I4CE
INSTITUTE FOR CLIMATE ECONOMICS
Une initiative de la Caisse des Dépôts et de l'Agence Française de Développement

The State of Europe's Climate Investment

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I4CE is a non-profit research organization that provides independent policy analysis on climate change mitigation and adaptation. The Institute promotes climate policies that are effective, efficient and socially-fair. The 40 experts engage with national and local governments, the European Union, international financial institutions, civil society organizations and the media. The work covers three key transitions – energy, agriculture, forest – and addresses six economic challenges: investment, public finance, carbon pricing, development finance, financial regulation and carbon certification.

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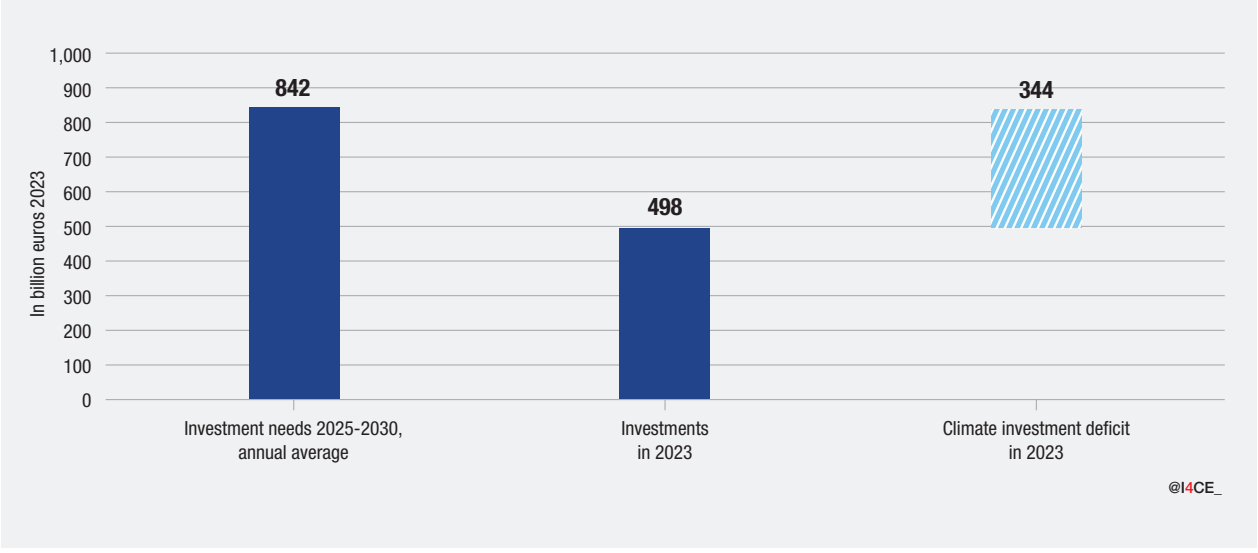
EXECUTIVE SUMMARY

A pivotal moment for the European Union: investment for decarbonisation, strategic autonomy and competitiveness

In a challenging geo-political context, Europe stands at crossroads. The attention in the European Union (EU) has pivoted towards security, strategic autonomy and competitiveness. At the same time, the EU's climate leadership is needed more than ever. In this context, Europe has an opportunity to lead on both climate action, and industrial competitiveness and strategic autonomy, but **this will only happen if ambitions are backed with real investments.**

In 2023, climate investments in the EU reached 498 billion euros, well below the 842 billion euros needed on average each year to meet the 2030 EU climate targets, leaving a 344 billion euros gap. Early projections for 2024 suggest that key sectors like wind power, building renovation, and electric vehicles are at risk of decline. Cleantech manufacturing investments are gaining ground, but production of EU cleantech facilities is falling short of demand, putting many of these assets at risk. As the EU recalibrates around competitiveness and resilience, this report offers a stark reminder: climate policy without sufficient investment will not deliver, and the cost of delaying action will only rise.

FIGURE 1. THE CLIMATE INVESTMENT DEFICIT IN THE ENERGY, BUILDINGS, TRANSPORT, AND CLEAN TECHNOLOGY MANUFACTURING SECTORS IS ESTIMATED AT 344 BILLION EUROS

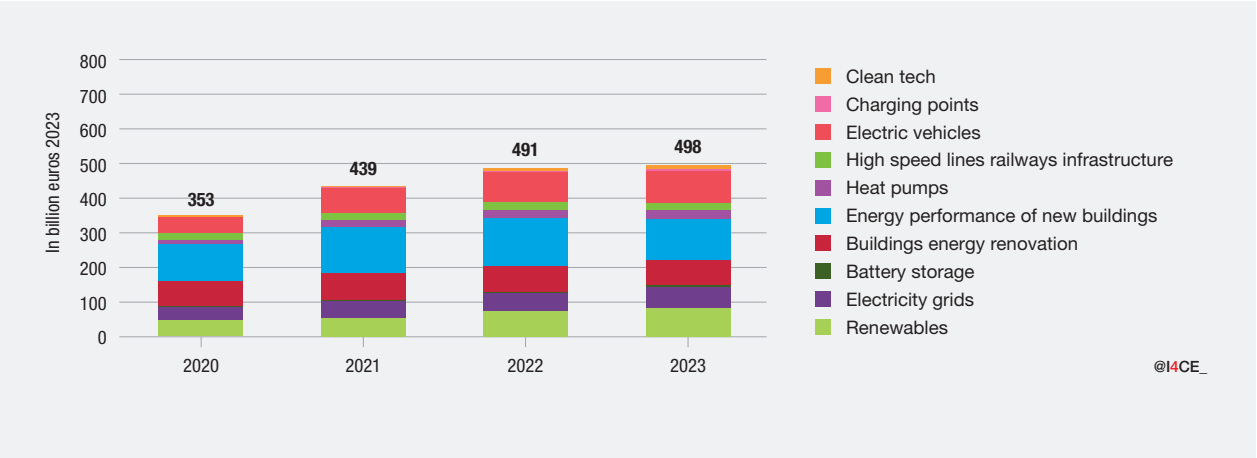


Source: I4CE. All data are in euros 2023. On the left, this graph represents the average climate investment needs per year for the EU to reach its climate objectives between 2025 and 2030 in the energy, buildings, and transport, and clean technologies manufacturing sectors in 2030 (842 billion euros). It compares them to the 2023 investments for the same sectors (498 billion euros). The difference between them gives the climate investment deficit (344 billion euros).

Climate investments: uneven growth in 2023 and expected slowdown in 2024

In 2023, climate investments in the EU reached 498 billion euros in the energy, buildings and transport and cleantech manufacturing sectors – or 2.9 of EU GDP. After years of significant growth, this represents an increase of only 1.5% compared to the previous year. This overall growth reflects **mixed dynamics across sectors**. This slowdown in the 2023 growth is mainly due to a contraction in new buildings construction investments. The building sector also suffered from a decline in renovation activity and heat pump sales. In contrast, investment in renewable energy, driven by solar power, and in electricity grids grew by 17% in 2023. The transport sector also saw an 8% rise in investment, driven mainly by the increasing adoption of battery electric vehicles.

FIGURE 2. THE YEAR-ON-YEAR GROWTH IN CLIMATE INVESTMENTS IS SLOWING DOWN IN 2023



Source: I4CE. All data are in 2023 euros. It represents climate investments in the energy, buildings, transport and clean technlogies manufacturing sectors between 2020 and 2023. 2024 preliminary results were not included due to incomplete data.

Early 2024 investment estimates for some sectors bring a more nuanced picture. Several climate investments are expected to have decreased in 2024, including renewable electricity (-7.2%), buildings energy renovation (-6.3%), heat pumps (-26.9%) and battery electric passenger vehicles (-2.9%).

Investments in wind turbines, solar panels, batteries, electrolysers and heat pumps manufacturing reached 13.9 billion euros in 2023. Battery manufacturing accounted for 90% of these investments. Despite progress in scaling up cleantech manufacturing capacities, underused capacity and factory closures in solar, battery and heat pumps sectors illustrate the strain of global competition and weak local demand. A tendency that is not likely to improve in the short-term as a slowdown in renewables deployment, heat pumps installation and battery electric vehicles are expected in 2024.

Accelerating climate investments to stay on course for the 2030 targets

Reaching the EU's 2030 climate and industrial policy objectives will require 842 billion euros per year on average between 2025 and 2030, – equivalent to 4.9% of EU GDP. **As climate investments reached 498 billion euros in 2023**, this leaves a **climate investment deficit of 344 billion euros**, or 2.0% GDP.

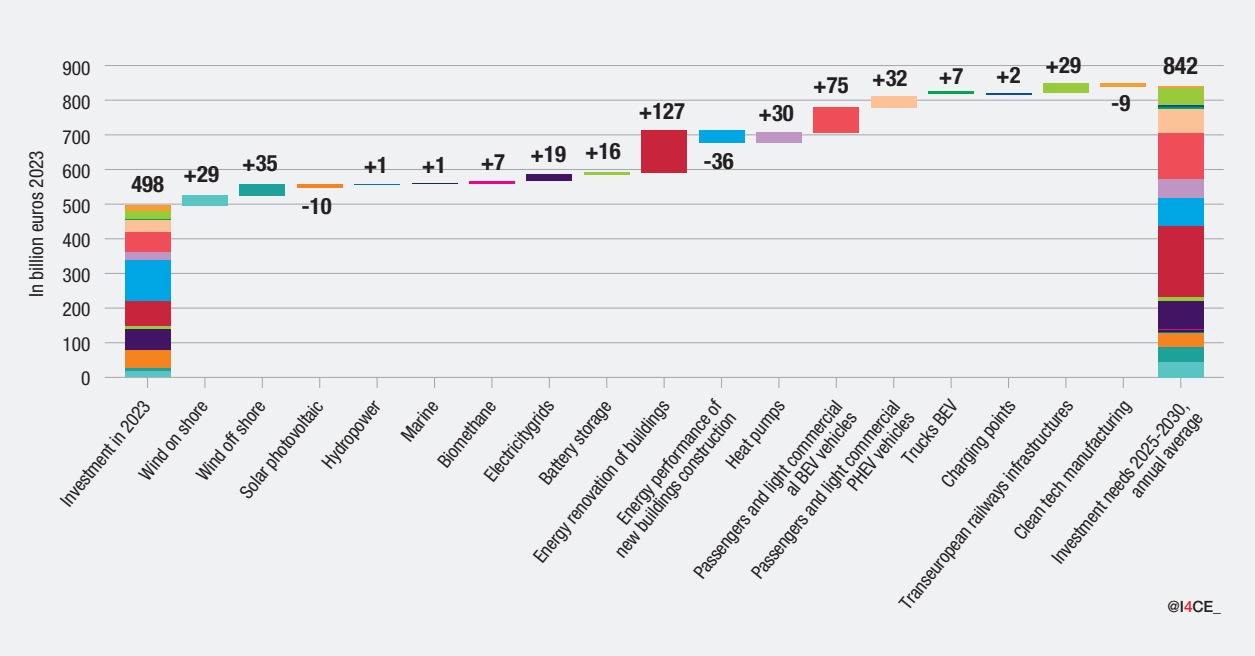
Most of the sectors studied in the scope of this report present a climate investment deficit, in various proportions. Some sectors are particularly far from reaching their 2030 targets. Wind power 2023 investment reached only 29% of what would be needed annually while investment in building energy renovation stands at around 34%. Finally, although investments in power grids have experienced strong growth in recent years, the 19 billion investment deficit needs to be closed as soon as possible as connection to power grids is one of the key enablers of renewables deployment and increased electrification.

On the other hand, 3 sectors present a climate investment surplus for various reason:

- the **solar power sector** shows an investment surplus of 10 billion euros, driven by a recent surge in solar installations that has put the EU on track to meet its sectoral targets.
- the **energy performance of new buildings sector** shows a surplus of 36 billion euros. This is largely structural and reflects the European Commission's expectations of a slowdown in new construction in the coming years, particularly in the non-residential segment.
- the **cleantech manufacturing sector** has a surplus of 9 billion euros, entirely due to the battery manufacturing segment, where recent investments have aligned the sector with the European Commission's desired targets set in the Net Zero Industry Act (NZIA) for this specific sector.

The investment surplus in new building construction is structural, driven by an expected decrease in new buildings construction while the surpluses in solar power and battery manufacturing are more conjunctural. These later simply indicate that the EU was investing at the right pace in 2023. Achieving the EU's climate and industrial targets in these areas will require maintaining this pace over time. However, solar power investments are projected to decline by 5% in 2024, and battery manufacturing by 11%. If these trends persist, the EU may fall short of its targets in both sectors.

FIGURE 3. THE EU OVERALL CLIMATE INVESTMENT DEFICIT OF 344 BILLION EUROS IN 2023 IS THE SUM OF SECTORAL EU CLIMATE INVESTMENT DEFICITS AND SURPLUSES. THE BIGGEST DEFICITS IN VOLUME ARE IN THE ENERGY-RENOVATION OF BUILDINGS (127 BILLION EUROS), BATTERY ELECTRIC VEHICLES (75 BILLION EUROS), AND WIND POWER (64 BILLION EUROS)



Source: I4CE. All data are in euros 2023. This graph indicates the split of the climate investment deficit by sector. The climate investment deficit corresponds to the difference between the annual average investments that are needed for the EU to reach its climate objective by 2030 and the investments that occurred in 2023. For example, for the onshore wind power sector, the climate investment deficit of 29 billion euros corresponds to the difference between the average investment needs (50 billion euros) and the 2023 investments (21 billion euros).

Looking ahead: Plan to invest, invest, invest

Overall investments growth in the EU's climate transition is slowing down in 2023, and early indications suggest a decline in 2024. The EU **needs to buck the trend rapidly** by increasing annual investments or **prepare to miss the 2030 emission reduction and cleantech manufacturing targets**, but not only. The EU also risks underinvesting in the modernisation of its infrastructures, as well as in its efforts to achieve greater strategic autonomy and enhance its competitiveness. **The impact could be picking up a higher bill further down the road, both in economic and ecological terms**.

At the same time, **several Member States are under pressure to decrease their public spendings following the implementation of the newly reformed EU fiscal rules**. Also, the Recovery and Resilience Facility is set to expire by the end of 2026 and the payback of the grants and loans allocated under the NextGenerationEU should start in 2028, adding a further strain on spending capacity in the EU. Upcoming debates on the next EU multiannual financial framework (MFF) will likely focus on adapting structure and strategic investment to new priorities, increase of the EU's own resources, and the possibilities for continued joint debt setting. If the MFF is an essential investment budget for Europe, it remains a limited share of total needs. Besides, a renewed and refocused MFF won't begin until 2028 – just two years before the 2030 deadline.

Facing these challenges, the EU needs to frontload a well-informed and coordinated **long-term investment framework**, that includes **a strategy for financing its ambition in term of climate, strategic autonomy and competitiveness**, anticipating and tracking the development of investments over time. Establishing a long-term framework is all the more crucial given the short-term challenges currently facing public spending. Such a strategy would offer stability in turbulent times, **providing predictability to private economic actors and help ensure the deficit is closed in a timely and cost-effective manner**. This strategy **must clarify the roles of public and private finance, using policy tools like fiscal levers, de-risking mechanisms, and regulation**. NECPs should evolve into real investment plans at national level. An effective strategy requires granular data on sector-specific needs and spending in each Member State. Improving this data will enhance accountability and support a broader, more inclusive view of investment needs, covering other areas like agriculture and climate adaptation.

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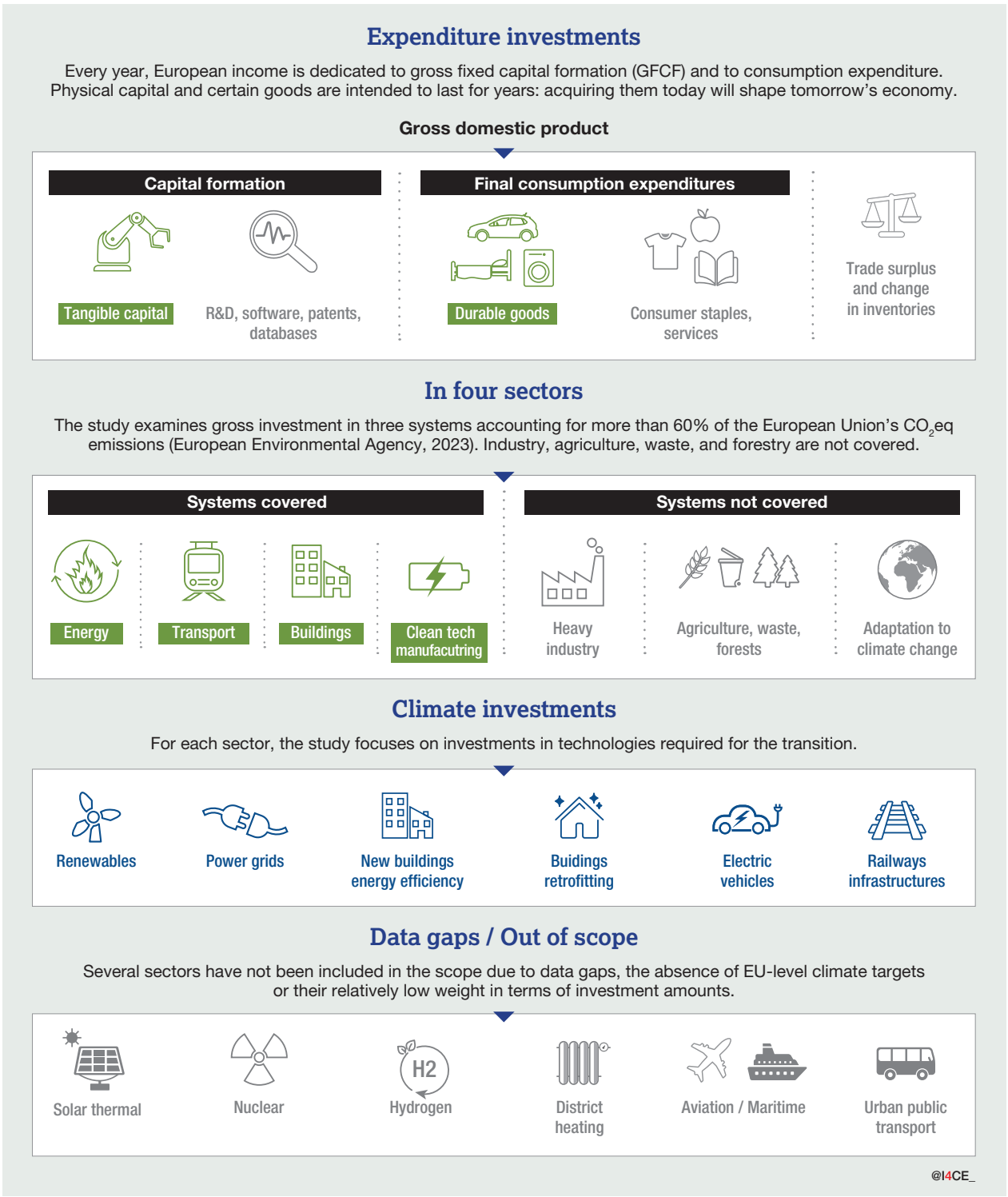
METHODOLOGICAL SUMMARY

This report estimates gross climate investments required to meet the 2030 objectives set by EU legislation. These investments encompass both public and private investments. The average investment needed between 2025 and 2030 is compared to 2023 levels. All data are in euros 2023. See the Methodology section for more information.

FIGURE 4. SCOPE OF THE CLIMATE INVESTMENT OVERVIEW



INTRODUCTION

A pivotal moment for EU climate policy: investment for decarbonisation, strategic autonomy and competitiveness

In a challenging geo-political context, the attention in the EU has pivoted towards security, strategic autonomy and competitiveness. At the same time, the EU's leadership for a sustainable and prosperous future is needed more than ever, with climate at the nexus of a decarbonisation and re-industrialisation agenda.

The Draghi report (2024) shed light on the urgent need to boost both investment and innovation in the EU, for a stronger business case to decarbonise the industrial sector and to reinforce the EU's competitiveness. The European Commission has subsequently pledged to be an Investment Commission and emphasised the continued commitment to the long-term goal of a climate neutral Europe by 2050 and to an ambitious 2040 target. It has also pledged to focus on investment and implementation to meet the emission reduction targets agreed under the Green Deal and the Net Zero Industry Act for 2030. In this context, Europe has a chance to lead on both climate action and industrial competitiveness, but only if it backs its ambitions with real investment.

Climate investments are a progress indicator for EU's 2030 targets

Estimating climate investments in the EU is one key way to track the EU's progress towards the achievement of its climate objectives. Investments in climate change mitigation are critical when it comes to assessing the structural changes of an economy and its capacity to reduce greenhouse gas emissions in the short, medium, and long term. Investment decisions made now shape our climate future Greenhouse gas emissions are directly linked to the type of equipment and infrastructure deployed on the ground, and only a fraction of them is replaced every year. The timing of climate investments is thus crucial to avoid the risk of carbon lock-in.

Climate investments are a good proxy to understand if the EU is on a path to reach the policy objectives set out in the EU Climate Law, as well as in sectoral regulations (such as the EU renewable energy target set into the renewable energy directive). However, it is important to notice that investment needs depend strongly on the assumptions made and the policies adopted. In case of strong technological progress, less climate investment may be needed. Moreover, current investment is also driven by cyclical developments and the general investment conditions (including financing costs).

The **EU climate investment deficit** estimated in this report is the difference between A) the total investment needs required annually by 2030 to achieve the EU 2030 targets, and B) the actual climate investments happening in the EU economy currently.

The report offers an independent analysis tracking current and future investments. The proposals for the next long term EU budget are in the pipeline and public budgets are under pressure in several Member States. The report seeks to inform a challenging political debate with clarity on the state of play on investments in the sectors which are central to climate transition and to competitiveness.

A methodology based on I4CE's French Landscape of Climate Finance

This report presents findings based on the methodology developed by the I4CE Landscape of Climate Finance in France (2023). Since 2014, the Landscape has been gradually estimating climate and fossil investments made in France from 2011 until now, and documents their short-term outlook. It compares current investments with investment needs, based on the French Long-Term Strategy. In the latest edition, published in December 2023, the investment needs are assessed against France's draft National Energy and Climate Plan (NECP) (I4CE, 2023).

Using a similar approach, this report estimates the investment required to achieve the EU 2030 objectives in 4 different sectors of the economy: energy, buildings, transport and cleantech manufacturing. It compares these investment needs with the investments made in the same systems in previous years in the EU (see Methodology). Due to data gaps, it excludes heavy industry, agriculture, forestry and climate change adaptation.

This report presents:

1. An overview of the climate investment deficit for the energy, buildings, transport and clean technologies manufacturing sectors in the EU.
2. Detailed results of the climate investment deficit for the energy system, including renewable energy and power grids; but excluding biomass, hydrogen and solar heating.
3. Detailed results of the climate investment deficit for the buildings sector, including energy renovation of buildings, energy-efficiency of new building construction and heat pumps deployment in residential buildings; but excluding district heating, biomass heating, and climate change adaptation investments.
4. Detailed results of the climate investment deficit for the transport sector, including electric vehicles and trans-European railways infrastructures, but excluding planes, ships and urban public transport.
5. Detailed results of the climate investment deficit for cleantech manufacturing sector, including wind turbines, solar panels, batteries, heat pumps and electrolysers.

1. OVERVIEW OF EUROPE'S CLIMATE INVESTMENT STATE OF PLAY: A SLOWDOWN IN 2023 JEOPARDISES EU 2030 TARGETS

This report tracks the level of climate investments made in the energy, buildings, transport and cleantech manufacturing sectors on an annual basis. In this regard, dozens of sub-sectors have been analysed to estimate the specific needs according to EU regulations by 2030 and the current level of investment (see the methodology section). This analysis provides information on the current trend of climate investments, the current needs to attain those 2030 targets, and the difference between both – the climate investment deficit.

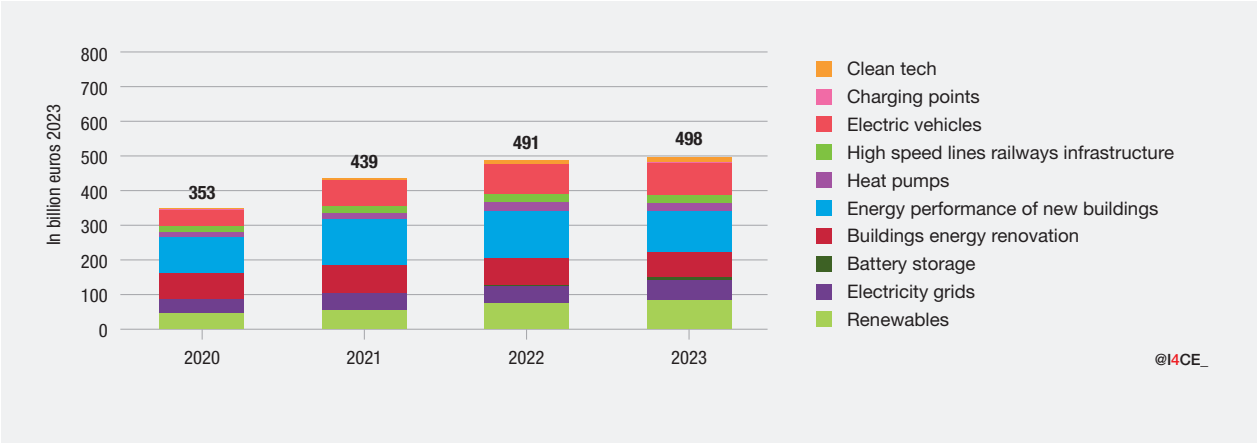
Key messages

- **After several years of significant growth, climate investment stagnated at 498 billion euros in 2023 in the energy, buildings, transport and clean technology manufacturing sectors**, a 1.5% growth compared to 2022. First estimations of 2024 investments predicts a further dip in investment, reversing the growth trend for the first time.
- Still, the EU economy is still far from reaching the investment level required to meet the 2030 climate transition targets. **As 842 billion euros would be needed every year from 2025 to 2030, the climate investment deficit stands at 344 billion euros in 2023** for these 4 sectors. Without a rapid scale-up, the investment deficit will widen, threatening both climate and industrial objectives.
- **Most of the sectors studied in the scope of this report present a climate investment deficit, in various proportions**. Some sectors are particularly far from reaching their 2030 targets. Wind power 2023 investment reached only 29% of what would be needed annually while investment in building energy renovation stands at around 34%.
- **Solar power, energy efficiency of new buildings construction and cleantech manufacturing are the only sectors that present an investment surplus**. While the investment surplus in the energy performance of new buildings construction is structural, the surpluses in solar power and battery manufacturing simply indicate that the EU was investing at the right pace in 2023.

Climate investments have risen in recent years, reaching 498 billion euros in 2023. After experiencing significant growth between 2020 and 2022, climate investment growth slowed in 2023, reaching 1.5%. However, this overall growth reflects mixed dynamics across sectors. This slowdown in 2023 growth is mainly due to a contraction in new buildings construction investments. The building sector also suffered from a decline in renovation activity and heat pump sales. In contrast, investment in renewable energy – driven by solar power – and in electricity grids grew by 17% in 2023. The transport sector also saw an 8% rise in investment, driven mainly by the increasing adoption of battery electric vehicles.

Preliminary investment estimates for 2024 give rise to concern. Several climate investments are expected to have decreased in 2024, including renewable electricity (-7.2%), buildings energy renovation (-6.3%), heat pumps (-26.9%) and battery electric passenger vehicles (-2.9%). The EU is still a long way from achieving its 2030 climate targets, and the drop in 2024 investment will contribute to widening the deficit even further.

FIGURE 5. THE YEAR-ON-YEAR GROWTH IN CLIMATE-FRIENDLY INVESTMENTS IS SLOWING DOWN IN 2023



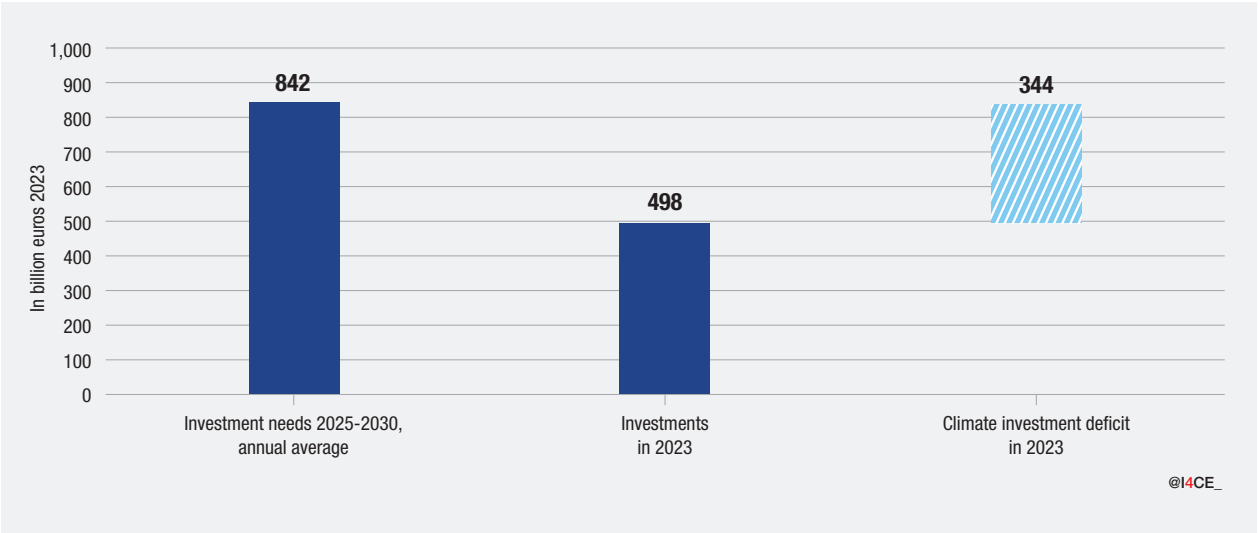
Source: I4CE. All data are in 2023 euros. It represents climate investments in the energy, buildings, transport and clean technlogies manufacturing sectors between 2020 and 2023. 2024 preliminary results were not included due to incomplete data.

The EU has set a range of specific sectoral targets in the energy, buildings, transport and clean tech manufacturing to be achieved by 2030. This includes targets such as attaining 510 GW of wind power installed capacity, (European Commission, 2022b), reducing the average primary energy consumption of residential buildings by at least 16% compared to 2020 (European Parliament & Council of the European Union, 2024a), or reducing passenger cars emissions per km by 55% (European Parliament & Council of the European Union, 2019). Achieving those targets requires investments in specific sectors of the EU economy.

Using the latest available investment costs for technologies or sub-sectors covered in this study, this report estimates that **842 billion euros, or 4.9% of the EU 2023 GDP**, will need to be invested every year until 2030, for the EU to achieve its targets. As climate investment reached 498 billion euros in 2023, this leaves a climate investment deficit of **344 billion euros, or 2.0% GDP**. In other words, the current level of investments in renewable energy, bioenergy, electricity grid, buildings energy-efficiency, clean mobility, and clean technologies manufacturing represents 60% of the yearly investments that are needed for the EU to deliver its 2030 targets.

These levels of investment are a strict minimum for several reasons. First, the scope of the report is limited (*e.g.* heavy industry and agriculture are excluded). Second, the investments' calculation methodology assumes favourable future economic conditions (*e.g.* decreased investment costs of energy generation infrastructures thanks to technological progress and a contained rise of raw materials prices).

FIGURE 6. THE CURRENT CLIMATE INVESTMENT DEFICIT IN THE ENERGY, BUILDINGS, TRANSPORT AND CLEAN TECHNOLOGY MANUFACTURING IS ESTIMATED AT 344 BILLION EUROS PER YEAR. TO ATTAIN THE 2030 EU TARGETS IN EACH SECTOR, CURRENT INVESTMENTS NEED TO INCREASE BY 69%



Source: I4CE. All figures are in euros 2023. On the left, this graph represents the average climate investment needs per year for the EU to reach its climate objectives between 2025 and 2030 in the energy, buildings, and transport, and clean technologies manufacturing sectors in 2030 (842 billion euros). It compares them to the 2023 investments for the same sectors (498 billion euros). The difference between them gives the climate investment deficit (344 billion euros).

By conducting a granular analysis of each of the 32 sub-sectors covered in this study, three key research findings come to light (see **Figure 7**):

1. Nearly all sub-sectors analysed in this report show a climate investment deficit, with only three exceptions:

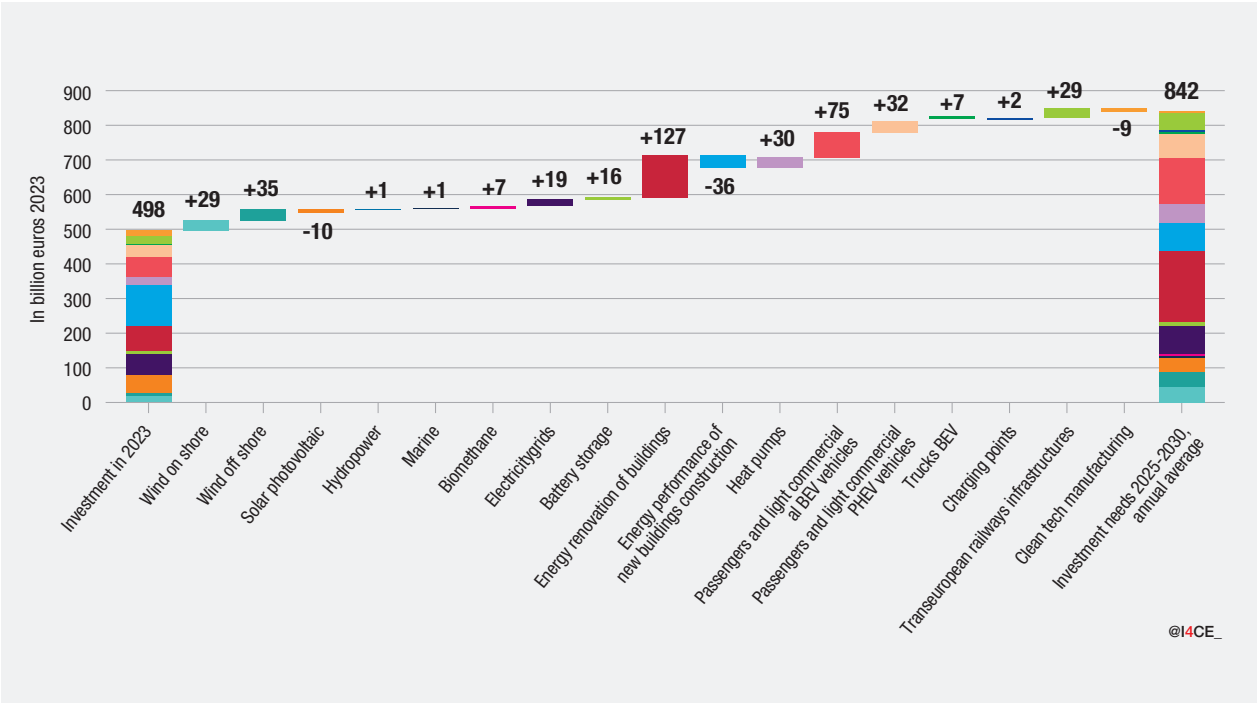
- the solar power sector shows an investment surplus of 10 billion euros, driven by a recent surge in solar installations that has put the EU on track to meet its sectoral targets.
- the energy performance of new buildings shows a surplus of 36 billion euros. This is largely structural and reflects the European Commission's expectations of a slowdown in new construction in the coming years, particularly in the non-residential segment.
- the cleantech manufacturing sector has a surplus of 9 billion euros, entirely due to the battery manufacturing segment, where recent investments have aligned the sector with the European Commission's desired targets set in the Net Zero Industry Act (NZIA) for this specific sector.

The investment surplus in new building construction is structural, driven by an expected decrease in new buildings construction while the surpluses in solar power and battery manufacturing are more conjunctural. These later simply indicate that the EU was investing at the right pace in 2023. Achieving the EU's climate and industrial targets in these areas will require maintaining this pace over time. However, solar power investments are projected to decline by 5% in 2024, and battery manufacturing by 11%. If these trends persist, the EU may fall short of its targets in both sectors.

2. Several sectors have a moderate level of investment deficit, defined as having 2023 investment representing at least 75% of the sector-specific needs: for instance, that is the case of hydropower, which current investment represents 82% of the needs, and electricity grids (76%).

3. More alarmingly, some sectors have 2023 investment levels that are below 50% of the estimated sector-specific needs: that is the case for wind power, whose level of investment stands at 42% of the needs for onshore and 15% for offshore, energy-renovation of residential and non-residential buildings (36% combined), railways (43%), and battery electric passenger and commercial light vehicles (43%).

FIGURE 7. THE EU OVERALL CLIMATE INVESTMENT DEFICIT OF 344 BILLION EUROS IN 2023 IS THE SUM OF SECTORAL EU CLIMATE INVESTMENT DEFICITS AND SURPLUSES. THE BIGGEST DEFICITS IN VOLUME ARE IN THE ENERGY-RENOVATION OF BUILDINGS (127 BILLION EUROS), BATTERY ELECTRIC VEHICLES (75 BILLION EUROS), AND WIND POWER (64 BILLION EUROS)[1]



Source: I4CE. All data are in euros 2023. This graph indicates the split of the climate investment deficit by sector. The climate investment deficit corresponds to the difference between the annual average investments that are needed for the EU to reach its climate objective by 2030 and the investments that occurred in 2023. For example, for the onshore wind power sector, the climate investment deficit of 29 billion euros corresponds to the difference between the average investment needs (50 billion euros) and the 2023 investments (21 billion euros).

1 This figure is printed in large format in the annex of this report.

2. THE ENERGY SECTOR: AT LEAST 87 BILLION EUROS OF EXTRA INVESTMENTS ARE NEEDED ANNUALLY TO ACHIEVE THE EU'S 2030 RENEWABLE ENERGY TARGETS AND TO STRENGTHEN POWER GRID INFRASTRUCTURES

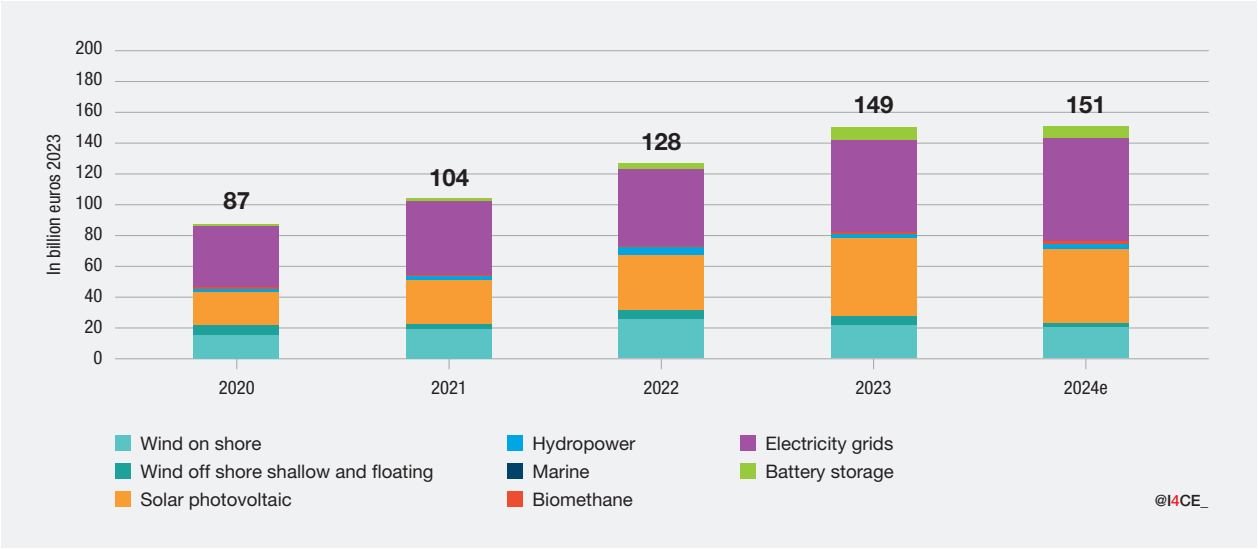
Key messages

- **The energy sector has demonstrated strong momentum in climate investment over the past few years**. In 2023, climate-related investments reached 149 billion euros — a 17% increase compared to 2022 — driven mainly by rising investments in solar PV and power grids. In contrast, investment in onshore and offshore wind, as well as hydropower, declined in 2023. However, the positive investment trend observed since 2020 may not continue in 2024. Preliminary data suggests that total investments are likely to stagnate or even decline.
- **Achieving the EU's 2030 overall and sector-specific energy targets will require at least 237 billion euros in public and private investments every year from 2025 to 2030**. This report thus estimates the EU **climate investment deficit in the energy sector to be of at least 87 billion euros per year in 2023**.
- **Wind power represents the largest gap**, with a 64 billion euros deficit, followed by power grids and battery storage, which together account for a 26 billion euros deficit. **Closing the investment gap in power grids is particularly critical**, as grid connectivity is a key enabler for the deployment of renewables and the broader electrification of the economy.
- **The overall deficit is partially offset by a 10 billion euros estimated investment surplus in the solar PV sector for 2023**. With a 25% growth in newly installed capacities from 2022 to 2023, the sector is currently on track to meet its 2030 targets, provided that the pace of new installations does not slow down.
- Addressing the climate investment deficit in the energy sector is key for the EU to rebound after the 2021-2023 energy price shock **and make electricity more secure and affordable**, especially in the current instable geopolitical context.

Between 2020 and 2023 the EU economy has increasingly invested in the energy sector to achieve both overall and sector-specific climate objectives. Looking at the latest EU-27 consolidated data for this sector, our research estimates that climate-related investments in the EU economy reached 149 billion euros in 2023, a 17% growth compared to 2022 (see **Figure 8**). This continuous increase in the energy sector investments has been mainly driven by two sectors: solar power, whose yearly investments rose by 28 billion euros since 2020, and electricity grids, which saw an increase of 20 billion euros over the same period.

However, the growth in climate investment for the energy sector observed since 2020 is at risk of being reversed. Total investments are expected to have stagnated at best, or even decreased in 2024 compared to 2023. Investments in wind power and solar photovoltaics (PV) are expected to have decreased by 14% and 5% in 2024 respectively. While the decline in solar PV investments is not yet a concern – as this sector is likely to remain in a surplus in 2024 –, it highlights a broader trend of stagnation or decline across most segments of the energy sector. The outlook is no more encouraging for battery storage and hydropower, whose levels of investment are expected to remain flat in 2024. These weak trends are partially offset by a projected increase in electricity grid investments, rising from 60 billion euros in 2023 to 67 billion euros in 2024, though this growth is more modest than in previous years.

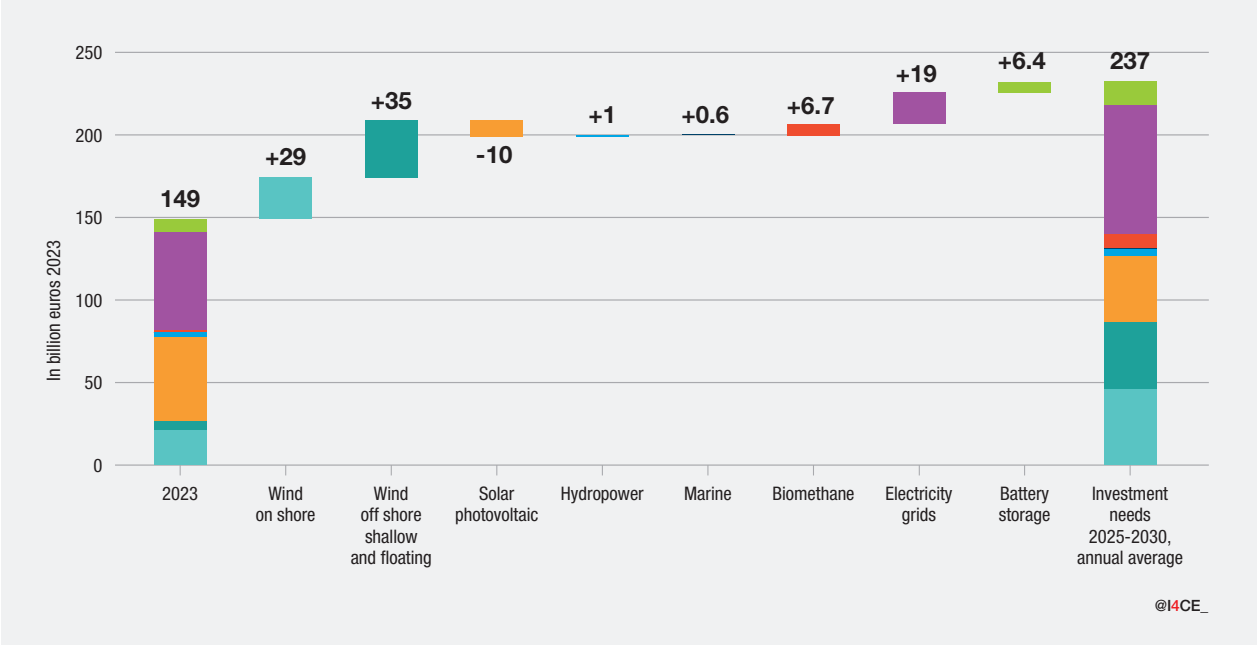
FIGURE 8. CLIMATE INVESTMENT IN THE ENERGY SECTOR HAS INCREASED SIGNIFICANTLY IN RECENT YEARS, DRIVEN BY SUBSTANTIAL GROWTH IN SOLAR POWER AND POWER GRIDS. INVESTMENT STAGNATION IS EXPECTED AT BEST FOR 2024



Notes: I4CE. All data are in euros 2023. They represent climate investment in the energy sector between 2020 and 2024.

Significant efforts remain to be made to achieve the 2030 targets. The adoption of the Renewable Energy Directive in 2023 raised the EU binding renewable energy target for 2030 to 42.5%[2] (European Parliament & Council of the European Union, 2023b), and if possible 45%. Achieving these objectives – and those more sectorial specific – will require a massive increase in capacities, especially in wind power, solar PV and power grids, which entails higher investment needs. To meet these targets, around **237 billion euros would need to be invested annually in the EU energy sector between 2025 and 2030**. **Building on this, the current climate investment deficit in the EU economy's energy sector amounts to 83 billion euros in 2023** (see Figure 9).

FIGURE 9. THE ENERGY CLIMATE INVESTMENT DEFICIT IS ESTIMATED AT 87 BILLION EUROS IN 2023. INVESTMENTS NEEDS ARE PARTICULARLY DRIVEN BY WIND POWER AND ELECTRICITY GRIDS NECESSARY SCALE-UP, AS BOTH SECTORS ACCOUNT FOR 72% OF TOTAL ENERGY INVESTMENT NEEDS



Source: I4CE. All data are in euros 2023. This graph represents the distribution of the climate investment deficit for the energy system. For each sector, the investment deficit compares the 2023 investment to the estimation required to meet the European regulations. For instance, 29 billion euros of additional investments are needed annually between 2025 and 2030 in wind on shore. Investment needs are averaged between 2025 and 2030.

2 42.5% is the mandatory level. Note, however, that the 2023 Renewable Energy Directive states that "Member States should endeavour to collectively achieve an overall Union renewable energy target of 45% in line with the REPower EU plan" (European Parliament & Council of the European Union, 2023a). This plan has been used in this report for the sectoral analysis of wind power, solar PV and biomethane production.

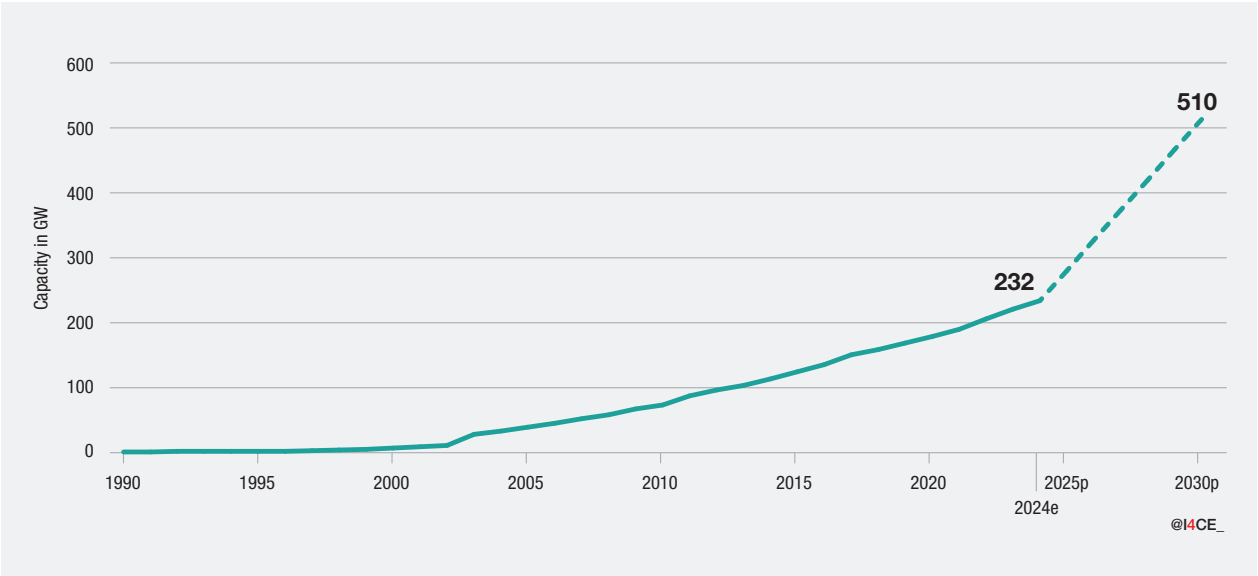
These investment needs are a minimum. The estimates provided are not exhaustive in scope, as they do not include investments in other sectors such as biomass, waste, and renewable heat which includes geothermal heat, district heating or solar thermal. As the EU does not have precise objectives to develop nuclear energy, this sector also remains outside the scope of our report.

2.1. Wind Power: a current low rate of investments puts 2030 wind targets at risk

Wind power 2023 investments amounted to 26.7 billion euros in 2023, a 15.6% decline compared to 2022. According to WindEurope (2025), this slowdown can be attributed to slowing installations caused by grid bottlenecks, challenging financial conditions, and lengthy permitting processes in several Member States. Wind sector investments expectations for 2024 are no more encouraging, with investments expected to fall by a further 15% to 23 billion euros. The decline is even more pronounced for the offshore wind power sector, where investments are projected to decrease by more than 50% to only 3 billion euros in 2024. However, final investment decisions (FID)[3] for the construction of new offshore power plants increased significantly in 2023. This could result to a notable increase in offshore installations from 2025 onwards (WindEurope, 2025).

The European Commission, with the REPowerEU plan (2022b) and the European Wind Power Action Plan (European Commission, 2023a) aims to achieve a total installed capacity of 510 GW[4] in 2030, including both onshore and offshore wind. This objective implies more than doubling the current 232 GW of capacity by 2030 (see **Figure 10**). This translates to a 46 GW of new annual average installed capacities, compared to only 16.5 GW installed in 2023. Failing to meet this annual target leads to a rise in future investment needs, as uninstalled capacities are carried over to subsequent years — progressively diminishing the likelihood of achieving the 2030 objectives.

FIGURE 10. TO MEET EU 2030 WIND POWER TARGETS, INSTALLED CAPACITIES WILL NEED TO BE MULTIPLIED BY 2.2 BETWEEN 2025 AND 2030



Source: I4CE based on Eurostat (2025a), the Repower EU plan (2022), Wind Europe (2025) and EU wind energy action plan (2023). This graph represents total wind power installed capacity in GW. In 2024, the total wind power installed capacities reached 231 GW in the EU according to Wind Europe. By 2030, a total capacity of 510 GW is targeted by RepowerEU plan, including 111 GW of offshore wind (of which 5.5 GW will be floating) with the rest coming from onshore installations. The data between 2024 and 2030 have been projected on a linear basis.

3 Final Investment Decision (FID) are the formal approval from a project developer to proceed with a specific project, marking the commitment to allocate capital resources and move from the project planning stages to execution. I4CE's investments estimation are accounted based on Gross Fixed Capital Formation estimation.

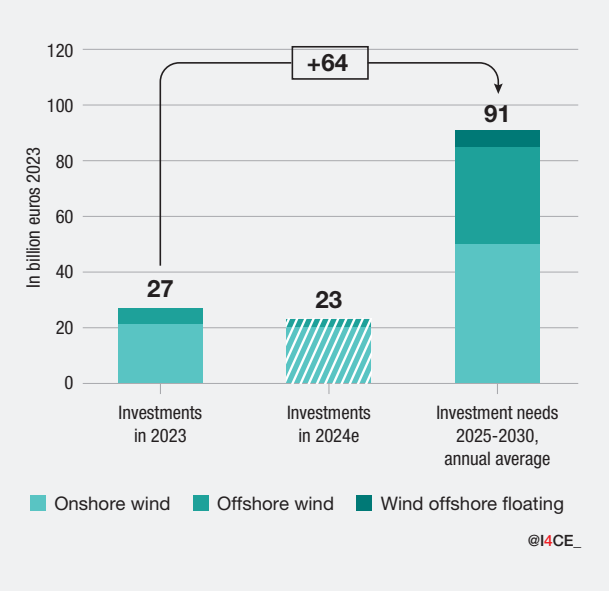
4 This Repower EU target was released in 2022 and is tied to a 45% renewable energy target in the RED III directive which was under discussion at that time. However, released in 2023, the RED III directive set the legally binding minimum target at 42.5%. In this new context, no other projections from the European Commission were made. This research thus keeps the 510 GW target as a 2030 objective.

Focusing on offshore wind, EU Member States, as part of the Trans-European Networks for Energy (TEN-E) (2023), agreed to deploy 111 GW of offshore wind capacity out of a total of 510 GW by 2030. Based on current project developments, it is estimated that 5 GW of the 111 GW will be offshore floating wind (4C Offshore, 2025). To meet the 2030 target, offshore capacity – currently standing at 19 GW – must be multiplied by more than five. Given that offshore projects take longer to develop than onshore projects (Agence de l'Environnement et de la Maîtrise de l'Énergie *et al.*, 2017), the likelihood of achieving this target is already at risk.

In addition to these new capacities' targets, a growing percentage of wind turbines will need to be replaced in the coming years. Since 2003, wind turbine installations have grown significantly, and with an average lifespan of 25 years (IRENA, 2024), WindEurope estimates that 75 GW of projects will reach the end of the operational life in 2030. Wind Europe expects that 17 GW out of the 75 GW of wind capacities, almost exclusively onshore, will realistically be refurbished by 2030 (WindEurope, 2025). To this must also be added the capacity that needs to be newly installed to compensate for the assets that will be decommissioned. The investment in refurbishment or renewal of existing capacities would represent around 3.9 billion euros per year over the same period.

Using the latest capital cost estimates from the European Commission (2024a), this report estimates that an average annual investment of 91 billion euros will be required in wind power through 2030 to meet EU targets stated above. As 27 billion euros were invested in 2023, this results in a wind power investment deficit of 64 billion euros in 2023 (see **Figure 11**).

FIGURE 11. 64 BILLION EUROS OF ADDITIONAL INVESTMENTS WILL BE NEEDED EVERY YEAR BETWEEN 2025 AND 2030 TO SUPPORT THE DEVELOPMENT OF ONSHORE, OFFSHORE SHALLOW AND FLOATING WIND PROJECTS



Source: I4CE based on Eurostat (2025a), 4C Offshore (2025), and European Commission (2024a). All data are in euros 2023. Current investments in wind power are estimated at 27 billion euros in 2023. The annual average investments needed to meet the EU's climate objectives are estimated at 91 billion euros between 2025 and 2030. The difference between these two levels of investments correspond to the climate investment deficit, estimated at 64 billion euros.

BOX 1. TO REACH THE 42.5% RENEWABLE ENERGY TARGET, THE GOAL OF 510 GW OF INSTALLED WIND POWER CAPACITY BY 2030 MAY BE OVERESTIMATED

This report estimates the investment needs in the wind power sector based on the REPowerEU plan, which set a target of 510 GW of installed wind power capacity by 2030. This figure was estimated by the European Commission based on a 45% renewable energy target, proposed in the REPowerEU plan in 2022. However, the 2023 Renewable Energy Directive (RED III) ultimately set a biding target of 42.5%, which would likely lead to a downward revision of the corresponding wind power capacity target. Additionally, the 510 GW estimate was based on capacity factor assumptions that are not widely agreed upon in the industry.

To address these two issues, WindEurope developed its own methodology to calculate the 2030 wind power target, considering the revised renewable energy share and differing capacity factor assumptions. According to their analysis, approximately 425 GW of installed capacity would be required by 2030 to reach 42.5% of renewable energy (WindEurope, 2025).

Based on this report's investment estimation methodology, the 2023 wind power investment gap would amount to 45 billion euros under the 425 GW scenario, compared to 64 billion euros under the 510 GW scenario.

2.2. Solar Power: keeping up with the current level of investment will make it possible to reach the 2030 target

Investments in the solar PV sector have flourished in recent years, rising by 42% in 2023 to reach 51 billion euros. The surge in electricity and gas prices in 2022 combined with growing concerns over energy security, made solar PV an attractive and cost-effective alternative for EU economic actors (SolarPower Europe, 2023). The growth in 2023 was driven by Germany, which nearly doubled its installed capacities that year. However, this upward trend is expected to come to a halt in 2024, with current estimates projecting a 5% decline in investment. This decline in investment is due both to a significant slowdown in the growth of solar PV installations but also to a decrease in PV investment costs. According to SolarPower Europe, this slowdown reflects the fact that, in many national markets, the easiest gains have already been achieved. As a result, large year-on-year increases are becoming less frequent, particularly as electrification and system flexibility have not kept pace with the rapid expansion of the solar sector (SolarPower Europe, 2024).

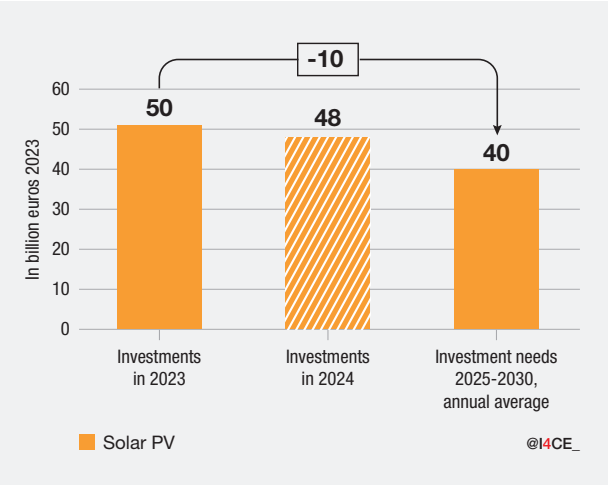
As part of the REPowerEU plan (European Commission, 2022a), the European Commission aims to bring online over 320 GW of solar photovoltaic capacity by 2025 and almost 600 GW by 2030, compared to 244 GW installed at the end 2023, and 294 GW expected at the end 2024 (**Figure 12**). This corresponds to an annual installation of new capacity of more than 49 GW, close to the 48 GW installed in 2023. The increase in the installation rate in 2023 is consistent with the rate observed over the past four years, at a 20% rate per year on average.

Unlike wind power, the need to replace solar panels is limited over the next decade. Solar panels have a lifetime of around 25 years (IEA, 2023), and their installation began to take off in 2010. Our report estimates that around 150 million euros on average per year will need to be invested in refurbishment between 2025 and 2030.

Using the latest available investment cost data from the European Commission (2024a), this report estimates that around 40 billion euros would need to be invested annually in solar PV in the EU economy until 2030 for the EU to achieve its targets. As, 51 billion euros has been invested in solar PV in 2023, this leaves a climate investment surplus of 10 billion euros (see **Figure 13**). This is the only sector in the energy system to experience an investment surplus in 2023.

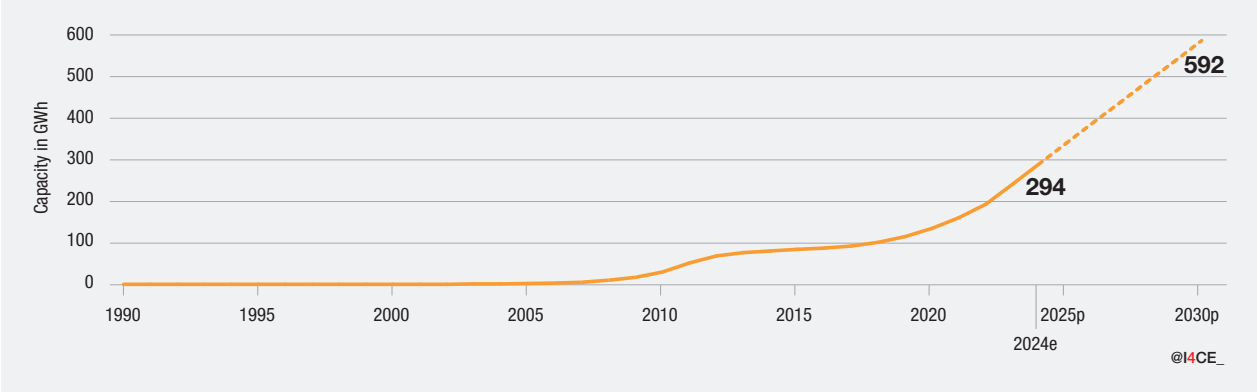
However, this surplus does not suggest that the pace of new capacity installations should slow down. The surplus in the solar PV sector is driven by several factors: a rate of new installations aligned with targets, declining cost assumptions over the decade (European Commission, 2024a), and an expected growing share of utility-scale PV projects in future sales, which benefit from greater economies of scale per kilowatt installed compared to residential PV.

FIGURE 13. ACHIEVING EU CLIMATE TARGETS IN SOLAR POWER WILL REQUIRE 40 BILLION EUROS PER YEAR ON AVERAGE BETWEEN 2025 AND 2030, LEAVING A 10 BILLION EUROS INVESTMENT SURPLUS IN 2023



Source: I4CE based on Eurostat (2025), SolarPower Europe (2024), and the European Commission (2024a). All data are in euros 2023. Investments in solar PV are estimated at 51 billion euros in 2023. Based on fleet projection favouring utility-scale PV deployment, the annual average investment required to meet the EU's climate objectives is estimated at 40 billion euros between 2025 and 2030. The difference between these two levels of investment corresponds to the climate investment surplus, estimated at 10 billion euros. Solar power investments are expected to decrease in 2024.

FIGURE 12. THE SOLAR PV SECTOR IS ON TRACK TO MEET EU'S 2030 OBJECTIVE OF 592 GW OF INSTALLED CAPACITY

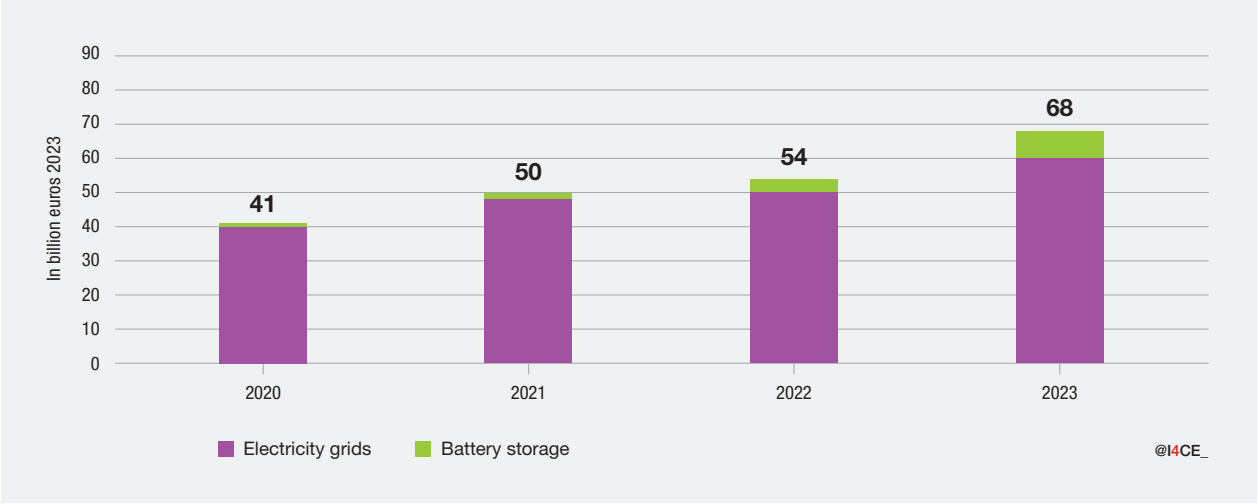


Source: I4CE based on Eurostat (2025a), Repower EU (2022b), SolarPower Europe (2024). This graph represents total solar PV installed capacities in GW. In 2024, the total solar power installed capacities was 294 GW. 592 GW are expected to be installed by 2030 according to RepowerEU. The data between 2024 and 2030 have been projected on a linear basis.

2.3. Power grid and battery storage: additional investments are required to integrate new renewable energy capacities and to support increased electrification

Electricity networks are the backbone of the EU's internal energy market and are thus essential for enabling the green transition. Electricity grids investments in 2023 have reached 60 billion euros, a 21% growth compared to 2022 (see **Figure 14**).

FIGURE 14. INVESTMENT IN POWER GRIDS AND BATTERY STORAGE SIGNIFICANTLY INCREASED IN 2023, FOLLOWING TWO YEARS OF STAGNATION

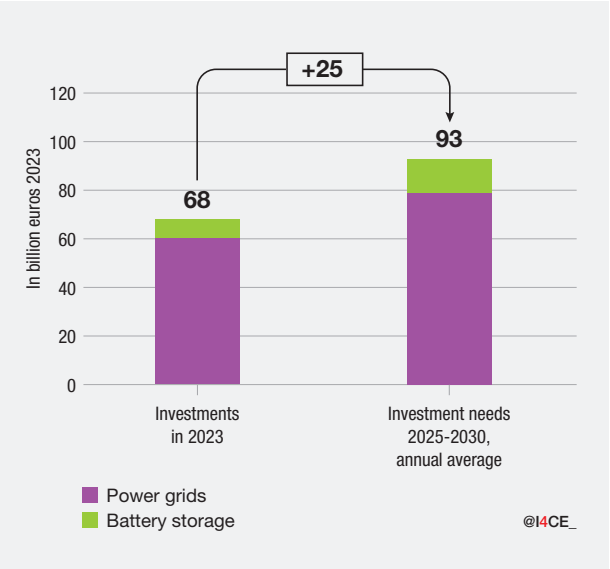


Source: the IEA (2024c) and the European Investment Bank (EIB, 2023).

The expected increase in the European Union's electricity consumption, the connection of new renewable energy capacities to the grids, and the rising needs of cross-border infrastructure, will require significant investments between now and 2030. These investments concern both transmission and distribution grids. The report also considers investment needs in grid modernisation, as around 40% of Europe's distribution grids are over 40 years old and need to be modernised (European Commission, 2023b).

This study considers investment needs estimates for power grids from a study conducted for the European Commission (Directorate-General for Energy, Artelys, LBST, Trinomics, Finesso, A. *et al.*, 2025). This study estimates that around 79 billion euros would need to be invested in power grids every year between 2025 and 2030. Distribution grid investments account for 53% of these investment needs. The power grids investment deficit would then amount to 25 billion euros in 2023.

FIGURE 15. 93 BILLION EUROS ARE NEEDED EVERY YEAR BETWEEN 2025 AND 2030 TO SUPPORT GRIDS EXTENSION AND MAINTENANCE, AS WELL AS BATTERY STORAGE DEVELOPMENT



Source: I4CE based on the IEA and the European Commission. Investment amounts are expressed in euros 2023."

Investments in battery storage amounted to 7.6 billion euros in 2023, almost twice as much as in 2022. According to the European Resource Adequacy Assessment, from ENTSO-E (2023), 170 TWh of battery storage capacities will need to be installed until 2030. It includes both residential and utility-scale installations.

According to Energy Transition Expertise Centre of the European Commission, estimated investment costs for these two technologies indicate that the average annual investments requirements between 2025 and 2030 amount to 14 billion euros. This results in an investment deficit of 6.4 billion euros.

BOX 2. THE INVESTMENT NEEDS ESTIMATES ARE CONSERVATIVE, REFLECTING THE DECREASING COSTS OF ENERGY TECHNOLOGIES ASSUMPTIONS

These energy investment estimates should be understood as minimal values. To assess investment needs across various technologies, this report relied on multiple sources of cost projections. Most of them assumed decreasing technology cost trends assumption until 2030. However, it is important to mention that technology costs are rather difficult to predict, as they are influenced by several factors, hard to foresee several years in advance. As an example, costs are highly influenced by the price of raw materials, which can vary greatly depending on political and geopolitical events.

Here are the sources and assumptions used in the cost projections for each sector covered in the energy section of this report:

- for **wind power** and **solar PV**, the latest investment cost projections from the European Commission were used, developed using the PRIMES model (2024a). This model plans favourable costs evolution for both technologies. For wind power, it projects a cost reduction of 18% for onshore, 17% for offshore shallow, and 29% for offshore floating technologies which are still being developed currently. For Solar PV, the model projects costs for different types of PV – residential, commercial and utility scale – whose cost are projected to decrease by 18% on average by 2030;
- to estimate investment needs for the EU **hydropower sector** – which is mainly refurbishment until 2030-2022 – cost estimations from the European Commission's Clean Energy Technology Observatory were used (2024). For projection 2022 to 2030 projection, the hypothesis taken was that the cost would remain stable as this is a rather mature/established technology.
- for **marine energy**, the World Energy Outlook's Announced Pledges Scenario (APS)'s cost estimation was used (IEA, 2022). This projection assumes that measures and targets announced by the European Commission are sufficient to achieve the net-zero emissions target by 2050, and that they will be implemented on time. This model predicts that the cost of marine energy production infrastructures will decrease by 25% between 2023 and 2030;
- to estimate the cost of increasing **biomethane** production to 35 billion cubic meters as targeted by the REPowerEU plan (European Commission, 2022a), the projections from the Danish Energy Agency were used (Energistyrelsen, 2025). The agency forecasts a 13% cost reduction for biogas production plants and a 17% decrease for biogas upgrading facilities by 2030.

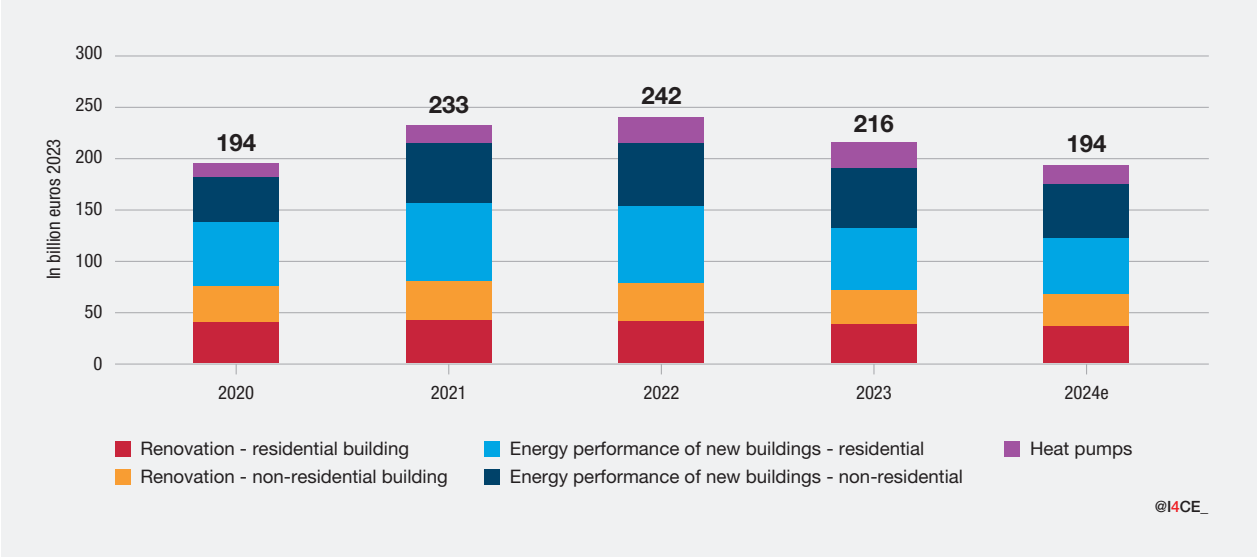
3. THE BUILDING SECTOR: AT LEAST 120 BILLION EUROS OF EXTRA INVESTMENTS ARE NEEDED TO MAKE MORE EU BUILDINGS ENERGY-EFFICIENT AND DEPLOY MORE HEAT PUMPS

Key messages

- **Following a period of increased investment in the post-Covid era, climate investments in the building sector declined by 10.5% in 2023, down to 216 billion euros**. This decline reflects the broader construction sector crisis and a scaling back of public support for heat pump deployment. A similar decline is expected in 2024.
- **Yet, 337 billion euros are needed every year between 2025 and 2030 to reach the EU objectives set by the EPBD and Repower EU, leaving a climate investment deficit of 120 billion euros in 2023**. This deficit is largely driven by building renovation, where investment would need to nearly triple to meet the EPBD targets. The downward trends in climate investments in the building sector threaten the achievement of the EU's 2030 targets on time.
- **The investment deficit in the building sector is partly by energy performance of new buildings which shows a surplus due a slowdown in the construction rate expected in the coming years**. This surplus can be seen as a reserve that could potentially be reallocated to other sectors.
- **Deep renovations are more efficient to save primary energy**. However, the individual cost of a deep renovation for households and businesses can be quite significant. It is important for the EU and national policy makers to put in place support measures to enable deep renovation (rather than medium or light) in residential and non-residential buildings, when possible.
- **Lack of updated and accurate public data makes it challenging to determine past investments in building energy renovation and new building construction**. Investment data until 2024 presented in the following section are estimates that should be treated with caution. Out of all the sectors covered in this report, building renovation is where access to reliable, open and up-to-date data was the biggest challenge.

Following a period of increased investments in the post-Covid era, climate investments in the buildings sector witnessed a 10.5% decline in 2023, down to 216 billion euros (**Figure 16**). This contraction is attributed to a decline in investments across all sub-sectors. The energy performance of new residential buildings is particularly affected by the drop of new constructions in 2023 (-22% vs 2022), despite rising construction costs (excluding inflation). Investment in heat pumps also started to decrease in 2023, after several years of continuous growth. This 3.7% drop in 2023 heat pump investments is mainly explained by less competitive electricity prices compared to gas prices, and less public support. Heat pump investments are expected to have decreased further down in 2024, by 26.9%.

FIGURE 16. FOLLOWING A PERIOD OF INCREASED INVESTMENT IN THE POST-COVID ERA, CLIMATE INVESTMENTS IN THE BUILDINGS SECTOR WITNESSED A 10.5% DECLINE IN 2023, DOWN TO 216 BILLION EUROS

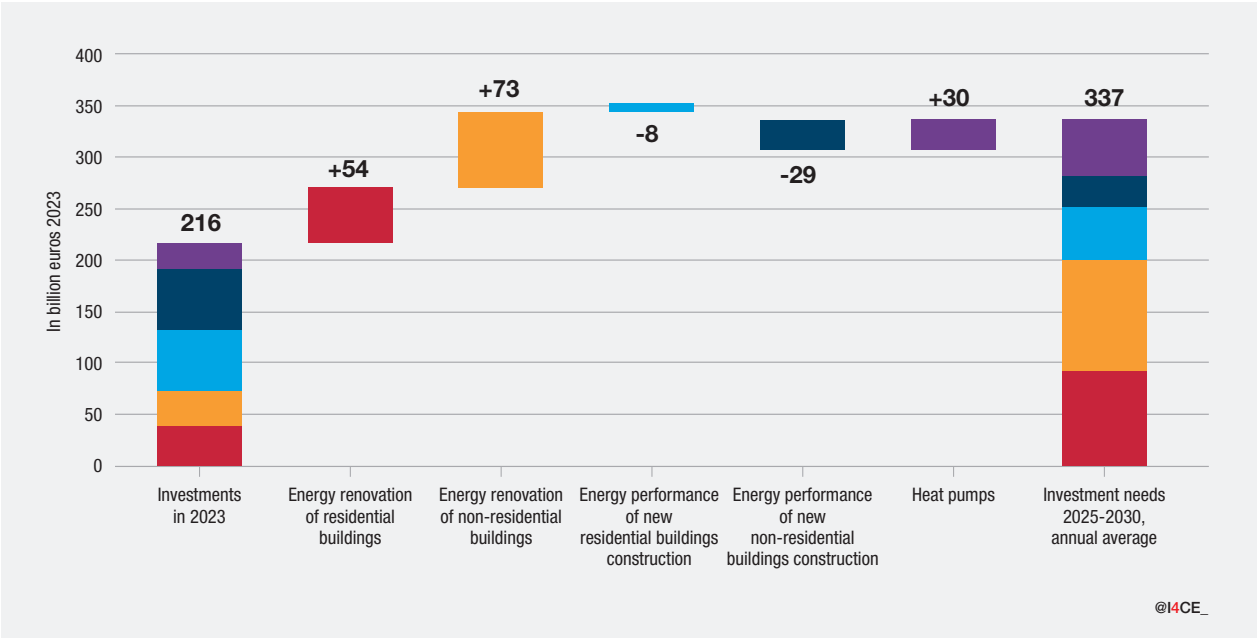


Source: I4CE based on the European Commission, Eurostat, Cravezero (2018) and EHPA (2024b). All data are in euros 2023.

And yet, the EU economy is still far from reaching the objectives set by the European Institutions. In 2020, the European Commission launched the Renovation Wave (2020) to boost the renovation of Europe's buildings to make them more efficient. In particular, the Renovation Wave aims to renovate 35 million buildings by 2030 and to promote deep renovation (see **Box 3**). To meet these objectives, the Renovation Wave led to the revision of the 2021 European Building Performance Directive (EBPD) (European Parliament & Council of the European Union, 2024a), as part of the Fit For 55 legislative package. Adopted in April 2024, the EPBD revision sets out to reduce the average primary energy use across residential buildings by at least 16% in 2030 compared to 2020, and the renovation of 16% of the worst-performing non-residential buildings based on energy performance.

Investment needs for the EU to achieve these objectives in the building system are estimated at 337 billion euros per year between 2025 and 2030. As the EU economy has invested 216 billion euros in 2023, it leaves an investment deficit of 120 billion euros for the building sector (**Figure 17**). These investment needs include both residential and non-residential buildings.

FIGURE 17. THE CLIMATE INVESTMENT DEFICIT IS ESTIMATED AT 120 BILLION EUROS. INVESTMENT NEEDS ARE MAINLY DRIVEN BY ENERGY EFFICIENCY RENOVATION NEEDS



Source: I4CE. All data are in euros 2023. 2023 investments are based on actual data. This graph represents the distribution of the climate investment deficit for the building sector. For each equipment, the investment deficit exists compared the investment required to meet the European regulation to 2023 investments. For instance, 54 billion euros of additional investments are needed annually for renovation in residential buildings. Investment needs are averaged between 2025 and 2030.

It is important to acknowledge that there is a significant **lack of data** at the European level regarding both the energy renovation of buildings and the construction of new buildings meeting NZEB standards. Most of the available data are from 2016 (European Commission. Directorate General for Energy. *et al.*, 2019). Therefore, the data for past and current investments presented in the following sections are estimates, derived from the aforementioned European Commission report and the FIEC (European Construction Industry Federation, 2024), and should therefore be treated with caution.

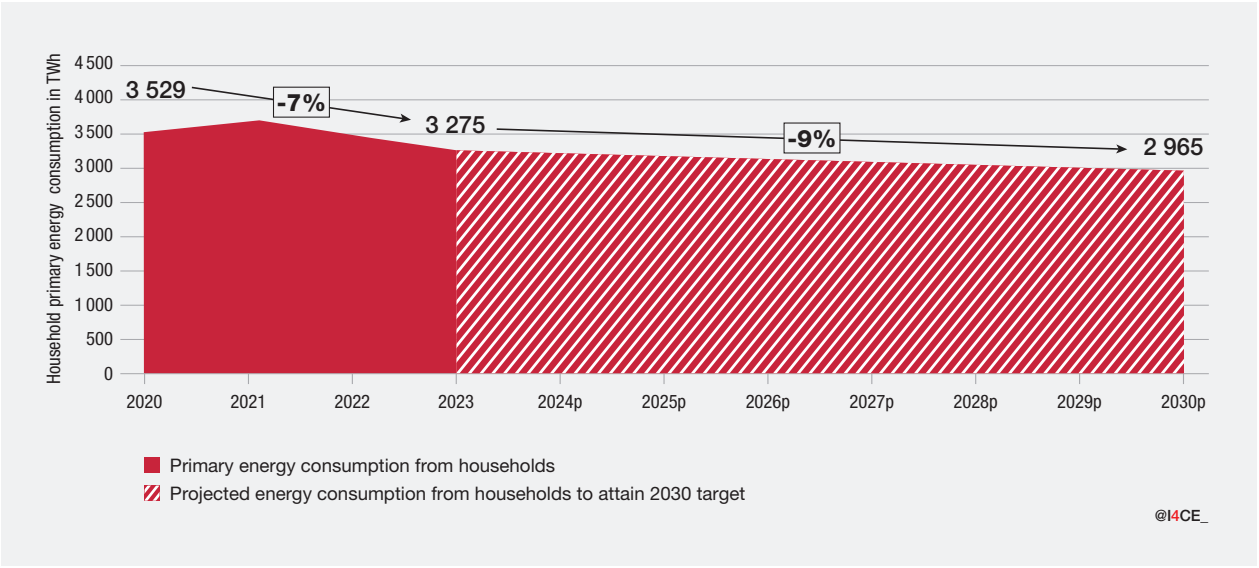
3.1. Buildings energy renovation: a need to scale up investment through cost-effective deep renovation

Building energy renovation is declining over the last few years. After a rebound following the COVID crisis, investment in building renovation has declined since 2021, to 72.5 billion euros in 2023. These figures are estimates based on general renovation trends reported by the FIEC (European Construction Industry Federation (FIEC), 2024) and should therefore be interpreted with caution. Limited data availability makes it difficult to accurately assess historical investment patterns.

The EPBD 2024 revision requires a reduction of the average primary energy use across residential buildings by at least 16% in 2030 compared to 2020 (European Parliament & Council of the European Union, 2024a). 55% of this reduction must come from the 43% worst performing buildings. The EBPD also sets a target to renovate 16% of the worst-performing non-residential buildings based on energy performance.

In the residential buildings sector, reducing at least 16% of average primary energy consumption implies saving around 565 TWh by 2030 compared to 2020 (see **Figure 18**). These energy savings must come from all Member States, which must all reduce their primary energy consumption by at least 16%. Of these 565 TWh, 219 TWh – or 39% – will come from heat pumps, if the REPowerEU targets on heat pumps deployment are met. The remaining energy savings will then come from building envelop insulation measures, or the change/replacement of other heating systems.

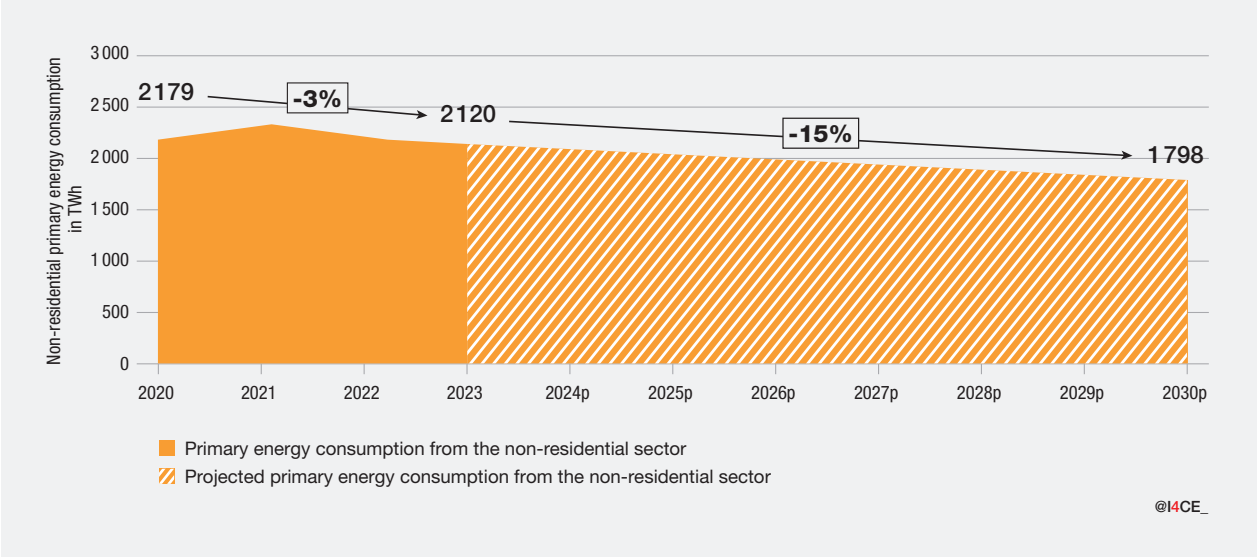
FIGURE 18. RESIDENTIAL BUILDINGS PRIMARY ENERGY CONSUMPTION NEEDS TO BE REDUCED BY 9% BY 2030 COMPARED TO 2023 LEVELS



Source: I4CE based on Eurostat (2025b) and European Commission (2023b).

In the non-residential sector, renovating 16% of the worst-performing buildings based on energy performance (European Parliament & Council of the European Union, 2024a) implies saving around 381 TWh of primary energy use per year by 2030 (**Figure 19**).

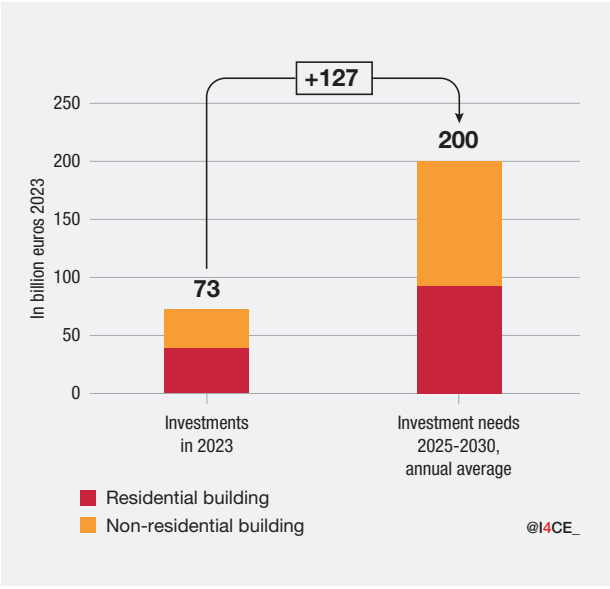
FIGURE 19. NON-RESIDENTIAL BUILDINGS PRIMARY ENERGY CONSUMPTION NEEDS TO BE REDUCED BY 15% BY 2030 COMPARED TO 2023 LEVELS



Source: I4CE based on Eurostat (2025b) and European Commission (2023b).

To reach the objectives set by the EPBD for both residential and non-residential buildings sector, 200 billion euros are needed every year until 2030, leaving a climate investment deficit of 127 billion euros (**Figure 20**).

FIGURE 20. ACHIEVING THE EBPD TARGET FOR BUILDING RENOVATION WILL REQUIRE 200 BILLION EUROS PER YEAR ON AVERAGE BETWEEN 2025 AND 2030, LEAVING A CLIMATE INVESTMENT DEFICIT OF 127 BILLION EUROS IN 2023



Source: I4CE. All data are in euros 2023. 2023 investments in buildings renovation are estimated at 73 billion euros. The annual average investments needed to meet the EU's climate objectives are estimated at 200 billion euros between 2025 and 2030. The difference between these two levels of investment corresponds to the climate investment deficit, estimated at 127 billion euros.

The investment costs of energy renovation for both medium and deep renovation correspond to building envelope insulation costs including roof, basement, and walls insulation costs, windows replacement and change of heating system. They do not include non-energy related renovation items. These costs vary among the different member states, depending on the cost of labour and raw materials in each country (European Commission. Directorate General for Energy. *et al.*, 2019). No increase in renovation cost has been projected over the 2024-2030 period.

For both residential and non-residential, estimation on deep renovation cost in euros per kWh saved has been taken into account to estimate building renovation investment needs (calculation based on data from European Commission. Directorate General for Energy. *et al.*, 2019). This is because deep renovations are a cheaper way to achieve a certain amount of kWh of primary energy consumption saved. A sensitive analysis indicates that undertaking only medium renovation instead of deep renovation would increase the investment needs for the residential sector by 50%.

However, this does not imply that doing a deep renovation is not expensive for households. The cost of deep renovation per square meter is higher than the cost of medium renovation, but the energy saved by deep renovation is much more important (see **Box 3**). In other words, doing deep renovation will require less investments in total in the EU economy to reach the EPBD target on primary energy savings, but the individual cost for households and business can be quite significant. It is then very important for EU and national policy makers to put in place support measures to foster deep renovation in residential and non-residential buildings. The National

Building Renovation Plans that must be submitted by Member States to the European Commission by the end of 2025 and the recommendations that will follow should go in this direction. The introduction of such an aid scheme would be doubly beneficial. It would enable households and businesses to undertake costly deep renovations, while also generating greater public spending savings.

BOX 3. DEEP RENOVATION AND MEDIUM RENOVATION DEFINITIONS

- We have included medium and deep renovations in our scope in accordance with the criteria adopted by the European Taxonomy.
- An energy renovation means the change of one or more building elements, according to EPBD Art. 2, 9 (*i.e.* building envelope and technical building systems), having the potential to significantly affect the calculated or measured amount of energy needed to meet the energy demand associated with one or several building services, such as: space heating and cooling, hot water, ventilation, lighting, etc.
- As stated in EPBD 2024 revision, the concept of deep renovation has not been defined in Union law. In the context of achieving objectives, the directive only provides the following point: "With a view to achieving the long-term vision for buildings, deep renovation should be defined as renovation that transforms buildings into zero-emission buildings but, as a first step, as a renovation that transforms buildings into nearly zero-energy buildings" (European Parliament & Council of the European Union, 2024a).
- Therefore, this research uses the same definition of the different level of renovation used by the latest UE scale report on building renovation in the EU made by the European commission (Directorate General for Energy. *et al.*, 2019). The depth of a building energy renovation thus corresponds to the primary energy savings achieved with a specific measure or package of measures that have been implemented in a calendar year. Four renovation depths can be identified:
  - **Below** threshold ($x < 3\%$ savings),
  - **Light** renovations ($3\% \leq x \leq 30\%$ savings),
  - **Medium** renovations ($30\% < x \leq 60\%$ savings),
  - **Deep** renovations ($x > 60\%$ savings).
- The different depths do not necessarily need to cover a specific minimum number of measures. They are just classified depending on the savings achieved compared to the primary energy performance level of the building in the calendar year before the energy renovation.

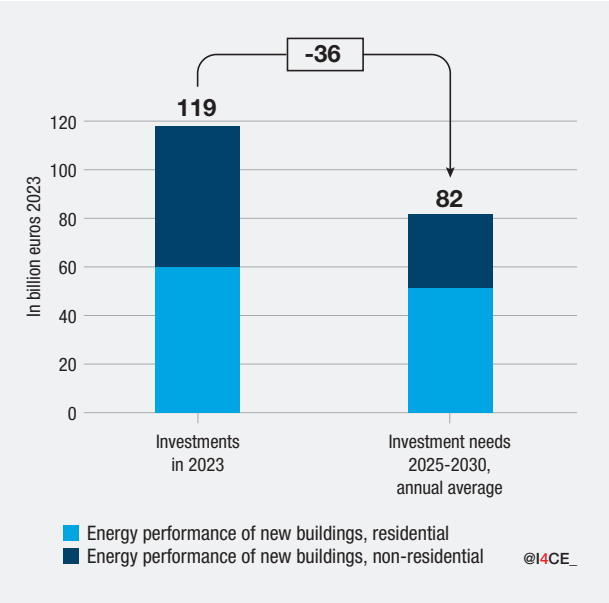
3.2. Energy performance of new buildings construction: towards a decline in investment?

Investment in the energy performance of new buildings corresponds to expenditure on energy-related items in new residential and non-residential buildings. Investment in the energy performance of new buildings construction has slowed down in recent years, after a boom in 2021 and 2022, due to a decline in new constructions, despite rising construction costs (excluding inflation). 2023 investments have decreased by 14% compared to 2022, to 119 billion euros.

In the coming years, investments in energy performance of buildings are expected to decrease significantly, due to decreasing construction rate. In the Staff Working Document accompanying the European Commission's proposal on 2040 target (2021a), the European Commission is expecting the residential floor area to increase by 21% in 2040 compared to 2015. It corresponds to only a 0.6% annual growth of the stock, compared to a 1% annual averaged growth between 2017 and 2020. The European Commission is also expecting a decrease of the non-residential total floor area until 2040 (+5% in 2040 vs 2015), corresponding to a 0.7% annual decrease of the stock.

This significant expected slowdown in the growth of new construction explains the substantial drop in in the energy performance of buildings investment needs between now and 2030. Average investment needs are expected to be around 82 billion euros on average between 2025 and 2030, leaving an investment surplus of 36 billion euros (see **Figure 21**). This surplus is mainly explained by an expected decrease of the non-residential building stock. The investments in the residential sector are expected to stagnate until 2030.

FIGURE 21. AN EXPECTED DECREASE IN NEW BUILDING CONSTRUCTION RESULT IN A 36 BILLION EUROS INVESTMENT SURPLUS IN 2023



Source: I4CE. All data are in euros 2023. 2023 investments in energy efficiency of new buildings are estimated at 119 billion euros. The annual average investments needed to meet the EU's climate objectives are estimated at 82 billion euros between 2025 and 2030. The difference between these two levels of investment corresponds to an investment surplus of 36 billion euros.

Translating a projected decline in the non-residential building stock into an annual construction rate is not obvious. In the absence of more detailed information, this report assumes a 50% reduction in the construction rate of non-residential buildings in the coming years. This assumption is primarily illustrative: it aims to show that a planned slowdown in new construction would lead to a corresponding drop in investment needs for this sector. This investment surplus is structural, and the funds saved could potentially be redirected to other areas facing an investment deficit, such as building energy renovation. However, reallocating this surplus across sectors is not straightforward. The transition involves significant sectoral transformations, with different actors involved, and public authorities will need to play an active role in managing and supporting these changes.

BOX 4. UNCERTAINTY ON DETERMINING CURRENT CLIMATE INVESTMENTS IN NEW BUILDINGS

The recast of the Energy Performance of Building Directive (2018) requires all new buildings to be NZEB from 2021.

The investment costs for achieving NZEB standards represent the total cost of insulating the new building. It includes roof, basement, and walls insulation costs, as well as the cost of double- or triple-glazed windows. It does not include every other non-energy related construction costs. Nor does it include a change of heating system, which is covered in a separate section. These costs vary among the different member states, considering the cost of labour and raw materials in each country (Cravezero, 2018). No increase in investment cost has been projected over the 2025-2030 period.

Estimation on current and past investment presents significant uncertainties. Our methodology assumed that all new buildings met NZEB standards since 2021. In 2016, around 21% of new residential buildings in the EU were considered NZEB, compared to 15% in 2012. For non-residential buildings, it was 11% (European Commission. Directorate General for Energy. *et al.*, 2019). This is a strong assumption, as there is currently no data available on the exact number of new buildings that meet NZEB standards.

3.3. Heat pumps: recent investment decline threatens achievement of RepowerEU targets

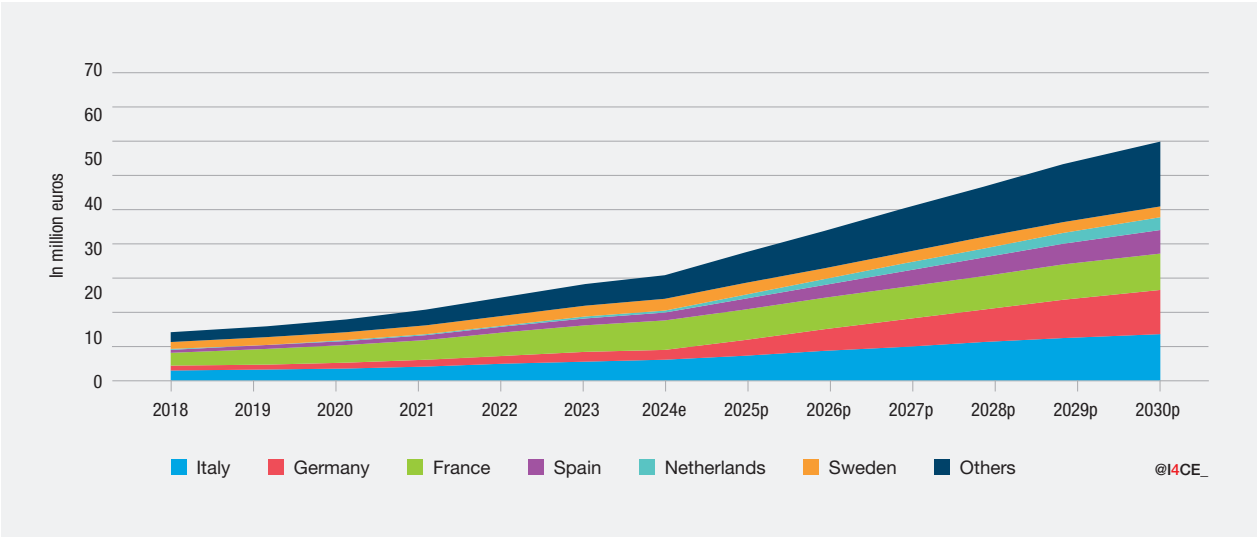
Heat pumps have benefited from strong investment momentum over the past few years. The sector experienced a 34% growth in 2021 and a 50% growth in 2022, mainly explained by high gas prices during this period that made heat pumps more competitive. However, this trend is beginning to reverse. Investments decreased by 3.7% in 2023 and are expected to further decrease by 27% according to the European Heat Pump Association (EHPA) estimation on 2024 EU heat pump sales (2025).

According to the EHPA (2024b), the primary cause of this decline can be attributed to fluctuations in energy prices. In the wake of the Russian invasion of Ukraine in 2022, gas prices experienced a notable surge, making heat pumps a more financially advantageous alternative to an oil or gas boiler. However, since 2023, gas prices have exhibited a downward trend. This recent decline has resulted in a situation where they are once again below electricity prices, rendering the purchase of heat pumps less economically attractive for households and industries.

Furthermore, as indicated by EHPA (2024b), the evolution of the heat pumps market in the EU is closely related to the political landscape. Several negative signals have been transmitted to the market in recent times, contributing to an overall atmosphere of uncertainty for investors and the market players alike. The European Commission's Heat Pump Action Plan, initially scheduled for late 2023, has been postponed to a later time. Similar shifts have also been observed at national level. For instance, the removal of government support for heat pumps in Italy largely explains the 44% decline in Italian heat pumps investment in 2023.

And yet, there is still a long way from achieving the EU's targets on heat pumps deployment. The REPowerEU Action Plan and the Green Deal Industrial Plan of the European Commission foresees the installation of 30 million heat pumps by 2030 (2022a), compared to 2020. The objective of these heat pump deployment is mainly to replace existing oil and gas boilers in existing dwellings. These heat pumps are supposed to be mainly hydronics. 10 million heat pumps will likely to be deployed in new residential buildings as well, in line with JRC assumptions (2023). The heat pump stock is expected to reach around 53 million units in 2030 if these objectives are achieved (**Figure 22**).

FIGURE 22. THE EU HEAT PUMP STOCKS IS EXPECTED TO REACH 53 MILLION UNITS IN 2030, 2.4 TIMES MORE THAN IN 2023



Source: I4CE. Stock is defined as the accumulated sales. This graph represents the total stock of heat pumps in the EU until 2030. In 2023, the EU stock of heat pumps was 21 million. The EU expects the installation of 30 million additional units in existing buildings by 2030, compared to 2020. 10 million units are also expected to be installed in new buildings. Data until 2024 are real data, based on EHPA market reports (2024). The 2024 landings have been estimated. Data from 2025 to 2030 are projected.

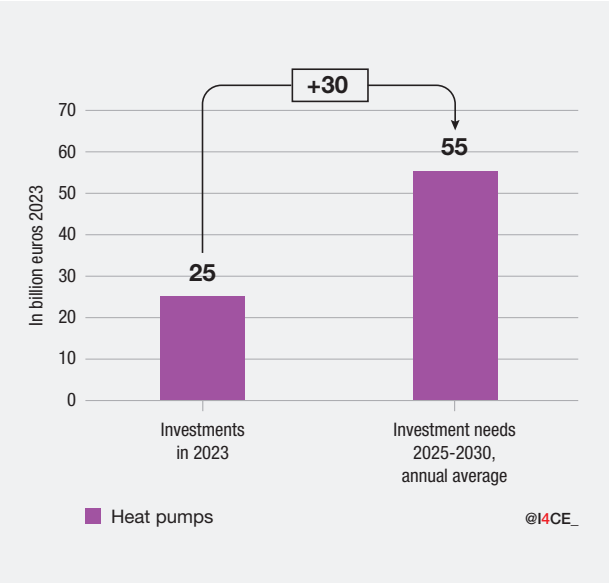
Achieving EU climate objectives for heat pump deployment will imply 55 billion euros per year of investments between 2025 and 2030, giving a climate investment deficit of 30 billion euros (**Figure 23**). The recent contraction in the heat pump market is hindering the EU's ability to achieve its targets for the sector. Without the implementation of supplementary public policy measures, the EU will not be on track to achieve its 2030 objectives for this specific sector.

BOX 5. METHODOLOGY ON HEAT PUMP COSTS

The data concerning past and current heat pump investment costs, categorised by type of heat pump, has been derived from the IEA (2021) and indexed to price levels indices by country.

The estimate of heat pumps investment needs uses the average investment cost of air-water heat pumps in the European Union. These investment costs differ between member states. Based on IEA data by country (2021), the average investment cost for air-water heat pumps in the EU have been estimated to be around 10,300 euros in 2023. It is assumed that the investment cost will remain constant until 2030. It should be noted that 35% of sales in 2023 were air-air heat pumps, which have a lower investment cost than air-water heat pumps (around 6,500 euros in 2023).

FIGURE 23. ACHIEVING EU CLIMATE TARGETS FOR HEAT PUMPS WILL REQUIRE 55 BILLION EUROS PER YEAR ON AVERAGE BETWEEN 2025 AND 2030, LEAVING A CLIMATE INVESTMENT DEFICIT OF 30 BILLION EUROS BN IN 2023



Source: I4CE. All data are in euros 2023. 2023 investments in heat pumps deployment are estimated at 25 billion euros. The annual average investments needed to meet the EU's climate objectives are estimated at 55 billion euros between 2024 and 2030. The difference between these two levels of investment corresponds to the climate investment deficit, estimated at 30 billion euros.

4. THE TRANSPORT SECTOR: AT LEAST 145 BILLION EUROS OF EXTRA INVESTMENTS ARE NEEDED PER YEAR FOR ELECTRIC VEHICLES, RECHARGING POINTS AND LONG-DISTANCE RAILWAY INFRASTRUCTURE

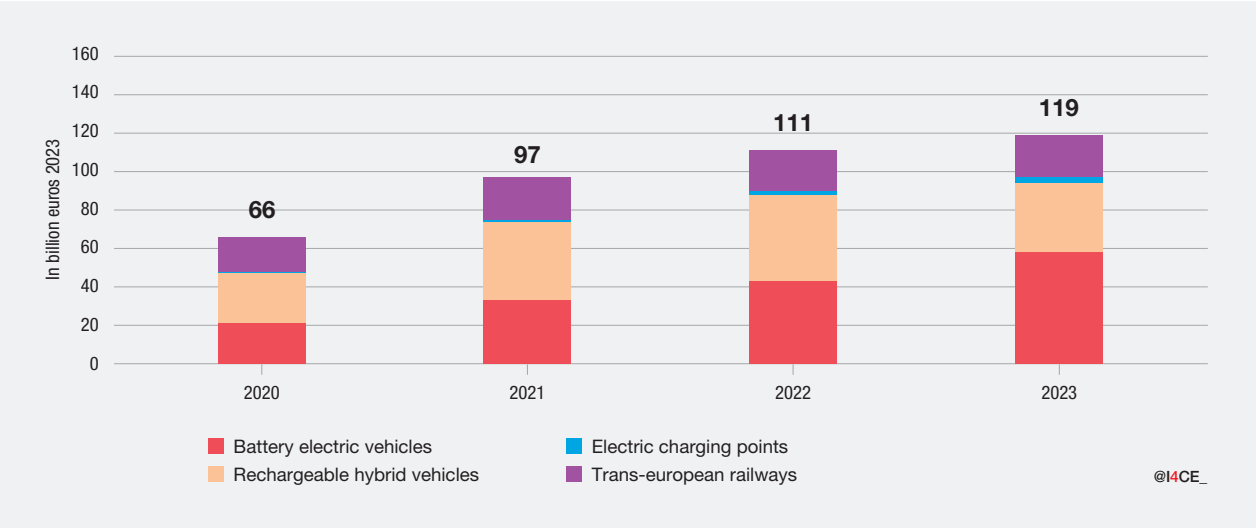
Key Messages

- **In 2023, climate-related investment directed to clean mobility – including road transport and long-distance railway infrastructures – increased by 7% to 119 billion euros**. This increase has been mainly supported by a respective 34% and 63% growth in electric passenger and commercial vehicles investments. Partial results for 2024 might not be encouraging, as investment in electric passenger vehicles is expected to reduce by 3%.
- **Yet, achieving the EU's 2030 transport decarbonisation targets will require at least 264 billion euros in investment per year between 2025 and 2030**. Building on these findings, this report estimates the **climate investment deficit of the transport system to reach 145 billion in 2023**.
- **Electric and hybrid plug-in light commercial and passenger cars make up the greatest contribution to the investment needs**. With a gap of 114 billion euros in 2023, their deployment is key for bridging the transport climate investment deficit. Favouring battery electric vehicles over more expensive and more polluting chargeable hybrid vehicles would be a political choice that would reduce the investments needs in the EU economy.
- **Electric charging points are essential to ensure that the transition to clean road transport move forward**. 4.8 billion euros of investment are needed every year, meaning that public and private investment need to almost double the 2023 investments estimated at 2.6 billion euros.
- **The 2030 objective for trans-European trains requires more than doubling current investments allocated to railway infrastructures across Europe**. If the European Union aims to decarbonize long-distance travel, given the public nature of such infrastructure, a significant boost in public investment is needed.

In 2023, climate-related investments in battery electric and rechargeable light and heavy vehicles, supporting charging points and trans-European railways are estimated at 119 billion euros (Figure 24). Excluding inflation, this level of investment represents an 80% increase since 2020, where climate investment in the transport sector was estimated at 66 billion euros. This ignores investments in key transport systems for reducing CO_2 emissions not covered by this report due to lack of data, such as urban public transport, regional railways and cycling infrastructures.

The steady annual growth in investment since 2020 is primarily driven by battery electric and plug-in hybrid passenger vehicles. Over four years, investments in this area have nearly doubled, rising from 46 billion euros to 90 billion euros in 2023. In 2024, they are expected to have reached 97 billion euros, although the rise is mainly driven by a 25% increase in investment in hybrid passenger cars, while investment in electric passenger vehicles is projected to have decline by 3%. Investments in public charging infrastructure for light electric vehicles have also tripled over the 2020-2023 period, reaching 2.6 billion euros. In contrast, investments in trans-European railways have stagnated, and spending on charging infrastructure for heavy-duty vehicles has yet to gain momentum.

FIGURE 24. CLIMATE INVESTMENTS IN THE TRANSPORT SECTOR HAVE INCREASED SIGNIFICANTLY IN RECENT YEARS, DRIVEN BY SUBSTANTIAL GROWTH IN BATTERY ELECTRIC AND RECHARGEABLE HYBRID PASSENGER VEHICLES



Notes: I4CE. All data are in euros 2023. They represent yearly climate investment in the transport sector between 2020 and 2023.

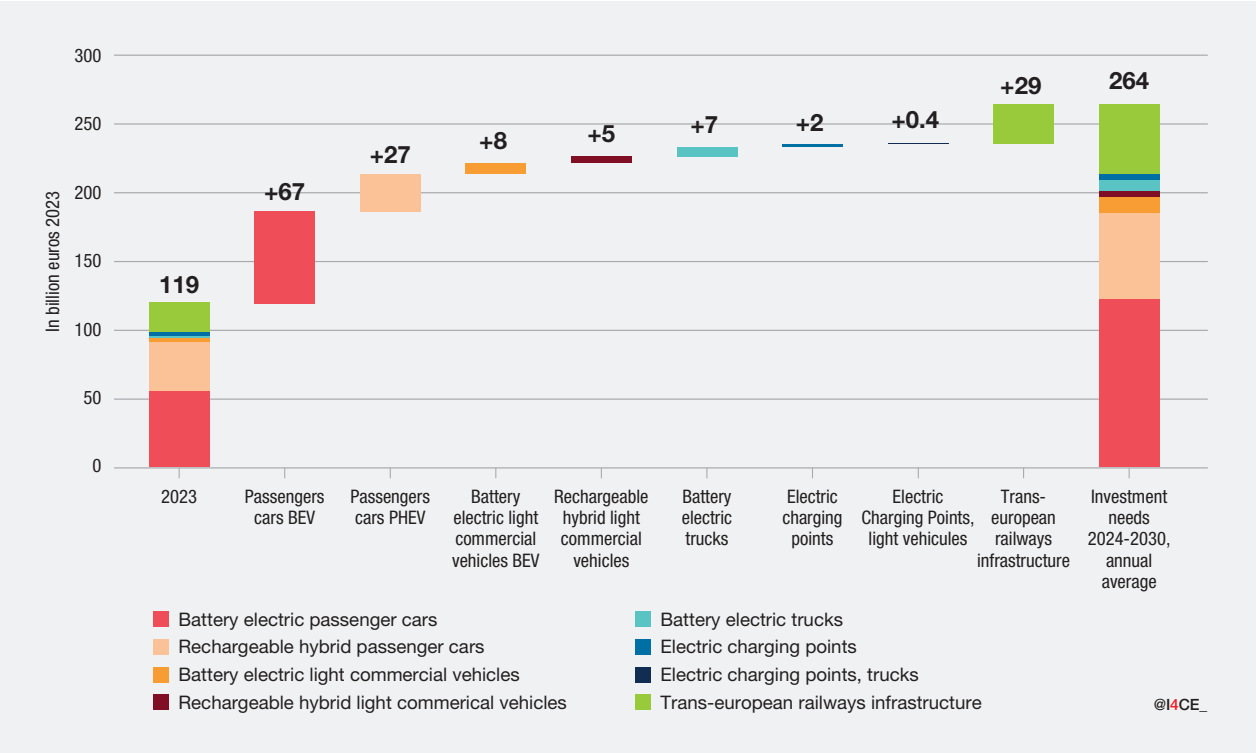
Although significant, this growth in investment is far from being sufficient to meet the 2030 targets on time.

By 2050, the EU aims to achieve a 90% reduction in transport related greenhouse gas emissions (European Commission, 2021c). To support this long-term goal, intermediate sector-specific targets have been set for 2030. Our estimation of the 2030 needs for climate investments in the transport system covered in this section originates from different agreed regulations of the European Green Deal:

- **for road transport**, the policies and scenarios considered are based on EU regulations aimed at reducing greenhouse gas emissions from new vehicles (European Parliament & Council of the European Union, 2019, 2024b). These regulations set emissions standards for passenger cars, light commercial vehicles (or vans), and heavy-duty vehicles. The deployment of electric technologies is necessary to meet this ambition.
- supporting the uptake of electric vehicles, the Regulation on the deployment of alternative fuels infrastructure (2023) set mandatory deployment of **public charging points**.
- **for rail transport**, the European Union wants to increase the rail transport modal share by developing trans-European long-distance railways. The Trans European Transport - Network regulation, known as **TEN-T** (European Parliament and Council of the European Union, 2024a)) defines certain rail projects as high-priority infrastructure for 2030. These "core Network" projects were used to estimate investment needs. The impact of the revision of TEN-T, is analysed in the rail section.

To meet these 2030 climate targets, this report estimates that around 265 billion euros, or 1.5% of the 2023 EU GDP, would need to be invested in the EU transport system annually between 2025 and 2030. The difference between current investments in the transport system and the estimated needs to attain the 2030 targets, *i.e.* the transport investment deficit, amounts to 146 billion euros in 2023, or 0.85% of EU 2023 GDP (**Figure 25**). In other words, on average, yearly transport climate investments will need to more than double during the 2025 to 2030 period to reach the stated targets.

FIGURE 25. THE CLIMATE TRANSPORT INVESTMENT DEFICIT IS ESTIMATED AT 145 BILLION EUROS. TRANSPORT NEEDS ARE DRIVEN BY BATTERY ELECTRIC PASSENGER CARS, REPRESENTING 69% OF THE TOTAL AVERAGE INVESTMENT NEEDS



Source: I4CE. All data are in euros 2023. This graph represents the distribution of the climate investment deficit for the transport system. For each sector, the investment deficit compares the 2023 investment to the estimation required to meet the European regulations. For instance, 67 billion euros of additional investments are needed annually between 2025 and 2030 for passenger electric vehicles. Investment needs are averaged between 2025 and 2030.

Investment needs between now and 2030 are primarily driven by the need of higher electrification of light and heavy vehicles (light passenger and commercial vehicles & trucks), which summed account for 79% of the total deficit or 114 billion euros. Supporting this technological shift, additional investments for light and heavy vehicles public charging points represents 2.2 billion euros, or only 2% of the total deficit. Trans-European Railways, with a deficit of 29 billion euros, have the second-highest need of additional investments (19%).

The investment needs presented in this study represent a minimum estimate, as the scope does not cover all investments required for the transition to clean mobility. Maritime and air transport are excluded. In the case of rail transport, due to data limitations, investments in maintenance, regional railway infrastructure, and urban public transport are not included. For road transport, investments in vehicle manufacturing facilities are also not accounted for at this stage, while battery production capacity is covered in the following section on clean technology manufacturing. Additionally, not all technologies and segments related to heavy-duty vehicles are included, and cycling infrastructure is entirely omitted.

BOX 6. GROSS INVESTMENTS FOR ELECTRIC VEHICLES

Investments are defined as gross investments. It measures total acquisition costs, and not the net investments compared to a reference. For example, a household can choose between an electric car at €34,000 and a fossil car at €27,000. In this case, buying the electric car requires a gross investment of €34,000 but a net investment of only €7,000 (= €34,000 minus €27,000). As a consequence, the cost of the alternative (a petrol-powered internal combustion engine car) does not impact our climate investment deficit estimate.

This precision is useful for policy-making, as investment includes both private and public spendings. In the specific case of electric cars, the challenge is to ensure that private investments are re-rerouted from fossil cars to electric cars. This involves guiding the same economic actors (households and businesses), who purchase new cars from the same suppliers and retailers, to pay for the extra upfront cost of investing €34,000 instead of €27,000.

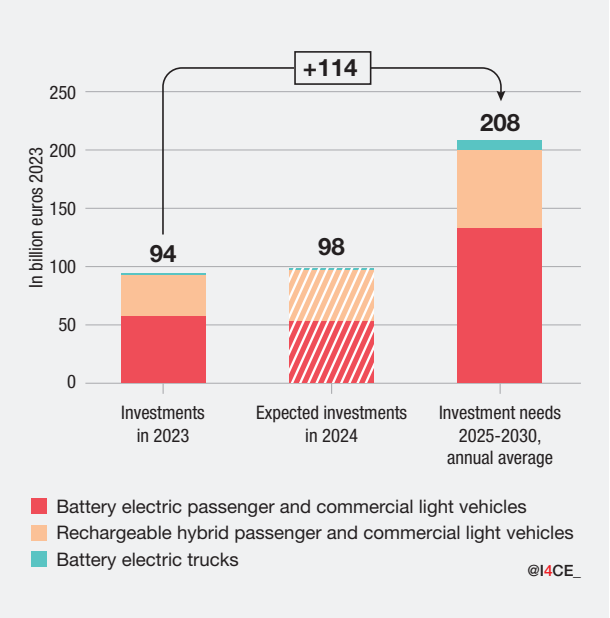
4.1. Electric vehicles account for more than ¾ of the total investment deficit in the EU transport sector

After several years of rapid expansion (+56% in 2021, +19% in 2022), investment growth in battery electric (BEV) and plug-in hybrid vehicles (PHEV) – both light and heavy – moderated to 7.1% in 2023, with total investments amounting to 119 billion euros. In 2024, investments in passenger BEVs are expected to have decreased by 3%, a first after years of rapid development. This decline is part of a broader downturn in vehicles sales in some EU countries, particularly in France (-3.2% registrations) and Germany (-1.0%) (ACEA, 2025). It also follows the end of government subsidies for electric vehicles in Germany, which contributed to a 13.5% drop in electric vehicles registrations (ACEA, 2025). This drop is however offset by a significant rise in passenger PHEVs investments, that are expected to have increased by 25% in 2024.

Current levels remain insufficient to meet the 2030 climate targets. The electrification of the European fleet is driven by the ambition to limit CO_2 emissions of new vehicles. In addition to the ban on the sale of new combustion-powered vehicles in 2035 (European Parliament and the Council of the European Union, 2023), the European Union has established CO_2 emissions performance requirements for vehicles to contribute to achieving the Union's target of reducing its greenhouse gas emissions[5]. The regulation strengthening the CO_2 emission performance standards sets a reduction of emissions per km in 2030 of 55% compared to 2021 levels for passenger cars and 50% for light commercial vehicles (European Parliament & Council of the European Union, 2019). A similar regulation for heavy-duty vehicles has been adopted in 2024 (European Parliament & Council of the European Union, 2024b). The European Commission proposed by 2030 a decrease of emissions of 45% compared to the level set for 2019 (European Commission, 2023c). These targets have been used as a reference.

208 billion euros per year are required on average between 2025 and 2030 to meet the objective as set out in these regulations (**Figure 26**). In 2023, 94 billion euros were invested, leaving a deficit of 114 billion euros. Battery and rechargeable hybrid light vehicles – passenger cars, vans and light commercial vehicles – represent 73% of the total accounted transport system investment deficit, which makes road transport the largest contributor to the overall transport deficit within the scope studies. Battery trucks investments account for only 5% of the road transport investment deficit, investments will need to increase rapidly. For example, while only 1% of all lorries trucks above 16 tons are electric, it will have to reach 23% by 2030 (European Commission, 2019).

FIGURE 26. INVESTMENTS IN ELECTRIC VEHICLES ARE INCREASING IN 2023, BUT AN ADDITIONAL 114 BILLION EUROS IS STILL NEEDED TO CLOSE THE CLIMATE INVESTMENT DEFICIT

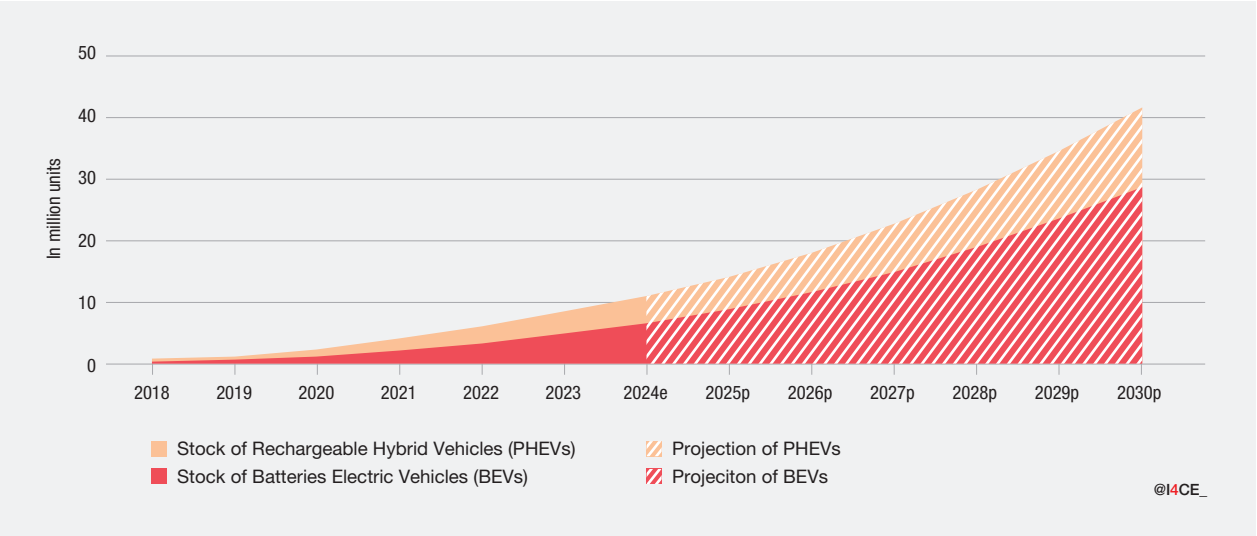


Source: I4CE. All data are in euros 2023. 2024 expected investments are estimated based on observed sales of light passenger vehicles and trucks, and a stable year on year projected sales of commercial light vehicles. Investments needs are the required investments for electrifying the fleet of new vehicles sold each year to meet the 2023 CO_2 emission standards.

The investment needs are driven by increasing sales needs of electric vehicles. Over the years, these sales will increase the stock of electric vehicles. Compared to 5 million BEVs and 3.6 million PHEVs in 2023, the EU fleet is supposed to reach 29 million BEVs and 13 million PHEVs in 2030 (**Figure 27**). These assumptions assume that the entire car market will follow historical trends, with a technology mix meeting the 2030 EU emission target. These estimations are based on various Staff Working Documents of the European Commission. In 2030, the European Commission expects that 41% of passenger cars will be BEVs[6] and 15% will be PHEVs (European Commission, 2021a)[7]. For light commercial vehicles, the breakdown would be respectively 35% and 13% in 2030, while 16% of trucks are expected to be BEVs (European Commission, 2021b). Plug-in hybrid trucks have been excluded from the scope of the study because of a lack of data on their possible prices.

5 In May 2025, the European Parliament has adopted some changes to CO_2 emission performance standards for new cars and vans (European Parliament, ENVI committee, 2025). These changes have not been considered in this research.
6 Hydrogen vehicles have been modelled as battery electric vehicles.
7 For passengers' cars, shares have been estimated from this source. In order to take into account that the Regulation strengthening the CO_2 emission performance standards (2023) has a target for passenger cars not calculated in the SWD, we average shares from different scenarios.

FIGURE 27. THE STOCK OF ELECTRIC VEHICLES IS EXPECTED TO REACH 42 MILLION UNITS BY 2030, FIVE TIMES MORE THAN IN 2023



Source: I4CE. Stock is defined as the accumulated sales. Vehicles include passenger cars, light commercial vehicles, and trucks. Data up to 2023 are based on actual sales. Sales for 2024 are estimated based on observed sales of light passengers' vehicles and trucks, and a stable projection based on 2023 data for light commercial vehicles. Between 2025 and 2030, sales of electric vehicles are modelled as a percentage of total car sales. The percentages are linearly projected between 2024 and the 2030 mix provided by the EU Commission. Total sales are assumed constant, based on the average value of historical data[8].

Increasing investment needs through time are not driven by costs. If the price of battery capacities continues to decrease due to economies of scale, it is also assumed that new electric vehicles will have greater range, resulting in larger capacity batteries, for an overall cost that remains relatively stable compared to today (I4CE, 2023). The prices calculated are a minimum, as they are based on the simplest version of cars. Thus, expensive options, with limited utility for climate, are not considered.

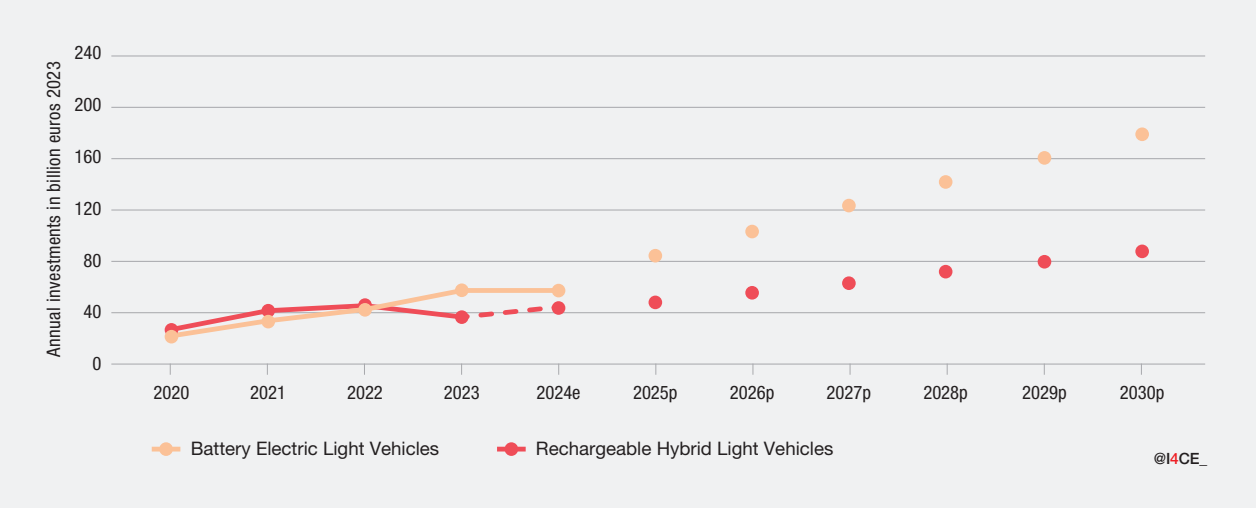
While investment in electric vehicles follows a positive investment growth, current investments are not yet aligned with future needs. Scrutinising the separate technologies, the capacity of BEVs, PHEVs and trucks to meet their respective investment needs is uncertain:

- After an uptake in BEVs investment observed from 2021 to 2023, the expected 2024 -0.4% investment decrease[9] in battery electric light vehicles investment makes meeting minimum deployments less likely (see **Figure 28**). Indeed, the investments that were not made in 2024 are being carried over the subsequent years. To meet the target, investments need to grow at an average rate of 22% per year starting from 2025. 2023 growth exceeded this value, increasing by 36% compared to 2022. 2023 was also the first year that BEV spendings overtook PHEV spendings. This is also expected to be the case in 2024 although the difference in spendings was reduced in comparison to 2023.
- 2024 investment trends in PHEVs sales, after a sharp 21% drop in 2023, are aligned with the 2025-2030 needs. The scenario proposed by the European Commission requires an increase in investments in PHEV of about 12% per year compared to 2024 levels. The expected 25% investment increase between 2023 and 2024 is thus above the needs and back to its pre-2023 levels. If this trend would continue, the PHEV 2030 targets would certainly be attained, although this would not compensate the overall transport objective in the case of a potential failure to meet BEV targets.
- Electric heavy-duty vehicles are in their early days, but investments must grow fast to respect 2030 targets. Investments in electric heavy-duty vehicles have shown an acceleration since 2020 from 0.1 billion euros to 1 billion euros in 2023. In 2024, expected investments have stagnated, at 0.9 billion euros. On average between 2025 and 2030, 7.7 billion euros are needed, and up to 11.2 billion euros in 2030. Looking more closely at volumes, the needs are driven by the electrification of trucks above 16 tons. They represent more than 80% of the sales of all battery trucks in 2030. This category, however, represents around 40 % of the electric sales of trucks for 2022 (Mulholland & Rodríguez, 2023).

8 Period of available data depends on the type of vehicles. Historical trends used for passenger vehicles are on the period 2014-2024 data, 2016-2023 for light commercial vehicles, and 2018-2024 for trucks.

9 This growth combines both passenger and light commercial vehicles. This estimation is based on the observed -3% decrease in BEV passenger vehicles investment in 2024, and have projected the growth from BEV light commercial vehicles according to historical data.

FIGURE 28. ELECTRIFYING THE NEW VEHICLE FLEET REQUIRES SCALING-UP INVESTMENTS FOR BATTERY ELECTRIC VEHICLES BEFORE 2030



Source: I4CE. All data are in euros 2023. Figures between 2020 and 2023 are showing investment based on observed data. Sales for 2024 are estimated based on observed sales of light passengers' vehicles and trucks and a stable projection based on 2023 data for light commercial vehicles. Investments between 2025 and 2030 are investments required to meet the 2030 objective of reducing CO_2 emissions of the new vehicle fleet. Light vehicles include passenger cars and light commercial vehicles.

Supporting a shift from PHEVs to BEVs would reduce the investment needs for the transition. In line with the European Commission's scenario to reach its 2030 target for the transport sector, PHEVs are taken into account. Overall, they represent 36 billion euros of yearly investments in 2023. Compared to BEVs, these vehicles are, based on our estimation for 2024, currently around 60% more expensive for passenger cars and emit CO_2, unlike BEVs. An increase in BEVs sales and a decrease in PHEVs sales, compared to the European Commission estimation, would achieve the same climate objective at a lower cost for economic actors.

With regards to BEVs, neccessary investments in battery manufacturing are covered in the **section 5.1**.

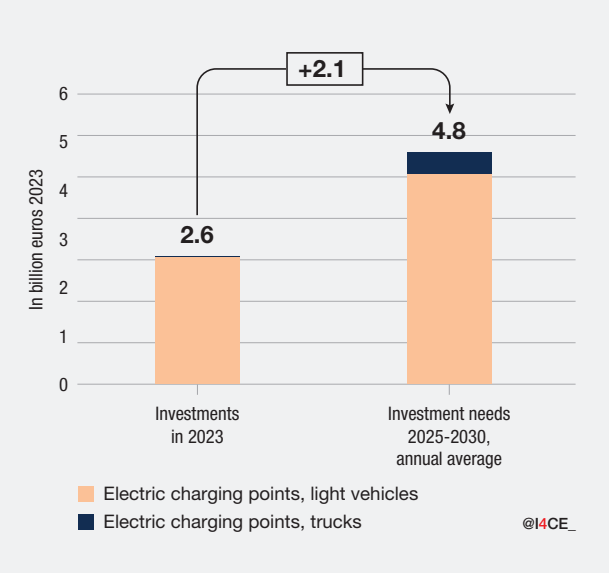
4.2. To support the electrification of passenger and commercial road transport, current annual investments in public charging points must increase by 85% to meet the average 2025-2030 needs

After achieving a 51% growth in 2021 and 79% in 2022, investments for light vehicles public charging points have increased by 24% in 2023, to 2.6 billion euros. This growth path is not yet followed by heavy vehicles charging points, which investment was estimated at non-existent in 2021 and 2022. According to the IEA, 160 charging points only of this type have been installed mid-2023 in the European Union (2024b).

In light of these contrasting investment trends, the EU has established clear 2030 targets to support the uptake of electric vehicles through the expansion of public charging infrastructure. In this study, the scope is limited to light and heavy-duty vehicles public electric charging points. The Regulation on the deployment of alternative fuels infrastructure (Regulation (EU) 2023/1804, 2023) has set a target of a minimal power deployment per electric vehicle. It also sets charging points deployment targets on the main European highways (defined in the Trans-European Transport Network regulation) for both light and heavy-duty vehicles.

With growing development of BEVs and PHEVs, investments for charging infrastructures need to accelerate, as the charging network must keep pace with the fleet expansion. On average between 2025 and 2030, 4.8 billion euros are required to be invested yearly for this sake, for both light and heavy vehicles (see **Figure 29**). Taken separately, 8.2 billion euros will need to be invested in 2030. Compared to 2023 investments estimated at 2.6 billion euros, an extra average of 2.2 billion euros should be invested for public charging points, including 0.5 billion euros for heavy vehicles charging points. On average, light vehicles account for 90% of the needs for meeting the target. But the infrastructures dedicated to heavy-duty vehicles have needs increasing faster as the deployment is only starting.

FIGURE 29. THE ELECTRIFICATION OF VEHICLES IS LEADING TO A GROWING DEMAND FOR CHARGING POINTS



Source: I4CE. All data are in euros 2023. The 2023 data is based on observed investments. Investment needs are required investments to meet the objectives. Charging points refers to public charging points. Light-duty vehicles include passenger cars and light commercial vehicles.

Because of reduced scope and conservative assumptions, these figures are a minimum. The underlying scenario only includes mandatory deployment. It only focuses on public charging points. It does not include the electric charging points required for trucks outside the Trans European Transport – Network (TEN -T) highways. Figures are also based on conservative assumptions about the deployment of EVs. Only a minimal EV uptake, to meet the objective of the regulation monitoring the CO_2 emissions of vehicles, is supposed. Any over-achievement of this regulation would lead to increased investment needs. Finally, investments in the electricity grids are covered in the energy system section.

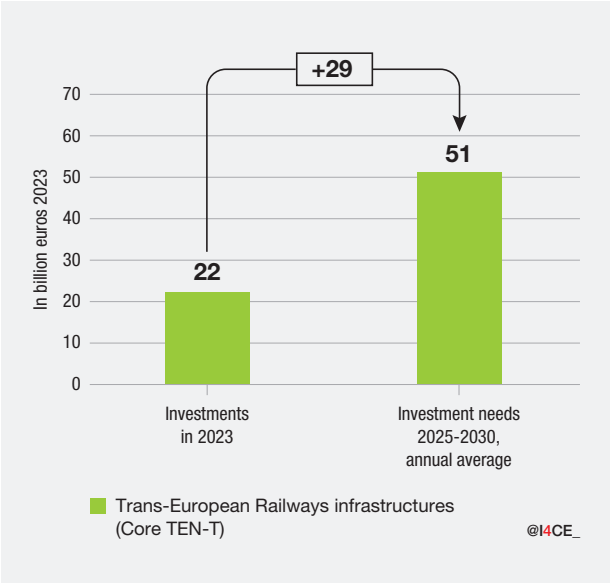
4.3. The level of investment in trans-European railways are not on track with the EU core TEN-T objectives

In 2023, investments in rail infrastructure for long-distance travel amounted to 22 billion euros. These investments have remained relatively stable, at constant prices, since 2020.

These investments estimation, although stable year on year, are far from being sufficient to meet the 2030 EU targets. The Trans European Transport - Network (TEN-T) regulation (2013) aims to develop transport infrastructures at the continental scale. It defines high-priority infrastructures that must be achieved by 2030, called Core TEN-T. For railways, it mainly includes the development of fast and long-distance rail transport and sets European standards. It has been revised in 2024 (European Commission, 2021c).

Based on the TEN-T objectives, building rail infrastructures for long-distance travel would require 51 billion euros of investments annually between 2025 and 2030 (see **Figure 30**). The 22 billion euros estimated investments in 2023 thus represent only 43% of the investments needs. Consequently, an average extra 29 billion euros should be invested annually in order to meet the stated targets. For comparison, the EU-economy has spent 60.1 billion euros on all its total railway infrastructure in 2023 (Independent regulators' Group - Rail, 2025).

FIGURE 30. THE COMPLETION OF THE 2030 OBJECTIVE FOR TRANS-EUROPEAN RAILWAYS (CORE TEN-T) WILL REQUIRE 51 BILLION EUROS ANNUALLY, LEAVING A CLIMATE INVESTMENT DEFICIT OF 29 BILLION EUROS IN 2023



Source: I4CE. All data are in euros 2023. 2023 investments in the Core Trans-European Transport Network (TEN-T) are estimated from spending on railway infrastructure provided by IRG-Rail (Independent regulators' Group - Rail, 2024, 2025). Investment needs are required investments to achieve the 2030 targets of the TEN-T regulation. It includes the future TEN-T revision currently under discussion.

The revision of the TEN-T[10] accounts for 11.7 billion euros[11] per year, representing 23% of the investment needs for the Core network. The remaining 77% of the needs are attributed to the previous regulation: 56% are the 2016 estimates made by the European Commission (2017), on which was added the delayed investment spanning from 2016 to 2023. Between 2025 and 2030, our research projected that catching up on these investments will cost 10.6 billion euros annually[12].

If the deficit for rail transport can seem small compared to road transports, it should be noted that the investment in railways is largely carried by the public sector, as railway infrastructures is often a natural monopoly. Fixing the 29 billion climate investment deficit in long-distance railway infrastructures will therefore require additional public funding. This may include extra EU-level funding, given the trans-European nature of many of those infrastructures.

This estimate provides a minimum level, focusing on the investment needs of the Core TEN-T infrastructures before 2030. Investments that are needed to meet the 2040 and 2050 goals, that should start during the 2020 decade, are not included. It also excludes the numerous investments that are needed to develop the network not covered by the TEN-T or just to maintain it. For comparison, France, accounting for only 13% of the European railways network, needs 13 billion euros to be invested in 2030 for all its railways network (I4CE, 2023).

This study provides figures of needs for European railway infrastructures before 2030. Dealing with the limited up-to-date accessible data, it's subject to uncertainties. The research shows that current EU regulation focuses on a small part of the network. To really understand the need for extra investments, the entire rail network should be considered.

10 Figures were estimated based on the Staff Working Document accompanying the proposal (European Commission, 2021b) for measures specific to railways objectives for the Core-Network. Even if, the latest trilogue, held in December 2022, has agreed on modifications to the EU Commission proposal, this estimation was the most reliable found.
11 Equivalent to 10 billion euros in euros 2015.
12 9 billion euros, in euro 2015.

5. EU CLEANTECH MANUFACTURING IS EXPANDING BUT WEAK DEMAND AND GLOBAL COMPETITION PUT FUTURE CAPACITIES AT RISK

Key Messages

- **In 2023, 13.9 billion euros were invested in wind turbines, solar panels, batteries, heat pumps and electrolysers manufacturing across the EU**. These investments are largely driven by the battery manufacturing sector, which accounted for 90% of these investments.
- **Currently, the European Union is investing at a good pace in several sectors especially in battery and wind turbines manufacturing**. The cleantech manufacturing sector experiences an investment surplus of 9.3 billion euros. This surplus is mainly explained by an investment surplus in the batteries manufacturing sector where capacities already under construction overreached the capacities targeted in this sector by the European Commission.
- Despite progress in scaling up manufacturing capacities, **underused capacity and factory closures in solar**, battery and heat pumps show the strain of global competition and weak local demand. 50% of existing and planned batteries manufacturing capacities are at risk of either being delayed or cancelled by 2030.
- To ensure the EU reaches its industrial targets, **Europe must strengthen both manufacturing capacity and domestic demand**. Failing to do so would risk falling behind global competitors and missing the benchmark targets set by the NZIA for the five key technologies.

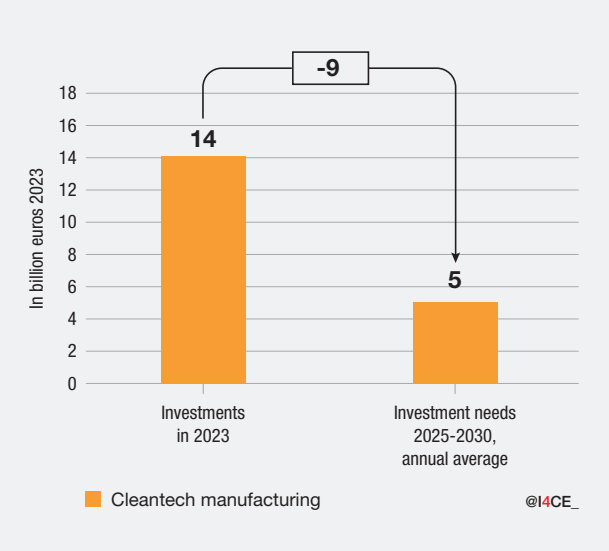
Clean technologies are a key pillar of the decarbonisation of our economies and offer an opportunity for Europe to strengthen its competitiveness on the global stage by reviving its manufacturing base. Global competition in the sector is strong. Notably, China leads across all clean technologies, accounting for more than three-quarters of global investments in clean technology manufacturing in 2023 (IEA, 2024a). Investments in the cleantech sector have soared in the United States following the adoption of the Inflation Reduction Act (IRA) in 2022[13]. For the battery manufacturing sector alone, US investments in battery manufacturing came from 6.5 billion euros in 2022 to 40.3 billion euros in 2024 (Bruegel, 2025b).

In this context, the European Union launched the Net-Zero Industry Act (NZIA) in 2023, to support the continent's decarbonization efforts, reduce strategic dependencies, and foster the EU clean technology industry. The NZIA sets a target for domestic production to meet 40% of the deployment needs for net-zero technologies by 2030 (European Parliament and Council of the European Union, 2024b) across a wide range of cleantech sectors. The Commission specified desired and non-binding higher objectives for "strategic technologies" (see **Box 7**).

In 2023, EU investment in cleantech manufacturing in these five sectors amounted to 13.9 billion euros. Battery manufacturing investment corresponded to 90% of these investments. To reach the specific targets set by the European Commission, 4.6 billion euros would be needed annually between 2025 and 2030, leading to an investment surplus of 9.3 billion euros. This surplus is mainly explained by an investment surplus in the batteries manufacturing sector where capacities already under construction overreached the capacities targeted in this sector by the European Commission. However, despite these very positive trends, underused capacity and factory closures in solar, battery and heat pumps show the strain of global competition and weak local demand.

13 While the continuation of this funding has been thrown into doubt under the second Trump presidency, recent US court decisions make it likely that the programme will continue, supporting a continuing upward momentum in US cleantech investment (Utility dive, 2025).

FIGURE 31. THE EU IS CURRENTLY ON TRACK TO REACH ITS 2030'S CLEANTECH MANUFACTURING TARGETS FOR KEY SPECIFIC TECHNOLOGIES BUT WEAK DEMAND AND GLOBAL COMPETITION PUT FUTURE CAPACITIES AT RISK



Source: I4CE. All data are in euros 2023. The scope of these investments includes wind turbines, solar panels, batteries, electrolysers and heat pumps manufacturing. Investments data for 2023 are based on the IEA cost assumption and public announcements made by various plant developers in Europe on capacities deployment for each technology. Investment needs are estimated from the benchmarks set by the European institutions for these specific technologies in the NZIA.

In 2023, investments in the **battery manufacturing sector** reached 13.9 billion euros, a 27% growth compared to 2022. However, early estimation of 2024 investment indicates that this latter is expected to fall by 11% in 2024. The overall investment deficit in 2023 amounts to 10.8 billion euros, meaning that the EU is currently on track to reach the specific target for this sector. However, this outlook remains uncertain, reflecting ongoing volatilities in the sector. According to T&E, over half of gigafactory plans, existing, under construction or announced, in Europe remain at risk of either being delayed or cancelled (T&E, 2024) (see **section 5.1**).

In 2023, 732 million euros were invested in blades, nacelles and towers manufacturing facilities to produce **wind turbines**. The EU currently produces between 22 and 32 GW of blades, nacelles and towers (Bruegel, 2025a; European Commission, Directorate-General for Energy & ECORYS, 2025). These capacities are currently above the yearly capacity installed of wind power plants (17 GW in 2023) (Eurostat, 2025a) but below the 36 GW that needs to be manufactured in 2030 to reach the EU specific target for this sector. 410 million euros would be needed every year between 2025 and 2030 to reach this target, leaving a light investment surplus of 320 million euros. If the EU is currently on track to reach its 2030 objectives for this specific sector, it must continue to invest every year at the same pace. Total planned investment until 2030 on facilities currently under construction amounts to 519 million in total while total investment needs over the same period amounts to while total investment needs over the same period amounts to 2.5 billion euros.

Investments in **solar manufacturing** in 2023 amounted to 398 million euros. These estimations cover the manufacturing of modules, cells, and ingots/wafers and polysilicon capacities. The EU is in a relatively good position when it comes to polysilicon and module manufacturing, even if the position of this latter is becoming fragile. In 2023, 3.6 GW_{AC} of additional capacity in modules manufacturing was installed, mainly due to Redcom's factory extension in France (SolarPower Europe, 2023). However, the pace of installation drastically reduced in 2024. The total amount of capacities installed decreased from 11.0 GW_{AC} in 2023 to 9.2 GW_{AC} in 2024, with several closures and bankruptcies. The biggest impact for this segment comes from the closure of Meyer Burger's 1.1 GW_{AC} module production facility in the spring of 2024, to avoid further losses in Europe, counterbalanced by an expansion of production in the US (SolarPower Europe, 2024). This wave of closures in the sector increases the annual installation needs in the coming years.

The picture is rather mixed for cells and ingots/wafers where installed capacities stood at just 1.6 GW_{AC} for cells and 0.2 GW_{AC} for ingots and wafers in 2023 (SolarPower Europe, 2023). The sector is increasingly under pressure from cheaper Chinese imports and US attractiveness., which have contributed to a wave of closures among European solar manufacturers (SolarPower Europe, 2024). For this reason, investments are expected to decrease drastically in 2024 to 25 million euros.

The European **electrolyser sector** has gained strong momentum in recent years. In 2024, it is estimated that investments amounted to 430 million euros, a significant jump from the 30 million euros invested in 2023 and the 10 million euros invested in 2022. Despite an annual investment gap of 698 million euros in 2023, significant investments totaling 3.1 billion euros are planned for the 2025-2030 period, covering approximately 70% of the sector's total needs. Nonetheless, European electrolyser manufacturing faces several challenges. Installed manufacturing capacity in the EU is projected to exceed actual demand by nearly four times, threatening the profitability of manufacturers as many planned hydrogen projects fail to reach final investment decision (FID) (PwC, 2025). As a result, much of the existing capacity remains underutilized. The sector is further undermined by uncertainty and volatility, including unclear technological trajectories (ECH2A, 2025). While some electrolyser technologies (*e.g.* alkaline electrolysis) are well-established and mature, their performance in complex industrial applications remains uncertain (EIB, 2022). Investors also point to operational uncertainties, due to the limited track record of these systems in real-world settings (EIB, 2022). On top of that, the potential market entry of low-cost Chinese imports raises concerns about the future competitiveness of European electrolyser manufacturers (Hydrogen Insight, 2025).

The investments in European **heat pump manufacturing** sector reached 190 million euros in 2023, a decline of 23% compared to 2022. This negative trend is largely driven by declining deployment of heat pumps installation in 2023, caused by a combination of cuts to government support schemes, and low subsidized gas prices disincentivising

deployment (EHPA, 2025). While the sector is yet to see the kind of closures observed in solar, for example, 2024 saw the first signs of these market conditions affecting manufacturing, with increasing layoffs across multiple locations (EHPA, 2025). Further support is still needed although the annual investment deficit remains relatively small, with an annual investment need of 210 million euros between 2025 and 2030. The investment deficit in this sector is expected to be covered by planned investments. For the 2025-2030 period, total investment needs amount to 1.29 billion euros, while planned investments amount to 2.27 billion euros. Despite current market uncertainties, the European heat pump manufacturing sector maintains a strong position globally (EHPA, 2024a). European manufacturers benefit from several structural advantages, including the use of relatively common raw materials and relatively straightforward manufacturing processes, which reduce both energy consumption and supply chain risks. The sector also relies on a "proximity strategy," as all heat pumps sold in the EU are produced within the region (Euractiv, 2023).

BOX 7. METHODOLOGY OF CLEANTECH MANUFACTURING INVESTMENTS' ESTIMATION

This report tracks the investment deficit in the cleantech manufacturing sector, focussing on 5 key strategic technologies: wind turbines, solar panels, batteries, heat pumps and electrolysers. It tracks current investments and investment needs based on the EU's 2030 cleantech benchmarks set in the Net Zero Industry Act (NZIA).

Past and current investments

Past and current investments were estimated based on the capacities of factories built in recent years, to which an average European investment cost was applied. Factory capacities were derived from public announcements made by various plant developers in Europe.

To translate these capacities into investment figures, an average cost per unit of capacity was used. These cost assumptions are derived from the Internation Energy Agency and correspond to overnight facility costs, including the core equipment and construction costs of a factory, but excluding land purchases and financing costs (IEA, 2024a).

The past and current investments take into account investments in capacities under construction. These investments, spent over the entire construction period of the plant, were divided equally between the Final Investment Decision (FID) date and the date on which the plant came operational.

Investment needs

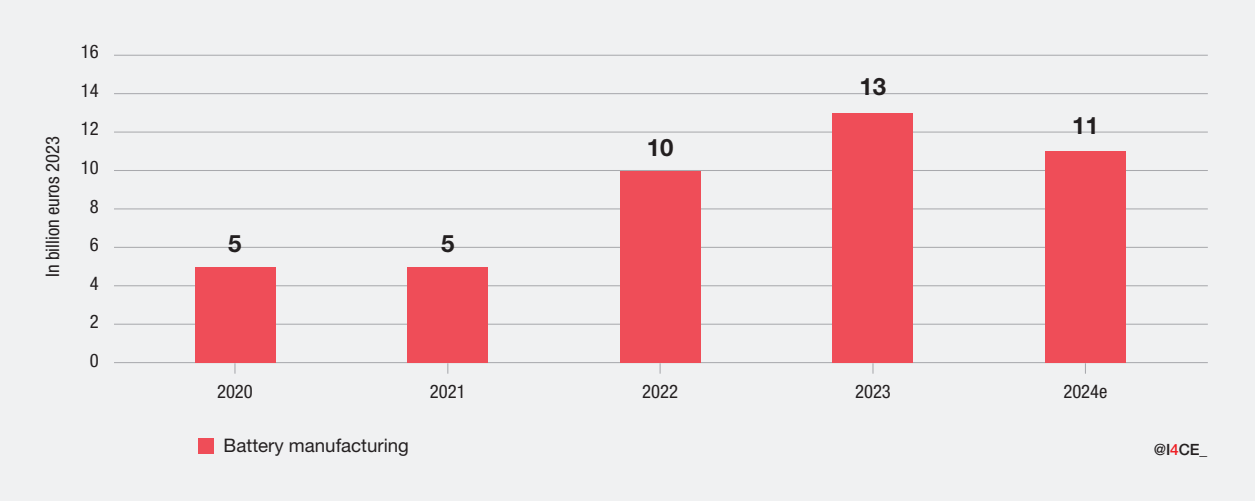
The Net Zero Industry Act sets a target for domestic production to meet 40% of the deployment needs for net-zero technologies by 2030 (European Parliament and Council of the European Union, 2024b) across a wide range of cleantech sectors. The Commission specified desired and non-binding higher objectives for "strategic technologies". By 2030, operational manufacturing capacity in the EU should reach 30 GW for solar PV, 36 GW for wind power, 31 GW for heat pumps, 550 GWh for batteries and 40 GW for electrolysers (European Parliament and Council of the European Union, 2024b). These benchmarks have been used to estimate the investment needs in these 5 specific sectors.

To translate these capacities into investment figures, the IEA's 2023 cost per unit of capacity was used. No evolution of the investment cost has been taken into account over the decade.

5.1. EU battery manufacturing sector is currently on track to reach its 2030 targets, but uncertainty and volatility could undermine recent progress

Battery manufacturing investments have shown strong momentum in recent years, reaching 12.5 billion euros in 2023, a 19.7% growth compared to 2022. However, investments decreased by 20% in 2024. although the sector is beginning to experience a decline in investment in 2024. Germany, Poland and Hungary largely dominate the current market.

FIGURE 32. BATTERY MANUFACTURING INVESTMENT HAVE GROWN SIGNIFICANTLY SINCE 2020 ALTHOUGH A DECREASE IS EXPECTED IN 2024



Source: I4CE based on public announcement of capacity installed and the IEA.

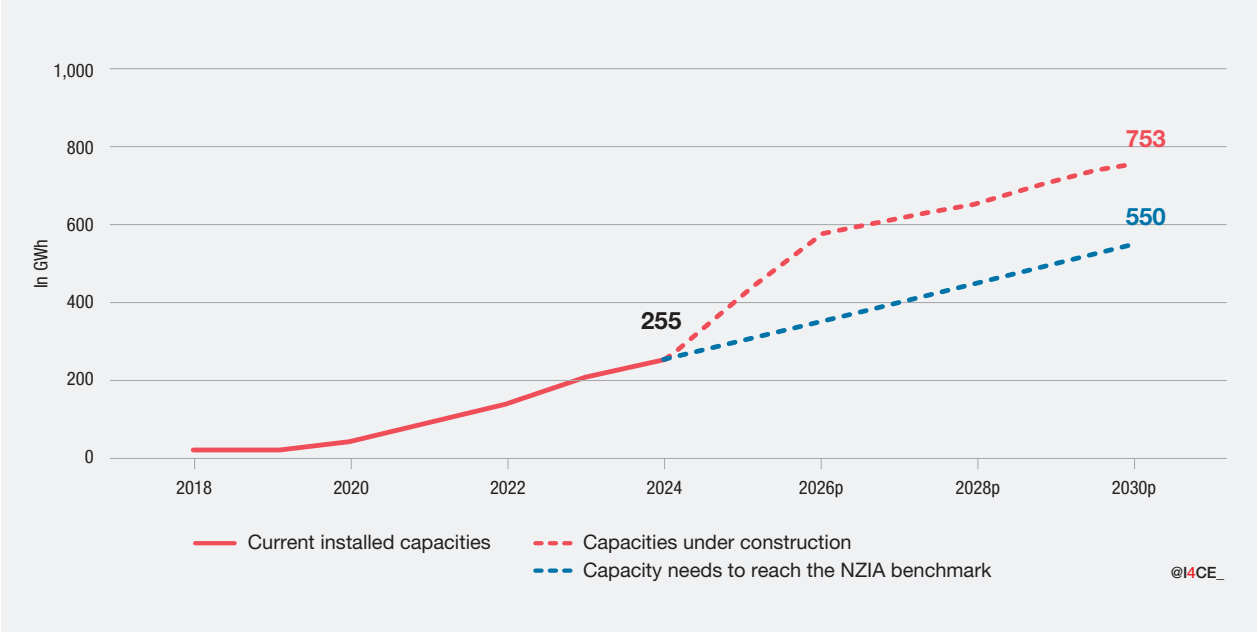
While Northolt is the most high profile setback to the EU's battery expansion ambitions, delayed expansions elsewhere indicate challenges for the sector as a whole (KrASIA, 2024). ACC, a joint venture between Stellantis, Mercedes-Benz, and TotalEnergies, recently halted plans to expand manufacturing capacities to Germany and Italy due to a slowdown in EV demand (Reuters, 2024). Even among operational plants, capacity is often underutilized. While detailed figures are not publicly available, the three major South Korean battery makers active in Europe, LG Energy Solutions, Samsung SDI, and SK On, have all reported declining utilization rates. LG Energy Solution, which operates a plant in Poland with a nominal capacity of 86 GWh, recorded an average utilization rate of 60% in the third quarter of 2024, down from 73% in 2023 (Business Korea, 2024). SK On, which runs three plants in Hungary with a combined capacity of 47.3 GWh, reported a utilization rate as low as 46%, a sharp drop from 95% in the same period the previous year (Business Korea, 2024).

The European Commission's industrial strategy set an indicative target of reaching 550 GWh of battery manufacturing operational capacity by 2030 (European Parliament and Council of the European Union, 2024b). In 2024, battery manufacturing capacities reached 263 GWh. Given the capacities that are already currently under construction, the EU is on track to meet its targets (see **Figure 32**), as planned capacities are expected to reach 753 GWh in 2030. Yet, despite this positive outlook, the inherent volatility of the battery sector calls for caution.

Planned capacity might not materialize as anticipated, as external market shifts and technical disruptions could lead to delays and cancellations. According to T&E, over half of gigafactory plans, existing, under construction or announced, in Europe remain at risk of either being delayed or cancelled (T&E, 2024). One of the main sources of concern is Tesla's gigafactory in Berlin, which currently has an operational capacity of 50 GWh and a planned expansion to 100 GWh, that is at risk of being closed (T&E, 2024). However, T&E's 2024 risk assessment found that the risk of cancellation or delay for battery gigafactories has decreased, falling from two-thirds to 50% in 2023 (T&E, 2024).

The EU is on track to reach NZIA specific target for the battery manufacturing sector – but the sector sits a crossroads. This outlook remains exposed to rapidly evolving market conditions, with signs of slowdown in both EV demand and plant performance, as the capacities effectively produced are well below the total manufacturing capacities in the EU. To ensure that the EU will eventually meets its industrial targets, Europe must bolster both manufacturing and domestic demand or risk failing not keeping pace with international competition.

FIGURE 33. THE EU IS ON TRACK TO REACH THE 550 GWH BENCHMARK FOR BATTERY MANUFACTURING SET IN THE NZIA, CONSIDERING THE CAPACITIES THAT ARE TODAY UNDER CONSTRUCTION



Source: I4CE based on public announcement of capacity installed and planned.

METHODOLOGY

Scope of the study

This report covers climate investment in four sectors of the economy:

- the energy sector, which includes electricity production, transmission and distribution;
- the building sector, which includes energy-efficient investment in the construction, energy renovation of buildings;
- the transport sector, which includes investment in transport infrastructures and vehicles;
- the cleantech manufacturing sector, which includes wind turbines, solar panels, electrolysers, heat pumps and batteries.

In these systems, some activities are not yet covered by investment records. The analysis of the energy system only considers investments made in the power system and does not include for instance solar thermal or geothermal energy. Nuclear energy has not been included as there is no EU objectives for that specific sector. In the transport system, the analysis does not include several investments in rail and public urban transport infrastructure, nor clean aviation or maritime transportation. Agriculture, industry, centralised waste treatment and land use sectors are not covered in this study, as the lack of data makes it difficult to identify investments. Finally, the study does not document investment in research and development, or in climate change adaptation.

For each sector, Climate investments are considered. It is defined as investments that contribute to reducing greenhouse gas (GHG) emissions in the EU.

An overview of the perimeter is given in **Table 1**.

Measuring past and current climate investments

Defining investments

The report examines:

- gross fixed capital formation (GFCF), *i.e.*, in national accounts, expenditure on the acquisition 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., which will be used to produce goods and services for more than one year.
- consumption of goods considered durable, in the sense that they provide services to consumers for more than one year. For example, this includes purchases of new vehicles made by households.

Measuring investments

Investments are measured at the EU-economy scale. It includes all actors, whether it's public or private, transnational or local.

Investment costs are based on the acquisition cost. They correspond to capital expenditure (CAPEX) in company accounting. These costs cover various expenses like studies, authorizations, equipment acquisition, and construction. It is excluding taxes for companies and public authorities but including taxes (VAT) for households. Project financing costs, such as interests paid, are excluded.

Investments are carried on a specific year. Depending on the sector and the national accounting policies, this 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, the costs are spread over several years.

Reporting past and future investments in today's currency

To make it easier to compare past and present climate investment with future needs, and to account for the effects of inflation, we report all investment expenditure in today's currency (euro 2023), in other words in constant currency. Neutralising the effect of inflation makes it easier to measure the real financial effort required to make investments. To calculate this, we divide the current expenditure for the historical period by the chain-linked price index of gross domestic product, also known as the "GDP deflator", provided by the Eurostat. Future investment needs describe the quantities of equipment to be deployed, as well as certain price expectations.

These expectations relate to sectoral phenomena specific to energy transition activities. For example, when our sources anticipate that batteries will cost less in the future, what they mean is that their price will fall relative to other products in the economy. Expressed in today's currency, their price will decrease. In other words, price expectations do not comment on the price level of the overall economy, but on the gap between future prices in a sector and overall inflation.

FIGURE 34. METHOD USED TO CORRECT THE INFLATION EFFECT OF HISTORICAL DATA

Gross investments

Our analysis only looks at gross investments, not net investments compared to a fossil-fuel baseline. For instance, in our analysis, we estimate the cost of an electric car to be around 34,000 euros in 2030. Our approach being centred on gross investments, the cost of the alternative (a petrol-powered internal combustion engine car) does not impact our climate investment deficit estimate.

Macroeconomists may also be interested in a complementary, net-investment approach. Such an approach would compare the cost of the climate investments with its alternative. For instance, it would look at the cost of both an electric car (34,000 euros) and of an internal combustion engine car (27,000 euros), leading to a gross climate investment of 34,000 euros and a net climate investment of 7,000 euros. We haven't included this approach in these second edition of the report.

Measuring climate investments needs

The EU has set itself the objective to reduce its greenhouse gas (GHG) emissions by 55% by 2030 compared to 1990 levels and to achieve carbon neutrality by 2050. To achieve this objective, the European Union has implemented several legislative measures and presented action plans, as part of the EU Green Deal.

Investment targets in terms of volume

We determine the number and characteristics of the equipment deployed based on the targets set by the European Union. For instance, we consider the number of homes renovated, the installed wind or solar power capacity, and the electric cars or rail transport infrastructure.

In this report, the volumes of chosen technologies that need to be deployed for each technology from 2025 to 2030 have been determined based on legislative documents and action plans from the European Union. When possible, investment targets have been determined based on binding EU objectives concerning volumes. This is, for example, the case for the renovation rate targets and energy efficiency targets for new buildings, which are enshrined in the last Energy Performance of Buildings Directive (EPBD) in 2018 and 2024 recast. The same applies to the targets for the deployment of charging stations within the Alternative Fuels Infrastructure Regulation (AFIR), or the targets for the development of rail within the Trans-European Transport Network (TEN-T) regulation. When volume targets are not explicitly mentioned in EU regulations, we use targets mentioned in EU scenarios, the European Commission's action plans, such as the RepowerEU plans, the Climate Target Plan, or in the European Commission Staff Working Documents. Finally, when the EU does not have any specific targets that can be translated into volume deployment, figures from the industry are used (see **Table 1**).

Future prices

We assign unit prices to equipment. These prices are projected from their most recent observed levels, typically in 2023. Our projections for 2025 and beyond reflect the cost expectations expressed in several recent studies.

Lower investment costs assumptions over the period 2025-2030 have been assumed for certain technologies. This is

particularly the case for investment costs in wind energy and solar PV, as well as in the price of batteries for electric vehicles. Renovation and construction costs, on the other hand, are projected to remain stable. The investment costs are expressed in euro 2025.

Cost projections are taken from different sources, including the European Commission Reference Scenario, the IEA, Ipsos and Naviguant, Cravezero, Bloomberg NEF, the ICCT, etc.

Economic conditions

The estimation of investment needs assumes favourable economic conditions. They presuppose a supply that can be met by labour and equipment at prices close to or below current levels. Rapidly increasing demand can lead to bottlenecks if supply is not properly supported and sized. Furthermore, future prices are uncertain and are based on assumptions about price trends for the main sectors. Several investment costs are expected to fall by 2030, particularly for wind and solar PV power plants and electric vehicles.

Climate Investment needs

The report determines the needs in relation to the levels of investment observed in 2023. The investment target is based on average annual investment over the period 2024-2030. This means that, to achieve its 2030 climate objectives, investment in the EU economy must be at the target level on average over the period 2024-2030. Every year, any unmade investment will contribute to an increase in the climate investment needs of the following year. Conversely, each year, any investment that matches or exceeds the required investment will help to reduce the climate investment deficit.

Understanding the investment deficit

The report defines an investment deficit. It is defined as the difference between: (1) the average investments required every year between 2025 and 2030 for the EU to reach its climate objectives, and (2) 2025 levels of investments in constant 2025 euros.

TABLE 1. EUROPEAN REGULATIONS AND TEXTS ASSOCIATED WITH CLIMATE OBJECTIVES BY SECTOR

System	Sub-sector	Climate investments considered	European regulations and texts associated with climate objectives	Technology covered in the scope of climate investments	Technologies not covered
Energy	Renewable energy generation	Renewable electricity,	RED, Repower EU plan, EU reference scenario	Wind power, solar power, hydropower, marine	Solar thermal, biomass, waste, geothermal, nuclear
	Networks and flexibility	Electricity grids Battery storage	No EU specific target, except for cross-border infrastructures	Transmission and distribution power grids Utility-scale and residential battery storage	
Residential and non-residential buildings	New buildings construction	Energy performance of construction	EBPD 2018	Building envelop insulation	Non-energy related construction items
	Energy-efficient renovation	Medium and deep renovation[14]	EU Renovation Wave, EPBD 2024	Building envelop renovation	Light renovation, renovation below energy savings thresholds[14], non-energy renovation
	Heating devices	Heat pumps installation	RepowerEU	Heat pumps	Other heating devices (wood heating, biomass, heating networks, …)
Transport	Road transport	Electric vehicles, Recharging infrastructures for electric vehicles	Monitoring CO_2 emissions for passenger cars and light commercial vehicles Monitoring CO_2 emissions for Heavy-Duty vehicles Alternatives Fuel Infrastructure Regulation (AFIR)	Passenger cars & Light-commercial vehicles: Battery electric vehicles, plug-in hybrid vehicles Battery electric trucks Public electric charging points	Other heavy-duty vehicles (buses, coaches, …) and Plug-in hybrid technology Private charging points and other refuelling station (hydrogen, gas, …)
	Rail transport	Infrastructure for a modal shift toward railways	Trans-European Transport Network regulation (TEN-T)	Long-distance trans-European railways infrastructures for 2030 (CORE TEN-T Network)	Maintenance and upgrade of existing railways Development of other infrastructures Urban transport
Cleantech manufacturing	Cleantech manufacturing	Wind turbines, solar panels, electrolysers, batteries and heat pumps production	The Net Zero Industry act (NZIA)	Wind turbines, solar panels, electrolysers, batteries and heat pumps	All the other clean techologies

Note: This table presents the systems and sectors considered in the study and the European regulations they are based on. Multiple sectors are not covered in the study and not shown in the table agriculture, heavy industry, centralised waste treatment, land use, adaptation to climate change.

14 See definition in **Section 3.1**.

CONCLUSION AND POLICY RECOMMENDATIONS: PLAN TO INVEST, INVEST, INVEST

Climate investments in the energy, buildings, transport and cleantech manufacturing sectors reached 498 billion euros, a stagnation compared to 2023. Early indications suggest a decline of climate investment in 2024. Although investment trends varied across sectors in 2023, most are likely to have seen a decline in 2024. Yet, the EU economy remains far from meeting its 2030's climate targets. **842 billion euros need to be invested annually until 2030, resulting in an investment gap of 344 billion euros**.

The EU urgently need to buck the trend and increase annual investment or prepare to miss the 2030 emission reduction targets in the energy, transport, building sector and the investment targets for the clean tech manufacturing sector. The impact could be picking up a higher bill further down the road, both in economic and ecological terms.

In the coming months, much attention will likely be directed towards the next EU multiannual financial framework (MFF) as a critical strategic investment budget, with discussions about increased own resources for the EU and continued joint debt setting. Still, the next MFF will likely remain a small percentage of the overall investment needed. Also, it enters into force only in 2028, and the 2030 deadline is approaching quickly.

At the same time, several Member States are under pressure to decrease their public spendings following the implementation of the newly reformed EU fiscal rules. This is at odds with the likely need for increased public spending to meet the EU's investment needs going forward, as suggested in the Draghi report. Also, the Recovery and Resilience Facility comes to an end in 2026, with pay back of the loans and grants allocated under the NextGenerationEU due to start in 2028.

Facing these challenges, the EU needs to frontload a well-informed and coordinated **long-term investment framework**, that includes **a strategy for financing the climate transition**, anticipating and tracking the development of investments over time. Establishing a long-term framework is all the more crucial given the short-term challenges currently facing public spending. Such a strategy would offer stability in turbulent times, providing predictability to private economic actors and help ensure the deficit is closed in a timely and cost-effective manner.

If the investment challenges differ across the various sectors, a climate transition financing strategy must assess the balance between public and private investment going forward and propose a policy mix that covers public budgets, fiscal policy levers, measures to de-risk private investment, as well as policy and financial regulations. **The National Energy and Climate Plans (NECPs) are tools that can be put to better use as genuine investment plans for the Member States going forward**.

An effective strategy for financing the climate transition will be based on a **granular understanding of investment needs and actual investments** in the relevant sectors for the climate transition per member states. To this end, better data is needed, including about spending of public budgets in the member states per sector. This will increase the accountability of public policy makers towards the climate transition. Also, the assessment of the investment needs should ideally be broadened beyond the scope of this report to include more sectors, including agriculture, as well as the challenge of climate adaptation.

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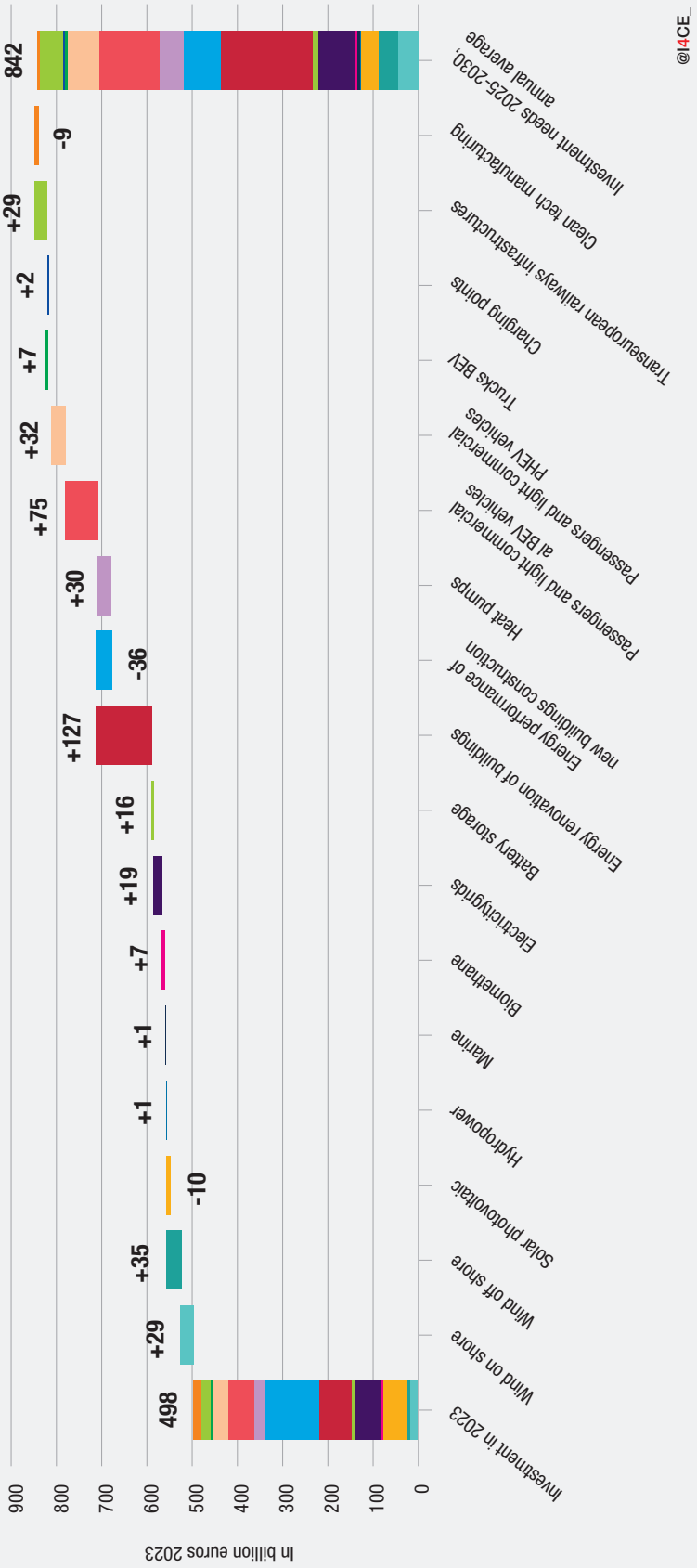
LIST OF ABBREVIATIONS

AC	Alternative current
AFIR	Alternative Fuels Infrastructure Regulation
APS	Announced Pledge Scenario (IEA, WEO)
BEV	Battery electric vehicle
CAPEX	Capital expenditure
DC	Direct current
EIB	European Investment Bank
EHPA	European Heat Pump Association
EPBD	Energy Performance of Buildings Directive
EU	European Union
EV	Electric vehicles
FID	Financial Investment Decision
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
GHG	Greenhouse gas
GW	Gigawatt
GWh	Gigawatt hours
IEA	International Energy Agency
IRA	Inflation Reduction Act
JRC	Joint Research Centre
MFF	Multi-annual Financial Framework
MS	Member States
NECP	National Energy Climate Plan
NZEB	Nearly Zero-Energy Building
NZIA	Net Zero Industry Act
PHEV	Plug-in hybrid electric vehicle
PV	Photovoltaics
RED	Renewable Energy Directive
SWD	Staff Working Document
T&E	Transport & Environment
TEN-E	Trans-European Networks for Energy
TEN-T	Trans-European Networks for Transport
TWh	Terawatt hours
VAT	Value-added tax
WEI	World Energy Investment (IEA report)
WEO	World Energy Outlook (IEA report)

ANNEX

FIGURE 7. THE EU OVERALL CLIMATE INVESTMENT DEFICIT OF 344 BILLION EUROS IN 2023 IS THE SUM OF SECTORAL EU CLIMATE INVESTMENT DEFICITS AND SURPLUSES. THE BIGGEST DEFICITS IN VOLUME ARE IN THE ENERGY-RENOVATION OF BUILDINGS (127 BILLION EUROS), BATTERY ELECTRIC VEHICLES (75 BILLION EUROS), AND WIND POWER (64 BILLION EUROS)



Source: I4CE. All data are in euros 2023. This graph indicates the split of the climate investment deficit by sector. The climate investment deficit corresponds to the difference between the annual average investments that are needed for the EU to reach its climate objective by 2030 and the investments that occurred in 2023. For example, for the onshore wind power sector, the climate investment deficit of 29 billion euros corresponds to the difference between the average investment needs (50 billion euros) and the 2023 investments (21 billion euros).

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