



TRANSPORT / EUROPE #6

DECARBONIZING TRANSPORT, AN ESSENTIAL GOAL

The issue of the decarbonization of transport is essential today and it will be for many years to come. It is a goal to be achieved taking into account the constraints of technical feasibility, cost, social and political acceptability, etc. In its session of July, the OPSTE (Observatoire des Politiques et Stratégies de Transport en Europe / Observatory on Transport Policies and Strategies in Europe) is aiming to compare how the issue of the decarbonization of transport is being addressed in different countries, considering the transport system as a whole, in order to identify similarities and differences and also to see how the national approaches are connected with the European transport policy, which is structured around the European Green Deal.

EUROPEAN PANORAMA

While today it has reached a new intensity, the search for “sustainable mobility” is part of an already long history of international climate agreements¹, even though it is regrettable that there are still too often declarations of intent with not enough concrete actions.

Greenhouse gas emissions in Europe

On the scale of Europe, European countries are in very different positions with regard to Greenhouse gas emissions and transport’s share in their generation, depending on their productive specialization (the share of industry compared with services, in particular), the way in which electricity is produced, the intensity of transports and their breakdown between the various modes, etc. While the average is 7.5 tons of total emissions per year and per inhabitant, the differences range from 4.5 to 17 tons.

An already long history of climate agreements

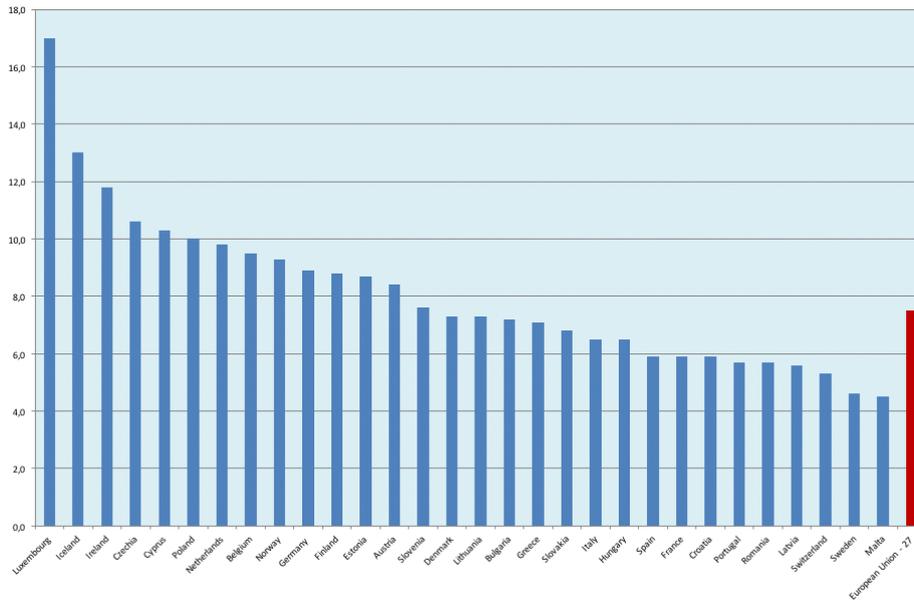
- United Nations Framework Convention on Climate Change of 1992 (UNFCCC),
- Kyoto Protocol of 1997,
- 2015 Program – Transforming Our World: the UN 2030 Agenda for Sustainable Development,
- European plan on climate change of December 2008,
- Green Deal for Europe of December 2019, followed by the Strategy for Sustainable and Intelligent Mobility (December 2020),
- The *Fit for 55* climate package, a set of thirteen legislative proposals published in July 2021,
- Ban on the sale of new combustion vehicles after 2035 adopted in June 2022 by the European Parliament and by the Council²,
- Without forgetting the initiatives of international NGOs pushing for more radical actions...

1. The agreements themselves were preceded by scientific thinking with, for example, the Meadows report *The Limits to Growth* of 1972 or the report of the National Research Council of 1979: *Carbon Dioxide and Climate: A Scientific Assessment* (<https://doi.org/10.17226/12181>).

2. The trilogues (negotiation meetings between co-legislators to produce a common final text) will be held in the second half of 2022.

Greenhouse gas emissions per inhabitant in Europe, 2020

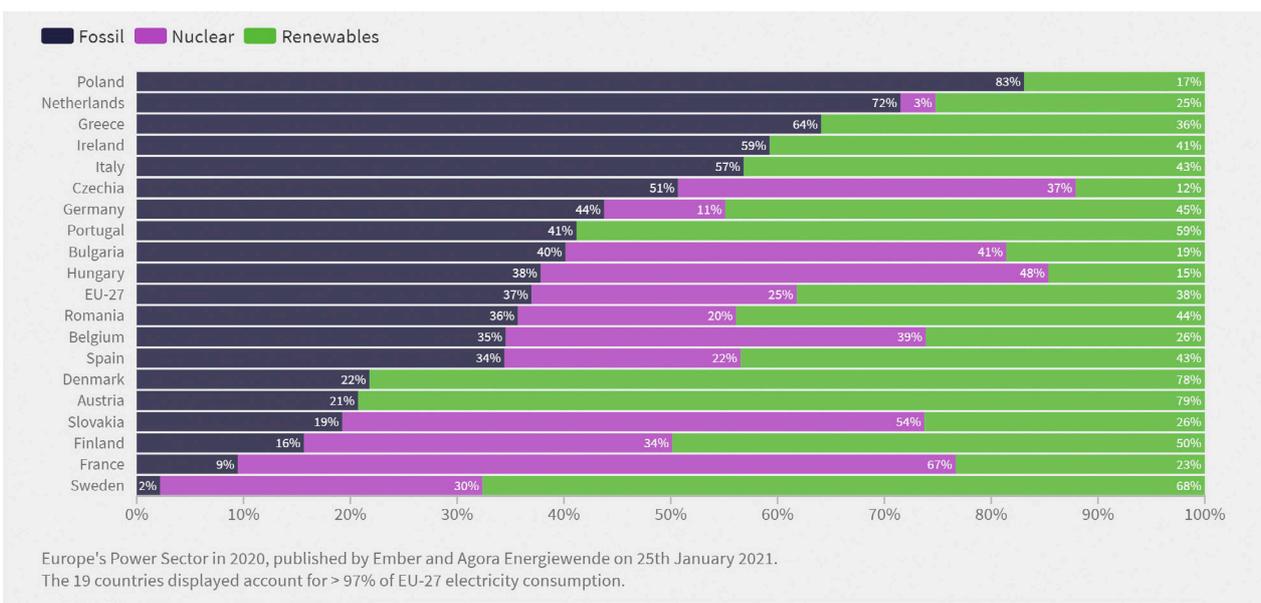
Source: Eurostat, 2022.



How should imported emissions be taken into account? According to the international climate agreements, producing States are responsible for their emissions (would China allow foreign countries to intervene on its territory to reduce emissions?). This issue cannot however be neglected by European countries, and the **Carbon Border Adjustment Mechanism (CBAM)**, which is among the legislative proposals of the Fit for 55 package now in negotiations, is, on the one hand, a tool in the fight against environmental dumping on the international production and trade of products and on the other hand an

incentive to relocate in Europe a share of the delocalized activities, in order to reduce the overall emissions but also to reconquer economic sovereignty over certain sensitive products.

Among the factors that determine the differences between the emissions of one country and another, we have the technique of electrical energy production, which is very unequally decarbonized. This factor is all the more important precisely because many people believe that the decarbonization of transport will occur through the substitution of electricity for fossil fuels: but this electricity must be “green!”



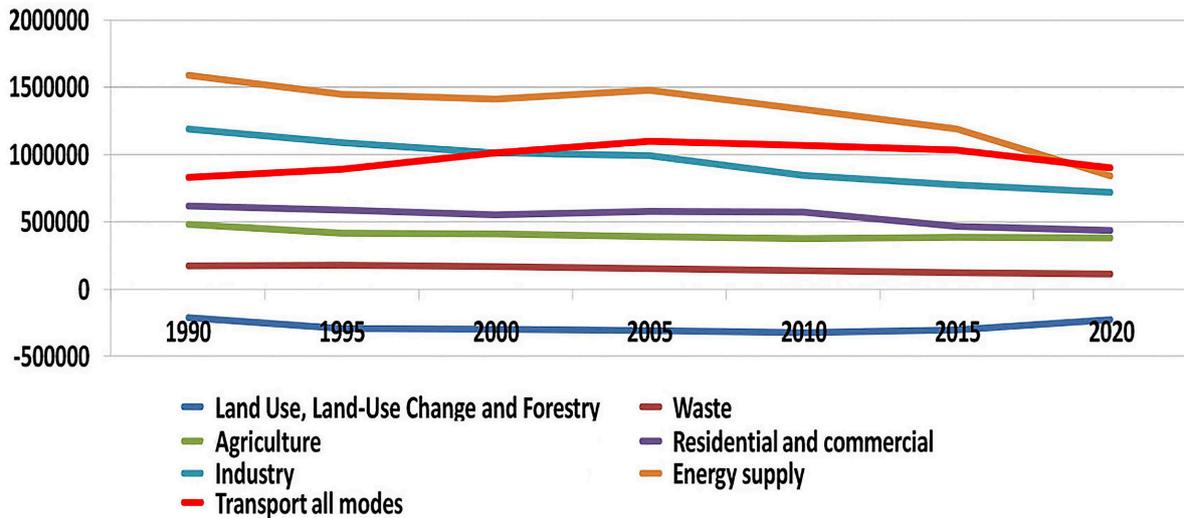
Electricity Mix in Europe (2021)
Production of electricity from fossil, nuclear or renewable energy

Source: The European Power Sector, Ember, 2021.

Greenhouse gas emissions of transport systems

In all cases, transport has a major place in decarbonization policies as it accounts for between 20% and 30% of total emissions depending on the European country, without counting the emissions linked to the

construction and upkeep of infrastructure, vehicles and batteries, the production and supplying of energy, etc. On the scale of the European Union of 27 members, transport is now the number one source of greenhouse gas emissions, ahead of energy production and industry.

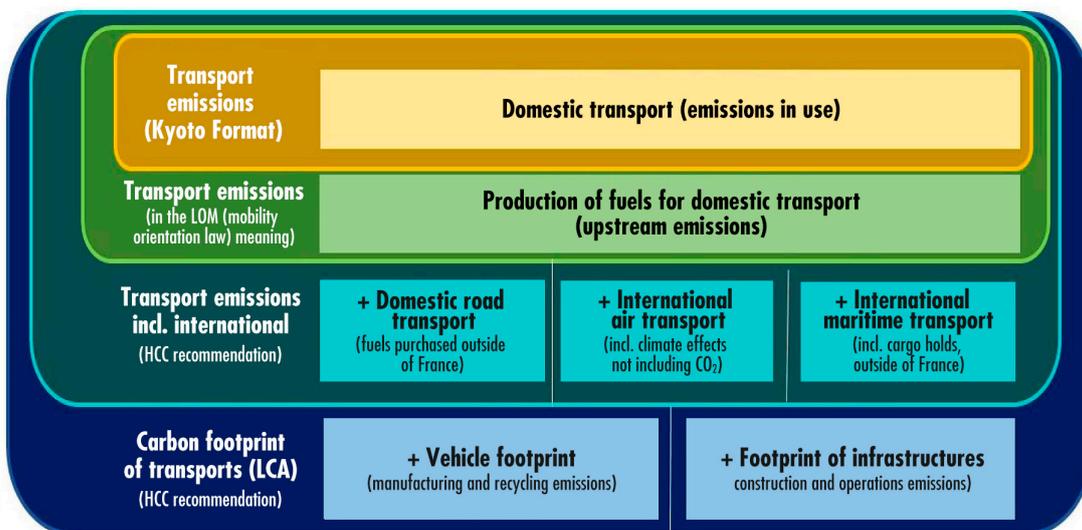


Greenhouse gas emissions in Europe (EU 27) by activity, 1990-2020

Source: AEE (transport all modes: domestic + international air + international maritime)

However, there is some uncertainty about the available data, especially for international comparisons, because the perimeter taken into account to measure the greenhouse gas emissions of transport can change considerably depending on whether we consider only the direct emissions of transport on the national

territory, we add in the emissions linked to the production of fuels, we take into account fuels purchased outside but consumed on site, or lastly that we do a life cycle assessment (LCA) including the manufacturing and recycling of infrastructure and transport equipment.



Carbon footprint of transport, from direct use to life cycle assessment

Source: CGEDD-France-Stratégie, 2022.

In fact, the issues are quite different for passenger transport and transport of goods, which now represent respectively two thirds and one third of transport emissions. These proportions should change in the future, partly because the possibilities for changes of behavior and alternatives to cars are greater for travelers (ridesharing, public transportation, active modes, etc.) than the alternatives to trucks for goods, and because the technical solutions to reduce the carbon footprint are currently more developed for automobiles than for trucks. The emissions of trucks and small vans (light commercial vehicles) are expected to exceed those of automobiles. Furthermore, with the progressive abandoning of fossil fuels and based on an analysis of the life cycle, the footprint of the manufacturing of vehicles and batteries should eventually exceed that of traffic in the strict sense.

Approaches to the decarbonization of transport

Before we even begin to analyze the means to accomplish the decarbonization of transport, a recent prospective study³ indicates that there is no inevitability, i.e., that there is substantial room for maneuver and that carbon neutrality in 2050 is not a pipe dream (although the steps to be taken may not be easy to accept or to finance!). The following graph presents long-term projections for France for transport emissions (travelers and goods) according to contrasted hypotheses: from laissez-faire with no action on transport volumes or transport techniques to the most proactive scenario of carbon neutrality (setting as a principle the achieving of a volume of emission compensated by the share of the carbon sink attributed to transport) and including greater or lesser intensities in the modification of transport behaviors or techniques. The spectrum of the final images is very broad:

it means that a determined and stubborn action can (must!) bear fruits.

The decarbonization of transport will involve several parallel actions, of different natures but ones that can be combined. Firstly, **a modification of behaviors** for better use of the existing means in terms of energy efficiency (increasing the number of passengers per car, filling trucks better, etc.), when possible, choosing public transportation over individual cars and for freight choosing rail or boats over trucks and even shortening or abandoning certain journeys. In a simplistic manner, all of these measures come under the umbrella of “sobriety.”

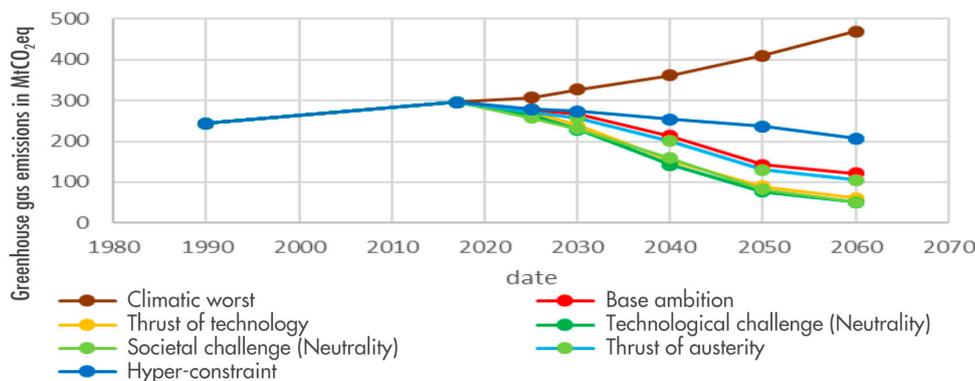
The difficult translation of the concept of “sobriété”

The notion of “sobriété”, when it is applied to energy consumption or transport, does not seem to have an exact equivalent outside of France. Translating it into English is not so easy, but some possibilities could be: “Sobriety,” “sober use,” “austerity,” “conservancy,” “moderation,” and “temperance.”

This concept includes ways of avoiding or reducing energy expenses, whether through technical and industrial improvements or through changes in individual or collective behaviors. For example, we can choose to travel using a low-emission vehicle, such as an electric car or a train, we can combine two trips to reduce the total distance travelled, or we can choose not to make the journey in question at all.

The concept of “sobriété” is a subject of political debate within France itself. We want to consume less, but how do we do that?

On the other hand, a technical evolution allowing for the intrinsic improvement of the performance of transport equipment (lower consumption of cars and trucks through improvement of the aerodynamic profile, tire friction, drivetrain, speed adjustment, etc.).



Emissions of traveler and goods transport, all modes (ground + air + sea), France, life cycle assessment

Source: CGEDD-France-Stratégie, 2022.

3. Prospective 2040-2060 of transports and mobility, General Commissariat for Ecology and Sustainable Development and France Stratégie, 2022.

This type of incremental improvement (partially cancelled out by the trend to increasingly heavier vehicles) has a quasi-permanent nature and has not exhausted itself. However, it cannot allow us to reach the objective of drastic reduction of greenhouse gas emissions that the strategy of the fight against climate change implies. A radical (“disruptive”) change is necessary, which consists of abandoning the use of fossil fuels through an energy transition. All of these measures come under the heading “**progress through technology.**”

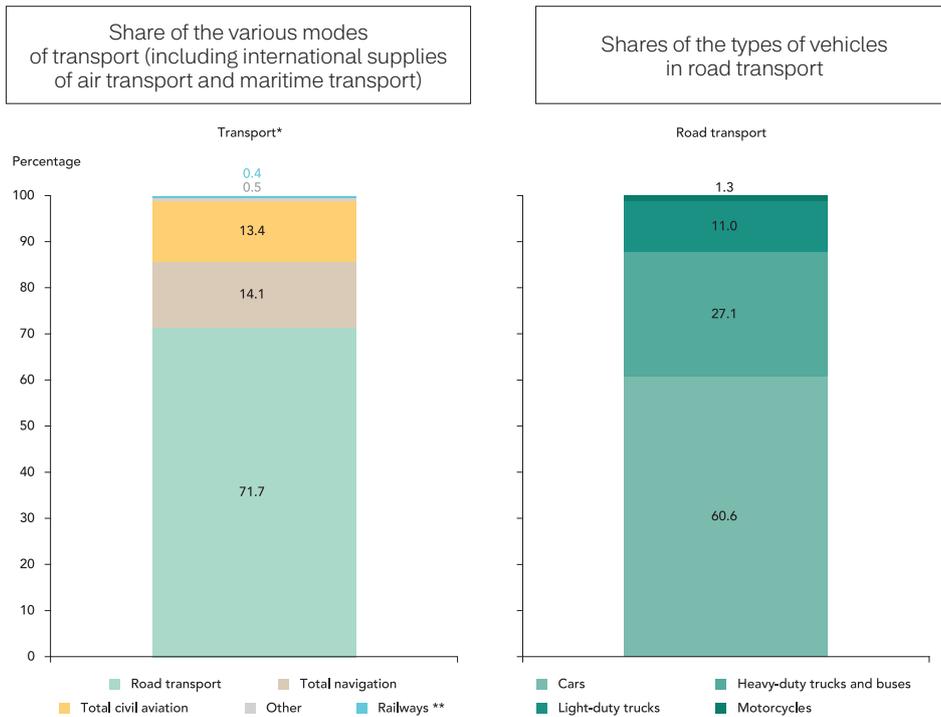
This dichotomy is simplistic. For example, the development of the use of public transportation and active modes will be facilitated by systems for information and organization of journeys from one end to the other of the MaaS (*Mobility as a Service*), which is highly technological. It nevertheless organizes a certain ideological and political break in public opinion, between the supporters of “sobriety” who want to bring into question a whole mode of living with consumption and the damage to the environment that accompanies it, and the supporters of technical progress who hope that effective responses will be available without disrupting everything. We can also imagine that it is possible to combine moderation and technical progress!

Decarbonizing transport as such means firstly decarbonizing road transport which represents the largest

share of greenhouse gas emissions: 72% of the total in the 27 EU countries in 2019 (considering the international supplying of maritime and air transport).

There are three policy levers to decarbonize road transport: support for the production of electrical vehicles, support for their purchasing and use, and implementation of an adequate network for the supplying of electricity.

The automobile industry, on the European and world scale, is in the midst of a transformation. There are investments of hundreds of billions of euros. After more than a century of exclusive use of fossil energy in combustion engines, electricity’s time has come. This has radically changed the situation for the entire design of vehicles, their manufacturing techniques, and the economy of their industry: closing of units for the production of engine blocks, gear boxes, exhaust systems, etc., and conversion or transfer to units for the production of electrical components (adapted engines and transmissions) and, a still more disruptive element, electric batteries. The public authorities support the industry in different ways: subsidies for research and innovation, low-interest loans, taking of holdings in the capital of companies. The European Union has returned to the notion of industrial planning with its support for the development of an electric battery construction sector to escape the domination of Chinese industry.



Greenhouse gas emissions of transport in Europe (EU 27) in 2019

Source: European Agency for the Environment, Transport and Environment Report 2021, 2022.

For the time being, while awaiting the economies of scale of mass production, electric vehicles are more expensive than combustion vehicles, even though their marginal cost in use may already be lower (because of the taxes on fossil fuels, and not on electricity in comparable proportions, as well as the lower upkeep costs). As a result, the traffic restrictions which affect the most polluting vehicles, in particular with the mechanism of low-emission zones (zones implemented in the large cities of several European countries: Germany, Belgium, Spain, France, Italy, The Netherlands, Portugal, United Kingdom, etc.) can have a strong social discrimination effect, with the poorer populations not having the means to change vehicles, all the more so because the market for used electric vehicles is still in its infancy. Aid for purchases can take the form of subsidies (premium), in contrast to the surcharges on the most CO₂ emitting combustion vehicles, as well as particular favorable terms for driving and parking. At a time when long-term rentals often substitute for the purchase of new vehicles, some governments are announcing the implementation of leasing accessible to low-income users.

Except for non-rechargeable hybrid vehicles (a transition formula which should eventually disappear), electrical vehicles need electrical recharging. The implementation of a network of charging stations, keeping up with the pace of the sale of electrical vehicles, is thus a necessary condition for this conversion. This brings us to infrastructure policy and regulations, involving public and private actors. In particular, the European Commission proposed within the framework of the *Fit for 55* package (through the draft regulation on the deployment of alternative fuels infrastructure, called the Afir regulation, of which the provisions are included in the new regulations on the Trans-European Transport Network, or TEN-T) a minimum level of equipment along the TEN-T corridors and called for considerable investments.

Before this decisive phase, electricity must be available in sufficient quality, at an affordable price and it must be decarbonized. **The comprehensive energy strategy** of governments is involved because, while the total consumption of energy is expected to decrease, electricity consumption will necessarily increase. What is the best mix of electricity production for transports, as well as for heating buildings, industries and services, etc.? The political positions are sharply contrasted between the adversaries of nuclear energy (all based on renewable energies) on the one hand, and partisans of a mix combining nuclear

and renewable sources on the other. Furthermore, if the production capacity is sufficient overall, the energy must also be distributed over the entire territory and continuously, through the inter-regional high-voltage distribution network but also through the local network (for the installation of rapid charging stations for trucks, in particular). In this case as well, there will be dozens of billions of euros in investments.

Such a transformation, urgent though it is in the face of climate disruption, will be spread over the course of a number of years. While the European Parliament and the Council voted⁴ to ban the sale of new combustion vehicles as of 2035 (a date which representatives of the automobile industry consider premature), the number of such vehicles in service will only disappear progressively (with the exception of collections of old cars). However, while the electrification of the automobile seems to be the strategy adopted henceforward by the majority of manufacturers and public authorities, technical uncertainties remain regarding the solutions adapted to road trucks and other modes (water and rail). Furthermore, the rhythms of change differ greatly from one solution to another: it is easier to install bike lanes in cities than it is to renovate a rail network.

The transition scenarios proposed by governments involve modes of transport and transport distances on the one hand, and sources of energy on the other (electricity by battery or by catenary, biofuels, biogas, hydrogen). While some options thus seem to be stabilizing, there is still an intense search for solutions which are more innovative but still far from the operational stage: transport in vacuum tubes (Hyperloop), very light vehicles (between bicycles and cars), use of hydrogen as fuel in combustion engines⁵, etc.

Moderation and technology

The other approach, complementary to technological change, involves reinforcing the use of **alternative solutions to road transport**, especially the individual car (the occupancy rate of cars for commuting journeys is on average 1.1 to 1.2 occupants per vehicle in Europe, but it is higher for journeys for other reasons, particularly leisure). The main solutions are as follows:

- First, the development of public transportation (with a very wide range covering several distances and serving various types of territories, ranging from group taxis upon request to heavy trains for metropolitan area networks). Rail, in particular, has a good image and substantial financing for its improvement has been announced here and there and particularly in Germany and in Italy.

4. Still subject to the conclusion of the trilogues.

5. On July 15, the European Commission approved an Important Project of Common European Interest (IPCEI) aiming to support research and innovation as well as the first industrial deployment in the hydrogen technology value chain, jointly elaborated and notified by fifteen Member States.

- Ridesharing improves the use of cars and is worth encouraging and organizing.
- For short distances and particularly in urban areas, soft modes (walking, bicycles – traditional and electric) have been developing substantially (in particular since the Covid crisis⁶).
- Teleworking, which also developed considerably during the pandemic, decreases commuting (but can free up time for other journeys, or lead to a transfer from collective modes to cars if it allows certain workers to leave dense cities).
- Lastly, in the longer term, a new territorial development could favor the establishment of housing, employment and services in areas that are well-served by public transportation and soft modes.

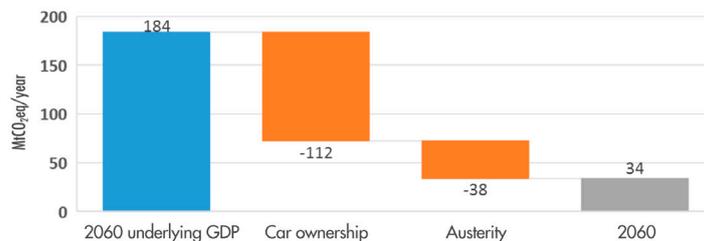
In the recent prospective thinking of the French government that was already mentioned⁷, there was an evaluation of the margins of progress offered by technical change on the one hand, and moderation on the other. According to these estimations, the contributions of moderation for journeys for people are on the order of 25% of the reductions targeted (38 million tons of CO₂ per year out of 150), more than for goods for which they are said to be only 7% (9 million tons per year out of 124).

Uncoupling transport and environmental nuisances: the case of freight

In order to uncouple freight transport and environmental nuisances, we must combine efficiency (logistical management in the optimization of goods circuits and the use of resources) and technology (improvement of the energy efficiency of combustion vehicles, transition to the use of decarbonized energy). We can:

- Decrease certain quantities transported (lightening products and packaging, drinking tap water rather than bottled water), i.e., acting on **tonnages**,
- Limit transport distances by choosing closer suppliers and consumers, i.e., acting on **ton-kilometers**,
- Use larger capacity vehicles, filling them better and limiting empty journeys, i.e., acting on **vehicle-kilometers**,
- Improve the energy efficiency of means of transport, including transfers to less consuming modes such as water and rail transport, without forgetting the cargo bike for urban logistics, and thereby acting on the **tons of CO₂ and local pollutants** per ton-kilometer transported,
- Lastly, radically change the **nature of the energy** consumed and no longer use fossil fuels: electricity, hydrogen, biofuels, etc.

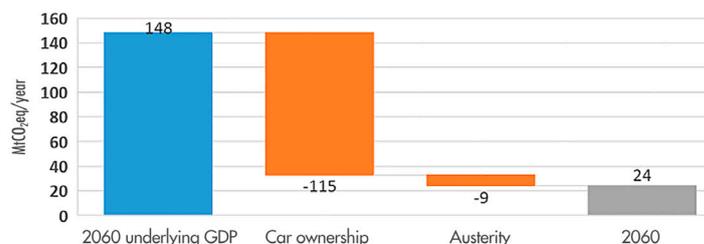
Efforts for reduction in LCA of greenhouse gas emissions of ground transports of passengers in the Base Ambition scenario



Reduction in life cycle assessment (LCA) of greenhouse gas emissions of ground transports of travelers (France)

Source : Prospective 2040-2060 of transports and mobilities, 2022.

Efforts for reduction in LCA of greenhouse gas emissions of ground transports of goods in the Base Ambition scenario



Reduction in LCA of greenhouse gas emissions of ground transport of goods (France)

Source : Prospective 2040-2060 of transports and mobilities, 2022.

6. See: <https://tdie.eu/transport-europe-bulletin-3-covid-19-crisis-and-transport-in-europe/>, bulletin *Transport/Europe* n° 3, June 2021.

7. *Prospective 2040-2060 of transports and mobilities*, General Commissariat for Ecology and Sustainable Development and France stratégie, 2022.

National policies and European framework

Such a transformation deserves the adjective systemic because it changes at the same time the instruments of transport (infrastructures and equipment), the practices and the economy of mobility and logistics, the energy policy as a whole, and of course the political, legislative and financial framework allowing for the accomplishing of these changes in a socially acceptable manner.

An example of a knock-on effect of the decarbonization of transport is its predictable effect on public finances. In the short term, the support for this transformation is mobilizing substantial public funds, whether in form of investments, subsidies or incentives, loans, etc. In the longer term, the tax resource that fossil fuels represent today will eventually decrease and disappear: What will it be replaced with? Not necessarily by a tax on electricity, at least for a while, if indeed we want to promote its use to substitute for fossil energies.

Tax revenues on fuels and public budget: the case of France

In France, in 2020, the tax on fuels (TICPE, domestic tax on the consumption of energy products) brought in some 26 billion euros to the government budget, without counting the value added tax which applies in addition to this tax (although companies can be partially reimbursed for this). By way of comparison, the transport investments of central and local public authorities represented 18.6 billion euros for the same year.

Source: *Bilan annuel des transports 2020*, Ministry of the Ecological Transition, 2021.

A long-term political process has thus been implemented, in each country according to its institutions, its democratic practices and its political situation, all the more so because the topics linked to decarbonization are frequently controversial and, according to the current expression, “divisive,” even though climate change affects all categories of the population and although climate skepticism positions are now very much in the minority: the place of nuclear energy in the energy mix, the place given to sobriety or to technology in the progress to be accomplished, the unequal social consequences of the rise in energy prices or the use of automobiles and offsetting mechanisms to be implemented for low-income people who are dependent on automobiles (what should be the



compromise between concerns about the end of the world and the end of the month, according to the expression that appeared during Yellow Jackets movement in France?), the place given to market mechanisms to promote electro-mobility, etc.

We note, and despite the pedagogical efforts of various economists, a broad reticence of opinion to the use of price signals as an effective instrument for incentive to change behaviors to best integrate the social cost of carbon. While it seems difficult not to act on energy prices, the purchase and the use of vehicles and the use of infrastructures, **a clear signposting of the allocation of the funds** thus collected to support the transition towards sustainable mobility (contrary to the principles of unicuity and annuality of the public budget) is a condition of their social and political acceptability.

In each country, in one way or another, proactive scenarios for the reduction of greenhouse gas emissions, particularly from transport, were established and received political approval: the goal of carbon neutrality in 2050, the basis of the Green Deal for Europe, is henceforth legally binding (regulation concerning the “European Climate Law” adopted in 2021). But it still needs the means for its implementation.



In Germany for example, the national climate protection law aims to have the current generations take on the responsibility for future generations. It sets as a goal a 65% reduction of greenhouse gas emissions by 2030 with reference to the situation of 1990. We note that, since 1990, transport emissions in Germany have stagnated, although they decreased for the other sectors.

In fact, a complex approach, both technical and political, is necessary, sometimes prepared with consultative work involving civil society, but its legitimacy can then be challenged in the face of the legitimacy of the elected parliamentary bodies. This approach combines prospective thinking exploring the field of long-term possibilities, technical-scientific evaluations of issues and possible solutions (in technical as well as economic and social terms), overall plans for energy and climate issues, more in-depth and detailed sector approaches for certain activities (energy, transport, etc.), planning and financing laws, without considering the interventions of European bodies, particularly through the Recovery and Resilience Plans.

Limiting ourselves to the example of Spain, we see for the recent period the *2021-2030 Integrated National Energy and Climate Plan* adopted by the government in March 2021, the *2050 Long-Term Decarbonization Strategy*, published in 2020 by the Ministry of the Ecological Transition and Demographic Challenge, the *Climate change and energy transition law* voted in May 2021, and the *2030 Safe, Sustainable and Connected Mobility Strategy* which led to an *preliminary draft law* which entered the debate as of March 2022. There are also the initiatives of the autonomous com-

munities, for example the Catalan objective of a “5 C” mobility: *Compartida* (shared), Collective, Connected, deCarbonized and managed by Catalunya, and local authorities.

Lastly, comparison of the countries of Europe shows the **effect of synchronization and convergence of EU decisions on national decisions** (except of course for Switzerland, which is nevertheless demonstrating a strong commitment to decarbonization). The consideration of environmental and climate issues by the European Union already has a long history. For a long time, it even constituted, alongside to the opening of the transport markets to competition, one of the two major orientations of the common transport policy. Moreover, it is the European Union which is negotiating the proposals of the COPs on behalf of the Member States⁸ and which has the responsibility for defining the procedures for implementation of the signed agreements. The European Union is thus playing a prescriptive role in terms of decarbonization following the Paris Agreement (the Member States do not negotiate, but they ratify the agreement).

- Over the years, the European orientation, combining proposals, regulations and directives, regulatory meetings, and financial incentives, brought together and led to convergence of the initially heterogeneous positions, and in some cases reserved or reticent positions, of the national governments. It was a three-way process, with the Parliament being generally more receptive to the proposals of the Commission than the Council, before reaching a series of compromises which, over the long term, traced an undeniable trajectory:

⁸ Conference of parties which brings together every year the signatory countries of the United Nations Framework Convention on Climate Change: UNFCCC.

- In 1992, the Commission published a Green Paper on the impact of transport on the environment: an EU strategy for the development of transports that are respectful of the environment,
- In 2007, following it a Green Paper Adapting to climate change in Europe,
- The Climate and Energy package, adopted in December 2008 and revised in October 2014, aimed to implement a common policy in terms of energy and the fight against climate change, recommending in particular a 20% decrease in energy consumption, a 20% rate of renewable energies in energy production, and an average emission level of 95 g CO₂/km for new vehicles,
- In 2018, the Parliament and the Council adopted the Clean Energy Package for all Europeans setting at 32% the share of renewable energies in the European energy mix in 2030, and a reduction of consumption in the same proportion as of the same date,
- Lastly, the Green Deal is a strategic document immediately presented as the framework of European policy as of 2020,
- It was materialized by a package of legislative proposals (*Fit for 55*). Substantial financing was allocated to it, in particular through the national recovery and resilience plans. These were approved after analysis of the European Commission by ECOFIN (Economic and Financial Affairs Council) bringing together the 27 Ministers of Finance of the European Union, and set a minimum proportion allocated to green investments (37%) and benefit from financing from the European recovery plan *Next*

Generation EU in addition to national financing. However, and given the numerous difficulties to be overcome, will the proactive objectives set on the national and European levels (*Fit for 55*) be reached?

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**MINISTÈRE
 DE LA TRANSITION
 ÉCOLOGIQUE
 ET DE LA COHÉSION
 DES TERRITOIRES**

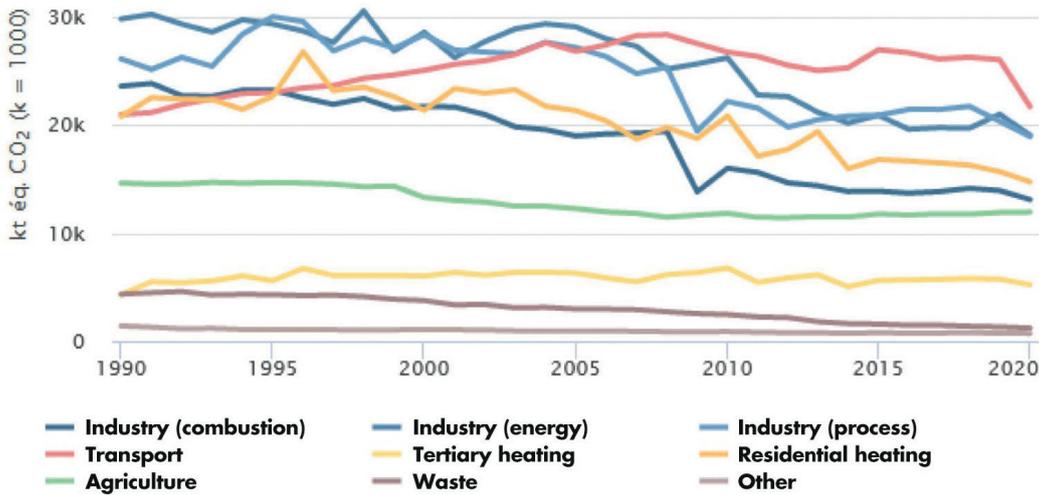
*Liberté
 Égalité
 Fraternité*



BELGIUM

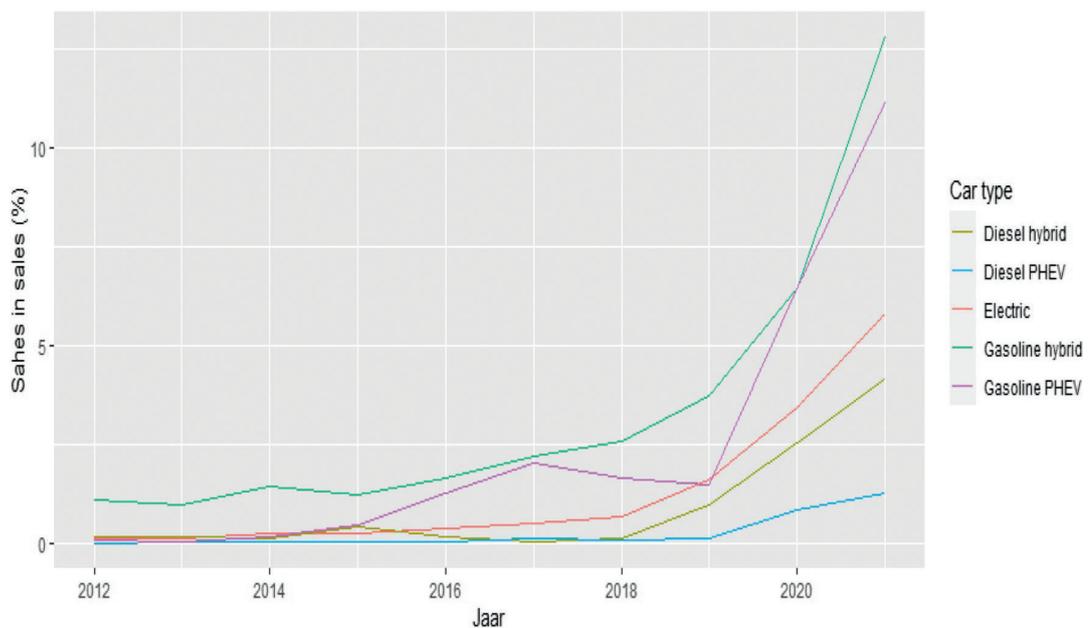
Over the years, transport has become the number one source of greenhouse gas emissions in Belgium with 20% of emissions in 2020 versus 14% in 1990. Over this period, the number of road vehicles increased by 66%,

traffic by 49% (in vehicle-kilometers) and freight transport by 112% (in ton-kilometers), along with an increase of average capacity engine vehicles. This resulted in an increase in greenhouse gas emissions of 25%.



Evolution of greenhouse gas emissions (1990-2020)

Source: climat.be

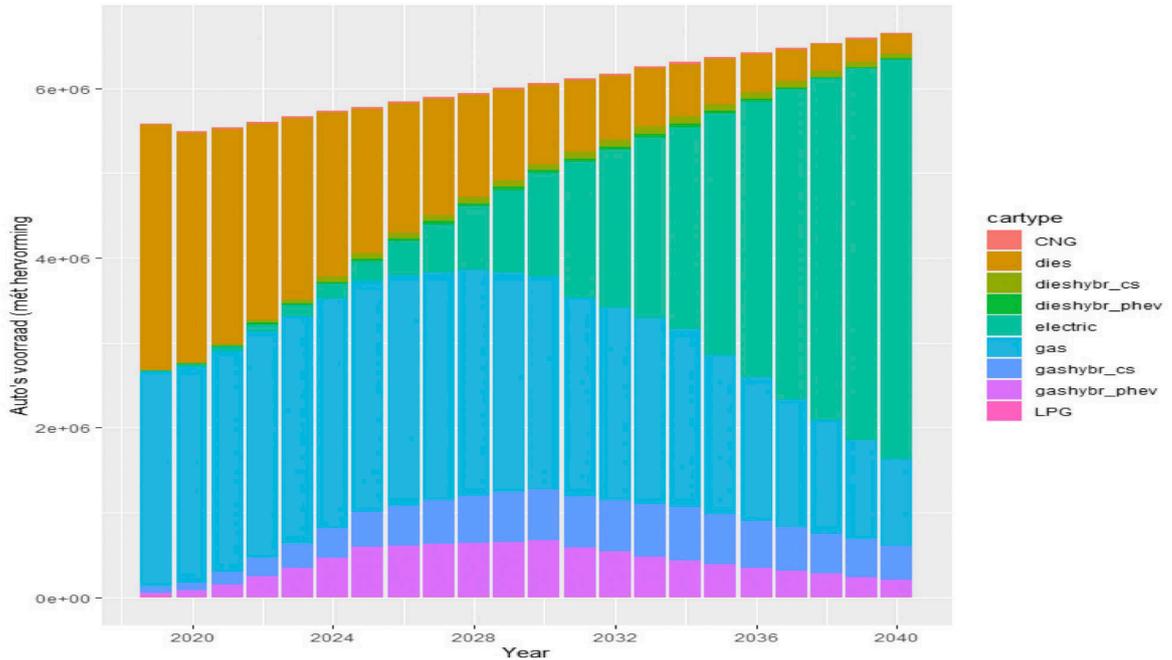


Sales of electrical vehicles

Source : Federal Public Mobility and Transport Service.

Sales of low-emission vehicles recently took off for fully-electric cars, rechargeable hybrids and hybrids. Eventually, a radical change in the proportions of ve-

hicles is expected, with the extinction of combustion engine cars and the development of hybrid and then entirely electric vehicles.



Composition of the vehicle fleet by 2040

Source : Bureau fédéral du plan.

According to these projections, the breakdown of emissions due to transport should change substantially, with the emissions from freight exceeding those of transport of people by 2040, or in other words the emissions of trucks and small vans will exceed those of automobiles.

These downward projections are part of a political will which is well shared between the federal level and the regions to decrease transport emissions. The country now has a National Energy–Climate Plan and a national recovery and resilience plan (compliant with the European framework), as well as agreements of national and regional governments.

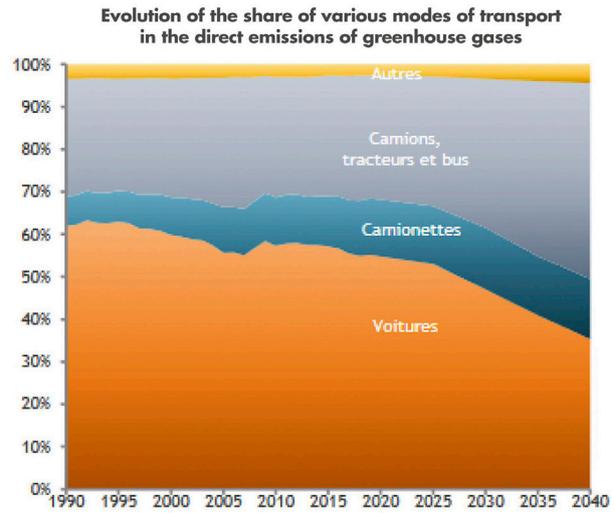
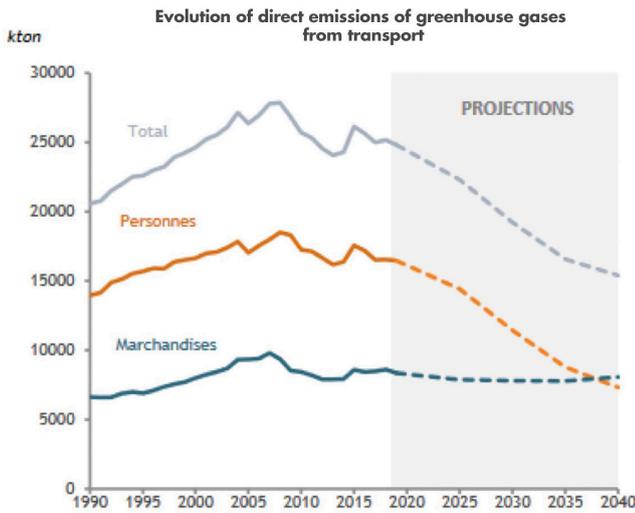
The **National Energy and Climate Plan**, for fields relating to transport, aims for:

- Reducing the demand for mobility (through behavioral and cultural changes and territorial development),
- Steering the development of mobility, by investing in a multimodal mobility system and promoting modal transfer through the improvement of public transportation and facilitating soft mobility (walking, bicycle),
- Progressively decarbonizing road transport thanks to low-emission technologies.

On the federal level, the objective is thus decarbonization and decreasing of negative externalities (envi-

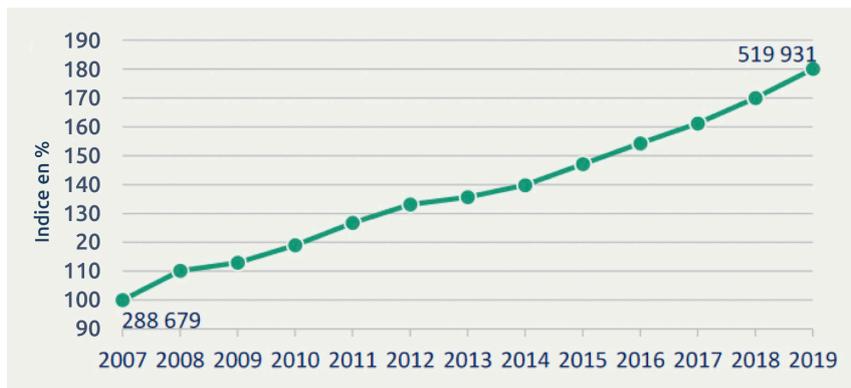
ronmental and societal) of mobility in Belgium, facilitating and regulating alternative fuels such as biofuels and establishing an inter-federal cooperation agreement on mobility on key subjects such as public transportation and the tax system of transport. There are consequently plans for investment in rail transport of passengers and goods of an amount of 35 billion euros, an adaptation of the legal framework and the greening of the fleet of company cars, a reform of the tax system to facilitate sustainable mobility and intermodality, stricter classification criteria for rechargeable hybrid cars, tax incentives to encourage ridesharing, company bicycles and micro-mobility, a change in the regulation concerning tires and automobile weights, etc. These orientations have not yet been implemented.

The three regions (Brussels capital, Flanders and Wallonia) share priorities such as the promotion of modal transfer and multimodality, promotion of bicycles (including adapted infrastructures), the search for a tax system that favors the sustainability of transport, the greening of public automobiles, the development of electrical recharging infrastructures and distribution of liquefied natural gas, and lastly concern for territorial development.



Direct greenhouse gas emissions until 2040

Source : Transport and PLANET v5.0 database (Bureau fédéral du Plan).



Evolution of the number of "salary-cars"

Source: Federal public service for Mobility and Transports, Key mobility figures in Belgium, 2021.

Flanders and Wallonia want to establish a public and semi-public transportation network composed of several hierarchical levels, associating for example the national train network as the backbone of public transportation, a structuring network of buses and trams between urban centers, a complementary network⁹ and lastly personalized transport. The development of Maas calls for governance of data and market regulation to implement an integrated fare system. Lastly, the relations between the network arcs will work in "mobipoles" or "mobipoints" allowing for multimodality.

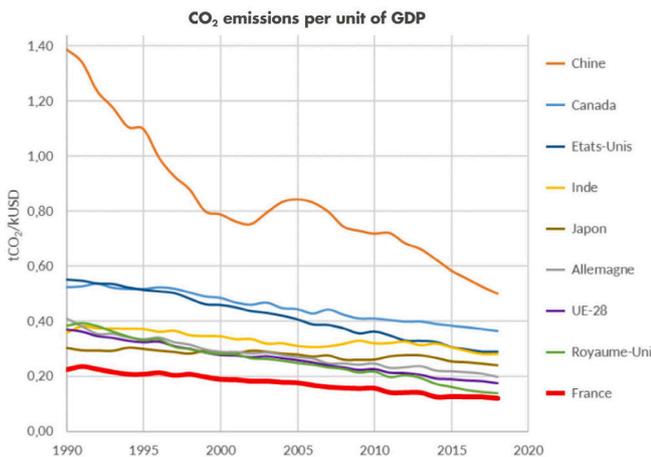
These provisions are included in the Recovery and Resilience Plan, while there is a reform underway for the tax system for infrastructure user charges: extension of the kilometric charging system from trucks to automobiles, and there are plans for a registration tax and a road tax.

We must also mention the issue of company cars in Belgium. The making available of a vehicle to an employee, for professional use extended to personal uses, exists throughout Europe. It has a particular importance here, because it is a substantial form of in-kind remuneration for a large share of employees. They are commonly referred to as **salary-cars**! These cars now represent 10% of the total cars in circulation. Challenging this system is politically delicate, while its environmental effects are unfortunate: incentive to not use public transportation, preference for heavy vehicles, little incentive to save energy due to the driving behavior and the use of rechargeable hybrid vehicles in thermal mode, with the fuel being at the employer's expense. A complex reform is underway to introduce criteria of sustainability in the calculation of the deductibility of car expenses from corporate taxes.

9. As the complementary network is composed of specialized services such as school transport, and regular services with lower frequency and capacity than in the structuring network.

FRANCE

As the production of electricity is already almost completely decarbonized (because of renewable energies and nuclear energy), in Europe France is one of the countries where greenhouse gas emissions are lowest in proportion to its GDP. These figures do not take into account emissions linked to the production and transport of imported products (which depends on the producer countries).



CO₂ emissions per unit of GDP, international comparison, 1990-2020.

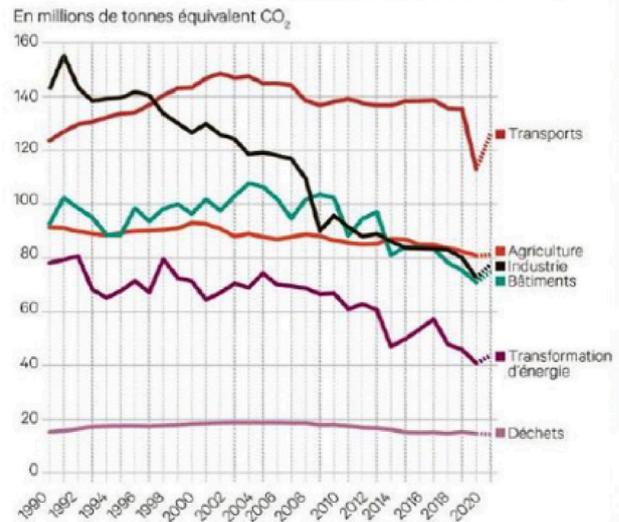
Source : Stratégie nationale bas-carbone, march 2020.

Consequently, the share of transport in the total emissions is particularly high here, on the order of 30% (or 21% for transport of people and 9% for freight). Since 2000, transport emissions have been decreasing and the country has met its European commitments in terms of decreasing emissions between 2005 and 2018, even if it has not reached its commitments in terms of development of renewable energies (particularly because of a growing reticence with regard to wind turbines within some parts of the population and delays in installing wind turbines in the sea).

But this progress is not sufficient to come within the perspective set by the National Low-Carbon Strategy (i.e., carbon neutrality in 2050 – as the remaining emissions are offset by carbon sinks), and as a planning law to specify its startup was announced for the year 2023. The acceleration of the decrease in emissions is also necessary to reach the international objectives (the Paris agreement of 2015) and recent legislative proposals of the European Commission *Fit for 55* of 2021.

We indeed observe that, by comparison with the situation of 1990, the gains obtained in terms of the energetic intensity of journeys (better efficiency of vehicles) and the carbon content of the energy consumed are offset by increases in the distances travelled and by

Evolution sectorielle des émissions de gaz à effet de serre



Evolution of emissions by activity, France, 1990-2020.

Source : Les Échos, June 30, 2022, «Énergie: la France sous contrainte».

the increase in the population. Along with these well-established trends, there is also a more recent question: with the massive adoption of teleworking, which decreases the number of professional journeys, will this be accompanied by an increase in greenhouse gas emissions if it allows part of the population to go live in zones poorly served by public transportation and where the use of cars is inevitable?

This incremental progress is not sufficient. A qualitative change is necessary, based on both **a modification of practices in the direction of moderation and on a technical transformation**: the shift to electro-mobility (at least, at this stage, for automobiles and light commercial vehicles), as long as the production of electricity does not use fossil energy. For trucks, the situation is more complex, and several solutions are now in technical development (electric batteries, supplying by catenary on highways, fuel cells, hydrogen as fuel, natural gas as a lesser evil transitional solution, etc.), although none of them really prevails today. In any case, industry is not yet able to massively supply clean trucks. Furthermore, the possibilities for transfer to waterways or rail are limited, at least in the short term, while awaiting the effects of the National strategy for the development of rail freight.

In these perspectives, the French recovery plan which is within the large European borrowing program, emphasizes the energy transition and transport: to renovate the rail network, support the sale of electric cars, to establish a hydrogen production sector, to reinforce waterways, the use of bicycles, etc.

There is also an industrial recovery plan supported by the Public Investment Bank for automobile construction and aeronautic construction.

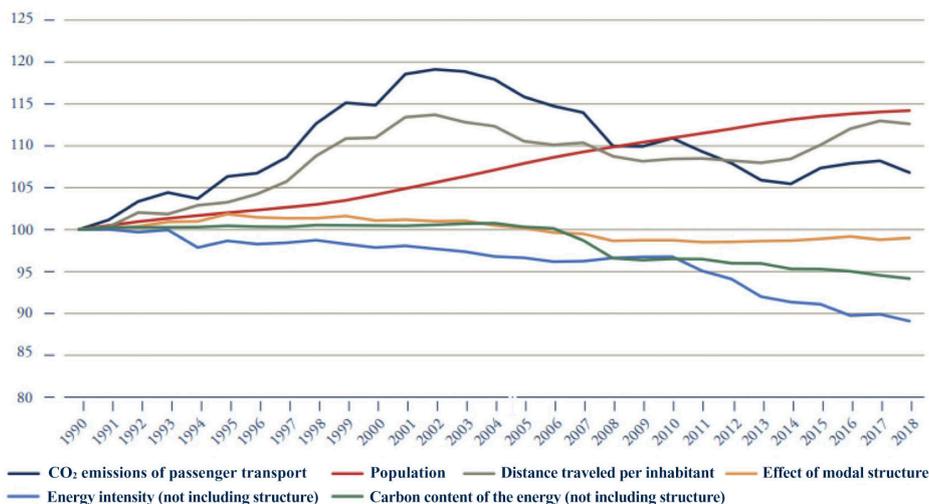
The purchase of electric cars is subsidized, and this type of vehicle already represents 12% of sales and is growing rapidly.

The implementation of Low-emission zones (*Zones à faibles émissions, ZFE*) in large urban areas, which will forbid access to the center to the most polluting vehicles, is now underway. While no one questions the effects of combustion engines on health, particularly due to the emission of microparticles (air pollution is said to cause some 48,000 premature deaths every year in France), political leaders on all sides cite the limitation on the freedom of movement and the social discrimination that affects the categories of people who cannot buy electrical vehicles which would follow from it.

More generally, public opinion is very divided on the subject to measures to be taken to fight against climate change, in particular regarding transport. While awareness of climate disruption and the need to limit it is more widely shared, **the use of the price system to change behaviors is poorly accepted**, despite the recommendations of economists: in 2013 the Red Hats movement opposed the establishment of a levy on the use of roads for trucks and the Yellow Jackets movement, from 2018 to 2020, opposed an increase, modest though it was, of the tax on fuels. At present, and because of the situation on international markets, the prices of automobile fuels have reached unprecedented levels. To support purchasing power, the government initially granted a tax reduction of 18 cents

per liter of fuel. Is this subsidy for fossil energy a timely price signal to limit greenhouse gas emissions? The debate at the National Assembly then addressed the scale and the duration of such a measure (with some people requesting a lowering of the taxes on fuels, others to concentrate these support measures on the social categories who need them, and still others wanting to put a time limit on this intervention which is very costly for the State budget and to develop as quickly as possible alternatives to the automobile, and, as the government proposes, easier access to electric cars with a rental package of 100 € per month, etc.). The measure finally approved was a new decrease in the tax (30 cents per liter of fuel), extended to all users but with a time limit.

These debates show that deep divisions separate citizens, between the partisans of decarbonization of transport through moderation efforts (reduction of journeys considered to be useless, ridesharing, use of public transportation when it exists, bicycles, which have had remarkable urban development over the past two years, and walking, etc.) and those who hope more for technical progress, particularly the massive use of “green” electricity to substitute for fossil energies. Is a reasonable transition possible? Is a radical break necessary? These issues are being raised in very different terms depending on the territories (city centers, outskirts, rural areas) and the social categories (in terms of income, level of education, life style, living and working conditions, etc.). Overcoming the objections and skepticism calls for an unprecedented political teaching effort and especially transparency in the collection and allocation of tax resources for transport, to support their decarbonization.



Evolution of transport emissions for travelers in France

Source : Service des données et études statistiques - Commissariat général au développement durable - Ministère de la Transition écologique

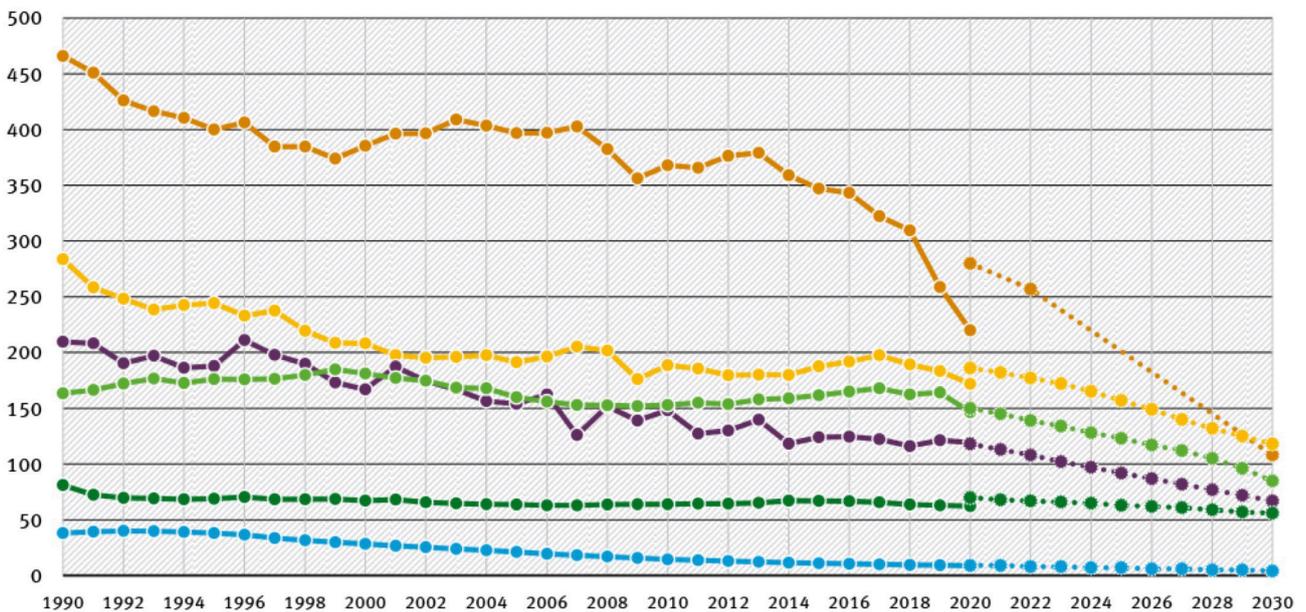
NB: CO₂ emissions are equal, to a factor of 100, to the product of the other quantities represented. The modal structure effect indicates the effect of Distribution between the different modes of transport: private vehicles, public transport by land, air. An evolution of this distribution towards modes of more carbon-intensive transport (individual or air road transport) results in an increase in the variable «modal structure effect».

GERMANY

The issue of decarbonization of transport is a very important one for Germany because the volume of transport, of both travelers and goods, has been increasing regularly in recent years, particularly in metropolitan areas (while the rural population, which is older, is less mobile). Within metropolitan areas, we observe a decrease in the number of cars in city centers, and an increase on the outskirts. The occupancy rate for journeys between home and work is 1.1 occupants per vehicle. There are 372 automobiles for 1,000 inhabitants in metropolitan areas and 649 in rural areas.

The time budget devoted to transport is on average 80 minutes per day and per traveler, for a distance traveled of 39 km. The number of cars on the road has increased, and there is a growing number of large vehicles.

In terms of modal sharing, road travel is the dominant mode for both the transport of people (70% of passenger-kilometers) and for freight (61% of the ton-kilometers for road, 28% for rail and 11% for waterways). For freight, the share of rail, substantially used for the transport of raw materials, is higher than the European average.



From top to bottom: energy (orange), industry (yellow), buildings (dark blue), transport (light green), agriculture (dark green), waste management and other (light blue).

Goals of the climate protection law: Emissions in CO₂ eq. by sector 1990-2020-2030

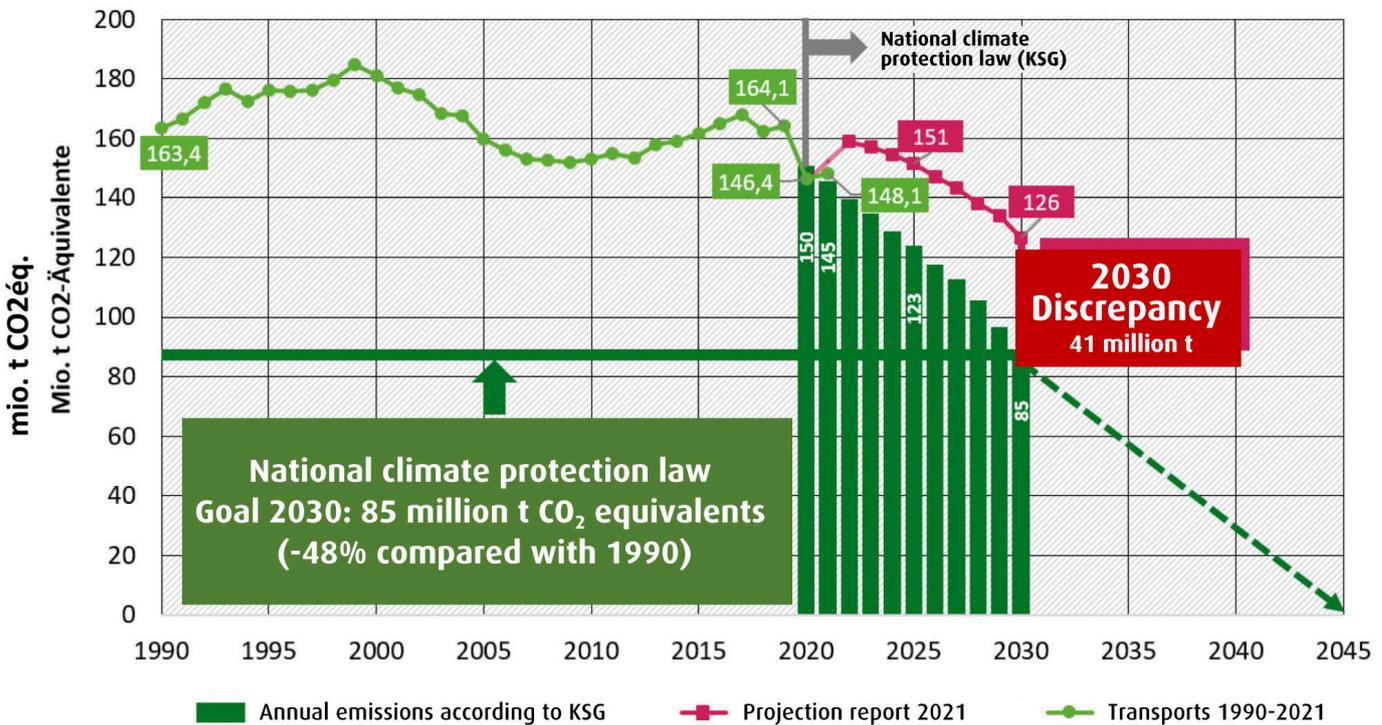
Source: Umweltbundesamt, 2021.

The transition of transport towards sustainability (Verkehrswende) is on the political agenda. It is estimated that, for travelers, 66% of the reduction in CO₂ emissions will come from the change in the mode of propulsion of vehicles and of the energy used (technology) and 33% from changes in mobility behaviors (moderation).

The national climate protection law is a legal procedure to take on responsibility with regard to

future generations. It sets as a goal a 65% reduction in greenhouse gas emissions by 2030 with reference to the situation of 1990.

For the time being, the projections estimate that transport activity will not follow the prescribed trajectory, leading to a “climate gap” in 2030 (a surplus with respect to the objectives) on the order of 40 million tons of CO₂ emitted per year.



Discrepancy between the emissions observed and the climate protection law projections

Source: Umweltbundesamt, 2021.

The arrival of a **new political coalition** in the government in 2021 led to a marked shift of the transport policy to reinforce measures affecting the environment. The following objectives were set:

- Conversion of the automobile industry to electric traction, with the goal of 15 million electric cars in service by 2030, supplied by one million public charging stations,
- Revision of the national plan for transport infrastructures (Bundesverkehrswegeplan) with new criteria, extension of rail infrastructures and increase in the percentage of rail freight to 25% of the total freight, renovation and maintenance of the road network,
- Differentiation of the “Maut” (road toll for utility vehicles) according to vehicle emissions and extension to all vehicles of more than 3.5 tons,
- Maintaining of Deutsche Bahn in the public sector (abandoning of the privatization plan),
- Extension and improvement of public transportation through additional subsidies, development of “Mobility Hubs” to increase intermodality possibilities,
- Acceptance of combustion engine cars only if they use synthetic fuels (with what carbon assessment?),
- Allocation of the aviation tax to the production and use of carbon-neutral fuels for aviation.

Substantial subsidies (4.6 billion euros since 2016) are intended for the purchase of clean vehicles, thereby helping the automobile industry to convert itself, which benefits Germany and foreign manufacturers. Furthermore, public financing helps cities which manage their transport systems to acquire electric buses.

The current program of the Federal Government provides for extending the recharging network for electrical vehicles, reinforcing public transportation with simpler prices and building new bike paths. Moreover, it will promote teleworking. In road freight, truck trailers and semi-trailers will be subsidized to improve their efficiency. Subsidies for electrical vehicles will continue, but at a reduced level.

In public opinion, the positions are divided between, on the one hand, the partisans of energy transition and a strong transport transition organized in association and, on the other hand, the partisans of the maintaining of the current uses (for example, the absence of speed limits on certain highways). We also see a reticence to pay to integrate the value of carbon in transport prices (value which remains very low compared with the proposals of economists).

GREECE

The topic of decarbonization is frequently addressed in political debate in Greece, whether for the general fight against climate disruption or more particularly the field of transport. The controversy involves issues of the compatibility or incompatibility between decarbonization and continuation of economic development.

The country is precisely at the average for European countries for the volume of greenhouse gas emissions per person, i.e., 8.4 t per year and per person, of which about one third is due to transport activities. In this regard, Greece is particularly dependent on the road mode for land journeys, both for passengers and for goods, as this mode conveys 97% of freight and 98% of people (by automobile and bus). Furthermore, Greece is an archipelago and maritime transport plays a very important domestic role (which does not include the substantial number of Greek flag ships for the international transport of goods on demand, or tramping). Domestic maritime transport only accounts for 2.2% of the country's greenhouse gas emissions.

Several planning documents sketch out the Greek decarbonization policy.

The National Energy and Climate Plan (2019) is a strategic plan, a road map indicating the measures to be taken to reach concrete energy and climate objectives for 2030.

The National Strategic Plan for Transport (2019) is the base document for sustainable development and transport infrastructure and services in the medium- and long-term. It follows the basic orientations of the National Energy and Climate Plan and materializes an infrastructure and action plan in the field of transport. It is structured around five principles:

- Support for economic development and the competitiveness of the Greek economy,
- Reinforcement of the connectivity of transport networks on the regional and international levels,
- Environmental sustainability,
- Reinforcement of accessibility and social integration of citizens,
- Safety in transport.

In this perspective, **nine strategic “pillars”** are designated:

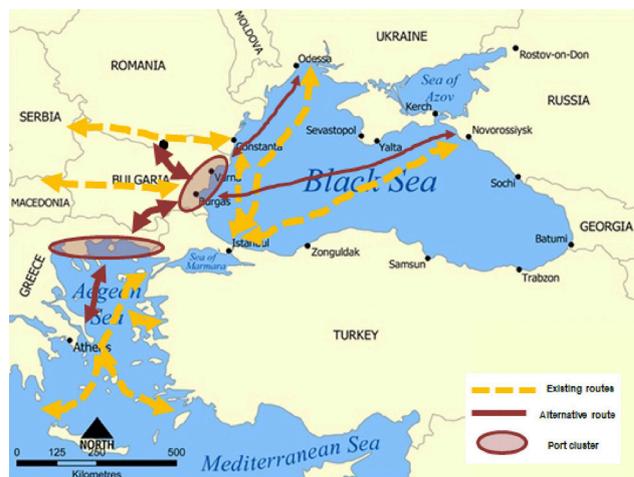
- Reinforcement of the safety, viability, profitability and competitiveness of the national transport system,
- Reinforcement of intermodality,
- Reinforcement of terrestrial connectivity,
- Reinforcement of the connectivity of the islands,
- Support for the tourism sector,

- Improvement of logistical performance,
- The development of an efficient and sustainable urban transport system,
- Reinforcement of regional development,
- The identification of long-term perspectives.

The Plan, combining new infrastructure projects and organization and regulatory measures, proposed three scenarios for the 2027 and 2037 horizons, evaluated according to the cost-benefit and multi-criteria analysis methods, followed by an environmental impact study. The scenario chosen consists of 25 “soft” measures and 41 infrastructure projects, requiring investments of about 10 billion euros, of which 7.5 are already approved. The expected effects of the scenario chosen are:

- 12% reduction in road traffic (vehicles.km),
- 20% increase in public road transport to the detriment of passenger cars,
- 44% increase in rail traffic for travelers (passengers.km),
- 35% increase in rail traffic for freight (t.km),
- Reduction of journey times (9% for automobiles, 20% for trucks, 11% for rail transport of passengers, 8% for rail freight),
- Reduction of the number of road accidents by 12%,
- Reduction of the “environmental cost” of 17%.

A number of specific policy measures complementary to the plan have also been developed, in particular support for the distribution of electrical vehicles: subsidies for purchasing (6,000 or even 8,000 euros per vehicle) plus various tax breaks and driving and parking advantages.



« Sea to Sea » project

Source: Rail T-K-A-B-V-R Project (« Thessaloniki, Kavala, Alexandroupolis, Burgas, Varna and Ruse Railway Connection », SYSTEMA SA, Ministry of Transport and Infrastructure, Greece, 2018.

In the same direction, the “Green fund” program includes, in addition:

- The study of the use of green technologies for the supplying of ships in ports;
- Studies for the cross-border rail network, particularly the “Sea-to-Sea” geostrategic project which will establish an alternate corridor to the passage by the Dardanelles for access to the Black Sea,
- Studies for the new Thessaloniki-Kavala-Alexandroupolis rail line,
- The establishment of nine parking lots for trucks along the TEN-T in Greece,

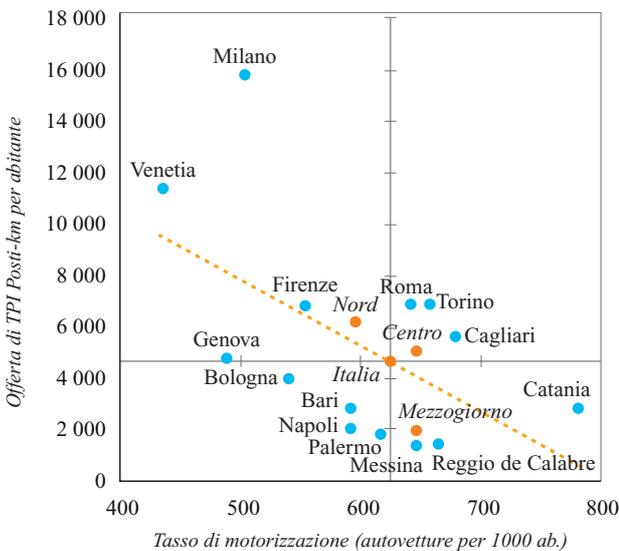
- A charging plan for electric cars.

There are also plans to replace the fleet of urban transport buses with 1,300 new buses (electric, compressed natural gas, hybrid diesel) for the Athens and Thessalonica metropolitan areas, a law for the development of ridesharing, car sharing and transport upon request, a new institutional framework for public road and rail transport and lastly the development of logistical platforms.

ITALY

Since 2000, with the application of stricter technical standards, emissions of nitrogen oxides and volatile organic compounds from transport activities have decreased by 61% and 82%, but **carbon dioxide emissions** have only decreased by 14%: more ambitious changes are necessary.

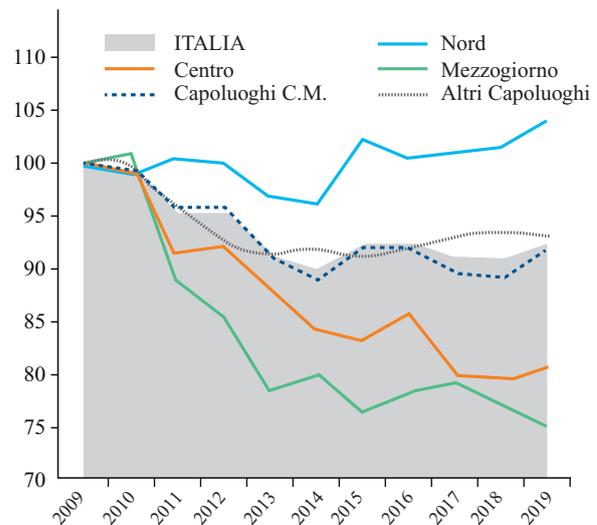
All Italian national policy will apply to a system of mobility which is sharply different from one region to another. The car ownership rate of households is higher in the South than in the North of the country, and reciprocally urban public transportation is more developed in the North than in the South.



Posti-km per abitante e Autovetture per 1000 ab

Supply of local public transport (in seat-kilometers) and car ownership rate in metropolitan areas in 2019.

Source : ISTAT, «Dati ambientali nelle città» ed Elaborazione su dati ACI, Pubblico registro automobilistico.



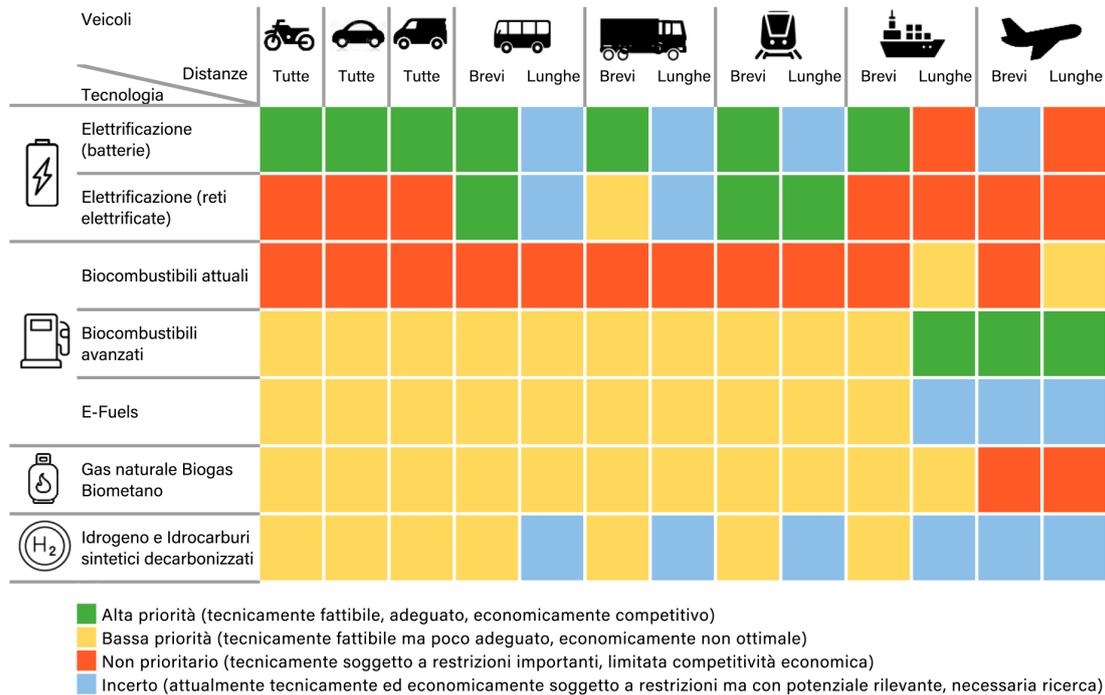
indice base 2009 = 100

Evolution of the supply of local public transport by large region, 2000-2019.

Source : ISTAT, «Dati ambientali nelle città» ed Elaborazione su dati ACI, Pubblico registro automobilistico.

Among the recent trends, we observe a significant increase in bicycle journeys, encouraged by the installation of bike lanes in metropolitan areas, but this only marginally affects home-work journeys: the bicycle remains for the moment a leisure practice. In the same search for a serene urban public space, we observe an increase in the number of “30 km/h

zones,” especially in the cities of the north, and the implementation of shared mobility services (ridesharing, self-service bicycles and scooters). Sales of electric cars are increasing, as well as the installation of charging stations, but we are still only at the first stages towards the ambitious goals set by the planning documents (the National Infrastructure



Evaluation of technological options by type of vehicle and distance

Source: Evaluation of technological options by vehicle type and distance

Plan for the recharging of vehicles supplied by electrical energy, *Piano Nazionale Infrastrutturale per la Ricarica dei veicoli alimentati ad energia elettrica* or PNire, of 2016, followed by the National Integrated Plan for Energy and Climate or ENCP of 2018 and National Recovery and Resilience Plan, NRRP, of 2021 entering into the European approach of the Facility for Recovery and Resilience¹⁰). The electrification of the automobile system shows the same North-South gradient as the other mobility indicators. In the interest of conciseness, only the objectives of the NRRP will be summarized here.

All of these orientations are based on preparation work, carried out by the Ministry of Infrastructure and Sustainable Mobility (MISM) and presented in the report: *The Decarbonization of transport – Scientific proof and policy proposals*, which presents the state of the art of research and the available technologies. It reminds us that the transport sector in Italy is directly responsible for 30.7% of CO₂ emissions, of which 92.6% is due to road transport of passengers and goods. In the automobile sector, electrical vehicles are considered as the option best suited for reaching the objectives of 2030, both in terms of energy efficiency and the reduction of emissions, which requires reinforcement of the recharging infrastructure and

investment in the domestic industrial production of batteries and vehicles, favoring the recycling of rare materials. The decarbonization of transport is indeed very closely linked to the overall energy strategy, to increase the production of decarbonized electricity, substituting for fossil energies for transport and also for the heating of buildings, various industries, etc. The available technical solutions are differentiated according to the transport modes and distances on the one hand, and the sources of energy on the other (electricity by battery or catenary, biofuels, biogas, hydrogen), distinguishing solutions which are high priority (in green), low priority (yellow), non-priorities (red) and lastly still technically or economically uncertain (blue).

The NRRP is thus built around **three priority areas**, specifying for each of them the resources allocated:

- Cities and urban mobility: 5,000 km of urban bike paths and 10,000 km of tourist bike paths (2 billion euros), purchase of 15,000 new electric buses (5 billion euros), construction of 150 km of tramways and 25 km of metros (8.5 billion euros), investments in local railroads and suburban trains (12.5 billion euros), urban logistics, shared mobility and traffic moderation measures (2 billion euros).

10. Issue 4 of *Transport / Europe* is precisely dedicated to the comparison of the NRRP in various European countries and their impact on transport.

- A green and equitable energy transition: development of recharging infrastructures (2 billion euros), electrification of government vehicles and incentives for shared vehicles (1.8 billion euros), incentives for the purchase or replacement of commercial vehicles (0.5 billion euros), support for the manufacturing industry and electrical components (1.5 billion euros), battery industry (1 billion euros), electrification of harbor docks (0.9 billion euros), pilot projects for green hydrogen and ammonia (0.25 billion euros).

- Roads and road safety (with the goal of zero deaths), within the framework of a 3.5-billion-euro investment program of the ANAS (National Autonomous Road Company).

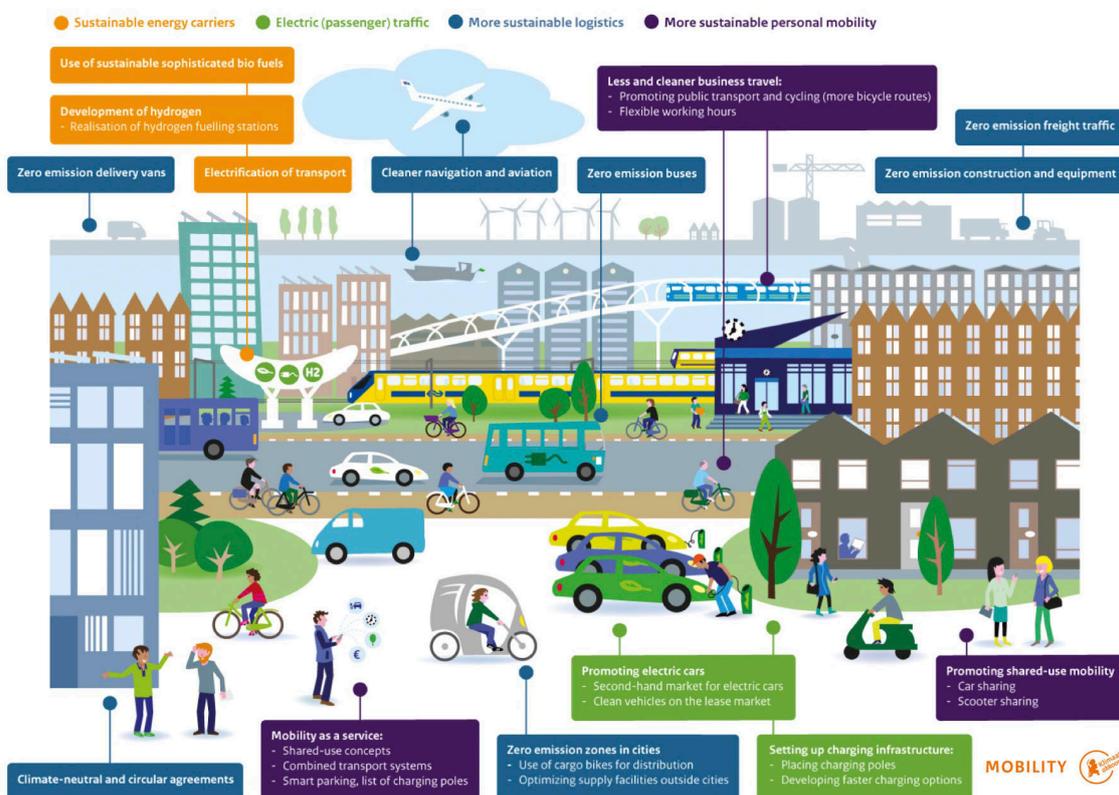
Thus, a total investment of 41 billion euros, divided between urban and regional mobility (29.7 billion euros), electrification (7. billion euros) and safety of road infrastructures (3.5 billion euros).

NETHERLANDS

The environmental policy in the Netherlands was marked by a lawsuit against the government in 2015, to compel it to accelerate its work towards sustainability (Urgenda). The court thus ordered the public authorities to reduce emissions by 25% by 2020 with reference to the level of 1990 (decision confirmed on appeal by the Supreme Court in 2019). On this basis, **a national agreement on the climate** was concluded between the government and the various sectors involved, including a substantial chapter on transport. Its long-term goal is the stopping of all emissions in 2050, with more detailed stages in 2030 concerning:

- Development of the use of hydrogen,

- The orientation of public purchases towards sustainable products,
- The stimulation of electric passenger transport and the installation of public recharging stations,
- Stopping of the sale of new combustion vehicles as of 2030,
- Improvement of the sustainability of logistics (with in particular definition of emission-free zones in some thirty municipalities between now and 2025),
- The use of low-emission work site equipment,
- Reduction of 8 billion kilometers of professional journeys.

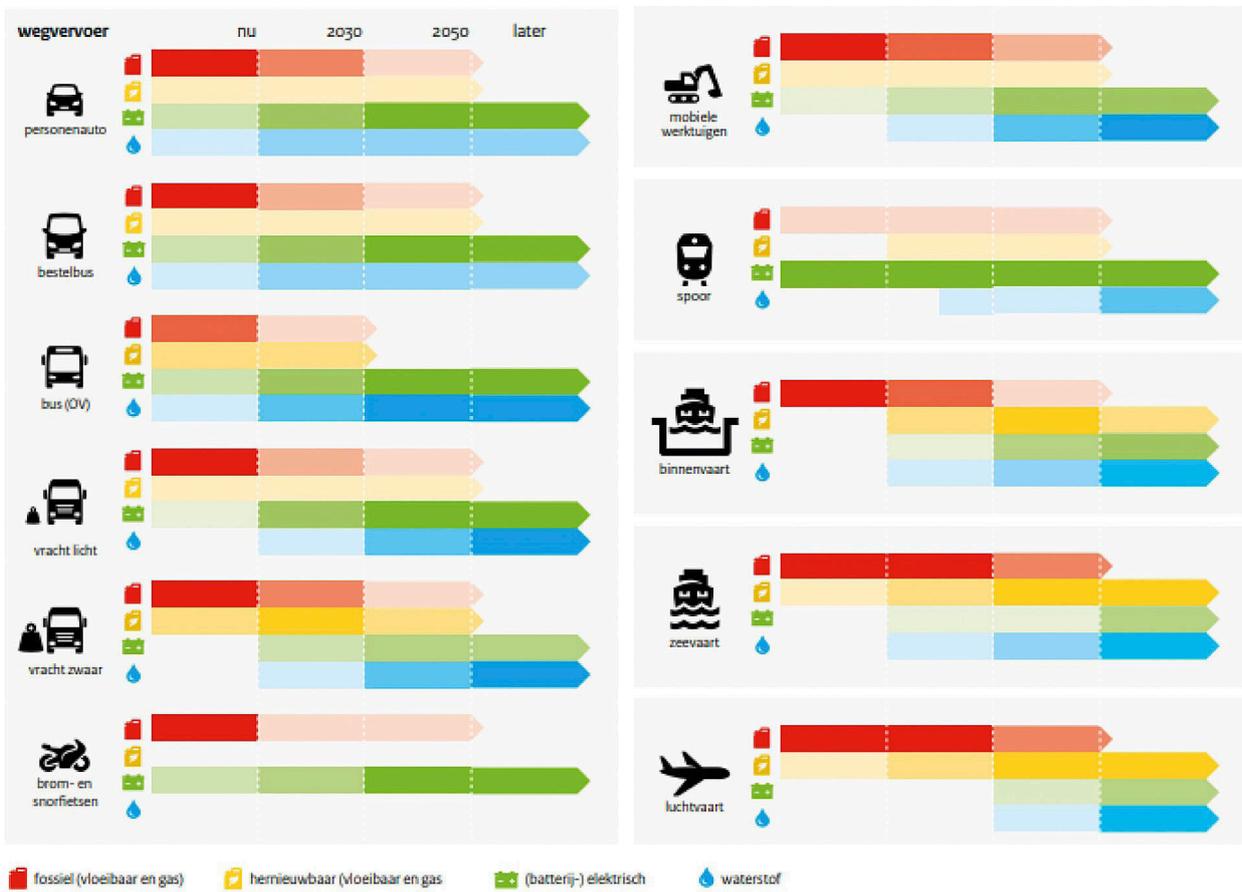


Chapter on mobility of the national agreement on the climate (2019)

Source: www.klimaatakkkoord.nl/mobiliteit

This agreement is the result of discussions carried out in 2018 and 2019 with various working groups (in which some 150 organizations took part), coordinated by five sectoral tables and one synthesizing body, the “Council on the Climate.” The initiative came from the government and is being carried out in an inter-ministerial manner, with the participation of Economic Affairs and the Climate (EZK), the Interior and Relations with the Kingdom (BZK), Agriculture, Nature and Food Quality (LNV) and the Management of Infrastructures and Water (IenW). However, the democratic nature of the approach is controversial because it did not initially go through the Parliament, which finally

approved it with a law in 2021. Opinion and the political parties have, with regard to transport, very different opinions, between the environmentalists who want higher taxes on automobiles with combustion engines and a drastic reduction of aviation, a climate-skeptic extreme right that wants to raise sea walls and a governmental coalition in which ecologists and liberals coexistent. The agreement provides for a decrease in total emissions of 49% between now and 2030 with respect to the situation of 1990 and includes in particular energy transition scenarios for each mode of transport.



Energy scenarios by mode of transport, 2020, 2030, 2050 and beyond

Fossil energy (red), renewable (yellow), electric (green), hydrogen (blue)

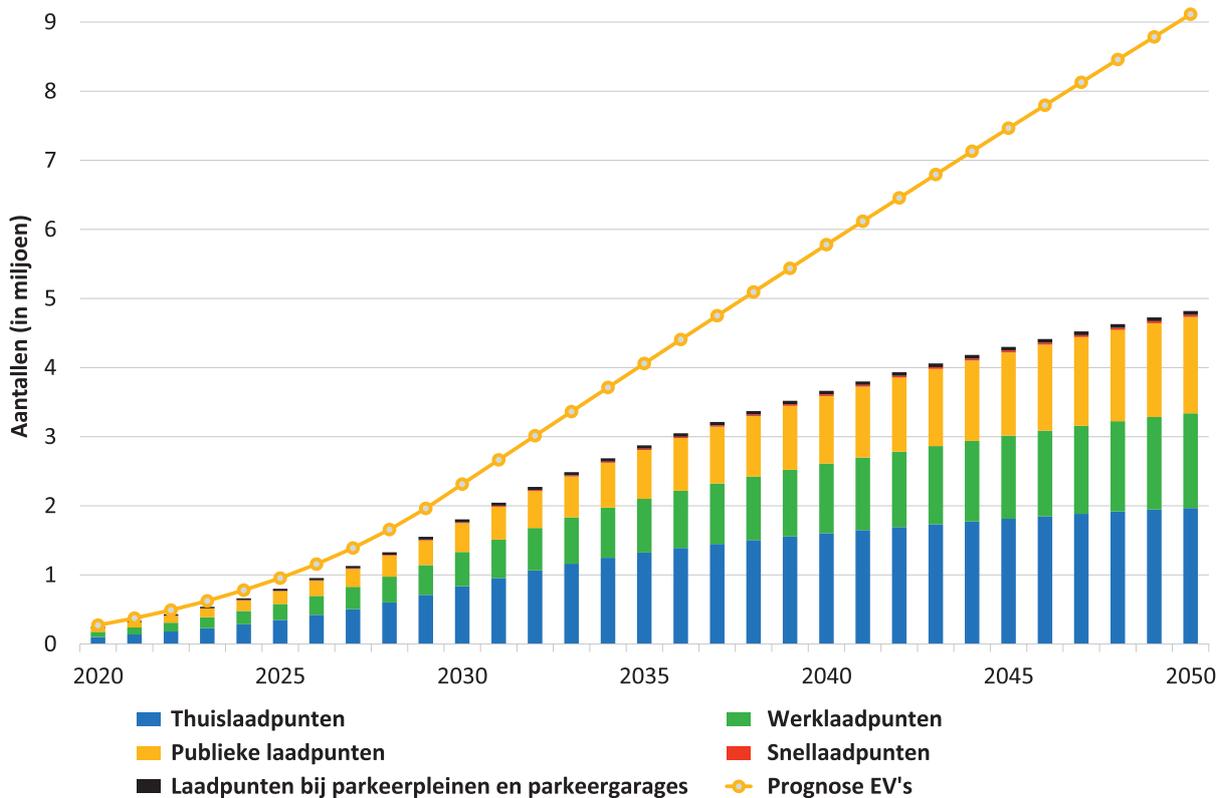
Source : Ministerie van Infrastructuur en Waterstaat.

The scenario of installation of charging stations distinguishes facilities at homes (in blue), at workplaces (yellow) and in the public domain (green). For the time being, the Netherlands is the country of Europe which has the largest absolute number of charging stations, ahead of Germany and France. A system for monitoring of the 2019 agreement has been implemented and distinguishes sustainable

energy, electro-mobility, sustainable logistics, and sustainable transport of people. Concretely, programs aim to continue the installation of charging stations, to help local authorities that organize mobilities to acquire electric buses, in the near future to forbid combustion mopeds in cities, to support the use of trains (which already use decarbonized electricity), to install emission-free logistical zones.

The Plan for the Climate of the Ministry of Economic Affairs and the Climate, elaborated based on the law on the climate, takes stock of the latest scientific knowledge on climate change, technological developments, international political developments and their economic consequences, defines the objectives for 2030 and 2050 and specifies the financing implemented:

- The establishment of a Claim and Transition Fund of 35 billion euros over ten years to reinforce the goals of the Law on the climate,
- Continuation of the Program of subsidies for sustainable energy: construction of energy infrastructure (for electricity, for which the capacity of the transport network must be reinforced, heat, hydrogen), green industrial policy and mobility and environment, more sustainable construction (with a budget of 13 billion euros in 2022, versus 5 billion in 2021),
- The definition of a greener tax policy, based on the distances covered in the case of automobiles.



Projection of the number of charging stations in The Netherlands on the 2050 horizon (high and low scenarios)

Source: ElaadNL (2021), « Elektrisch rijden in stroomversnelling. Outlook Q3 2021 », ElaadNL, Arnhem.

POLAND

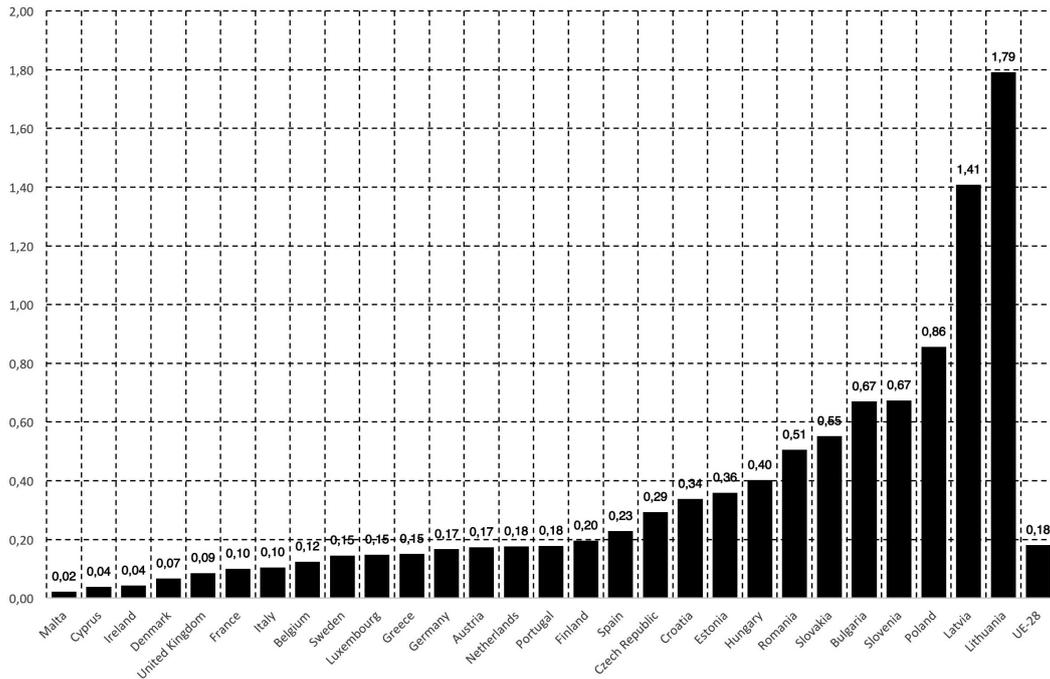
In Poland, decarbonization is now perceived as a necessity, countering past policies. It supposes a rather radical change of the transport system, especially when the idea is to reduce mobility which is considered unreasonable (a politically sensitive topic) and the possibilities of modal transfer are limited (all the more so because the Covid-19 pandemic decreased the use of public transportation and they have not yet returned to their prior level of activity).

In Poland as elsewhere, other concerns mark political life: inflation, the war in Ukraine and the risk of energy shortages in particular, but the government has maintained its intention to implement a decarbonization strategy for transport. From this angle, the current situation is not without problems: freight transport is heavily by road, the automobiles in circulation are relatively old and consume a great deal of fuel, the production of electricity relies heavily on coal and lignite. Things are changing nevertheless and for example sales of electrical vehicles seem to be taking off.

In terms of freight, Poland is characterized by the “transportivore” nature of its economy, because there is a ratio of 0.86 ton-kilometer per euro of GDP, one of the highest in Europe where the European average is 0.28 t.km/€.

The mobility of the Poles increased substantially over the past twenty years, increasing from 6,800 to 11,400 passenger-kilometers per inhabitant between 2000

and 2019. Half of it is provided by automobiles, while air transport accounts for some 25% of transport, far ahead of inter-city buses and rail. During the coronavirus-19 pandemic (2020-2022), the transport of passengers by airplane, train, bus and urban transport in Poland decreased considerably (- 60%), while journeys in passenger cars increased by 10% (because of the fear of infections in public transport).

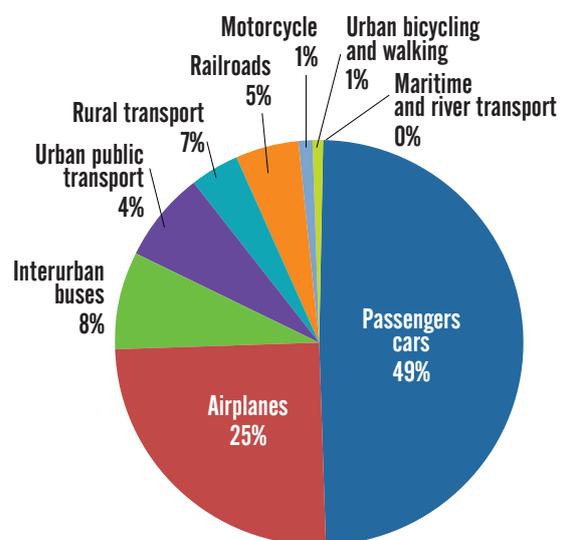


**Intensity of demand for ground transport of freight with respect to the GDP
 UE-28, t.km/1€, constant 2010 prices**

Source : calculations based on Eurostat 2022 data and statistical data of the European Commission (EU transport in figures 2021).

The Greenhouse gas emissions per inhabitant and per year in Poland are 10.4 tons, an amount that is higher than the European average, but which has remained stable over the past twenty years despite the significant increase in the standard of living. In all of the emissions, the contribution of transport is on the order of 18.5%, mainly due to road transport (travelers and goods).

The word decarbonization does not appear in the text of the Strategy for sustainable development of transports until 2030 adopted by the Council of Ministers on September 24, 2019, which rather refers to the environmental performance of Polish transports. However, the word is used several times in the draft of the **National Recovery and Resilience Plan (NRRP)** sent to the European Commission at the end of April 2021. This revised plan was approved by the Commission on June 1, 2022 and by the European Council on June 17, 2022 after more than a year of disputes.



**Modal breakdown of transport of travelers in Poland
 (Passenger-kilometers, 2019)**

Source : calculations based on data from the Central Statistics Office, Poland, 2022.

It covers the period 2022-2026 and includes a whole series of measures affecting transport: development of public transportation and purchase of low- or zero-emission buses, modernization of railroads (purchase of new rolling stock, renovation of infrastructure, implementation of the ERTMS), establishment of a regulatory framework to allow for the use of hydrogen, etc.

The validation of the Polish plan by the European Union was delayed because of the various policies affecting the independence of the courts, and the delay in implementation could be rather short for the building of infrastructures.

Sales of electric cars are still of limited volume, but they are rising quickly, supported by government aid for companies and households and on the order of 25% of the price of the vehicles. These vehicles also

benefit from advantages for driving in cities (with the authorization to use bus lanes and the making available of parking spaces). For the moment these are mainly hybrid vehicles, which are not dependent on the availability of charging stations.

Their installation has also begun. The goal of the program, supported by the environment budget, is a network of more than 17,000 recharging stations for electric cars and 20 hydrogen stations by 2028. There should be 5.5 million electrical vehicles in 2030, or 20% of all individual cars.

One of the limits on the electrification of vehicles could in the future be the capacity of the country to produce a sufficient quantity of electricity (close to 10% of consumption is already imported) and the foreseeable increase in the price of electricity, without forgetting the need to decarbonize production.

SPAIN

The decarbonization of transport is perceived in Spain as a sectoral consequence of a still greater imperative: the decarbonization of the economy, the constitution of a new industrial ecosystem around the production of decarbonized energy for all uses. Politically, the European Union offers a reference legislative framework accompanied by corresponding financing, a decisive issue to the point that the Ministry of Transport (MITMA) recognized it and declared in February 2022 in the title of a press note: *Spain targets accelerated decarbonization of transport with financing from European funds*.

These general objectives are also taken on by the autonomous communities and local authorities. The Government of Catalunya, for example, is planning to implement a “5 C” mobility: *Compartida* (shared), Collective, Connected, deCarbonized and managed from Catalunya.

These orientations are covered by **several laws and long-term programs**. The 2021-2030 Integrated National Energy and Climate Plan adopted by the government in March 2021, in application of the paper of the European Commission *Clean energy for all Europeans*, COM (2016) 860 final, provides for a 23% reduction of greenhouse gas emissions with respect to 1990, an offer of 42% renewable resources on the final use of the energy, an increase of 39.5% in energy efficiency and 74% renewable energy for the production of electricity. With regard to transport, the proposed measures are:

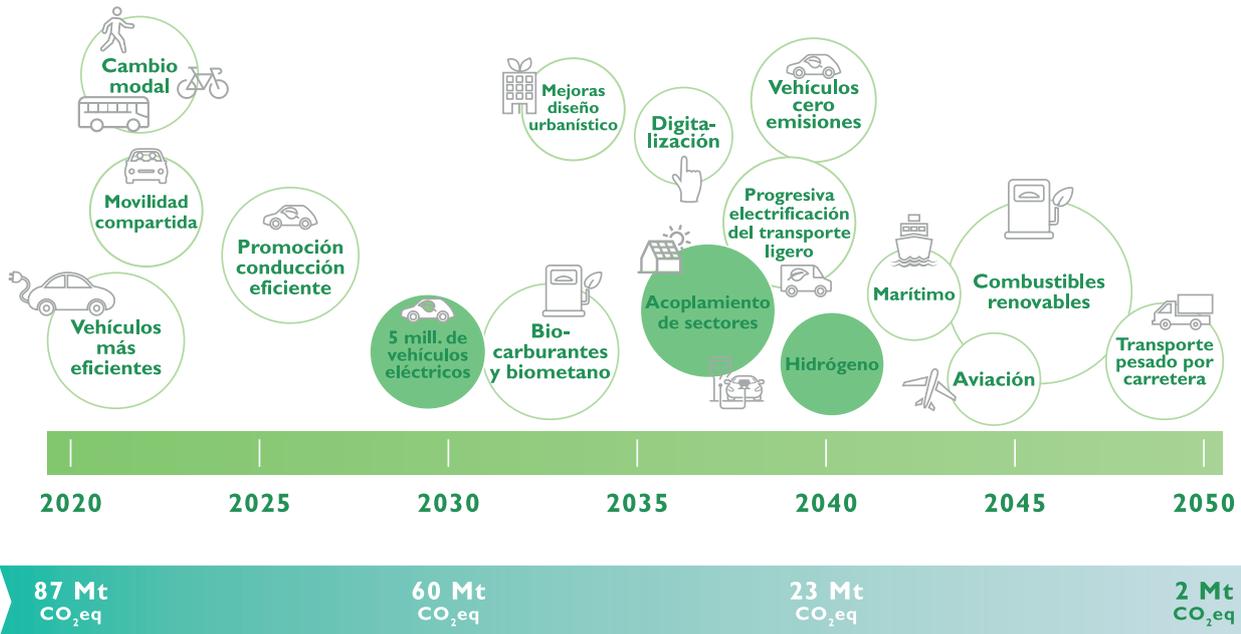
- The implementation of low-emission zones and promoting modal transfer in urban areas of more than 50,000 inhabitants,

- More efficient use of transport resources: better management of road transport fleets, eco-driving for professional drivers, transition from a culture of ownership of individual cars towards shared services,
- Replacement of old cars with new cars,
- Encouraging electric vehicles.

The 2020 Road map for hydrogen is aiming for large-scale decarbonated hydrogen production and its use in transport, with, between now and 2030:

- The commissioning of 100 to 150 public access hydrogen stations on the highway network,
- The introduction of 150 to 200 buses with hydrogen cells, eight of which will be progressively commissioned in the urban transports of Barcelona (TMB),
- The introduction of 5,000 to 7,500 light and heavy commercial vehicles equipped with fuel cells,
- The introduction of hydrogen-fueled trains on at least two rail lines.

The 2050 long-term decarbonization strategy, published in 2020 by the Ministry of the Ecological Transition and Demographic Challenge, targets the application of the *European regulation on the governance of the Union of energy and action for the climate* of 2018, which defines a cooperation framework between the Member States. Its target is a 90% reduction in greenhouse gas emissions in 2050 compared with 1990, it recommends modal transfer and the integration of urban planning for urban mobility, and for rail transport efficient conduction and the recovery of braking energy, the electrification of lines and the use of renewable liquid and gas biofuels on the non-electrified sections.



Proposed evolution of the transport and mobility sector looking ahead to 2050: technologies and tools to allow for reductions in emissions

Source: Ministerio para la Transición Ecológica y el Reto Demográfico: *Estrategia de descarbonización a largo plazo, 2050*, p. 36.

All of these proposals were politically validated in the Climate change and energy transition law approved in 2021.

In its last part, this law requests that the government present to the Parliament a draft law to address in particular sustainable mobility and the financing of transport.

In this perspective, in 2021 the Council of Ministers adopted the 2030 Strategy for safe, sustainable and connected mobility, preparing a draft law and including a section devoted to low-emission mobility and which thus recommends:

- Incentives for the use of alternative and sustainable energy sources: charging stations for electrical and hydrogen vehicles, etc.,
- Incentives for the use of low-emission means of transport: renovation/replacement of automobiles, rail, maritime and auxiliary systems,
- The sustainability of buildings, terminals, and other transport facilities,
- The fight against other forms of pollution and environmental nuisances due to transport: noise and protection in marine areas.

A preliminary draft law was finally brought into the debate in March 2022. Environmental organizations consider that it does not set sufficiently ambitious objectives for transport and that the financing of the measures mentioned is not clearly set, even if it comes from the Next Generation fund of 700 billion

euros from the European Union, in accordance with the Spanish Recovery and Resilience Plan approved by the European Commission in April 2022.

Beyond the texts and laws which provide a framework for the overall evolution of the mobility system to improve its sustainability, there are various actions targeting more particular topics:

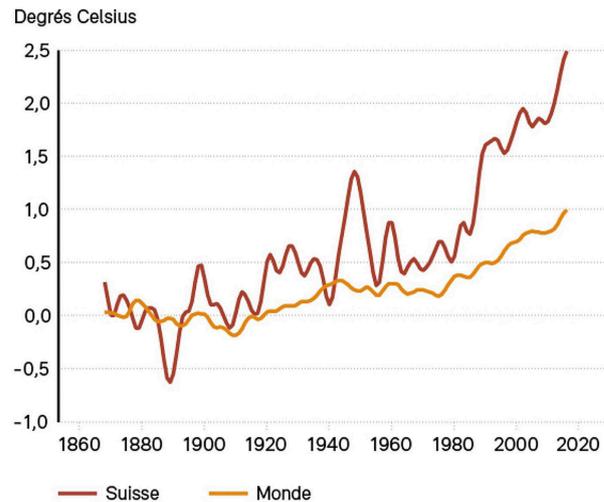
- The automobile industry, with a major project for manufacturing electric cars of the VW-Seat Group, with support from the Spanish government and the establishment of a battery manufacturing unit,
- Aid for the acquisition of electrical vehicles for individuals, with additional aid for residents of sparsely populated areas,
- The decarbonization of professional road transport, for the acquisition of new alternative energy vehicles (electric, hydrogen, hybrid, LNG or CNG, for gas only until the end of 2023), the scrapping or retrofitting of old vehicles, the installation of electric charging stations, the acquisition of semi-trailers for rail high-ways,
- The development of rail transport, with continuation of construction of the high-speed network and the improvement of suburban trains,
- The digital and sustainable transformation of urban transport,
- Low-emission zones,
- Air and maritime transport, with the electrification of ports to supply ships at docks.

SWITZERLAND

Climate change is already very perceptible in Switzerland, with a temperature increase which is higher than the world average compared with the end of the 19th century. The issue is not new because in 1973 the Club of Rome, in its report *The Limits to Growth*, alerted us to the risks of climate disruption.

We observe a decrease of greenhouse gas emissions in Switzerland, but at a pace which is not sufficient to reach the objective set on the international level. Between 1990 and 2020, the structure of the emissions by sector was modified somewhat, with the share of transport increasing from 27.6% to 31.6% of the total, one of the highest proportions in Europe.

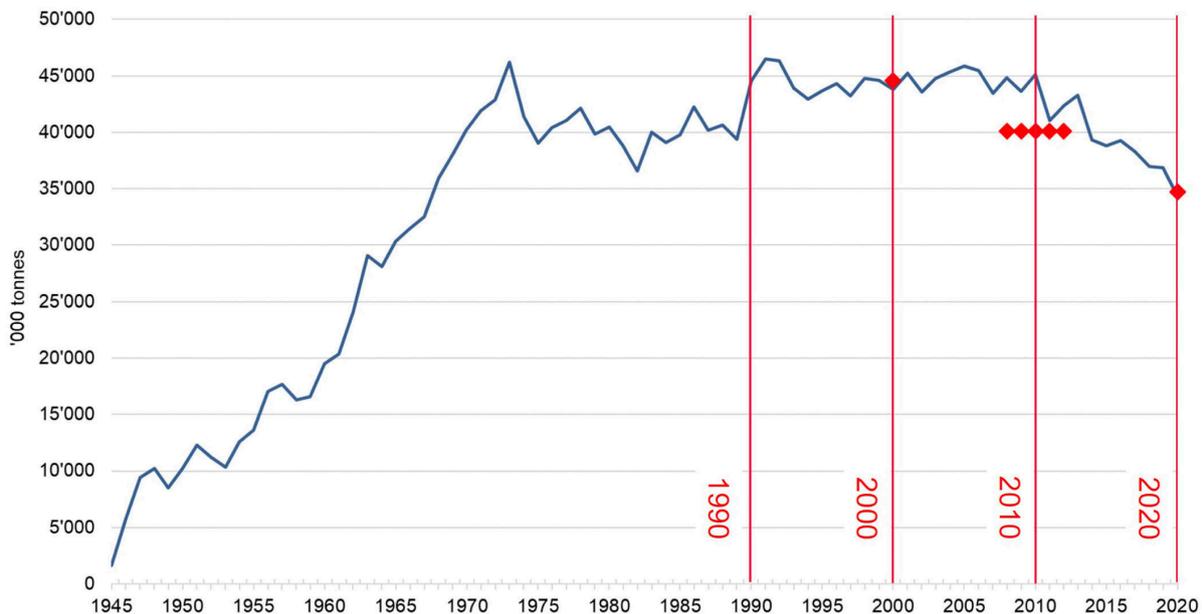
To achieve substantial results and to honor its international commitments, Switzerland adopted three instruments: *The Climate Strategy*¹¹, *the Energy Strategy*¹² and the law on CO₂¹³, while encouraging research efforts for a “deep decarbonization” of the economy, which can include exploring original innovation approaches, with the goal of an emission level of 1 ton of CO₂ per inhabitant in 2050, versus 5.1 tons today.



Evolution of the average temperature in Switzerland and in the world

Source : MétéoSuisse

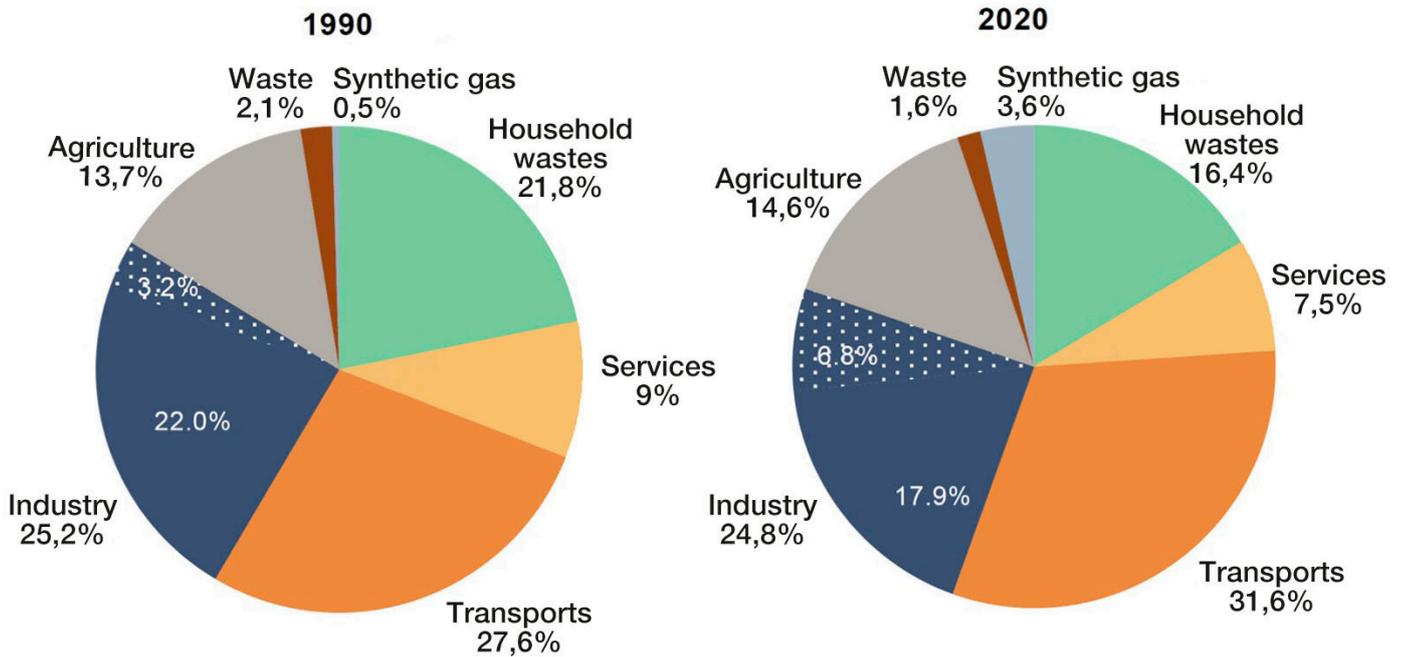
Since the work of Nicolas Stern¹⁴, we know that the cost of actions aiming to limit the temperature rise to 1.5 °C at the end of the century will be well below the damage resulting from an insufficient action.



Greenhouse gas emissions since 1945

Source: Office fédéral de l'environnement, OFEV, Indicators of the evolution of greenhouse gas emissions in Switzerland 1990–2020, updated in April 2022.

11. <https://www.bafu.admin.ch/bafu/fr/home/themes/climat/info-specialistes/reduction-emissions/objectifs-reduction/objectif-2050/strategie-climatique-2050.html>
 12. <https://www.bfe.admin.ch/bfe/fr/home/politique/strategie-energetique-2050.html>
 13. <https://fedlex.data.admin.ch/filestore/fedlex.data.admin.ch/eli/cc/2012/855/20130101/fr/pdf-a/fedlex-data-admin-ch-eli-cc-2012-855-20130101-fr-pdf-a.pdf>. We note that the revision of the law on CO₂ was refused by the people on June 13, 2021; a new proposal was prepared and presented to the Parliament in September 2022.
 14. *Stern Review on the Economics of Climate Change*, The Office of Climate Change, 2006.



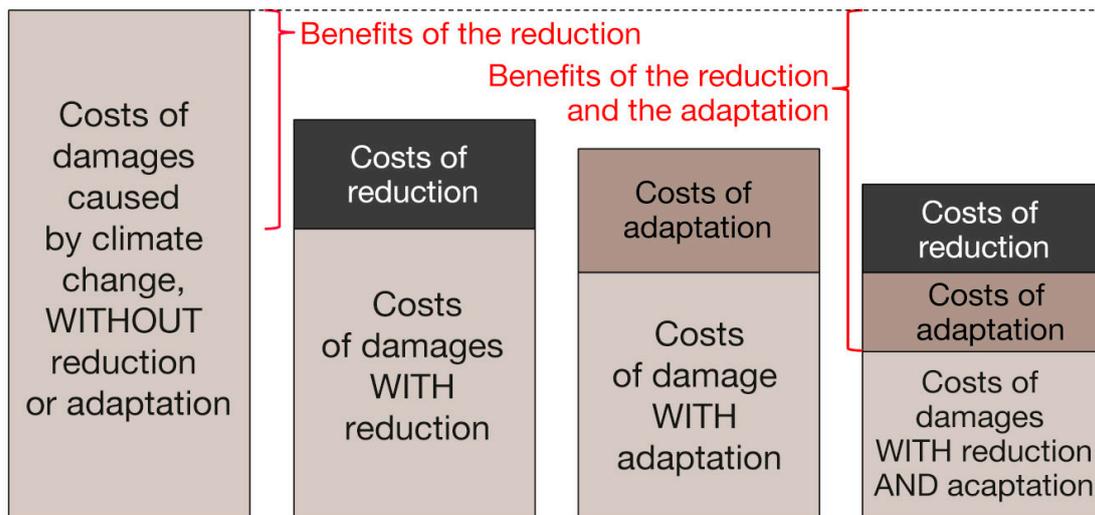
In the blue dotted areas, incineration of household wastes

Structure of emissions by activity sector, 1990-2020.

Source : Federal Environment Office, OFEV, Indicators of the evolution of greenhouse gas emissions in Switzerland 1990–2020, updated in April 2022.

Through intensive research efforts, scenarios are being studied which bring together production (or importing) and final energy consumption looking towards 2060. In the following graph, the volumes of final energy by type of energy are “stacked” on top of each other. Thus, in 2060, the consumption of fossil energy (black curve) will disappear.

For electricity, we imagine in an average scenario the necessity of substantial storage capacity to deal with daily and seasonal consumption peaks with reserves constituted during low consumption periods, particularly by letting water rise up in hydraulic dams.



Costs of reduction and damage compared, with and without adaptation

Source: Philippe Thalmann, EPFL.

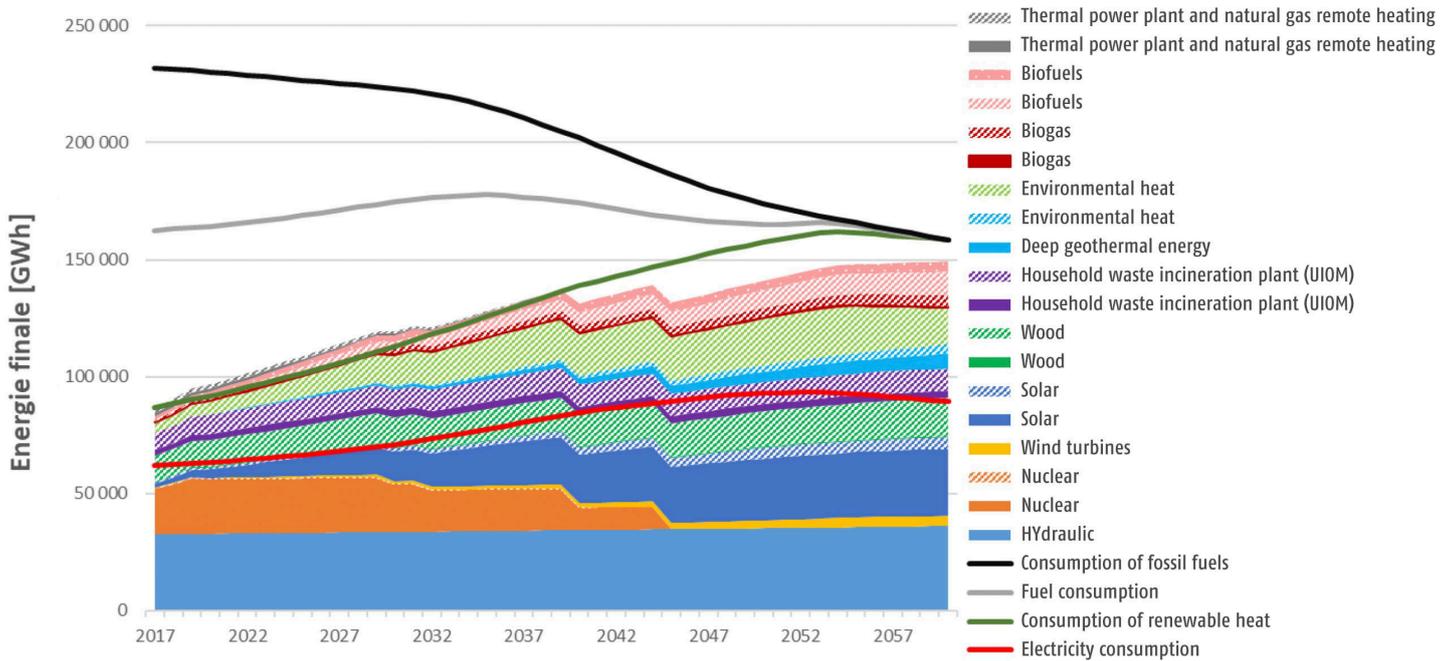


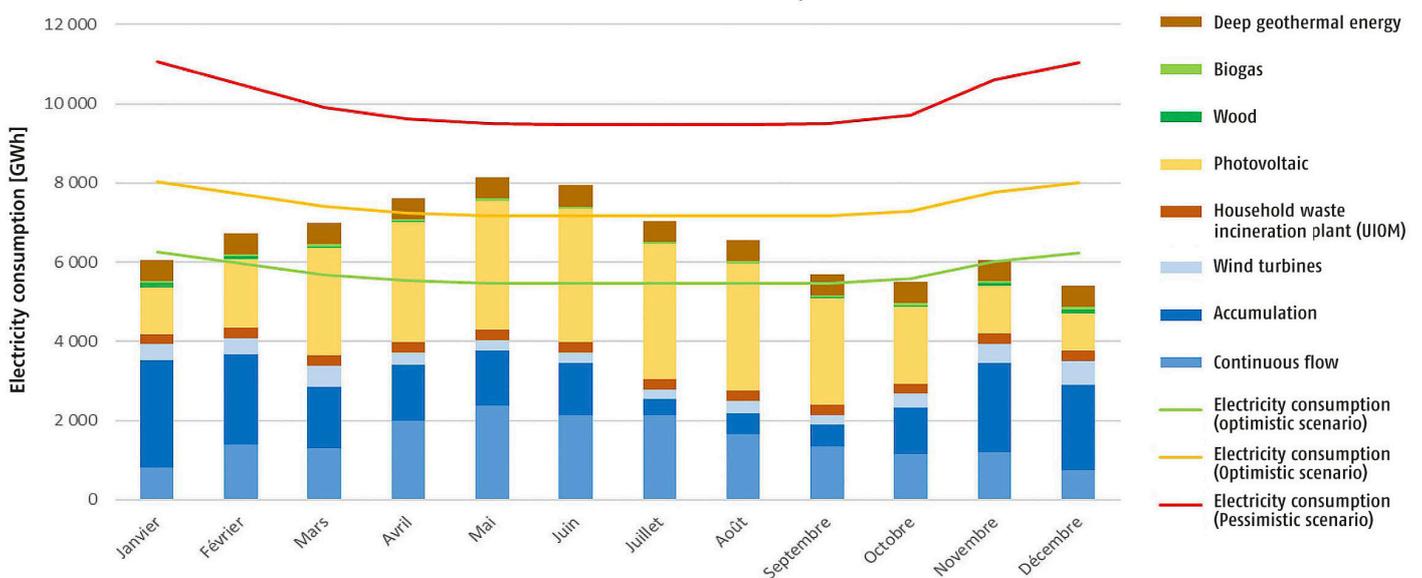
Figure 1: Evolution of consumption and production of final energy in Switzerland (average scenario) * stripes = thermal / solid background = electricity / white points on solid pink background = biofuel imports

Energy: long-term projection

Source : Julien Michellod, Scenarios for complete decarbonization of the energy sector in Switzerland, HES-SO report, Valais, Sion, 2019.

But **public opinion** is by no means stabilized or consensual. Should we apply the recommendations of certain economists who, convinced that market mechanisms can make it possible to internalize the

external costs, propose to sharply increase the prices of fossil energies, supposing that such measures will be socially and politically accepted?



Monthly production/consumption of electricity in 2060

Source : Julien Michellod, Scénarios de décarbonisation complète du secteur énergétique en Suisse, rapport HES-SO Valais, Sion, 2019.



Source: Swiss Climate Protection Association, <https://www.klimaschutz-schweiz.ch/fr>, screen capture

Are we convinced of the possibility of producing sufficient electricity (covering all roofs with photovoltaic panels?), storing it, distributing it, in particular for the recharging of electric cars? The possibility of recycling batteries?

The state of science and techniques will evolve considerably between now and 2050 and innovation approaches that have barely been explored today will perhaps in the shorter or longer terms offer unprecedented solutions. An intense research effort is being

supported. It addresses, for example, the possibility of using hydrogen as a fuel (at the price of a relatively simple adaptation of the current combustion engines), the capture of carbon dioxide at the most intense sources of emissions (cement plants, steelworks, etc.), the use of vehicles much lighter than the current automobiles, the use of underground transports, possibly in vacuum conditions¹⁵? The paths towards a decarbonized (and happy!) society remain largely to be explored.

15. Topic discussed in issue 1 of the bulletin *Transport / Europe* of June 2020, <https://tdie.eu/the-new-tdie-bulletin-transport-europe>.