

Public investment required to achieve climate neutrality in Germany

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It is not a foregone conclusion that Germany will achieve its climate targets. That will require substantial contributions from the private and public-sector. The transition to climate neutrality will require considerable investment of around EUR 5 trillion all across the economy. This climate action investment needs to be carried out by businesses and private individuals in combination with the federal, state and local governments. The share of public investment requirements in particular is of special interest to policymakers – even if an exact quantification is methodologically challenging.

A study conducted on behalf of KfW Research provides a frame of reference. Thus, up until the target year 2045, the public sector will have to invest approx. EUR 500 billion in climate action, or EUR 20 billion per year on average. These amounts will need to be invested primarily in the energy and transport sectors. The volume of funds is similar to the interest paid on government debt, for example. However, these amounts represent roughly a six-fold increase on previous climate action investment, constituting a significant shift in budget policy – and requiring new capacity to be developed for implementation.

What is unclear is how the responsibilities and funding arrangements will be determined between the different federal levels. Thus, realising the necessary investments in climate neutrality requires not just prioritisation within the public budgets but the clarification of functions and financial flows between the federal, state and local governments.

The goal of climate neutrality requires an in-depth economic transformation

Germany has committed to providing its contribution to global climate action and becoming climate neutral by 2045.¹ That means the German economy must reduce its net greenhouse gas emissions to zero in around two decades. It also means the way in which the economy operates will have to be fundamentally altered and represents a huge transformational challenge.

The technical processes required to achieve climate neutrality are generally known, and some are already available.² However, a prerequisite for achieving the goal is that nearly all upcoming investments must be compatible with the goal of climate neutrality and avoid a carbon lock-in. Currently, however, sufficient incentives are not yet available to align all investments in this way and initiate a timely transformation of the economy.³

State actors in particular are therefore called upon to create the appropriate conditions and make public-sector investment itself climate neutral as well.

In Germany, necessary additional investment totals around 2% of GDP

On behalf of KfW Research, Prognos et al. (2021) have summarised the current research situation on transformation-related investment and contributed their own calculations of the investment required to achieve climate neutrality in Germany.⁴

Overall, around EUR 5 trillion will need to be invested across the economy as a whole by the middle of the century in order for Germany to achieve climate neutrality (info box). Of this sum, around EUR 1.9 trillion is additional investment⁵ beyond the investment requirements in the reference case. If total climate action investment is spread out over the years remaining until 2045, EUR 190 billion or 5.2% of Germany's GDP will need to be invested on average each year. The additional investment amounts to a good EUR 70 billion or 1.9% of GDP annually.

The transport sector will take a large portion of these climate action investments – EUR 2.1 trillion. It is followed by energy with EUR 875 billion, manufacturing with EUR 620 billion and private households with EUR 636 billion.⁶ The commerce, trade and services sector accounts for EUR 237 billion. A further approx. EUR 500 billion is necessary to bridge the difference between the sector-specific climate action plan and the goal of climate neutrality. This essentially applies to the industrial and agricultural sectors and, to a lesser extent, the energy sector.

Info box

KfW commissioned the study '[The contribution of green finance to achieving climate neutrality in Germany](#)', which estimated that around EUR 5 trillion will need to be invested in climate action in Germany. Specifically, it quantified the amount of additional investment, climate action investment and overall investment for a current scenario (climate action plan scenario, in short: CAP), broken down by sectors and groups of actors, at around EUR 4.5 trillion. It estimated that another approx. EUR 0.5 trillion in investment is needed to close the remaining gap to the net zero emissions target. The result is a first comprehensive picture of the investment amounts required for all sectors on the way to climate neutrality.

Based on that study, the short study 'Öffentlicher Anteil an Klimaschutzinvestitionen (Public share of climate action investment – in German)' was prepared as part of a special analysis, which estimated the proportion of public investment. The present study quantifies the approximate public investment amounts needed to achieve climate neutrality on the basis of those results as well as further assumptions.

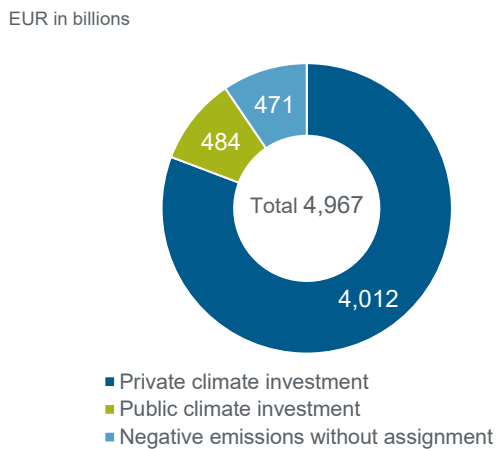
The state plays a key role in realising the upcoming investments

The public sector will have a dual role to play with regard to the necessary investments. First, it must set a framework for incentivising private investments. These include not just determining a carbon price and further charges and levies but the targeted promotion of green technologies. Second, the federal, state and local governments also have areas of investment of their own and a role model function which state institutions can fulfil by undertaking climate action investments of their own. However, little information about the level of funding required for public budgets is available, and some of it is very inconsistent.⁷

On the basis of the above study, a special analysis was prepared in the form of a short study to estimate the public share of investment requirements.⁸ It covers both the necessary climate action investments and the additional investments contained therein, but no consumption-side transfer expenditures such as subsidies and promotional programmes aimed at incentivising private climate action investment. Furthermore, the results are based on the CAP scenario which presents only partial climate neutrality, so that further assumptions must be made to close this gap.

In consequence, public climate investment required to achieve near climate neutrality can be estimated at EUR 484 billion (Figure 1).⁹ Further investment may be added to this if portions of the EUR 471 billion for negative emissions also fall into the public domain. The latter, however, cannot yet be reliably estimated.

Figure 1: Investment required to achieve climate neutrality



Source: Prognos (2022), KfW Research

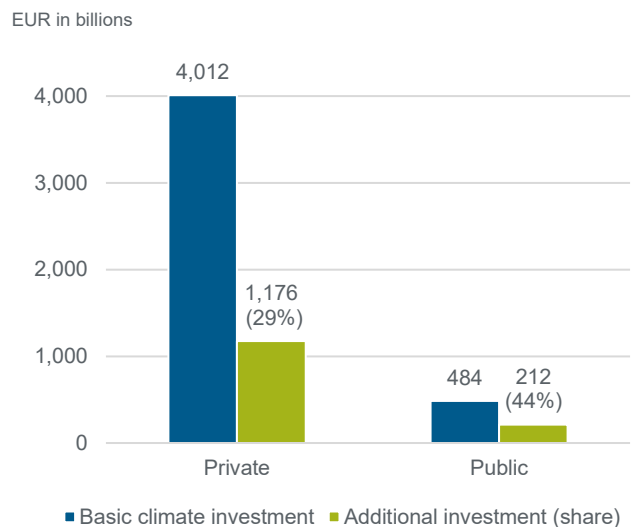
Thus, the public share is at least around 10% of total climate investment. Up to 90% must be made available by private investors. Furthermore, this almost exactly matches the current share of private investors in total gross fixed capital

formation in Germany, which averaged around 89% over the past ten years.¹⁰

The public sector must realise higher additional climate investment

Of the EUR 484 billion in public climate investment, around EUR 212 billion is additional investment. That is slightly less than half (44%) and thus a higher share than for private investment (29%, Figure 2). If the amounts required are applied to the current target trajectory for achieving climate neutrality in 2045, the volumes determined represent average public investment requirements of around EUR 19 billion, or additional investment of around EUR 8 billion per year.¹¹

Figure 2: Climate investment and additional investment needed to achieve climate neutrality



Source: Prognos (2022), KfW Research

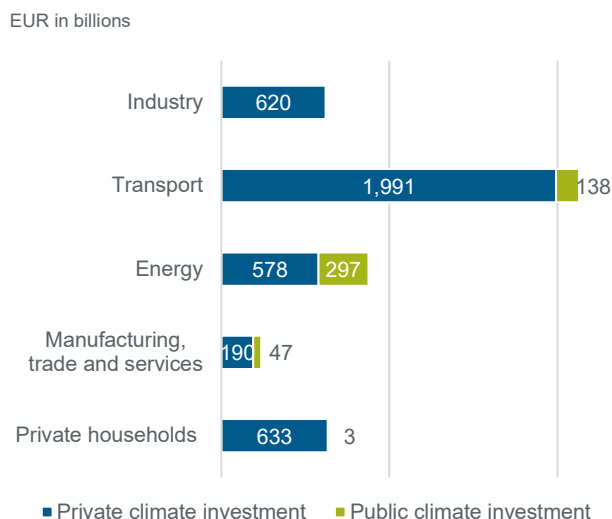
The public budgets should generally be capable of realising the volume of EUR 19 billion annually, especially as it has the character of an investment. For comparison: It is roughly on the scale of total interest expenditure which the federal, state and local governments had to pay on public debt in 2021.¹² But it constitutes a significant increase in previous investment expenditure on climate action. Thus, the official statistics for 2018 recorded a mere EUR 3 billion in public investment in environmental protection.¹³ Thus, the amount would be roughly a sixfold increase on the investment requirements identified in that study.

The areas in which the state can invest in climate action lie mainly in energy and transport

Investment needs can be identified for the state in almost all economic sectors except manufacturing (Figure 3).

At EUR 297 billion, the largest public investment requirements are in the energy sector. These are essentially renewable energy facilities (EUR 249 billion), reflecting the fact that measured by the quantity of electricity generated, nearly half of the largest electricity generators in Germany are owned by German local authorities.¹⁴

Figure 3: Private and public-sector investment requirements by economic sector to achieve climate neutrality



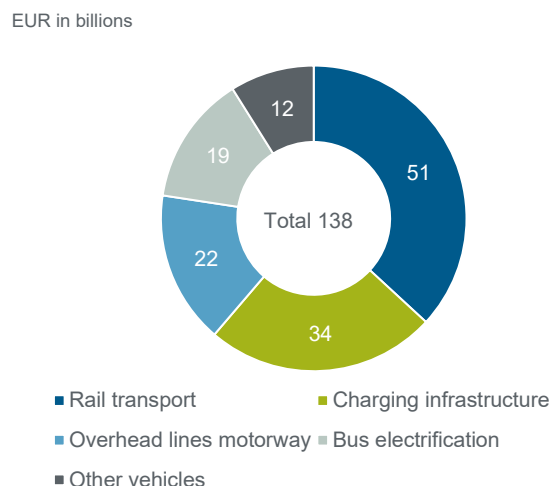
Source: Prognos (2022), KfW Research

The transport sector is in second place with climate investments totalling EUR 137 billion. Here, infrastructure measures make up the lion's share, for example rail transport (EUR 51 billion), charging infrastructure (EUR 34 billion) and overhead lines for freeways (EUR 22 billion); the remainder is accounted for by vehicles (Figure 4).

The manufacturing, trade and services sector ranks third with a public sector investment requirement of around EUR 47 billion, specifically for improving energy efficiency in public buildings. Private households give rise to a further EUR 3 billion for energy efficiency in public sector housing. No investment requirements in manufacturing can be attributed to the public sector.

In addition to investments that can be directly allocated to sectors, investment requirements totalling EUR 471 billion remain to compensate for the residual emissions remaining under the CAP scenario, primarily from negative emission technologies (such as direct air capture). Residual emissions are expected primarily in the manufacturing and agricultural sectors, although it is currently unclear who will ultimately be responsible for implementing negative emission technologies. Should the public sector participate in reducing negative emissions, that would once more increase and, in an extreme case scenario, nearly double its investment requirements. But these investments would then not accrue until a later date on the transition pathway.

Figure 4: Public climate investment areas in the transport sector



Source: Prognos (2022), KfW Research

The federal levels have different investment requirements and financing options

Under the chosen approach, it is nearly impossible to further break down the investment requirements at the federal, state and municipal levels. This missing piece of the puzzle is unfortunate because the federal levels have very different degrees of financial scope to meet the financing needs associated with the climate neutrality investments.

The federation, for example, has relatively broad scope for budgeting the necessary expenditures. The upcoming investments can be financed in various ways. One conceivable measure, for example, would be to eliminate environmentally harmful subsidies, allowing an estimated EUR 46-57 billion per year to be counter-financed.¹⁵ Increasing climate investment to the necessary level could also be financed with debt. If the debt-to-GDP ratio is stabilised at 60%, fiscal scope for sustainable future-facing investments on a scale of up to EUR 40 billion per year can be identified.¹⁶ Thus, the federal budget appears to provide sufficient options for funding direct public sector climate investments.

For the federal states, financing climate neutrality investments is more challenging as their budgetary targets forbid new debt and budgetary restructuring is more difficult because of the high share of fixed personnel expenditure. However, the states have even more options for generating their own tax revenues than municipalities, which in turn are very much caught up in existing expenditure and revenue patterns and furthermore are heavily dependent on the fiscal decisions of the Federal Government and their own state government.

Climate neutrality will largely be achieved locally

Nevertheless, municipalities have a key role to play in achieving climate neutrality. Local engagement extends from allocating land for renewable energy facilities through the modernisation of public buildings such as schools and town halls to the implementation of plans for the heating and mobility transition.¹⁷

It is estimated that municipalities, communities and rural districts provide nearly two thirds of the necessary public sector investment in climate action measures.¹⁸

If we also take into account the difficulties municipalities are facing in even adequately funding their existing services and infrastructure, it becomes clear that the financial requirements for achieving climate neutrality will be a particular challenge for municipal budgets. According to the KfW Municipal Panel 2022, the investment backlog they are already experiencing amounts to around EUR 159 billion, a sum that largely does not yet include further requirements for climate action.¹⁹ The costs they will incur can therefore hardly be covered from the current budgets, and at the same time budgetary law prevents them from borrowing.²⁰ Therefore, within the scope of their responsibilities for municipal finances, the federal and state governments will have to set the course in a way that ensures the funding of climate neutrality at local level.

Climate action investment pays off economically, too

Funding will thus be a challenge, even if the sums are modest compared with Germany's key economic figures. What is also important is that climate action investments must not be seen as stranded costs. Rather, they open up the opportunity to improve Germany's competitiveness and prosperity because after all, green markets are future-facing markets with growth potential.

Model calculations demonstrate that the overall economic effects of climate action investments will at least generate a breakeven situation and, in the long term, can even be expected to yield slightly positive effects on gross domestic product and employment.²¹ And the balance turns out even more advantageous when the positive effects of climate action, for example as a result of reduced extreme weather events and reduced climate damage, are taken into account.²²

Conclusion: More public-sector climate action investment is necessary – and possible

The state must invest more in climate action in order to achieve the goal of climate neutrality. Initial financial volumes that are to be directly provided by the state can be estimated on the basis of previous considerations on the necessary transformative investments. If further foreseeable but not yet quantifiable requirements are taken into account, it becomes clear that all estimates tend to be conservative assumptions and thus represent the lower end of the required climate action investment volumes. Ongoing (consumptive) expenditure, for example on operating and maintaining facilities, which is not taken into account here, will also have to be added to the investments.

However, what is more important than absolute euro amounts is to actually embark on the journey towards systematic climate action in the first place. In this, the aim should be to continuously raise targeted public investment so that the capacities of public administrations and the private sector can be expanded in a sound manner while avoiding price increases and preventing actions from ending up being just a flash in the pan.

Substantial investment and financing requirements should be expected after 2025 at the latest, meaning that by then an investment pathway must be adopted step-by-step to lay the groundwork for the then upcoming investments.

The challenge for the federal, state and local governments will be not just to identify and implement suitable measures in due time but, with an eye on the tight budgets, to direct the financial flows in the federal system to where they are needed for the transformation. An urgent question, for example, is how the funds can get from the federal to the local level.

The analysis also illustrates that the public sector cannot shoulder all the necessary investment on its own and that some 90% of climate action investment must be made by private investors. It is therefore essential that public investment be followed by extensive private investment. Private capital is available and 'only' needs to flow to climate-friendly targets. What will be helpful here are appropriate political frameworks, especially a rising carbon price, supplemented by supporting tools such as carbon border adjustment mechanisms, carbon contracts for difference and promotional programmes – which will also have to be funded from public budgets.²³ The quantified volume of the upcoming investments must be understood as a rough estimate, but its scale is in tune with the few other available figures. Krebs and Steitz (2021), for example, estimate the need for direct public climate action investment at EUR 26 billion annually. This figure is slightly above the EUR 19 billion identified here, which can be explained by the slightly different focus, a slightly broader technical definition and a different estimation methodology.²⁴

Public investment in this order of magnitude appears feasible but requires climate action to be systematically prioritised, even when considering the funds additionally required to stimulate private investment (for example by supporting private climate action measures), for which roughly the same volume would also have to be raised, according to initial estimates.²⁵ However, it is not easy to open up the necessary scope in the public budgets – particularly in times of crises.

Effective climate action is insurance against a range of future risks and opens up opportunities. It generally reduces the probability of extreme weather events and the resulting climate damage costs, makes the country less dependent on fossil energy imports from global crisis regions and ensures participation in green markets of the future.

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- ¹ The basis for this is the Federal Climate Change Act ([Klimaschutzgesetz](#)), which was adopted by the German Parliament on 24 June 2021.
- ² Cf. Brüggemann, A (2021): [Transitioning to climate neutrality by 2050: a major challenge for German industry](#), Focus on Economics No. 322, KfW Research.
- ³ In particular, the carbon price does not yet reflect the economic cost of emissions, which the German Federal Environment Agency estimates at EUR 180 per tonne of CO₂, cf. German Federal Environment Agency (2018). [Hohe Kosten durch unterlassenen Umweltschutz](#) (*High costs from neglected environmental protection* – our title translation, in German). As time is running out, and given the risk of path dependencies, it also appears doubtful whether rising carbon prices alone can trigger in-depth innovation effects quickly enough.
- ⁴ Cf. Brand, S., Römer, D. and Schwartz, M. (2021): [Investing EUR 5 trillion to save the climate – a surmountable challenge](#), Focus on Economics No 350, KfW Research. Cf. also Prognos et al. (2021): [Contribution of green finance to achieving climate neutrality in Germany](#) (in German only), study commissioned by KfW.
- ⁵ Additional investments are investments that go beyond those undertaken in the reference in any case (for example, the cost difference between an insulated and an uninsulated school building façade). The reference comprises both non-climate action related 'anyway investments' and certain climate action-related 'anyway investments' (specific renewable energy facilities, for example, are already included in the reference), cf. Prognos et al. (2021): loc cit.
- ⁶ In the energy sector, the study also includes EUR 35 billion in investment that will be required to be able to replace the fossil gases remaining in the CAP scenario and run power plants with greenhouse gas-neutral green hydrogen instead.
- ⁷ Cf. SVR (2021): [Transformation gestalten: Bildung, Digitalisierung und Nachhaltigkeit – Jahresgutachten 21](#) (*Shaping the transformation: education, digitalisation and sustainability – annual report 21* – our title translation, in German), Table 15, page 166. An initial estimate puts the federal, state and local governments' climate investment requirements for reducing greenhouse gas emissions by 65% compared with 1990 levels at EUR 460 billion by 2030. Of this sum, EUR 90 billion is for federal investment, EUR 170 billion for municipal investment and EUR 200 billion for promoting private investment. Cf. Krebs, T. and Steitz, J. (2021): [Öffentliche Finanzbedarfe für Klimainvestitionen im Zeitraum 2021–2030](#) (*Public finance requirements for climate investment in the period 2021–2030* – our title translation, in German), Forum New Economy Working Paper No. 03 2021. The different studies have a low level of comparability as each analysis is done with a different method. They differ in terms of their inclusion of specific measures, the financing and implementation responsibilities and variations in the definitions of key concepts and timeframes, so that the estimated amounts should at best be regarded side-by-side with regard to their rough scale and results orientation.
- ⁸ Cf. Prognos (2022): [Beitrag von Green Finance zum Erreichen von Klimaneutralität in Deutschland – Öffentlicher Anteil an Klimaschutzinvestitionen](#) (*Contribution of green finance to achieving climate neutrality in Germany – Public share of climate investment* – our title translation, in German) Short study on behalf of KfW.
- ⁹ This figure is composed of EUR 467 billion from the CAP scenario as well as EUR 17 billion for achieving climate neutrality accruing in the energy sector and corresponding to the public share (49.5%) of the EUR 35 billion for the expanded use of hydrogen.
- ¹⁰ Cf. SVR (2021): [Transformation gestalten: Bildung, Digitalisierung und Nachhaltigkeit – Jahresgutachten 21](#) (*Shaping the transformation: education, digitalisation and sustainability – annual report 21* – our title translation, in German), No. 209.
- ¹¹ For the sake of simplicity, we assume a linear investment requirement here over time. In reality, investment and financing requirements will differ at different times, although requirements will likely tend to grow further as time passes.
- ¹² Cf. Federal Statistical Office (2022): [Vierteljährliche Kassenergebnisse des Öffentlichen Gesamthaushalts](#) (*Quarterly cash results of the overall public budget* – our title translation, in German), FS. 14 R. 2, 1st-4th quarter 2021, Tab. 1.1.
- ¹³ Cf. Federal Statistical Office (2021): [Environmental-Economic Accounting](#). In addition to investment, ongoing environmental protection expenditure of EUR 6.9 billion is recorded. Public expenditure on climate action, however, goes beyond this, for example in the form of EUR 2.4 billion to finance climate action measures in development cooperation. By contrast, industrial enterprises (producing sector without construction) report climate action investment totalling EUR 3.5 billion (2019).
- ¹⁴ For the energy sector this figure is composed of EUR 280 billion from the CAP scenario and EUR 17 billion for achieving climate neutrality accruing in the energy sector and corresponding to the public share (49.5%) of the EUR 35 billion for the expanded use of hydrogen.
- ¹⁵ In a report the Federal Environment Agency summarised subsidies of around EUR 57 billion in the year 2012 classified as environmentally harmful, cf. Köder, L. and Burger, A. (2016): [Umweltschädliche Subventionen in Deutschland](#) (*Environmentally harmful subsidies in Germany* – our title translation, in German). According to an estimate commissioned by Greenpeace from the Forum Ökologisch-Soziale Marktwirtschaft, internationally known as Green Budget Germany in 2020, the German Federal Government could generate as much as EUR 46 billion in revenue annually by gradually dismantling ten subsidies in the energy, transport and agricultural sectors that are particularly harmful to the climate, cf. Beermann A. et al. (2020): [Zehn klimaschädliche Subventionen im Fokus](#) (*Spotlight on ten subsidies that harm the climate* – our title translation, in German).
- ¹⁶ Financial scope rises from abandoning current budget balancing targets that would lead to a reduction in the debt-to-GDP ratio to below 60%. Cf. Prognos (2021): [Schulden-Check Corona. Wie stark belastet die Corona-Krise die langfristige Tragfähigkeit der öffentlichen Finanzen?](#) (*Coronavirus debt sustainability check. How much pressure is the coronavirus crisis placing on the viability of public finances?* – our title translation, in German), study commissioned by Initiative Neue Soziale Marktwirtschaft.
- ¹⁷ Cf. E.g. Difu (2018): [Klimaschutz in Kommunen – Praxisleitfaden](#) (*Climate action in municipalities – guidelines for practice* – our title translation, in German) or German Federal Environment Agency (2022): [Klimaschutzpotenziale in Kommunen - Quantitative und qualitative Erfassung von Treibhausgas-minderungs-potenzialen in Kommunen](#) (*Climate action potentials in municipalities – quantitative and qualitative identification of greenhouse gas mitigation potentials in municipalities* – our title translation, in German).
- ¹⁸ Cf. Krebs, T. and Steitz, J. (2021): loc. cit.
- ¹⁹ Cf. Raffer, C. and Scheller, H. (2022): [KfW Municipal Panel 2022](#), KfW Research.
- ²⁰ Cf. Brand, S. and Salzgeber, J. (2021): [Finanzierung öffentlicher Investitionen: Kredite allein helfen den Kommunen nicht](#) (*Financing public investment: loans by themselves will not help municipalities* – in German), Focus on Economics No. 360, KfW Research.
- ²¹ Cf. Brand, S., Römer, D. and Schwartz, M. (2021), loc cit: For a detailed presentation of methodology and results cf. Prognos et al. (2021): loc cit.
- ²² Cf. i. a. Kikstra, J. et al. (2021): [The social cost of carbon dioxide under climate-economy feedbacks and temperature variability](#), Environmental Research Letters, 16(9) and for Germany Kempfert, C. (2007): [Klimawandel kostet die deutsche Volkswirtschaft Milliarden](#) (*Climate change costs the German economy billions* – our title translation, in German), DIW Weekly Report 11 / 2007, p. 165–169.
- ²³ Cf. Römer, D. and Schwartz, M. (2022): [Wie können CO₂-Differenzkontrakte zum Ziel der Klimaneutralität beitragen?](#) (How can carbon contracts for difference contribute to the target of climate neutrality? – in German) Focus on Economics No. 389, KfW Research.
- ²⁴ Krebs and Steitz (2021) consider only the years up to 2030 but include further measures indirectly related to climate change, including strengthening continuing education and development offices (EUR 20 billion), digitalisation of railroads (EUR 50 billion including new construction), broad support for social housing (EUR 50 billion), using various individual sources as a basis instead of central modelling, cf. Krebs, T. and Steitz, J. (2021): loc. cit.
- ²⁵ Cf. Krebs and Steitz (2021): loc. cit.