

# TRANSPORT / EUROPE #8



## THE DECARBONIZATION OF ROAD TRANSPORT IN EUROPE

The topic of decarbonization of transport was recently addressed for the OPSTE<sup>1</sup> college of experts. This initial approach was extended and deepened with a session held in April 2023.

The focus here is on the decarbonization of the road transport of people and merchandise. Road transport is by far the dominant mode in Europe (in terms of both passenger-kilometers and ton-kilometers) and, according to all available projections, it will remain so in the future. Even if we achieve a substantial transfer from road transport towards other modes, which may be more virtuous from an environmental standpoint, this transfer will reduce but will not eliminate the dominance of road transport and will not be sufficient to resolve the issue of its nuisances. **As road transport is the first source of environmental problems, it must necessarily also be the first field of progress in terms of the decarbonization of transport.**

### EUROPEAN PANAOGRAMA

Several important European legislative texts for the decarbonization of road transport were recently adopted or are now in development:

- CO<sub>2</sub> emission standards for light vehicles and trucks,
- The Alternative fuels infrastructure regulation (Afiir, to be deployed along the main highways),
- The new Euro 7 emission standard for automobiles,
- The Eurovignette, etc.

The ban on the sale of new cars with internal combustion engines as of 2035 is emblematic. What are the strategies of the actors involved to prepare for this deadline? What approaches are being used for the decarbonization of road transport in Europe? Based on the information collected and analyzed by the OPSTE college of experts, some strong ideas have emerged.

### The European Union for the convergence of national policies for the decarbonization of transport

For the decarbonization of transport as for other political concerns, the differences between the starting situations between European countries are very large, reflecting their economic and political histories, particularly in terms of energy (with very unequal degrees of dependency on fossil fuels for electricity production). In a global outlook, the contrasts are still more marked. Even in countries which reduced the total volume of their emissions (in industry, electricity production, service sector), those due to transport are decreasing slowly or, more often, stagnating or increasing.

We simultaneously observe, in speeches as in the orientations of public policies, **a progressive convergence of concerns**. The interaction between national and European policies is getting stronger over time, encouraged by *ad hoc* financing, and this interaction determines a minimal rhythm and a convergence of actions.

1 - The OPSTE bulletin, Transport/Europe #6 : [Decarbonizing transport, an essential goal](#), November 2022, 30 p.

The European Recovery and Resilience Facility (RRF), a significant share of which was allocated to transport, played an indisputable role of intensification and coordination of efforts<sup>2</sup>.

However, there is no consensus on the measures affecting the decarbonization of transports, neither in public opinion, nor among governments. Some people consider that the emphasis is too exclusively put on technical progress and doubt in particular that electric cars can be a solution on the global scale, even over time. From another standpoint, while changes of behaviors are also needed, the freedom to come and go remains a fundamental value<sup>3</sup> and “de-mobility” is not officially promoted in any Member State of the EU.

### Laws for the climate and energy

In a concordance of scheduling with its international commitments (particularly the international climate agreement stemming from Cop 21 [Conference of parties of 2015 in Paris]) and with the European orientations (the Green Deal and its legislative translation according to the Fit for 55 packet), informed moreover by the Intergovernmental Panel on Climate Change (IPCC) of the crucial necessity of intensifying the fight against climate change, each country has established a national legislative framework determining the outlook and the objectives in terms of the environment and energy.

More or less complex, composed of a limited number of texts or broken down into multiple texts which are more or less coherent and stable or revised periodically, these systems strongly affect transport, the number one source of greenhouse gas emissions. In some countries, this comprehensive approach, affecting all sectors over the long term, is seen as part of the planning process.

Developing a decarbonization law is one thing, making sure that it is effective is another. The situation differs from one country to another in terms of the monitoring of the implementation of policies, measurement of the discrepancies between the objectives announced and the results obtained in terms of decarbonization and regular reports to the Parliament and citizens.

### Political instruments

A mobility system transformation such as a radical change of the energy used is systemic. It supposes the simultaneous implementation of multiple instru-

ments for action, playing on both incentives and on the contrary on fines relating to the purchase and use of decarbonized or traditional vehicles, on technical standards, on differentiated access to infrastructure (through tolls) and to city centers. At the same time, the implementation of equipment for distribution of new types of energy is an indispensable condition for this change. **As for the electricity used, its production should itself be decarbonized and its available volume should be increased** so that the change is coherent from an environmental standpoint, which is far from being the case in many European countries.

At the same time, the carbon market, formerly ineffective in Europe due to an excessively generous distribution of free emission quotas before the recession of 2008, is beginning to function (with the economic recovery and the international energy price increases) and will apply to both maritime transport and to intra-European air transport. Moreover, the Emissions Trading System (ETS) was extended to road transport. Motorized travel, with its corresponding polluting emissions, mostly occurs in densely populated urban areas. For public health reasons, which can also converge with concerns about limiting greenhouse gas emissions, Low Emission Zones (LEZ) were installed or are in the process of being installed in large European cities. The system involves reserving access to these zones to vehicles which are not too polluting. While they are already numerous and well accepted in some countries, they are a source of reticence elsewhere, because the acquisition of a less polluting vehicle – recent and expensive – is financially impossible for poorer households despite the aid for the purchase of electric cars. The low emission zones can thus have a socially discriminating effect in terms of access to city centers. They could also make things difficult for tradesmen using older utility vehicles.

Measures intended to develop alternatives to cars in cities are often presented as an accompaniment of the low emission zones, to facilitate their acceptance:

- The development of the public space and support for active mobility (walking, bicycle),
- The development of public transport (with a special effort for decarbonizing buses),
- The digitizing of journeys (*Mobility as a Service, MaaS*) to help with the organization of multimodal travel chains,
- In some countries, the low emission zones have taken on the form of urban tolls. Some of the resources thus generated are used to improve public transport.

2 - See issue number 4 of the bulletin *Transport / Europe: From the Covid Crisis to Recovery Plans. The Stakes and Consequences for Transport*, September 2021.

3 - The Universal Declaration of Human Rights of the United Nations, adopted in 1948, states, in its article 13: “Everyone has the right to freedom of movement [...]”. The French law of 1982 (orientation law for domestic transport) went further, going from freedom of movement to a right of transport.

Company fleets represent major stakes for automobile decarbonization. In some countries they account for half of the sales of new vehicles and, with rather rapid reselling, they substantially supply the used car market. These vehicles are often considered as non-monetary professional income by their beneficiaries (in Belgium people speak of “salary-cars”). The tax system for these vehicles goes beyond general discussions of yields and equity and has a major environmental impact, because of its effects on the replacement of cars on the road, if it favors decarbonized vehicles over combustion vehicles.

We observe that these measures apply mainly to urban areas and to densely populated zones, with reinforced support for suburban and regional rail systems. In rural and less dense areas where public transport is less effective, there are for the moment few relevant solutions beyond the decarbonization of automobiles as such.

**Tomorrow’s cars and trucks**

Even if we cannot predict the pace, the entire system of road transport will undergo a radical transformation. From the standpoint of decarbonization, the shift to forms of energy other than fossil fuels will be the major change, while at the same time the digitizing and connection of vehicles and infrastructures will transform other uses, up to perhaps automated driving in more of less usual traffic conditions...

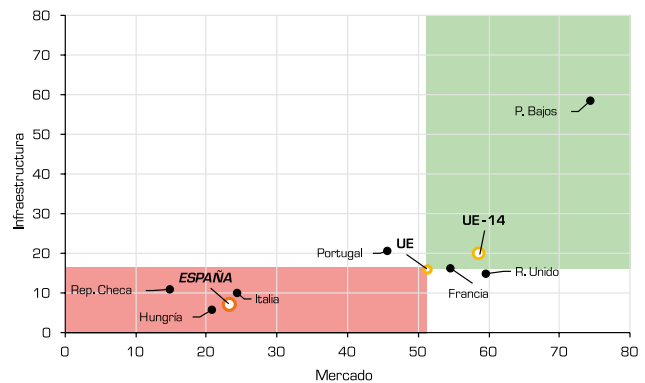
**There is still plenty of technical progress to come.** Some technologies are reaching industrial maturity (without becoming rigid, with possibilities for further progress, or even breakthroughs), they are adapted to certain means of transport, used in certain circumstances and territories (as a function in particular of the distance of journeys and their accumulated daily length). However, other segments of the road system do not yet have relevant solutions for their carbon footprints, from neither a technical nor an economic standpoint. This is particularly true for trucks over long distances, for which several research investigations are underway with no satisfactory solution for the moment.

To take just the example of the fuel cell (transforming hydrogen into electricity in a vehicle), we observe that the automobile is totally transformed, with essential parts disappearing (engine, gear box, transmission, exhaust) and others appearing (hydrogen tank, battery, fuel cell, converter, electric engine). The manufacturing (among manufacturers and their multiple suppliers) is no longer the same, nor is the upkeep in the maintenance network or in energy distribution

(electricity, hydrogen, biofuels, etc.).

Focusing here solely on the electrification of automobiles, it now involves several forms (hybrid, rechargeable hybrid, all electric) of which only the last will remain after a transition phase. The massive distribution movement is in any case underway and is in the initial stage, growing substantially, of the traditional logistic S-curve. In many countries, against a backdrop of a temporary slowing of new automobile sales because of coming out of Covid and because of the high prices of the models on offer, electrified automobiles are catching up with gasoline automobiles, while diesel models continue their decline. From one year to another, the changes are spectacular. In parallel, the number of electric charging stations, private and in the public domain, is increasing rapidly.

**Most likely, the shift towards electric cars will continue at different paces from one country to another.** Countries in which the population has higher incomes can more rapidly replace their cars while elsewhere it will depend more on the offering for sale of new vehicles that are less expensive and the formation of a used car market. The following graph, which shows the penetration of electric cars on the market (abscissa) and the rate of installation of charging stations (ordinate), gives an idea of the disparity of the current situations in Europe.



**Deployment of electric cars in Europe (market share of sales and density of installation of electric stations)**

Source : ANFAC, *Barómetro de la electromovilidad*, 2022  
 [Mercado: market share of sales of electric vehicles, all categories (BEV, PHEV and E-REV) / Infraestructura: public charging stations compared with the objective of 10.3 stations per 1,000 people of driving age]

In any event, if sales of new combustion vehicles end in 2035, these vehicles will not disappear from European streets and roads before 2050 at the earliest. Furthermore, from the standpoint of climate change which, as we know, is a worldwide phenomenon,

4 - We see that a traditional road vehicle using hydrogen as a fuel is both a combustion and a decarbonized vehicle. This solution should not be ruled out for some cars, alongside the electric solution.

combustion automobiles which become obsolete in Europe will continue their lives in other countries and their carbon assessment will not be changed until they are permanently removed from circulation or perhaps retrofitted. The parameter influencing the climate will thus be the speed of the gearing up of the production and sale of electric vehicles (and we know that, for light commercial vehicles in particular, the production is now inadequate to meet the demand, which increased with the implementation of the low emission zones).

**The industrial stakes linked to this energy transition are high, in terms of investment and employment** (including the important issue of skills and conversion to new jobs), national and European public aid, economic sovereignty, re-industrialization and regional development. Automobile manufacturers are announ-

cing the modernization of their European sites, while the first battery “mega-factories” with aid from the EU are being established in Europe.

We can thus anticipate a trend which is insufficiently mentioned: the lengthening of the working life of vehicles, because electric cars experience less mechanical wear (and thus require less upkeep) than combustion vehicles, which will affect the entire maintenance network. Upgrading and recycling during the life of vehicles must find an industrial translation. Carsharing is a way of increasing the intensity of vehicle use (a private car used individually is driven for one hour a day on average), sharing the fixed costs, and shortening its working life to benefit from technical progress at the time of replacement. Will we find organizational forms for its large-scale development?

**The issue of the number of automobiles**

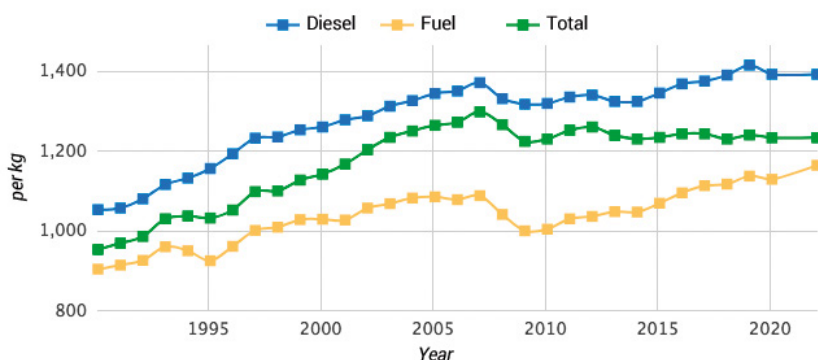
In their reconversion towards electric cars, European and American manufacturers have thus far favored high-end cars. This choice makes the conversion to electric cars impossible for households with modest means. The massive decarbonization of road transport will require a massive supply of entry-level decarbonized vehicles, the prices of which must be similar to those of equivalent combustion vehicles. It is moreover an imperative objective for European manufacturers themselves, because in the present state of industrial development, Chinese manufacturers have a competitive advantage for small electric vehicles with a cost on the order of 10,000 euros.

Less expensive vehicles are also lighter vehicles (smaller, less equipment, less powerful). The decrease in the average mass of automobiles for commercial reasons also addresses an environmental concern, because the total carbon footprint of a vehicle (with a life cycle assessment outlook including manufacturing, use and lastly the recy-

cling of the product) is more or less proportional to its mass.

To alter the trend of the increasing mass of automobiles (which is made worse with electrification because of the batteries) we must aim for its reduction, i.e., downsizing. We know that a Tesla automobile weighs 2.5 tons, including 570 kg of battery, often to carry one single passenger (100 kg with baggage). We must seek to develop light vehicles, sufficient for daily local use. Several start-ups are exploring this market alongside the traditional manufacturers.

The following graph shows the change in the average mass of new cars sold in France as of the 1990s. For the attentive reader, it gives a good example of a structural effect explaining an apparent paradox: while the weight of diesel and gasoline cars is increasing, the average weight of the whole is not increasing. This is explained by the fact that the share of gasoline vehicles, which are comparatively lighter, is increasing compared with that of diesel vehicles.



**Evolution of the average mass Private new vehicles sold in France**

Source : Ademe, [Car Labelling](https://www.carlabelling.ademe.fr/chiffrescles) [cartlabelling.ademe.fr/chiffrescles](https://www.carlabelling.ademe.fr/chiffrescles) 2023



Moreover, it has already been underscored that technical progress is not frozen, for the improvement of electric batteries but also the development of alternatives to fossil fuels. We must continue our research, including fundamental research with uncertain practical outlets and for technologies that are today much more expensive than traditional solutions, because they have not been brought to an industrial scale. Today, the purchase price of a bus powered by a fuel cell is almost three times that of a diesel bus.

### **A strategic approach**

At the end of this panorama, several primordial topics emerge:

- **The systemic nature of the transition.** The scale and the complexity of the issues raised call for the intervention of specialists of fundamental and applied research, industrial development of innovations and also human sciences. Some issues are connected to the academic world, others to the private sector.
- **The large margins for progress in fundamental and applied research.** Scientific and technical progress is a major factor for access to sustainable development. However, the change is a global social phenomenon in which the hard science specialties must come to terms with geopolitics, economy, urban planning, law, etc. in an interdisciplinary rationale.
- **The critical nature of the situation.** Even if the word crisis is sometimes overused, the situation in terms of climate disruption (in Europe and well beyond) calls for a radical ecological and energy transformation, which is difficult to imagine, implement, finance, and have accepted, even though it is indispensable.
- **The risk of shortages of the products essential to new technical developments.** The transformations which are occurring are mainly based on the production of decarbonized electricity as a substitute for fossil fuels. They harness resources (nickel, cobalt, lithium in particular, for the manufacturing of electric batteries and wind turbines) which are very unequally available around the world and the access to which is already largely controlled by certain countries. China has many of these on its land and also dominates the international industry for their refining. The subsoil of Europe also has some resources, lithium in particular: could it be extracted rather than relying on imports? The search for strategic (and geopolitical) autonomy, a formula commonly used in Europe with regard to gas, is very significant in this case.
- **The high costs of these changes.** The effects of learning and economies of scale will reduce them over time, but how can we finance them and distribute the charges, whether for research investments, investments for implementation and then for their operation?
- **The need for medium- and long-term planning.** The market rationale is not able to undertake very large expenditures, with uncertain scientific and technical success, with unforeseeable cost-effectiveness (but potentially substantial social returns).

Only State and inter-State cooperation systems are capable of such anticipation, associating public and private actors in their respective roles. In Europe, the notion of industrial policy, not long ago deliberately ignored, has once again found its place.

- **Very lively international competition.** This competition is economic, but also geopolitical and geo-strategic. Whether for access to rare resources or, in a more immediately operational manner, the production of sustainable facilities for the production and storage of electricity or electric vehicles, Chinese industry has a notorious head start (a Chinese electric car costs about 10,000 euros less than its European equivalent). What protection will the European Union implement for this nascent industry?

We must lastly underscore the need for a rational and informed approach to these complex issues, thick with emotion, intuition, prejudices and, according to the current formula, divisive. Faced with the doubting of scientific thought as such, “fake news”, or even obscurantism, science and technology have a major role to play in the search for solutions, without losing sight of the crucial role of social practices and the need for a political approach that will allow for participation and the support of citizens for the necessary changes.

**Michel Savy, Director of the Observatory of transport policies and strategies in Europe**

**TRANSPORT POLICIES  
AND STRATEGIES IN EUROPE**

The issue of *Transport / Europe* includes contributions from OPSTE experts:

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*The documents of OPSTE experts reflect solely the opinions of their authors.*

It is with great sadness that the members of OPSTE learned of the sudden death of **Tristan Chevroulet**. He was a Researcher at the Federal Polytechnic School of Lausanne. Tristan took part in the work of the OPSTE from the outset, and then over the course of many years. He was then in charge of the 2050 Program for the implementation of energy strategies for public transport (SETP 2050) at the Federal Transport Office. Tristan was a competent expert who very early on took an interest in the links between transport and the environment. He was an especially pleasant, available and motivated colleague. We send our sincere condolences to his family.

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**THE OPSTE BULLETIN**  
TRANSPORT POLICIES AND STRATEGIES IN EUROPE  
Edité par TDIE - 9, rue de Berri - 75008 PARIS - 01 44 13 31 80 - [opste@tdie.eu](mailto:opste@tdie.eu)  
Directeur de la publication: Michel Savy - Bulletin édité en français et en anglais,  
diffusé par voie électronique - ISSN 2742-8842

Soutenu  
par



**MINISTÈRE  
DE LA TRANSITION  
ÉCOLOGIQUE  
ET DE LA COHÉSION  
DES TERRITOIRES**  
*Liberté  
Égalité  
Fraternité*



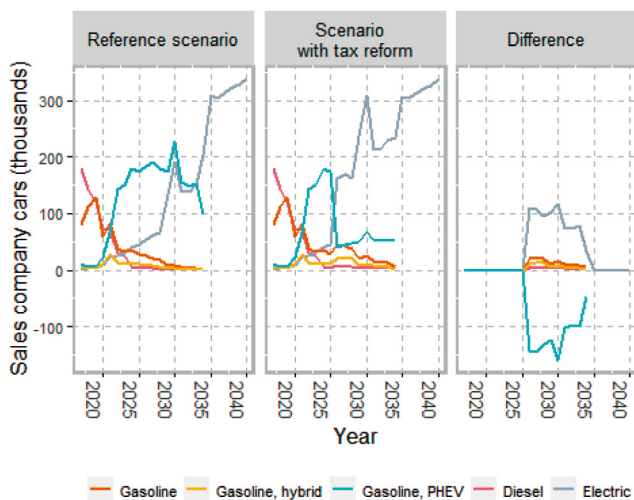
**BELGIUM**

Road transport is unquestionably the dominant mode in Belgium. From an industrial standpoint, the country has maintained an automobile manufacturing activity, but only two factories remain (Audi and Volvo) and they do not have an influence on the country's transport policies.

The transport policies (and transport decarbonization policies) are sharply marked by the country's institutional structure.

**On the federal level, the most important recent event is the reform of the tax on company cars**, which account for 50% of new vehicle purchases and which therefore have a major impact on the total fleet of cars in circulation through the used car market. Starting in 2026, only zero-emission cars will be deductible from corporate taxes. The tax advantages for the users of these cars (cars made available to their users as in-kind benefits are commonly called "salary-cars") were not modified, thereby facilitating the acceptance of this reform.

A modelling of the effects of this reform was established by the Federal Plan Bureau. It shows, in addition to a very sharp decline in sales of traditional gasoline and diesel cars, that the increase in sales of rechargeable hybrid vehicles (which we know are commonly used as gasoline vehicles) is being progressively limited by the reforms, until the decrease in these sales well before 2030 to the benefit of sales of electric cars. During this substitution phase, the decrease in greenhouse gas emissions expected is on the order of one million tons of CO<sub>2</sub> equivalents per year.



**Effects of the tax reform on the structure of the sales of company cars**

Source: Belgian Federal Planning Bureau, [Ex ante evaluation of the reform of company car taxation in Belgium, 2022](#).

In Flanders, the recent political debates have focused more on the nuisances linked to nitrogen emissions, some of which come from automobile traffic, and in particular on the consequences of their reduction on agriculture, more than on decarbonization (a debate which marked the provincial elections of March 2023 in the Netherlands). In 2016 the region already reformed its tax system on automobiles to take into account the Euro class and CO<sub>2</sub> emissions. Electric cars are exempted from the annual road tax and the registration tax. Two low emission zones have been implemented, with the Euro class determining the rights of access to the city center. An ambitious bicycle plan was recently announced. Its objective is that 30% of journeys will be by bicycle by 2040, versus 14% today, and the investments in cycling infrastructure will be substantially increased.

In the Brussels Capital region, the objective is to forbid access to diesel vehicles (including hybrids) as of 2030, followed by a ban on access to all internal combustion engine cars as of 2035. There is a project for the implementation of a kilometer-based urban toll paid by all users, while the current road tax would be abolished for residents of the region. While the political debate on this topic is not yet closed, a share of the financing for the measures in preparation for their implementation has already been subsidized within the framework of the Recovery and Resilience Plan.

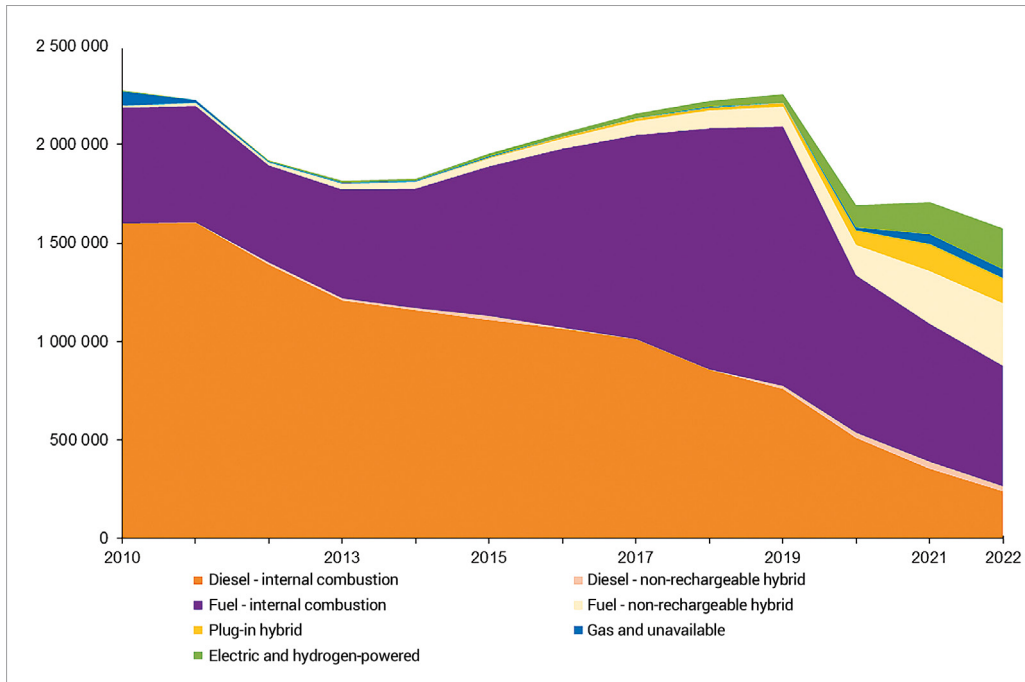
In Wallonia, the annual road tax and the registration tax are still based solely on the fiscal horsepower. Other vehicle parameters (mass, length, Euro class, etc.) are currently ignored, which does not encourage decarbonization. A reform of the registration tax (distinct from the road tax, which is annual) was proposed and will take into account parameters such as mass, power, and type of motorization, but no decision has been made for the moment. A calendar for the elimination of combustion vehicles was established.

Lastly, plans for the deployment of charging stations have been announced in each region.

**FRANCE**

France's ambitions in terms of the electrification of automobiles fall within the framework of the European orientations. While the majority of the population considers that this evolution is desirable, there is reticence and even opposition regarding its concrete implementation.

Reproaches have been made that the low emission zones are pushing out of city centers households with modest incomes, who are unable to buy electric vehicles which are still too expensive, as well as small businesses and tradesmen who use small vans which are archaic but necessary for their professional activities.



**Registrations of new private cars according to their type of motorization, 2010-2022, France**

Source : SDES, [Registrations of private cars in 2022: sharp drop in new and used cars](#) / Data and statistical studies, ([developpement-durable.gouv.fr](#))

The implementation of these zones, to meet the European criteria for air pollution in cities, is the responsibility of the metropolitan areas involved according to the mobility orientation law of 2019. However, a parliamentary mission<sup>5</sup> is aiming to establish general rules to ensure overall coherence of the measures taken in different areas and to facilitate their implementation. Faced with overambitious time frames, we observe postponements of deadlines, considerably lightened verifications of the respecting of the limitations and dispensations for some users.

In the discussions underway to establish the new Euro 7 standard for the pollution of internal combustion engines for automobiles, some industrialists and political leaders consider that it should not be too demanding and costly for the automobile industry, which must invest heavily in the transition to electricity between now and 2035.

In the meantime, the automobiles on the road are aging, electric vehicles remain very expensive (particularly because of manufacturers' choice of producing up-market vehicles, with higher profit margins) and in the temporary absence of a used car market. A price war between manufacturers and the launching of battery giga-factories in Europe could seal the shift towards all-electric cars. Even though we observe a decrease

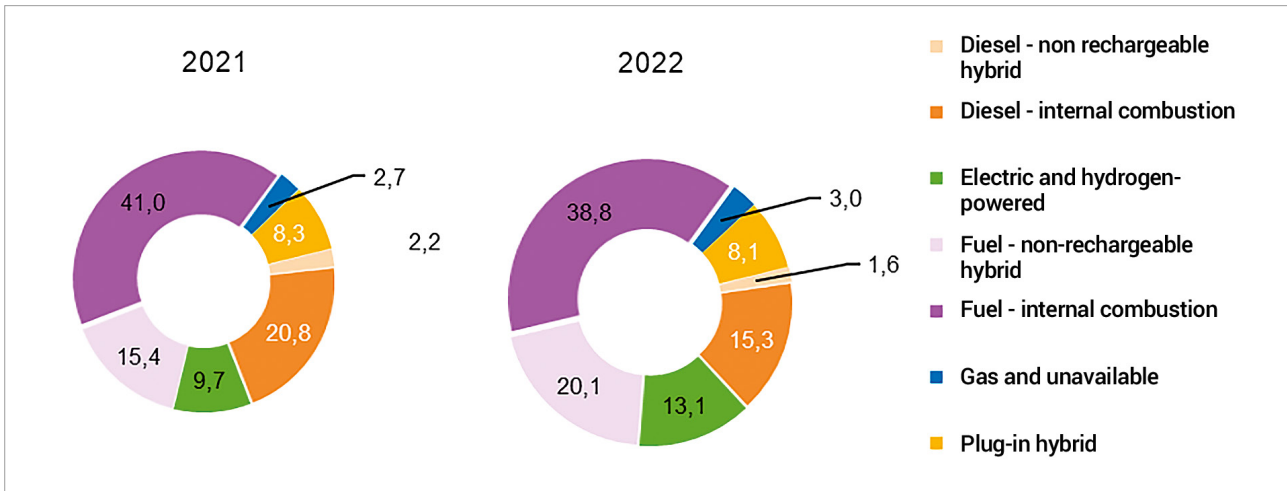
in the number of new vehicles registered after the Covid crisis, the structure of new vehicle registrations by type of energy is changing rapidly.

In just one year (from 2021 to 2022), the share of combustion diesel fell from 20.8% to 15.3%, while that of electric vehicles and hydrogen rose from 9.7% to 13.1%. We can see in the implementation of the low emission zones in large cities one of the factors that is pushing people to purchase electric vehicles or hybrids.

The growth in the number of **charging stations** is in parallel with that of sales of electric and rechargeable hybrid cars, with the support of European and national financing. Even though 90% of the recharging facilities are private, the number of stations in the public domain (in cities, along highways, etc.) is increasing rapidly. From 8,600 in 2014, it rose to 64,100 in 2022 (with an increase of 58% for 2022 alone). The goal of 100,000 stations in 2023 and about 400,000 in 2030 does not seem out of reach. Various actors (suppliers of charging stations, network managers, energetics specialists and alliances between these various actors) are taking positions to conquer the new markets for public charging stations, aiming to obtain the best locations. We can expect European level consolidations in the coming years.

5 - "Mission flash" regarding measures to accompany the creation of low emission mobility zones. Two Parliamentary missions are also in the process of formulating proposals for harmonization or easing of the rules for the Low Emission Zones.





**Breakdown of types of motorization of new private cars in 2021 and 2022, France**

Source : SDES, [Immatriculations des voitures particulières en 2022 : forte baisse dans le neuf comme dans l'occasion](#) (Données et études statistiques [developpement-durable.gouv.fr](#))

(Registrations of new private cars in 2022: sharp drop for new and used cars / Data and statistical studies)

**The conversion of automobile construction to electrical energy is a radical transformation, affecting both manufacturing and maintenance activities.**

French manufacturers are announcing that they are locating in France a large share of their manufacturing of electric vehicles, although they had strongly delocalized their production in the past decades. They are now planning to sell lighter and less expensive electric vehicles (at prices on the order of 25,000 euros), although the competition (particularly China) can supply vehicles of this type at very competitive prices.

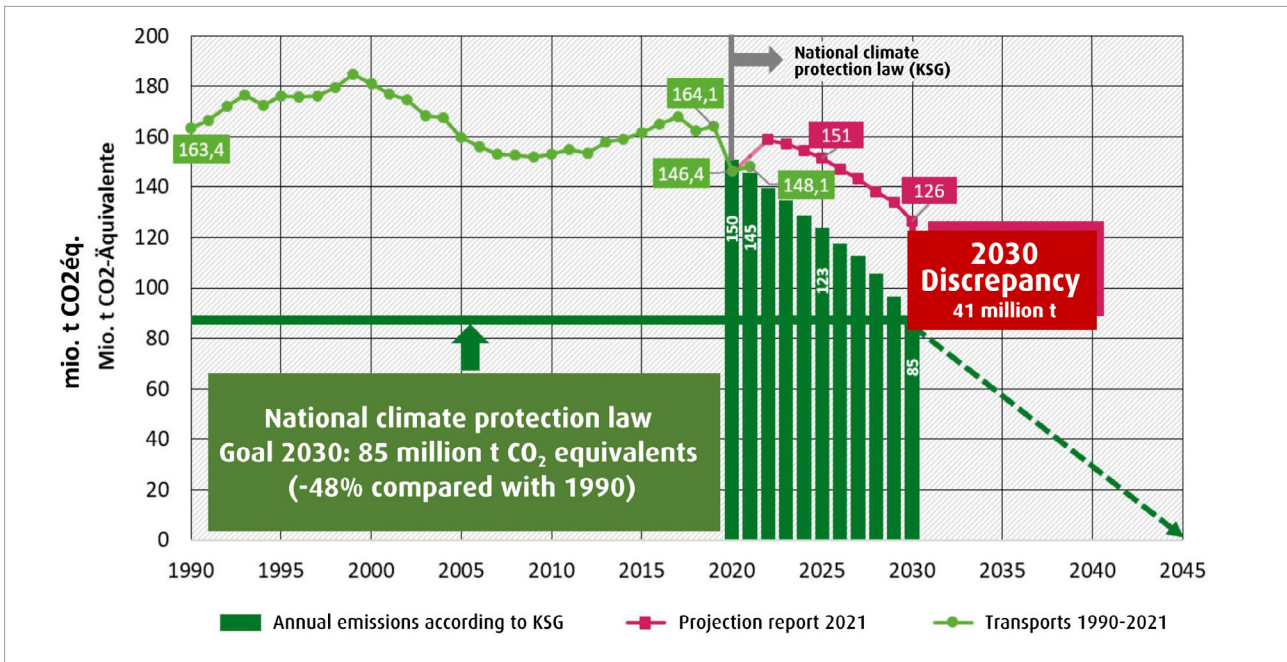
The establishing of large factories for the manufacturing of batteries (gigafactories), designated as Important Projects of Common European Interest (IPCEI), is an opportunity for the re-industrialization of Europe as well as for the re-establishment of technical and economic sovereignty in the face of Chinese competition and the US Inflation Reduction Act, which has protectionist effects. Three projects are now being implemented, especially in the north of the country, the same number as in Spain, in Italy and in Hungary, and eight in Germany. There is also the issue of the reduction of the dependency of European industries for battery components (lithium, rare earth metals, etc.) and the relaunching of mining activities for products available in France and in Europe.

Furthermore, Renault is converting one of its historic assembly sites into a retrofit factory for combustion vehicles (especially light utility vehicles) and the renovation of damaged vehicles in a circular economy rationale. We note lastly that France maintained its trajectory of reduction of greenhouse gas emissions defined by the intergovernmental Panel on Climate Change for 2022.

**GERMANY**

The political topic of transition in transport (*Verkehrswende*) echoes that of the energy transition (*Energiewende*). Transition in transport itself has two orientations: the traction transition (*Antriebswende*) is its technological component, while the mobility transition (*Mobilitätswende*) refers to changes of behaviors. These two complementary orientations contribute to the decarbonization of transport. Estimations based on a modeling of demand attribute between half and two-thirds of the reduction of CO<sub>2</sub> to technology (tank to wheel), and the remainder to changes of behaviors. Conjointly, political discussions were held between the three parties of the government, focusing mainly on climate protection and the action – which some people find insufficient– of the minister of transports. Three orientations have emerged:

- A new way of setting the goals for reducing greenhouse gas emissions, which will be done comprehensively and not sector by sector (which seems less demanding for transport activities);
- The use of some of the receipts from road tolls for trucks (*LKW Maut, Lastkraftwagen Maut*) to finance rail investments;
- The resumption of the extension of the national highway network.
- The legal basis of these orientations is the Climate Protection Law of 2019, modified in 2021 at the request of the Constitutional Court which considered its provisions insufficient to take into account the interests of future generations. This law increases the ambitions of the preceding law in terms of the reduction of greenhouse gas emissions on the horizon of 2045. Over the past few years, the emissions from



**Discrepancy (Lücke) between the greenhouse gas emission objectives set by the Federal Climate Protection Law (in green) and the transport emissions observed (in red)**

Source: UBA 2022; Berechnungen des Projektionsberichts 2021 – Abweichungen Projektion zu IST für 2020 und 2021

transport have not been reduced very much, while the progress for industry and construction is better than initially expected. A comparison of the observed evolution and the objectives set shows significant differences between modes of transport.

Various measures were chosen to close this gap. The tax on greenhouse gas emissions, still modest, should be increased and combined with a quantitative cap on the volume emitted starting in 2026. Simultaneously, the supply of alternative modes will be reinforced, while taking into account the changes of behavior linked to the digitizing of the economy, such as the continuation of teleworking subsequent to the Covid 19 crisis. There were discussions with the European Commission about the use of artificial decarbonized fuels (the production of which will be based on electrical energy as long as its production is decarbonized) allowing for a derogation, for certain vehicles, from the ban on sales of combustion vehicles as of 2035. E-fuels will in fact be necessary in aviation, maritime navigation and for certain truck uses.

The observation of the reduction of greenhouse gas emissions, particularly from transports, has a very familiar place in political life and has been covered by many studies. The government must report on these issues to the Parliament, and must moreover send a report on the corresponding projections to the Euro-

pean Commission. A council of independent climate experts is establishing a sector-by-sector evaluation. It will make recommendations for the implementation of the climate plan and its particular programs.

On the federal level, the objective is to bring the share of rail from 22% today to 25% of freight transport by 2030. The emissions of trucks will be regulated more severely with differentiated tolls (*LKW Maut*) according to the emission levels (the tolls can be doubled depending on the performances of the vehicles) and some of the income from this will go to rail development.

These measures are supplemented by the Länder but in different ways according to their own strategies. Baden-Württemberg, for example, has a law for the protection of the climate and adaptation to climate change, and Berlin was the first Land which developed a mobility law in 2018. The Länder can invest in collective transports, cycling infrastructure, and developments for pedestrians, but their actions remain oriented by a national framework law (for the sharing of roads for example).

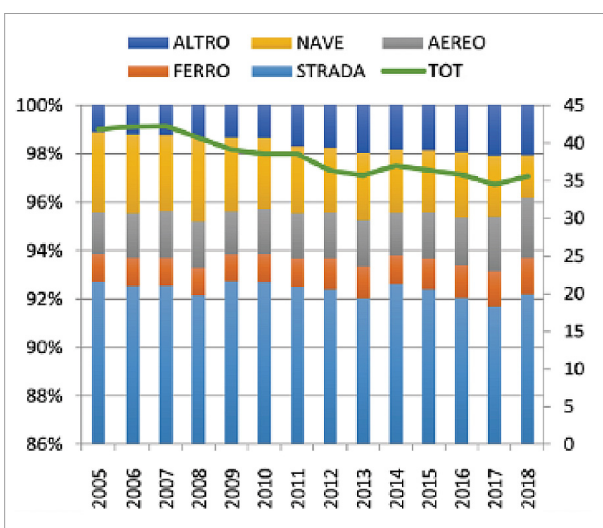
On the municipal level, sustainable mobility is promoted in many cities for the main reason of improving the quality of life, associated with a reduction of greenhouse gas emissions. Low emission zones are being implemented in the largest cities, especially in the west of the country.

We observe a rapid increase in the number of electric vehicles in service, with one million all-electric vehicles today, but the goal of 15 million such vehicles by 2030 seems uncertain. There has been substantial support for purchasing, on the order of almost 7 billion euros thus far, with a ceiling of 6,750 euros per vehicle. The fleet of company vehicles is a primordial objective in this regard, because it represents about half of the new vehicle registrations. Automobile manufacturers are deploying their industrial and commercial strategies for electric cars. They have thus far favored the production of up-market vehicles, which are more expensive and lucrative, but the competition from Chinese manufacturers (for example MG Roewe) could push them to offer lighter and less expensive vehicles.

In a complementary manner, there are subsidies for the installation of charging stations (with the goal of one million public stations in 2030) and the purchase of electric buses. New players are appearing in this emerging economic sector: several automobile manufacturers are creating a joint subsidiary to finance these charging stations in 24 European countries, mainly along highways.

**ITALY**

After a decrease in energy consumption by transport due to the financial crisis of 2008 and then the Covid crisis, we now observe a certain recovery. Road transport accounts for 90% of ground transport in Italy, and most of the corresponding greenhouse gas emissions (92% in 2018).



**Final energy consumption of transport, total (Mtoe at right) and by mode (in %, at left), Italy**

Source : Baldissara, B., Lelli, M., Valentini, M.P. (2020), *Energia, ambiente e innovazione*, 3/2020. DOI 10.12910/EAI2020-085.

The road transport decarbonization policy is mainly based on the established link between energy efficiency and decarbonization. The idea is to improve the technical performance of vehicles rather than acting on demand and mobility behaviors. Some documents, such as the Integrated National Energy and Climate Plan (INECP), imagine a more balanced approach however, combining both levers for action. The preference given to electrification with respect to the moderation of mobility is criticized even by certain economic agents, who consider that it is not very efficient in terms of the cost-benefit analysis. For example, Iveco underscores the cost of installation of charging stations and the reinforcement of pavements due to heavier buses.

The INECP is setting objectives for 2030, while adopting a long-term strategy, including the abandoning of the use of coal as a fossil fuel in 2025. It is targeting climate neutrality by focusing on:

- The priority of reducing the need for mobility and increasing soft mobility and collective mobility, particularly through rail, for passengers;
- For merchandise transport, the shift from road to rail is being favored;
- Lastly, for the remaining needs, the distribution of bio-fuels, particularly bio-methane, and sales of electric vehicles are being encouraged (with an objective of six million such vehicles in 2030).

The plan also includes funds intended for research but focusing on large projects, and we observe difficulties in finding young researchers to carry out this work.

The Structure of Ecological Transition for Mobility and Infrastructure (Setmi) was inherited from the preceding government. We note that, while it was formerly called the Ministry for Infrastructures and Sustainable Mobility (*Ministero delle infrastrutture e della mobilità sostenibili*, Mims), the ministry in charge of transports has returned to the traditional name of the Ministry of Infrastructures and Transport (MIT), with no reference to sustainability. Setmi aims in particular to reinforce the link between technical-scientific analysis and political decisions. It established in particular an evaluation of the feasibility and the timeliness of the four main technical alternatives to fossil fuels in transport (electrification, biofuels, biogas and hydrogen) as a function of the transport solutions (mode, vehicle size, length of journeys). We observe that for heavy freight and long-distance road transport, no satisfactory solution has yet been found.

Veicoli	Tecnologia	Distanze		Tutte		Brevi		Lunghe		Brevi		Lunghe	
		Tutte	Tutte	Tutte	Tutte	Brevi	Lunghe	Brevi	Lunghe	Brevi	Lunghe	Brevi	Lunghe
Elettrificazione (batterie)		Alta	Alta	Alta	Alta	Alta	Alta	Alta	Alta	Alta	Alta	Alta	Alta
Elettrificazione (retielettrificate)		Non prioritario	Non prioritario	Non prioritario	Alta	Alta	Bassa	Bassa	Alta	Alta	Non prioritario	Non prioritario	Non prioritario
Biocombustibili attuali		Non prioritario	Non prioritario	Non prioritario	Non prioritario	Non prioritario	Non prioritario	Non prioritario	Non prioritario	Non prioritario	Bassa	Bassa	Bassa
Biocombustibili avanzati		Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Alta	Alta
E-Fuels		Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa
Gas naturale Biogas Biometano		Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Non prioritario	Non prioritario
Idrogeno e Idrocarburi sintetici decarbonizzati		Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa	Bassa

■ Alta priorità (tecnicamente fattibile, adeguato, economicamente competitivo)  
■ Bassa priorità (tecnicamente fattibile ma poco adeguato, economicamente non ottimale)  
■ Non prioritario (tecnicamente soggetto a restrizioni importanti, limitata competitività economica)  
■ Incerto (attualmente tecnicamente ed economicamente soggetto a restrizioni ma con potenziale rilevante, necessaria ricerca)

**Evaluation of the technological options for different types of vehicles and distances**

Source: Mims (Ministero delle Infrastrutture e della Mobilità Sostenibile), *Dicarbonizzare i trasporti. Evidenze scientifiche e proposte di policy*, 2022.

For its National Recovery and Resilience Plan, Italy received the highest EU contribution of all members of the European Union, with a substantial share devoted to transport<sup>6</sup>.

Within the framework of its Mission 2: Green revolution and ecological transition and the chapter on Renewable Energy, hydrogen, networks and sustainable mobility, it includes an ambitious program of production of sustainable electrical energy. Limiting ourselves here to transport, the mission identifies three priority domains, specifying the expenditures necessary to reach the objectives, for a total amount of 41.15 billion euros:

- Urban and regional mobility (29.7 billion euros): active modes, collective transport, electric buses, urban logistics, etc.;
- The electrification of transports (7.95 billion euros): simultaneous distribution of electrical cars and charging stations with the objectives of 6 million vehicles and 100,000 charging stations in public areas in 2030;
- The safety of road infrastructure (3.5 billion euros).

This plan will not only be used to finance new projects: many of those that were selected had already been evaluated from a technical standpoint and were awaiting financing.

Within the framework of its Mission 3: Infrastructures for sustainable mobility, the plan aims to build a system of modern infrastructures, digitized and ecologically sustainable, between now and 2026. The first of the two components of the mission, Investments in the rail network, will receive 25.4 billion euros to supplement and modernize the main lines of the country, in order to provide rapid mobility which is respectful of the environment and technologically advanced. The territorial dimension is taken into account to reduce the historical disequilibrium between the north of the country and the south.

The use of hydrogen is being considered on a large scale to substitute for diesel for train traction on non-electrified lines, leading to savings in investments for catenaries, as well as for road trucks over long distances. This will require investments in the production of (decarbonated) hydrogen and for its distribution.

In addition, a new Fund for sustainable mobility for the period 2023-2034 was implemented to finance the greening of buses, the purchase of hydrogen trains, the construction of bike lanes, the development of intermodality in merchandise transport, the adopting of alternative fuels for boats and airplanes, the transformation of airports and the replacement of

6 - See Transport / Europe No. 4, September 2021, *From the Covid crisis to recovery plans: stakes and consequences for transport*

road transport vehicles. Half of this will be allocated to cities with more than 100,000 inhabitants.

Lastly, the implementation of a national ecotax is being considered to penalize the most heavily greenhouse gas emitting vehicles, to encourage the shift to clean vehicles, and to finance the development of renewable energies.

Other initiatives are being taken on the local level, such as implementation of an urban toll in Milan, conceived as a congestion tax from which the receipts will go to collective transport, in addition to the tax on fuels charged by the Lombardy region.

We observe lastly that low emission zones and pedestrian streets are now considered normal in Italy and are no longer a source of disputes. However, there is still in this respect a gap between the north and the south of the country, with Milan being the most active city for the decarbonization of its center. As for the large suburbs of cities and sparsely populated areas, the automobile remains the only means of mobility which is really available.

From a transport policy standpoint, the current government is continuing the policies of the preceding one, except for the relaunching the project for a bridge over the Straits of Messina.

**POLAND**

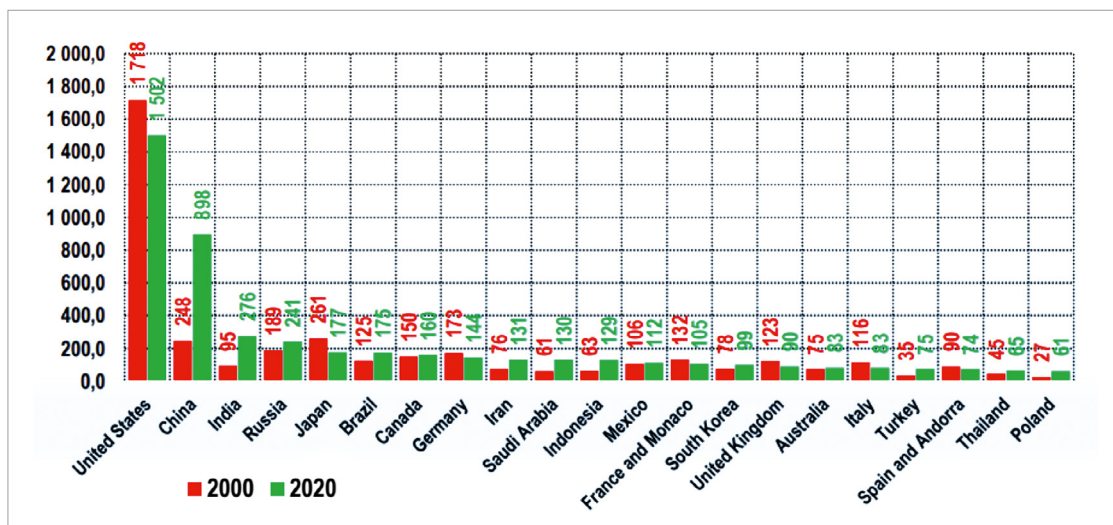
Awareness of the need for decarbonization in Polish society is very unequal. While the scientific and ecologist circles and some business circles are convinced of it, strong reticence remains in the conservative milieux which see in it a threat of impoverishment of the country.

The country's high level of greenhouse gas emissions

is due partly to its historical inheritance of the weight of heavy industry in its economy and the massive use of coal to produce electricity. Recent changes have also contributed to this, particularly **the considerable increase in the greenhouse gas emissions of transport**, of both passengers and merchandise, which have doubled since the year 2000. The share of transport in total Polish emissions rose from 8% in 2000 to 21% in 2020. Road transport accounts for most of these emissions. The improvement of the energy efficiency of automobiles was cancelled out by the increase in traffic and congestion, more frequent solo driving, etc. The Polish truck fleet also has a large place in the road transport of international merchandise within Europe.

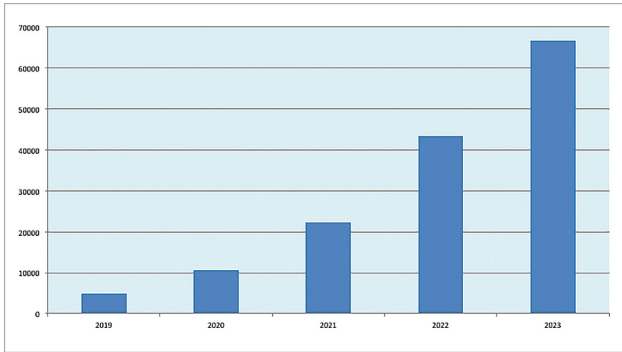
To decarbonize transport, the government does not want to display an alignment with the European Green Deal strategy and its implementation systems. Without having a formal plan, it uses several levers for action simultaneously: technology, standards, user behaviors, reduction of demand, spatial organization, the rationalization of investments in transport infrastructure, market regulation (modal sharing, external effects), etc. We observe the application of four parallel programs.

The program *Mój Elektryk* (My Electrician), started in 2021, receives half of its financing from the European Union and the remainder from the Polish tax on fuels. It aims to subsidize the purchase of electric cars, with a limit of 4,100 euros per vehicle. While still modest compared with other European countries, the Polish fleet of electric cars is growing rapidly.



**Changes in transport emissions between 2000 and 2020 in the highest emitting countries**

Source : Monica CRIPPA et al., [CO<sub>2</sub> emissions of all world countries](#), 2022 JRC Report, Publications Office of the European Union, Luxembourg, 2022



**Number of electric cars (with batteries and rechargeable hybrids) in Poland**

Source : Polskie Stowarzyszenie Paliw Alternatywnych (Polish Association for Alternative Fuels), [Pojazdy elektryczne w Polsce 2019-2023 \(Electric vehicles in Poland\), 2023](#)

Published in 2021, the Polish Strategy for Hydrogen until 2030 (with an outlook up to 2040) aims to use fuel cells (Fuel Cell Electric Vehicle, FCEV) in the field of public transport and heavy and long-distance road transport, along with applications for air, rail, river and maritime transport. Trains running on hydrogen could become attractive for freight and for passengers on the non-electrified regional lines. The number of vehicles running on hydrogen remains very limited, but 32 filling stations will be built between now and 2025 and their number will increase in the years ahead.

The purpose of the Green Public Transport program is to co-finance projects for the reduction of the use of polluting fuels in collective public transport. This can involve the purchase or rental of electric buses using batteries, trolleybuses supplied with electricity by catenaries but equipped with a supplementary propulsion system to continue their routes without electric traction and lastly buses using electricity produced from hydrogen. The program also includes the construction of infrastructure allowing for the use of these vehicles. At the end of 2022, Polish cities had about 800 electric buses, 3,083 tramways and 241 trolleybuses.

The support for infrastructure for recharging electric vehicles and infrastructure to supply hydrogen aims to distribute forms of energy which are alternatives to fossil fuels to reduce the number of vehicles emitting CO<sub>2</sub> and NO<sub>x</sub>, thereby improving air quality. The program allows for the co-financing of the installation of a recharging station with power of at least 22 kW for private use, 22 kW charging stations coupled with public recharging stations, charging stations accessible to the public with power of at least 50 kW, including at least one station allowing for the supplying of a direct current service, and lastly the installation of a public station for the distribution of hydrogen. At the end of 2022, there were more than 2,500 public

stations for electric cars, including more than 1,800 stations for alternating current and about 700 stations for direct current (DC), with more than 4,800 recharging stations in all.

We can consider that, on a global scale, the ban on combustion vehicles in 2035 will be ineffective because it will barely apply outside of Europe, and that it would be more meaningful to limit the mass and power of vehicles. Locally, the Polish Government continues to support the use of coal to produce electricity rather than massively developing solar and wind energy. Things are changing however. Sales of electric cars are increasing and opinion is slowly shifting towards an awareness of the need for decarbonization.

## SPAIN

Spain is continuing its efforts to fight against transport nuisances, but has been condemned by the European Court of Justice for its **excessively high levels of urban pollution**. This public health topic is connected to that of the decarbonization of road transport, whether we consider substitutes for cars or for the decarbonization of cars themselves. With the abandoning of fossil fuels, the decarbonization of road transport is sharply reducing greenhouse gas emissions as well as local pollution and particle emissions. A draft law on sustainable mobility is now under discussion and is focusing particularly on the decarbonization of transport. Ecologist groups consider it too general. In particular, it does not have a part devoted to the financing of the policies thus enacted.

The decarbonization of transports includes several orientations. One of them is support for transport solutions which consume less fossil energy (collective transport and active modes in cities, rail, etc.). Another one is the decarbonization of road transport as such, the largest mode and the one which has the highest greenhouse gas emissions.

A large share of road transport (for both passengers and merchandise) occurs in urbanized zones. The low emission zones aim to restrict access to city centers by the most polluting vehicles, with a progressive knock-on effect on the fleet of vehicles and transport practices in all metropolitan areas. Since January 1, 2023, municipalities of more than 50,000 inhabitants must have a low emission zone, i.e., 149 municipalities in addition to islands, where low emission zones are mandatory, independently of the number of residents. A government decree specifies the demarcation criteria and provides the legal security which the municipalities demand. But so far only about twenty municipalities, including Madrid and Barcelona, have implemented low emission zones. We know that the

implementation of low emission zones without accompanying measures will inevitably have a social discrimination effect, through the eviction of users of automobiles (or utility vehicles) who don't have the resources to purchase a low-pollution vehicle.

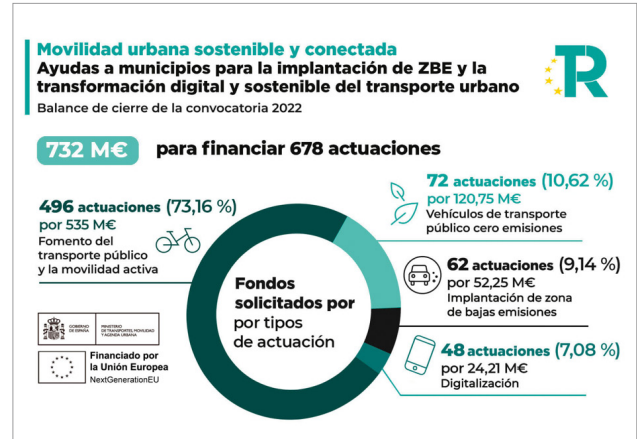
res of support for active mobility, the purchase of zero emission buses and the digitizing of transport.



**Low Emission Zones in Spain (end of 2022)**

Source: Ministry of Transport (MITMA), [www.mitma.es](http://www.mitma.es)

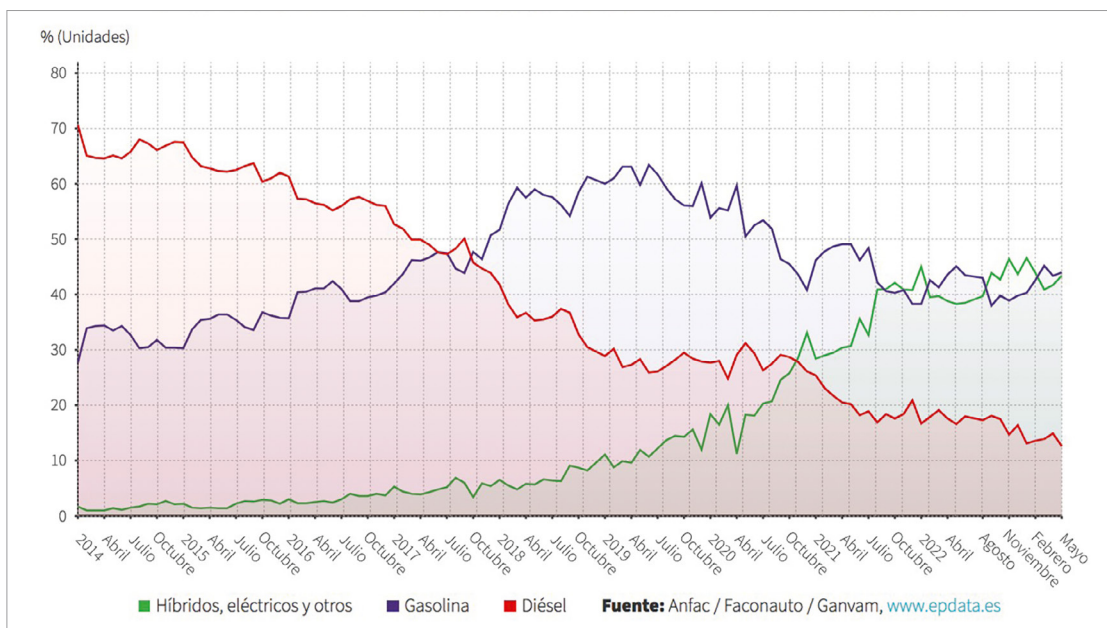
We note that, in its presentation of the implementation of the low emission zones, the Spanish Minister of Transport mentioned that complementary measu-



**Accompaniment of low emission zone implementation (732 M€ of Next Generation EU funds for 678 actions)**

Source : Ministry of Transports (MITMA), [www.mitma.es](http://www.mitma.es)

The electrification of the automobile fleet remains low and we observe a general aging of the cars on the road (the average age is fourteen, versus twelve for the European average): electric vehicles are expensive and there is not yet a sufficiently large used car market. However, we observe an evolution in the structure of the sales, with a decrease for diesel vehicles and hybrid and all-electric vehicles catching up with gasoline vehicles. The objectives set for 2030, both for the number of electric cars and the number of charging stations, will not be easy to reach.



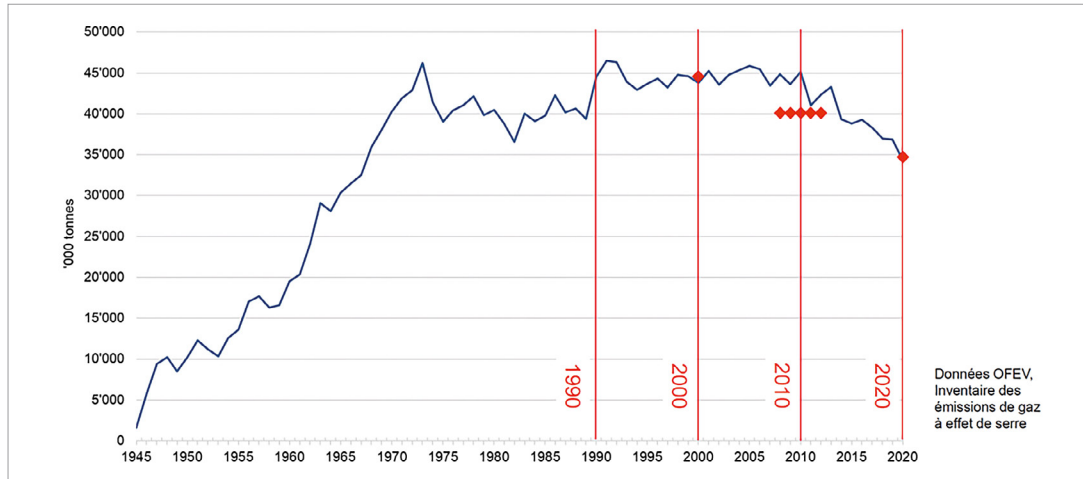
**Evolution of market shares for new cars in Spain by type of driving energy, 2014 - 2023 (March)**

Source : ANFAC (Spanish automobile manufacturers' association), elaborated by Europa Press

**SWITZERLAND**

In terms of greenhouse gas emissions, Switzerland has now returned to its level of 1970. In light of the country's economic structure, transport represents a considerable share of these emissions (41% in 2016, versus 28% as the European Union average<sup>7</sup>) and thus constitutes the first part of a decarbonization policy.

Road transport is within the competence of the Confederation, the cantons and municipalities (they each pay for their roads). Since 1995, the Swiss requirements in terms of exhaust gases have been totally harmonized with those of the European Union. Trucks which emit little pollutants (Euro 6) are put in the most advantageous category of the heavy traffic levy (*redevance poids lourds liée aux prestations*, RPLP), of which the



**CO<sub>2</sub> emissions in Switzerland since 1945**

Source: Philippe Thalmann, *La decarbonization de la Switzerland: où en sommes-nous, et quel chemin reste-t-il à faire?* (The Decarbonization of Switzerland: Where are we now, and what remains to be done?) conference LGT Investorama, May 24, 2022.

To manage this situation and to respect the protocols and agreements that it signed, Switzerland adopted three instruments:

- A climate strategy,
- An energy strategy,
- A law on CO<sub>2</sub>.

These political tools federate all of the institutional levels (from local to federal, in a country which is highly decentralized and attached to bottom-up approaches). The country is a member of international agreements such as the EU Strategy for the Alpine Region (Eusalp, macro-region touching four countries and under the authority of the Council of Europe) and the Alpine Convention (international public law treaty for the sustainable development of the Alps including the European Union and eight countries). At the same time, the cantons can sign agreements with border regions without going through the federal level.

In the field of public transport, the Federal Office of Transport raises the awareness of all actors involved and acts through subsidies to support research initiatives and innovative applications by offsetting some of the non-depreciable costs, in cooperation with the Federal Offices for Energy and the Environment, for all modes of transport.

rate is adjusted to the external effects of road traffic and from which two-thirds of the profits are distributed to the cantons and one third to the Confederation, which reinvests it in large rail projects.

The shift to electrification challenges the traditional breakdown of responsibilities, because the adopting of one or several alternative technologies has a systemic dimension. Reorganizing the value chains involves complex management, especially in a liberal approach, i.e., bottom-up.

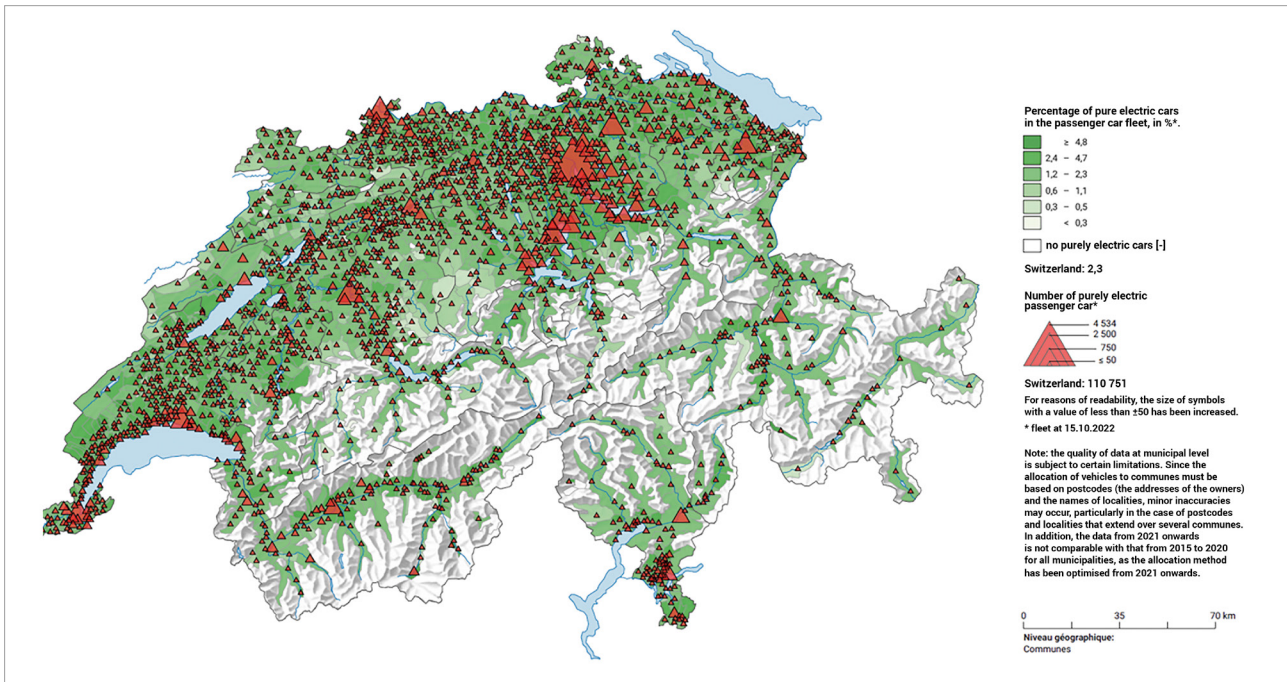
Although such systems are frequent in Europe, there are no low emission zones in Switzerland. However, pedestrian areas with restricted automobile access and speed limits of 30 km / hour in the city, are becoming more numerous. Lausanne now applies 30 km/hour throughout the city from 22:00 to 6:00.

In 2023, electrified cars (hybrids, rechargeable hybrids and all electric) represented 55% of new private car registrations (an increase of 50% compared with 2022). Electric vehicle charging stations are already numerous in large cities. The map of the breakdown of automobile ownership in the country, by type of vehicle, shows both the highly contrasted nature of the population density in the country and the leading role of cities in electrification.

The technologies that could contribute to the decarbonization of road transport are far from having reached

7 - Source: Ph. Thalmann, M. Vielle, *Lowering CO<sub>2</sub> emissions in the Swiss transport sector*, Swiss Journal of Economics and Statistics (2019) 155:10





**Distribution of electric vehicles in Switzerland**

Source : Swiss Federal Statistical Office, Share of purely electric cars among passenger cars, as a percentage, carte interactive.  
[https://www.atlas.bfs.admin.ch/maps/13.353/map/mapIdOnly/26674\\_fr.html](https://www.atlas.bfs.admin.ch/maps/13.353/map/mapIdOnly/26674_fr.html)

their limits. Batteries, in particular, already represent substantial markets and intense research on them is now underway. We must hope that the gigafactories now being built will not freeze technical progress. Other approaches are being actively explored, such as bio-fuels, hydrogen as a fuel (of which the NO<sub>x</sub> emissions can be substantially reduced in combustion of hydrogen in an engine), hybridization, etc. For the moment, these solutions are significantly more expensive than the traditional solutions.

The technologies that could contribute to the decarbonization of road transport are far from having reached their limits. Batteries, in particular, already represent substantial markets and intense research on them is now underway. We must hope that the gigafactories now being built will not freeze technical

progress. Other approaches are being actively explored, such as bio-fuels, hydrogen as a fuel (of which the NO<sub>x</sub> emissions can be substantially reduced in combustion of hydrogen in an engine), hybridization, etc. For the moment, these solutions are significantly more expensive than the traditional solutions. Keeping in mind that the first parameter on which to act is the number of vehicles, it is necessary to experiment with several technological approaches, including orientations that have thus far been ignored. Both financial and industrial agility are need for this, public and private. The approach must consider carbon assessments in their entirety (life cycle assessment), the development of the recycling and retrofitting of old vehicles, in a circular economy vision. The environmental stakes thus require an interdisciplinary, integrated and participatory approach.

	Diesel	Battery	Bus (fuel cell)	Hydrogen-powered bus
Purchase price (CHF)	500 000	935 000	1 300 000	700 000
Operating time (years)	12	12 (vehicle) 6 (battery)	12 (vehicle) 6 (battery)	12
Conso. (/100 km)	43.5 l	340 kWh	12 kg	14 kg
TCO (10 years) <b>Current situation</b>	1 820 000	3 050 000	3 130 000 - 3 450 000	2 480 000 - 2 860 000
TCO (10 years) <b>Projection 2025</b>	1 820 000	3 050 000	2 880 000 3 230 000	2 190 000 - 2 600 000
TCO (10 years) <b>Projection 2030</b>	1 820 000	3 050 000	2 720 000 2 990 000	2 010 000 2 320 000
TCO (10 years) <b>Projection 2050</b>	1 820 000	3 050 000	2 720 000	2 010 000

**Total cost of ownership (TCO) of regional transport buses depending on the energy chain used**

Source : N. Monney, L. Andrès, C. Nellen, Motorisation à l'hydrogène des bus de transport public, *Rapport final du projet P-155*, Office fédéral des transports, 25.02.2022, p. 31.