ECONOMIC POLICIES FOR AFFORDABLE, SECURE AND CLEAN ENERGY
INSIGHTS FROM FRANCE

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France has launched a vast transformation of its energy system, with the aim of providing affordable, secure and clean energy. This paper focuses on the policy reforms needed to make this transformation a success, including reforms of taxes, public subsidies, and regulation.

1. France's electricity system is accessible to all. However, repeated rises in electricity prices have created problems of energy poverty. In addition, the difficulties faced by nuclear and hydroelectric power plants in 2022-2023 have threatened the country's resilience. The country's goal of rapid electrification will therefore require substantial investments.

2. To reduce the high level of emissions from road transport, the adoption of electric vehicles is an important part of the answer. Action is also needed to encourage modal shift toward bicycles, trains and buses.

3. Reducing housing energy consumption presents a number of challenges. A significant proportion of homes suffer from poor energy efficiency, but renovation work is often ineffective, despite its high cost, particularly for low-income households.

**Fiscal policy and regulatory framework reforms would help meet these challenges.**

1. Energy taxation should take greater account of greenhouse gas content. This would encourage the electrification of energy demand by reducing the cost of electricity relative to the price of fossil fuels.

2. The many tax expenditures benefiting fossil fuels should be gradually eliminated, while protecting households vulnerable to price hikes.

3. High financing costs are likely to hamper investment in the electrification of the energy system. Part of the solution to reducing these financing costs is to offer public guarantees and subsidize interest rates, as well as EU funding programmes and contracts for difference.

4. Encouraging solar self-consumption would reduce network costs. Electricity solidarity from the donation of surplus electricity would support acceptability by local stakeholders.

5. The adoption of electric vehicles by low-income households would benefit from expanding the “leasing social” programme and making used cars eligible to it. This could be financed by making the “bonus écologique” means-tested, or even by abolishing it.

6. Greater incentives for biking and taking buses over short distances would reduce road congestion and urban pollution. Phasing out tax expenditures that benefit aviation would restore the competitiveness of traveling by train over medium and long distances. Similarly, modal shift toward train would benefit from securing funding to modernise rail infrastructures.

7. Subsidies for home improvement (MaPrimeRénov’) should be conditional on results, in particular an effective ex-post improvement in energy performance, verified by independent audits.

8. Lighter regulations to encourage entrepreneurial dynamism and labour market flexibility are essential in the energy conversion sector.
1. TRANSFORMING THE ELECTRICITY MIX

France's electricity mix is highly decarbonized, thanks to nuclear, hydro, wind and solar power. There are 56 nuclear reactors currently in operation - the second largest number in the world in terms of capacity (61 GW), behind that of the United States (97 GW) and ahead of China (53 GW). Hydropower has been present for a long time, and onshore wind farms have rapidly expanded over the past 20 years, particularly in the north and east of the country. Solar power is also developing rapidly. One advantage of the French electricity mix is that it has the flexibility to adapt to rapid variations in electricity supply and demand, including the intermittency of renewable energies, without costly storage facilities.

France's electricity production remained stable between 2002 and 2019 at around 550-575 TWh (Figure 1). It then fell in 2020 and 2021 due to the Covid-19 pandemic. In 2022, the low availability of nuclear power, with many reactors shut down for maintenance, weighed heavily. In 2023, production rebounded thanks to the greater availability of nuclear power, which made it possible to export a significant amount of electricity to Italy, Switzerland and Great Britain, without however returning to historical levels.

![Figure 1: France - Electricity generation in TWh](image)

Sources: EMBER (historical data), official projections (France's draft Integrated National Energy-Climate Plan submitted to the European Commission, October 2023), and RTE’s Forecast (June 2023).

The government projects a reversal of this downward trend and a rapid increase in electricity production over the next decade. This increase in production will be necessary to meet the country’s electrification objectives, with the adoption of electric vehicles, heat pumps and decarbonized industrial technologies. The government’s ambition is to reach production levels of around 600 TWh in 2030 and 677 TWh in 2035 (Figure 1).
Reaching such high production levels will require significant investments. The average age of the 56 reactors is around 38 years, and costly maintenance work will be needed to extend their lifespan. The nuclear safety authority does not rule out the possibility that these reactors could remain in operation until 2040-50, i.e. for around 60 years, as is envisaged in the United States for reactors using the same technology. These ageing nuclear plants would then be replaced by a new fleet of third-generation pressurized water reactors (EPR2), which would have to be built. Construction of the first 6 EPR2s is expected to cost at least €52 billion (recently revalued at €67.4 billion). The government also forecasts a doubling of renewable electricity by 2030 (to 200 TWh) and a tripling by 2035 (300 TWh).

The electricity grid will need to be strengthened to connect all these new installations. The Réseau de Transport d’Electricité (RTE), France’s transmission system operator, estimates that investments in the electrical grid of €100 billion are needed between now and 2040-45. The distribution network would require investments of around €90 billion over the same period, according to ENEDIS. Investments will also be needed in storage capacity and backup thermal power plants.

Funding of €300-350 billion is required over the initial 15-year period according to RTE’s projections. Discussions are currently underway on the conditions required to ensure the profitability of these investments. The companies involved (such as EDF, RTE, ENEDIS and ENGIE) can finance these investments from their own funds and by borrowing from banks and financial markets. As the sole shareholder of EDF, and indirectly of RTE and ENEDIS, the French government can also play an important role in these financing plans. Regulatory and competition authorities, such as the Commission de Régulation de l’Energie (CRE), the Autorité de la Concurrence, and the European Commission, also have a role to play. Various configurations are being discussed (Contract for Difference, Purchasing Power Agreement, regulated asset base, and public budget contributions). The government has indicated that a financing plan will be decided by the end of 2024.

The French government can also set the price at which EDF sells its electricity. Discussions are underway due to the end of the ARENH (regulated access to historical nuclear electricity) scheme, which sets the selling price of nuclear electricity at €42/MWh until the end of 2025. The French Cour des Comptes has estimated the full cost of nuclear production at between €50.7 and €68.4/MWh in 2019. In November 2023, a target price of €70/MWh was proposed, significantly higher than the price in force until the end of 2025. The cost of new transmission and distribution infrastructure could be financed by increases in the tariff for the use of electricity networks (TURPE), which will also increase bills.

However, financing new investments via a sharp rise in electricity bills is likely to meet with social and political resistance. Electricity prices have already risen faster than overall consumer prices over the past ten years and are now approaching the European average for consumers and businesses. Electricity prices paid by businesses are well above those prevailing in the USA (Figure 2), with risks that businesses will relocate to benefit from lower energy costs, as shown in the literature. Further rapid increases in electricity bills could also discourage the electrification of uses and prevent decarbonization targets from being met.
Small, modular nuclear reactors are also in scope of what is being considered. Smaller in power (340 MWe for EDF’s NUWARD project), they are said to require less land, be built more quickly, cost less thanks to their standardization, be safer, and pose fewer problems for nuclear waste treatment. However, the technology is still experimental, the discounted cost of electricity is much higher than for renewables, and only 3 models are currently in service worldwide (China, India and Russia).

Another approach would be to delay plans for nuclear expansion. Carbon neutrality could be achieved in 2050 by extending the operation of existing nuclear power plants while promoting renewable energies. According to some estimates, this approach is less costly. Indeed, the levelized cost of energy (LCOE) of solar and wind power should continue to fall rapidly over the next few years, reaching $35/MWh in Europe for photovoltaics and offshore wind power as projected by the IEA, i.e. around half the projected cost of nuclear power. The IEA has estimated that European countries have already seen their energy bills reduced by €100 billion by 2021-23 thanks to new wind and solar capacity. This would have lowered the cost of electricity by €350 per inhabitant per year, according to an estimate presented by l4CE to a Senate inquiry commission.

However, an economic approach to the power system cannot be satisfied with LCOE alone. This is because LCOE excludes system costs such as network, flexibility and storage costs. The scenarios produced by RTE (Futurs Energétiques 2050) recognize that the unit production costs of renewable energies are lower than those of nuclear power, but they also identify a surcharge linked to the network and flexibility costs of these energies. When these flexibility costs are taken into account, the difference between the different energy sources in these scenarios is relatively small. There is, however, a considerable margin of uncertainty
in the results of these scenarios, as technological developments and the economic environment are difficult to predict.

**All this argues in favour of a margin of flexibility in the planning of the electricity mix.** By not setting rigid goals for the future electricity mix, the government could react to unexpected technological developments and take advantage of any favourable changes in operating costs. This also argues in favour of a diversified power mix, rather than one dominated by a particular technology. Diversification has many advantages. Combining nuclear, wind, solar, hydro and biogas technologies is a good way to offset intermittency, provide flexibility and strengthen resilience to shocks. Flexibility in the deployment of technologies also makes it possible to take into account the acceptability of local stakeholders, as well as the characteristics of local employment areas, particularly in terms of skills and industrial tradition. Territories already accustomed to nuclear power plants have less resistance to new reactors, while other regions may prefer renewable energies.

**Whatever the technology, financing costs will be high.** For most power technologies, costs are concentrated during construction, and much less during operation. Borrowing interest rates (especially long-term interest rates) and return on equity are therefore key parameters in determining the cost of investment in the power system. Solutions to lighten the burden of financing would help make electricity more affordable, encourage electrification, and combat fuel poverty.

**The renationalization of EDF in June 2023 comes with an implicit guarantee against insolvency risk.** This greatly reduces the risk premium associated with operating nuclear power: **EDF was thus able to raise €1 bn in November 2023 with a fixed coupon of just 3.75% for a 3.5-year bond.** For renewable energies, contracts for difference resulting from CRE calls for tenders provide a predictable return on capital, which reduces the risk premium. Such mechanisms are likely to continue in the future. An additional avenue to alleviate financing costs is a “green interest rate”, as suggested by President Emmanuel Macron. Similarly, the "structural operations" as part of monetary policy implementation, as envisaged by the ECB, could also facilitate the financing of these energy transformation investments.

**These costly investments in the power system will only be justified if the electrification of energy use develops rapidly.** In 2023, electricity consumption was down from 2022, and around 7% below the 2014-2019 historical average. Encouraging electrification therefore remains a challenge.

**Reforming energy taxes to reflect the greenhouse gas content of different energy products would encourage electrification.** Such a reform would lead to lower taxes on electricity than on fossil fuels. This would encourage the transition to electric vehicles, heat pumps and industrial processes using electricity. Electricity consumption in France is subject to several taxes - VAT, electricity excise duty, and the “Contribution tarifaire d'acheminement” (which finances the pensions of employees in the sector) - representing 23% of bills in 2022 (despite the tariff shield). This tax reform could take place within the framework of a reform of the EU Energy Taxation Directive (ETD).

**To encourage electrification, the government should also eliminate the tax expenditures that benefit fossil fuels and discourage electrification.** According to some estimates, these amount to **€16 billion** - including tax breaks on kerosene, non-road diesel, commercial diesel and the tax differential between diesel and petrol. Accompanying measures would be needed to help affected consumers.
The cost of future investments in the electricity sector could also be alleviated by innovative small-scale solutions tested in France:

- **Individual or collective self-consumption of solar energy** is authorized by regulations, with different methods of resale to the grid. Expansion of this type of production is helping to make up for France's lag in solar energy. However, the taxation of self-consumption is penalizing, including VAT for large installations and payment of TURPE, even when using a "microgrid". The Spanish experience suggests that such taxation discourages self-consumption. In Belgium, the prosumer tariff is reimbursed in many cases. The government should therefore rethink the taxation of solar self-consumption.

- **As well as encouraging self-consumption, the public authorities could also encourage electrical solidarity.** Local groups are experimenting with collective self-consumption within a group of houses or buildings. In addition, in the context of their broader mission and their ESG rating, companies such as La Poste, are donating their surplus electricity. To strengthen social relations, some companies allow their employees to recharge their electric vehicles free of charge from surplus solar-generated electricity, with many positive spin-offs. Encouraging solidarity electricity would be a step in the right direction.

- **Other sources of electricity production - affordable, secure and clean - would also be supported by basing energy taxation on their greenhouse gas content.** These include biogas, natural hydrogen, marine energies (tidal, tidal turbine, thermal, wave and osmotic) and geothermal energy.

**France’s electricity strategy must be seen in the context of the EU electricity market.**

As a result of successive EU reforms, the French electricity system is closely integrated with that of its neighbouring countries. Thanks to transmission interconnections, French operators can buy or sell electricity on the European market, enabling them to balance supply and demand in the short term and to enter into forward contracts for longer periods. French electricity producers benefit from their exports to partner countries (in 2023: net exports of 50 TWh, gross exports of €6.8 billion). In the event of difficulties, such as the low availability of nuclear and hydroelectric power plants in 2022, France can make up the shortfall by benefiting from electricity produced elsewhere in Europe (Figure 3). The European market also offers very short-term advantages. Over the course of the day, consumption peaks occur at different times in France and its neighbours (e.g. dinner times in France and Spain), reducing the need for generating capacity used only during temporary peaks.
The EU electricity market is therefore a source of resilience and diversification. These advantages will be even greater when the electricity mix is dominated by renewables: wind regimes (wind), sunshine levels (solar) and rainfall (hydro) differ between European countries, reducing the need to compensate for intermittency with storage batteries or back-up power plants. European harmonization of national electricity policies, with exchange of information on infrastructure programs and pooling of innovations, also appears to have reduced financing and investment costs.

However, the European market has failed to stabilize electricity prices. Until 2020, wholesale market prices were too low to make operators profitable. The massive integration of renewable energies during this period led to an oversupply, resulting in a sharp drop in wholesale market prices that eroded operators’ profitability. Newly-built gas-fired power plants were dismantled, even though they could have been used as back-up plants, and the critical situation of the operators prevented them from repairing and renovating the existing reactors. Conversely, prices skyrocketed in 2021 and 2022, putting consumers in critical situations, and resulting in massive financial transfers between players in the sector. In addition to the problems of volatility, electricity prices in Europe have remained persistently higher than in the United States (Figure 2), creating competitiveness problems for European manufacturing industry.

EU energy policy should seek to reduce price volatility and restore business competitiveness. This would require more active European coordination of national policies, and intervention in the market in the event of disorder, as has been introduced in the EU
Emissions Trading System (EU ETS). Investments in the electricity sector should be discussed at European level, to avoid situations of shortage or oversupply as seen in the past. Europe could also contribute to the financing of these investments, with "Energy Eurobonds", to reduce financing costs and share risks, as in the "Fit for 55" package. State aid rules, which have been relaxed, should be tightened in the case of energy to avoid distortions of competition. In the meantime, France’s electricity policy needs to use a variety of instruments to protect players in the electricity market.

**Figure 4 - Wholesale electricity market prices**

(in €/MWh)

Source: Ember

**EU policy to promote renewable energies should go hand in hand with strong ambitions to produce solar panels, wind turbines and storage batteries.** The current dependence of France and other European countries on producers located in Asia presents supply risks. The United States requires a minimum domestic content for access to subsidies under the Inflation Reduction Act. One uncertainty is the ability of the European industry to become competitive with its Asian rivals, who have a head start in terms of innovation, learning, economies of scale and production chain. The prospect of the US virtually closing its borders to Asian solar modules could lead these countries to transfer their exports to Europe, further exacerbating the financial difficulties of Europe's few photovoltaic panel manufacturers. An anti-dumping investigation could prove necessary.
2. RETHINKING MOBILITY

The transport sector is the main energy user in France, accounting for 34% of final consumption, and the leading source of greenhouse gas emissions (Figure 5). The private car is one of the main sources of pollution: light vehicles account for around three quarters of fuel used, and heavy goods vehicles for a quarter. Passenger cars generate 17.4% of national emissions. Consumption of diesel and petrol peaked in 2002, but has since fallen only moderately.

![Figure 5: Greenhouse gas emissions by sector (in MtCO2e)](image)

Source: CITEPA, Monthly emissions barometer

Despite policies to encourage modal shift, rail’s share of passenger transport has only risen from 10% to 11% in fifteen years. The SNCF receives various fiscal contributions estimated at €20 billion/year. Urban rail transportation receives also significant contributions: public employers pay 75% of commuting fares, private employers pay a "mobility payment" tax based on payroll, and some towns make public transport free. But all this has yet to translate into a major shift from car to railways transportation. Increasing the modal shift from car and plane to train remains an important policy objective. The government has announced a plan for the future of transport, which includes investments of €100 billion up to 2040 to improve the railways infrastructure and investment in daily commuting transport. Securing these investments is crucial.

The operating expenses of rail transport in urban and regional areas are high (Table 1). Mass transit by rail in dense urban areas (metro, RER, Transilien) is expensive but helps to reduce negative externalities from road traffic – especially local air pollution, noise and
use of space. Regional trains (TER) are also expensive because these trains typically have low occupation rates, though recent initiatives by regional councils have helped to improve occupancy thanks to modal shift.

Table 1: Operating expenses of passenger trains and cars

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<th>Operating expenses in €/passenger.km</th>
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<td>2019</td>
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<td>Total</td>
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Source: National Transport Account (CTN)

**Rail has a social role to play.** For people on modest incomes, public transport offers real opportunities, particularly for commuting to work or educational establishments. Continued development of the railways, including better use of existing infrastructure and competition between passenger and freight transport companies, remains an imperative. However, the cost of railways to public finances is a challenge at a time when public administrations are already heavily in debt. Increasing the SNCF’s productivity should be a major component of rail transport planning. France could follow the example of Germany, where the productivity of regional trains is notoriously higher thanks, in particular, to investments made to modernise, maintain, and rationalise the infrastructure, including train stations.

**Reducing passenger cars’ emissions is an essential objective.** New light vehicles must be gradually decarbonized over the next few years until the 2035 deadline, when all new cars must be zero-emission in France and throughout the European Union. There are currently 1.6 million electric vehicles (including 1 million all-electric) on the road in France, out of a total of 39 million. The market share of electric cars remains low: 17% for all-electric vehicles in 2023, and 9% for plug-in hybrids. These market shares increase each year (13% and 8% in 2022), but reaching 100% of zero-emission new vehicles by 2035 remains a distant goal.

**What is more, electric vehicles remain out of reach for modest and middle-income households, even with public subsidies.** The "leasing social" subsidy, temporarily introduced in early 2024, has made it possible to lease an electric car for €100 a month. However, the quantities of cars available and the budgetary appropriations were small compared with the number of 13 million people considered to be in a situation of "mobility precariousness", either because of difficulties in paying their fuel bill or because they depend on the car for their travel without having sufficient income.

Faced with all these challenges, the priorities could be:

- **Favouring the “leasing social” as the main tool for decarbonizing automobile transport.** The “leasing social” met with great success in early 2024, enabling low-income households to access electric vehicles on attractive financial terms. However, it was hampered by insufficient budget funding. In order not to discourage
participation in the labour market, the “leasing social” benefits should gradually decrease as household income rises, as is already the case for the “cheque énergie”.

- **In order to free up budgetary margins for social leasing, the “bonus écologique” subsidizing the purchase of electric vehicles should be made means-tested, or even abolished.** All households in France currently have access to a “bonus écologique” capped at €4,000, and individuals whose reference tax income is less than or equal to €15,400 are eligible for a total bonus of €7,000. As is already the case with France’s “prime à la conversion”, and following the example of the United States since the *introduction of the IRA*, the “bonus écologique” could completely exclude the highest-income households. It could also be eliminated altogether if the “leasing social” becomes the government’s preferred tool.

- **The benefits of “leasing social” could also be applied to used cars.** At the start of 2024, carmakers were unable to supply sufficient quantities of the vehicles required for the “leasing social”. French households mainly buy second-hand cars, which account for **74.5%** of passenger car purchases. These are often company vehicles (company fleet, leasing, rental cars) resold after a few years. The adoption of electric motorization by households will therefore involve the second-hand market. As in the case of the Inflation Reduction Act in the United States, subsidies could help low-income households gain access to used electric cars.

- **Providing other benefits for electric vehicles.** Norway’s success in popularizing electric vehicles is largely due to tax incentives, but other benefits are also having a positive **impact**: free or reduced road tolls; free parking; free electric recharging; and access to bus lanes. France could learn from it.

- **Encouraging the transition of the European automotive industry.** The decision by the European Council and Parliament to require all new light vehicles to be zero-emission from 2035 presents a challenge for the European automotive industry, which is lagging far behind its Chinese and North American competitors. The social and industrial risks for the automotive industry are real. Encouraging the industry’s transition to zero-emission vehicles should be a priority. Where there is evidence of dumping, vehicle subsidies should include a preference for local content, as in the case of the Inflation Reduction Act.

- **Encourage the European Union to tighten emission standards for heavy-duty vehicles.** Manufacturers are obliged to maintain an average emission level of 95 g CO2/km across their entire range, but this standard can be increased according to the weight of the vehicles sold, which favours SUVs and other heavy vehicles - the biggest CO2 emitters. France could [encourage the European Parliament](https://www.uneuropeparlement.org/) to review this advantage in the context of EURO 7.

- **Give greater impetus to new forms of mobility**, both for short daily journeys and for longer distances, which account for **40%** of kilometers traveled. As in other countries, greater public subsidies could encourage new types of short-distance mobility (electric bikes, microcars, [express coaches](https://www.expresscoaches.org/), [autonomous shuttles](https://www.autonomousshuttles.com/) and [automated](https://www.automatedvehicles.com/) vehicles).

- **Further discouraging polluting company vehicles.** In 2024, France introduced [two new taxes](https://www.taxesfrance.com/) on company vehicles. These taxes are based on emissions of CO2 and other atmospheric pollutants, encouraging the electrification of car fleets. However,
the numerous exemptions to these two taxes could be eliminated (rental vehicles, taxis and VTCs, vehicles for sports competitions or for non-profit associations). Tax and social security benefits for the provision of an electric vehicle could be extended beyond 2024, as could the charging of a private vehicle at the workplace. In addition, the quota of electric vehicles in fleets purchased by large companies should exclude hybrid vehicles, which are often as polluting or even more polluting in practice than combustion-powered cars.
3. TRANSFORMING ENERGY DEMAND IN HOUSING

The residential sector accounts for **28%** of final energy consumption in France. Consumption is mainly for space heating, with lesser demand for domestic hot water, cooking and air conditioning. These needs are covered by electricity and natural gas, with biomass also making a significant contribution (Figure 6). Consumption peaked in 2008 at 511 TWh (corrected for climatic variations) and then gradually declined, reaching **473 TWh in 2023**.

**Figure 6: Residential energy consumption, all uses**

Source: Précarité-Energétique.org

**Fuel poverty persists in France.** At the start of 2022, around **11%** of people said they were unable to heat their homes sufficiently for financial reasons, a proportion at the top end of European countries. The "chèque énergie" scheme provides means-tested assistance with the payment of housing energy bills, benefiting almost 5.6 million households. The average amount is €150, with a range from €48 to €277 depending on tax income and household size. An exceptional cheque of €100 to €200 was also allocated at the beginning of 2023 in response to energy price increases. Relatively simple in administrative terms, the "chèque énergie" has been criticized by the Cour des Comptes for its relative inefficiency: the Court "notes in particular that the sole criterion used by the public authorities - the standard of living of household members - makes its targeting inefficient."
- The energy voucher could be transformed into an "electricity voucher" to better encourage the use of clean energies, in line with France's climate objectives. At present, it subsidizes the use of fossil fuels, and stimulates emissions via a "rebound effect".

- In addition, the payment of the voucher should take into account the energy needs of the beneficiaries, so as not to subsidize households with low energy consumption (location in the south of France, new and renovated housing, etc.). One approach would be to make the voucher conditional on the share of the energy bill in household income.

For the medium and long term, the government’s priority is to eliminate the leaky homes ("passoires thermiques"). The aim is to combat fuel poverty and meet national greenhouse gas emission targets. The number of dwellings classified as F and G is high in the private rental sector (18.5% of dwellings), as well as among primary residences (15.7%). Most occupants of these homes are elderly, live alone and have modest incomes.

The government has earmarked €5 billion to be spent in 2024 to support home energy renovation work. This budget appropriation finances two main subsidy programs: MaPrimeRénov, directly subsidizes renovation work in principal residences; energy saving certificates (CEE) encourage energy suppliers to actively promote energy efficiency among energy consumers. In addition, a reduced VAT rate (10% instead of 20%) applies to certain renovation work, and zero interest loans subsidized by the state budget are available.

However, energy renovation work appears to have very little effect on energy consumption. For €1,000 worth of work, the saving on the bill would be just €14 per year. In fact, the energy efficiency gains from these renovations are most often lower than calculated by thermal engineering models. As a result, subsidies for energy renovation do not appear to be economically efficient. To increase impact, renovation subsidies should be based on the actual results achieved when the work is carried out. Making the payment of renovation subsidies conditional on an energy efficiency improvement actually measured ex-post, and not the projections made ex-ante, and paying subsidies to companies rather than households, would encourage a focus on effective improvements. The ex-post assessment could be based on an actual improvement in the Energy Performance Diagnostic (DPE), which would encourage companies to carry out genuinely efficient renovations. Using the DPE as a performance indicator for energy renovations is not entirely optimal, however, as research shows that the energy efficiency actually achieved differs from that predicted by the DPE. Public action should seek to improve the methodology of the DPE, to bring it closer to the actual energy consumption of homes.

Energy renovation work is often hampered by the lack of availability of contractors, who themselves are constrained by the unavailability of manpower. This is largely due to the fact that the regulations governing the operation of small and medium-sized businesses in France are still too strict. Similarly, labour market rigidities are still a constraint on the mobilization of skills on the labour market. This is true in the home improvement sector. Similar difficulties are encountered in mobilizing companies and workers for the renovation of nuclear power plants, uranium recycling, and the manufacture, installation and maintenance of solar panels and wind turbines.

Electricity is more heavily taxed than natural gas. This holds back renovation work, such as replacing a gas boiler with a heat pump. Taking greater account of carbon content in energy taxation would change the price of electricity relative to natural gas. Energy taxation
has had little to do with carbon content since the failure of various attempts to introduce a carbon tax. Rather than introducing a carbon tax, the aim should be to reduce the tax burden on decarbonized energies while increasing the tax burden on fossil fuels. This would lead to lower electricity bills and higher natural gas and heating oil bills. Such an overhaul could be carried out as part of the revision of the European Energy Tax Directive (ETD). Rebalanced in this way, taxation would encourage discarding natural gas and oil-fired boilers, and favouring heat pumps - which are far more energy-efficient than fossil-fuel heating systems.

In the long term, housing policy and urban planning policy also need to be made more coherent. The trend over the last thirty years has been to encourage new housing construction, with tax credits for rental investment and social housing. This has encouraged an increase in the number of dwellings per inhabitant and in living space per inhabitant, with new housing construction consuming a lot of materials and energy. Moreover, half of all new homes are single-family houses, which consume more energy than apartments. This approach has also encouraged urban sprawl outside city centers and inner suburbs. As a result, employees living away from urban centers have to use their cars to get to work.

- **Public subsidies should do more to combat urban sprawl.** Tax breaks for new homes could be reserved for those located close to public transport (e.g. less than one kilometer away) and subject to an energy performance standard.

- **Tax credits and public subsidies should be redirected to encourage the renovation of unoccupied dwellings.** France has 3 million vacant dwellings (unoccupied and immediately habitable) that could be put to better use, rather than resorting to new construction. The majority of these vacant homes are multi-family dwellings, and are more likely to be found in rural areas and small towns than in major urban centres. There are a number of reasons for this high - and rising - vacancy rate. Landlords may be reluctant to rent them out due to restrictive regulations that are more favourable to tenants than to landlords. Renovation work may be required, particularly in the context of Energy Performance Diagnostics (DPE), which could be subsidized more and better calibrated.

- **Vacant housing is often located far from employment areas and public services, which greatly reduces its attractiveness.** Housing vacancies could be reduced thanks to the rise of telecommuting, either at home or in coworking hubs when the employee's presence in the workplace is not essential on a continuous basis. However, the attractiveness of localities with large numbers of vacant homes can sometimes pose problems (education, health and transport). Efforts by local authorities to provide additional public services in these areas are currently discouraged for cost reasons. Less costly solutions can be sought, such as neighbourhood or building-based micro-nurseries, to increase the viability of local revitalization programmes.