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INSTITUTE FOR CLIMATE ECONOMICS

Landscape of Climate Finance in France

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2022 Edition

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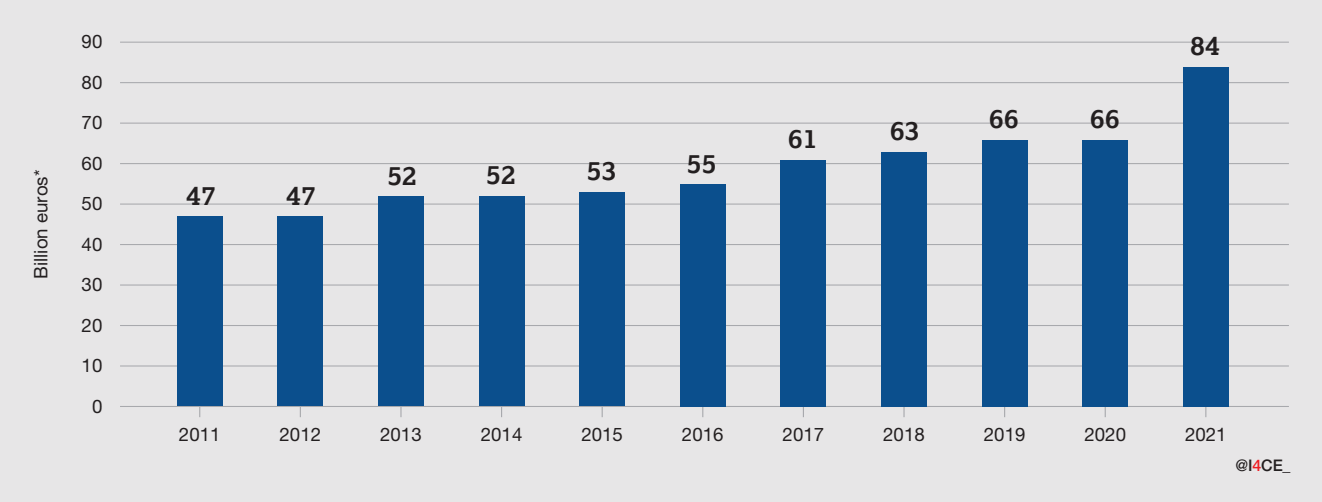
ABSTRACT

In 2022, France is paying dearly for a dependence on fossil fuels maintained by a chronic lack of investment in the decarbonisation of the economy. This edition of the Landscape of climate finance in France makes a detailed analysis of these critical expenditures by households, companies and public authorities, in the retrofitting of buildings, the purchase of electric vehicles, and renewable energies, as well as in rail, cycling and urban public transport infrastructures. Encouragingly, climate investments have increased significantly in the past year, driven, among other factors, by favourable regulations and by state support under the recovery plan. But this growth remains fragile, and analysis of several transition scenarios shows that climate investments need to increase further in order to stay on track to carbon neutrality and to ensure a lasting reduction in France's dependence on fossil fuels.

Growth in climate investments is still fragile

Having weathered the health crisis, climate investments by households, companies and public authorities increased significantly to reach 84 billion euros in 2021, *i.e* 18 billion more than in 2020. They grew in most sectors, in particular in electric and hybrid vehicles, renewable energies, and retrofitting of buildings. This growth is explained by the delivery of projects postponed in 2020, but also by regulations, especially in the automotive sector, and by increased state support, in particular under the recovery plan.

FIGURE 1: CLIMATE INVESTMENTS IN FRANCE



*Data in current prices.

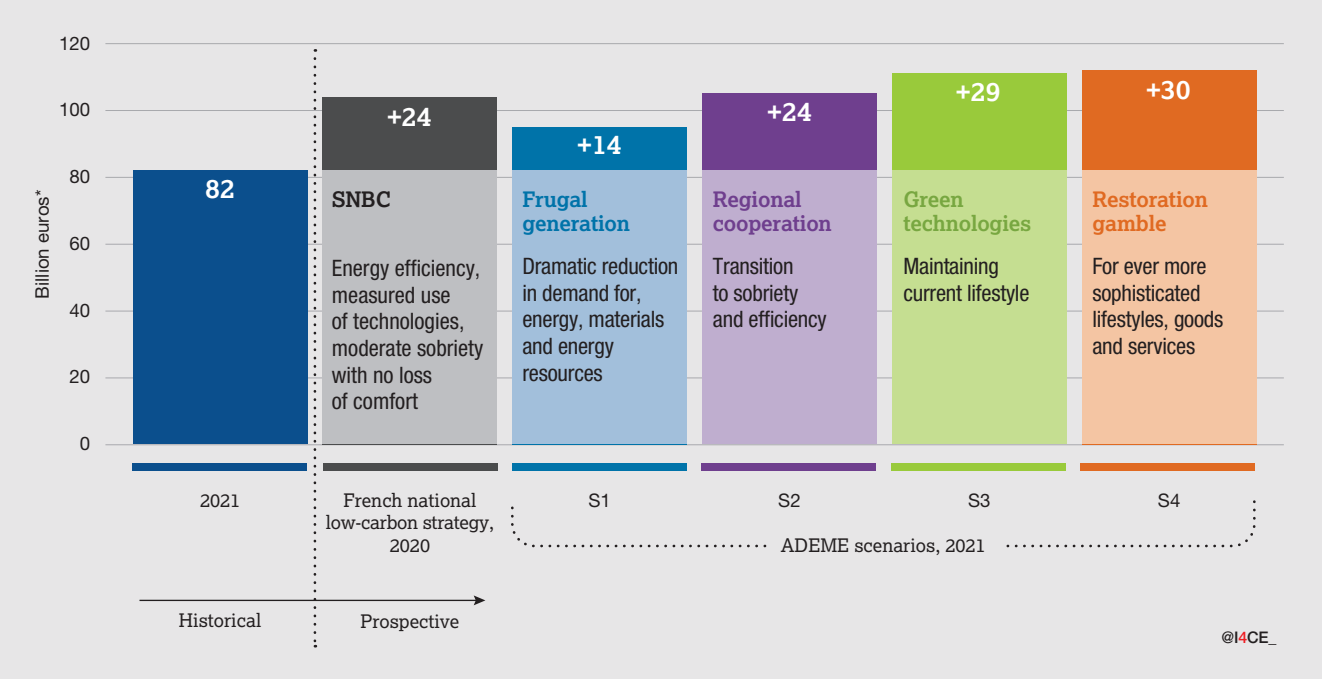
However, the level reached in 2021 remains fragile. In the face of more expensive materials and a shortage of workers and expertise, households, companies and public authorities are increasingly struggling to undertake and to finance their climate investment projects. Moreover, the exceptionally high energy prices have suddenly deprived them of some of their financing capacities.

Further investments are needed to stay on track to meet climate targets

Despite significant growth, climate investments are still insufficient. Based on the ADEME "Transition(s) 2050" scenarios, we estimate the additional climate investments that would be needed in buildings, transport and energy production to get on track to carbon neutrality. They stand at between 14 billion euros per year for a frugal transition and up to 30 billion euros per year in a scenario in which technical progress maintains lifestyles. These are minimum amounts, which do not cover the requirements of agriculture, industry or adaptation to climate change.

FIGURE 2: CLIMATE INVESTMENT REQUIREMENTS 2021-2030

Annual public and private investments in buildings, transport and the energy sector



*In billion euros at constant 2015-2019 prices.

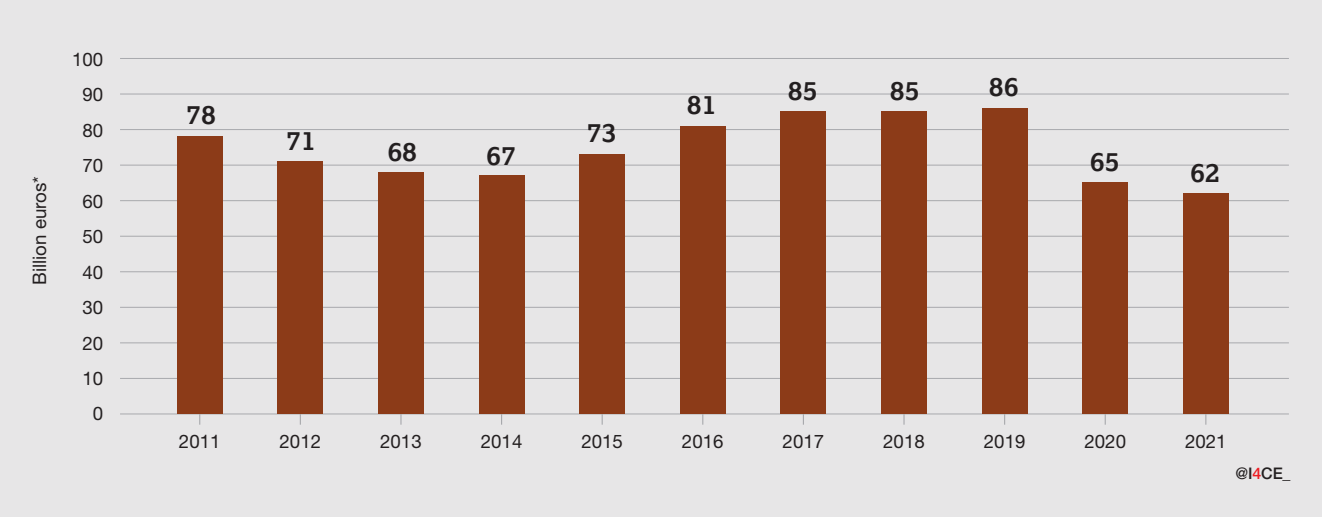
NB: In this figure, adjustments are introduced in order to compare real investments and requirements for the same geographical and sectoral scope. Consequently, the amount of climate investment is slightly different from what is presented above. All of the adjustments are given in **annex 4**.

The government is currently revising its climate strategy and will need to select one of these transition scenarios. But whichever scenario is chosen, it will imply investing more in low-carbon equipment and infrastructure, in particular to meet the new EU objective of reducing net greenhouse gas emissions to 55% below 1990 levels by 2030. With the funding under the recovery plan terminating at the end of this year, the public authorities will need to provide for long-term resources to continue to support households and companies. This will be one of the issues of the budget debate this autumn, then of the Loi de Programmation Energie-Climat (LPEC, energy and climate planning law), scheduled for summer 2023.

Fossil investments are declining, but could still rebound

Fossil investments have declined sharply since the health crisis, standing at 62 billion euros in 2021. This drop is primarily explained by the decrease in registrations of conventional vehicles, resulting from supply chain issues with semiconductors, but also from stricter regulations on vehicle emissions. To meet national targets, fossil investments still need to be halved by 2030.

FIGURE 3: FOSSIL INVESTMENTS IN FRANCE



*Data in current prices.

However, fossil investments could still rebound. If the supply chain issues are resolved, more conventional vehicles could be registered. And if the energy crisis continues, it could lead to new investments in gas imports or in thermal power stations.

To avoid this rebound and to reduce France's dependence on fossil fuels in the long term, climate investments must be accelerated without delay.

INTRODUCTION

Today's investments determine tomorrow's greenhouse gas emissions. Households, companies and public authorities invest in buildings, equipment and infrastructure. These installations, through their functioning, condition the level of fossil fuel consumption over time and the associated GHG emissions, which must be reduced to address the climate emergency.

Through its next climate strategy, scheduled for summer 2023, France must take account of the new EU target of reducing net GHG emissions to 55% below 1990 levels by 2030, which goes far beyond the initial targets, and maintain the goal of carbon neutrality by 2050. In order to inform the planners of the next Stratégie Nationale Bas-Carbone (SNBC, French National Low-Carbon Strategy) and the Programmation Pluriannuelle de l'Energie (PPE, Multi-Year Energy Plan), several organisations have conducted foresight exercises, which help to determine the possible pathways to carbon neutrality by 2050, in particular ADEME, through its "Transitions 2050" report. In this work, ADEME has produced four very contrasting decarbonisation scenarios, with the goal of identifying different routes to carbon neutrality and debating them for the next SNBC and PPE. Thus, these four scenarios translate into different investment dynamics in the sectors of the national economy.

The Landscape of Climate Finance provides an overview of strategic expenditures made for the low-carbon transition, and identifies the additional investments to be made in the different economic sectors according to the decarbonisation scenarios. The 2022 edition of the Landscape of Climate Finance covers:

1. The state of climate investments up to the end of 2021, as well as the outlook for 2022 and 2023;
2. The state of fossil investments up to the end of 2021, as well as the outlook for 2022 and 2023;
3. The investment requirements identified according to the SNBC and PPE (2020) and according to the ADEME "Transitions 2050" scenarios (2021).

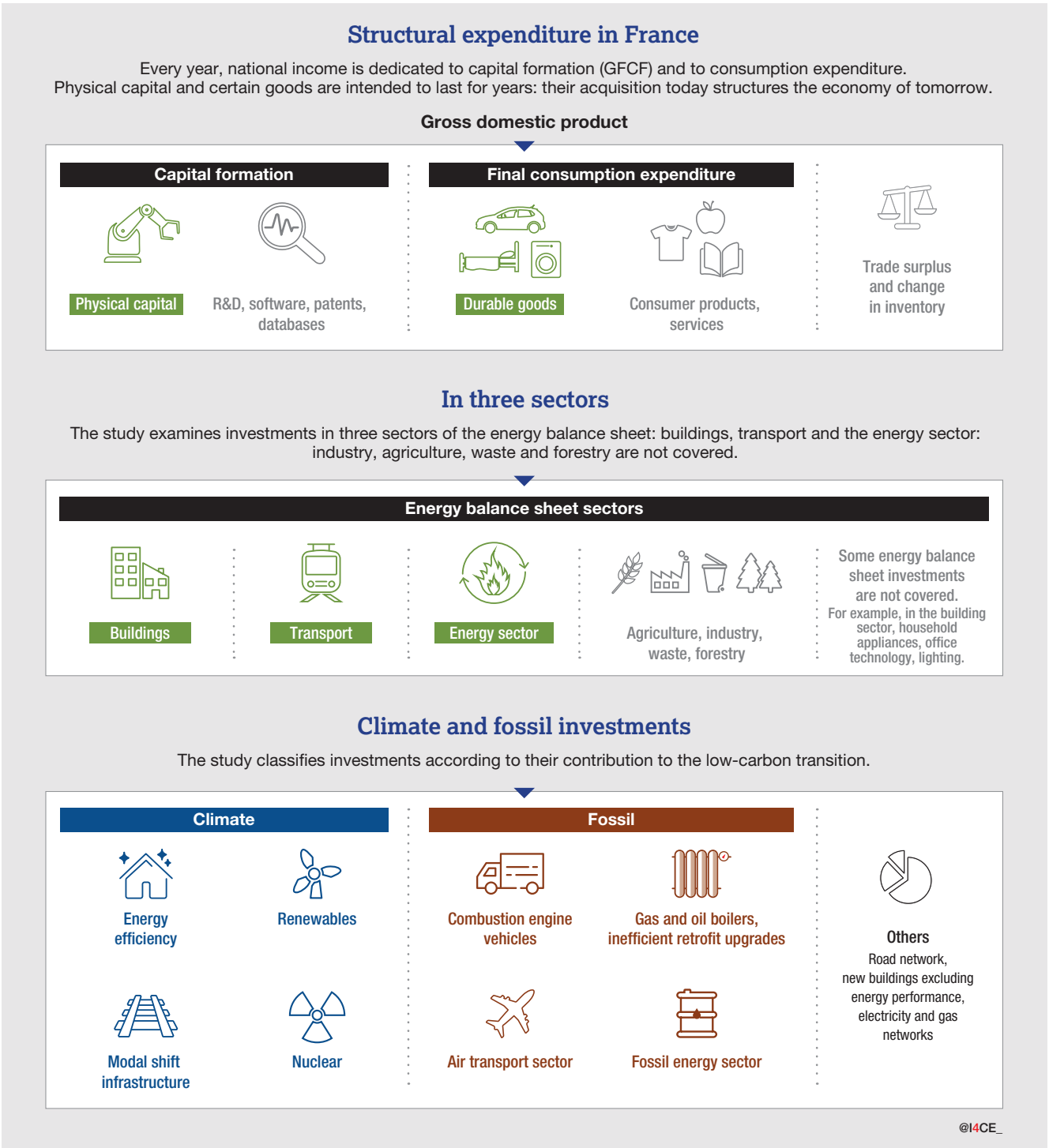
CAUTION

The results presented in this report replace those in the previous editions of the Landscape of Climate Finance in France and cannot be compared to them. Indeed, changes in the sources, the methodology or the scope of the study require the revision of results for the whole period covered by the study. However, the comparisons between years presented in this edition and its annexes remain valid, since they use the same methodology.

METHODOLOGY

The Landscape measures the climate and fossil investments made in France from 2011 to 2021, and documents their short-term outlook. It compares current investments with requirements based on several climate scenarios for the period 2021-2050.

THE SCOPE OF THE LANDSCAPE OF CLIMATE FINANCE



Investment records

Definition of investments

The Landscape studies the fraction of wealth produced in France (GDP) devoted to investment.

- More specifically, the study examines gross fixed capital formation (GFCF), in other words, in national accounts, expenditure on acquisitions of tangible and intangible assets (Eurostat, 2013). The notion of assets implies that expenditures will serve to provide goods or services for more than a year, which distinguishes them from consumer goods. The assets covered by the study are physical equipment such as buildings, transport and network infrastructure, boiler houses, power plants, etc.
- In addition, the study examines the consumption of goods known as "durable", in the sense that they provide services to consumers for more than a year. This includes in particular purchases of new vehicles, when made by households[1].

Sectors covered

This study breaks down investments into sectors, according to the nomenclature of the energy and GHG emissions balance in the "climate plan" format, which serves as a reference for developing the French National Low-Carbon Strategy and the main energy scenarios.

The Landscape covers:

- the **building sector**, which includes investments in the construction, maintenance and improvement of housing and tertiary buildings;
- the **transport sector**, which includes investments in transport infrastructure and vehicles;
- the **energy sector**, which includes energy extraction, transformation, transportation and distribution activities.

In this edition of the study, some activities are not yet covered by investment records, including construction materials, rolling stock (train, tram, underground), river and sea transport infrastructure, and motorised vessels.

The agriculture, industry, centralised waste management and land use sectors are not covered in this study. The lack of data makes it difficult to identify investments in these four sectors. Moreover, investments in research and development for the low-carbon transition, which are not associated with the emissions in any specific sector, are not studied. Finally, beyond the issue of reducing GHG emissions, investments in adaptation to climate change are not documented.

Climate and fossil investments

Climate investments contribute to reducing GHG emissions in France, and concern:

- energy efficiency, such as insulation of buildings, high-efficiency heating equipment and electric cars;
- the production of renewable energies, whether electric or thermal;
- public transport (rail, UPT) and cycling infrastructure, which encourage a modal shift from polluting modes such as passenger cars;
- nuclear power generation.

Fossil investments concern the production, distribution or consumption of coal, oil and natural gas in France. These investments delay the transition, because they prolong the consumption of fossil energies and compete with their low-carbon alternatives. By extension, this group also includes inefficient work on buildings, such as exterior renovation or re-roofing without thermal insulation, which are missed opportunities for the transition.

The distinction between climate investments and fossil investments considers the characteristics of equipment and is based on:

- the French National Low-Carbon Strategy (SNBC, 2020);
- the Multi-Year Energy Plan (PPE, 2020);
- the nomenclature of the France Finance Verte (Greenfin) label;
- the criteria set out by the Climate Bond Initiative;
- the criteria of the reports by the EU Technical expert group on sustainable finance (TEG 2020), prefiguring the EU taxonomy for sustainable activities;
- the report on the environmental impact of the state budget (2021);
- the environmental accounts (Eurostat, 2016 and 2017);
- ADEME's study 'Marchés et emplois de la transition énergétique' (2022).

Sometimes, for a given installation, the reference documents diverge on the criteria to be taken into account, or they establish criteria based on different characteristics of the equipment studied. In general, preference is given to definitions for which coherent data exist for the whole study period (2011-2021). **Annex 5** details the references taken from the different documents (French version only).

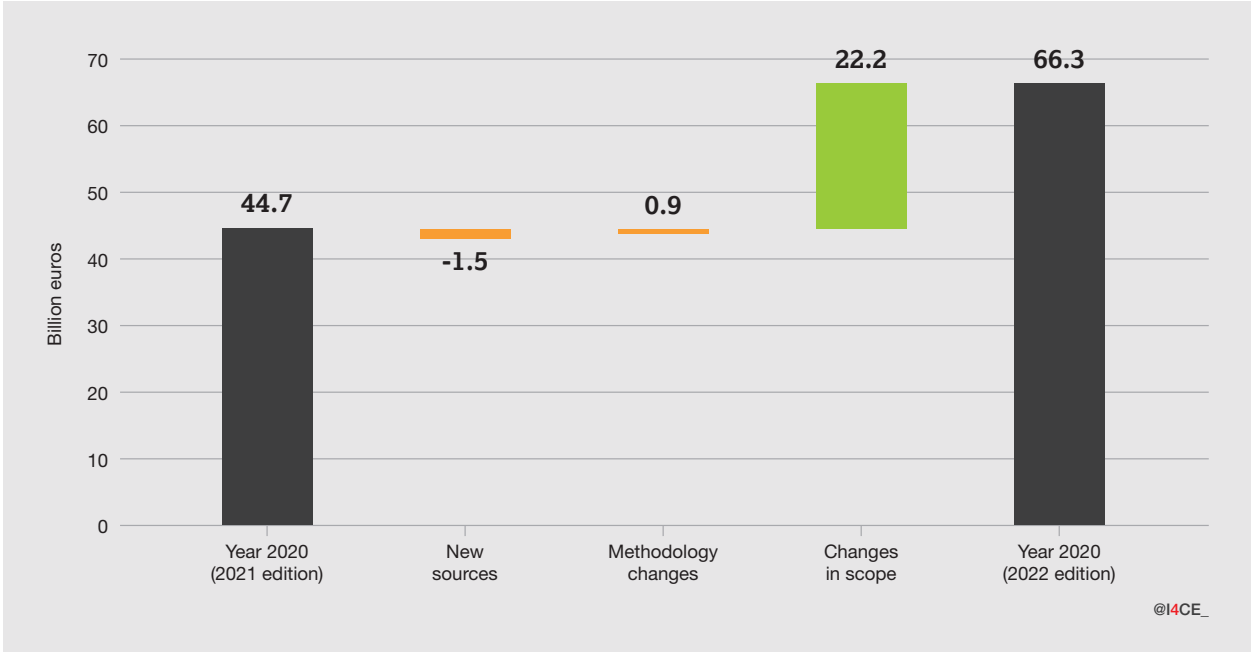
1 When made by companies and public authorities, these purchases are included in the GFCF.

BOX 1: CHANGES IN SCOPE RELATIVE TO THE 2021 EDITION

In this new edition, the scope has been revised in order to better cover investments in the building, transport and energy sectors. The revision of the scope requires the revision of results for the whole period 2011-2021, to ensure that the methodology remains constant. Comparisons between years presented in this edition are therefore possible.

In terms of climate investments, the study again covers the **energy performance of new buildings**, with a new methodology covering total energy expenditure in buildings. This methodology differs from the approach adopted up to the 2020 edition of the Landscape, which considered the additional investment in relation to a building constructed according to the RT 2005 standard. With the new methodology, climate investments in the energy performance of new buildings are assessed at 18 billion euros for 2020, whereas with the former methodology, they would have stood at 4.8 billion euros. Furthermore, the study reintegrates the **energy retrofitting of tertiary buildings** for a total of 4 billion euros.

FIGURE 4: VARIATIONS BETWEEN THE 2021 AND 2022 EDITIONS – IMPACT ON CLIMATE INVESTMENTS RECORDED IN 2020



Where fossil investments are concerned, the way combustion engine vehicles are counted has changed. In the 2021 edition, combustion engine vehicles were classified according to the conventional emissions measured from the exhaust pipe, in gCO_2 / km. In the 2022 edition, all diesel, petrol and self-charging hybrid cars are considered as fossil investments. This change makes it easier to compare current levels of investment with those of the low-carbon scenarios, in which the fleet is broken down according to motor energy rather than to conventional CO_2 emissions. Using this new definition, investments in combustion engine vehicles (petrol and diesel engines, including self-charging hybrids) reached 38.2 billion euros in 2020, compared to 27.2 billion euros the same year with the previous definition (see **annex 1**). Moreover, in the building maintenance and improvement sector, certain energy expenditures are incorporated into fossil investments when they are very inefficient. These include, for example, re-roofing or exterior renovation works without thermal insulation. These inefficient retrofit measures, assessed based on the OPEN and TREMI 2017 surveys by ADEME, stood at 6.7 billion euros in 2020. They should not be confused with shallow retrofitting, which describes the insulation of part of a home, or the installation of a high-efficiency heating system without insulation.

Measurement of expenditure

Investments are recorded by their acquisition costs. These costs correspond to the CAPEX (capital expenditure) in company accounting or project financing. They are given exclusive of tax for companies and public authorities, and inclusive of tax for households.

Depending on the sector and the accounting policies applying to it, the expenditures involved in acquiring and commissioning equipment may cover: preliminary studies, obtaining administrative authorisations, surveys, acquiring machines or equipment, civil engineering, labour, inspections, etc. However, the investment costs exclude the interest paid during the construction phase and, more generally, the cost of project financing. This corresponds to the concept of overnight costs, especially in the calculation of the cost of electricity generation (LCOE, see IEA, 2020).

Depending on the sector and the national accounting policies, the reference date for costs can be the date of work carried out (the case of construction or energy retrofitting), registration (the case of vehicles), or equipment installation (the case of renewable energies). For the biggest projects, such as transport infrastructure or nuclear, the costs are spread over several years depending on the progression of fixed assets in business accounting.

All of the climate and fossil investments reported in the study for the period 2011-2021 are expressed in current euros, in other words at the prices observed in the year the investments were made. Annex 1 reflects variations in volumes and prices.

Main sources

The Landscape of Climate Finance aggregates publicly available data on climate and fossil investments between 2011 and 2021. Most of the information concerning climate investments is taken from the annual market review for energy efficiency and renewable energy equipment (“Marchés et emplois de la transition énergétique”) published yearly by the French ecological transition agency (ADEME), the latest edition of which was published in September 2022. Additional data is taken from the National accounts of the building sector (Compte du Logement), from the SITADEL database and from the Annual transport report (Bilan Annuel du Transport) by the Data and Statistics Department (SDES, Service de la Donnée et des Etudes Statistiques) at the French Commission on Sustainable Development (CGDD, Commissariat Général au Développement Durable), as well as from the economic reports of the French Building Federation (FFB, Fédération Française du Bâtiment). The ADEME and French National Housing Agency (ANAH) budgets are examined based on the documents communicated by both agencies. The main sources for each investment record are given in annex 1.

Short-term outlook

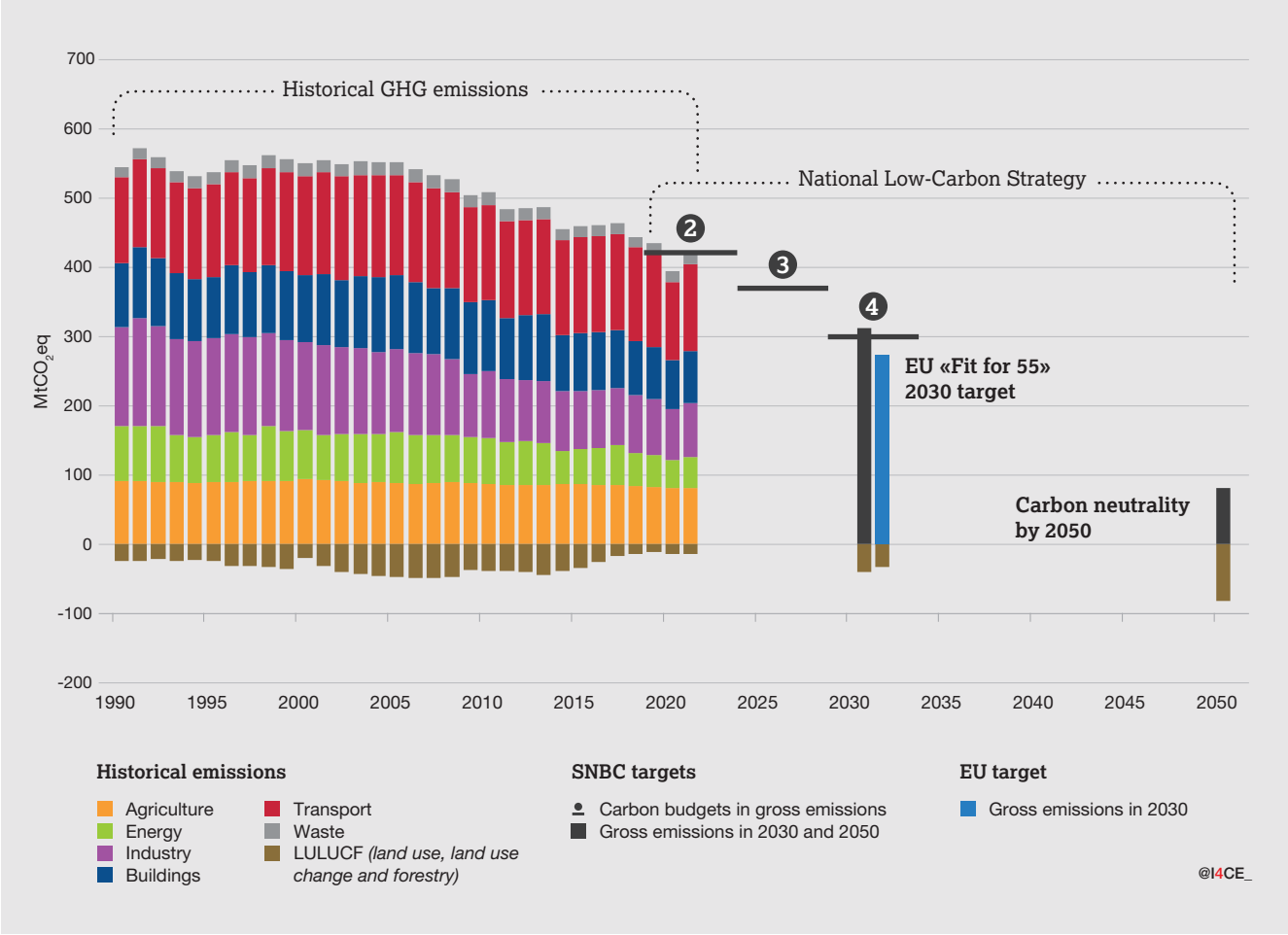
This study documents the outlook for climate and fossil investments in the short-term, in other words for the years 2022 and 2023, compared to the 2021 level. To do so, it uses the first figures available for the year 2022 (monthly, quarterly or six-monthly statements, depending on the equipment concerned), interviews with professionals and the authors’ understanding of the main factors influencing investment decisions, including the public policy measures taken recently, whether budgetary or regulatory. These factors are detailed for each sector in annex 3 (French version only).

Investment requirements

Climate targets

The Landscape considers France's climate targets, especially the goal of achieving "carbon neutrality" by 2050, in other words a balance between the quantity of greenhouse gases emitted and that of the greenhouse gases absorbed by sinks. This target, taken up at the EU level, is the European Union's national contribution to the Paris Agreement.

FIGURE 5: GREENHOUSE GAS EMISSIONS IN FRANCE (1990-2021) AND NATIONAL TARGETS (2030 AND 2050)



Sources: I4CE from CITEPA, the French Ministry for the Energy Transition, the French High Council on Climate.

In spring 2020, the French government adopted its second National Low-Carbon Strategy, as well as the carbon budgets for the periods 2019-2023, 2024-2028 and 2029-2033. The carbon budgets set the maximum amount of greenhouse gas emissions that should not be exceeded at the national level over five-year periods.

In July 2021, the European Union adopted the target of reducing net greenhouse gas emissions to 55% below 1990 levels by 2030, compared to the previous target of reducing gross greenhouse gas emissions by 40%. Net emissions take account of the absorption of greenhouse gas emissions by carbon sinks (forests, other lands, wood products, as well as carbon capture and storage).

According to the French High Council on Climate (Haut Conseil pour le Climat, 2022), this new EU target will lead France to revise the target for reducing GHG emissions by 2030 compared to 1990, by:

- -50% for gross emissions;
- -54% for net emissions.

In 2022, the government began the revision of the French Climate and Energy Strategy (SFEC, Stratégie Française Energie-Climat), updating the National Low-Carbon Strategy and the Multi-Year Energy Plan. This third SNBC will include the more ambitious EU intermediate target for 2030, and will maintain the target of carbon neutrality by 2050.

Climate scenarios

To determine the investment requirements, the Landscape refers to carbon neutrality scenarios, in particular:

- **the "With additional measures" scenario** of the National Low-Carbon Strategy (SNBC, 2020) and the Multi-Year Energy Plan (PPE, 2020). This is the scenario "chosen by the government for its public action" (DGEC, 2019). The Ministry of Ecology develops this scenario to determine the strategic guidelines for the SNBC, to define the carbon budgets for each sector, and to identify the priorities for government action. This scenario is also communicated to European and international partners, especially in the context of the Paris Agreement. It is designed to be consistent with climate targets, reasonable in terms of the path to carbon neutrality, and realistic in view of the current situation and of what can be expected in the future (technologies, lifestyles);
- **the "Transitions 2050" scenarios**, developed more recently by ADEME, explore four contrasting paths to carbon neutrality. These are archetypes of strategy to collectively consider the possible alternatives, and to reflect on what seems more realistic and more desirable, but without claiming to cover all possible scenarios (ADEME, 2021). They aim in particular to deliberate on the ecological transition strategy, especially in order to revise the SNBC and the PPE by 2024.

These scenarios are based on the target of carbon neutrality and explore, through guidelines, stories and models, the economic and social changes required to achieve it (the backcasting method). These scenarios can be debated, different ways of meeting the same climate targets can be considered, and alternative targets can be proposed. But we believe the scenarios selected for this study are useful, since they cover a broad spectrum of possibilities and take account of numerous technical, social and economic constraints.

The climate scenarios are documented based on the main publications and their annexes (ADEME, 2021; DGEC, 2019). Exchanges with the scenario authors and modellers have confirmed our interpretation of the data available and, where necessary, have enabled us to request further data.

Investment pathways

The investment pathways are derived from the climate scenarios, by multiplying the number of installations (volumes) by the anticipated unit costs.

- In each sector covered by the study, and for each scenario, we identify the amount and the characteristics of equipment deployed to reduce emissions, for example: the number of retrofits in homes, the wind or solar power capacities installed, the programmes for the development or regeneration of transport infrastructure. We build on the expertise of the modellers and on previous works in order to avoid omitting equipment crucial to the transformation of each sector.
- We assign unit costs to equipment. These costs are projected based on their levels observed in the recent period, in other words between 2015 and 2020. When the recent sources do not specify the year for which they have observed costs, we assume that prices have not evolved over the period 2015-2020. Generally, we consider that the costs are constant, except where the characteristics of the equipment have evolved (for example, larger and larger batteries for electric vehicles), or where the reference sources anticipate changes in costs linked to technical progress or to economies of scale specific to the equipment (for example, a reduction in the cost of the solar kW). However, we do not comment on variations in the transversal components of investment costs (for example, the cost of labour, capital or energy). Investment pathways are thus given in constant euros.

This additive process enables us to effectively make the link between the changes specific to each sector and their economic consequences. However, it does not entail any macroeconomic closure.

Investment targets and requirements

In this edition, the Landscape compares current investment levels and the pathways derived from the climate scenarios for the periods 2021-2030 and 2031-2050. For both of these periods, the investment targets are established according to the average annual investments for each period. This implies that to meet the climate targets in accordance with the climate scenario, the investments should be, on average over the period, around the level of the target. Thus, delayed investments can be offset by over-investment in the following years, and investments that potentially exceed the target can avert future difficulties.

We strive to develop pathways that are comparable in terms of volumes and prices to those observed for the historical period, which leads us to make adjustments when comparing the historical records with requirements (see annex 4).

In some sectors, certain scenarios do not assume any additional expenditures, but imply changing the nature of the projects undertaken. For example, energy retrofitting expenditures could concentrate on deep retrofits rather than on step-by-step approaches. When these gaps cannot be measured quantitatively, we mention them in the comments on results.

TABLE 1: INVESTMENT SECTORS

Energy balance sheet sectors	Study sectors	Climate investments	Fossil investments	Other investments
Buildings	**Construction**	Energy performance of construction	-	Construction excluding energy performance
	Maintenance - improvement	Energy retrofitting: efficient measures	Energy retrofitting: gas and oil boilers, inefficient measures	Related work Other maintenance-improvement
Transport	**Vehicles**	Low-emission vehicles	Combustion engine vehicles	-
	Infrastructure	Modal shift infrastructure: rail, urban public transport, cycling network and alternative fuel infrastructure	Airports and air transport equipment	Road network
Energy sector	**Renewable energies**	Electric renewables, thermal renewables, district heating, biorefineries	-	-
	Nuclear	EPR and "Grand Carénage"	-	-
	Fossil energies	Carbon capture and storage	Fossil fuel electricity Refineries and pipelines	-
	Networks and flexibility	Flexibility: electrolysis, methanation and stationary batteries	LNG terminals	Electricity and gas networks
✖ Not covered	Agriculture, industry, centralised waste management, land use, adaptation to climate change			

BOX 2: ENERGY RETROFITTING TERMS

Energy retrofitting refers to work on energy items in buildings: walls, floors, roofs, windows and doors, and heating, ventilation and control systems. Each retrofit measure is classified according to performance criteria established by the OPEN and TREMI surveys by ADEME, concerning for example the thermal resistance of walls or boiler efficiency.

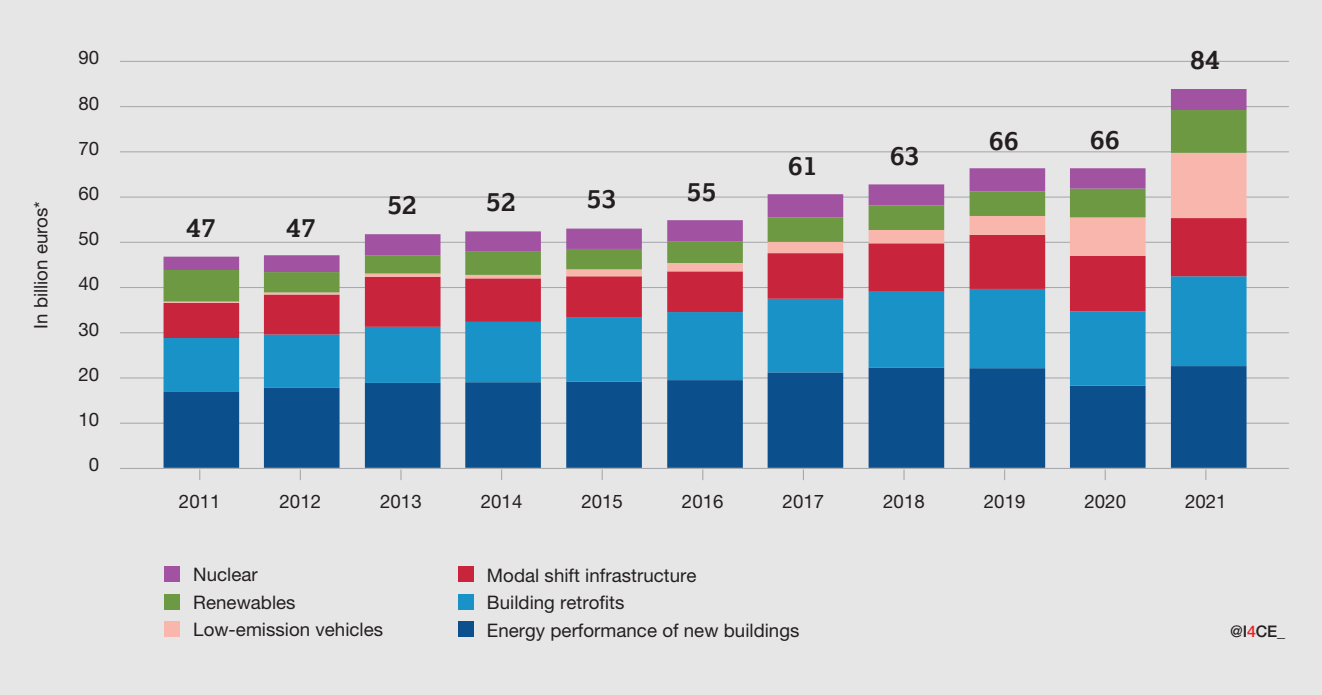
Efficient measures, either in the context of a shallow retrofit, in other words insulating only part of a building or replacing a heating system without insulation, or as part of a *deep retrofit*, involving several measures and potentially covering all parts of the building, are considered as climate investments.

The installation of low-temperature gas boilers or oil boilers, as well as *inefficient measures*, for example exterior renovation or re-roofing without thermal insulation, are considered as fossil investments.

CLIMATE INVESTMENTS GROWTH IS STILL FRAGILE

After a slight slowdown in 2020, climate investments grew significantly in 2021, reaching 84 billion euros. They benefitted from the economic recovery, an increase in public financing and regulatory measures. Climate investments should increase in the short-term but are increasingly confronted with soaring material costs and the energy price crisis.

FIGURE 6: CLIMATE INVESTMENTS IN FRANCE BY SECTOR



*Data in current prices.

Source: I4CE, Landscape of Climate Finance, 2022 edition.

A net increase in climate investments in 2021

In 2021, climate investments increased significantly and stood at 84 billion euros, or 18 billion euros more than the previous year. This high growth concerns all sectors, except for modal shift infrastructure and nuclear power.

This surge in climate investments is primarily linked to the rescheduling of projects postponed in 2020. Indeed, the lockdown in spring temporarily halted certain transport infrastructure, new construction and energy retrofitting projects, as well as the installation of renewable energy production capacities. From late 2020, and even more so in 2021, the economic recovery and the end of the main health restrictions enabled these sectors to finish the projects that had been postponed, and to invest even more.

In addition, certain investments benefited from increased state support, such as energy retrofitting of housing, or the acquisition of low-emission cars. Households received 5.1 billion euros of subsidies from the French state (in particular MaPrimeRénov' and Habiter Mieux), as well as subsidised loans (interest free eco-loan), which is 1.8 billion euros more than in 2020. In energy retrofitting, investments also increased in the tertiary building stock, thanks to increased state support for work on public buildings in the context of the recovery plan. The public authorities also spent more in the transport sector. The state paid a globally higher ecological bonus, but above all, the state and the regional authorities increased the subsidies given to SNCF Réseau, which enabled the rail network operator to

temporarily increase investments compared to 2020.

Moreover, regulations have led to growth in investments, especially in low-emission vehicles. The car manufacturers had anticipated the entry into force of the EU regulation on CO_2 emissions from new cars, leading them to propose low-emission models on the market. Furthermore, the establishment of low-emission zones and the obligation to green the fleet have encouraged buyers to opt for electric or plug-in hybrid cars. Thus, the share of electric and hybrid vehicles in sales of new cars rose to 18% in 2021, compared to only 11% in 2020 (CGDD/SDES, 2022).

Finally, and to a lesser extent, the increase in climate investments is also due to the continuation or escalation of certain major projects. The work underway in offshore wind farms is boosting investments, as is the work on the Grand Paris Express and the "Grand Carénage" nuclear power plant refit programme. Together, these major projects contributed to an increase in climate investment of around 1.4 billion euros in 2021 compared to 2020.

BOX 3: GROWTH IN CLIMATE INVESTMENTS IS ESPECIALLY DUE TO AN INCREASE IN THE NUMBER OF SYSTEMS INSTALLED, DESPITE LARGE PROJECTS THAT ARE MORE EXPENSIVE THAN EXPECTED

Across a sample of almost 90% of climate investments made in 2021, prices had increased on average by 3% relative to 2020 (see annex 2). Thus, although the increase in equipment prices contributed to growth in climate investments, this growth is mainly due to the increase in volumes. Households, companies and public authorities registered more low-emission vehicles, installed more photovoltaic solar panels, and undertook a larger number of retrofit measures than in previous years.

This average increase masks wider variations by sector. The prices increased more in the building and transport infrastructure sectors, because material costs rose sharply in 2021, primarily due to supply chain issues. In other sectors, the prices fell, especially for the installation of photovoltaic solar panels and registrations of private electric cars. These changes are explained by composition effects. Indeed, the share of large solar photovoltaic power plants in new installations increased, while these large power stations represent lower costs per megawatt than installations on canopies or roofs. Similarly, the share of low-cost electric cars in sales increased as new cheaper models entered the market.

Moreover, the cost of certain large projects is revised as the work is carried out. For example, the Grand Paris Express and EPR Flamanville projects have required more investment than what was initially planned. These increases account for 1.8% of climate investments over the period 2011-2021.

In total, measured in constant euros, climate investments increased by 71% between 2011 and 2021. They stood at 2.2% of GDP in 2011, and 3.6% in 2021. Thus, a growing proportion of national wealth is being dedicated to climate investments.

In the short term, fragile growth in climate investments

In 2022 and 2023, climate investments should increase moderately, with investment trends being positive in several sectors.

The first data available for the year 2022 indicate that more electric vehicles are being registered (CGDD/SDES, 2022) and more new buildings are under construction, leading to more investments in the energy performance of new buildings (CGDD/SDES, 2022), or in high-efficiency heating equipment (Observ'ER, 2022). The regulations remain conducive to an increase in climate investments, in particular in the low-emission vehicle sector. The rent freeze on buildings that leak too much heat since August 2022 and the gradual entry into force of the ban on renting out homes with a very poor energy rating will increasingly motivate landlords to undertake retrofit measures in their energy-intensive dwellings. The planned growth in investments, in particular in offshore wind power and public transport infrastructure, will feed growth in climate investments.

However, the rate of growth will not reach the rate observed in 2021. The effect of the post-Covid catch up will dwindle from 2022. Climate investments could not be increased in 2020 because of the health restrictions, and this growth was largely transferred to the year 2021.

Moreover, in some sectors there is a shortage of workers to meet demand, especially the building sector. Since September 2021, 60% of companies in the sector say they are struggling to recruit staff (Banque de France, 2022). Shortages of materials are also a problem. For the same budget, some actors are reducing the volume of work undertaken, for example in rail infrastructure or renewable energies.

Furthermore, the unprecedented energy price hikes are only leading to opportunistic investments for the time being. Thus, in winter 2021-2022, households and small companies that were replacing heating equipment opted for wood boilers or heat pumps in order to immediately reduce their energy bills, without undertaking more ambitious insulation work. They are also increasingly turning to electric vehicles in response to the high petroleum fuel prices. However, the energy price hikes do not seem to have prompted any substantial climate investments by companies. Many are still adopting a wait-and-see attitude, convinced that prices will eventually fall again. Moreover, the price hikes have been sudden, whereas major investment projects require lengthy preparations (studies, permits, etc.). Finally, the increase in energy bills is sometimes so huge that it curbs the investment dynamic by depriving households and companies of their financing capacities.

TABLE 2: CLIMATE INVESTMENTS: AMOUNTS IN 2021, SHORT-TERM OUTLOOK (2022-2023)

(In billion euros)	Investments in 2021	Change relative to 2020	Outlook 2022-2023*	
Energy performance in new buildings	22.5	+4.4 *(+24%)*	**Increasing**	↗
Energy retrofitting in buildings	19.9	+3.3 *(+20%)*	**Increasing**	↗
Modal shift infrastructure	12.9	+0.7 *(+5%)*	**Increasing**	↗
Low-emission vehicles	14.4	+5.8 *(+68%)*	**Increasing**	↗
Renewable energies	9.5	+3.2 *(+52%)*	**Stable**	→
Nuclear	4.6	+0.1 *(+2%)*	**Stable**	→
All investments	83.9	+17.6 *(+27%)*	**Increasing**	↗

*Outlook is given in current euros.

The state of climate investments by sector

ENERGY PERFORMANCE OF NEW BUILDINGS: catching up on projects interrupted in 2020

Investments increased significantly in 2021, by around 24%. This increase is primarily due to the resumption of construction projects for housing and tertiary buildings, which were seriously disrupted in 2020 by the health crisis. The increase in prices (+5%) explains to a lesser extent the growth in investments in 2021. Still subject to the RT 2012 standard, the average energy performance of buildings has not evolved.

In 2022 and 2023, investments in the energy performance of new buildings should continue to grow. Based on data concerning permits and construction start-ups communicated by the SDES (2022), the volume of building activity will increase slightly in the short term. But the growth in investments should be mainly driven by the increase in prices, due to high inflation in construction materials. The increase in the energy performance of new buildings constructed under the new heating regulations (RE 2020) should contribute marginally to the increase in investments, especially in the residential sector in the short term, with additional costs to be planned for energy uses.

ENERGY RETROFITTING IN BUILDINGS: despite growth in investments driven by state support, there are still few deep retrofits

Investments have rebounded and stand at 19.9 billion euros. Many projects were interrupted in 2020, especially in the territory building sector, because of the periods of health restrictions. In the private housing segment, it is especially heating equipment (heat pumps, wood burning appliances, very high-efficiency gas boilers) that are boosting investments. The MaPrimeRénov' aid programme has contributed to this growth in investments, especially with the extension of support to landlords. However, despite this increase, investments in energy retrofitting are not sufficiently improving the energy performance of buildings. Households, but also companies and public authorities, are failing to coordinate the different retrofit measures within a building, with the prospect of ultimately achieving the low-energy building rating.

Overall, investments in energy retrofitting should increase slightly in 2022 and 2023, but should be largely concentrated in heating equipment. The energy price hikes that began in late 2021, despite being limited by price cap measures, are prompting households to opt for higher efficiency appliances when replacing their heating equipment. However, households will not undertake any more ambitious or heavy work, especially in terms of insulation, because of the surging cost of materials and the stability of the level of support. Consequently, the deep retrofit market is still not expected to grow, due to a lack of sufficient financing solutions and support for households. On the tertiary market, the implementation of the "Eco énergie tertiaire" (tertiary eco energy) decree, which requires tertiary building owners to reduce their energy consumption by 40% by 2030, should drive a slight increase in investments in the sector in the short term.

MODAL SHIFT INFRASTRUCTURE: growth in investments in 2021, but also in 2022 and 2023

Investments have picked up again, with a 5% increase compared to 2020. Investments in the maintenance and modernisation of the rail and public transport networks have increased, after 2020, when work was interrupted during the first lockdown. Moreover, SNCF Réseau has benefited from aid granted to rail infrastructure under the recovery plan and from the partial assumption of the debt by the French state, which enabled it to temporarily increase its investments while restoring cash flow and limiting borrowing (SNCF Réseau, 2022). The Grand Paris Express project is gaining momentum and mobilising more and more investment. Households, companies and public authorities have also installed more electric charging points than in previous years.

In the short term, investments should increase marginally. The planned reduction in investments by SNCF Réseau (-0.4 billion euros in 2022 and 2023 compared to 2021) will be more than offset by the increased momentum of work on the Grand Paris Express (+1.8 billion euros in 2022 compared to 2021). Although SNCF Réseau is investing up to the value of the financial package set out in the contract concluded with the French state, the rail network operator is obliged, because of high inflation, to reduce the volume of renovation on its railway lines. Moreover, the prospect of restoring its financial balance in the long term is limiting its investment capacities. In urban public transport infrastructure outside Ile-de-France, investments should increase slightly, in particular thanks to funding granted in the context of the call for proposals "Transports collectifs en site propre et pôles d'échanges multimodaux" (Public transport lanes and transport hubs) published in 2021. But the public transport authorities such as Ile-de-France Mobilités are facing economic difficulties (Cour des Comptes, 2022). In particular, the decline in usage linked to increased homeworking is affecting their operating

budgets, which could lead them to reduce their investments in the medium term. The regional authorities are expected to invest the same amount in cycling facilities as in 2021, according to the first data available for 2022. Investments in electric charging points and NGV stations should increase slightly in 2022 and 2023, in connection with the increase in registrations of low-emission vehicles.

LOW-EMISSION VEHICLES: a sharp increase in investments in 2021, but a slowdown in registrations in the short term

Investments have risen sharply again (+5.8 billion euros). For the passenger car segment, EU regulations are leading manufacturers to sell a higher proportion of electric models, especially city cars that are cheaper to purchase than what was proposed up to now. The densification of the network of electric charging points, the increase in vehicle range and the maintenance of aid for the purchase of light vehicles, such as the automobile bonus, are convincing households and companies to opt for low-emission models. In the other vehicle segments, the evolution varies: while registrations have been relatively stable for light-duty electric and NGV vehicles, they have increased sharply in the low-emission bus and heavy goods vehicle segment. Likewise, investments in bicycles have increased, driven by the boom in e-bike sales.

In 2022 and 2023, investments should continue to increase, but less rapidly than in previous years. The trend remains positive thanks to the public policies in force, in particular EU regulations and aid for purchases (bonuses, conversion premiums), but also thanks to the deployment of charging stations. In the shorter term, the high petroleum fuel prices are encouraging buyers, especially households, to choose electric vehicles over their diesel or petrol alternatives. However, the higher price of vehicles and the longer delivery times, especially linked to the shortage of semiconductors, are causing fleet managers to postpone the replacement of their vehicles, and are therefore delaying the greening of the fleet, despite the different regulatory measures in favour of low-emission vehicles (low-emission zones, obligations regarding green renewal of vehicle fleets).

RENEWABLE ENERGIES: dynamic activity in 2021, stable investments in the short term

Investments stood at 9.5 billion euros in 2021, or an increase of 3.2 billion euros compared to 2020. Whereas they are constant in onshore wind power, they have increased significantly in solar power, offshore wind power, biomethane injection and district heating. In offshore wind power, the different projects launched in the last two years are gaining momentum and have mobilised more investments than in 2021. In solar power, much higher capacities were linked up in 2021, with a net increase in installations of large ground-mounted solar farms. This growth stems from the results of the French Energy Regulatory Commission's (CRE) calls for proposals, but also to a catch-up effect after 2020, which was marked by the health crisis, resulting in delays in the realization of projects in photovoltaic generation. Growth in biomethane injection investments were concentrated in agricultural methanization in 2021. Projects in the creation and extension of district heating are mobilising more investments thanks to aid granted under the ADEME Fonds Chaleur (Heat Fund).

However, in the short term, investments in renewables will undoubtedly remain stable. Offshore wind projects should drive investments upwards, but project developers are facing structural difficulties. They are confronted with a lack of available land for the construction of renewable power generation facilities and, especially for onshore wind power projects, come up against local opposition, which delays the implementation of projects. But they are also facing short-term difficulties. With the current increase in material costs, projects are no longer as profitable as expected in view of the feed-in tariffs agreed with the French state, which are not indexed to inflation. Wind, solar and biomethane injection project developers are therefore adopting a wait-and-see approach.

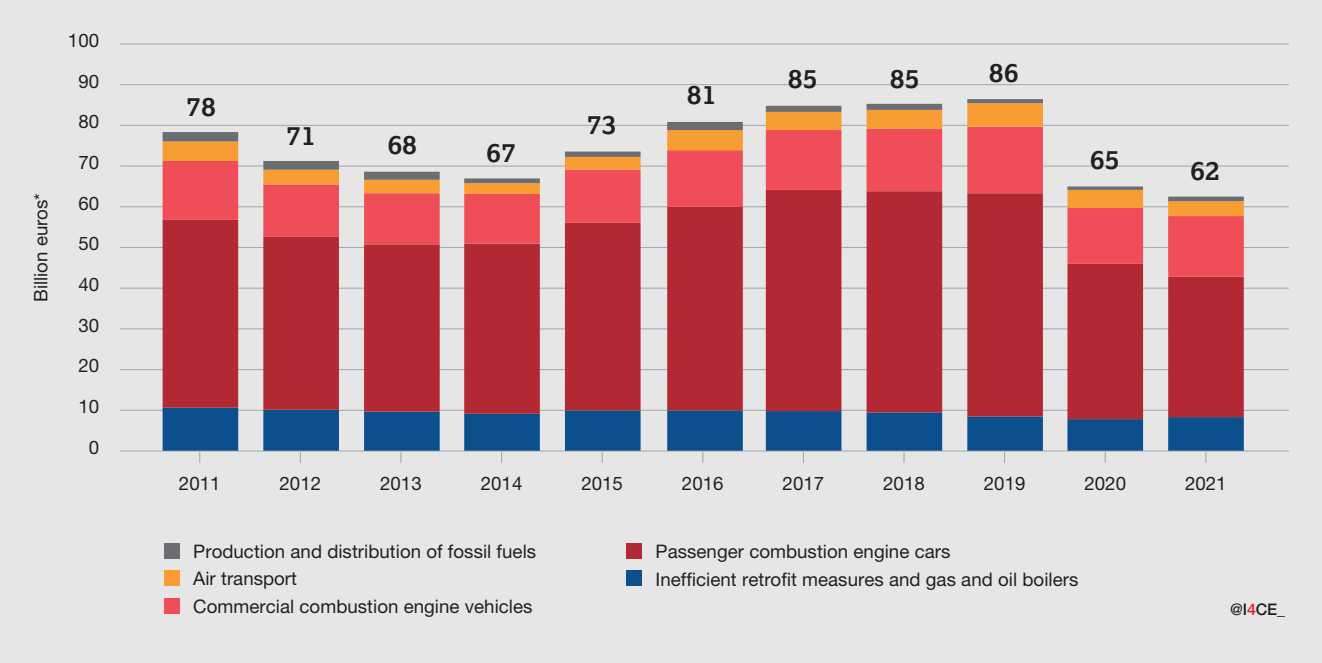
NUCLEAR: a stable level of investments between 2020 and 2023

Investments have remained stable, standing at 4.6 billion euros in 2021. Investments in the maintenance programme for existing nuclear plants, known as the "Grand Carénage", have increased slightly. As for the EPR in Flamanville, investments decreased marginally in 2021, and should be even lower in the next two years, due to its commissioning scheduled for the second quarter of 2023. Overall, investments should remain relatively stable over the next few years.

FOSSIL INVESTMENTS CONTINUE TO DECLINE, BUT COULD STILL REBOUND

After a sharp decline in 2020, fossil investments fell marginally to reach 62 billion euros in 2021, driven downwards by the reduction in registrations of combustion engine vehicles. In the short term, fossil investments should decrease slightly, but a rebound is still possible in the medium term. As for the future of the investments made urgently to secure gas and electricity supply, this will depend primarily on the continuation of climate investments in the next few years.

FIGURE 7: FOSSIL INVESTMENTS IN FRANCE BY SECTOR



*Data in current prices.

Source: I4CE, Landscape of Climate Finance, 2022 edition.

Fossil investments are well below pre-crisis levels

After a sharp decline in 2020 caused by the health crisis, fossil investments fell marginally in 2021. This drop in fossil investments is largely down to the reduction in registrations of private petrol and diesel cars. Since the health crisis, the automobile market has been severely disrupted by the shortage of semiconductors. Combustion engine vehicles face increasing competition from low-emission vehicles thanks to the different public policies implemented. Moreover, investments in the air sector are still declining, with air transport heavily impacted by the drop in traffic due to the health crisis.

The decline in fossil investments in 2021 was mitigated by the increase in prices, which rose by 2% relative to 2020. This price hike particularly reflects increases in the prices of vehicles purchased by households and companies.

France could still face a rebound in the medium term

The first indicators show that fossil investments should continue to decline marginally in the short term. Supply chain issues for semiconductors are limiting production volumes and thus sales of combustion engine vehicles. But the different regulations in place are also contributing to the reduction in fossil investments. EU regulations oblige car manufacturers to sell a smaller proportion of combustion engine vehicles, while the recent decree on heating equipment should result in a sharp decline in new installations of oil boilers.

However, the conditions for a rebound in the middle of the decade are still possible. A return to a period of stable prices and the recovery of supply chains could give rise to renewed investments in combustion engine vehicles, a rebound that will nevertheless be capped by regulatory measures.

Moreover, if France is unable to meet its energy requirements in the coming months and years, especially because of the geopolitical crisis with Russia, it is likely to invest more in infrastructures that will enable it to secure its supply of fossil energies, in particular natural gas. This will depend, among others things, on the continuation of climate investments. These investments, which result in energy savings or in new low-carbon energy production capacities, will reduce France's dependence on fossil fuels. But if climate investments do not increase in the coming years, or even regress, then investments in the supply of fossil fuels are likely to increase once more.

TABLE 3: FOSSIL INVESTMENTS: AMOUNTS IN 2021, SHORT-TERM OUTLOOK (2022-2023)

	Investments in 2021	Evolution compared to 2020	Outlook 2022-2023*	
Combustion engine passenger cars	**34.4**	-3.8 *(-10%)*	**Decreasing**	↘
Combustion engine commercial vehicles	**14.9**	+1.3 *(+10%)*	**Decreasing**	↘
Air transport	**3.5**	-0.9 *(-21%)*	**Increasing**	↗
Inefficient retrofit measures and gas and oil boilers	**8.3**	+0.6 *(+8%)*	**Stable**	→
Production and distribution of fossil fuels	**1.3**	+0.4 *(+50%)*	**Stable**	→
All investments	**62.5**	-2.3 (-4%)	**Decreasing**	↘

*Outlook is given in current euros.

The state of fossil investments by sector

COMBUSTION ENGINE PASSENGER CARS: regulations and supply constraints are slowing investments

Investments have decreased despite a slight increase in prices. Supply chain issues for semiconductors have disrupted the automobile market. At the global level, the production shortfall due to supply chain disruption stands at 7.7 million vehicles (AlixPartners, 2021). The repeated interruptions in the manufacturing of these microchips in the Asian countries, especially in China, have forced manufacturers to close some production lines. Lead times have therefore increased. In 2021, manufacturers were unable to meet demand for combustion engine vehicles.

This supply shortfall is expected to continue until at least 2023, leading to a reduction in registrations. The number of registrations of combustion engine vehicles fell by 18% over the first eight months of 2022 relative to the same period in 2021 (SDES, 2022). Investments in vehicles are declining because of supply chain disruptions for semiconductors caused by the health crisis. Automobile sector professionals are expecting a return to normal in 2024. In addition, EU regulations oblige manufacturers to sell a smaller proportion of diesel and petrol cars. However, the increase in combustion engine car prices impacted by the rising cost of materials, including steel, should mitigate the decline in the amount of investment. The consumer price index for cars increased by 5.4% between December 2021 and August 2022 (INSEE, 2022).

COMBUSTION ENGINE COMMERCIAL VEHICLES: a decline in investments expected in the short term

Investments have increased by 10%, without reaching the pre-crisis level. The recovery in sales of vehicles and the improved business outlook for companies have contributed to the increase in fossil investments. In this segment, low-emission vehicles compete less with their conventional equivalents, since supply is less developed, especially for heavy goods vehicles. The technology is less efficient given the range required and the weight of these vehicles. Moreover, EU regulations provide for financial penalties on conventional emissions from new heavy goods vehicles only from 2025 onwards (European Commission, 2019).

In 2022 and 2023, investments should decline. As with the passenger car segment, the first data on registrations indicate that investments are declining in 2022, especially in the light commercial vehicle and bus segments. Compared to 2021, manufacturers are struggling to meet demand for vehicles. The longer delivery times caused by material shortages are delaying the entry into service of new vehicles. Companies are tending to defer the renewal of their fleet because of the rising costs. The increase in market share for electric LCVs, thanks to the regulations in force, and for low-emission buses ordered by the authorities, should contribute to a slight reduction in registrations. Although volumes are expected to decrease, prices should increase in 2022 and 2023, with automobile manufacturers passing on material cost increases to the selling price.

AIR TRANSPORT: investments declined in 2021, before a rebound in the next two years with the recovery of air traffic

The volume of investments fell sharply from 2020. With air traffic at a lower level than projected prior to the health crisis, airport managing bodies and airlines have had to significantly reduce their investments to take account of the lower level of operating revenues and to maintain their cash flow. However, greater visibility on expected growth in traffic is leading them to plan higher investments in 2022 and 2023. Aéroports de Paris (2022), for example, is planning to increase its annual investments by 100 to 350 million euros relative to investments made in 2021, without however returning to the pre-crisis level. Similarly, the airlines are planning to increase their investments to renew their air fleets.

INEFFICIENT RETROFIT MEASURES AND GAS AND OIL BOILERS: investments are expected to stagnate in spite of regulatory measures

Investments rebounded in 2021. With the resumption of retrofitting projects, many households have undertaken work, some of which has not improved the performance of the energy components concerned: re-roofing or exterior renovation without insulation.

Although heating equipment regulations are now seriously limiting the number of oil boilers, the other inefficient retrofit measures could be maintained, or could even increase in 2022 and 2023. In particular, during exterior rehabilitation or re-roofing work, households tend to request little or no insulation in order to minimise costs, despite existing aid, especially as the current heating regulations for existing buildings are not adequately enforced.

PRODUCTION AND DISTRIBUTION OF FOSSIL ENERGIES: investments will remain stable in 2022 and 2023

Investments increased in 2021. This growth is explained by higher investments in gas power plants and LNG terminals.

In response to the energy crisis, France has programmed several investments in fossil energies. In particular, it is planning to commission a floating LNG terminal in Le Havre, with an investment cost in the order of 400 million euros, estimated from data published by the OIES (2017). The delayed decommissioning of the Saint-Avold coal-fired power plant in order to ensure electricity supply for winter 2022-2023 should result in a very small volume of investment, in the order of 10 million euros (Le Monde, 2022). Although the public authorities are planning limited operational lives (five years for the floating LNG terminal, and until March 2023 for the power plant), these will largely depend on the evolution of climate investments in the next few years.

Sustained growth in climate investments in the short term would generate energy savings and an increase in the production of low-carbon energy, which would reduce the need for gas supplies and make it possible to halt coal-fired power generation.

Overall, investments in the fossil energy sector should remain stable in 2022 and 2023. Indeed, these new investments will be offset by the reduction in investments in installations of new capacities in gas-fired power plants. The Landivisiau power plant, which required around 450 million euros in the last few years, has been in service since spring 2022.

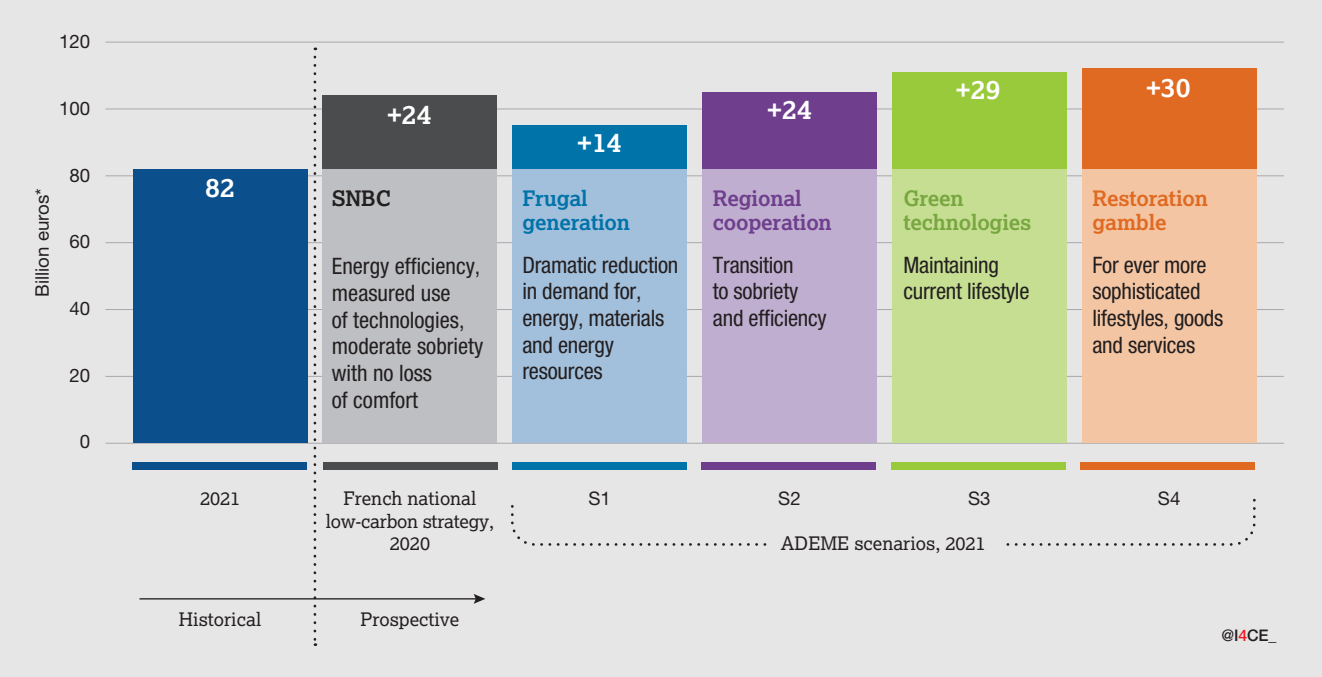
INVESTING MORE TO STAY ON TRACK TO MEET CLIMATE TARGETS

To stay on track to meet climate targets, between 14 and 30 billion euros of additional climate investments will be needed every year between 2022 and 2030, depending on whether the transition is frugal or technological. At the same time, fossil investments will need to slow down, and be halved before 2030 and reduced to zero between 2040 and 2050. Overall, a transition based on energy sufficiency would reduce total investment requirements in the sectors studied, whereas a more technological transition would require slightly more investment than today.

Additional climate investments of 14 billion euros per year for a frugal transition, and up to 30 billion euros per year under a technological scenario

FIGURE 8: CLIMATE INVESTMENT REQUIREMENTS

Annual public and private climate investments 2021-2030, in buildings, transport and the energy sector



*Data in real terms.

Source: I4CE, Landscape of Climate Finance, 2022 edition.

NB: In this figure, adjustments are introduced in order to compare real investments and requirements for the same geographical and sectoral scope. Consequently, the amount of climate investment is slightly different from what is presented above. All of the adjustments are given in annex 4.

These requirements are a minimum, some sectors are missing and the new 2030 target is not always met. Our estimate concerns only the building, transport and energy sectors, without considering the requirements for agriculture (with the exception of methanization), industry, research and development or adaptation to climate change. Moreover, although some of the scenarios studied come close to the new EU target for 2030, other are still built on the target of reducing emissions by 40% by this time horizon (see **table 4**, p.24). And while some scenarios opt for a greater effort before 2030,

others assume a more gradual transformation, which defers part of these requirements. Overall, climate investment requirements increase beyond 2030, except in the ADEME scenario 1, where they are relatively constant.

Moreover, these projections are based on the assumption of relatively favourable economic conditions. In particular, it is assumed that equipment supplies are available even for high investment volumes. Thus, outside the trajectories determined by the climate scenarios themselves, there are no industrial constraints or price pressures. In reality, rapidly increasing demand for investments can lead to bottlenecks if supply is not properly supported and dimensioned. Likewise, the projections do not include any a priori financial constraints, since they serve to measure the gaps between climate scenarios and actual financing.

The outlook for growth in climate investments in 2022 and 2023 will probably not be enough to cover requirements. Many factors can explain this lack of investment. Some projects are not profitable enough to be undertaken without public support. Moreover, competition with fossil technologies is an obstacle to the development of climate-friendly projects. These economic limitations are sometimes compounded by regulatory obstacles and a lack of support. Inadequate financing options can also be a limiting factor, but are not enough to explain the gap observed.

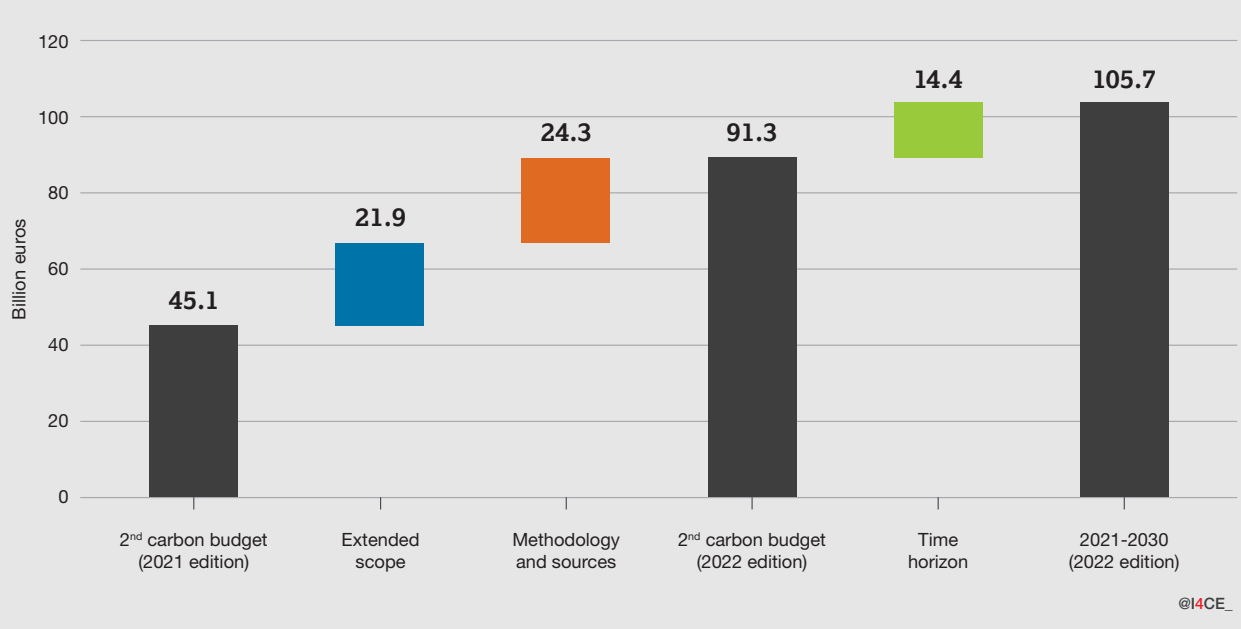
BOX 4: THIS EDITION OF THE LANDSCAPE SCALES UP CLIMATE INVESTMENT REQUIREMENTS

In this edition of the Landscape, climate investment requirements are higher than those reported in previous years. Indeed:

- We have covered new sectors, especially the energy performance of buildings, hydropower and nuclear power (but not agriculture or industry). Their inclusion in the scope explains most of the gap with previous editions.
- We have revised our methodologies when new sources and knowledge have enhanced the way investment requirements are calculated, or when the prices of certain equipment have significantly risen or fallen.
- In previous editions, the requirements reported concerned the period of the second carbon budget (2019-2023), whereas this edition presents requirements for the period 2021-2030. However, in most of the scenarios, climate investment requirements increase over time. Thus, extending the time horizon increases the requirements.

The figure below reports changes in the climate investment target according to the SNBC. In the previous edition of the Landscape, the target stood at 45 billion euros of climate investments, or, including the backlog, 13 to 15 billion euros more than the level for 2019-2020. In this edition, the target is assessed at 91 billion euros for the second carbon budget and at 106 billion euros for the period 2021-2030.

FIGURE 9: REVISION OF CLIMATE INVESTMENT REQUIREMENTS (SNBC TRAJECTORY)



Investment priorities that depend on the transition strategy

Investment requirements do not form one block, and each climate scenario determines a different level of investment and different sectoral priorities :

- **The SNBC scenario, developed between 2018 and 2020, is intended to be reasonable and realistic**. It is characterised by a measured use of technologies such as hydrogen or carbon capture, a moderate reliance on energy sufficiency – with no loss of comfort – and a sharp increase in energy efficiency. In particular, this scenario targets a "low-energy" building stock by 2050 and the rapid deployment of electric vehicles. Although it assumes significant growth in renewables by 2030, the scenario does not specify the relative share of renewable energies and nuclear power in the energy mix by 2050. Because it aims for a 40% reduction in GHGs by 2030 relative to 1990, the scenario no longer corresponds to France's medium-term targets. It is currently being revised in the framework of the new French Climate and Energy Strategy (SFEC).
- **The ADEME scenario 1 achieves a rapid ecological transition through a dramatic reduction in demand for energy, materials and resources**. This frugality is partly voluntary and partly mandatory, seeking the equitable distribution of efforts between citizens. Untested technologies, such as carbon capture and storage, are not deployed, nuclear power is phased out by 2050 and nature is widely protected in order to preserve natural resources. This scenario assumes a slowdown in construction in favour of a very ambitious retrofitting programme and a sharp reduction in individual travel. Although climate investment requirements are low compared to other scenarios for the period 2021-2030, they are in fact balanced between declining sectors (construction, vehicles) and priority sectors, including retrofitting (see **Figure 10**).
- **In the ADEME scenario 2, the country evolves rapidly towards energy sufficiency and efficiency, more through cooperation than through constraint**. Civil society drives profound changes in lifestyles towards more measured and shared consumption of goods. Solid regional institutions accompany this transition, in particular by building new transport infrastructures, and by rapidly retrofitting homes and tertiary buildings. This scenario assumes large investments in energy retrofitting and the extension of sustainable transport networks with new infrastructures, in particular to develop bicycle use.
- **In the ADEME scenario 3, green technologies meet environmental challenges while maintaining most current consumption behaviours**. Metropolitan areas drive the transition: they are rebuilt to become denser and more efficient, at the risk of increasing the contrast between urban and rural areas. The state intervenes particularly through market regulation, including putting a market value on natural resources. International trade continues to be dynamic. Two variations of power generation exist in this scenario, one focusing on offshore wind power, and the other on nuclear power, but these two variants diverge very little in terms of the associated investment amounts.
- **In the ADEME scenario 4, lifestyles are safeguarded and households continue to acquire ever more sophisticated goods and services**. Society, largely guided by companies, makes the gamble that technology can resolve the biggest environmental challenges. This scenario calls into question current targets on energy sufficiency and land degradation, in favour of globalised growth in material flows and digital technology.

TABLE 4: CLIMATE SCENARIOS, SEVERAL WAYS TO ACHIEVE CARBON NEUTRALITY

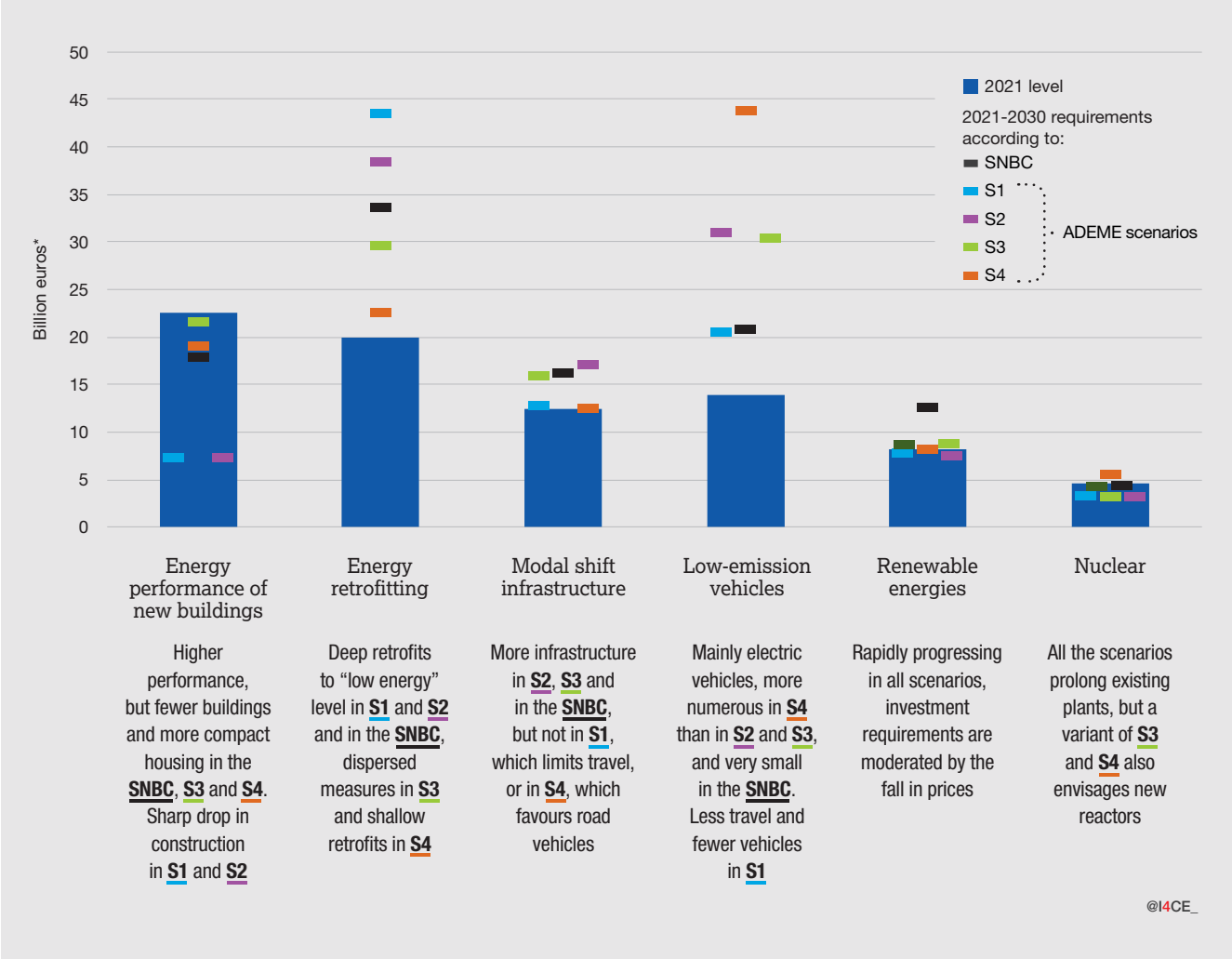
	Gross GHG emissions[1] relative to 1990 (2021: - 23%)		Final energy consumption[2] in TWh (2021: 1 768)	
	2030	2050	2030	2050
LTECV target (2015)	- 40%	- 75%	1 464	915
LEC target (2019)	- 40%	- 84%	id.	id.
EU target (2021)	- 50% [4]	-	-	-
SNBC (2020)	- 40%	- 85%	1 442	993
ADEME scenarios[3] (2021)				
S1 – Frugal generation	- 54%	- 86%	1 350	790
S2 – Regional cooperation	- 53%	- 87%	1 400	833
S3 – Green technologies	- 47%	- 84%	1 600	1 074
S4 – Restoration gamble	- 40%	- 75%	1 700	1 360

(1) Gross emissions do not include natural and technological sinks. The latter are more developed in S4, which explains the lower level of emissions reductions in this scenario relative to 1990, while achieving carbon neutrality.
(2) Including non-energy uses, excluding international bunkers, metropolitan France.
(3) The ADEME scenarios cover the scope of metropolitan France.
(4) See the chapter on **Methodology, p.6**.

Sources: ADEME (2021, Transitions 2050, pp.11, 649 and 669), DGEC (2019), CITEPA (2021), SDES (2021 and 2022).

Investment priorities for carbon neutrality, depending on the scenario

FIGURE 10: CLIMATE INVESTMENT REQUIREMENTS BY SECTOR, 2021-2030



*In billion euros at constant 2015-2019 prices.

Source: I4CE, Landscape of Climate Finance, 2022 edition.

TABLE 5: CLIMATE INVESTMENT REQUIREMENTS, 2021-2030

(Billion euros[1] per year)	2021 level	2021-2030 targets (gaps)					
		SNBC	S1	S2	S3 RE variant	S3 nuclear variant	S4
Energy performance of new buildings	**22.5**	17.8 *(-4.7)*	7.2 *(-15.3)*	7.4 *(-15.1)*	21.5 *(-1.0)*	21.5 *(-1.0)*	18.9 *(-3.6)*
Energy retrofitting	**19.9**	33.6 *(+13.7)*	43.4 *(+23.5)*	38.4 *(+18.5)*	29.5 *(+9.6)*	29.5 *(+9.6)*	22.5 *(+2.6)*
Modal shift infrastructure	**12.4**	16.2 *(+3.8)*	12.8 *(+0.4)*	17.0 *(+4.6)*	15.9 *(+3.5)*	15.9 *(+3.5)*	12.4 *(-0.0)*
Low-emission vehicles	**13.9**	20.8 *(+6.9)*	20.5 *(+6.6)*	31.0 *(+17.1)*	30.4 *(+16.5)*	30.4 *(+16.5)*	43.8 *(+29.9)*
Renewable energies	**8.2**	12.6 *(+4.4)*	7.8 *(-0.4)*	7.4 *(-0.8)*	8.8 *(+0.6)*	8.8 *(+0.6)*	8.3 *(+0.1)*
Nuclear	**4.6**	4.3 *(-0.3)*	3.3 *(-1.3)*	3.2 *(-1.4)*	3.2 *(-1.4)*	4.3 *(-0.3)*	5.5 *(+0.9)*
Carbon capture and storage	**0**	0	0	0	0.1 *(+0.1)*	0.1 *(+0.1)*	0.1 *(+0.1)*
Flexibility[2]	**0**	0.4 *(+0.4)*	0.2 *(+0.2)*	0.6 *(+0.6)*	1.1 *(+1.1)*	1.1 *(+1.1)*	0.2 *(+0.2)*
All	**81.5**	**105.7** *(+24.2)*	**95.2** *(+13.7)*	**105.0** *(+23.5)*	**110.5** *(+29.0)*	**111.6** *(+30.1)*	**111.7** *(+30.2)*

(1) Historical investments are recorded in current prices, whereas requirements are expressed in constant euros for prices observed in recent years (2015-2019). In some sectors, the projection includes price changes, for example under the effect of economies of scale or learning gains.

(2) Flexibility includes stationary batteries, the production of hydrogen from electricity, and methanation.

ENERGY PERFORMANCE OF NEW BUILDINGS: a decline in investment, despite energy improvements

The SNBC and the ADEME scenario 4 assume a gradual slowdown in the construction of housing and tertiary buildings, reflecting the fact that population growth is slowing. In scenario 3, improving the building stock entails rebuilding, which contributes to maintaining investments, although the new buildings are generally smaller than the dwellings demolished. In scenarios 1 and 2, investments in construction fall sharply. Rather than building new housing, these scenarios address population growth by optimising the existing stock, including second homes, which are converted into primary residences. In all of these scenarios, improving the energy performance of new housing results in a moderate increase in construction costs, but without offsetting the decrease in volumes.

Shallow or deep **ENERGY RETROFITS**

The SNBC and the ADEME scenarios 1 and 2 focus on the massive retrofitting of housing towards the “low energy” (BBC) level, targeting at least 700 000 homes per year by 2030. In relation to current levels, this implies not only increasing investments, but especially concentrating them in deep retrofit projects. Scenario 2 provides that work can be conducted in two or three stages, provided that these stages are very well coordinated (ADEME, 2021).

Scenarios 3 and 4, on the other hand, assume current practices continue, with isolated retrofit measures. Moreover, their targeted reduction in consumption by 2030 is not as high. In scenario 3, retrofits take a whole-house approach, but in successive stages, which requires almost as much investment as in scenarios 1 and 2 (over the period 2030-2050), but results in much higher consumption levels. In scenario 4, two thirds of dwellings are only partially insulated, but very efficient retrofits (the “passive” label) are undertaken for the remaining third, where the architectural characteristics allow for the industrialisation of work.

Where the tertiary sector is concerned, all scenarios envisage rolling out the requirements of the “Eco Energie Tertiaire” decree, to different degrees, which would lead owners (state, authorities, companies) to undertake major insulation work.

What **TRANSPORT INFRASTRUCTURE** to ensure the modal shift?

Climate investments in transport infrastructure concern trains (passenger and freight), urban public transport, the cycling network and charging points.

In the ADEME scenarios 2 and 3, the modal shift entails significant investments in infrastructure, in order to encourage motorists to use trains, urban public transport and bicycles. Scenario 2 extends tramways, bus routes and cycle lanes into the suburbs, whereas in scenario 3, the infrastructure mainly concerns metropolitan areas and high-speed intercity train lines (TGV). Both scenarios also include investments in the transport of goods by rail (rail freight). Current investment levels are insufficient to meet these targets.

Where the SNBC is concerned, the projections highlight a considerable investment gap before 2030, but they are subject to uncertainty on several levels. Indeed, although the national scenario targets an increase in the number of passengers using trains or public transport, the resulting investment requirements depend on many other parameters, such as the relative share of the different services (underground trains, trams, high-speed TGV trains, regional TER trains, etc.), the circulation of additional passengers in off-peak or peak times, plans to make better use of the parts of the network that are underused today or, on the contrary, plans to extend networks to more urban or rural areas, with TGV trains or conventional services. Under certain conditions among all of these parameters, current investment levels could be sufficient to transport the passengers envisaged by the scenario, while according to other estimates, more investments will need to exceed the requirements reported here (FNTP, 2022).

In scenario 1, the modal shift is based on better use of existing infrastructure, while reducing passenger and freight transport at the source. Current investment levels are theoretically sufficient, but at the risk that capacities will be saturated on certain lines or at peak times.

Finally, in scenario 4, passenger cars maintain their current modal share, which moderates investment requirements in rail transport and cycling network infrastructures.

What **LOW-EMISSION VEHICLE** fleet?

All of the scenarios studied opt for the replacement of current conventional models (petrol and diesel) by low-emission alternatives, mainly battery electric vehicles.

In the ADEME scenarios 1 and 2, sales shift towards light electric models. Car travel is reduced by new practices such as homeworking, active modes or new rail services (regional lines, night trains), meaning rates of passenger car ownership decline and the vehicle fleet contracts.

In scenarios 3 and 4, the characteristics of electric cars are more aligned with those of current conventional models, especially to compete with their greater range. Although the unit cost of batteries (in €/kWh) falls rapidly due to strong economies of scale in the booming global industry, the size and weight of batteries increases in order to improve vehicle range, such that the average price of electric vehicles remains stable over the next few years. If sales of electric vehicles continue to progress at the pace observed over the last two years, the target set by the scenarios seems achievable.

The SNBC, which was developed before the ADEME scenarios, envisaged the rapid roll-out of small light electric vehicles, placing investment requirements at around the same level as the ADEME scenario 1. However, the electric models sold today are heavier and have bigger batteries than those considered in the scenario, meaning that requirements could be revised upwards to take account of these developments.

Moreover, heavy vehicles running on electricity, NGV and hydrogen are progressing in the heavy goods vehicle and bus segment. By 2050, they almost entirely replace the diesel models that dominate sales today.

RENEWABLE ENERGIES: more installations, falling prices

By 2030, installations of renewable energies are slightly more rapid in the SNBC than in the ADEME scenarios, although the latter assume very high deployment levels by 2050. As in the RTE scenarios, the installation cost of renewable power capacities (expressed in €/kW) continues to diminish over the period, which reduces the need for investments to renew and expand the generating fleet.

However, the biomass and biogas cogeneration sectors are assumed to peak, in favour of direct uses of their energy potential (injection, district heating). In scenarios 2 and 3, the ambitious targets for district heating translate into high investments, in the order of 500 million euros, compared to 340 million euros at present[2].

2 For the extension of district heating alone, to which should be added the production of renewable heat and the cost of connecting dwellings and tertiary buildings (not assessed, but included in the retrofit).

NUCLEAR: convergence on prolongation, but not on new capacities

Although the PPE of 2020 does not specify the trajectory for nuclear power plants after 2030, the ADEME scenarios are built on coherent energy mixes capable of covering anticipated consumption. In all of the scenarios, investments in the "Grand Carénage" programme continue beyond the fourth "10 year visit" of most existing reactors, in order to prepare their exploitation for up to 50 years and to improve their safety. In 2050, between 10 and 14 GW of existing capacities are still in operation in scenarios 2, 3 and 4. At the same time, scenario 3 (in its nuclear variant) and scenario 4 provide for the construction of new EPR reactors from 2025, for a total of 10 and 16 GW respectively in 2050.

FLEXIBILITY, CARBON CAPTURE AND STORAGE: preparing for their deployment as of now?

Flexibility measures include electrolysis, stationary batteries and methanation units, designed to facilitate grid load balancing or to produce green hydrogen for use in transport and industry. Although their deployment is mainly envisaged after 2030, the scenarios foresee the first large-scale demonstrators in this decade. As for carbon capture and storage through industrial processes, these are only really envisaged in the ADEME scenarios 3 and 4, and only after 2030 in the SNBC. These apparently long lead times should not mask the current challenge, which is to prepare the economic, regulatory and technological conditions required for their potential deployment.

BOX 5: INCREASING CLIMATE INVESTMENTS DOES NOT NECESSARILY MEAN THAT THE TRANSITION IS MORE COSTLY

The climate investments presented in the Landscape should not be confused with carbon abatement costs. The abatement cost of carbon cumulates the investment and operational expenditures for an installation over its useful life. These expenditures are discounted, then calculated per tonne of CO_2 avoided. One way to determine the carbon abatement cost is to compare the anticipated expenditures and emissions of a project, a sector, or the whole economy, between a transition scenario and a baseline scenario. Thus, according to the carbon abatement costs calculated in 2016 by the D-CAM model, INSEE estimates at around 100 billion euros per year the public and private climate investments required to meet the target of carbon neutrality, in other words double the level observed at that time (INSEE, 2020, p.6; CGDD/SEEIDD, 2016).

The investments presented in the Landscape measure investment expenditures as a whole, both historical and prospective. With the exception of carbon capture and storage installations, these investments do not serve only to reduce GHG emissions: they are useful in terms of housing (construction, retrofitting), travel (vehicles, infrastructure) or energy production (wind turbines, solar panels, etc.). Climate investments are only one part of the carbon abatement cost.

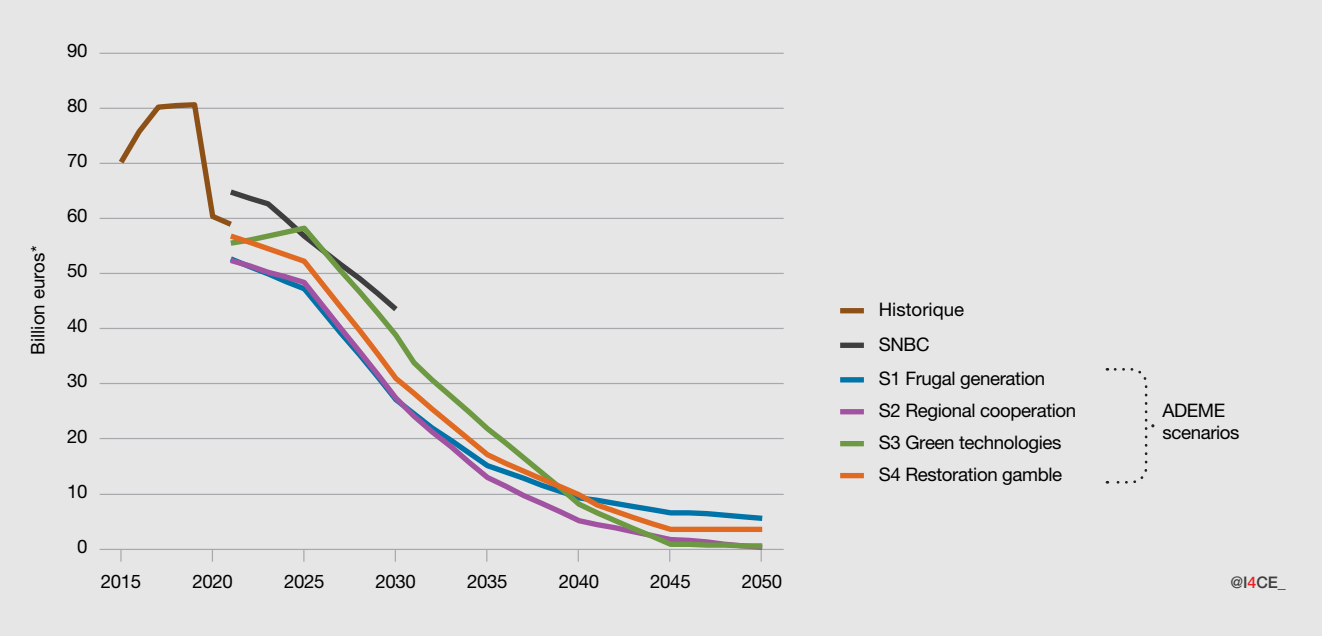
Increasing climate investments does not therefore necessarily mean a higher cost of carbon. Even when climate installations are initially more expensive than their alternatives, this extra cost can be offset by savings during use, or by social co-benefits. Moreover, the discount rate used has a significant impact on the carbon abatement cost (France Stratégie, 2021).

Furthermore, a high abatement cost does not necessarily mean that the transition is costly. Because new investments only gradually replace existing installations, it may make economic sense to consider as of now projects with high abatement costs (Vogt-Schilb *et al.* 2013). Finally, carbon abatement costs generally remain well below the costs and risks of climate inaction (DG Trésor, 2020).

Fossil investments need to decrease to be close to zero by 2050

For the first time, this study presents a projection of fossil investments, especially those in combustion engine vehicles. According to all of the scenarios studied investments decline sharply: they are halved before 2030, and disappear almost entirely by 2040.

FIGURE 11: TRAJECTORIES OF FOSSIL INVESTMENTS BY SCENARIO, 2015-2050



*In billion euros at constant 2015-2019 prices.

Source: I4CE, Landscape of Climate Finance, 2022 edition.

NB: the scenarios envisage different 2021 levels depending on whether the trajectory was developed before the decline in sales during the COVID crisis (the case of the SNBC), or whether it anticipates different rebound levels further to this crisis (the case of the ADEME scenarios).

COMBUSTION ENGINE VEHICLES: a sharp decline in all scenarios

Investments reach zero between 2035 and 2045, first for passenger cars, then for light and heavy commercial vehicles. Only the ADEME scenario 1 maintains a small proportion of combustion engine vehicle registrations at this time, along with a high degree of sufficiency in travel. Currently, the number of registrations of new petrol and diesel cars is decreasing. Despite improvements in the performance of their engines, they present stable average conventional CO_2 emissions because of the concentration of sales in heavier vehicles (SUVs).

In the medium term, purchasers of conventional vehicles could rebound, especially in the heavy goods vehicle segment.

The gradual phasing out of **INEFFICIENT RETROFIT MEASURES**

In all of the scenarios, investments in inefficient retrofit measures fall sharply, replaced by more efficient measures. Only a small proportion of these works persist in cases where technical or architectural constraints make insulation prohibitive. Where systems are concerned, the replacement of electric heaters by radiant panels slows in favour of more efficient systems, such as heat pumps.

Currently, in the context of wall and roof insulation works, households still tend to request that building professionals install little or no insulation in order to minimise costs, despite existing aid for efficient retrofit measures. The existing building regulations to avoid these inefficient measures in existing buildings are not sufficiently enforced.

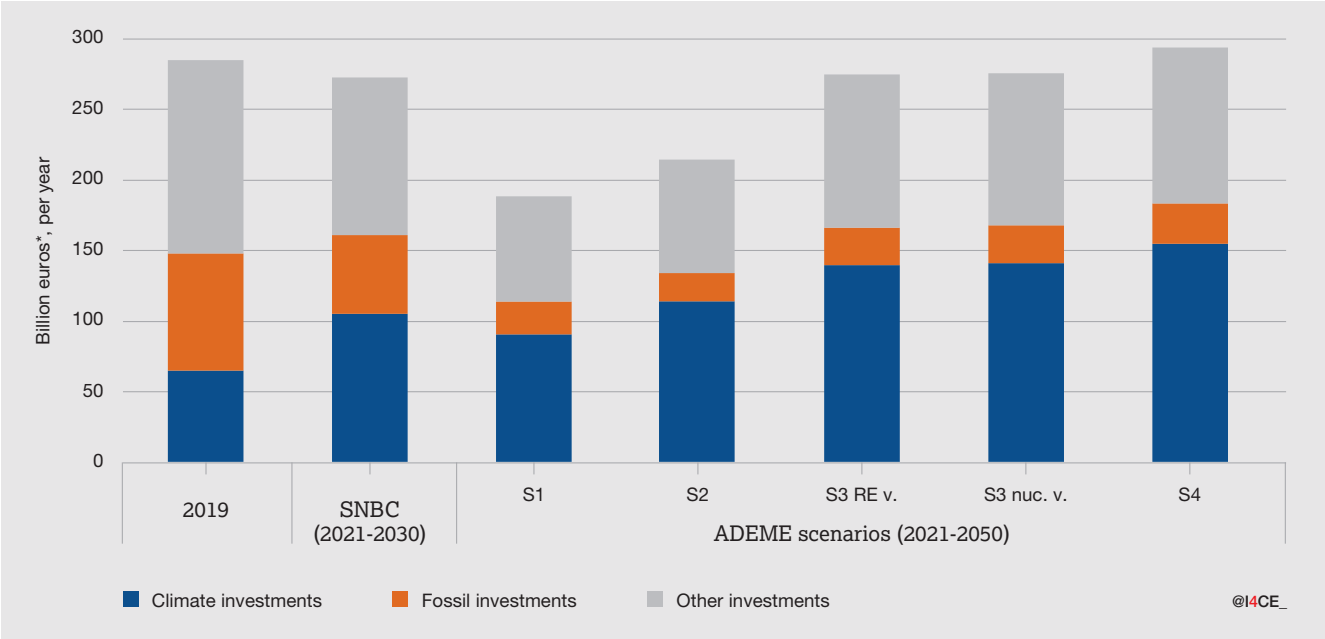
To reach carbon neutrality in 2050, total investments in the sectors studied will not necessarily be higher than today

For the first time, this study presents total investments[3] **in buildings, transport and the energy sector**. These totals include the increase in climate investments, the decrease in fossil investments, but also other investments in these three sectors. For example, total investments in construction do not include only the share of "climate" expenses linked to energy performance, but also the other construction expenditures. The detail of these other investments is given in Table 1 p.12.

On average, from 2021 to 2050, total annual investments in the sectors studied are close to or below the 2019 levels. Only ADEME scenario 4 implies slightly higher investment levels with about 9 billion euros per year more over the period 2021-2050. The total requirements are compared to the year 2019, which is more representative of the historical level than 2021, when total investment in vehicles was well below the range of the scenarios, due to temporary factors such as supply chain disruptions for semiconductors.

In the carbon neutrality scenarios, the redirection of investments towards the climate and away from fossil fuels is not uniform across all sectors. Thus, total investments decline in construction, remain stable in retrofitting, and increase in vehicles and the energy sector (see Figure 13).

FIGURE 12: COMPARISON OF TOTAL INVESTMENTS IN BUILDINGS, TRANSPORT AND THE ENERGY SECTOR, ACCORDING TO THE TRANSITION SCENARIO



*In billion euros at constant 2015-2019 prices.

Source: I4CE, Landscape of Climate Finance, 2022 edition.

In the technological scenarios, total investments are close to their 2019 level, which contrasts with previous estimates

The Quinet Commission on the Value for Climate Action estimates, using the TIMES model, that total investments in the energy system in a "net zero emissions" scenario clearly exceed those in a baseline scenario (France Stratégie, 2019, p.121). Even excluding the agriculture and industry sectors (which are not covered in this assessment), the investment gap reaches 1.1 GDP points in 2030 and 2.4 GDP points in 2050, or 27 to 60 billion constant euros.

Similarly, the European Commission estimates that an EU target of reducing GHG emissions by 55% by 2030 relative to 1990 levels would require investing between 2.5 and 3 points more in the energy system (excluding transport), compared to a baseline scenario (European Commission, 2020). In general, the Commission identifies a strong correlation between the increase in climate ambition and investment requirements in the energy system.

3 To describe these, the Quinet Commission on the Value for Climate Action refers to investments "net of substitution effects" (France Stratégie, 2019).

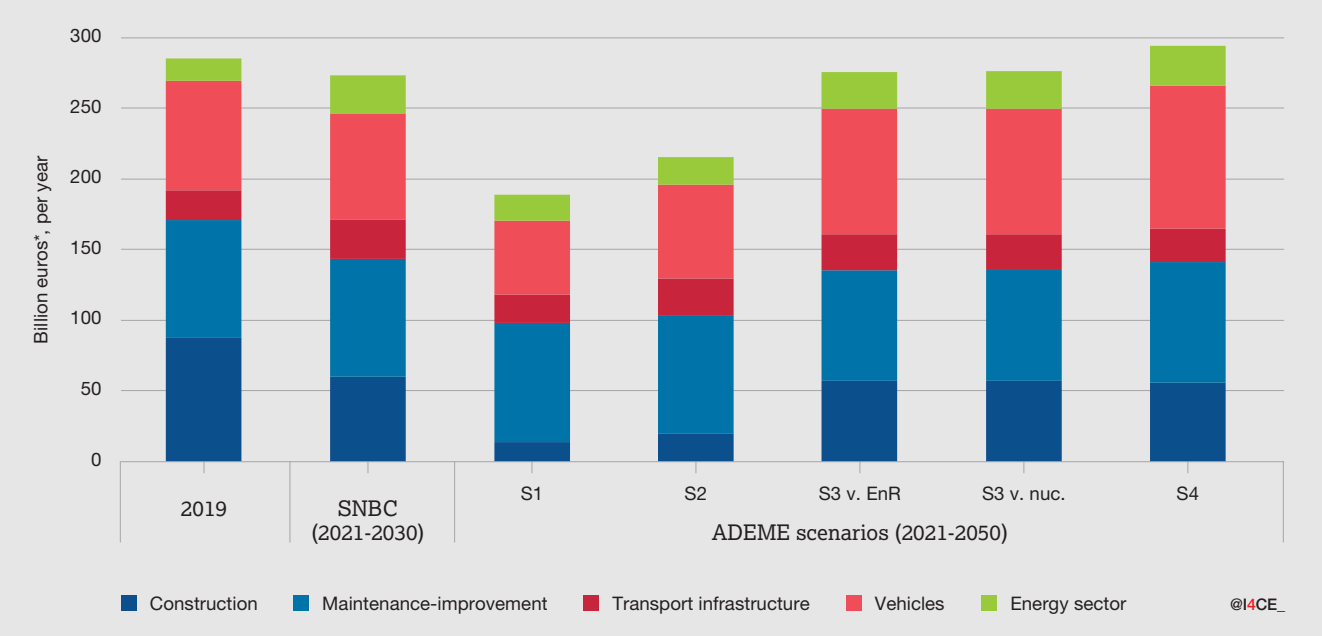
Without fully explaining it due to the lack of a sufficiently detailed comparison of input data, the gap between these results could be due to:

- a more moderate projection of population growth and energy service requirements in the ADEME scenarios, in particular in relation to the TIMES model, in which demand is driven by the population and by GDP growth;
- the inclusion of additional redirections between fossil fuel and climate investments, specifically in the maintenance and improvement of buildings, where inefficient works (e.g. re-roofing without insulation) are not always represented in energy models;
- the relatively high level of total investment in 2019, due to greater efforts on climate action. Without these efforts, the gap with climate scenarios would be bigger, potentially returning to the ratio of 1 to 3 additional GDP points suggested in previous works.

In energy sufficiency scenarios, total investments are halved by 2050

The construction of housing and tertiary buildings slows considerably, to reach levels close to zero in 2050. Given the importance of construction expenditures in national investment, this slowdown alone explains a large part of the total decline in investment (see **Figure 13** below). Where vehicles are concerned, scenario 1 assumes a reduced fleet comprised of light electric vehicles, with less costly batteries than heavier models. Previously, a study on decarbonisation pathways at the EU level showed that an energy sufficiency scenario would require less investment than a scenario relying on technologies (Climact, 2020).

FIGURE 13: DISTRIBUTION BY SECTOR OF TOTAL INVESTMENTS, ACCORDING TO THE TRANSITION SCENARIO



*In billion euros at constant 2015-2019 prices.

Source: I4CE, Landscape of Climate Finance, 2022 edition.

In line with these scenarios, the decrease in investments follows a reduction in demand rather than a restriction of supply. Thus, scenario 1 envisages that elderly people cohabit more with younger households, and that vacant and second homes, which are often located outside of towns, serve as primary residences. These dynamics lead to a reduction in the number of new homes, while their construction costs increase with higher energy performance.

However, if supply were to decline more rapidly than demand, for example if the number of building permits were limited, the selling price of new homes would undoubtedly rise, offsetting, at least partially, the reduction in volumes. In short, the particularly low investment levels in scenarios 1 and 2 for construction and vehicles depend on the measures for implementing the transition.

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