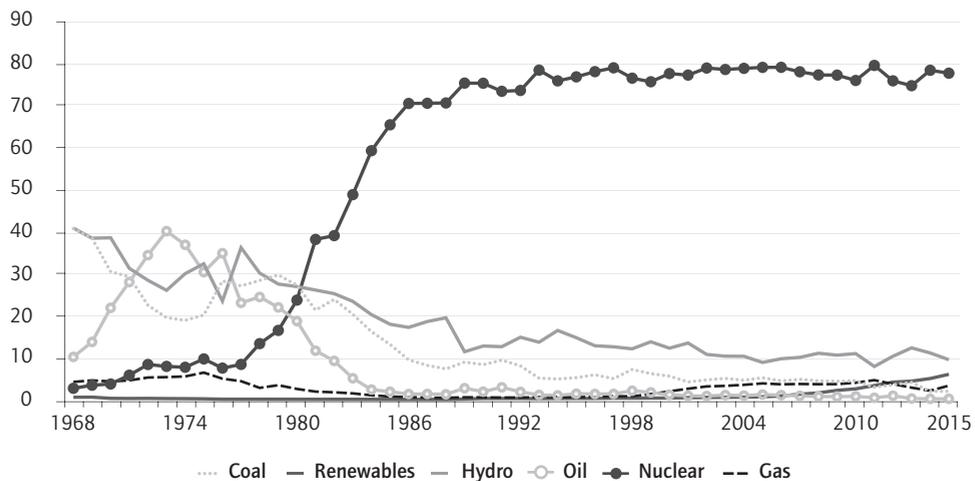
## 1.1 France's greenhouse gas emissions

In 2017, GHG emissions per inhabitant reached 5.8 tonnes per capita, against 10.3 in Germany and 8.3 for the G20 group (Climate Transparency 2017). At sectoral level, the main sources of emissions are transport (38 per cent), the residential/services sector (23 per cent) and manufacturing industry (22 per cent). The energy sector accounts for only 14 per cent of France's total GHG emissions (INSEE 2019).

Between 1990 and 2016, emissions dropped by 14.2 per cent (Eurostat 2019). This decrease is mainly due to a better performance in manufacturing (a drop of thirty per cent over the period, thanks to increased energy efficiency but also a reduction in industrial activity) as well as in the energy transformation sector (a drop of 42 per cent) due, in particular, to the development of renewable energy sources and the decarbonisation of heating networks. Meanwhile, emissions from the residential sector have decreased by seven per cent while emissions from transport have grown by eight per cent (INSEE 2019).

The relatively low level of emissions of the French economy is linked to the introduction, following the first oil shock of 1973, of policies targeting the reduction of energy consumption and the development of electricity production from nuclear energy.

Figure 1 France – structure of electricity generation by fuel (1968-2015, as per cent of total production)

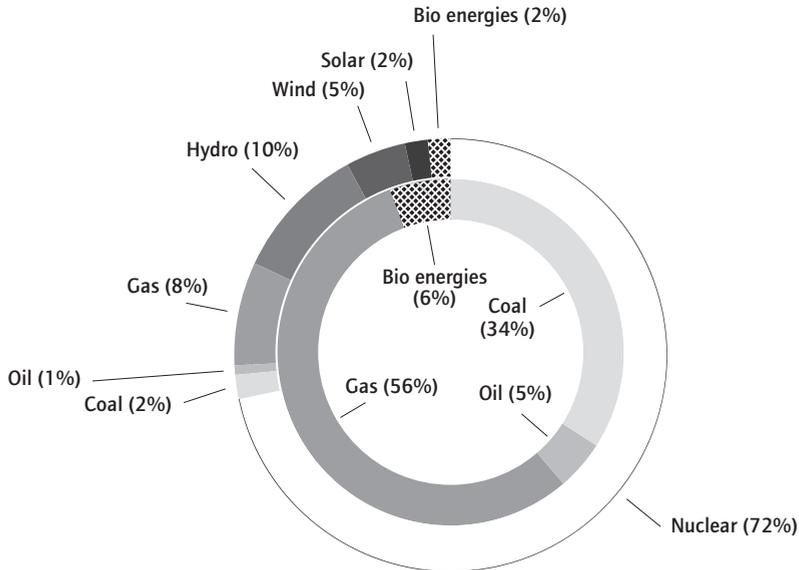


Source: World Bank.

As Figure 1 shows, in the last four decades nuclear energy has progressively replaced coal as the dominant source of power generation. In 2017, it accounted for 72 per cent of total electricity production, followed by renewables (nineteen per cent) and gas (eight per cent). Coal represents only between two and three per cent of annual power generation (depending on weather conditions and the availability of nuclear plants and renewable installations). Coal-fired power plants account, however, for more than one-

third of the sector's GHG emissions, as shown by Figure 2 (34 per cent, against 56 per cent for gas-fired power plants).

Figure 2 French electricity sector: structure of national production (outer circle) and CO<sub>2</sub> emissions (inner circle) by fuel (2017)



Source: <https://www.statistiques.developpement-durable.gouv.fr/>

## 1.2 The French National Low-Carbon Strategy (SNBC)

The 2015 National Low-Carbon Strategy (SNBC) (French Government 2015b) was established by the Energy Transition for Green Growth Act (French Government 2015a). It aims at cutting GHG emissions by forty per cent by 2030 and by 75 per cent by 2050 compared to 1990 ('factor 4' scenario).

Recently, following the election of Emmanuel Macron as president and the adoption of Nicolas Hulot's Climate Plan,<sup>1</sup> a revised version, which now targets climate neutrality by 2050, was presented in December 2018 (French Government 2018a). The government has raised the country's ambitions, despite France not having reached its current short-term climate targets.

The SNBC has been based on a wide consultation process and includes measures targeting the social impacts of the transition.

1. M. Nicolas Hulot was replaced by M. François de Rugy as Minister for the Environmental Transition on 4 September 2018.

## Main objectives

The amended strategy, which should be adopted by mid-2019, is based on 47 cross-cutting and sectoral recommendations. These are sweeping measures which aim, among others, at placing carbon footprint reduction at the heart of public decision-making (at national, regional and local levels); maximising the effects of government funding; promoting R&D and innovation; and raising the awareness of the public on the impact of consumption choices.

Sectoral recommendations define emissions reduction targets for seven sectors and set out a series of measures which aim at realising these objectives. At a later stage, they will be supplemented by sectoral action programmes. The targets set for the sectors concerned are presented in Table 1 below.

Table 1 Sectoral GHG emission reduction targets by 2050 (%)

Transport	Residential	Agriculture	Industry	Energy production	Waste	Total	LULUCF*
-97	-95	-46	-81	-95	-66	-83	64

Source: SNBC.

Note: \* Land use, land-use change, and forestry.

To achieve its long-term targets, France has adopted a system based on five-year national ‘carbon budgets’, which are tools in the monitoring and evaluation of the implementation of the strategy. The carbon budgets define GHG emission caps for the sectors covered by the strategy, as shown in Figure 3.

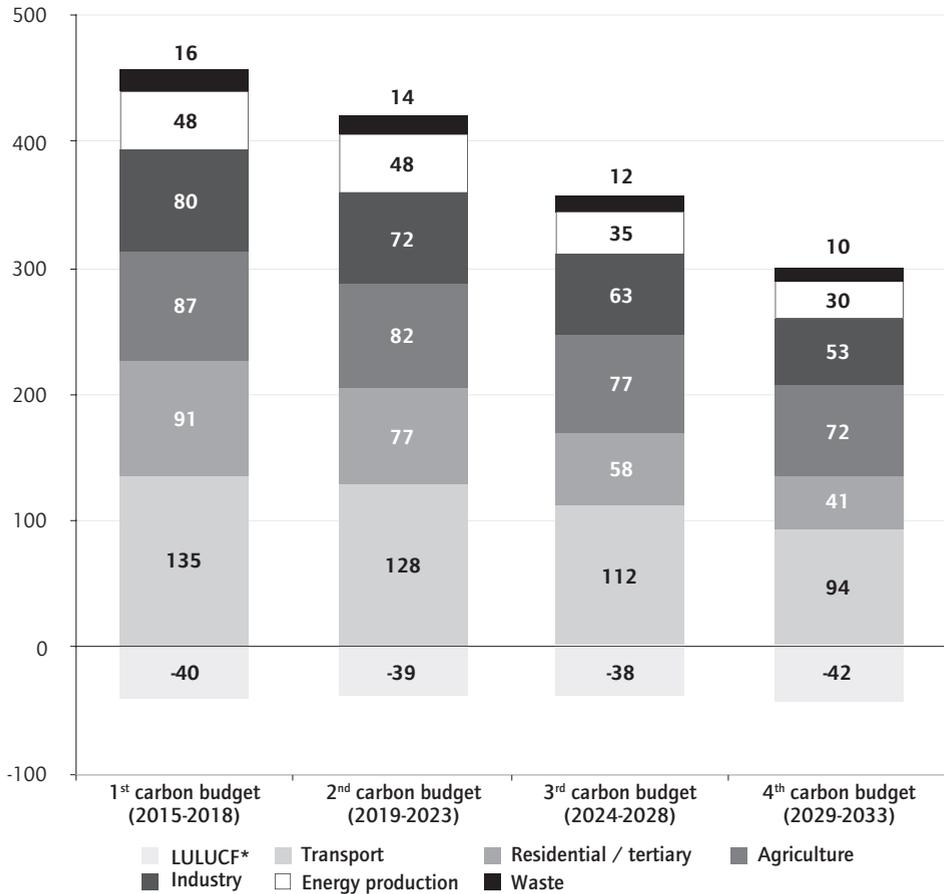
Regarding electricity production, the Strategy targets the development of a carbon-free power generation sector by the mid-century. It plans to achieve this through a complete decarbonisation and diversification of the energy mix (via the development of renewables including biomass, the roll-out of carbon capture and storage (CCS) technologies, etc.), supported by an overall improvement in energy efficiency (cross-sectoral measures).

In November 2018, the French government published the national Multiannual Energy Plan (PPE) for the period 2019-2028 (French Government 2018b), which sets out some initial measures aimed at realising these objectives (Mandard *et al.* 2018). The announced measures include the closure of all coal-fired plants by 2022. The government has also announced a ban on investment in new fossil-fuelled production capacities and an increase up to forty per cent in the share of renewables in the electricity production mix (against seventeen per cent in 2018), mainly based on the development of solar and wind energy. Total solar installed production capacity should grow from 8.4 GW to 40 GW, while wind energy production capacities (onshore and offshore) should reach 38 GW (against 17 GW in 2018).

Decarbonising the electricity sector will be a considerable challenge as, at the same time, the government is planning a reduction in the share of nuclear power to fifty per

cent of the electricity production mix. This development will involve the shutdown of fourteen nuclear reactors by 2035, including the two reactors of the Fessenheim plant in spring 2020.

Figure 3 Carbon budgets – sectoral breakdown (MtCO<sub>2</sub>eq)



Source: SNBC.

Note: \* Land use, land-use change, and forestry.

### The public debate

The National Low Carbon Strategy is based on a reference scenario developed during a modelling exercise within the Multiannual Energy Programme. This scenario highlights the different potential public policy measures that would allow France best to respect its short- and medium-term climate and energy objectives.

The scenario, as well as the main political orientations of the SNBC, have been defined through a comprehensive consultation process that has involved multiple stakeholders, including trade unions.

The core hypothesis of the SNBC was first developed under the aegis of a steering committee, made up of experts from the relevant ministries and industrial sectors. This steering committee was cross-disciplinary in nature, incorporating sector-specific sub-committees (energy, transport, construction, industry, waste management, agriculture and forestry) when necessary.

In the meantime, an Information and Orientation Committee (CIO), composed of members coming from the different organisations represented in the National Council for the Environmental Transition (a consultative body which brings together representatives of employees, employers and consumers, environmental NGOs, regional authorities and members of parliament), was also set up. Throughout the working process – i.e. from the definition of the fundamental hypotheses until the presentation of the final results – the Information and Orientation Committee (CIO) met six times, allowing civil society figures to provide input regarding the modelling decisions and to discuss the resulting out-turns.

Last but not least, an online nation-wide consultation process was also organised (French Government 2018a).

The objectives of this wide consultation process have been twofold: gather as much relevant information as possible; and gain acceptance from the largest number of stakeholders. A similar procedure was used during the revision of the Strategy, which took place during 2017 and 2018. The CIO met six times since June 2017 at each key stage of the review process (such as validating the main assumptions or the final text of the draft strategy). In addition, CIO members have also been invited to participate in the meetings of the different sectoral and cross-sectoral working groups.

In the future, civil society representatives (including trade unions) should also be associated with the next revisions and update of the SNBC. The text of the Strategy lays down that such a revision should take place every five years. Furthermore, according to the French Law, the National Council for the Environmental Transition should be consulted by the government on any law relating to energy and climate change.

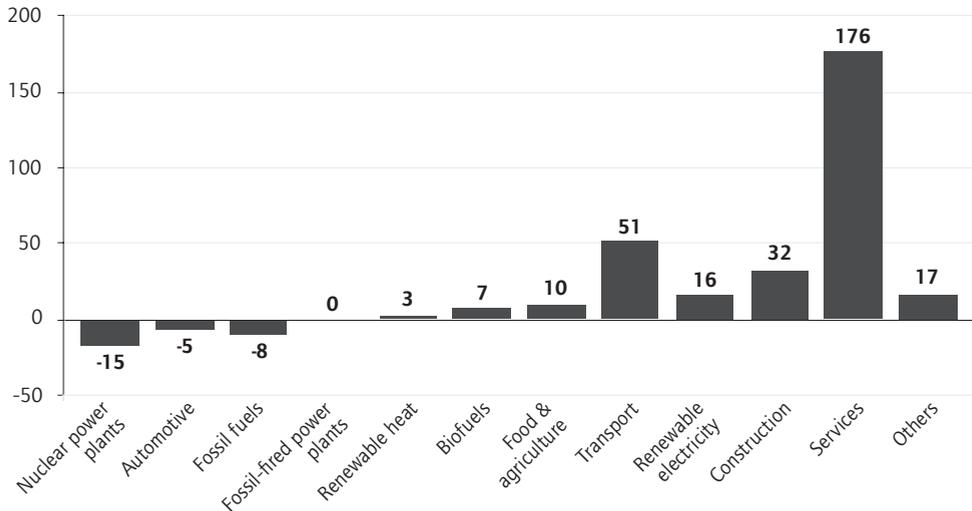
### **Expected impacts on employment and skills**

The SNBC's macroeconomic assessment anticipates that the implementation of the Strategy would have a positive effect on growth and job creation: 300,000 to 400,000 additional jobs by 2030 and 700,000 to 800,000 new ones by 2050 compared to the baseline scenario. In the same way, it is estimated that the implementation of the measures contained in the Multiannual Energy Plan (which relates to energy issues only) would also have a positive effect on employment to the extent of 280,000 new jobs by 2030.

Important differences between sectors are expected, however, as Figure 4 shows (e.g. job creation in the environmental sector, construction, transport and services; but job losses in nuclear, automobiles and carbon-intensive sectors). The transition is also expected to have major impacts in terms of qualifications and skills (the 'greening' of

certain activities implies the need for new skills and job profiles and may have effects as regards health and safety at work, etc.).

Figure 4 Estimated employment impacts, by 2030, of the implementation of the Multiannual Energy Plan (in 000)



Source: PPE.

As an adequate policy is required in advance, one of the cross-cutting recommendations of the SNBC facilitates the implementation of tools aimed at anticipating and managing the impacts of the transition upon employment and skills. This includes two main measures: the first is an adaptation of education, vocational training and lifelong learning structures and programmes to the needs of a greener economy; while the other is the encouragement of better integration and understanding of issues to do with the transition among sectors, companies and regional authorities, and in favour of occupational shifts, reskilling and the development of green jobs.

The latest recommendation includes awareness-raising actions as well as the development of sectoral and/or regional prospective job and skills management strategies (GPEC). To support this, several tools have been designed such as, for example:

- employment and skills management plans (PPEC; *Plan de programmation de l'emploi*) which aim at mapping employment and skills evolutions at regional level in relation to the implementation of regional climate, air and energy strategies. PPECs are to be elaborated by regional public authorities, in cooperation with social partner organisations. They relate only to the energy sector;
- sectoral prospective jobs and skills management plans (to be elaborated by the social partners, in the framework of sectoral skill councils);

- publication of a methodological toolkit aimed at supporting professional conversions within the sectors affected by the transition in terms of developing alternative career path possibilities (French Government 2019a). This guide (which has been tested in four French regions) is designed for various stakeholders such as public institutions, sectoral organisations, social partners and companies;
- environmental transition contracts (French Government 2019b), which are tools seeking the involvement of regional communities and economic actors within a global (and regional) approach to environmental, economic and social issues (see below).

## 2. France's last coal-fired power plants

The French government announced in December 2017 its intention to close the remaining French coal-fired power plants by 2022 (Rouaud 2019). These four units (five blocks of 600 MW) have a total installed production capacity of around 3 GW. Their planned decommissioning follows a first wave of closures that occurred between 2013 and 2015.

### 2.1 Location, production and employment

#### Four plants, four regions, two owners

The four power plants are located in different parts of France and are the property of France's EDF and Spain's Uniper. Table 2 summarises their main characteristics.

The Cordemais (EDF) power plant is the most important. It operates two 600 MW units and produces 25 per cent of the total electricity consumed in the Loire-Atlantique region (4.28 TWh). There are 462 EDF employees working at the site (which is 150 hectares), as well as 250 permanent employees of external services providers. The site also hosts fifty apprentices and trainees. Until recently, two oil-fired production units were also functional (2 x 700 MW) but these were closed in 2017 and 2018.

The Le Havre power plant (EDF) is located in Upper Normandy, in the very heart of the Le Havre agglomeration. The plant, built on a site of 33 hectares, has one remaining production unit of 600 MW, two units (250 MW and 600 MW) having already been shut down in 2013. The plant's immediate proximity to the sea allows for the unloading of coal at the quayside and the cooling of the production unit by seawater. 221 people are currently working on site. Service providers reinforce EDF staff during peak periods.

The Gardanne power plant (Uniper, 600 MW) was commissioned in 1984 and is known for having the highest chimney in France (at 297 meters). As far back as 2011, Uniper announced its intention to transform it into the largest biomass plant in Europe. Several tests have been carried out since 2016 but the project is now being questioned because

of its high cost and because of environmental concerns (see below). Here, 180 jobs are under threat.

The Emile-Huchet (Uniper) plant (600 MW) is located between the cities of Saint-Avold and Carling (Moselle). Commissioned in 1981, it produces electricity from both gas and coal. More than 350 people were working at the site in 2012, but at least 100 jobs have been cut since then. According to the unions, up to 150 jobs are at risk as a result of the forecasted closure.

Table 2 French coal-fired power plants and their main characteristics

Site	Company	Start of operations	Installed capacity	Employment
Cordemais	EDF	1983	1200 MW	462 employees
Le Havre	EDF	1963	600 MW	221 employees
Gardanne	Uniper	1984	600 MW	180 employees
Emile-Huchet	Uniper	1981	600 MW	250 employees

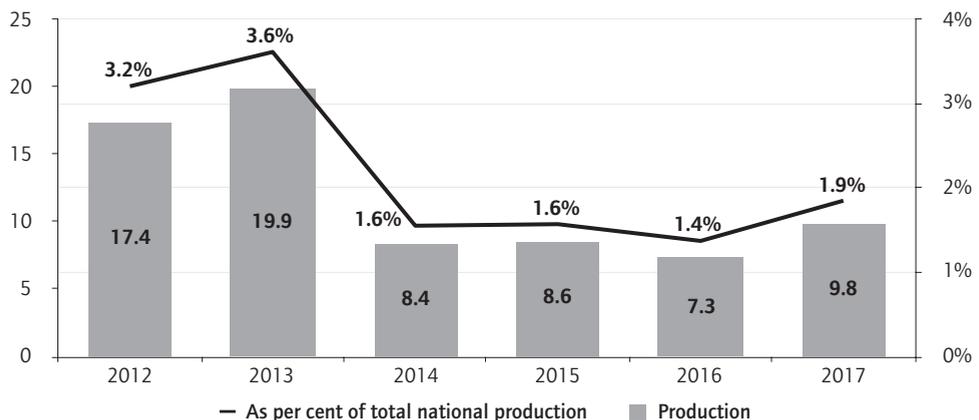
Source: EDF, trade unions and own research.

All these plants have recently been modernised in order to adapt to the emissions standards set by the Industrial Emissions Directive (IED). EDF has, for example, deployed a €480m investment plan aiming at the installation of flue gas treatment systems and dust collectors, as well as de-sulphurisation and de-nitrification facilities.

### Production and sourcing

In France, coal-fired power plants, like all other fossil-fuelled production units (gas, oil) are used only and during peak periods (from September to April). During the last three years, their share of total national electricity production has ranged from 1.6 to 1.9 per cent. In 2017, their production level was relatively high (9.8 TWh), as Figure 5 shows, due to maintenance being undertaken at several nuclear facilities.

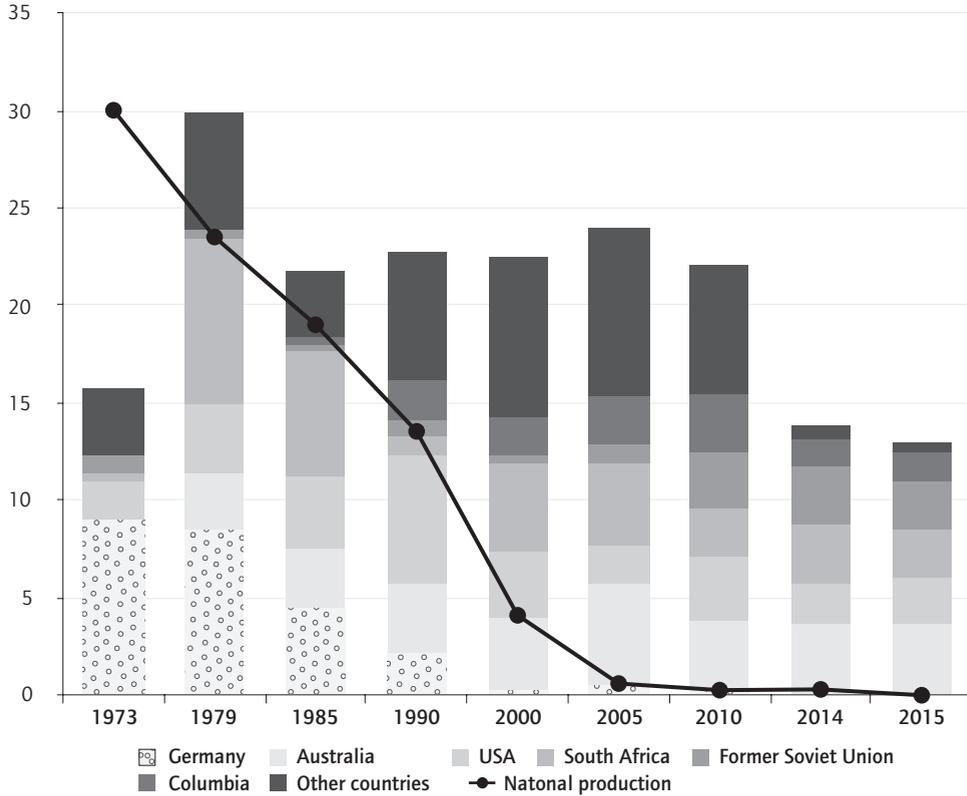
Figure 5 French production of electricity from coal (TWh)



Source: RTE.

The coal used to produce electricity is sourced only from imports. Figure 6 shows the development of national coal production and coal imports with their composition in the most recent decades. France closed its last coal mine in 2004. Since then, production has been limited to salvage operations from heaps, located in the Hauts-de-France, Gard and Lorraine regions. This ceased in 2015.

Figure 6 France's national production and imports of coal per country of origin (tonnes, m)

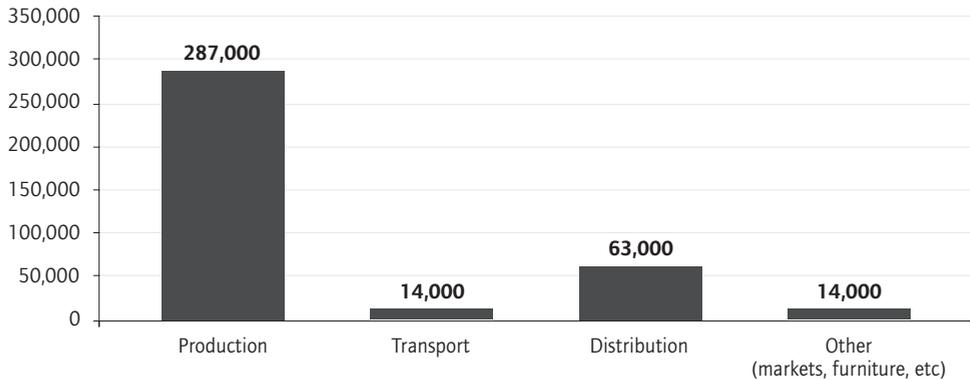


Source: INSEE.

### Only a small share of employment in the sector

According to the French Electricity Union (UFE, Union française de l'électricité), employment in the electricity sector represents a total of 378,000 jobs (direct and indirect jobs) of which 75 per cent are in the production sector and twenty per cent in the transport and distribution sector.

Figure 7 Direct and indirect employment in the French electricity sector (2016)

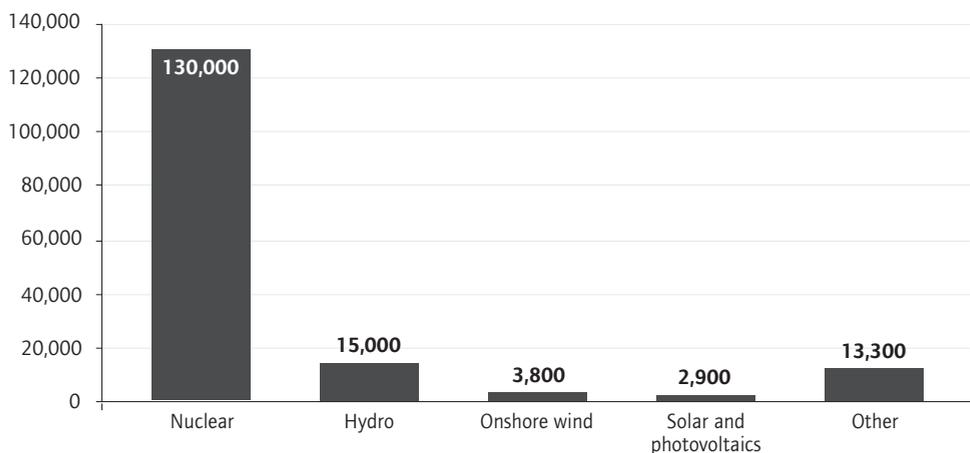


Source: UFE.

In the production sub-sector, around 165,000 jobs are associated with the exploitation and maintenance of power plants; the rest being linked to investment (construction, repowering, decommissioning), with around 40,000 jobs; and other activities (R&D, public authorities, etc.) and exports, accounting for some 83,000 jobs.

Employment in French power plants has remained stable over several decades. In 2016, nuclear power plants took the lion's share of this category (130,000 jobs), followed by hydro (15,000), wind energy (3,800) and solar and photovoltaics (2,900), as Figure 8 shows. The remaining workers (around 13,000 jobs) are employed in fossil-fuelled power plants (gas, coal and oil) and in the bio-energy sector (waste, biomass and biogas).

Figure 8 Direct employment – exploitation and maintenance of power plants (2016)

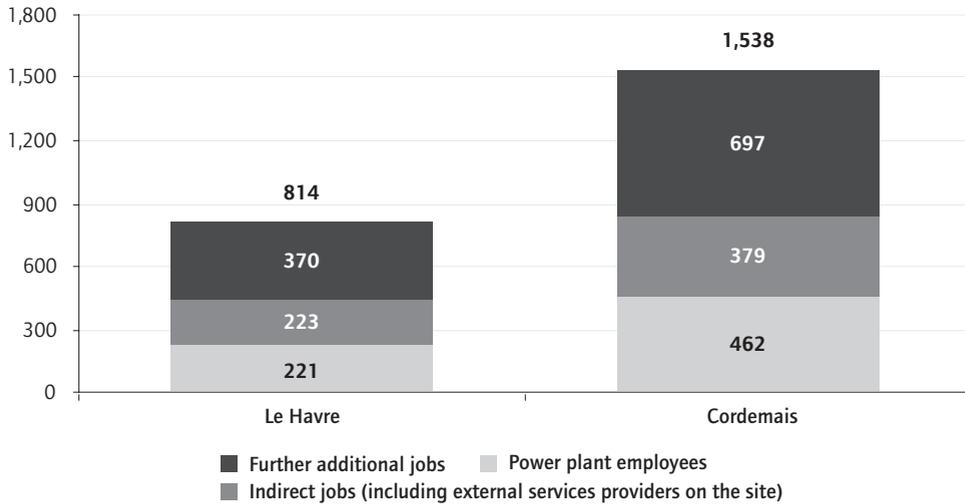


Source: UFE.

Direct employment in our four remaining coal power plants accounts for slightly above 1,000 jobs and represents therefore only a minor part of the sector’s total employment.

There is no evaluation of how many indirect jobs are supported by the activity of these power plants. According to the UFE, a ratio of 2.5 indirect jobs can be associated with each direct job in a coal power plant. Following this hypothesis, some 2,500 additional jobs could directly depend on these facilities. As there are important differences between these units (location, presence of other production units, technology, etc.), this number cannot, however, be considered a precise estimate and it could indeed be understated. Recently, an internal study made by EDF has estimated that the total employment impact of the closure of its Cordemais and Le Havre plants could reach 2,300 jobs (see Figure 9). The CGT trade union assesses that around 5,000 jobs are linked directly or indirectly to the activities of the four plants.

Figure 9 Estimate of the total employment impacts of the closure of EDF’s Le Havre and Cordemais power plants



Source: EDF.

## 2.2 The first wave of closures of coal-fired power plants (2013-2015)

As mentioned, the closure of these four power plants represents a second wave of closures after those that occurred between 2013 and 2015, when EDF and E.ON<sup>2</sup> proceeded to the closure of fifteen coal-fired production units.

These closures primarily affected the oldest production blocks (fourteen units of 250 MW and one unit of 600 MW, opened between 1958 and 1971). Table 3 below shows

2. E.ON has subsequently been transformed into Uniper France.

that there has also been an impact on sites which are still in operation (i.e. the closure of production units at Gardanne, Emile-Huchet and Le Havre).

The decision to close the units is linked both to environmental and financial reasons, with the cost of adapting the plants to fulfil the requirements of the IED Directive being seen as too high. Furthermore, the entry into force of the second phase of the EU ETS (and therefore the obligation to buy 100 per cent of the GHG emissions quotas) had seriously damaged the economic model of these facilities.

Table 3 Coal-fired power plants affected by closure between 2013 and 2015

Company	Name	Opened	Production	Units closed	Date of closure	Estimated direct employment
EDF	Bouchain	1970	650 TWh (2009)	250 MW	2015	65
	La Maxe	1971	1292 TWh (2009)	2 x 250 MW	2015	110
	Blénod	1963	2 820 TWh (2010)	3 x 250 MW	2014	145
	Vitry	1970	1 172 TWh (2010)	2 x 250 MW	2015	110
	Le Havre	1968	3 914 TWh (2010)	250 + 600 MW	2013	337
E.ON	Gardanne	1967	2 507 TWh (2009)	230 MW	2013	
	Emile Huchet	1958		125 + 330 MW	2015	357
	Hornaing	1970	475 TWh (2009)	235 MW	2013	86
	Lucy	1971	543 TWh (2009)	245 MW	2014	67

Source: own research.

No study or research has been made on the employment impacts of these closures. According to publicly available data (regional press, trade unions and employer sources), it can be estimated that 800 to 950 direct jobs have been cut. The closures have, however, not led to redundancies.

Both companies deployed measures intended to limit the social costs of the closure: early-retirement measures; internal mobility;<sup>3</sup> outplacement; and voluntary departure schemes. Some of the workers are also working on the decommissioning of the production units and/or are participating in the cleaning-up of the sites.

From a social point of view, it seems that the social transition has been easier at EDF than at E.ON facilities (Chape 2012). EDF employs 160,000 people in France and had, therefore, much better internal mobility possibilities than E.ON. Furthermore, EDF workers could benefit from the generous prospective employment and skills management scheme, signed in 2009 (Liaisons sociales 2009).

Two of the former EDF coal-fired sites have also benefited from investment in new gas-fired production facilities. In 2016, EDF inaugurated a new gas combined cycle plant of 600 MW in Bouchain. The plant already produces twenty per cent of the total electricity

3. After retraining, some EDF workers have, for example, been moved to some of the company's nuclear power plants.

consumed in the Hauts-de-France region (3 TWh in 2017).<sup>4</sup> According to EDF, the plant is listed in the Guinness Book of World Records for its efficiency. On 28 April 2016, its efficiency performance reached 62.22 per cent. Sixty workers are working on the site, among them being twenty former workers of the coal-fired unit. In 2011, a similar unit (438 MW) was opened in Blénod, for which EDF evaluates the total investment cost at €350m. The new production unit is used during high consumption periods and employs 45 workers, as well as thirty people engaged in the provision of external services.

### **3. Closing the power plants: a sensitive issue from both a social and a technical point of view**

The closure of the power plants will, of course, not be an easy task due to the social concerns that this project raises and to the opposition of workers and trade unions. According to RTE (Réseau de Transport d'Electricité), the managing authority for the national transmission network, there are strict conditions that must also be filled from a technical point of view.

In order to address the social and economic consequences of the decommissioning of the plants, the French government has announced its intention to manage the transition of the four regions towards a greener economy through the adoption of environmental transition contracts.

The pilot phase of this programme started in 2018, but no ETC has, for the moment, been designed for any of the sites. At the same time, alternative projects aiming at converting the plants into biomass-fired units have emerged for Cordemais, Le Havre and Gardanne. While the two EDF plants may be allowed to extend their activity beyond 2022, the future looks much more uncertain for Uniper's workers in Gardanne, with the closure of the Saint-Avold plant within the next four years definitely confirmed in November 2018 (Lhuillier 2018).

#### 3.1 Social and technical concerns

##### **Strong opposition from trade unions and workers**

The project to close the plants is confronted with the opposition of workers and all the major trade unions (CGT(2019), CFDT, FO (2018) and CFE-CGC), who are fighting for the extension of the lifespan of the production units and/or for the development of alternative projects.

CGT is the strongest trade union in both EDF and Uniper's plants. In Le Havre and Cordemais (EDF), CGT, FO and CFE-CGC have created a joint trade union committee

---

4. <https://www.edf.fr/groupe-edf/producteur-industriel/carte-des-implantations/centrale-a-cycle-combine-au-gaz-naturel-de-bouchain/presentation>.

to defend workers' interests. According to CFDT, trade union membership reaches around sixty per cent in these two plants.

Since the government's decision (French Government 2018a), several protests, including strikes, have been organised. In March 2018, a one-day strike was held at Cordemais and Le Havre. Entry to both sites was blocked by workers from the plants and from the two neighbouring ports (Le Havre and Nantes-Saint Nazaire). Fresh industrial action was organised during autumn 2018, with production being stopped for one day at Cordemais on 9 October. At Uniper's Saint-Avold site, twenty workers went on strike for the first time in May 2018 before again ceasing work on 22 November. On 13 December, a demonstration (following the call of CGT) was held in Paris, in front of the Ministry for the Environmental Transition. At the same time, a new strike was started by workers in the four power plants and the three ports hit by the closure project (the two already mentioned, plus Fos-Marseille). Production had restarted at Cordemais on 9 January as workers had been requisitioned by RTE due to high winter electricity demand. The strike was still ongoing at Gardanne until August 2019 when negotiations about a possible reconversion plan were started.

CGT and FO argue that the government should withdraw the closure project. According to them, the plants represent only a minor part of France's CO<sub>2</sub> emissions and taking them off-grid represents a threat to the French electricity system as coal-fired plants play a crucial role in responding to winter demand peaks. Both organisations have also denounced the high social costs of the closure, which could lead to up to 5,000 job losses, according to CGT.

CFDT has a more balanced approach regarding the transition. This trade union supports the decarbonisation of the energy sector but denounces the lack of visibility on the future of the sites. It also calls on the government to set employment as one of the priorities of the transition and underlines that it will be vigilant for solutions to be found for all employees concerned by the upcoming restructuring.

Naturally, all the trade unions support the conversion projects as developed by EDF and Uniper (see below).

### **Concerns regarding the electricity supply security**

The closure of the plants is not only an environmental issue but also represents a challenge with regards to the security of electricity supply. According to RTE, ceasing electricity production from coal by 2022 is feasible, but only if certain strict conditions are met. These conditionalities apply at both national and local levels.

#### *Supply/demand equilibrium of the national electricity grid*

In recent years, the implementation of the French energy and climate strategy has already led to the closure of several electricity production units (both oil and coal-fired). According to RTE's last annual report on the national electricity balance (RTE 2018):

- Currently, there is no overcapacity left in the electricity production system. The production fleet is now dimensioned in practice and not only in theory.
- This analysis integrates the contribution of the different interconnections between France and its neighbouring countries. Even if the country remains a net exporter during most of the year, it occasionally uses imports during winter consumption peaks.
- Today, France is in an atypical situation compared to its neighbours, as the flexibility of its production fleet is very much based on hydro and nuclear power. This situation is at the source of the country's very good performance in terms of GHG emissions. Nevertheless, it entails a strong dependence on the performance of the nuclear fleet.

Considering the numerous challenges being faced by the French energy system in relation to the transition, ensuring equilibrium between supply and demand is a primary concern for RTE. The situation is all the more complex due to the different constraints and uncertainties related to the availability of the French nuclear fleet:

- A major part of it was built in the early 1980s. Despite the government's will to reduce the share of nuclear energy, a great number of the plants should see their activity prolonged above their originally foreseen forty-year period of operation. The extension of their lifespan will necessitate safety inspections and maintenance periods that will lead to their unavailability. Usually, their length goes from 100 to 200 days. Most of the time, however, the unavailability of the plants is longer than initially planned (up to sixty additional days on average). In 2016, France already had problems with the unexpected unavailability of several nuclear power plants during the winter period. This situation resulted in increased imports and important price hikes.
- On 1 February 2019, the French government confirmed the closure of the Fessenheim nuclear power plant by summer 2020 (Chhum 2019). Originally, this closure was conditioned to the start of operation of EDF's new EPR (third generation pressurised water reactor) unit in Flamanville. The Flamanville nuclear plant has, however, suffered several delays due to a string of serious technical problems. According to EDF, the reactor should be connected to the grid in the first quarter of 2020, and its commercial start at full power has now been scheduled for the second quarter of 2020. Nevertheless, further delays are possible. Moreover, as set by French regulations regarding nuclear safety issues, the plant is also planned to be stopped for a long safety inspection after 18 months of operation.
- Last but not least, it has also to be mentioned that France is currently not on track to meet its renewable energy targets, set by the Multiannual Energy Plan. Regarding wind energy, the level of additional annual capacities needed to reach the objectives was met for the first time in 2017. Additional investments are also needed in solar and offshore wind energy production.

According to RTE, the forecasted evolution of the supply-demand equilibrium does not make it possible to plan the closure of any production facility before mid-2020. During winter 2020, some limited security margins should reappear, making it possible progressively to close the coal-fired plants,<sup>5</sup> but only under strict conditions as listed below:

- Overall stability in electricity consumption should be secured. Increased investments in renewable energies are necessary and the development of interconnections with neighbouring countries (three new interconnection lines are to be opened in 2020 and 2021 between France and Italy and the UK) should proceed.
- A higher flexibility of the electricity system is necessary with the development of demand response mechanisms and proper and timely management of nuclear plant safety inspections.
- The start of operation of the Flamanville EPR and of the new gas combined cycle power plant planned by EDF in Landivisiau (CCGT, 400 MW) is also necessary.

#### *Concerns over Brittany's security of electricity supply*

Historically, the security of the electricity supply in the region of Brittany (near to which the Cordemais plant is located) has always been considered as 'fragile'.

This situation is linked in particular to the low production capacity installed in the region (the 'electric peninsula' situation). In 2010, an 'electricity supply pact' was signed by the French state, the Brittany regional authorities, RTE and ADEME (Compagnie électrique de Bretagne 2010). The pact sought to reinforce the security of the electricity supply in the region through increased energy efficiency, a reinforcement of the network and the development of additional production capacities (via renewables including a 450 MW offshore wind farm in Saint-Nazaire and the construction of the Landivisiau plant). Since the construction in 2017 of a high voltage underground power line, the situation is considered to have been stabilised.

Despite this, concerns remain regarding the stability of the regional electricity supply system, especially during consumption peaks. In winter, electricity imports from the UK and Belgium tend to rise. Imported electricity is transported over long distances and crosses the transmission networks not only of Brittany but also of the Loire-Atlantique and Ile-de-France regions, two regions which, similar to Brittany, are not themselves well-endowed with the means of production. Long-distance transport has the effect of causing a voltage drop that can be marked if consumption is high. In such situations of low voltage, the electricity system is weakened with the risk of a collapse of voltage that can spread to surrounding areas.

---

5. Two units by mid-2020, two in 2021 and the last remaining one in 2022.

The Le Havre and Cordemais power plants therefore play a key role regarding Brittany's electricity supply. According to RTE, their closure will be possible only after the Landivisiau plant has been started up.

### 3.2 Employment transition contracts

In 2018, the French government announced the creation of the environmental transition contracts programme to incentivise and speed up the transition towards the low-carbon economy at regional level. The pilot phase, which covers four areas, was launched in 2018 and, during 2019, eight new ETCs will be set up (French Government 2019b).

Initially, the government planned to include the sites of coal-fired plants in the first pilot phase. However, for the moment, no ETC has been designed for them which may be explained by the plants' still uncertain futures. Despite the closure announcement, no specific plan or road map has been drawn up even though projects for alternative uses are being developed.

#### **What are environmental transition contracts?**

Environmental transition contracts are strategies that take the form of binding agreements (contracts), designed for and by regional authorities and companies, which seek to advance the implementation of the economic and social transition to a low-carbon economy in French regions and territories. ETCs are based on local or regional low-carbon development initiatives and are adapted to the economic and environmental specificities of each area. Regarding their content, ETCs have the following main objectives:

- they constitute the main axis of the local low-carbon transition strategy and set the objectives to be achieved in terms of environmental gains (green energy produced, carbon emissions avoided, etc.);
- they include specific actions and investment projects to achieve the defined objectives in developing local low-carbon industry or services, as well as the role the different parties will play. They also include a monitoring procedure;
- these objectives can relate to a wide range of different measures, such as the development of renewable energies, energy efficiency projects and circular economy loops; and measures targeting agriculture, construction, urbanism, mobility or biodiversity, etc.

Table 4 below provides examples of the different measures that can be implemented.

According to the French Ministry for the Environmental Transition, ETCs are not meant to be only a list of environmental projects. Their objective is to create a 'stimulating'/'spill-over' effect across the whole area on which they are implemented through the development of the local (or regional) economic and social structure:

the development of new economic activities in relation to the selected projects; the development of local sourcing; the adaptation of educational and vocational training programmes; etc.

Table 4 Main measures under the ETC framework

Field	Type of measures – examples
Renewable energies	Use of industrial buildings for the production of renewable energy (e.g. the large-scale deployment of solar panels on the roofs of buildings) and the creation of economic activity around the operation/maintenance of these panels.  Construction of hydrogen production units coupled with green electricity production – training/retraining programmes for employees whose activity is adversely affected by the transition.  Widespread development of renewable energies in an area, correlated with the establishment of energy production cooperatives
Energy efficiency	Implementation within an industry of an energy use optimisation plan – training of employees  Energy efficiency renovation plan targeting public administration buildings (or social housing) – creation of local SMEs and the hiring of long-term unemployed people
Circular economy	Development of activities linked to recycling and re-use (for example of construction materials)  Collection and storage of unsold food products – development of a canning industry
Construction / urbanism	Creation of virtuous economic zones and/or areas  Building renovation programmes

Source: French Ministry for the Environmental Transition.

This approach makes it necessary to establish a proper governance system but also to develop synergies between the different projects included within the ETCs to identify possible partnerships, organise the actors, identify possible means of financing and provide the parties with the necessary administrative, technical and legal support.

### Who can participate?

ETCs are based on a voluntary approach which means that contracts will only be signed in those regions and by those parties which have declared their interest in participating in the programme.

ETCs are primarily designed for public bodies and companies. To be successful, a project needs, however, to gain the support of as many local stakeholders as possible. That is why, once a project has been identified, various actors – such as regional/local chambers of commerce, business organisations, trade unions and environmental NGOs – will be invited to participate. Participation implies becoming a party to the contract and, therefore, being bound by hard commitments (to advance the achievement of the overall objectives).

The development of an ETC presupposes an initial dialogue between public bodies and companies, as well as the identification of common needs and objectives. Here, networks involving businesses and state authorities play a crucial role. To encourage the development of such collaborations, the French government has set up a country-wide communications plan targeting the different local stakeholders.

As the participation of companies is critical, specific measures aiming at mobilising business have also been established. These include the following activities:

- integration within ETCs of a communications/marketing aspect intended to encourage business participation in the different projects (local communications strategies; help with getting funding; integration in the Clean Tech Network (a platform connecting innovative companies); etc.) is one of the core elements of an ETC;
- targeted communication with companies through local chambers of commerce and public regional development agencies, as well as with business associations, sectoral organisations, academia and companies that have been set up in special economic zones or that are part of an industrial cluster;
- the involvement of major French industrial groups such as EDF and Total;
- specific measures targeting the creation of ‘start-ups’, for example via the provision of free experimental sites, help with funding and with the organisation of partnerships through the Clean Tech Network, and the organisation of meetings between start-ups and regional and local authorities.

### Approach

The establishment of ETCs is supposed to be based on a fast, three-month negotiation with the objective of maintaining the initial momentum. In this context, although the approach will obviously be adapted from location to location, the elaboration of the contract should include the following steps:

- rapid diagnosis, based on existing tools, studies and plans, of local climate, air and energy plans (*Plan Climat Air Energie*); local waste prevention programmes; other territorial projects; existing socio-economic studies; etc.);
- the quick identification of potentially-interested stakeholders, including local businesses; chambers of commerce in agriculture and trades; trade unions; and active NGOs. This phase includes a call for participation by companies and initial information meetings, as well as a call for contributions from the general public;
- the organisation of a mini-‘Grenelle’ conference<sup>6</sup> over one or two days (presupposing the participation of trade unions) to identify possible courses of action based on the projections and objectives of the existing territorial development plans. The objective at the end of this phase is to have completed the identification of the

---

6. The *Grenelle de l’environnement* was an open multi-party debate, held in France in 2007, that brought together representatives of national and local government and organisations (industry, labour, professional associations and non-governmental organisations), with the goal of defining the key points of public policy on issues connected with the environment and sustainable development over the following five-year period. The name ‘Grenelle’ comes from the first conference bringing all these players together, which took place in May 1968 in the Rue de Grenelle ([https://en.wikipedia.org/wiki/Grenelle\\_Environnement](https://en.wikipedia.org/wiki/Grenelle_Environnement)).

strategic axes of the ETCs as well as to have identified the specific actions to be undertaken;

- the organisation on this basis of a public consultation process and a public campaign aiming at the mobilisation of citizens;
- the negotiation of the contract establishing these actions, particularly as regards their financial and regulatory aspects.

### **Governance**

The establishment and execution of the ECT is placed under the legal and operational responsibility of an inter-town cooperation network (ECPI; Etablissement de Cooperation Intercommunale). ECPIs are groupings of towns or other local/regional authorities (counties, for instance) whose aim is to encourage intra-regional cooperation. They have the status of a public body with legal identity and are usually created for specific purposes such as territorial development issues or projects.

Once the ECPI has been set-up, a specific team in charge of the negotiation, management and follow-up of the ETC must be created. This project team is composed of the following participants:

- representatives of the aforementioned stakeholders identified for the project;
- a representative of the National General Council for Environment and Sustainable Development (CGEDD) – a national public body which provides consultancy and expertise to public authorities in the areas of sustainable development, infrastructure, transport, the energy environment and housing construction and planning;
- local representatives of various public agencies, such as the National Water Management Agency, the Regional Development Agency, the French Environment & Energy Management Agency (ADEME), etc.;
- a representative of the Deposits and Consignments Fund (CDC; Caisse des Dépôts et Consignations) – a French public sector financial institution created in 1816 and one of the government institutions under the control of parliament. Often described as the ‘investment arm’ of the French state, it is defined in the French Monetary and Financial Code as a ‘public group serving the public interest’ and a ‘long-term investor’.

As regards the elaboration of the contract, specific support mechanisms may be put into place in order to help the parties during the negotiation process (approach, mechanisms intended to encourage dialogue, economic and technical evaluation of proposals, etc.).

To strengthen the efficiency of ETCs, the French state has decided to set in place a range of measures to simplify and shorten administrative procedures. The different

state agencies involved (DREALs, the regional directorates for environment, urban planning and housing; DDTs, the regional area directorates; DIRECCTEs, the regional directorates for enterprises, competition policy, consumer affairs, labour and employment; ADEME, the French Environment & Energy Management Agency; the CDC; etc.) in the ETC will provide the project holders with regulatory, financial, social and administrative support. A single window procedure will be defined to facilitate the process. Furthermore, derogation procedures will be set down to simplify the administrative formalities (shorter delays, a single administrative procedure for the different environmental permits, lower administrative burdens, etc.).

## Financing

No specific funding has been arranged to finance the different measures and projects which will be developed in the framework of ETCs. Instead, the French government plans to finance them through already-existing measures and funds targeting the transition: measures aimed at increasing energy efficiency and the development of renewable energies; specific funds for air or water quality improvement; heating funds (Fonds Chaleur<sup>7</sup>); etc. The Deposits and Consignments Fund will grant loans on the basis of its 'Green growth loans' programme while the financial agency may also participate in certain projects through direct investment.

In the field of research and innovation, companies will be supported in the search for national or European funds, including the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the various funds for research and innovation (Horizon 2020, European Fund for Strategic Investments (EFSI), the Investments for Future programme (PIA3), etc.). The French government also plans the mobilisation of private funding through the creation of financing hubs, dedicated savings schemes and the use of crowdfunding tools.

As already mentioned, participants in ETCs commit themselves to achieving specific environmental objectives. If these objectives are not met, the project holders must totally or partially reimburse the funds that have been obtained.

## The social approach

Within the framework of ETCs, several tools and measures are planned to address the social aspects of the transition. In particular, a territorial analysis has to be carried out to identify the jobs that may be at risk as well as the probable need for new jobs and skills profiles. This analysis is conducted at local level, in collaboration with companies, and an action plan may subsequently be set up whose objectives will be included in the ETC (as binding commitments). Financing for this aspect will be made available from DIRECCTE through its EDEC system (a specific fund for the establishment of employment and skills management plans).<sup>8</sup>

---

7. The Heating Fund, managed by ADEME since 2009, participates in the development of renewable heat production. It is intended for collective housing, communities and businesses.

8. [https://les-aides.fr/fiche/bpBrDntGxfTeBGZeTUzZ4\\$Vm/directce/edec-engagement-de-developpement-de-l-emploi-et-des-competences.html](https://les-aides.fr/fiche/bpBrDntGxfTeBGZeTUzZ4$Vm/directce/edec-engagement-de-developpement-de-l-emploi-et-des-competences.html).

Other measures targeting the social aspects of the transition include the provision of free human resources consulting for businesses, such as professional support for mobility (schemes intended to encourage intra-sectoral mobility, facilitate exchanges of personnel between companies and provide assistance with geographical mobility). Support for training, at company level and through the National Employment Fund (FNE) and the National Employment Agency, is also available. Measures including the adaptation of local educational and vocational systems, or the development of ‘green skills’ certification schemes, are also part of the programme.

## 4. Alternative projects

In recent years, both EDF and Uniper have started projects to convert coal power plants into biomass-fired units. While EDF’s units may see their activity extended beyond 2022, Uniper’s project in Gardanne is, however, under threat given the environmental concerns that exist.

### 4.1 EDF: Ecocombust

EDF’s Ecocombust project (EDF 2019), which began in 2016, aims progressively to replace coal burned to produce electricity with a new kind of biomass-based fuel consisting of consolidated and dried wood waste that cannot currently be used (and which is usually buried or sent to landfill). The project, in which EDF has invested around €10m so far, is being carried on at both Cordemais and Le Havre plants.

Under this programme, biomass would be sourced locally. It is then supposed to be transformed into pellets that the company plans to produce on-site and in respect of which a pellet production prototype has been started. At the same time, EDF is continuing with a complementary project (*Caméléon*) that aims to capture and recycle the residual carbon emissions still emitted by the plant (Serres 2018). This could be done through microalgae culture with the CO<sub>2</sub> then methanised to serve the production of biogas or fertilizers (total investment cost estimated at €70m).

The initial results of the Ecocombust project have been encouraging. According to the company, the implementation of this technology could lead to a significant reduction in CO<sub>2</sub> emissions (which could be divided by 25). In Cordemais, the company has run a series of tests that have allowed the powering up of the plant with eighty per cent biomass and only twenty per cent coal. The company has ensured that it is possible for biomass to reach an 87 per cent share without the need for modification of the production units. Similar tests have been conducted in Le Havre albeit with, for the moment, a much lower input of wood waste.

In January 2019, the Ministry for the Environmental Transition announced that EDF may be authorised to convert its coal-fired units and extend their lifespan up to 2026. This, however, is only as long as the concerns over Brittany’s security of electricity supply continue. This potential authorisation is, therefore, linked to the

possible start-up of the operations of EDF's Landvisiau gas power plant and of the 450 MW offshore wind farm at Saint-Nazaire (French Ministry for the Environmental Transition 2019).

According to the Ministry, should agreement be given, the plant would, however, be allowed to use annually only a maximum of four per cent of the quantity of coal it currently needs to function. This means the plant's activity would be reduced to 800 hours per year against 4,000,000 hours at the moment. The project would, therefore, not allow all existing jobs to be saved since the workforce would have to be reduced proportionally.

## 4.2 Uniper

In 2014, Uniper converted one of the coal-fired units at Gardanne into a 150 MW biomass plant. The total investment cost is estimated at €250m. Eighty people are currently working in the new unit. The project is planned to be based, for one-half of its biomass needs (a total of 850,000 tonnes per year), on local sourcing.

The project was given the approval of the regional authorities in 2012, with the company obtaining a feed-in tariff of €115/MWh over the next twenty years (compared with a €35/MWh market price for conventional generation). According to Uniper, the success of the project could help to maintain around 150 jobs on the site as well as 1,000 indirect ones (Isnard-Dupuy 2018).

The project is, however, facing strong opposition from numerous NGOs and the National Forest Office (ONF), as well as from the managing authorities of two nearby national parks (Luberon and Verdon), because of its potential negative impact on the environment. This is because Uniper plans to fuel the power station with forest biomass, which could have a detrimental effect on the local ecosystem. At the moment, only a minor part of the biomass is sourced locally, the rest being imported from Spain and from Brazil. Pollution linked to the combustion process (fine particulate matter – PM<sub>2.5</sub>) and to the transport of biomass (thirty trucks per day) has also been pointed out (Isnard-Dupuy 2018).

In 2017, the plant's environmental permit was cancelled by Marseille's administrative court on the grounds that the plant's environmental impact study focused only on a 3km area whilst Uniper planned to source local biomass in forests located up to 250 km from the plant. Uniper appealed against the court's decision and has been granted temporary production authorisation by the regional authorities. The final decision of Marseille's administrative court is expected to occur in the second half of 2019.

In the meantime, in December 2018, the company announced its decision to sell all its French assets (which include two gas-fired units, six wind farms and two solar plants in addition to the two coal plants) to the Czech company EPH (Energetický a Průmyslový Holding), owned by Czech billionaire Daniel Kretinsky. Following this, EPH announced its willingness to negotiate with the French state the extension of the lifespan of the

coal-fired plants beyond 2022 and its intention to transform all of them into biomass units. Evidently, there is no guarantee of success in this endeavour.

## 5. Conclusion

The newly-created environmental transition contracts can certainly be regarded as valuable instruments to promote and manage the transition towards a greener economy at regional and local levels, at the same time advancing the achievement of the targets set by the National Low-Carbon Strategy. Even though it is still a little early to claim they are going to be successful, they nevertheless constitute an interesting example of how the transition can be managed as well as a transposable experience for many European countries or regions struggling to adapt their economy. Among the different positive aspects of ETCs, three of them in particular can be highlighted:

they provide the opportunity for an integrated reflection on the future of the regional economy by encouraging the emergence of local initiatives and by linking the low-carbon transition with the development of the local economic and social structure;

their social dimension favours the implementation of a just transition for workers (green and decent jobs), as promoted by the ETUC. In this field, as in others, ETCs set specific objectives. Furthermore, they encourage the anticipation of change through the adaptation of local educational and vocational training systems while also promoting lifelong learning;

ETCs are based on the presence of wide local debate integrating all relevant stakeholders (from NGOs to trade unions). Such a level of association favours the development of common objectives and the acceptance of conversion projects. Seeking the acceptance of the largest number is of particular importance, especially in the context of the *gilets jaunes* crisis – a series of major protests initiated following a rise in the French carbon tax and which has shined a spotlight on the high costs of the transition.

Despite these positive aspects, the question of whether or not environmental transition contracts are the proper instruments for managing the closure of coal-fired power plants or their conversion into a new activity remains unsolved. Indeed, many questions arise: what kinds of new activities could be developed on the sites or close to them? As ETCs are based on a voluntary approach, what kind of companies could be interested in taking part in new projects? Will these new projects be considered suitable solutions for the plants' workers? The answer to the last question here is not so evident. Electricity production is a specific activity and workers in the sector often benefit from a status and from advantages that they may not be willing to see suppressed. In the past, EDF has managed to transfer workers from closed coal-fired power plants to its nuclear plants. This solution cannot, however, be applied in the case of Uniper's workers. Neither can sending workers on pre-retirement schemes be considered as a magic bullet fix, since this kind of solution was already applied to older workers when the first units of coal-fired plants were shut in the 2013-2015 period. In Le Havre and Cordemais, for example, the average age of workers is now estimated at slightly above forty years.

Nevertheless, the main problem is that there is no clear vision for the future of the sites. Despite the announcement of closures, no transition strategy (which should be the basis of an ETC) or plan has yet been defined by the authorities. A specific ministerial committee is at present working on the question, but no date has been given regarding the publication of its work. Converting plants to sustainable biomass-fuelled units would certainly be an acceptable solution. However, the Gardanne project is in jeopardy and, in the case of EDF's Ecocombust, the government has underlined that it will give its agreement to the project only if the problems linked to Brittany's electricity supply are not fixed. Regarding the closure of the coal-fired power plants, as it continues to face strong social opposition and the *gilets jaunes* crisis, it really looks as if the French government is walking on eggshells.

## References

- Centrale Emile-Huchet à Saint-Avold : les salariés de la tranche 6 en grève, Républicain Lorrain, 22 November 2018. <https://www.republicain-lorrain.fr/edition-de-saint-avold-creutzwald/2018/11/22/centrale-emile-huchet-les-salaries-de-la-tranche-6-en-greve>
- CGT (2019) Les grévistes autorisent les essais Biomasse. <https://cgt-centrale-de-gardanne.blogspot.com/2019/02/les-grevistes-autorisent-les-essais.html>
- Chape R. (2012) E.ON France retire son projet actuel de licenciement, Maritima Medias, 3 April 2012. <https://www.maritima.info/depeches/emploi/aixMaritima-en-provence/12336/e-on-france-retire-son-projet-actuel-de-licenciement.html>
- Chhum G. (2019) François de Rugy a signé le projet qui prépare la fermeture de la centrale nucléaire de Fessenheim, France Bleu, 1 February 2019. <https://www.francebleu.fr/infos/economie-social/francois-de-rugy-a-signe-le-projet-qui-prepare-la-fermeture-de-la-centrale-nucleaire-de-fessenheim-1549037418>
- Climate Transparency (2017) Brown to green: the G20 transition to a low-carbon economy. <https://www.climate-transparency.org/wp-content/uploads/2017/07/B2G2017-France.pdf>
- Compagnie électrique de Bretagne (2010) Qu'est-ce que le Pacte Electrique Breton? <http://www.landivisiau-lacentrale.com/pacte-electrique-breton/le-pacte-electrique-breton.html>
- Cosnard D. (2018) Le milliardaire tchèque Daniel Kretinsky achète deux centrales électriques en France, Le Monde, 24 December 2018. [https://www.lemonde.fr/economie/article/2018/12/24/le-milliardaire-tcheque-daniel-kretinsky-achete-deux-centrales-electriques-en-france\\_5401838\\_3234.html](https://www.lemonde.fr/economie/article/2018/12/24/le-milliardaire-tcheque-daniel-kretinsky-achete-deux-centrales-electriques-en-france_5401838_3234.html)
- EDF (2019) Communiqué de presse, 28 janvier. <https://www.edf.fr/groupe-edf/espaces-dedies/journalistes/tous-les-communiques-de-presse/edf-franchit-un-jalon-important-dans-la-mise-en-oeuvre-d-ecocombust>
- Esclauze A. (2018) À Gardanne, polémique autour de la centrale biomasse, La Croix, 13 March 2018. <https://www.la-croix.com/Sciences-et-ethique/Sciences-et-ethique/A-Gardanne-polemique-autour-centrale-biomasse-2018-03-13-1200920315>
- European Parliament and Council (2010) Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control), Official Journal of the European Union, L 334, 17 December 2010.
- Eurostat (2019) Greenhouse gas emissions. [https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=sdg\\_13\\_10&plugin=1](https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=sdg_13_10&plugin=1) [accessed 30.01.2019]

- Fermetures des centrales à charbon : la CGT se mobilise, Le Figaro, 29 March 2018. <http://www.lefigaro.fr/flash-eco/2018/03/29/97002-20180329FILWWW00196-centrales-a-charbon-mobilisation-de-la-cgt-contre-leur-fermeture.php>
- Force Ouvrière (2018) Centrale de Cordemais, Press Release, 27 March 2018. <http://force-ouvriere44.fr/communiquede-presse-centrale-de-cordemais/>
- French Government (2015a) Loi de transition énergétique pour la croissance verte [Energy Transition for Green Growth Act], Paris, Ministère de la Transition Écologique et Solidaire. <https://www.ecologique-solidaire.gouv.fr/loi-transition-energetique-croissance-verte>
- French Government (2015b) France National Low-Carbon Strategy, Paris, French Ministry of Ecology, Sustainable Development and Energy. [https://www.ecologique-solidaire.gouv.fr/sites/default/files/SNBC\\_France\\_low\\_carbon\\_strategy\\_2015.pdf](https://www.ecologique-solidaire.gouv.fr/sites/default/files/SNBC_France_low_carbon_strategy_2015.pdf)
- French Government (2018a) Stratégie Nationale Bas-Carbone, Paris, Ministère de la Transition Écologique et Solidaire. <https://www.ecologique-solidaire.gouv.fr/strategie-nationale-bas-carbone-snbc>
- French Government (2018b) Multiannual Energy Programme: what are its aims? <https://www.gouvernement.fr/en/multiannual-energy-programme-what-are-its-aims>
- French Government (2019a) L'accompagnement des transitions professionnelles. <https://www.ecologique-solidaire.gouv.fr/laccompagnement-des-transitions-professionnelles>
- French Government (2019b) Les contrats de transition écologique. <https://www.ecologique-solidaire.gouv.fr/contrat-transition-ecologique>
- French Ministry for the Environmental Transition (2019) Centrale à charbon de Cordemais : le ministère de la Transition écologique et solidaire met en œuvre les engagements du Plan Climat et étudie un projet de reconversion, Press Release, 11 January 2019. <https://www.ecologique-solidaire.gouv.fr/communiquede-presse-centrale-charbon-cordemais-ministere-transition-ecologique-et-solidaire-met-en>
- Groupe Caisse des dépôts et consignations (2016) A €4mn Green Growth loan for Issy-les-Moulineaux. <https://www.holdco-siic.fr/en/eu4mn-green-growth-loan-issy-les-moulineaux>
- INSEE (2019) Émission de CO<sub>2</sub> par activité : données annuelles de 2000 à 2018, Paris, Institut national de la statistique et des études économiques. <https://www.insee.fr/fr/statistiques/2015759#tableau-figure1> [accessed 30.01.2019]
- Isnard-Dupuy P. (2018) Le développement des centrales biomasse, un remède 'pire que le mal' face au réchauffement climatique ?, BastaMag, 27 September 2018. <https://www.bastamag.net/Le-developpement-des-centrales-biomasse-un-remede-pire-que-le-mal-face-au>
- Liaisons sociales (2009) La division production ingénierie thermique d'EDF met en place une GPEC, Liaisons sociales quotidien, 14 October 2009. <http://www.wk-rh.fr/actualites/detail/17195/la-division-production-ingenierie-thermique-d-edf-met-en-place-une-gpec.html>
- Lhuillier C. (2018) Fermeture confirmée de la centrale à charbon de Saint-Avold, France Bleu, 18 October 2018. <https://www.francebleu.fr/infos/economie-social/fermeture-confirmee-de-la-centrale-a-charbon-de-saint-avold-1539881247>
- Mandard S., Le Hir P., Allix G., Wakim N. and Malingre V. (2018) Nucléaire, renouvelables... le détail du plan du gouvernement en matière d'énergie, Le Monde, 27 November 2018. [https://www.lemonde.fr/economie/article/2018/11/27/nucleaire-renouvelables-le-detail-du-plann-du-gouvernement-en-matiere-d-energie\\_5389319\\_3234.html](https://www.lemonde.fr/economie/article/2018/11/27/nucleaire-renouvelables-le-detail-du-plann-du-gouvernement-en-matiere-d-energie_5389319_3234.html)
- Moragues M. (2012) Fermeture des centrales à charbon : EON passe à l'offensive, L'usine nouvelle, 15 October 2012. <https://www.usinenouvelle.com/article/fermeture-des-centrales-a-charbon-eon-passe-a-l-offensive.N183999>

- Muzyczka J. (2018) Carling : blocage levé à la centrale Emile Huchet, mais la production à l'arrêt, France Bleu, 29 May 2018. <https://www.francebleu.fr/infos/economie-social/carling-les-salaries-en-greve-la-centrale-emile-huchet-a-l-arret-1527593801>
- Reuters (2018a) France to revise carbon emissions target after missing 2016 goal, Press Release, 20 January 2018. <https://www.reuters.com/article/us-france-carbon-emissions/france-to-revise-carbon-emissions-target-after-missing-2016-goal-idUSKBN1FB2W0>
- Reuters (2018b) EDF's Flamanville reactor start again delayed to 2020, Press Release, 25 July 2018. <https://uk.reuters.com/article/us-edf-flamanville/edfs-flamanville-reactor-start-again-delayed-to-2020-idUKKBN1KF0VN>
- Rouaud P. (2018) La France prépare la fermeture de ses dernières centrales à charbon, Le Monde, 11 February 2018. [https://www.lemonde.fr/entreprises/article/2018/02/11/la-france-prepare-la-fermeture-de-ses-dernieres-centrales-a-charbon\\_5255168\\_1656994.html](https://www.lemonde.fr/entreprises/article/2018/02/11/la-france-prepare-la-fermeture-de-ses-dernieres-centrales-a-charbon_5255168_1656994.html)
- RTE (2018) Bilan prévisionnel 2018. <https://www.rte-france.com/fr/article/bilan-previsionnel>
- SDES (2019) Données et études statistiques. <https://www.statistiques.developpement-durable.gouv.fr/> [accessed 30.01.2019]
- Serres E. (2018) Charbon. Pour ne pas mourir, Cordemais arrête le coke et se met au vert, l'Humanité, 23 October 2018. <https://www.humanite.fr/charbon-pour-ne-pas-mourir-cordemais-arrete-le-coke-et-se-met-au-vert-662533>
- UFE (2017) L'électricité au service d'une transition écologique et solidaire, Paris, Union française de l'électricité. <https://ufe-electricite.fr/publications/etudes/article/l-electricite-au-service-d-une-transition-ecologique-et-solidaire>
- World Bank (2019) World Bank Open Data. <https://data.worldbank.org> [accessed 30.01.2019]

## Websites consulted

EDF - <https://www.edf.fr/>

French Cleantech - <https://www.frenchcleantech.com/about-us.html>

INSEE - <https://www.insee.fr/fr/accueil>

All links were checked on 9 August 2019.