

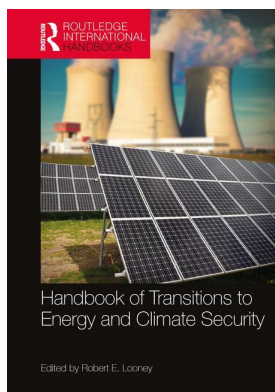
This article was downloaded by: 10.3.97.143

On: 11 Dec 2023

Access details: *subscription number*

Publisher: *Routledge*

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: 5 Howick Place, London SW1P 1WG, UK



Handbook of Transitions to Energy and Climate Security

Robert E. Looney

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Publication details

<https://www.routledgehandbooks.com/doi/10.4324/9781315723617-25>

John S. Duffield

Published online on: 29 Nov 2016

How to cite :- John S. Duffield. 29 Nov 2016, *France and the energy trilemma from:* Handbook of Transitions to Energy and Climate Security Routledge

Accessed on: 11 Dec 2023

<https://www.routledgehandbooks.com/doi/10.4324/9781315723617-25>

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France and the energy trilemma

How the Fifth Republic has sought to balance energy security, affordability and environmental sustainability

John S. Duffield

Although not the leading power it once was, France continues to play an important role in world energy affairs. It remains among the 10 largest energy consumers. And for many years, it has been the second largest producer of nuclear power, after the United States.

Since the 1970s, France has had a relatively easy time balancing the often competing imperatives of energy security in the form of reliable access to adequate supplies of energy, reasonably priced energy sources to promote economic growth and competitiveness, and environmental sustainability. This happy state of affairs is largely attributable to the country's heavy investment in nuclear power following the first oil shock in 1973. The primary purpose of the nuclear program was to reduce France's reliance on what had come to be unreliable and expensive energy imports, especially petroleum. But the program also resulted in relatively inexpensive electricity supplies and low CO₂ emissions.¹

Nevertheless, France's emphasis on nuclear power has not been an unmitigated blessing. As a result of nuclear bounty, France paid relatively little attention to renewable sources of energy. And energy efficiency took a back seat to finding ways to consume the prodigious amounts of electricity produced by France's nuclear power system.

In more recent years, the tradeoffs between the horns of the energy trilemma have grown sharper for France. One reason has been heightened concern about the effects of greenhouse gas emissions, especially climate change, despite France's relatively low per head emissions levels. Another has been new worries about the safety of nuclear power, especially following the 2011 disaster at Fukushima Daiichi in Japan. And the cost of building new nuclear reactors has escalated far beyond initial expectations. As a result, the perpetuation of nuclear power as the centerpiece of French energy policy has become less certain, and French energy policy is now in flux. Increased attention is being belatedly paid to energy savings and renewable sources of energy.

This chapter takes a chronological approach, examining how France has addressed the energy trilemma over time. It begins with a review of the situation before the oil shocks, when France was becoming steadily more dependent on imports of oil. It then describes how France

responded to the oil shocks, devoting particular attention to the rapid buildup of the country's nuclear power capacity. A third section covers the review of energy policy that took place in the first years of the new millennium, which culminated in a renewal of France's commitment to nuclear power. The following section examines the developments of the past several years. These have called into question more than ever before France's long-standing reliance on nuclear power and resulted in a much ballyhooed "energy transition." What difference this latest policy initiative will make, however, remains to be seen.²

French energy priorities and policies before 1973

During much of the postwar era, France faced not an energy trilemma but a dilemma: balancing the security of energy supplies against their costs. Environmental concerns ranked well behind these first two considerations. During the decade and a half prior to the first oil shock, moreover, it appeared that there were few or no tradeoffs to be had. It appeared that France could have virtually all the low cost energy, principally in the form of imported oil, it needed at little or no cost in terms of energy security. In fact, however, the costs and risks of foreign oil dependence were mounting beneath the surface, waiting for the right combination of geopolitical conditions to reveal them.

During the first decade and a half after World War II, the French economy relied primarily on coal, much of which was produced at home. As oil production exploded in the Middle East, however, the government began to promote the use of oil over coal. The former had become less expensive, and its abundance led many to believe that prices would remain low indefinitely. At the same time, the government withdrew support for the coal industry, offering less protection than any other country in Western Europe.

As a result of these actions and market forces, French petroleum consumption soared during the following decade, increasing at an average annual rate of 12% between 1960 and 1973. Over the same period, oil's share of total primary energy consumption (PEC) jumped from just 30% to more than two-thirds. By 1973, 60% of energy demand in the critical industrial and power sectors was met by oil. Meanwhile, coal production peaked at 60 million tonnes in 1960, when coal still accounted for more than half of PEC, and then steadily declined. By 1973, just one-sixth of PEC was provided by coal.

Because France had little oil of its own, it became increasingly dependent on energy imports, especially oil. In 1960, France produced 62% of the energy it consumed. By 1973, that figure had dropped to less than 25%, and nearly 70% of France's energy needs was met by foreign oil alone. Consumption of natural gas also grew substantially 1960 to 1973, to 8.5% of PEC, but a growing share, more than half, was also imported.

To be sure, the French government took several precautions against this growing dependence on imported oil. As early as 1958, it required that importers maintain a stockpile equivalent to three months of domestic sales. It promoted the formation of national oil companies that could compete with the so-called "majors" for control of overseas oil resources. It sought to diversify the sources of France's imports away from the Persian Gulf, with particular emphasis on Algeria, which soon provided one-third of France's crude oil imports. And after the 1967 Middle East war, it adopted a pro-Arab foreign policy.

Finally, France initiated a nuclear energy program of significant size. By 1973, it had built 11 experimental and small power reactors, and it had begun construction on or had ordered six 900 megawatt (MW) pressurized water reactors (PWRs). The plan was to order a total of 10 commercial reactors between 1971 and 1975 with a total generating capacity of just under 10 gigawatts (GW).

In the end, however, these measures did little to buffer France against the shock that was to come. Nuclear power accounted for just 2% of PEC in 1973. The best that can be said is that they did lay the groundwork for a rapid shift in energy policy when that became necessary.

Priorities and policies after the oil shocks

The 1970s and 1980s did indeed see a dramatic shift in French energy policy. The previous emphasis on low energy prices, with its concomitant open door to imported oil, was hastily replaced by an emphasis on energy security through self-sufficiency. This goal was to be achieved primarily through the rapid buildup of France's nuclear power generating capacity. It turned out, though, that the ambitious nuclear program yielded the additional benefits of keeping electricity prices low while reducing France's CO₂ emissions.

Impact of the oil shocks

The primary impetus for the shift in French policy was the first oil shock of 1973. In fact, however, France had experienced a setback of its own just two years previously. At that time, Algeria nationalized a controlling share of the French oil concessions in that country, causing most of the French oil companies to leave.

In fact, France was not directly targeted by the Arab oil embargo that began in 1973, thanks to its pro-Arab policy in the Middle East. Nevertheless, the French economy was hit hard by the Arab oil production cuts and the quadrupling of world oil prices that followed. Although France suffered a reduction in oil supplies of just 7%, and then for a duration of just four months, the economic consequences of the oil price rises were severe. French GDP growth was cut in half, while inflation and unemployment more than doubled. Despite efforts to limit oil imports, their cost tripled from 1973 to 1974, from 14.6 billion to 43 billion French francs. Even after the production cuts ended, it was widely assumed in France that oil scarcity would eventually return.³

Policy actions

In response to these events, France adopted what French energy policy expert Robert Lieber has called "the most coherent and vigorous energy program of any principal oil consuming state."⁴ Abroad, France engaged in intense energy diplomacy aimed at securing access to foreign sources of oil. At home, it sought to reduce oil consumption while developing substitutes for oil, especially in the form of nuclear power for electricity production.

Following the Arab oil production cuts and selective embargo, France moved quickly to lock up oil supplies from foreign producers. As early as December 1973, it struck a deal with Saudi Arabia to provide 27 million tonnes of oil over three years. This initial agreement was followed in early 1974 by a more substantial one promising 800 million tonnes over 20 years, or enough to meet a third of French oil demand at the time. That same year, France reached an agreement with Iraq for 20 – later increased to 30 – million tonnes per year. These efforts continued into the early 1980s, when France signed a 5 million tonnes per year contract with Mexico, which had just emerged as a major producer.

In the end, however, France's energy diplomacy yielded only very limited benefits. France received little or no break on the prices that it paid for oil. And its bilateral deals with Persian Gulf states did nothing to protect France from the oil supply disruptions that subsequently resulted from the Iranian revolution and the Iran-Iraq war.

Arguably more important, then, were the efforts France made at home to reduce its dependence on imported oil. On the demand side, it increased the prices that could be charged for petroleum products while maintaining gasoline taxes that were among the highest in Europe. The government also increased insulation standards for buildings and provided subsidies for investments in energy savings.

Most notable of all were France's efforts to develop alternatives to oil. After pushing the substitution of oil for coal during the previous decade and a half, it now encouraged the use of coal in industry and power generation. Nevertheless, coal consumption increased only modestly before resuming its previous slide in 1979.

Instead, the biggest gains were made in the promotion of nuclear power, which constituted "the most ambitious program in any Western country during the 1970s."⁵ The center-right governments in power between 1973 and 1981 ordered more than 40 additional reactors, with the standard reactor size increasing from 900 MW to 1.3 GW. Although the Socialist government that took office in 1981 initially cancelled one reactor and suspended work on 18 others, it eventually raised the goal of nuclear capacity to 56 GW by 1990 and ordered six more units in the early 1980s. Overall, construction began on no fewer than 55 reactors between late 1971 and 1984.⁶

Outcomes

What were the fruits of these efforts? Collectively, they resulted in a significant increase in France's energy security without compromising the other goals of affordability and environmental sustainability, at least in the short to medium term. In March 1974, the French government had set a number of ambitious energy goals for 1985.⁷ These included:

- 1 cutting PEC from a projected 285 million tonnes of oil equivalent (mtoe) to just 240 mtoe (although this would represent a 30% increase from the actual PEC of 185 mtoe in 1973);
- 2 reducing the share of PEC obtaining from imported energy from 76% to just 55–60%, and reducing oil's share of PEC from 70 to just 40%;
- 3 installing more than 40 GW in new nuclear capacity and raising the nuclear share of PEC from less than 2 to 25%; and
- 4 limiting the amount of oil imported from any single country to 15% of the total.

By 1985, these goals had been largely met and in some cases even exceeded. PEC was up only 6% from 1973 and 18% lower than the target of 240 mtoe. Oil's share of PEC was down to 43% and still dropping. Fifty-four nuclear reactors had either entered commercial operation since 1978 or were under construction. The share of PEC coming from nuclear power had already reached 25% and was still rapidly rising, on its way to more than 35%.

Meanwhile, the substitution of nuclear power for oil and eventually coal in power generation had had some sizeable side benefits. Thanks to a high degree of standardization in reactor design, the cost of the nuclear program had been kept in check, resulting in low electricity prices. The program had also contributed to a sharp decline in CO₂ emissions, which had fallen from 538 million tonnes in 1973 to just 410 million tonnes in 1985, approximately where they would remain for the next 25 years.

If anything, the rapid buildup of nuclear generating capacity had been too successful. By the mid-1980s, it had become clear that France would be able to produce more electricity than it needed. In response, the government heavily promoted electricity use by industry and in the residential sector.

The 2000s: renewal of the nuclear commitment

For the next two decades, from the mid-1980s to the early 2000s, France enjoyed the security, economic, and environmental fruits of its post-oil shock energy investments, especially those in nuclear power. In the early to mid-2000s, however, a new set of concerns prompted France to undertake a comprehensive review of its energy policy. The principal result was a renewed commitment to nuclear power. At the same time, however, the country adopted ambitious energy efficiency measures and, for the first time, began to promote renewable energy to a significant extent.

Motives for the review of energy policy

The review of French energy policy was prompted by growing concerns in each of the three areas captured by the concept of the energy trilemma. One was the rising cost of oil and other energy imports. Beginning in 2000, the price of oil, France's principal energy import, rose above \$20 a barrel for only the second time in a decade and continued to climb. Between 2003 and 2006 alone, the cost of France's energy imports doubled, nearly reaching the all-time high set a quarter century before during the peak of the second oil shock.

As for energy security, it was not too soon to start thinking about the future of the nuclear program. Although the first reactors would not reach the end of their expected 40 year lifespans until late the following decade, planning for what would come next would have to begin well in advance, given the long lead times for reactor design and construction. And because all but four of France's 58 commercial reactors had commenced operation between the late 1970s and 1990s, large numbers of replacements might have to start coming on line by 2020.

Finally, with regard to environmental sustainability, France had begun to take seriously the problem of climate change. In 2000, it adopted a comprehensive National Program to Combat Climate Change, which set a goal of reducing greenhouse gas emissions in 2010 by about 10% below projected levels. The program specified some 100 low cost measures for achieving that goal, though it relied primarily on voluntary agreements rather than taxation and regulation. Then in 2002, France ratified the Kyoto Protocol, whereby it pledged to bring emissions back down to 1990 levels by the end of the decade.⁸

Policy responses

These challenges were spelled out in a 2003 white paper on energy, which set the stage for the adoption of a broad framework law two years later.⁹ The resulting energy law, adopted in 2005, reflected the changing constellation of concerns, putting the fight against climate change on par with the long-standing goals of guaranteeing the security of energy supplies and assuring competitive energy prices (as well as ensuring energy access to all). It established ambitious long-term targets for cutting CO₂ emissions by 75% by 2050 and reducing France's energy intensity on an annual basis by 2% through 2015 and 2.5% thereafter. In the short term, the law called for reducing energy imports by 10 mtoe, or nearly 10%, by 2010 and for increasing the share of renewables in France's PEC and electricity supply to 10% and 21%, respectively, over the same time period.¹⁰

To achieve these goals, the government took a number of actions. Most important was a renewal of France's commitment to nuclear power, which was now justified in part as a contribution to the fight against climate change. The first step would be to extend where possible the lifetimes of the existing reactors beyond 40 years, although upgrades costing on the order of 400–600 million euros per unit would be required. The national power company, Électricité de

France (EDF), estimated that service periods of up to 60 years would be possible. This meant that even the oldest reactors might operate for another two decades.

At the same time, the government laid the groundwork for the construction of a new generation of reactors, the so-called European Pressurized Reactor (EPR). Work on the first EPR began in 2007 and was expected to be completed by 2012. Two years later, the site for a second EPR was chosen, with construction expected to begin in 2012.

Not least important, the government took steps to build and maintain broad public support for nuclear power. One of these was the creation in 2006 of an independent Nuclear Safety Authority (Autorité de Sûreté Nucléaire, or ASN), which would have to approve all lifetime extensions and sign off on new reactors before they could begin commercial operation.

On the demand side, the government established an ambitious “White Certificate” program, which placed an obligation on energy suppliers to generate energy savings by their customers. For the first three-year phase (2006–2009), the goal was extremely modest. But it was expected to rise over time, eventually resulting in significant energy savings. The government also adopted new regulations to reduce energy use in both new construction and existing structures, eventually setting a target of cutting consumption by 38%. And it took steps to limit oil consumption in the transportation sector.

Finally, France made its first major foray into the promotion of renewable energy sources. It had introduced a feed-in tariff for electricity in 2000, but this program was limited to plants with a capacity of less than 12 MW and had not resulted in much new generating capacity. So the tariffs were made more favorable in 2006, with particular emphasis placed on wind power. At that time, a goal was set for 2015 of 17 GW of wind capacity, later raised to 25 GW by 2020. And when in 2011 the desired level of investment continued to fall short, the government announced tenders for 3 GW of offshore wind power. Meanwhile, in the transportation sector, the government sought to increase the share of biofuels in the fuel supply by further cutting taxes. It set goals of 7% of the fuel supply by 2010 and 10% by 2015.

One potential measure that France did not pursue during this period was the use of hydraulic fracturing to increase domestic production of natural gas. The U.S. Energy Information Administration estimated that France might possess on the order of 4 trillion cubic meters of technically recoverable shale gas, which would put it near the top of European gas reserves.¹¹ But strong public concerns about the potential environmental impact of fracking led the Parliament to prohibit the practice in 2011.

Outcomes

During the years leading up to the presidential election of 2012, France’s energy situation showed notable improvements. PEC experienced a gradual decline, from 262 mtoe in 2005 to 244.5 in 2012. Oil consumption dropped even more dramatically over the same time period, from 93.1 million tonnes in 2005 to just 80.3 million in 2012. And partly as a result, CO₂ emissions fell steadily, from 433.4 in 2005 to 379.5 in 2012. Meanwhile, wind-generated electric power rose rapidly, from just 1 terawatt-hour in 2005 to more than 14 in 2012. Biofuel production jumped as well, although it plateaued in 2009 at just 2.3 mtoe, or the equivalent of about 3% of France’s oil consumption.¹²

2010s: the energy transition

Hardly had the policies adopted in the second half of the 2000s gone into effect, however, than did the new Socialist government of François Hollande, elected in 2012, undertake a further

sweeping review of energy policy. During the campaign, Hollande had pledged to cut the share of France's electricity generated by nuclear power by one-third, to just 50%, by 2020 and to shut down France's oldest nuclear power station before the next presidential election in 2017. According to David Buchan, Hollande's pledge was the result of electoral politics in the wake of Germany's 2011 decision to accelerate its long-planned nuclear phaseout.¹³ Early in the campaign, another Socialist candidate had called for eliminating nuclear power altogether, albeit over 25–30 years, and some significant gesture in that direction was needed if the Socialists were to establish a desired electoral alliance with the French Green Party. Indeed, Hollande's pledge corresponded roughly with the degree to which Germany was planning to reduce its reliance on nuclear power.¹⁴ But the so-called "energy transition" was not simply the outcome of short-term political calculations; deeper forces were at work.

Motives for the adoption of a new energy law

One impetus for the new review was problems encountered with the nuclear reactor program. The construction of the first EPR was subject to delays and cost overruns. As a result, the price more than doubled and the date for commercial operation was pushed back until at least 2017, some five years later than originally expected. Then, in 2015, tests found potential flaws in the reactor pressure vessel, which led to a further delay in the expected start-up date, to late 2018, and yet another price increase, to nearly \$12 billion.¹⁵ A further consequence of these problems is that EDF decided to put the start of the second EPR on hold indefinitely.

Then, in 2011, the nuclear disaster at Fukushima Daiichi in Japan raised searching questions about the safety of nuclear power. In response, the ASN imposed a demanding new set of safety standards in early 2012. EDF would have to quickly make a number of physical and organizational improvements at each of its facilities in order to increase their robustness to extreme situations, and it would be required to deploy a national nuclear rapid response force that could deal with such contingencies. The new measures were expected to cost at least 13 billion euros.

A third factor was developments within the European Union in response to growing concerns about climate change. These developments culminated in the adoption in 2009 of the Climate and Energy Package, which set ambitious goals for energy savings, renewable energy, and greenhouse gas emissions for 2020. Under the Effort Sharing Decision that followed, France agreed to cut its 2020 greenhouse gas emissions by 14% below the 2005 level in sectors not covered by the EU Emissions Trading System. And under the subsequent Renewable Energy Directive and National Renewable Energy Action Plan, France pledged to increase the share of renewables in final energy consumption to 23% and in electric power generation to 27%, both also by 2020.

Yet in 2012, France still had a long way to go to reach these targets. Hydroelectricity still accounted for the lion's share of renewable power; other forms of renewables were providing only about 5% of total electricity production.¹⁶ Solar power capacity stood at less than 4 GW. Instead, the greatest hopes were placed on wind power, which had grown in capacity by roughly 1 GW per year since 2005, to some 7.7 GW in 2012. In order to achieve the government's goal of 25 GW, including 6 GW offshore, by 2020, however, it would have to grow even faster during the remainder of the decade.¹⁷

As the International Energy Agency (IEA) noted in 2010, however, "wind farm developers face significant challenges related to the complexity of the permitting process and to public opposition."¹⁸ Wind turbines could be installed only in specified zones that were a minimum distance from areas designated for housing. And in 2011, the government created additional obstacles by establishing more cumbersome review procedures for wind turbines over 50 meters

tall and requiring that wind farms have a minimum of at least five turbines. As a result, there were good grounds to expect that because of environmental, aesthetic, or other concerns, the development of wind power would proceed more slowly than the government had hoped.¹⁹ Thus to achieve the targets for renewable energy, policies more aggressive than those adopted by the previous conservative governments might well be required.

Development of the new energy law

Despite the prominence given to energy in the 2012 presidential campaign, the adoption of the energy law took more than three years, or nearly two years longer than originally expected.²⁰ The process began with the government conducting another national “debate” during late 2012 and much of 2013. The debate was largely inconclusive, especially with regard to the future of nuclear power. According to Buchan, “all participants agreed on the need ... to define a strategy for the evolution of the nuclear fleet ...” but not much more.²¹

The government did not present a draft energy law to the French Parliament until June 2014. By then, the pressure was growing to take action prior to the UN Climate Change Conference scheduled to be held in Paris in late 2015.²² Although the proposal received swift passage in the lower house, the French Parliament as a whole did not adopt the final legislation until July 2015.²³ The delays reflected continuing divisions within the government, the legislature, and French society regarding the appropriate direction for energy policy, and especially the role of nuclear power. Indeed, the French senate offered some 1,000 amendments to the original proposal, although most of these were removed from the version ultimately adopted.²⁴ The new energy law, which contained 215 articles, was formally published on August 18, 2015.²⁵

Provisions of the new energy law

The new energy law reflected the escalating nature of targets for reductions in greenhouse gas emissions, energy savings, and the penetration of renewable energy. Most importantly, France would:

- 1 reduce greenhouse gas emissions over the 1990 baseline by 40% in 2030 and by 75% in 2050;
- 2 reduce final energy consumption from the 2012 baseline by 20% in 2030 and by 50% in 2050;
- 3 reduce the consumption of fossil fuels by 30% by 2030 in comparison with 2012; and
- 4 increase the share of renewables in final energy consumption to 23% by 2020, consistent with the EU’s Renewables Directive, and to 32% by 2030 – by that same year, renewables should account for 40% of electricity production, 30% of heat, 15% of liquid fuel, and 5% of gas.

The law also contained some short-term goals, especially in the area of transport. Greenhouse gases from transportation would fall by 10% by 2020 and 20% by 2025. Meanwhile, the share of renewable energy in the transport sector would rise to 10% by 2020.

The reductions in energy use and greenhouse gas emissions would be achieved, moreover, while seemingly reducing France’s reliance on nuclear power. As Hollande had previously pledged, the share of electricity provided by nuclear power would be reduced to 50% around 2025, although no precise target date was included. In addition, France’s nuclear generating capacity would be capped at the current level of 63.2 GW. This meant that EDF would have to

close older nuclear reactors in order to bring any new ones on line, and, according to some estimates, France would have to close as many as 23–25 of its 58 reactors to meet the 50% target.²⁶ In addition, the law created a stricter regulatory framework for the operation of facilities more than 40 years old. Nevertheless, the Minister of Ecology, Sustainable Development and Energy, Ségolène Royal, who had spearheaded the effort, declared that nuclear power would remain the “linchpin” of France’s energy mix.²⁷

How, then, was France to achieve the goals of energy policy – security, affordability, and environmental sustainability – while reducing reliance on nuclear power, which had previously been the secret of France’s success? The new energy law was generally short on detailed policies for achieving these targets, although it did offer some specifics.²⁸

With regard to reducing energy consumption, the primary focus was the building sector, which accounted for 44% of energy use in 2012. One tactic would be to accelerate the renovation of the existing housing stock, increasing the number of units renovated to 500,000 per year. To this end, the government would offer tax credits and interest free loans. A second approach would be to improve the performance of new construction by instituting even higher standards. And greater attention would be paid to the management of consumption through the deployment of smart meters and the tracking of individual energy use in apartment buildings.

Other measures would target the transportation sector, which was responsible for about 27% of France’s greenhouse gas emissions in 2011. Particular emphasis was placed on promoting the use of electric and other “clean” vehicles through the use of rebates and the proliferation of charging stations. In addition, the governmental and other public bodies would set an example by buying “clean” vehicles for their fleets.

With regard to renewables, which accounted for just 14% of energy consumption in 2012, the law would simplify the procedures for establishing wind parks as well as the environmental permitting process for both wind and biogas installations. The government also established a new support scheme for all types of renewable electricity and called for the creation of 1,500 biogas projects in rural areas over three years.

Perhaps the biggest surprise was the last-minute inclusion of a progressive rise in the carbon tax, which had been introduced in 2014. The tax would now rise from 14.5 euros per tonne of carbon in 2015 to 22 euros in 2016, and then to 56 euros in 2020 and 100 euros in 2030.²⁹

Overall, though, the new law was relatively silent on the specific programs that would be employed to achieve the headline goals. There was no mention, for example, of how the share of electricity provided by nuclear power might be reduced, even as overall energy consumption declined, and there were few provisions for promoting the massive buildup of renewable energy sources envisioned by the law. Likewise, how the various long-term targets for reductions in greenhouse gas emissions, final energy consumption, and fossil fuel use would be met was left largely unclear. Most of the concrete measures that were adopted by the government were very short-term in nature. Instead, the determination of many details and difficult decisions, such as which nuclear plants to close, were deferred to a later date. The law merely called upon the government to open a discussion by the end of the year on the development of a multi-year implementation strategy.

Analysis

The new energy law represented potentially the greatest shift in French energy policy since France’s response to the oil shocks some four decades ago. For the first time in many years, France would significantly reduce its reliance on nuclear power. At the same time, it would

bring down substantially both its energy consumption and greenhouse gas emissions, in part by expanding the share of energy coming from renewable sources.

Nevertheless, or perhaps because of its ambitious nature, the new energy law left some important questions unanswered. For example, it appeared that the buildup of renewable power generation would progress more slowly than the decline in the nuclear share of electricity production. If so, what sources of power, other than fossil fuels, would make up the difference? Likewise, the reduction in greenhouse gas emissions by 2030 would proceed more rapidly than that of fossil fuel consumption. What other measures would contribute to achieving the former target?

In addition, little information has yet emerged regarding the many considerations that went into determining the details of the energy law. The limited number of financial provisions reflected the fact that government resources remained limited, as France continued to struggle to reduce a persistent budget deficit on the order of 4% of gross domestic product. At the same time, the nuclear industry remained a very powerful force in French politics, representing some 200,000 generally well-paying jobs,³⁰ and localities that hosted nuclear power plants were generally opposed to shuttering them.³¹ Hence it is not surprising that the law contained no concrete timetable or provisions for meeting the planned reduction of nuclear power as a share of total electricity consumption.

Other recent developments in French energy policy

Before concluding, at least two other developments in French energy policy in the 2010s merit mention. One concerned the ban on hydraulic fracturing that the Parliament had adopted in 2011. The ban was quickly challenged in court, but it was upheld by a ruling of the French Constitutional Council in 2013.³²

Another was the establishment of a capacity market for electric power generation that would enhance the security of electricity supplies. This market was created in response to a steady growth in peak electricity demand. Between 2002 and 2012, the peak load increased by about 30%, even as total electricity consumption increased by just 10%.³³ As a result, insufficient generating capacity to meet peak demand was expected as early as 2015, and the problem would only become more acute thereafter with the closing of coal-fired power plants under the EU's Large Combustion Plant Directive.

The underlying cause of the problem was the sensitivity of French electricity consumption to temperature changes because of the country's widespread use of electricity for heating. According to one estimate, a 1 degree drop in temperature created an extra 2.3 GW of electricity demand.³⁴ The problem was expected to be exacerbated by the growing penetration of intermittent renewable generating capacity.

The overall goal of the new capacity market was to keep flexible but otherwise unprofitable power generation available to meet spikes in demand. The mechanism, which was established in early 2015, placed responsibility on each electricity supplier to balance supply and demand. The supplier could meet this reliability obligation by acquiring sufficient capacity certificates from power generators. Suppliers could also pay customers to reduce their demand in the event of a supply shortage. The first certificates were issued in 2015 with the expectation that the system would go into operation in 2017.

Conclusion

Since the 1970s, France has had a relatively easy time of balancing the often competing goals of energy security, energy affordability, and environmental stability. In addressing the energy

trilemma, France got considerable mileage out of its heavy investment in nuclear power in the 1970s and 1980s. Nuclear power helped greatly to reduce both France's imports and consumption of fossil fuels, which in turn did much to lower its CO₂ emissions. In addition, the substantial economies of scale made possible by such a large program and a high degree of standardization meant that the cost of generating electricity from nuclear plants was kept relatively low in comparison with other fuels and other countries.

Nuclear power has not been an unqualified blessing, however. Its virtues also served to inhibit the development and introduction of new renewable sources of power. Likewise, the low electricity prices it made possible and an excess of generating capacity acted as a brake on efforts to improve energy efficiency.³⁵ And the potential long-term costs of decommissioning reactors and nuclear waste storage were amplified by the large size of the nuclear program.

Recent developments, moreover, have caused France to reconsider its substantial reliance on nuclear power. Particularly consequential was the 2011 nuclear accident at Fukushima Daiichi, which raised sweeping questions about the safety of nuclear facilities. The potential economic benefits of nuclear power also appear to have evaporated with the repeated delays in and the escalating costs of the construction of the first EPR in France as well as the expensive safety measures for nuclear facilities that have been ordered by the ASN. Thus, although most of the existing reactors may be able to operate for many more years, it seems unlikely that they will ever be replaced on something like a one-for-one basis.³⁶ The prospects for an eventual significant decline in nuclear power's contribution to France's energy mix are now greater than ever.

Instead, France will eventually have to develop a new formula for managing the energy trilemma. The outlines of such a formula have been suggested by the energy law adopted in mid-2015. As in many other developed countries, greater emphasis will have to be placed on renewable sources of energy as well as advances in energy conservation and efficiency. These alternatives are still relatively expensive in France, however, and how quickly they can compensate for reductions in the use of fossil fuels and nuclear energy production remains to be seen. Many renewable sources, moreover, still suffer from the disadvantages of intermittency. France can only hope that its large nuclear legacy will tide it over until the costs of these alternatives, including large-scale power storage, can be brought down to prevailing energy price levels.

Notes

- 1 According to a former CEO of Électricité de France, Henri Proglia, French electricity prices are 35% lower than the European average and French per head CO₂ emissions are one-third lower than in Germany. "France Needs More Electricity, Not Less Nuclear," *World Nuclear News*, October, 15, 2012, www.world-nuclear-news.org/EE_France_needs_more_electricity_not_less_nuclear_1510121.html.
- 2 This chapter draws on John S. Duffield, *Fuels Paradise: Seeking Energy Security in Europe, Japan, and the United States* (Baltimore, MD: Johns Hopkins University Press, 2015).
- 3 Duffield, *Fuels Paradise*, 122.
- 4 Robert Lieber, *The Oil Decade: Conflict and Cooperation in the West* (New York: Praeger, 1983), 76.
- 5 *Ibid.*, 81.
- 6 David Buchan, *The French Disconnection: Reducing the Nuclear Share in France's Energy Mix* (Oxford: Oxford Institute for Energy Studies, 2014), www.oxfordenergy.org/wpcms/wp-content/uploads/2014/01/SP-32.pdf, 3.
- 7 Duffield, *Fuels Paradise*, 123.
- 8 International Energy Agency, *Energy Policies of IEA Countries: France 2000 Review* (Paris: International Energy Agency, 2000), 49, 546; International Energy Agency, *Energy Policies of IEA Countries: France 2004 Review* (Paris: International Energy Agency, 2004), 62.
- 9 Nicole Fontaine, *Livre blanc sur les énergies*, 2003, www.ladocumentationfrancaise.fr/var/storage/rapports-publics/034000650.pdf.

- 10 “Loi n° 2005–781, 13 juillet 2005 de programmation fixant les orientations de la politique énergétique,” (LPOPE), 2005, www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000813253.
- 11 Energy Information Administration, *Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States* (Washington, DC: Energy Information Administration, 2013), 6.
- 12 BP, “Statistical Review of World Energy 2015: Data Workbook,” BP, 2015, www.bp.com/content/dam/bp/excel/energy-economics/statistical-review-2015/bp-statistical-review-of-world-energy-2015-workbook.xlsx.
- 13 Buchan, *The French Disconnection*.
- 14 Ibid., 1.
- 15 “Flamanville EPR Timetable and Costs Revised,” *World Nuclear News*, September 3, 2015, www.world-nuclear-news.org/RS-French-regulator-expects-to-report-soon-on-EPR-anomaly-2101501.html.
- 16 Buchan, *The French Disconnection*, 7.
- 17 Réseau de transport d’électricité (RTE), *2014 Annual Electricity Report* (Réseau de transport d’électricité, 2015), www.rte-france.com/sites/default/files/bilan_electrique_2014_en.pdf.
- 18 International Energy Agency (IEA), *Energy Policies of IEA Countries: France 2010 Review* (Paris: International Energy Agency, 2010), 121.
- 19 IEA, *Energy Policies of IEA Countries*, 98, 121; Alexander Ochs, and Serre Camille, “An Analysis of France’s Climate Bill: Green Deal or Great Disillusion?” *World Watch*, 2013, www.worldwatch.org/analysis-france%E2%80%99s-climate-bill-green-deal-or-great-disillusion.
- 20 Buchan, *The French Disconnection*, 2.
- 21 Ibid., 5.
- 22 Marion Bitoune, *The German and French Energy Transitions: Have the Two Changed European Energy Policy?* (Washington, DC: Heinrich Böll Stiftung, 2015).
- 23 Michel Rose, “French Energy Law Dodges Decisions on Nuclear Cuts,” *Reuters*, July 22, 2015, www.reuters.com/article/2015/07/22/france-energy-bill-idUSL5N10242K20150722.
- 24 Pierre Le Hir and Laetitia Van Eeckhout, “Transition énergétique: comment le Sénat a changé la loi,” *Le Monde*, February 19, 2015, www.lemonde.fr/planete/article/2015/02/19/transition-energetique-comment-le-senat-a-change-la-loi_4580129_3244.html.
- 25 The full text of the law, *LOI n° 2015–992 du 17 août 2015 relative à la transition énergétique pour la croissance verte*, is available at www.legifrance.gouv.fr/eli/loi/2015/8/17/2015-992/jo/texte.
- 26 Geraldine Amiel, “France to Dim its Reliance on Nuclear Power,” *The Wall Street Journal*, June 18, 2014, www.wsj.com/articles/france-to-dim-its-reliance-on-nuclear-power-1403113287.
- 27 Cécile Barbière, “Nuclear Remains Linchpin of French Energy Transition,” Euractiv, August 1, 2014, www.euractiv.com/sections/energy/nuclear-remains-linchpin-french-energy-transition-303832.
- 28 Ségolène Royal, *La Transition Énergétique pour la Croissance Verte*, August 18, 2015, www.developpement-durable.gouv.fr/IMG/pdf/CP_Loi_TECV_publication_citoyens.pdf. See also Ministry of Ecology, Sustainable Development, and Energy, *The Energy Transition: A User’s Guide* (Ministry of Ecology, Sustainable Development, and Energy, 2014), www.developpement-durable.gouv.fr/IMG/pdf/14123-2_plaq-NMTE-parlementaires_GB_DEF_Light-2.pdf.
- 29 Tara Patel, “France Passes New Energy Law Quadruples Carbon Price,” *Bloomberg Business*, July 23, 2015, www.bloomberg.com/news/articles/2015-07-23/france-passes-new-energy-law-quadruples-carbon-price.
- 30 Amiel, “France to Dim its Reliance on Nuclear Power.”
- 31 Rose, “French Energy Law Dodges Decisions.”
- 32 David Jolly, “France Upholds Ban on Hydraulic Fracturing,” *International New York Times*, October 11, 2013, www.nytimes.com/2013/10/12/business/international/france-upholds-fracking-ban.html?_r=0.
- 33 RTE, *2014 Annual Electricity Report*.
- 34 Buchan, *The French Disconnection*, 9.
- 35 Ibid., 13.
- 36 Ibid., 60.