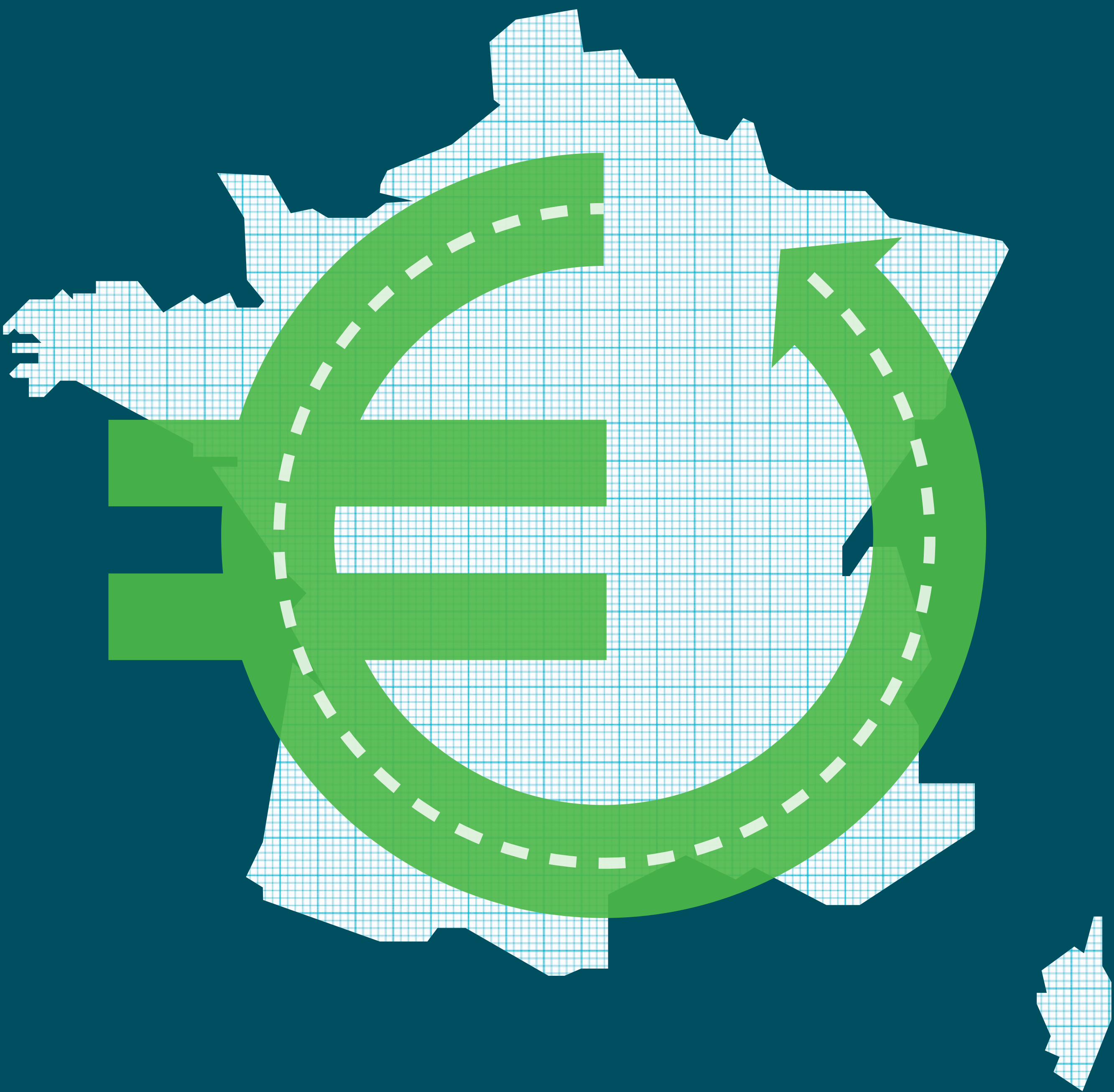
Fuelling France



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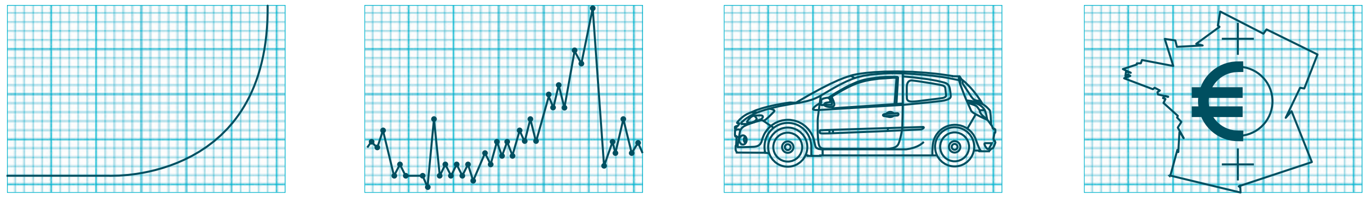
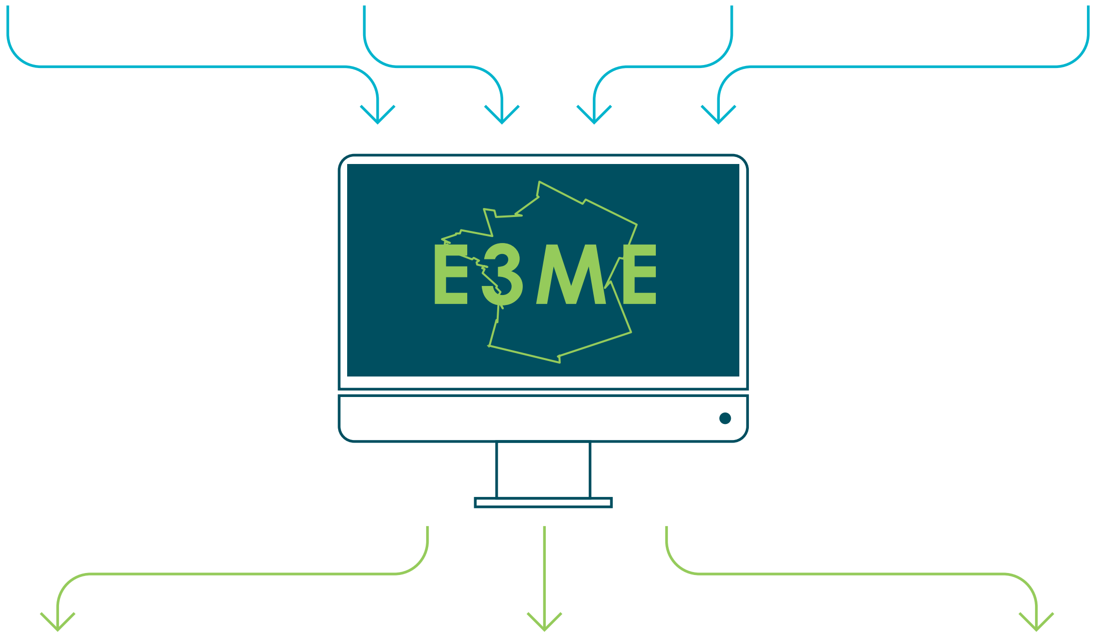
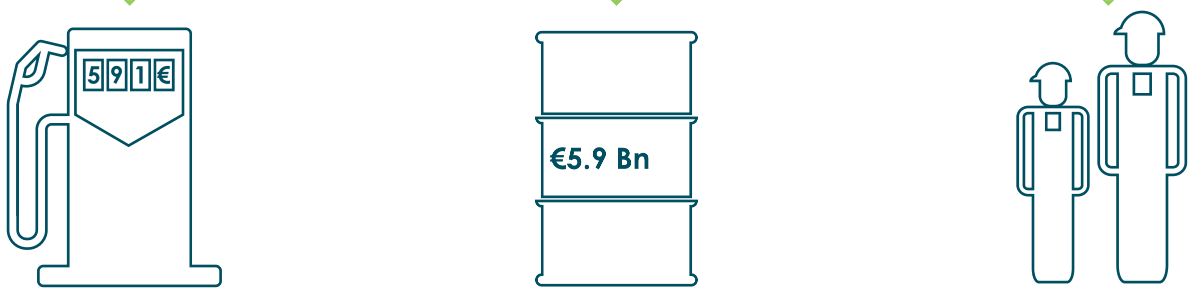






Average avoided spending on fuel in 2030: €591 annually per motorist

Avoided annual spending on petroleum that stays in the French economy in 2030: €5.9 Bn

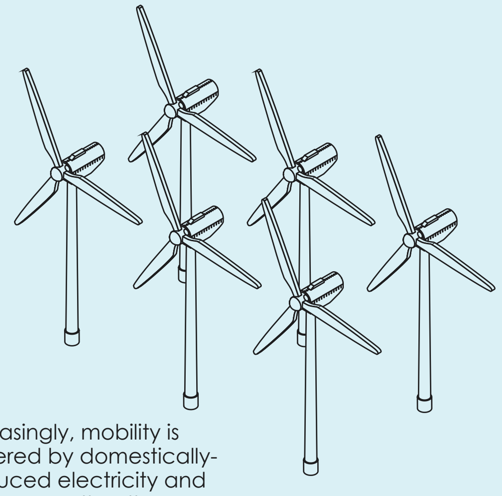
Net additional jobs in 2030: 66,000 – 71,000

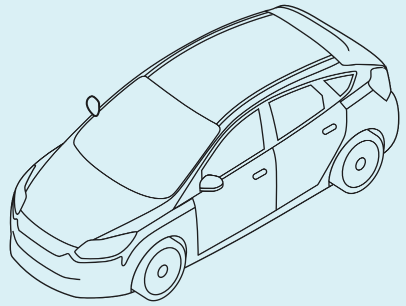
CO_2 reduction in 2030: 40%

NOx reduction in 2030: 72%

PM reduction in 2030: 92%

Economic impacts of low-carbon vehicles in 2030

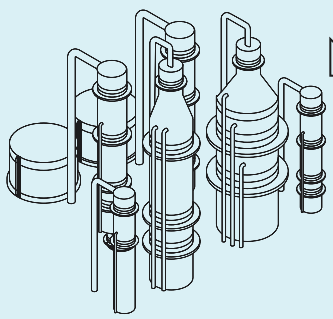


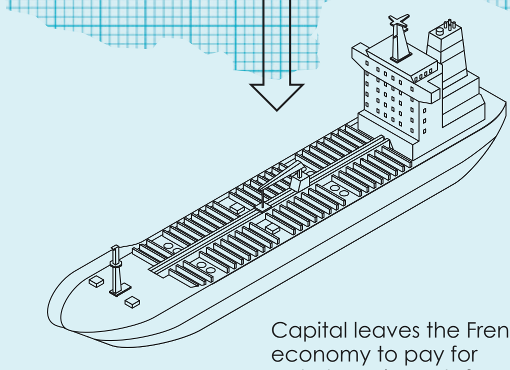


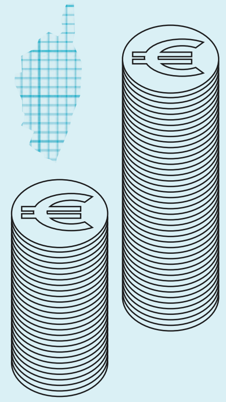
Increasingly, mobility is powered by domestically-produced electricity and hydrogen, rather than imported oil. This creates €3.1 bn per year of value for French energy producers in 2030.

Consumer spending on vehicles increases by €6.1 bn in 2030, due to the cost of clean technologies, but this economic value is mostly captured by French companies and re-circulated to the French economy.

For each driver, spending on fuels is reduced by €591 per year, outweighing the cost of technology, so overall mobility costs are reduced. This means a saving of up to €7,681 over the lifetime of the car. By 2030, €12.4 bn is saved across the economy and is spent on other goods and services.







Consumer spending on petroleum fuels is reduced, so the value captured by French refiners and fuel distributers is reduced by €470 mn.

Capital leaves the French economy to pay for petroleum imports from overseas. This amount is reduced by €5.9 bn per year in 2030.

Summary

How can low-emissions vehicles contribute to the French energy transition and the national low-carbon strategy? What are the benefits for the economy, and under what conditions? How can France and its territories improve air quality?

In order to discuss these questions, this project brought together industry and civil society. Representing the automotive industry, Renault, Valeo, Michelin, Saft and Eurobat provided their valuable expertise on technological aspects. The French Aluminium Association, European Aluminium and the chemical group Lanxess provided input on materials. On the energy and infrastructure side, data evaluation was provided by ERDF, Air Liquide and ABB. Civil society was represented by the FGMM CFDT (General Federation of Mines and Metallurgy), the Nicolas Hulot Foundation and the European Climate Foundation.

The work has helped quantify the likely impact on the French economy of the transition towards more energy-efficient light-duty vehicles, principally fuelled by electricity, from renewable energy sources, and by hydrogen. Following many months of analysis and exchange, the project showed that the transition towards low-carbon mobility helps generate sizeable economic co-benefits, creating jobs in technological innovation, while reducing French dependence on oil. For these benefits to be realised, close collaboration between the government, local authorities, industry and civil society is required.

Given the inherent uncertainty around new and future technologies it is difficult to precisely quantify the economic impacts. We have therefore limited the margin of uncertainty by using a conservative set of data, which has been tested according to multiple economic scenarios.

Data on the cost and potential of each low-carbon automotive technology are based on data that was originally produced by the European Automobile Manufacturers' Association (ACEA) and the European Association of Automotive Suppliers (CLEPA), and this dataset has been examined and updated as necessary by the French experts working on the project. Oil price projections were taken from the International Energy Agency (IEA), and projections related to electricity and hydrogen were based on the French energy transition law and H2 mobility France.

The transport sector accounts for 71% of oil consumption, of which nearly all is imported. **For every 100 euros spent on filling a fuel tank, 33 euros leaves France and goes to producing states and foreign petroleum companies.** By reducing spending on oil imports, it is thus possible to reconcile the fight against climate change with the creation of new economic opportunities.

The transition towards efficient vehicles with an increasing level of electrification would reduce capital outflow from the French economy. It would allow French households to reduce expenses related to the use of their vehicles, more than offsetting the slightly higher purchase price of vehicles. By increasing the share of domestic energy, particularly that produced by renewable energy, France's energy trade balance will be improved, limiting exposure to the price volatility of crude oil.

Improvements to conventional vehicles are already saving money for motorists. Breakthroughs in engine optimisation, the use of light materials, energy-efficient tyres and the gradual introduction of electric propulsion will contribute to further cost reductions.

In France, motorists spend an average of €1,191 per year on fuel. **By 2030, using an efficient conventional car or a more energy-efficient hybrid would save 583 euros per year, compared to today's average vehicle.** Greater savings might be made with new electric and hydrogen vehicles: Up to around 1008 euros per year per motorist, although the amount of savings made depends greatly on the decisions of the French government regarding fuel tax and energy sources for transport.

If enacted at a global level, this transition to low-carbon vehicles would help reduce the price of crude oil, further boosting the economies of oil-importing countries, such as France.

While the purchase price of these technically advanced vehicles may turn out to be higher than for conventional vehicles, the **extra cost should be entirely recovered in a few years by savings made at the fuel station.** This means that overall, the percentage of French household budgets spent on buying and operating cars is lower in a low-carbon scenario.

On a national scale, by 2030, the total cost of renewing and powering vehicles in France and the associated energy distribution should be around €12.4 billion less thanks to the integration of low-carbon technologies compared to vehicles using current technology. Even if petroleum prices were to remain at today's historically low levels, the cost would be €6.4 billion less.

Altogether, these factors are likely to boost the French economy. **The report shows that switching to low-carbon vehicles would help to create 66,000 jobs in France by 2030** through a transitional period dominated by hybrid and electric vehicles.

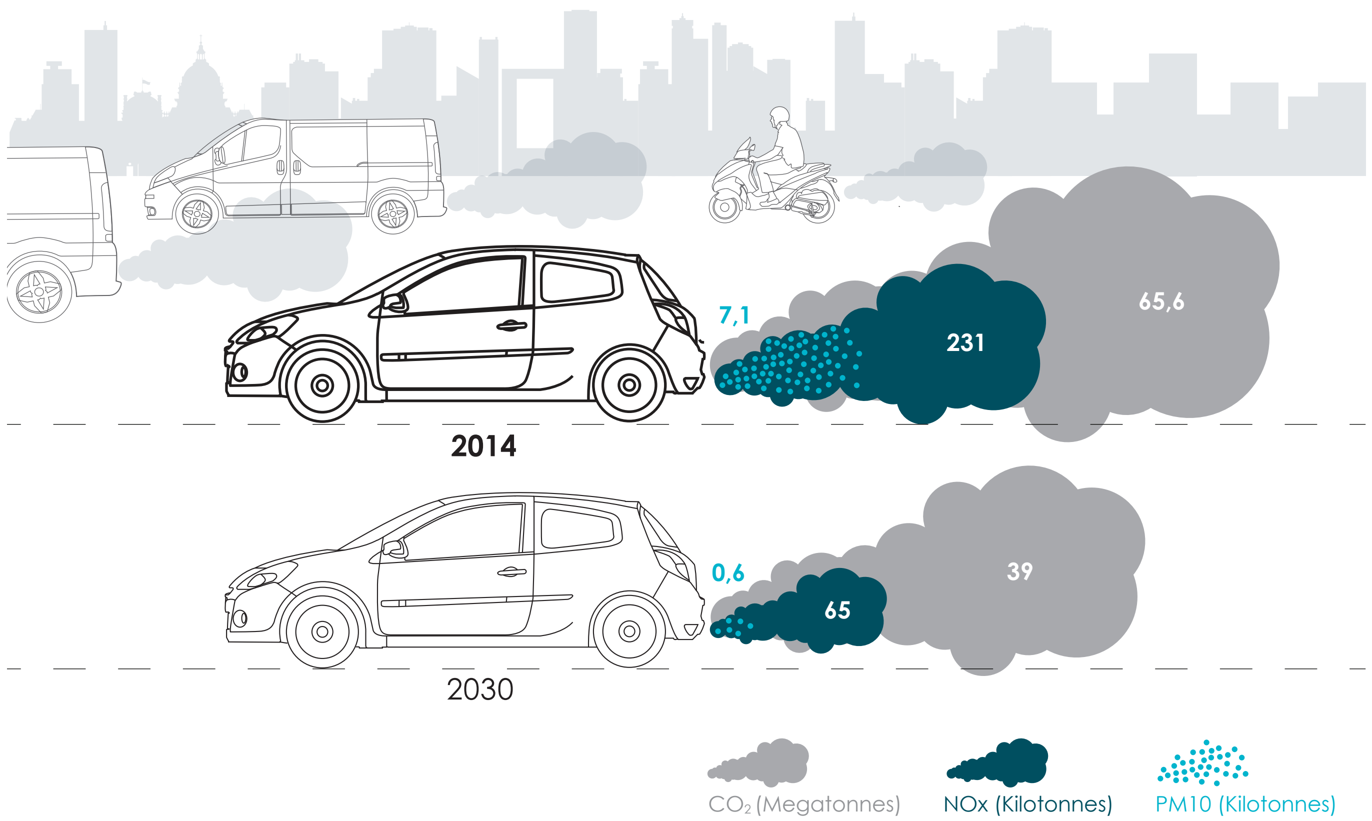


Figure 1

French emissions of CO_2, NOx and particulates are significantly reduced between now and 2030 in the "Low Carbon Technology" scenario.
Sources: European Environmental Agency, Cambridge Econometrics

Furthermore, CO2 emissions from cars and commercial vehicles could be reduced by 40% by 2030 and up to 90% by 2050. In this case, air pollution caused by Nitrogen oxides and fine particulate matter would also be greatly reduced, by 97% in 2050. **The health benefits of better air quality are estimated at €5.1 billion for the French economy in 2030**[1]**.**

The project analysis showed that, if there is a move towards smart charging systems and the use of photovoltaic solar energy combined with storage solutions, the number of electric vehicles modelled in the project would not require additional generating capacity, notably from nuclear and fossil fuels, and would facilitate the evolution towards a lower-carbon electricity mix.

However, this low-carbon transition will not happen without political will: it requires collaboration to create the right conditions. Investment in infrastructure will be necessary; employee training is crucial to make France more competitive; and vocational retraining will be needed for those who have lost their jobs in the refining sector or in the production of outdated technologies.

Low-carbon investments in France: the story so far

After an initial hesitant start, the modern French automotive industry began to develop after the First World War. Investments in the French automotive industry have increased to meet the imperative of keeping global temperature increases well below 2°C. Through applied research manufacturers have therefore been able to reduce the size of an engine while maintaining its power and curbing pollutants. As one of France's major innovators, the automotive industry spends around €6 billion per year on R&D.[2]

Reform of the "Crédit d'Impôt Recherche" (Research Tax Credit) and the introduction of an ecological bonus-malus system in 2008 helped the sector to adjust, placing France among the frontrunners, like the Netherlands and Norway, of countries that have lowered average CO_2 emissions from cars and vans. The support given by the authorities meant that investments could be directed towards a long-term low-carbon strategy. For example, component manufacturers invest a significant part of their turnover in R&D. In this respect, Valeo was the 5th most prolific company filing patents in France in 2014. The Energy Transition Law passed in August 2015 substantiates the aims of the French government regarding electro-mobility, without ignoring the opportunities from domestic production.

Renault has also invested €50 million in its plant at Cléon in Normandy to develop and manufacture new generation electric motors for the Zoé and Kangoo-ZE models. Batteries are a strategic part of the architecture of electric cars and there are already several production sites in France. Production volumes are designed to satisfy the growing demand for electric mobility.

France certainly has significant expertise in the development and manufacture of lithium-ion batteries. The Saft plant at Nersac in Poitou-Charentes is the first industrial site in the world with large-scale production of lithium-ion batteries for hybrid cars, and plays a strategic role in supporting sustainable transport. Using the certified ISO-TS (automotive) process, the Nersac plant has the capacity to produce batteries for several thousand hybrid cars each year. These investments are geared towards the real potential for a boom in this market.

Technological potential

The necessity of maintaining global temperatures well below the threshold of 2 °C and of improving the quality of air in urban areas gives a clear direction for policies to encourage investments in low-carbon technologies.

In this project, we explored the impact of low-emission cars and vans in France by modelling a series of scenarios. Many experts believe that future vehicles will be powered by a variety of low-carbon technologies, accompanied by efforts to reduce the carbon footprint in a dynamic circular economy. These technologies comprise more energy-efficient combustion engines with varying degrees of hybridisation, electric vehicles and hydrogen fuel cell cars. The scenarios were designed to achieve the objectives of the French Energy Transition Law as well as the European objectives to reduce emissions from transport by 60% by the year 2050.

Electric vehicles fitted with a battery will certainly play an important role in reducing CO_2 emissions and pollution on the roads in France. Future trends for rechargeable electric vehicles are difficult to predict, although 15,045 vehicles[3] were sold in 2014. Compared with analyses to date, the sales estimates for the key scenario of this study lie within the average range. In this scenario, sales of electric vehicles comprise around 5% of sales of cars and vans in 2020, increasing to 30% in 2030 and 65% in 2050. In the longer term, electric motors could also be powered by converting hydrogen in fuel cells. Commercialisation of this type of vehicle is already underway. The scenario analysed estimates sales of fuel cell vehicles of 7% in 2030 and 25% in 2050.

Great progress has been made to improve the energy efficiency of internal combustion engines. Start-stop systems are the first stage in deploying electric propulsion. Numerous competitive hybrid technologies are available today in the automotive market and others will emerge. The central scenario in this study estimates that hybrid vehicles will comprise 20% of sales in France in 2020 and 42% in 2030.

All vehicles, irrespective of how they are powered, can become more energy efficient by reducing their weight, rolling resistance and improving aerodynamics.

In today's cars, around one tank of fuel in five on average is consumed due to drag. Parts manufacturers are developing new sizes of tyres, both in height and width, which together with innovative internal architecture using light materials and platforms, will significantly diminish air and rolling resistance.

The projections in this study envisage energy savings of around 15% in 2030 and up to 25% in 2050, simply by reducing vehicles' mass. Weight reduction has already been implemented in seats, windows, interior parts, and through the increased use of aluminium and high resistance steels, high-technology metal compounds and plastic composites for car frames and bodywork. The components for the powertrain, windscreen wiper system and lights also benefit from this process. In the case of electric cars, which are already energy efficient, these weight savings translate into longer battery life.

In the medium to long term, greater reductions in weight, of about 30-40%, will be achieved through the increased use of aluminium and greater use of fibre-reinforced plastics in frames and bodywork. Slightly heavier than carbon fibre, glass-fibre reinforced plastic offers much lower production costs and raw material costs, making them more suitable for mass production. By 2030, lightweight materials in a new car could reduce fuel costs by €1,580 over the lifetime of a vehicle for an increase in the cost of the average car of €220.

There is a clear trend towards ultra-light materials in the automotive sector and reducing weight is becoming an integral part of OEMs' strategy to cut CO_2 emissions. With the right policy design, reducing vehicle weight could actually reduce the total upfront costs of reaching EU CO_2 standards by 16% during 2020-2030, according to Ricardo-AEA.[4]

Alternative fuelling infrastructure

Utilisation of ultra-low-carbon vehicles requires a recharging infrastructure to be put in place. This includes charging at home, installation of ultra-fast charging points and hydrogen charging points for vehicles fitted with fuel cells. Measures to promote installation of charging points, which have been included in the automotive framework plan and the French Energy Transition Law, allow the national network to be improved to support the development of e-mobility. In France, the installation of public electric multi-standard rapid charging points started last year and the number of public projects including these types of charging points have increased greatly in 2015.

In this study, we looked at two variants of infrastructure deployment. Throughout the whole of the study, utilisation of electric charging points is dominated by the installation of residential wall boxes. At the same time, a significant spread of public charging points is modelled so as to help lower overall infrastructure costs. Distribution of hydrogen remains relatively centralised in the various scenarios.

Installation of a domestic charging point allows 'normal' charging. Depending on the size of the battery, charging a vehicle to the maximum level takes between 4 and 10 hours, irrespective of the type of power point. Charging time can change with the size of the battery. Therefore normal charging is initially preferred at work and in car parks but the study considers rapid charging points from 2020, with charging possible in around 1 hour. Ultra-rapid charging points will be installed on motorways, dual carriageways and transit points, which have a significant level of traffic. They offer charging times of around 30 minutes. The majority of public projects to install electric charging points already include 5 to 15% of ultra-fast charging points.

From 2025 onwards, the increase in the number of users of ultra-fast charging points will allow privately managed models to be developed, thus increasing the number of charging points available. In view of battery cost reductions and changes to battery size, the percentage of these types of charging points should increase.

The installation of infrastructure for refuelling hydrogen should go hand in hand with the entry into the automotive market of fuel cell vehicles. The cost of hydrogen refuelling stations installed in petrol stations, for example, should fall by 50% between now and 2030 due to economies of scale and improvements in the fuel distribution chain. According to the scenario projections in this study, 600 hydrogen charging stations would be installed between now and 2030 in France.

The costs of charging stations in a domestic or work environment is assumed to be paid for by the owners of electric vehicles. However, installation of electric and hydrogen charging stations in public places will require investment by the state and local authorities. Hence their installation is likely to be carried out on the basis of collaboration between the various private and public players, with technologies being promoted that are compatible with smart energy management.

Synergies between vehicles and electric systems

The trend towards the electrification of transport creates challenges and opportunities for the electricity system in France. If not managed properly, this change could result in substantial investment requirements to increase electricity generation capacity and to reinforce electricity distribution networks. However, if smart charging is implemented, electric vehicles can help energy providers and network operators to better manage the imbalances between demand and supply. Electric vehicles can also help to manage overloading, voltage levels and mains frequency, and can absorb surplus electricity from renewable energy. This smart management is a necessary condition to avoid having to fall back on additional production capacity to cover peaks in demand.

In this project, we tried to quantify the maximum number of electric vehicles that could be deployed in France without having to create new electricity generation capacity. We also estimated the potential costs of the distribution network reinforcement, which would be needed to enable the use of electric vehicles. In order to get a comprehensive overview of all the effects of the transition to ultra-low emission vehicles on the electricity system in France, these costs were compared to the value of the synergies potentially created by smart charging systems.

A model that considers departure and arrival times of vehicles was used to evaluate the times at which most cars are driving and the times at which the marjority of cars are stationary and available for charging. If vehicle charging is unmanaged, or passive, charging would be done mainly after the morning rush hour, when vehicles are connected at the work place, or just after the evening rush hour when vehicles are connected at home.

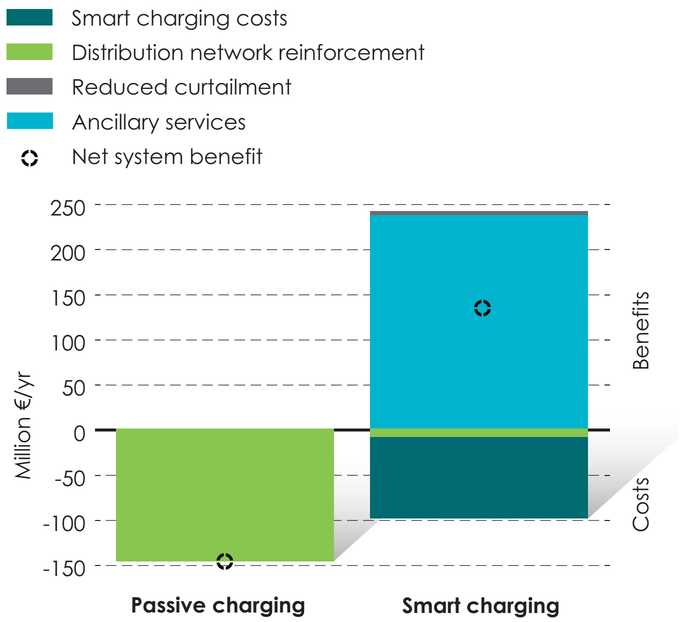
In contrast, managed or smart charging would use systems that allow electricity system operators to optimise charging so that it helps meet the needs of the electricity system. In this case, charging during morning hours could be extended during working hours in order to absorb the surplus from solar energy, while in the evening charging could be postponed to during the night when the surplus from wind energy could be utilised.

Storing hydrogen produced, for example, by electrolysis, could also be a complementary means to integrate renewable energy in electricity distribution networks. As an example, storing 5 kilos of hydrogen in bottles would use 300 kWh of electricity, taking the output of compression and electrolysis into consideration. In addition, while not addressed in this study, electricity stored by electric vehicles could also be fed back to the electricity grid in order to provide additional value to the electricity system.

The project analysis showed that if there is a move towards smart charging systems and the use of photovoltaic solar energy combined with storage, the number of electric vehicles modelled in the project would not require additional generation capacity,

Figure 2

Costs and benefits of integrating rechargeable vehicles in electricity distribution networks in France
Source: Element Energy



notably from nuclear and fossil fuels, and would facilitate the evolution towards a low carbon combination of electricity sources.

In France, using passive charging, up to 4 million extra electric vehicles could be deployed without requiring additional production capacity, while a smart charging system would allow more than 20 million vehicles to be integrated.

In this study, we also calculated the value of the services that electric vehicles could provide to grid operators. 4 million electric vehicles could generate nearly €228 million of benefits per year for the system in 2030.

In both cases, this assumes that additional electricity distribution lines will be installed to satisfy the energy needs of vehicles. However, only €10 million per annum would have to be mobilised in 2030 with smart management of electricity demand, compared to €150 million of costs for reinforcing the distribution network if vehicles are charged in a passive way.

When the costs and benefits described above are combined, smart management of charging systems for electric vehicles could help to generate a net benefit for the energy system of €125 million in 2030, while allowing much greater integration of renewable energy.[5]

Taking the number of vehicles in the central scenario of this study, this means a benefit of €30 to €50 per year and per car owner. Finding an effective means to monetise the provision of these services would reduce the total cost of ownership and would create beneficial services for the network without any significant need to improve the infrastructure. Nevertheless, the commercial model for tapping into these services depends on how the market design and regulation of managers and operators of transmission and electricity distribution networks will evolve.

Impacts on French motorists

Although trends for fuel prices at the pump are difficult to predict (linked to the price for a barrel of crude), this project used a range of projections to cover these uncertainties. The analysis showed that the cost of running a car in France will fall in all low-carbon scenarios, compared with the current situation. The addition of technologies to reduce fuel consumption will increase the costs of new cars, but this will be more than offset in a few years by the reduction in fuel costs, with significant savings made over the lifetime of a car.

Certain studies have shown that car owners underestimate future fuel savings when buying a car. However, a recent survey[6] of potential buyers showed that one in three would be prepared to pay between €1,000 and €2,000 more for a hybrid vehicle, while more than one in four would be prepared to pay €2,000 and more.

Conventional vehicles already contain electrical components to increasing degrees. For example, start-stop systems are used by almost all manufacturers today and certain types of semi-hybrids are becoming established.

In the central scenario, production costs of more energy efficient vehicles will increase the cost of a new car by €2,166 in 2030 compared to today's costs, but the energy bill for a car would be lower by an average of €591 per year, meaning a saving of up to €7,681 over the lifetime of a car. The number of kilometres travelled in the first years following purchase of a vehicle is much higher than in subsequent years,[7] and this helps to accelerate the return on investment of energy efficiency technologies. Consequently, the pay-back for the average car owner in France for vehicles fitted with energy efficiency technologies will occur after 2.2 years.

Electric and fuel cell vehicles represent a different ownership proposition, with higher purchase costs but lower operating costs. That is why it is instructive to consider not only the purchase costs, but also all other expenses throughout the lifetime of a vehicle. Although car-sharing and car-pooling were not included quantitatively in the analysis, they also help to lower mobility costs for people in France.

The study shows that the total cost of ownership of an electric car will be broadly similar to that of a conventional car from 2025 onwards.

The above calculations show savings made if fuel prices follow the projections of the International Energy Agency (IEA). However, the project explored a scenario with fuel prices 30% lower than the projections of the IEA. In this case, the additional cost of low-carbon cars would still be compensated by lower fuel costs in the 3rd year of the average vehicles's life.

Energy efficiency measures have lowered fuel consumption and if deployed globally would put a downward pressure on the oil price even with economic growth. For example, the US economy has grown 8.9% since 2007, while demand for refined petroleum products fell by 10.5%.[8] People in North America are driving less and are choosing cars that consume less fuel. Conversely, without policies to promote vehicle efficiency the world would need much greater quantities of fuel, putting upward pressure on fuel prices.

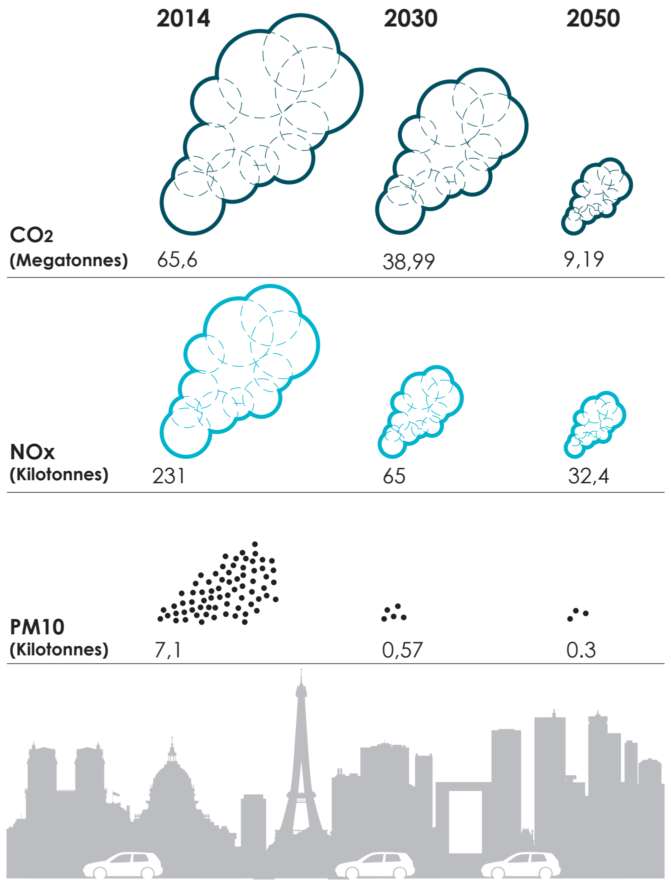
Concerted action exerted by a group of countries with developed economies would be enough to impact oil prices. Resolute agreement at a global level would have an even greater impact. According to the IEA, a scenario aimed at limiting the rise in temperatures to 2°C below pre-industrial levels could lower petroleum costs by up to 35% between now and 2040.[9] Analysis by the New Climate Economy[10] indicates that these effects could lead to a reduction in prices of up to 50%.

In this way, owners of low-carbon vehicles will also help owners of cars with internal combustion engines by helping to lower their fuel expenses.

Impact on climate and French air quality

Figure 3

Emissions of CO_2, NOx and particulate matter will be greatly reduced between now and 2050 in a low-carbon scenario.
Sources : European Environmental Agency, Cambridge Econometrics



In order to avoid global warming of more than 2°C and the disastrous consequences of climate change, it is widely acknowledged that all emissions must be reduced to at least 80% below 1990 levels between now and 2050. Given the extent of the challenge posed for many transport sectors by these levels of reduction, this will have to be balanced by ensuring that cars and vans are almost entirely zero carbon by 2050.

Given that the lifetime for cars and vans is 14.5 years in France, this suggests that by around 2035 all sales of new vehicles will have to be practically zero-emission if we want to remain on track to attain our climate objectives. Consequently, a far-reaching transformation will have to be made in the vehicle fleet. The transition to low-carbon technologies, as described in this study, would reduce CO_2 emissions substantially by 40% in 2030 and 86% in 2050.[11]

When burning fuels, cars also produce nitrogen oxides (NOx) and particulate matter. In high concentrations these air pollutants have a harmful effect on human health. Current estimates are that 983,000 tonnes of NOx and around 270,000 tonnes of particulate matter are emitted in France each year.[12] Ozone, a secondary pollutant because it results from chemical changes in the atmosphere between nitrogen oxides and organic compounds, also has an impact on health as well as on agricultural yields. Low-carbon technologies help to lower the consumption of fossil fuels, also reducing the production of NOx and particulate matter resulting from combustion. The transition to low-carbon technologies in vehicles as described in this study would reduce NOx emissions by 72% in 2030 and 86% in 2050. Put simply, reducing carbon would simultaneously help reduce direct emissions of NOx from car exhaust pipes.

In the reference scenario, where no low-carbon technologies are used, NOx emissions will be up to 63% lower in 2050 due to the implementation of Euro 5 and Euro 6 emissions standards. However, these reductions are less certain and less extensive than those achieved in scenarios with ultra-low-carbon technologies; this includes a large number of vehicles with zero emissions from the tailpipe and energy generation causing few emissions if from a renewable source.

Particulate matter (PM10 and smaller) also has an impact on human health. Estimates show this to be the cause of 458,000 cases of premature death in Europe in 2011.[13] The European Environment Agency estimates that 90 to 95% of the urban population in Europe could be exposed to annual average levels of PM10 above those prescribed by the World Health Organization (WHO), while 10 to 14% have been exposed to PM10 above statutory threshold values. The transition to low-carbon technologies as described in this study would reduce emissions of particulate matter caused by road transport (private cars) by 92% in 2030 and 96% in 2050.

All vehicles have a carbon footprint. Various studies on Life Cycle Assessment (LCA) show a lower carbon footprint in hybrid, electric and hydrogen cars compared to conventional cars with internal combustion engines. This footprint will become smaller with the implementation of renewable energy and technological progress, such as projected increases in the energy densities of batteries, solutions for materials recycling and improvements in production processes.

Impacts on auto-sector competitiveness

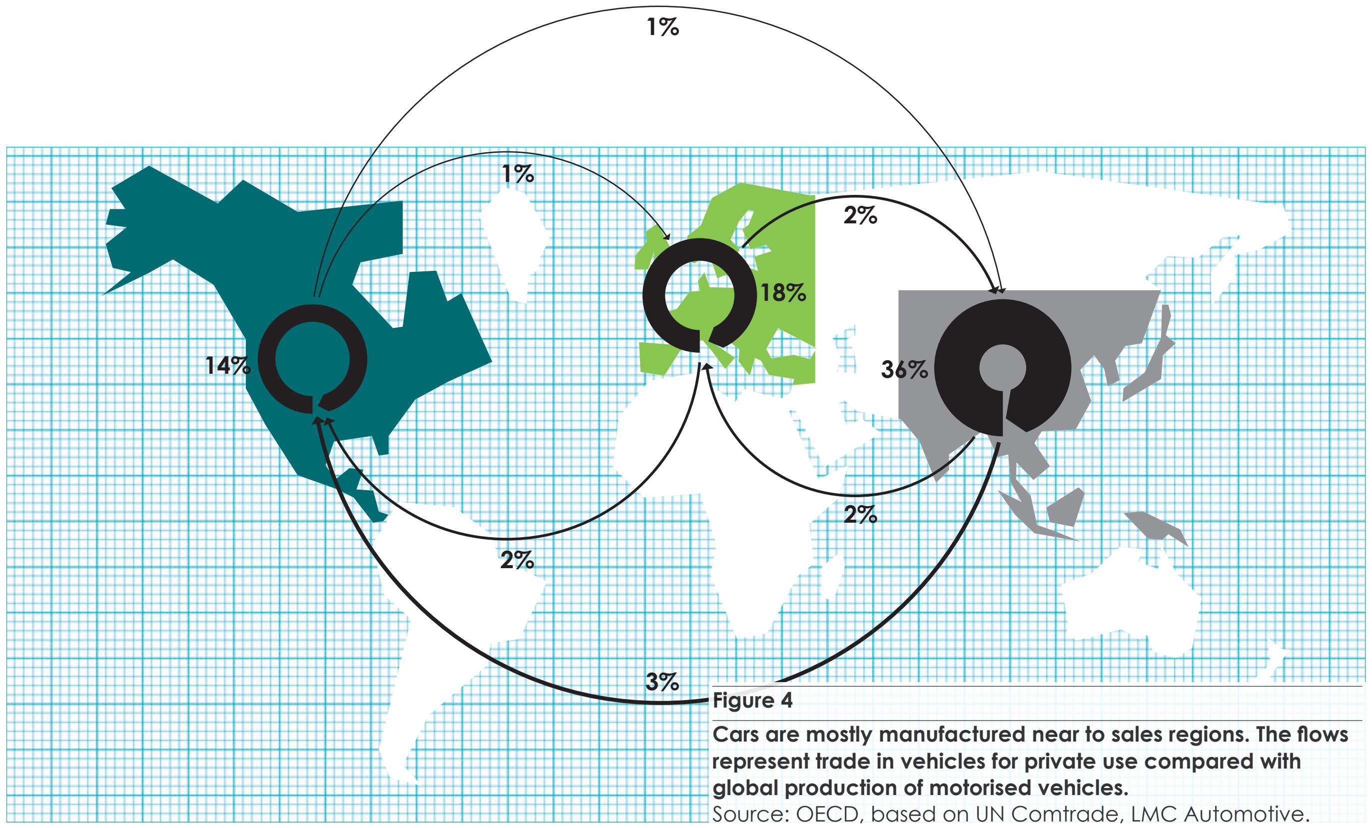


Figure 4

Cars are mostly manufactured near to sales regions. The flows represent trade in vehicles for private use compared with global production of motorised vehicles.
Source: OECD, based on UN Comtrade, LMC Automotive.

The automotive manufacturing industry exists in a global market. Given the volumes and dimensions of cars, transporting them represents a significant cost, whether road, rail or sea routes are used. Therefore car-makers generally position production chains near to markets. For example, the quantity of cars assembled physically in Asia and then imported to Europe accounts for 2% of the global automotive trade, while imports of American cars to Europe account for barely 1%.[14]

Similarly, automotive parts manufacturers generally place their production facilities near car assembly plants.[15] France has more than 628 parts manufacturers, which contribute equivalent to 75% of the value of the final product of the automotive industry.[16] In addition, the plastics and chemical industries play an important role in providing innovative materials and technical solutions.

In Europe, imports from non-European countries represent a relatively low percentage of supply. Trade figures show that total imports for motorised light vehicles in Europe were around €28 billion in 2013, compared with a new vehicle market in Europe of nearly €470 billion. In the same year, European exports of motorised vehicles accounted for €23 billion.[17] Vehicles exports from France to other European countries and the rest of the world accounted for €40 billion.[18]

The implication is that while individual manufacturers might see changes in market share, the overall changes to auto sector manufacturing in Europe are likely to be small. It is also worth noting that a large proportion of the value-added generated by car manufacturers accrues to the employees through the supply-chain and not to the owners of the business. As a result, it is more important to the macroeconomic results to consider where the production of the vehicles and their components takes place, rather than where the owners of a particular company are located.

One of the great challenges for the automotive industry to retain value in Europe is to anticipate the need for skills and to prepare the necessary investments. Investments in technologies to improve internal combustion engines have already allowed automotive manufacturers and parts manufacturers in France to position themselves at the front of global innovation. During the transition to low-carbon transport, additional investments will have to be made in technology, for example in the hybridisation of engines. Fully electric vehicles, using batteries or fuel cells, that can be charged using renewable energy, are the ultimate solution for low-emission mobility, a sector where French manufacturers already have a head start.

In summary, the transition to cleaner air and a zero carbon society will help French manufacturers remain at the forefront of global innovation.

Less oil leads to more jobs and growth

France imports large volumes of petroleum. More than 51 million tonnes of crude oil were imported into France in 2014. Compared with the motorised vehicle sector and other sectors of the French economy, the value chain associated with petrol and diesel has two main characteristics: It has a low labour-intensity, which means that for each million euros spent on road transport fuels, relatively few jobs are created; and 60% of the value chain is located outside France, which means that the greater part of money spent on petrol and diesel (excluding tax) is lost from the French economy.

Low-carbon vehicles will reduce oil import costs on a national scale. Figure 5 shows that the energy bill for cars and vans will rise until 2030 if no investment is made in technologies to reduce emissions. Compared to today, France will spend €10.4 billion more on road transport fuels in 2030 if oil prices remain close to the predictions of the IEA.

In the low-carbon technology scenario of this project, internal combustion vehicles will be lighter and considerably more efficient by 2030, while electric vehicles will be more efficient still. As a result, energy consumption will be reduced, and by 2030 the automotive fuel bill in France will be €5.7 billion lower than today, and 39% lower than in a situation without any investment in low-carbon technologies.

By shifting to more efficient vehicles, less money leaves the French economy, and households and businesses have more disposable income, even after accounting for the slightly increased cost of vehicles. The transition to electricity and hydrogen produced domestically will increase the amount of energy spending that is retained within the French economy. Thus, the transition to low-carbon vehicles represents a shift in spending away from the petroleum supply-chain, which creates relatively low value, and towards the vehicles and electricity and hydrogen supply-chains, which create relatively higher value for France.

At the same time, investments will be necessary to build the infrastructure for charging. In the low-carbon scenario, the aggregated cost of capital will increase by €6.1 billion between now and 2030 (excluding tax), compared to a future where cars continue to run on current technologies. While these sums represent a cost to consumers, they also represent a source of revenue for the automotive value chain.

The transition to the vehicle technologies described above will also require a transition to new skills across the French workforce. Recycling low-carbon vehicles will also be an important element in reducing emissions in the transport value chain, while also creating jobs. According to a study carried out by the Observatoire Paritaire de la Métallurgie, the skills needed for this transition will be around the BAC +3 (BSc) and BAC +5 (MSc) level.[19]

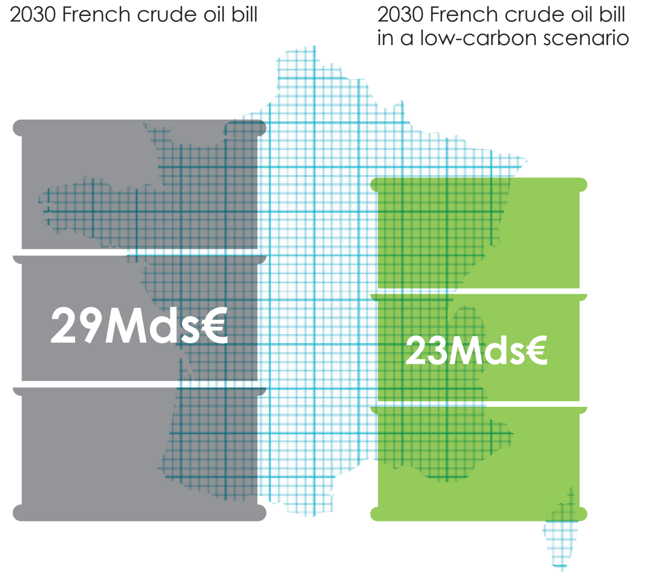
By using the macro-economic model E3ME, we have made estimates of the net impact arising from the change in economic flows.

The net effect of reduced expenditure on petrol and diesel; increased spending on domestically-produced electricity or hydrogen; and increased expenditure on vehicles translates to an increase in French GDP of between 0.2% and 0.4% in 2030. Within this range, the growth rate depends on the choice of the French government on how to compensate for the loss of receipts from taxes on road transport fuels.

Spending more on vehicles, less on imported fossil fuels and more in other sectors of the economy would result in net job creation of around 66,000 to 71,000 in France by 2030.

Figure 5

Petroleum expenses in France in 2030 based on two scenarios of technological implementation
Source: Cambridge Econometrics



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