Fuelling Spain's Future

How to boost the economy while leaving carbon behind

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This report is a summary in English of *Fuelling Spain's Future* by Cambridge Econometrics and Element Energy. This report can be found at: https://www.camecon.com/how/our-work/fuelling-spains-future/

The organisations which have contributed to this study had the common aim of establishing a constructive and transparent exchange of views on the technical, economic and environmental issues associated with the development of low-carbon technologies for cars. The objective of the *Fuelling Spain's Future* study is to evaluate the impact the transition towards light passenger transport vehicles with low carbon emissions would have on the Spanish economy, highlighting the challenges and opportunities involved. This study has been complemented with an analysis of the impact this transition would have on the electricity grid *(Grid Synergy Analysis and Impact)*. Those who have taken part in this report have contributed their knowledge, experience and vision. The information and conclusions of the report have taken into account these contributions; however, it must be highlighted that this report does not reflect the outlook or opinions of the companies and organisations involved.

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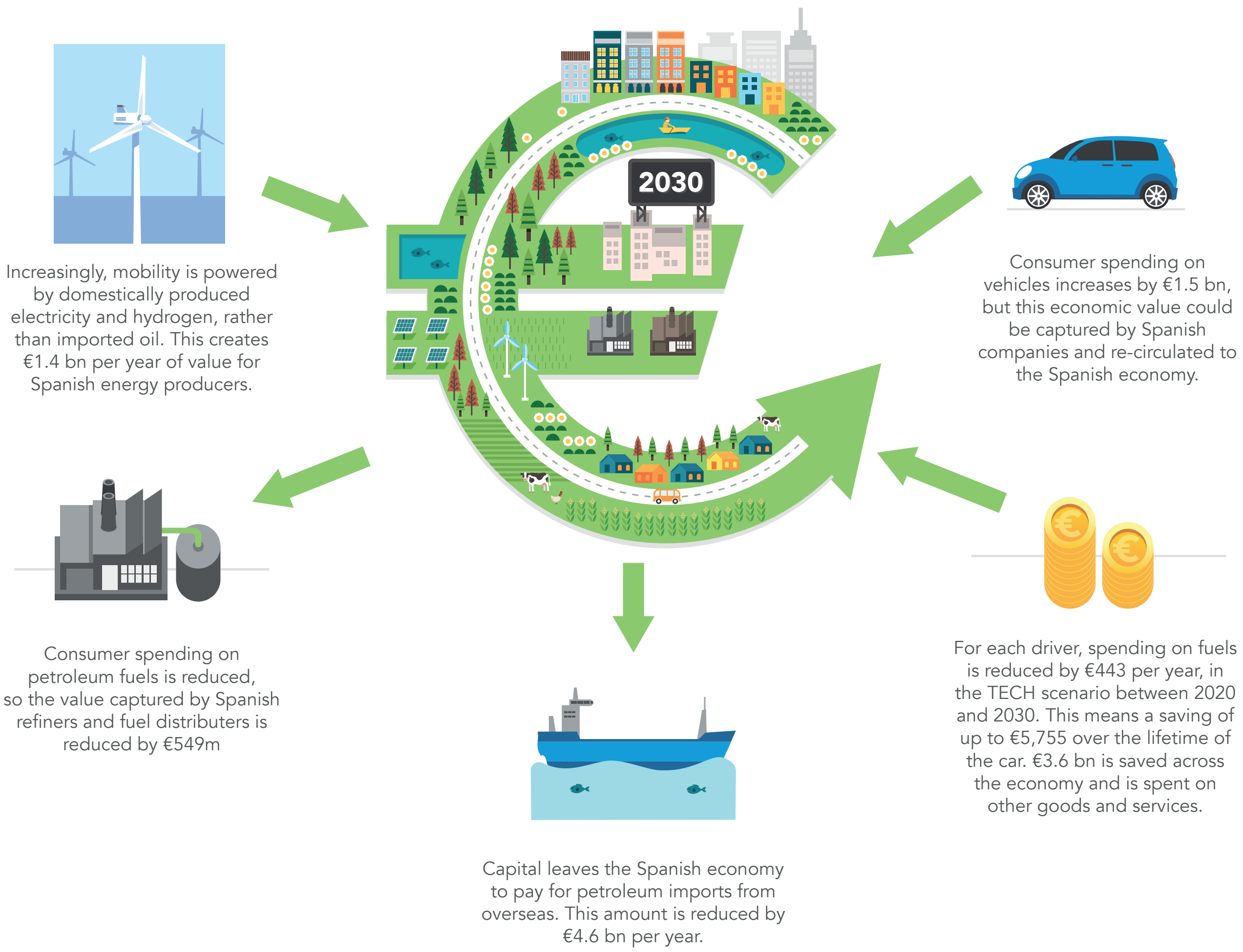


2030
Increasingly, mobility is powered by domestically produced electricity and hydrogen, rather than imported oil. This creates €1.4 bn per year of value for Spanish energy producers.
Consumer spending on vehicles increases by €1.5 bn, but this economic value could be captured by Spanish companies and re-circulated to the Spanish economy.
Consumer spending on petroleum fuels is reduced, so the value captured by Spanish refiners and fuel distributers is reduced by €549m
For each driver, spending on fuels is reduced by €443 per year, in the TECH scenario between 2020 and 2030. This means a saving of up to €5,755 over the lifetime of the car. €3.6 bn is saved across the economy and is spent on other goods and services.
Capital leaves the Spanish economy to pay for petroleum imports from overseas. This amount is reduced by €4.6 bn per year.

Executive summary

This project has shown that improving the efficiency of cars and the greater use of zero emissions vehicles (fuelled via electricity and hydrogen) helps to considerably reduce the CO_2 emissions and air pollutants. This also has a positive impact on the economy and the labour market.

The transition from mobility centred on oil imports towards a domestic alternative based on clean energy will keep billions of Euros in the Spanish economy, improving the balance of trade. This transition will create net employment, so that the number of workers in sectors such as the production and installation of recharging posts, electrical equipment, other manufacturing and, above all, new services, will more than offset the lower number of workers in the direct manufacture of vehicles, which could occur in the long term. It is essential to ensure that the transition is done fairly, generating quality employment and guaranteeing environmental, social and economic sustainability.

The final cost of mobility for Spanish drivers will decrease due to the transition. In 2030, the annual expenditure on fuel for a medium-sized car will be on average €443 cheaper than for a car in 2020, thanks to greater efficiency and the deployment of pure electric vehicles. Compared to a conventional car, an electric car could save the consumer an average of €1,439 a year on fuel and maintenance costs in 2030, which may offset to a large extent the greater initial expenditure when purchasing the vehicle.

On a domestic level, the benefits of the transition include a larger economy; in 2030, GDP is estimated to be €3.2 billion higher than in the reference scenario[1] in the year 2030. Of this, €2 billion is due to the reduction in oil imports. In addition, in the same year, the greater use of electric vehicles will contribute to the creation of 23,185 net jobs in Spain, as compared to the reference scenario.

CO_2 emissions from cars will be reduced by 27.8% in 2030, and up to 91.6% in 2050, compared to the reference scenario. This environmental benefit are accompanied by an 89% reduction in the emissions of both particulates and nitrogen oxides by mid-century.

The transition will require investment in new infrastructure, especially recharging posts, as well as in the electricity grid. However, it has been demonstrated that if the transition includes measures to promote smart charging, the net impact on the electricity grid will be feasible from the point of view of the possible additional necessary investment. It will also allow for a greater and faster integration of renewable energy in the electricity grid.

This study comes to the main conclusion that, despite the challenges, the transition towards zero emission vehicles brings financial advantages to the public, improves air quality, addresses climate change, and benefits the Spanish economy in general. For these benefits to become a reality, close collaboration between the different administrations will be required. This involves the local, autonomous and state governments, as well as the private sector and civil society.

Introduction and methodology

Spain is the second-largest producer of vehicles and has the fifth-largest vehicle market in Europe. However, in the medium term, it must reduce greenhouse gas emissions from a diffuse range of sectors, which includes transport. There must be a 26% reduction in emissions by 2030, as compared to the year 2005. This creates challenges for both the manufacturing industry and the end sales market.

There is currently a revolution in the type of vehicles being sold in this country. In just a few years, sales of diesel vehicles have fallen from over 70% to just 35% of total. However, plug-in hybrids and pure electric vehicles barely made up 0.6% of total sales in 2017. This is not enough to reach the long-term goals, which involve reducing the emissions to practically zero in this sector. This is required of all European countries, to comply with the Paris Agreement. Despite these targets, transport emissions continue to increase year after year.

Based on these factors, the European Climate Foundation (ECF) has analysed what the impact of a transition towards low emission cars would be on the economy, society and the environment in several European countries and in the EU as a whole. Now it's the turn of Spain.

A panel of experts from different sectors was created for this project. They met on five occasions to share their views with the analytical team. This document summarises the main conclusions drawn from all the work carried out during the first half of 2018.

The methodological aspects can be found in greater detail in the technical report by Cambridge Econometrics, which accompanies this report and is summarised schematically in Figure 1.

The study is based on a series of scenarios. They are not intended to be predictions of the future, rather they analyse what would happen under a series of suppositions, which were discussed in depth by the panel of experts. This information was included in a vehicle fleet simulation model. The outcomes were then integrated in the E3ME macroeconomic model of Cambridge Econometrics.

The E3ME model has two fundamental strengths. The model's integrated treatment of the economy, the energy system and the environment enable it to capture two-way linkages and feedbacks between these components. Its high level of segregation enables relatively detailed analysis of effects at a sectoral level. E3ME delivered results in terms of changes to household budgets, the energy trade balance, consumption, GDP, employment, CO_2, NO_x and particulates emissions. In turn, these results in terms of emissions have been processed to estimate the effects on health.

During the project, four different scenarios were agreed upon which are described below. Each scenario has a different combination of technologies and they reflect a plausible mix of the make-up of the vehicle market in Spain in the future:

- Reference scenario (REF): no efficiency improvements in new cars. The vehicle fleet will be a little more efficient as the older and inefficient vehicles are replaced by cars built to the latest standards. This is merely an instrumental scenario that is used as a reference for making comparisons.

• The current policy initiatives (CPI) scenario: gradual improvements in the efficiency of cars with internal combustion engines in line with the current vision of the technology and deployment of hybrid cars, plug-in hybrids and pure electric cars to meet the 95g CO_2/km target for 2021 and a 15% reduction in average new vehicle emissions for 2025, and 30% for 2030, to meet the European Commission's proposal.

• TECH scenario: gradual transition towards hybrid cars, plug-in hybrids, and pure electric and hydrogen vehicles in 2030, so that these are the only cars sold by 2050.[2] This is considered the central scenario, as it is the most similar given the technological developments and current policies.

• TECH Rapid scenario: rapid transition to a fleet dominated by plug-in hybrids and pure electrics in 2030. After 2030, the market will be dominated by pure electric cars, although there will also be more plug-in hybrids of electricity and hydrogen.[3] A faster technological development occurs in this scenario.

Finally, the analysis has been complemented with a sensitivity which includes the use of natural gas and renewable energy in cars in the most extreme case: maximum deployment of gas-powered cars and use of biomethane to its maximum technical potential. This is explained in more detail in the section entitled 'Role of gas in the transition'.

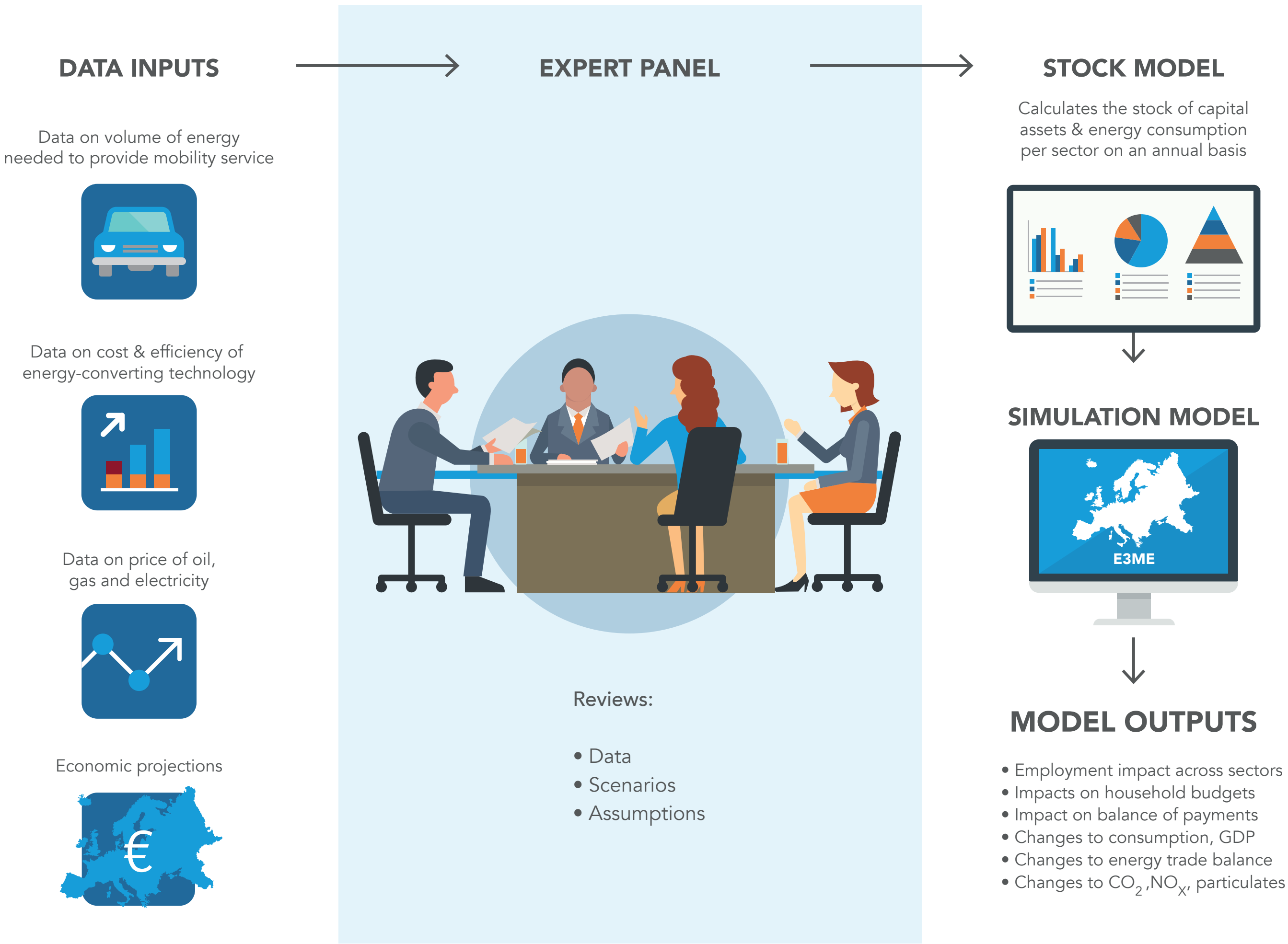
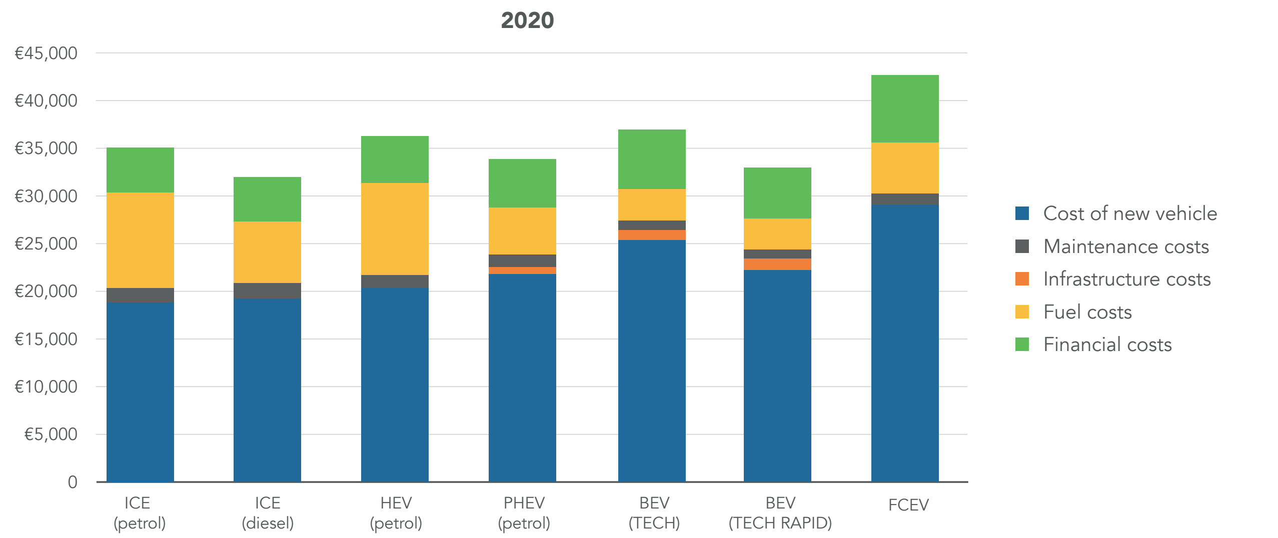


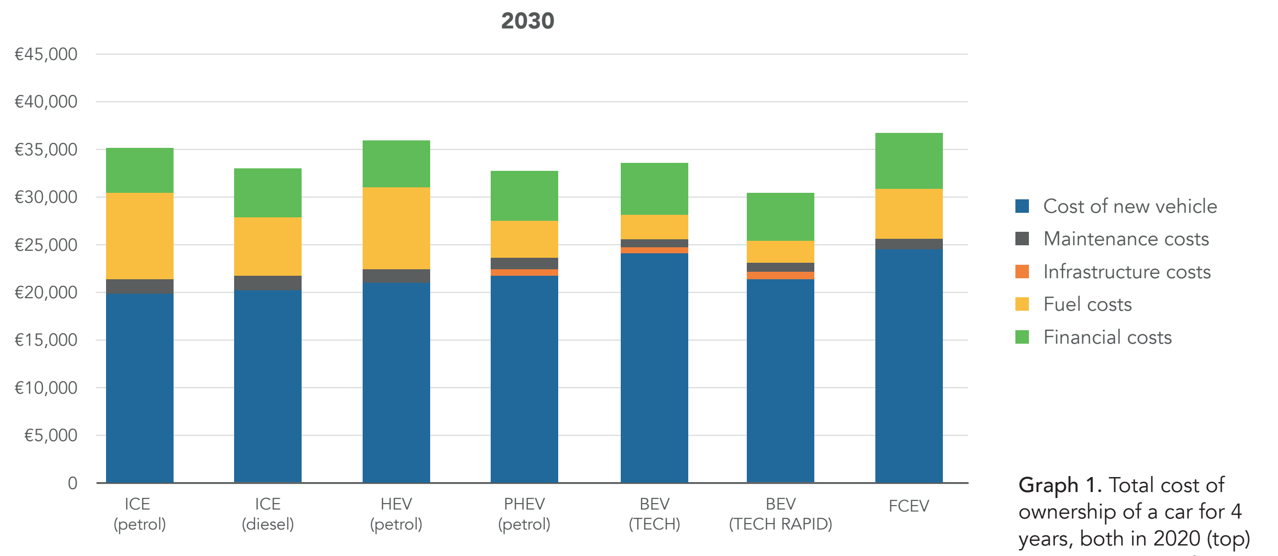
Figure 1. General description of the approach used in the modelling of the project.

Consumer impacts

The scenarios drawn up have an impact on consumers and their decision-making when it comes to buying cars. It has often been argued that consumers do not accurately consider all the relevant factors when buying cars. They are often unaware of the total cost over the useful life of the car. This problem is exacerbated when there is uncertainty regarding future prices. This can include, for example, uncertainty regarding the future price of energy, the cost of technology, or depreciation.

In line with the TECH scenario, by 2020, the total cost of owning[4] (TCO) a medium-sized car for four years, which influences buying decisions, is still slightly higher (around €2,000) for a pure electric car compared to an internal combustion engine vehicle, despite the latter having greater fuel costs.





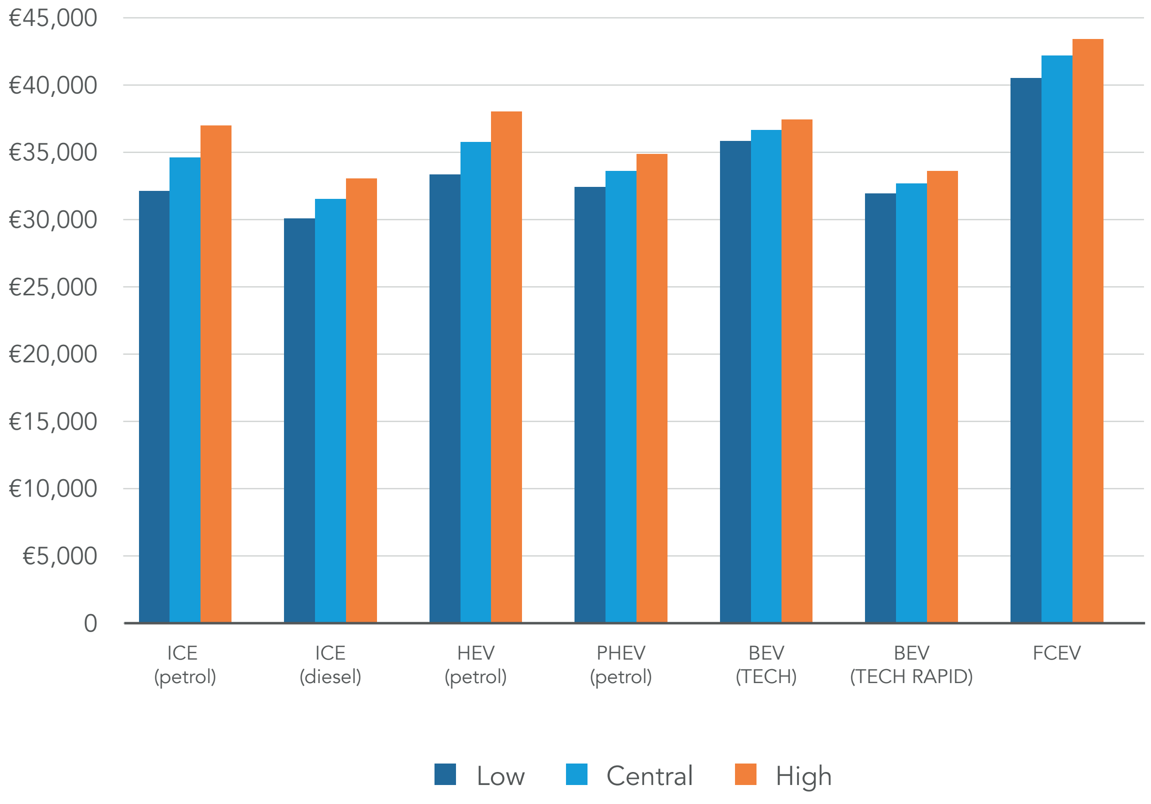
Graph 1. Total cost of ownership of a car for 4 years, both in 2020 (top) and 2030 (below) for a new medium-sized car.

In the TECH scenario, in 2030, improvements in fuel efficiency and technology mean that an average internal combustion engine vehicle and a pure electric vehicles have a total ownership cost for four years which is less than that of the internal combustion engine in 2020.

In the study, several sensitivities have been explored. The most relevant is the impact of different fuel costs, reflecting the uncertainty of their price evolution. Three price scenarios have been analysed: a central case and an additional two in which all fuel costs were 25% higher and 25% lower, to understand the differential impact on consumers.

For instance[5], where costs are lower, there is a reduction in the costs of running an electric vehicle of €842 in 2020, due to lower electricity prices. As the same analysis was performed for all fuels, they are not directly comparable across powertrains. For example, if electricity prices decrease, it doesn't necessarily mean that petrol prices also decrease, and vice versa.

However, if the whole of the useful life of the vehicle is considered rather than just the first four years, the costs of pure electric and plug-in hybrids converge with those of internal combustion vehicles toward 2030. In this outlook, even diesel cars would be more expensive than electric vehicles.

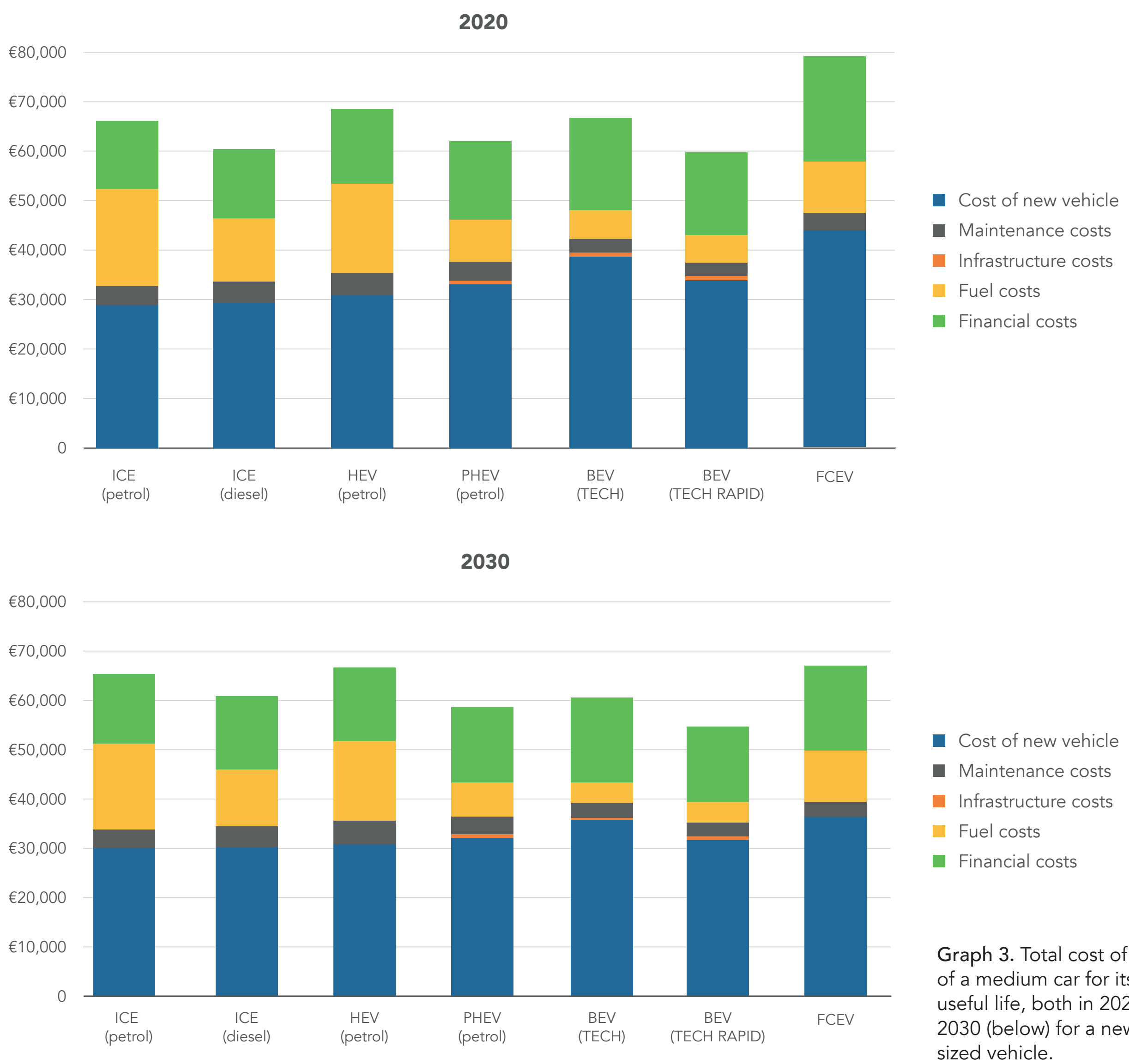


Graph 2. Total cost of ownership of a car for 4 years in 2020 according to the various fuel price scenarios.

Hydrogen fuel cell vehicle costs converge much more gradually, given their current high cost, despite a moderate reduction in price in the future.

It should be noted that the most cost competitive powertrain in 2030 are pure electric cars. In fact, some experts suggest that this may come about even earlier. Therefore, in the TECH Rapid scenario, technological development coupled with lower battery costs can lead to them becoming the lowest cost option even by 2020. Other costs not included in the model, such as exemptions in registration and circulation taxes, or in parking costs in big cities, would increase the differential in the total cost of ownership in favour of low emission vehicles.

In short, with the necessary infrastructure available, the demand for electric vehicles would be seen as a logical financial preference in the Rapid Transition TECH scenario. There will be a positive impact on the average consumer, for which vehicle ownership and use will become more affordable between 2020 and 2030, as has been observed in the TECH scenario. Provided that public policies are in line with these new circumstances, the consumers will have greater disposable income to spend on other goods and services, which further enhances the economy.



Graph 3. Total cost of ownership of a medium car for its entire useful life, both in 2020 (top) and 2030 (below) for a new medium-sized vehicle.

Impact on health and air quality

Cars produce NO_x and particulates which are atmospheric pollutants with very damaging consequences for human health. According to study estimates, the Spanish car fleet emitted around 115,000 tonnes of NO_x and 3,600 tonnes of particulates in 2017.

The NO_x emissions commonly lead to increased rates of diseases such as asthma and, in some cases, bronchitis or even pulmonary oedema. Nitrogen monoxide (NO) is a cause of pulmonary oedema and harms the blood due to the formation of methemoglobin. In addition, nitrogen dioxide (NO_2) irritates the eyes, the mucus membranes and lungs and exacerbates respiratory diseases such as asthma, allergies, irritations and bronchitis. The number of premature deaths in Spain caused by NO_2 was 6,704 in 2014. It also forms fine particulate matter ($PM_{2.5}$) as it reacts with the atmosphere. It is estimated that fine particulate matter (PM_{10} and $PM_{2.5}$) was responsible for 17,190 premature deaths in Spain[6] in the same year. According to the European Environment Agency, between 90 and 95% of European citizens have been exposed to greater levels of $PM_{2.5}$ than those recommended by the World Health Organisation, while around 80% have been exposed to excessively high levels of PM_{10}.[7] The finer particulates, when inhaled, can cause serious diseases (asthma or cardiopulmonary diseases and strokes), with additional carcinogenic consequences in the case of prolonged exposure.[8]

Due to the serious impact these two types of pollutants cause, this study has focused on them, in particular in the urban areas of Madrid and Barcelona, where they are most prevalent. In each, we estimate the cost of healthcare in relation to hospital admissions as a result of the corresponding diseases.

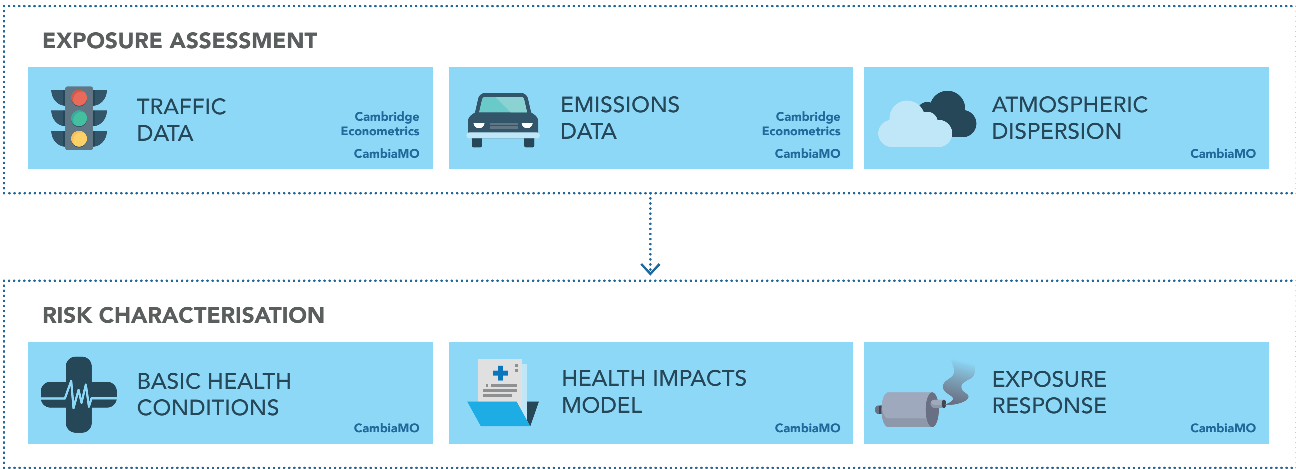


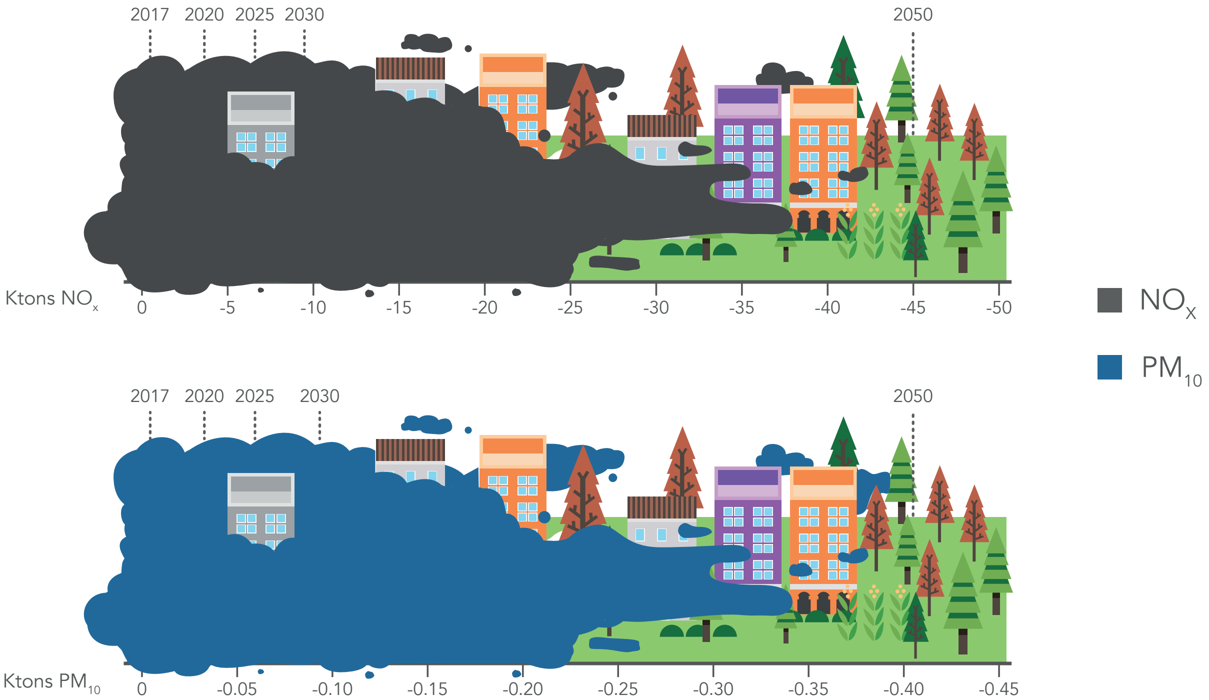
Figure 2. Description of the specific approach used on the impact on health.

Air quality monitoring in Madrid shows that the limits are typically exceeded close to those roads and highways with the most traffic, which suggests that transport is causing this pollution. Following the methodology of the impact of traffic on health[9], the morbidity of the population in Madrid due to NO_x rises to 43,400 cases, which represents 1.3% of the population. In addition, the increase in emergency hospital admissions during peak pollution times as a result of NO_x leads to a healthcare cost of €54,473,657.[10]

In contrast, particulates are the main problem in Barcelona given its geographical nature and meteorology. In its case, the estimates indicate that the morbidity caused by health affected by pollution decreases from 36% (32,700 cases per year) when the European limits of 40 mg/m^3 are observed.[11]

Changing to low carbon vehicles will gradually reduce the emissions of NO_x from automobiles; by 1% in 2020 and 6% in 2025 in the TECH scenario compared to the REF scenario; and would reduce particulates by 3% in 2025. In the long run, the tailpipe emissions of both NO_x and particulates would reduce by 89% in 2050, given that electric vehicles and hydrogen-fuelled vehicles generate no NO_x and hardly any particles (Graph 4).

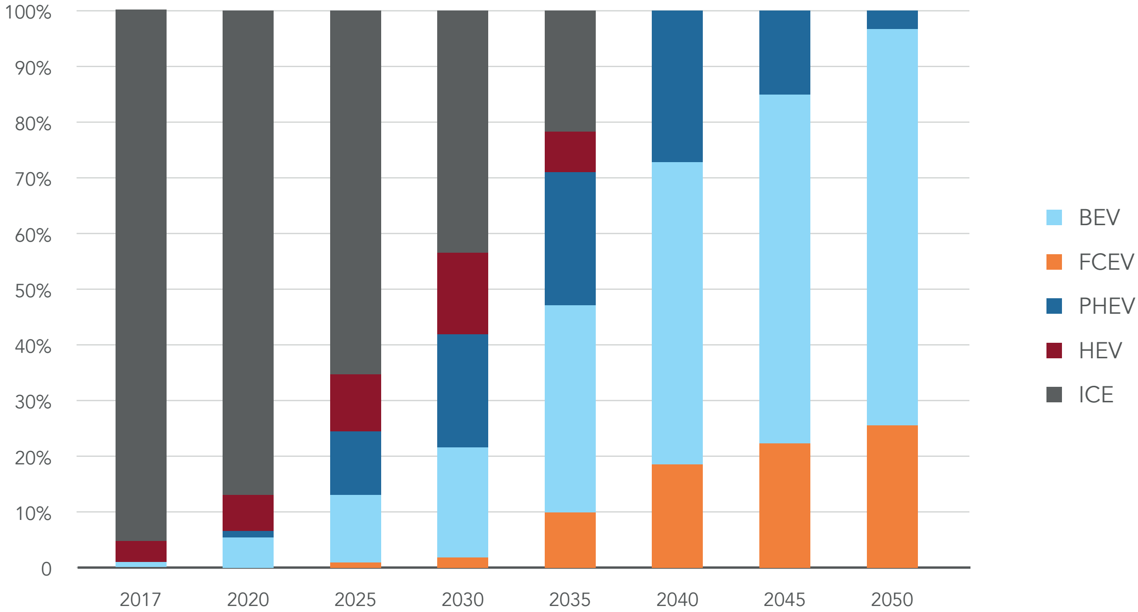
Noise pollution is another problem of urban traffic. This study has not specifically focused on estimating the levels of noise produced by urban traffic. However, this factor also leads to disorders such as heart attacks and stress and produces more than 1,000 premature deaths a year in Spain.[12] The transition towards low emission vehicles decreases the production of noise.

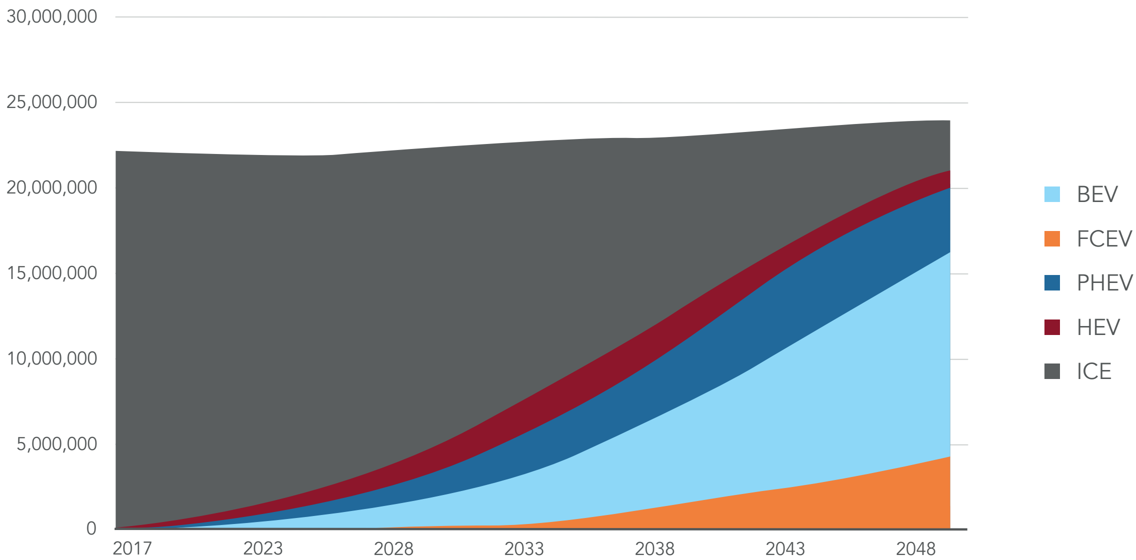


Graph 4. Impact on reduction of pollutants (savings), in thousands of tonnes, comparing the REF and TECH scenarios.

Impact on the climate

Greenhouse gas emissions from cars are directly associated with the dominant powertrain type. In the central scenario (TECH, see Graph 5), the fleet of vehicles evolves from one which is dominated by internal combustion vehicles to another in which half the new vehicles in 2030 will be hybrid, plug-in hybrids, pure electric or hydrogen-fuelled. In 2040, internal combustion engine cars would no longer be sold. However, the fleet in Spain, even in 2050, would still contain vehicles which use fossil fuels, given the time needed to overhaul the entire fleet, as can be seen in Graph 5.

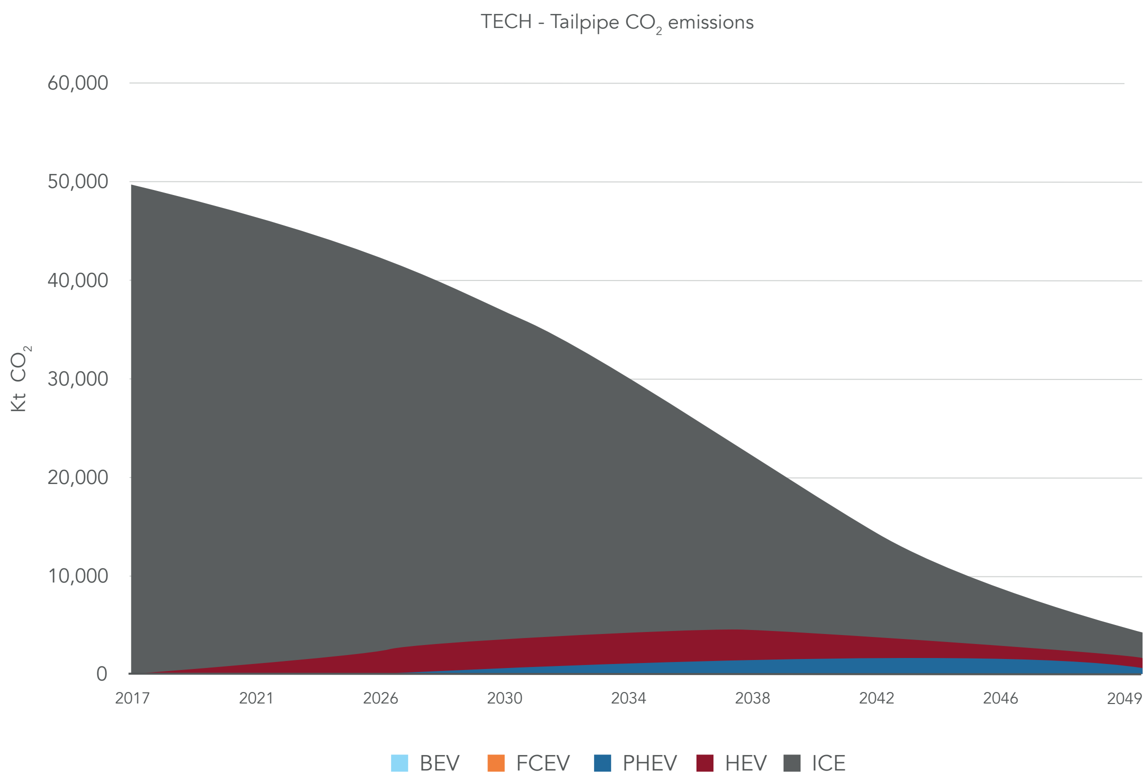




Graph 5. proportion of car sales and resulting fleet in the TECH scenario.

In the central scenario, the total direct emissions of CO_2 from cars reduce from 50 million tonnes (Mt) in 2017 to 37 Mt in 2030 (which involves a reduction of 34% compared to the year 2005) and to 5 Mt in 2050 (Graph 6). Although the study only analyses direct emissions, a similar gradual decarbonisation of the electric mix is also assumed.

The study has focused exclusively on how to decarbonise existing light vehicles. However, a key hypothesis of the study is that the demand for new vehicles doesn't change (the number of cars per 1,000 inhabitants is held constant over time). The study therefore doesn't consider possible changes in mobility, for example the impact of autonomous vehicles or new shared mobility initiatives. In addition, group experts also highlighted the important influence public transport has in the effectiveness of the transition. It could offer more guarantees in terms of comfort, times, routes, timetables, accessibility, and prices, as well as provide more information to the user about the need to reduce contamination through sustainable mobility.



Graph 6. Direct CO_2 emissions in the TECH scenario.

Economic impact: GDP, employment, taxation and energy security

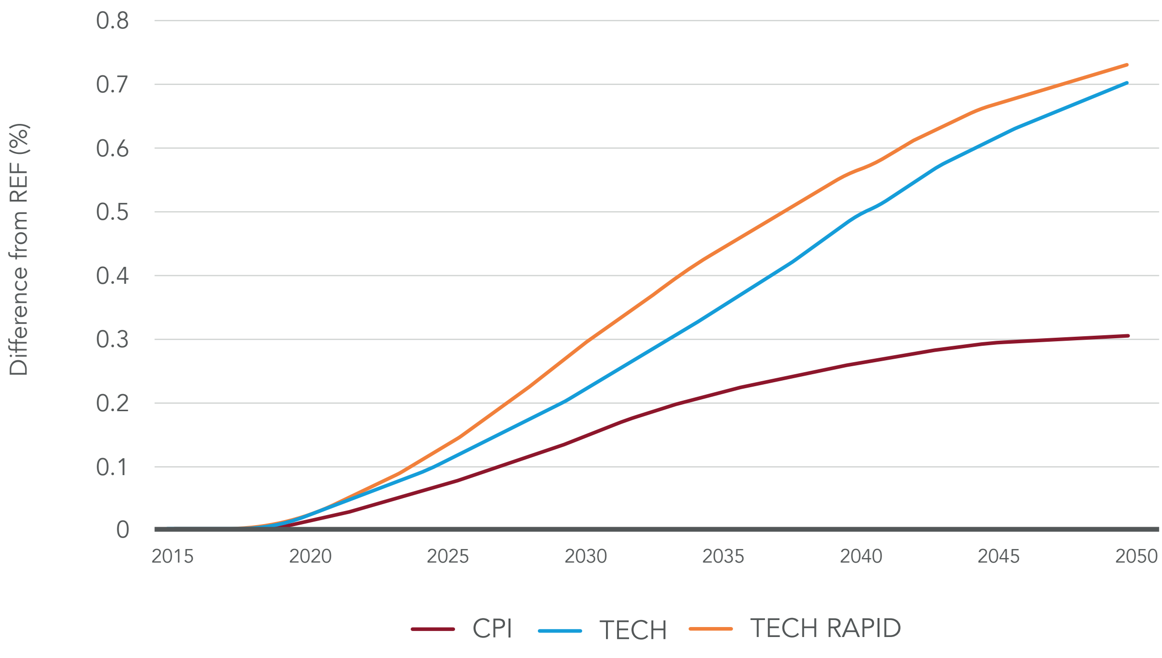
The study has calculated the impact each of the scenarios has on the GDP. The macroeconomic model used provides a result which stands out because of a higher GDP in the TECH and Rapid Transition TECH scenarios, in comparison with the reference scenario.

For the year 2050, the GDP gains are substantially superior in the TECH and Rapid Transition TECH scenarios, compared to the CPI scenario. For their part, the TECH and Rapid Transition TECH scenarios tend to converge in the long term.

The improvement in the efficiency of the vehicle powertrains leads to a substantial reduction in the total energy consumption, with greater demand for electricity and an accumulated reduction in petroleum imports. The positive impact on the trading balance of the latter, and the second-order effects of increased domestic spending, is reflected in improved GDP.

Spending on imported fuels is instead re-allocated to expenditure on other goods and services with a large domestic content; for example, on electricity to power an electric vehicle, which is domestically produced, but also to goods and services not related to transport. In addition, there are positive economic effects associated with the investment in infrastructure. These all create economic activity in the Spanish economy, which is recycled through additional consumer expenditure (the so-called multiplier effect).

In relation to employment, additional jobs are generated in key sectors of the economy, as well as the services and energy sectors. In the short to medium term, it will also boost the manufacture of vehicles and their supply chains, as internal combustion vehicles require additional fuel efficient technologies, and hybrid vehicles require dual powertrains.



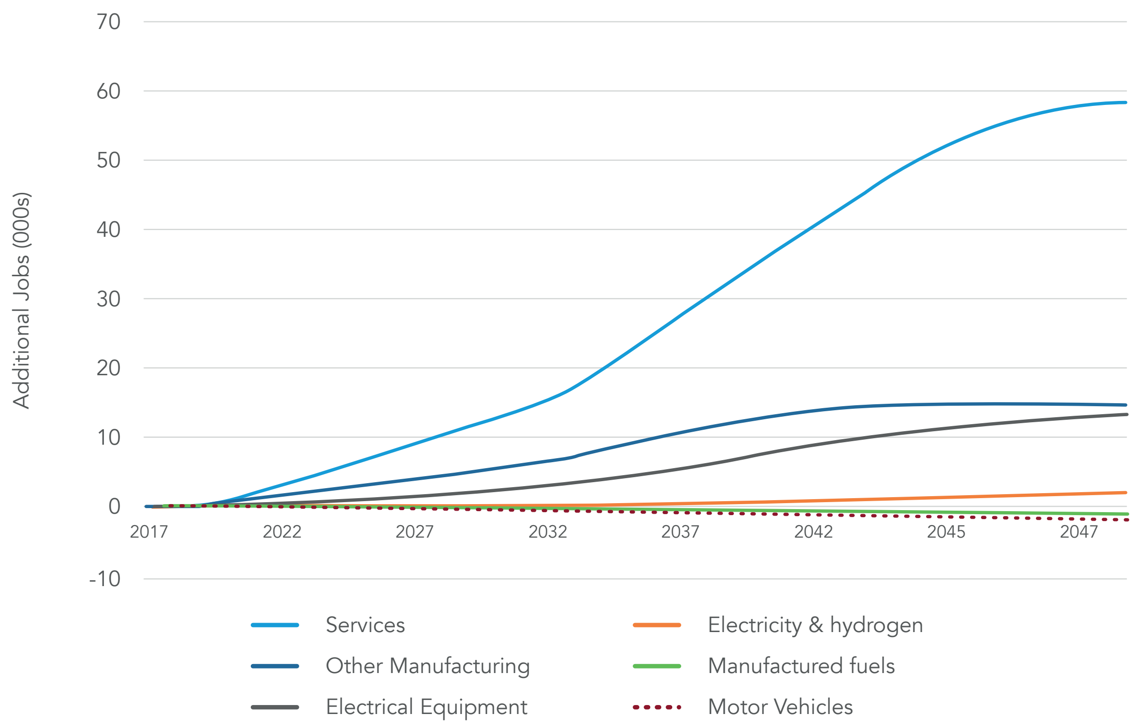
Graph 7. Impact the central scenarios have on the GDP compared to the Reference.

However, there will be a long-term differentiated impact on each of the sectors. Policies should focus on this during the transition. Among other aspects, they should consider the quality of employment and an equal territorial balance, in accordance with the general guidelines for a fair transition.[13] In any case, this transition is beneficial due to the increase in net jobs and more work in the sectors involved. There is therefore room for transformations which respect the workers and the regions involved. Using a proactive, rather than a reactive approach, these transformations can be planned for in such a way that there are sufficient measures and financing. The aim of which is to ensure that those affected have access to an equivalent job to the one they had before, both in terms of remuneration and quality.

It can be deduced from analysing employment by sectors that, if the amount of employment in a sector of the economy is measured as jobs by added value of €1 million, the fuel production sector has a lower intensity of employment, much lower than the service and electrical equipment sectors. For this reason, when the economic activity moves from the oil sector to other areas of the economy, it will generate an increase in net jobs, leading to improved GDP.

It should be noted that, given the lower consumption of hydrocarbons, the tax revenue from these fuels is reduced. In the macroeconomic model, the fiscal impact this transition has on the State is assessed. However, tax on hydrocarbons does not make up a substantial part of the total government tax revenue.

The study shows that in 2030, in the TECH scenario, the income from hydrocarbon tax would be reduced by 3.2 billion Euros compared to the REF scenario. This amount is partially compensated through the increase in the GDP, which leads to an increase in the collection of direct and indirect taxes, as well as social security contributions. The rest of the tax revenue lost can be addressed with changes to other taxes. These could be in transport or in the general economy, ensuring that state revenues are not compromised and providing a new economic impulse at the same time. In light of this, the scale of the necessary changes to tax revenue is considered



Graph 8. Impact on employment by sector, in thousands of additional jobs, comparing the REF and TECH scenarios.

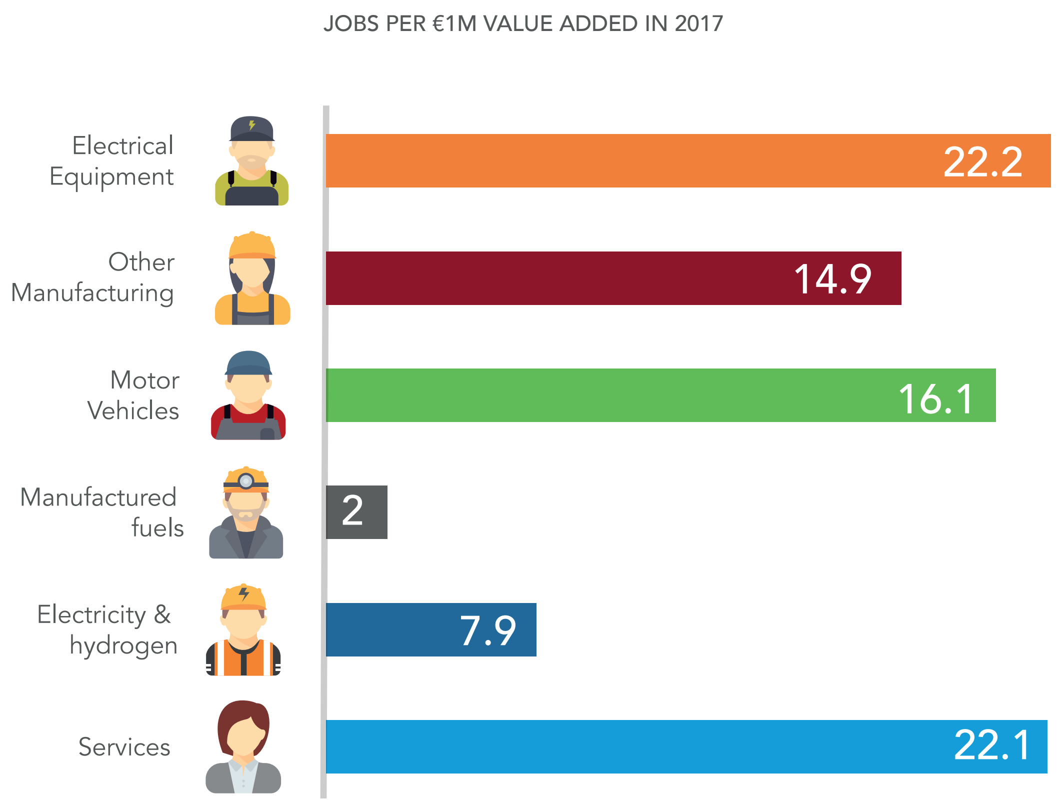
manageable. Likewise, the magnitude of the revenue to be offset would be less taking into account that a sharp decline in pollution implies a decrease in the costs deriving from it. Additionally, there would also be a subsequent decrease in public spending (health care costs and sick leave).[14]

Finally, any assessment of the benefits the State gains from the development of these scenarios which progressively see the disappearance of carbon dioxide would be unbalanced unless energy security is taken into account. Spain's condition as an 'Energy island', sparsely interconnected, and dependent on external resources, permeates the entire energy security strategy of the State. In the same way, the growing dependency on oil imports considered to be of risk has been a geopolitical concern within the European Community.

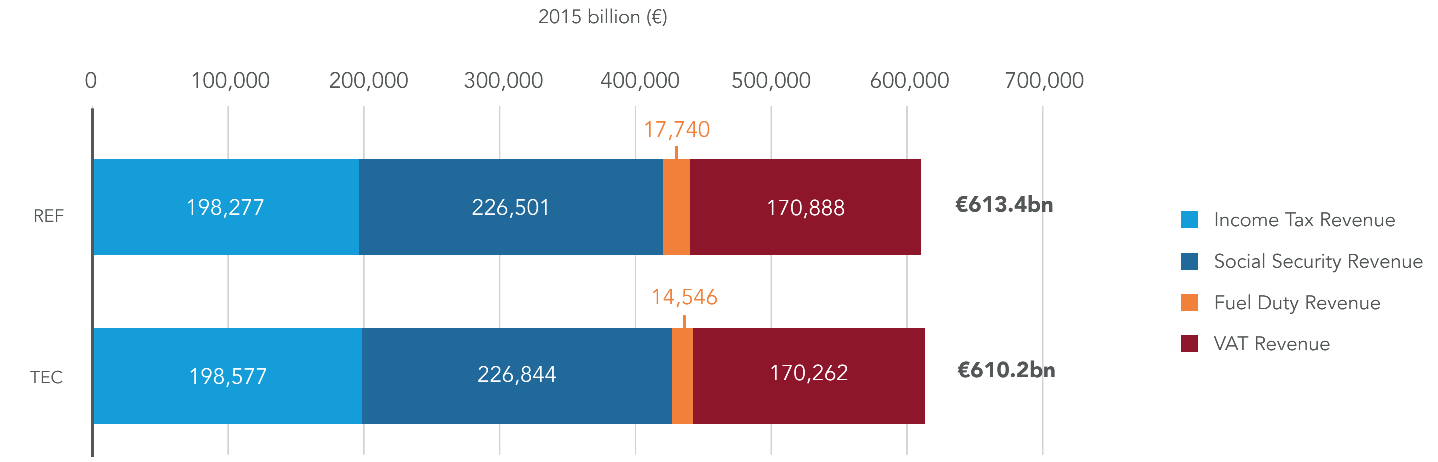
The total energy consumption, in the TECH scenario, will be reduced as vehicles are equipped with more efficient powertrains. The demand for fossil fuels will decrease, while the demand for electricity and hydrogen increases, both of which are produced within Spain. This scenario would lead to two impacts: a decrease in imports which would have a positive impact on the trade balance, as has been commented above; and greater energy security.

In 2030, lower demand in the TECH scenario for gasoline and diesel will lead to a total reduction in oil imports of around 186 million barrels of equivalent oil in comparison with the REF scenario. This saving is much larger in 2050, with a total reduction of 1.843 billion barrels over the period 2017-2050. The TECH Rapid scenario shows even greater reductions in imports over the period 2020-2040, as it achieves a quicker transition to advanced powertrains.

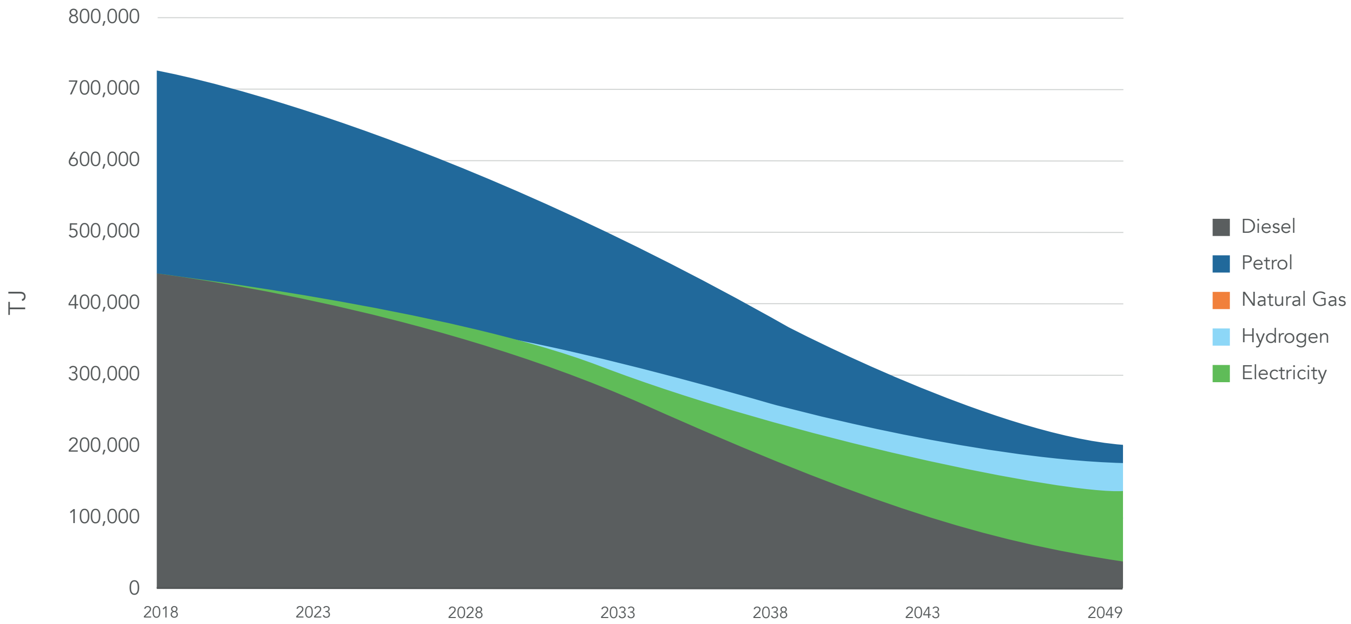
In short, this greater energy security, which leads to lower risk in the future, will provide additional financial benefits to the State, as well as improving the Spanish trade balance, which is currently in deficit.



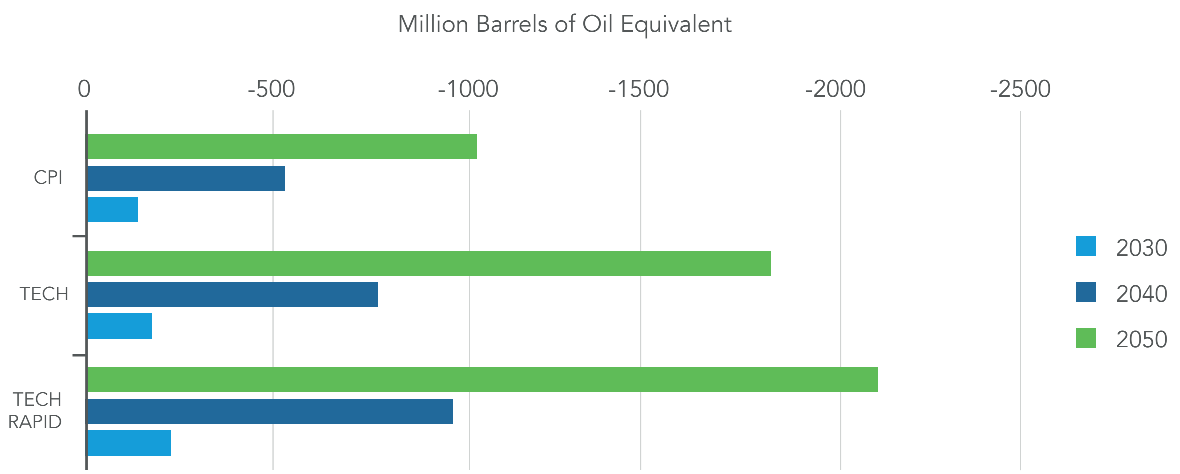
Graph 9. Impact on employment by sector.



Graph 10. Total tax revenue of the government in 2030.



Graph 11. Total consumption by fuel type in the TECH scenario.



Graph 12. Cumulative savings on oil imports.

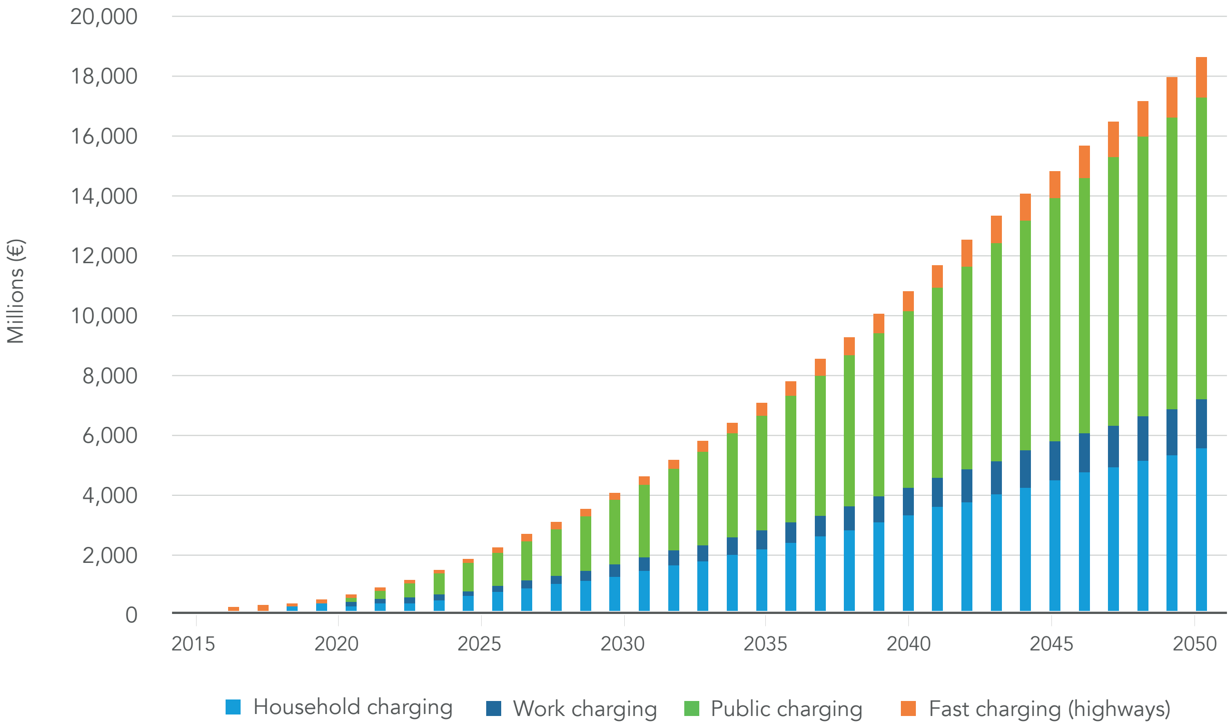
Infrastructure

The use of zero emission vehicles requires charging infrastructure to be put in place, which includes charging at home, at work or leisure places, fast and ultra-fast charging posts on highways, and hydrogen supply posts.

This study has estimated a density of charging posts related directly to the number of electric vehicles in the fleet. It considers that there will be a charging post at home or at the workplace for each electric vehicle. There will also be two public charging posts in urban zones for every ten electric vehicles in circulation. Finally, on motorways, there will be one charging post for every 500 vehicles, in line with previous studies.

The main conclusion to be drawn is that in the period up to 2030, €3.9 billion of investment in infrastructure is required for electric vehicle charging. Of this, €2.4 billion are to provide public charging infrastructure (slow public charging posts and fast-charging posts on highways) in the period up to 2030. The study assumes that all infrastructure costs are met by consumers; either through an up-front payment (in the case of home charging) or through higher prices levied by the owners of infrastructure (in the case of public and rapid charging).

In addition, the total accumulated investment in the hydrogen refuelling infrastructure in the TECH scenario requires €377 millionup to 2030. Smaller refuelling stations (between 200 and 500 kg per day) will gradually be replaced after 2030 with greater capacity stations (1,000 kg per day). The requirements are more substantial in the period between 2030 and 2040. €2.5 billion of investment is required in refuelling infrastructure during this period.



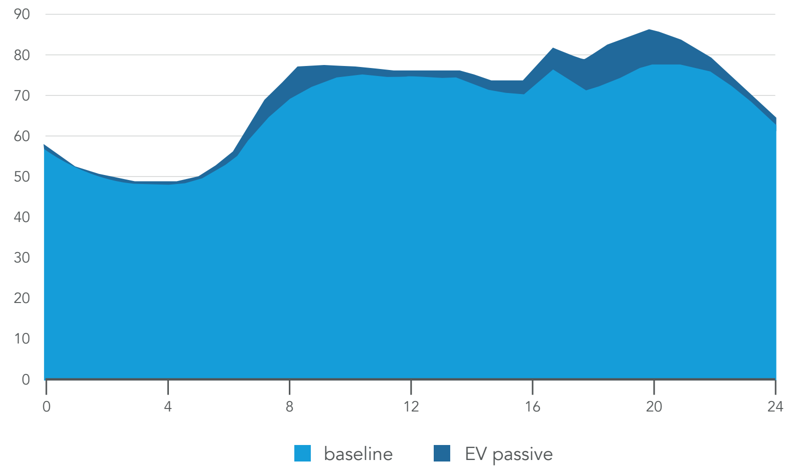
Graph 13. Total accumulated investment to supply all the electric vehicles in the TECH scenario.

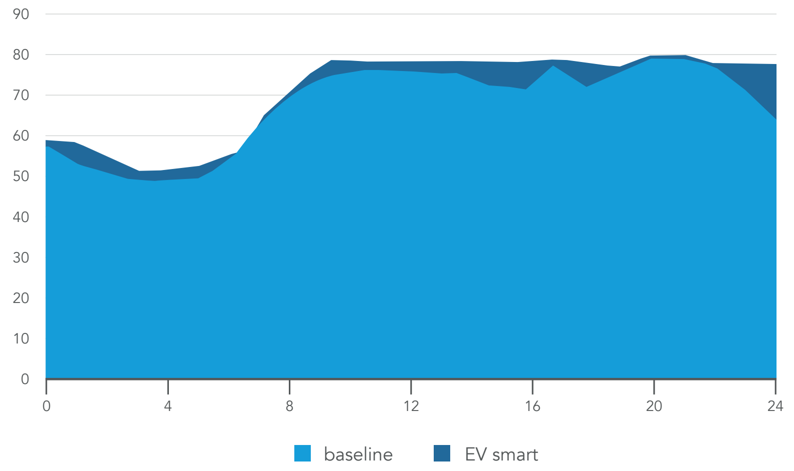
Synergies between transport and the electricity grid

The change to electric vehicles in the TECH scenario leads to an increase of just 6% of final demand for electricity in 2050, above demand from the rest of the economy. This means that the investment for generating additional electricity during the transition can easily be provided over the next three decades.

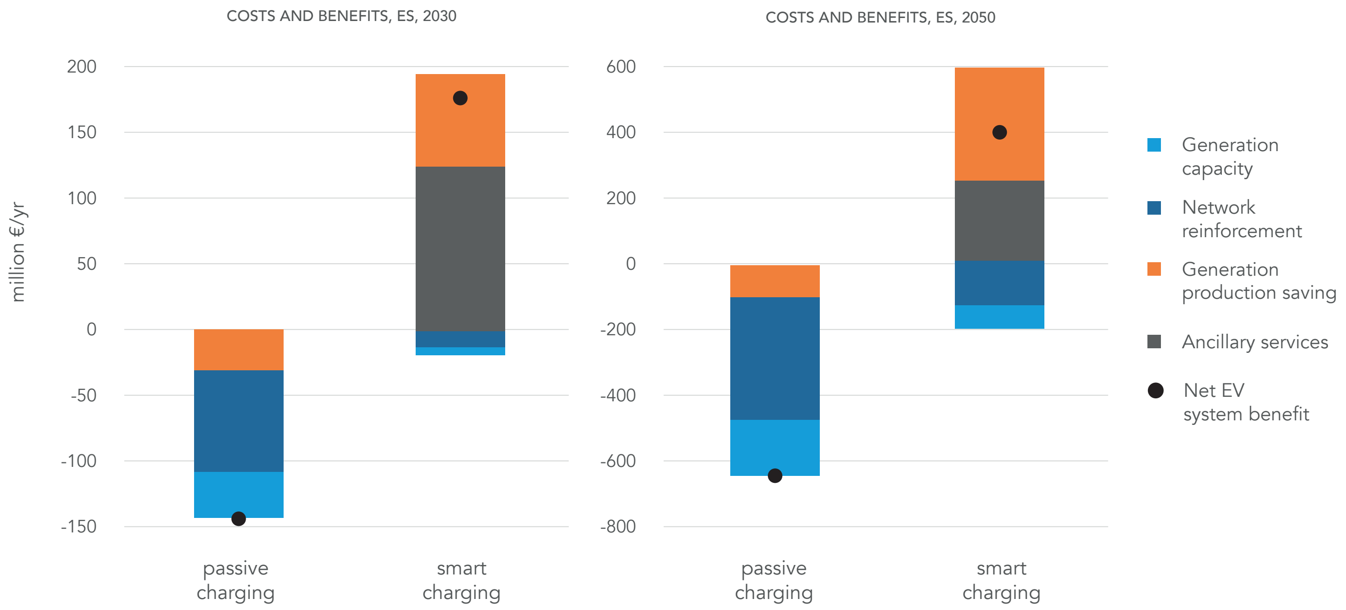
However, the mass adoption of electric vehicles would imply that electricity grid needs to be adapted to recharging needs. If, for example, electric vehicles are charged when people arrive at their destination (passive charging), the demand for electricity would increase significantly during the morning (when drivers arrive at work) and the early evening (when they arrive at home). Investment would be required to adapt the distribution networks, as well as to provide additional capacity of power generation plants.

On the contrary, with smart charging, peaks in demand would be avoided, and investment in additional network infrastructure and new power generation capacity would be minimised. Moreover, the use of intermittent renewable energy sources, such as wind or solar power, could be increased by moving the electricity demand for recharging cars to hours of high renewable energy production.





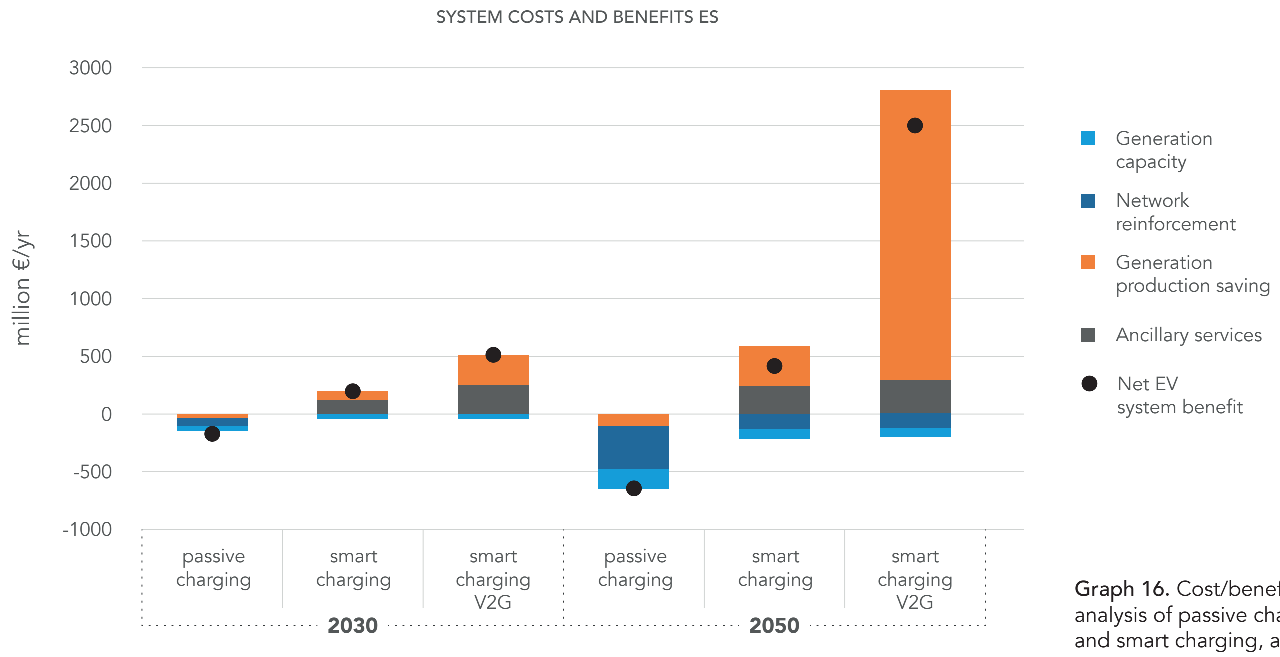
Graph 14. Daily demand (GW) with passive and smart EV charging in Spain in 2050



Graph 15. Cost/benefit analysis of passive and smart charging in 2030 (left) and 2050 (right).

Grid stabilisation services are an additional source of benefits that EVs could provide. In their simplest form, these services will switch EV charging on or off remotely to help manage peaks in demand and maintain a stable grid frequency. In the short term, these services could offer revenues to EV owners and accelerate the roll out of EVs and smart charging infrastructure.

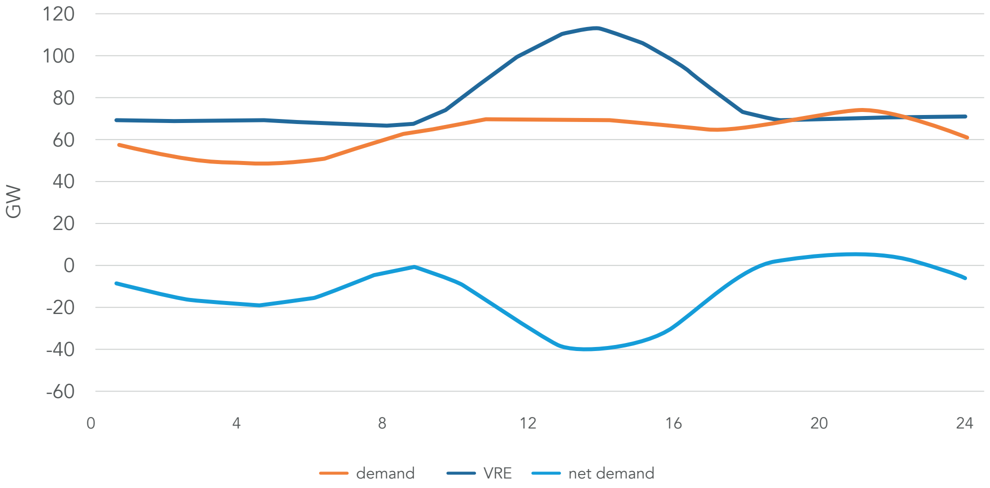
Our analysis shows that the deployment of smart charging would lead to approximate benefits of €320 million per year in 2030, compared to passive charging (Graph 15). These benefits could increase if the batteries of the electric vehicles were also used to store energy and return it to the grid at the most convenient time for the electricity system. This option, known as V2G (vehicle-to-grid) shows a much greater saving in the production of electricity than the smart charging scenario (Graph 16).

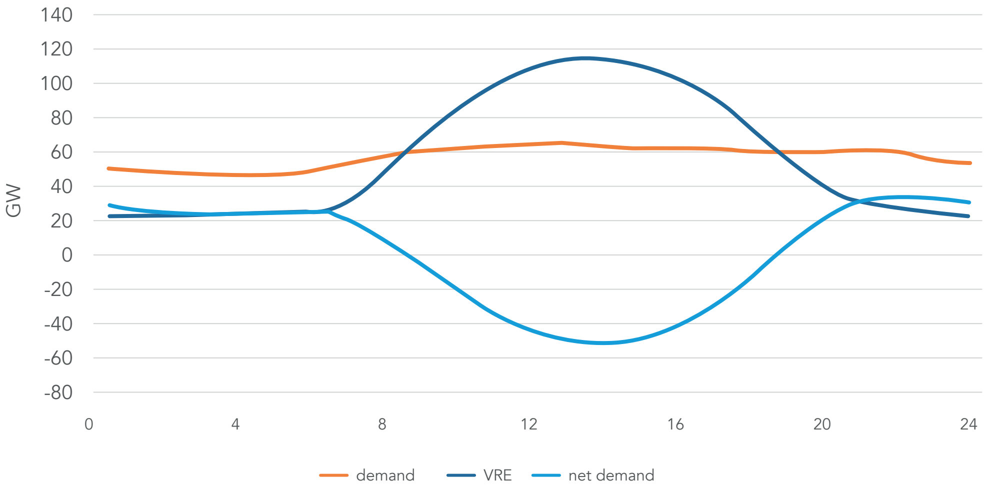


Graph 16. Cost/benefit analysis of passive charging and smart charging, as well as smart charging combined with V2G.

In Spain, the high production of solar energy in the future will often exceed demand. V2G enables this excess energy generated during the day to compensate the shortfall in renewable energy during the night. Electric vehicles would be charged with energy during the day, and the additional energy received would be returned to the grid in the evenings to respond to increased residential demand for energy, with no impact on user habits. This would allow the utilisation of significant amounts of energy from renewable sources which would otherwise be lost. As a result, EVs would help to reduce the carbon intensity of electricity by one third compared to a scenario without V2G, as well as to reduce the cost of electricity.

Utilising the V2G concept would require deployment of compatible charging posts to ensure that EVs could be charged during the day and supply energy back to the grid during the evening and night. The investment in this infrastructure would bring about significant economic benefits and would greatly reduce carbon emissions.



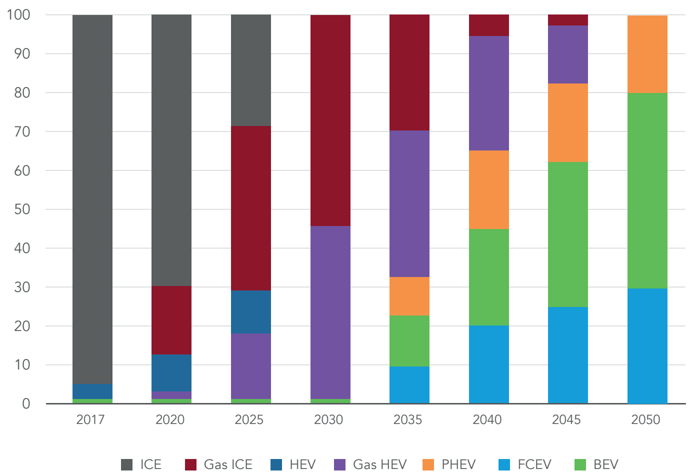


Graph 17. Daily demand profiles, generation of variable renewable electricity and net demand (monthly average) in Spain in 2050 (top: January, below: July)

Role of gas in the transition

Some studies indicate that natural gas and biomethane will play an important part in the decarbonisation of cars. To make a comparison, a compatible sensitivity analysis has been carried out with long-term climate objectives in mind. In this analysis, cars using compressed natural gas (CNG) are considered as an alternative to hybrid cars, plug-in cars and pure electric cars. This scenario is not like the others considered, because the hypothesis is considered to be technically and financially difficult. Firstly, it assumes a very rapid change in sales of cars towards gas vehicles (Graph 17). Secondly, with data from the ICCT[15] for Spain, the maximum production potential of biomethane was estimated and modelled as all being used in the transport sector - neglecting other sectors such as the industrial sector or domestic use, which also could use this biogas for decarbonising.

In this analysis, the CO_2 emissions of cars decrease throughout the period, reaching low levels in 2050. However, compared with the TECH and Rapid Transition TECH scenarios, the reduction is slower as pure electric vehicles and hydrogen-fuelled vehicles, much more efficient in terms of energy and CO_2, only start to enter the market after 2030. Using only gas vehicles is not enough to meet the climate goals. In addition, from 2030, it must be assumed that electric vehicles will enter the market mix, as the potential of low carbon biomethane is limited. In the absence of low carbon biomethane, the reductions are smaller given that fossil gas has higher greenhouse gas emissions.



Graph 18. sales mix in the analysis of gas.

With regard to the impact on the GDP, the positive economic impact in the TECH and Rapid Transition TECH scenarios is mainly generated by reductions in oil imports. In this analysis, natural gas will be imported, which does not improve energy security or favour the economy in comparison with the CPI scenario in the medium term. After 2030, the deployment of pure electric cars and hydrogen-fuelled cars leads to a positive impact on the Spanish economy.

In the case of a rapid switch to gas, the reductions in fuel duty revenues would occur more quickly than in the central scenarios, and the administration would have to compensate this shortfall by creating new charges. This would probably have a negative impact in the short to medium term on the Spanish economy. As is explained in more detail in the technical report, this case would make the TECH gas analysis more harmful to the economy than the CPI scenario.

In the TECH gas analysis, a reduction of €6.2 billion in tax revenue on fuel in the year 2030 (due to the minimum taxation of gas in comparison to gasoline and diesel) would be more difficult to compensate than in other scenarios, even if the VAT is increased to alleviate the loss of income.

Notes

1 The reference scenario assumes that efficiency improvements will not be introduced in new vehicles. For more details, see the methodology section.

2 This is in line with the TECH scenario outlined in *Fuelling Europe's Future II*, published on 20 February 2018.

3 This is in line with the TECH OEM scenario described in the *Fuelling Europe's Future II* report.

4 The calculation of the Total Cost of Ownership of a vehicle includes the purchase price, financing costs, fuel, maintenance and charger costs if it is an electric vehicle. Analysis is performed over two periods: over the whole of the useful life of the vehicle, which amounts to thirteen years; and over the first four years, which influences the purchasing decision of the first owner. The latter will determine whether the low-carbon technologies enter the vehicle fleet or not.

5 For more details, check the full study.

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