Expert Commission on the Energy of the Future Monitoring Process

Promoting climate protection, enhancing prosperity – Comments on central fields of action for the German energy transition in the European context

Berlin · Münster · Nuremberg · Stuttgart, June 2020

- Prof. Dr Andreas Löschel (Chair)
- Prof. Dr Veronika Grimm
- Prof. Dr Barbara Lenz
- Prof. Dr Frithjof Staiß

ENERGY OF THE FUTURE

Commission on the monitoring process

Prof. Dr Andreas Löschel (Chair)
Prof. Dr Veronika Grimm
Prof. Dr Barbara Lenz
Prof. Dr Frithjof Staiß

Expert Commission:

Prof. Dr Andreas Löschel (Chairman)

Westfälische Wilhelms-Universität Münster
Am Stadtgraben 9, 48143 Münster
E-mail: loeschel@uni-muenster.de
Phone: +49 251-83-25004

Prof. Dr Veronika Grimm

Friedrich-Alexander-Universität Erlangen-Nürnberg
Lange Gasse 20, 90403 Nuremberg
E-mail: veronika.grimm@fau.de
Phone: +49 911-5302-224
Fax: +49 911-5302-168

Prof. Dr Barbara Lenz

German Aerospace Center (DLR)
Institute for Transport Research
Rudower Chaussee 7, 12489 Berlin
E-mail: barbara.lenz@dlr.de
Phone: +49 30 67055-206
Fax: +49 30 67055-283

Prof. Dr Frithjof Staiß

Centre for Solar Energy and Hydrogen Research
Baden-Württemberg (ZSW)
Meitnerstr. 1, 70563 Stuttgart
E-mail: frithjof.staiss@zsw-bw.de
Phone: +49 711-7870-210
Fax: +49 711-7870-100

This report is also based on the knowledgeable and committed work done by our research assistants:

Westfälische Wilhelms-Universität Münster
Gerald Zunker, Dr Oliver Kaltenegger

Friedrich-Alexander-Universität Erlangen-Nürnberg
Sandra Kretschmer, Dr Christian Sölch

German Aerospace Center (DLR)
Felix Steck

Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW)
Maike Schmidt, Andreas Püttner

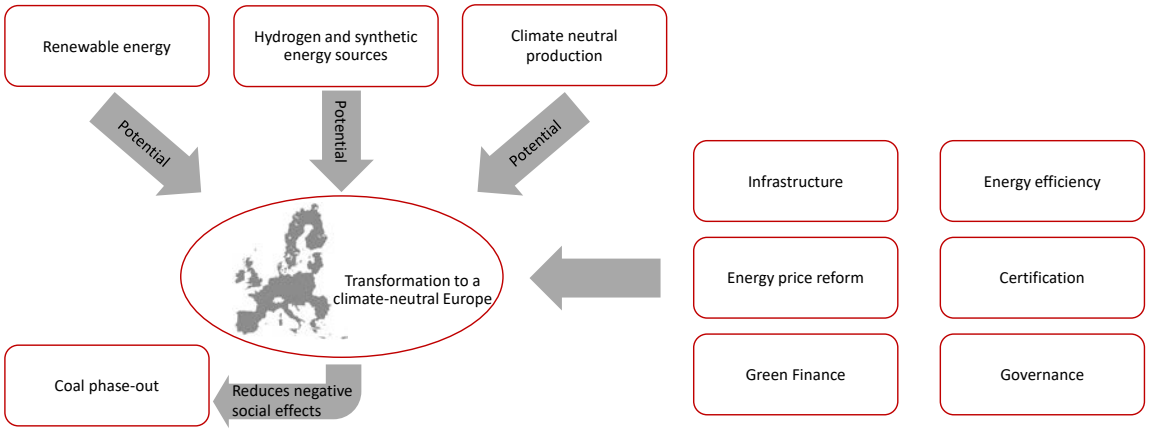
Promoting climate protection, enhancing prosperity - Comments on central fields of action for the German energy transition in the European context

The independent Expert Commission supports the monitoring process "Energy of the Future" that was launched by the German government in 2011. It comments on the Federal Government's monitoring and progress reports on a scientific basis and supports the Federal Government in developing joint solutions and strategies for central fields of action regarding the energy transition (“Energiewende”). In order to support the upcoming political discussions on the effective and efficient advancement of the energy transition, and on sustainable economic development in times of the Corona pandemic, the Expert Commission wishes to use this commentary to make recommendations on central measures and on the regulatory framework. This is set against the background of a proposal by the Coalition Committee for a comprehensive economic stimulus and future technologies package, the forthcoming German Presidency of the European Council and political discussions about the European Green Deal. The German government's economic stimulus package addresses important areas of the German energy transition, in particular the hydrogen economy, infrastructure development and sustainable mobility. The subsidy for reducing the EEG (Renewable Energy Sources Act) levy is the first step towards an energy price reform. It is now important to carefully specify, develop and integrate the measures on a European scale. The Expert Commission will go into greater detail in this respect – as well as on the recently published Integrated National Energy and Climate Plan (NECP) – in its statement on the Federal Government's next monitoring report. The present commentary focuses primarily on recommendations for central measures and appropriate conditions and their adaptation to the European context. In its second progress report on the so-called “energy transition”, the German government correctly states: "The energy transition is not solely a German effort, rather it is embedded in European energy policy [...]. Successful European cooperation will enable the German energy transition to be successful". The European Green Deal aims for a climate-neutral European Union (EU) by 2050. However, the prospects for this new strategy are only credible if strategically important climate-neutral value chains and European markets can be established, international cooperations can be forged and the competitiveness of businesses can be secured.

The focuses of the Expert Commission's statement include the increased use of renewable energies, industrial transformation towards emissions-neutral technologies and products, as well as the future role of hydrogen and synthetic fuels in the defossilisation of the heating and mobility sector and industry as a whole (cf. Figure 1). At present, support mechanisms and instruments are often too complex, fragmented, short-term and insufficiently intertwined. Hence, an essential component of the recommendations is a CO_2-based energy price reform, which, in particular, stipulates a comprehensive reduction of levies and charges included in the electricity price and, in the medium term, their refinancing from revenue derived from the CO_2 pricing. Ambitious CO_2 price paths, combined with undistorted energy prices, create uniform incentives for climate-friendly behaviour for all actors in the European member states. If implemented correctly, this reform will provide important impulses for the economy, by disburdening households and many small and medium-sized enterprises, and by promoting the forward-looking transformation of the industry. However, future opportunities will only arise if the desired coordination across the various dimensions of the Energy Union, regions, sectors and technologies, is successful. This requires measures that can be implemented without major hurdles, and which benefit both the energy transition and the economy, as well as relying largely on market coordination. The present report also shows how the international integration of climate policy instruments can be facilitated, and which opportunities exist for the currently

necessary economic recovery as well as future climate-friendly growth, through modifying the regulatory framework and the targeted development of infrastructures.

Figure 1: Central fields of action for the transition to a climate-neutral Europe



Source: Own representation

The transition towards a sustainable economy in Europe requires the creation of strategically important, climate-neutral **value chains** (Chapter 1), the avoidance of critical interdependencies through diversification, and the strengthening of European markets. Securing the competitiveness of European firms also requires the further development of international energy and trade cooperation in a forward-looking and resolute manner. In particular, renewable energies, the industrial transformation to climate neutrality, green hydrogen and synthetic energy carriers have potential for international innovation and technology leadership, and European value added.

Renewable hydrogen and synthetic energy carriers (Chapter 6) play a key role, as they can be used in a variety of ways. Applications can be found in the transport sector, electricity storage, industry (also as a raw material) and the heating sector. In the transport sector, synthetic fuels can be used especially in areas where neither battery nor fuel cell drives are technologically feasible, at least in the medium term, e.g., in air and international maritime transport. For the defossilisation of energy-intensive industry, hydrogen is the only reasonable alternative. Similarly, for seasonal electricity storage, only hydrogen or synthetic methane are practicably suitable. To use hydrogen and synthetic energy carriers on a large scale, it is necessary to transform and supplement existing value chains: from production to logistics and consumption. A central prerequisite for this is the rapid ramp-up of the industrial production of key components of a future hydrogen economy in Germany and Europe.

An accelerated **industrial transformation** (Chapter 7) is a prerequisite for the successful implementation of the Green Deal. This gives rise to central fields of action both in the direct sphere of influence of companies, the purchase of energy sources, and along the entire value chain of products. Industrial transformation also enables international technological leadership in key sectors and secures the industrial basis of the European Union. Such a lead market can set (technology) standards for global development, and creates additional opportunities for European companies in global competition.

Further action is needed in the field of **renewable energies** (Chapter 5), as the implementation of long-term climate goals and the Green Deal require a massive increase in expansion targets. At the same time, this will create additional potential for added value. Particularly for the development of renewable energies, European solutions need to be strengthened in order to better complement national activities. Not least, the establishment

of climate-neutral value chains enables compensation for the loss of jobs associated with the **coal phase-out** (Chapter 4) and structural change.

In order to fully exploit these fields of action, appropriate conditions need to be created at national and European levels and appropriate measures have to be taken as well. The Expert Commission recommends a **CO_2-based energy price reform** (Chapter 2) as a guiding instrument. In addition, infrastructure measures, incentives to and an improved environment for sustainable investments (green finance), uniform standards for the certification of climate-friendly value creation and measures to increase energy efficiency, are all also important. At the national level, a CO_2-based energy-price reform includes the implementation of a more ambitious CO_2 price path, which entails a minimum price for CO_2, as well as a comprehensive alignment of the current very complex system of fees, taxes, charges and levies which correspond to the actual external effects. At the European level, the Energy Tax Directive and the European Emissions Trading System are to be revised and possibly border carbon adjustments should be introduced. The aim is to create a uniform European-wide framework with a climate-friendly steering effect, efficient price signals and competition between actors and technologies on the basis of a level playing field. The reforms must take into account the induced distributional effects at both national and European levels.

Infrastructures (Chapter 8) must be adapted and developed for the transport, distribution and storage of hydrogen and synthetic energy carriers. In addition, storage facilities with different volumes are needed, so as to enable independence of generation and consumption over time, especially regarding electricity supply. Moreover, a rapid expansion of the electricity grid, coordinated in the long term at the European level, is necessary in order to align with the requirements of the future energy system and to achieve the expansion targets for renewable energies. In terms of transport, the Europe-wide expansion of a filling station system for new renewable fuels and a charging infrastructure along the trans-European transport network, must be developed.

Public investment and financing can and should only provide the basis for implementing the Green Deal. In order to activate the required capital from private sector investors, further measures to increase the level of **Green Finance** (Chapter 10) must be implemented, such as the extension of disclosure obligations for companies and financial market players in line with EU taxonomy.

Improved conditions and uniform standards for **certification** (Chapter 3) can provide markets with important bases for decision-making, not only for climate-relevant activities of companies and financial market players. This requires a uniform and reliable registration of CO_2 emissions across all sectors, so that they can serve as a relevant benchmark for assessment. In particular, the implementation of sector coupling, with the aim of defossilising transport, buildings and industry, requires the recording of CO_2 emissions caused by energy flows, products and services. A system of credible and reliable certification could already be effective without further legal requirements. Furthermore, it can be the basis for regulatory measures aimed at reducing CO_2 emissions.

Measures to increase **energy efficiency** (Chapter 9) are an important pillar of defossilisation in the real estate and transport sectors and can avoid increasing costs for end users in the long term. Investment decisions by end consumers require confidence in the future attractiveness of both systems and products. This applies both to expectations of the price development of CO_2 emissions and infrastructure. Furthermore, subsidy programmes and an appropriate legal framework can support purchasing decisions. It is not only in the transport sector that cost savings often lead to rebound effects that compensate or even overcompensate for efficiency gains and must therefore be avoided through the appropriate regulation.

An effective interplay between the different governance structures at EU, national, regional and local levels is crucial for the success of a comprehensive transformation. Regarding **governance structures** (Chapter 11), EU-wide, market-based mechanisms are to be preferred in order to achieve simple coordination across the dimensions of the Energy Union, regions, sectors and technologies. In addition, conflicts between individual instruments must be resolved and counterparts of European and national regulations must be coordinated.

In all measures recommended by the Expert Commission, it must be borne in mind that crisis management in the corona pandemic is a priority. Nevertheless, some of these measures can be implemented without major hurdles, and are even more urgent and pressing in times of corona. Examples include the energy price reform and measures for a climate-neutral transformation of industry, which will all support the economy, increase the resilience of the overall system and protect vulnerable groups.

Promoting climate protection, enhancing prosperity - Comments on central fields of action for the German energy transition in the European context

Enhance European added value and ensure international integration

The transformation towards a sustainable economic system requires the establishment of strategically important climate-neutral value chains, the avoidance of critical dependencies through diversification, the strengthening of European markets, establishment of international cooperation agreements and securing the competitiveness of European firms.

Address CO_2-based energy price reform rapidly and design it appropriately

A CO_2-based energy price reform will give a boost to the economy by disburdening households and companies and promoting the transformation of the industry, if it is appropriately designed. At the national level, an ambitious CO_2 price path should be targeted, as well as a comprehensive orientation of the current complex energy price system towards real external effects in all sectors. The proposed elimination of levies for renewable energies and for combined heat and power generation, and the reduction of the electricity tax will result in a net reduction in electricity prices in Germany – despite higher CO_2 prices. In addition, the lower electricity, oil and gas prices resulting from the corona crisis will open up additional room for manoeuvre. Higher ambitions in climate protection at the European level require not only a tightening of the CO_2 pricing in the EU ETS, but also a reform of the EU Energy Tax Directive and, if necessary, the introduction of border adjustments.

Align certification with the Green Deal

In order to enable effective international climate protection, clear certification standards are needed, with CO_2 emissions as the decisive assessment criterion. Such standards will enable the implementation of sector coupling, with the aim of defossilising the transport, housing and manufacturing sectors, provide a basis for investment decisions by companies and financial market players, and create suitable conditions for the establishment of climate-neutral international value chains.

Phase-out coal efficiently and improve the effectiveness of market signals

The coal phase-out decided on in Germany needs to be amended according to the resolutions of the European Green Deal. The coal phase-out should take place much more quickly, and largely through market-based CO_2 price signals. Compensation payments to companies should be avoided wherever possible. EU ETS certificates that become available should, ideally, be completely withdrawn from the market. The transition to a low-carbon economy in Europe must also be made socially acceptable.

Expand renewable energies more quickly

The implementation of long-term climate targets and the Green Deal require significantly higher target quantities for for renewable energies. Since sufficient generation potential would be available, the primary objective is to provide impetus for accelerated increases. It is precisely for this purpose that European solutions need to be strengthened in implementation in order to better complement national activities. At the same time, this will create additional potential for added value, not only through the expansion but also through the use of renewable energies.

Develop key global technologies for hydrogen and synthetic energy carriers

Renewable hydrogen and synthetic energy carriers play a key role in achieving climate neutrality by 2050, with applications in the transport sector, electricity storage, industry (especially for raw materials), and the heating sector. In order to be able to use hydrogen and synthetic energy carriers on a large scale, it is necessary to transform and complement existing infrastructures, supply and value chains. A central prerequisite is the rapid ramp-up of the industrial production of key components. At the international level, both existing and new energy partnerships must be considered.

Accelerate industrial transformation through climate-neutral production

Climate-neutral production is a central field of action for the implementation of the Green Deal, both in the direct sphere of influence of the companies, when purchasing energy sources and along the entire product-related value creation on the procurement and sales sides. Companies' own initiatives should be supported and strengthened by the appropriate regulatory framework. For example, the establishment of value chains in a hydrogen economy offers excellent opportunities for both German and European industry to adopt a leading position in the world market.

Expand infrastructures in a coordinated manner

Infrastructures must be adapted and extended for the transport, distribution and storage of hydrogen and synthetic energy carriers. In addition, storage facilities with various different volumes are needed to enable independence from generation and consumption over time, especially regarding electricity supply. Moreover, a rapid expansion of the electricity grid, in the long term, and coordinated at the European level, is necessary, in order to align the grid with the requirements of the future energy system and to achieve the expansion targets for renewable energies. Concerning transport, a Europe-wide filling station system for renewable fuels and charging infrastructure along the trans-European transport network must be developed.

Deal systematically with energy efficiency

Measures to increase energy efficiency are an important pillar for defossilisation in the building and transport sectors and can avoid increasing costs for end consumers in the long term. In the building sector, national and European appropriate conditions must be developed further with regard to their price signals in the heating sector, leading to a climate-neutral building stock throughout Europe in 2050. In the road transport sector, a plan for climate-neutral transport is needed over and above current regulations on CO_2 limit values, so that companies have planning security for the "Antriebswende"[1]. Furthermore, energy efficiency potential can result from shifting traffic flows and avoiding some traffic altogether.

Intensify activation of private capital for Green Finance

The European Green Deal provides for more ambitious energy and climate targets, which will increase the annual investment requirements for climate-mitigation activities. Public investment and funding can and should only provide a basis for subsequent private activity. The required capital from private sector investors for achieving the targets must therefore be activated more strongly, for example by extending the disclosure obligations of companies and financial market players, in line with the EU taxonomy. Furthermore, a rapid and consistent implementation of the European Green Deal can send a strong signal to the financial market and create the necessary, consistent and long-term appropriate conditions.

Formulate governance of the Energy Union coherently

A sound interplay between the different governance structures at EU, national, regional and local levels is crucial for the success of a comprehensive transformation. EU-wide, market-based mechanisms are to be preferred as a means of achieving straightforward coordination across the various dimensions of the Energy Union, regions, sectors and technologies. In addition, conflicts between individual instruments must be resolved and counterparts of European and national regulations coordinated.

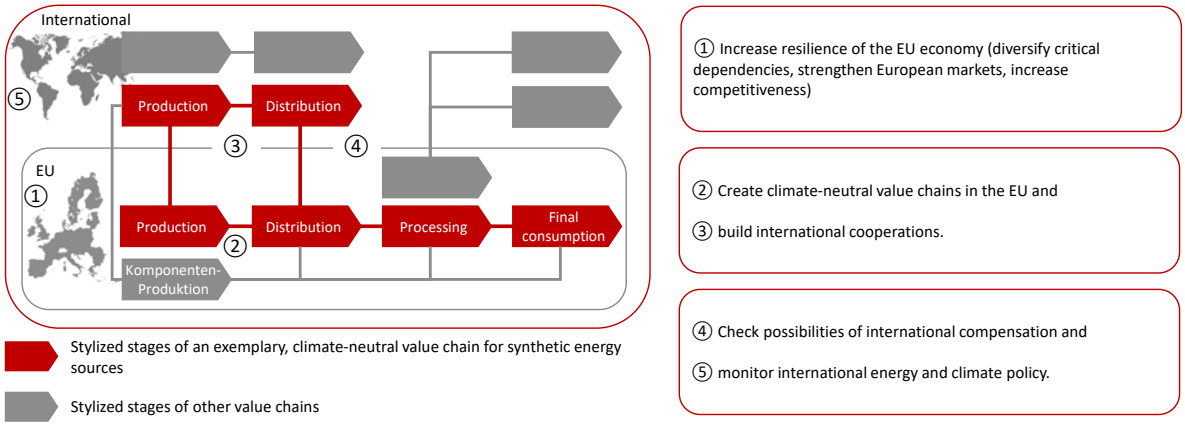
[1] "Antrieb" refers to the automobile driveline, "Wende" to the "Energiewende", i.e. energy transition.

Content

1 Enhance European added value and ensure international integration

The transformation towards a sustainable economy is a priority of European economic and environmental policy. The Green Deal promises a new growth strategy for the EU, through a corresponding transformation towards clean value chains (EU-KOM, 2019). This new strategy is only credible if it succeeds in developing strategically important climate-neutral value chains, avoiding critical dependencies through diversification, strengthening European markets, promoting international cooperations, and securing the competitiveness of European firms. The shock to global value chains induced by the Corona crisis increases the urgency, but at the same time offers the opportunity to create the desired incentives in the short term, so that firms can now adapt optimally. The Expert Commission recommends the following steps, which will not only benefit the energy sector, but also economic and societal sustainability as a whole (see Figure 2).

Figure 2: Steps towards strengthening climate-neutral European value added: the example of synthetic energy sources



Source: Own representation

(1) Increase the resilience of the EU economy as a whole, including the energy sector, in the context of different crisis scenarios. To this end, critical dependencies are to be avoided through diversification, European markets are to be strengthened and the competitiveness of European companies secured.

Domestic value creation is embedded in global value chains. Large companies generally have about 100,000 suppliers in more than 100 countries. This international division of labour should be considered as something positive. During the Corona crisis, however, many sectors, such as steel or pharmaceutical, reported supply bottlenecks from China. The energy industry recorded price declines (especially for crude oil) and reduced demand. The cost of a 2% drop (alone) in the production of intermediates from China costs Europe USD 16 billion (UNCTAD, 2020).

The strengthening of European markets and strategically important value chains for Europe would increase the resilience of the overall system. Simulations and the experience gained from the current shutdowns of national economies indicate critical interdependencies in global value chains.

An important option for increasing competitiveness is a reform of the energy price system. If it is well designed, not only electricity intensive companies will benefit from a reform, but also the average firm or socially weak households. Particularly negatively affected companies or households can and should be taken into consideration. The Green Deal enables a European, efficient solution to CO_2 pricing even in sectors not covered by the European Emissions Trading System (cf. Chapter 2 and Chapter 11).

(2) Prioritise the development of climate-neutral value chains, especially for green hydrogen and synthetic energy carriers. Establish appropriate international cooperation agreements.

Europe should position itself as a leader in the market for synthetic fuels and hydrogen in technology and innovation. These energy sources play a key role in European industrial strategy (cf. Chapter 7), especially for the steel sector (EU-KOM, 2020a), and also for the energy transition in air, sea, rail and heavy goods road transport. Further potential for value generation lies in storage, distribution and research, as well as in technology exports. From a strategic point of view, the resource bases for these value chains should be secured at an early stage. This includes agreements at both state and private sector levels. Investments in research and development projects to achieve climate neutrality, for example in the context of the economic stimulus packages, have both substantial economic multiplier effects and positive impacts on climate protection (Hepburn et al., 2020). For new projects, operating cost and investment subsidies could be used where appropriate (cf. Chapter 10).

The climate-neutral industry which is intended to be developed, can compensate for job losses as a result of structural change. Even though there may be negative effects at a regional level, as estimates of the German coal phase-out demonstrate, the energy transition has a cushioning effect (Oei et al., 2020; cf. Chapter 4 and Chapter 5) and achieves positive employment effects on a net basis, i.e. across all regions and industries.

Importing synthetic energy carriers and hydrogen from non-European countries, i.e. from locations with excellent conditions for photovoltaics and wind power, could be cheaper for domestic consumers (despite trading and distribution costs) than domestic production. Moreover, domestic capacities are limited. In order to meet domestic demand for synthetic fuels and hydrogen, imports will therefore be necessary in addition to domestic production. Reliable and diversified energy partnerships should therefore be entered into, and trade agreements established (cf. Chapter 6). Promising locations can be found, for example, in Australia, New Zealand, Patagonia, Chile, USA, North Africa, the Middle East, and China. In the long term, this could also trigger a shift in global energy trade away from fossil fuels and towards renewable energy sources.

(3) Balance out internationally differing speeds of climate policy. Examine all cooperations to achieve climate neutrality with regard to potential for international compensation. Subject international climate policy to monitoring.

The European Union should work to balance out internationally, substantially different levels of ambition in climate policy. In value chains that are not limited to EU member states, border carbon adjustments are an obvious measure (cf. Chapter 2), which are also described in the Green Deal. However, it would be preferable for the European Union to work towards a largely uniform CO_2 price at the international level, at least with important partners (so-called Climate Clubs), so that no border carbon adjustments required.

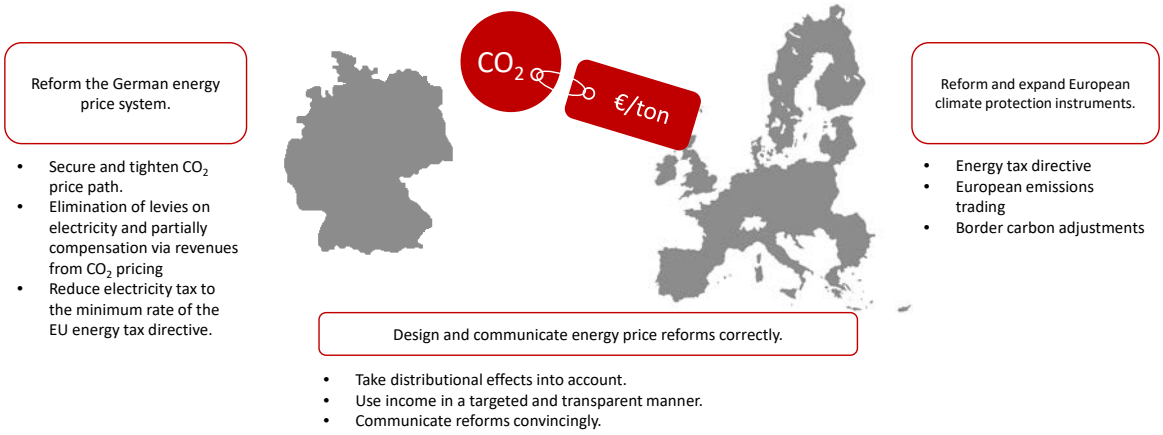
Value-added chains are increasingly geared towards climate-neutral production (cf. Chapter 7). In this context, the potential for international compensation should be examined. In the sense of a flexibility mechanism, the Paris Climate Change Agreement allows countries to offset joint efforts against their target achievement, i.e. against their respective nationally determined contributions (Articles 1, 6 and 8). The prerequisite for this is that states cooperate voluntarily (Article 3) and that reductions in greenhouse gas emissions be credited by only one of the cooperation partners (Artcile 5). This requires reliable accounting (Article 2) and clear standards (cf. Chapter 3).

For the purposes of continuous reporting, the internationally varying speeds of climate policy and the associated transformation of value chains should be monitored (Löschel and Großkurth et al., 2018).

2 Address CO_2-based energy price reform rapidly and design it appropriately

In order to achieve the medium to long-term energy transition goals, the advantages and various options for a CO_2-based energy price reform have been discussed in Germany over the last four years. The Green Deal at the European level is presently intended to pave the way for achieving the EU climate protection targets for 2030 and 2050, and at the same time, directly promote industrial transformation towards climate-friendly technologies and products. However, this results in a new and urgent need for reform, in order to "ensure effective CO_2 pricing throughout the economy". At the same time, abolishing taxes and levies on the electricity price, as part of an already necessary economic stimulus package, can initially relieve households, as well as small and medium-sized enterprises on a broad front, before lost revenue is subsequently counter-financed in the medium term by revenue from CO_2 pricing. The Expert Commission recommends the following focal points (see Figure 3):

Figure 3: Priorities for a CO_2-based energy price reform



Source: Own representation

(1) An energy price reform in Germany will provide important impulses for the economy and for a forward-looking industry transformation.

Germany has long been attempting to achieve climate protection goals with a variety of complex support mechanisms and instruments. These are often not geared to the causes of climate change (greenhouse gas emissions) and are too small-scale, short-term and not interlinked. This results in heterogeneous price signals for CO_2, which is contrary to a cost-efficient climate policy. If the sole objective is the cost-efficient reduction of greenhouse gas emissions, emissions trading should be implemented that covers as many emitters as possible, or alternatively, a comprehensive CO_2 tax should be implemented. Through existing European climate instruments such as the EU ETS or the Energy Tax Directive, this has already been realized to some extent. The instruments at national and European levels, as well as their interaction, need to be reformed in order to create a more substantial, preferably uniform CO_2 price signal. This would not only benefit the climate, but also improve the market opportunities for sector-coupling technologies (cf. Chapter 6) and the chances of a market-driven coal phase-out without new state intervention (cf. Chapter 4). The costs of promoting renewables (cf. Chapter 5) would also be reduced.

On the basis of the Climate Protection Programme 2030 (Klimaschutzprogramm 2030), the Federal Climate Protection Act (Bundes-Klimaschutzgesetz) and the Fuel Emission Trading Act (Brennstoffemissionshandelsgesetzes, BEHG), the Federal Government decided to introduce CO_2 pricing, with a fixed price for transport and heating for buildings, in the medium term a national emissions trading system (nEHS), and in the long term, the goal of its

integration into the EU emissions trading system with a minimum price. The CO_2 price path starts with a fixed price in the heating and transport sector of 25 Euro/t CO_2 in 2021. By 2025, the price will rise to 55 Euro/t CO_2. From 2026, the price is to be formed on the market as long as it remains between a fixed minimum and maximum price of 55 and 65 euros respectively. In 2025, it is to be determined to what extent maximum and minimum prices are reasonable and necessary for the period after 2027. Nevertheless, it may not be possible to meet the targets for 2030 (Edenhofer et al., 2019a, 2019b). Apart from this uncertain achievement of targets, questions of social redistribution have not yet been addressed conclusively. The fundamental problem of the coexistence of a multitude of complex support mechanisms or instruments also remains to be solved.

Failure to achieve climate protection targets could result in substantial compensation payments by Germany. For Germany, the EU Effort-Sharing Regulation (EU-Klimaschutzverordnung, also known as Zielverteilungsverordnung) requires a 38% reduction in emissions in the transport, building and agricultural sectors, and in parts of the industrial and energy sectors, all by 2030 compared with 2005. From this perspective, too, Germany needs to reform its climate policy instruments. Translating the ambitions of the Green Deal into reduction targets will make the situation even worse.

In order to achieve the emission targets within the framework of the chosen path, the Expert Commission recommends the abolition of levies and taxes on electricity as soon as possible, which will be refinanced in the medium term largely by means of a CO_2-related surcharge on fossil fuels. The difference would be financed from the government budget and would be a good substitute for transfers such as consumption vouchers, which are mentioned elsewhere in political discussions. This reform proposal would not conflict with the decisions of the Federal Government and would also be politically swiftly implementable.

Specifically, the EEG and KWKG (Erneuerbare-Energien-Gesetz and Kraft-Wärme-Kopplungsgesetz) levies (approx. 23.9 and 0.9 billion euros in 2020) should be abolished and the electricity tax rate of the German electricity tax law should be reduced to the permitted minimum rate in accordance with the EU Energy Tax Directive (this corresponds to a reduction in the tax rate from 2.05 ct/kWh to 0.1 ct/kWh; the approximate magnitude of the current electricity tax at 2.05 ct/kWh is of 6.7 billion euros in 2020). A refinancing volume of approx. 25 billion euros could be secured in all sectors at a CO_2 price of approx. 50 euro/t CO_2. This would also include a national CO_2 surcharge under the EU ETS in order to introduce a minimum price for CO_2, also in the sectors of the EU ETS. According to current plans, the CO_2 prices in the transport and heating sectors are unlikely to be sufficient for refinancing, without a surcharge in the ETS sector, especially as a number of other initiatives are to be financed from this revenue. Further considerations on energy price reform should also include the Energy Tax Act (Energiesteuergesetz). The energy tax should be reduced - in analogy to levies on electricity - and replaced by a CO_2-based instrument. Currently, energy taxes are also levied on green energy sources, e.g. green hydrogen, contrary to a reasonable steering effect.

In the light of the Corona crisis, the proposal for an energy price reform is gaining additional importance. The abolition of levies and charges on the price of electricity would relieves the burden on households and many firms, creates opportunities for new business models and makes sustainable products (such as battery-powered electric vehicles or heat pumps) more attractive. The reform can therefore be expected to have a directly stimulating effect on the economy, even (or especially) if the abolition of levies and charges is not directly or completely offset by the revenue from CO_2 pricing. On average, the energy price reform does not have negative distributional effects but, on the contrary, positive ones, especially since the CO_2 footprint is positively correlated with income. In individual cases, however, measures to cushion social hardship are necessary. This does not, however, constitute a case to delay the reform.

The need for a reform of electricity prices is also clearly demonstrated by the fact that the low demand for electricity induced by the corona crisis, combined with high feed-in from renewables, inevitably leads to low electricity prices and rising costs for promoting renewables. As a result, the EEG levy - relatively stable over the past four years - could rise by more than 20% in 2021. However, especially in the wake of a recession with a simultaneous transformation towards climate-neutral production, an increase in effective electricity prices would be counterproductive and counteract the necessary investment incentives. If the recommendations of the Expert Commission described above were implemented, electricity prices would be reduced net - despite higher CO_2 prices - due to the abolition of the EEG and KWKG levies and the reduction of the electricity tax.

(2) Reform the Energy Tax Directive and the EU ETS at European level and, if necessary, introduce Border Carbon Adjustments (BCA) in order to achieve a uniform framework throughout Europe with a climate-friendly steering effect, efficient price signals and a level playing field in competition.

Although embedding it in a European framework is not a prerequisite for an ambitious German climate policy, it is a decisive success factor. This not only makes European climate protection more efficient, but also creates a level playing field. Loftier ambitions in climate protection at European level require not only a tightening of CO_2 pricing in the EU ETS, but also a reform of the EU Energy Tax Directive (2003/96/EC). In its current form, the directive provides excessively heterogeneous or inefficient price signals and has hardly any steering effect, for example towards more climate-friendly means of transportation. A predominantly uniform CO_2-based tax structure for electricity and fuels leads to explicit CO_2 price signals in the use of transport. This supports the implicit CO_2-based price signals in transport, for example the EU fleet limits for cars and light commercial vehicles. The new directive should eliminate national differences in tax rates or the numerous exceptions, and take the CO_2 balance of the energy sources as a starting point. Since the directive addresses both emitters within and beyond the European Emissions Trading Scheme, the reform must be made consistent with the recommended extension of the EU ETS to the heating and transport sectors.

Substantially higher CO_2 prices can put a strain on the competitiveness of European industry. A useful instrument for levelling out these competitive distortions for particularly affected sectors can be found in Border Carbon Adjustments. This entails compensating for a local burden (the increased CO_2 price in the EU), which is offset by a levy imposed on products because of the crossing of a border (i.e. the border adjustment on products imported from non-European countries). The adjustments result in products manufactured abroad being made more expensive at the European border, according to their CO_2 content. The distortion of competition induced by climate policy is thus levelled out. At the same time, increased efforts at CO_2 pricing or a reduction of CO_2 emissions in production, become relatively more attractive for trading partners outside the European Union, as this reduces the additional burden at the European border. Furthermore, BCAs can also reduce the risk of carbon leakage, i.e. the relocation of production and consequently of CO_2 emissions to locations with a less stringent climate policy (Schenker et al., 2018). In order to avoid trade policy distortions, BCAs can only be used in a very targeted and prudent manner, i.e. if at all, only successively in a few sectors. Moreover, compliance with WTO and EU law must be ensured (Mehling et al., 2019). Regardless of the design, clear guidelines and standards for measuring emissions are needed (cf. Chapter 3). In addition, before introduction, it is necessary to examine the extent to which trading partners already price CO_2 explicitly or implicitly.[2]

[2] A Carbon Added Tax (CAT) can be considered as an economically comparable approach. This could be structured analogously to the value-added tax principle, i.e. the added CO_2 content of products would be taxed at each stage of production. Alternatively, the tax would only be levied on the final consumer. In any case, the final consumers pay the tax on the entire production process. This instrument appears to be more difficult to implement than BCAs because of the increased administrative effort and the explicit burden on citizens.

(3) Take distributional impacts seriously and communicate reforms appropriately.

When implementing an energy price reform, the distribution effects must be analysed. Particularly in the area of low income, care must be taken to ensure that the reforms are not accompanied by a decline in disposable income. In this context, time frames within which no adjustments can be made initially, and the scope for action by the various actors, must be taken into account. Low-income households which, due to their characteristics (e.g. energy source mix, energy intensity, household size or mileage travelled) are among the losers of the reform and have little immediate scope for adjustment, can and should be compensated financially (Edenhofer et al., 2019b).

Good communication of the idea of reform is of considerable importance. Reducing the levies and charges on electricity prices, and refinancing them through revenue from the CO_2 tax, will not only relieve the burden on a large number of households and companies, but will also create incentives to switch to climate-friendly technologies and products, which in turn will boost demand and accelerate the transformation. This represents a decisive advantage over other proposals for using revenue from the CO_2 levy, which does not have such a double leverage effect (e.g. per capita lump sums to households, cf. Hepburn et al., 2018, or support for affected regions, cf. Oei et al., 2019, 2020). It may prove to be a disadvantage that communicating the benefits to the population is a challenge due to the low transparency of the effects. However, the beneficial effects remain considerable. A multi-person household with an electricity consumption of approx. 3,500 kWh per year would, ceteris paribus, save approx. 310 euros (excluding the VAT effect) on its electricity bill in 2020 if the EEG and KWKG levies were abolished and the electricity tax rate were reduced to the permitted minimum rate. With a counterbalanced higher CO_2 price of 50 Euro/t CO_2, the household as a (assumed) low driver with economical gas heating, still has left about 30 Euros net. In addition, it must be considered that the lower electricity, oil and gas prices caused by the Corona crisis will further reduce energy costs.

The Expert Commission has already made proposals for the effective communication of reforms in the past. Among other things, the communication strategy should refer to tried and tested examples and pay attention to comprehensibility. An effective communication strategy is based on accepted values, refers to proven examples, is consistent, simple and context-dependent in its approach, creates trust and involves stakeholders. Appropriate specialists should be involved at an early stage. For more complex mechanisms and details, the focus should be on “what the system does” rather than “how the system works”. Trust is created by continuously evaluating the overall process of the energy price reform and developing it further, if necessary. Potential winners and losers of the reform should be identified and their concerns addressed. Consideration should also be given to involving trusted individuals in the communication strategy, if necessary externally. The acceptance of reforms can also be raised by setting up citizens' forums on the knowledge transfer and participation taking place there (at the EU level this was done, for example, in the form of a European Citizens Assembly, cf. Ciaglia et al., 2018). Individual communication offers, e.g. in the form of advice, especially for those negatively affected (cf. Caritas energy saving checks), can accelerate the perception of challenges being dealt with in the right manner.

3 Align certification with the Green Deal

In order to enable effective international climate protection, clear certification standards are needed, with CO_2 emissions as the decisive assessment criterion. In order for CO_2 emissions to serve as the relevant assessment measure, emissions must be registered credibly and reliably across sectors (Mehling et al., 2019). This is the only way to implement sector coupling with the aim of defossilising transport, real estate and industry. At the same time, this provides the basis for investment decisions by companies and financial market players, and enables the establishment of climate-neutral international value chains (cf. Chapter 1). Recording the CO_2 emissions caused by energy flows, products and services is particularly necessary for the introduction and exchange of climate-friendly technologies and products. Uniform certification is also an important prerequisite for the increased use of emission-neutral fuels and industrial raw materials. Binding sustainability requirements for both liquid biomass and biofuels have been in place at the European level since 2009 as part of the EU Renewable Energies Directive (2018/2001/EU), which also regulates the eligibility for GHG savings targets. From 2021 onwards, the regulations of RED II will apply, which stipulates stricter reference and limit values. In addition, RED II now also provides explicit sub-targets for ground-based transport.

A transparent and internationally recognised system for recording the CO_2 content of products and services opens up new opportunities, especially for international compensation mechanisms (cf. Chapter 1 and Mehling et al., 2018).

(1) The uniform determination and certification of the carbon footprint of sustainable financial products and (imported) goods is an essential prerequisite for many industrial policy measures.

In industry, there are already efforts to prove the sustainability of production processes, especially since this will have a significant impact on the valuation of companies (cf. Chapter 7). It is to be expected that a system of credible and reliable certification can hence already be effective without further legal requirements. Furthermore, this system can be the basis for regulatory measures aimed at reducing CO_2 emissions. The uniform certification of sustainable financial products and determination of the carbon footprint of (imported) products according to an explicit European standard are equally essential prerequisites for measures such as border tax adjustments on imports and green finance products (cf. Chapters 1 and 10).

(2) Certification should be based on the emissions caused by the production, use and disposal of goods, and should prevent strategic behavior.

Certification should be based on the greenhouse gas emissions caused by the production, use and disposal of goods. When production processes cannot be traced directly, appropriate heuristics should be used, such as the CO_2 content of an average European reference product in the respective sector, or the corresponding state of the art (Cosbey et al., 2019; Mehling et al., 2019). Companies and importers should then have the opportunity to prove that their product-specific CO_2 balance is better than this reference value. This increases the incentive for CO_2 reduction and reduces the probability of a potentially disadvantageous classification, while the administrative burden of proof lies with the respective company. Care must be taken to ensure that existing rules cannot be exploited for strategic behavior.

However, the determination and crediting of emissions in the value-added process is not straightforward. For example, meaningful life cycle analyses require clear rules and delimitations. In the case of CCS or CCU, the longevity of carbon capture or possible release at a later date must be taken into account (acatech, 2018; Freudendahl, 2016). If possible, international valuation standards should be developed for this purpose.

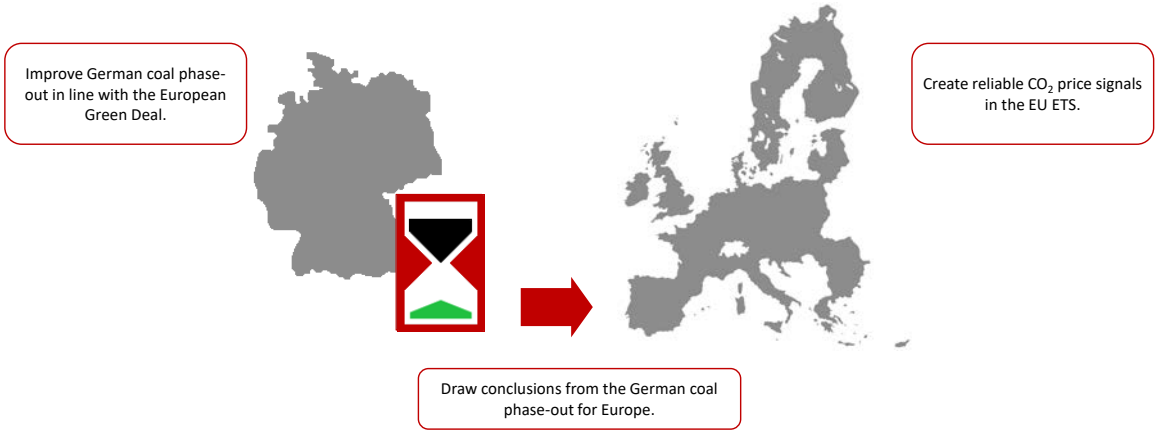
(3) Labelling of carbon footprints should be intuitive and easy for end consumers to understand.

In addition to the CO_2 emissions caused, other characteristics are also relevant to consumer behaviour. In the field of hydrogen and synthetic energy carriers, these include the differentiation as to how CO_2 emissions are avoided (CCU, CCS, use of nuclear power). If end consumers are the target group, it is important to provide an intuitive, easy-to-understand labeling of the carbon footprint. One option would be a multi-level, coloured label similar to the energy labelling of household appliances like a traffic light. This would also allow the carbon footprint of products to be used in retailing and for advertising purposes.

4 Phase-out coal efficiently and improve the effectiveness of market signals

The European Green Deal calls for the development of a European energy sector, based largely on renewable energy sources with a simultaneous “rapid phasing out of coal” (p. 6; EU-KOM, 2019). In Germany, the cabinet passed a coal phase-out law in January 2020 with an exit path for hard coal and lignite-fired power plants by 2038 (Die Bundesregierung, 2020), but this has not yet been adopted. The German phase-out of coal-fired power generation also has implications for the European Community, particularly in the context of the European Emission Trading Scheme (EU ETS), and as a possible model for a socially acceptable energy transition. The current corona crisis reinforces the importance of the latter aspect in particular. The Expert Commission makes three recommendations (see Figure 4):

Figure 4: Priorities for an effective coal exit and for improving the effectiveness of market signals



Source: Own representation

(1) Improve the coal phase-out agreed upon in Germany on the basis of decisions on the European Green Deal.

The agreed upon regulatory phase-out of coal-fired power generation in Germany must be viewed critically from both climate and efficiency perspectives. The coal phase-out needs to take place much more quickly, in order to be in line with international climate protection targets set out in the Paris Climate Change Agreement and the Green Deal; in fact, it should to take place as early as 2030. In addition, it would have to be largely driven by market CO_2 price signals (cf. Chapter 2). Compensation payments to firms should be avoided wherever possible. However, the current draft bill provides for a largely regulatory phase-out of coal-fired power generation in Germany by the end of 2038 at the latest (with a gradual reduction to 15 gigawatts of hard coal and lignite each in 2022, and to 8 and 9 gigawatts respectively in 2030). However, without the legally regulated exit path, many German coal-fired power plants would probably have exited the market earlier, particularly due to price developments in the European Emissions Trading System and the relatively sharp drop in gas prices. Due to the high compensation payments provided for in the law, there is even a risk that power plants will be operated for longer than would have been the case without the regulatory coal exit, with correspondingly higher emissions. The Expert Commission recommends that the current draft law be improved with regard to the exit modalities.

Especially if higher CO_2 prices are achieved within the framework of the Green Deal, the case may arise in which the regulatory exit path is too slow compared to a market-driven exit. The German exit therefore urgently needs to be reassessed in terms of the Green Deal decisions and, if necessary, improved.

(2) Create reliable CO_2 price signals for companies at the European level.

The coal phase-out in Germany has implications for European emissions trading. Uncertainties arise due to the complicated volume-based cancellation mechanism within the framework of the market stability reserve (MSR) of the EU ETS. These are both climate-related and price-related. Although the MSR will cause a shortage of allowances (and thus a reduction in emissions) in the short term, the allowances in the MSR may become free again at a later date (Perino, 2018). In its current volume-based form, the MSR cannot provide clear price signals for investors either. Therefore, the MSR should be changed from quantity-based to price-based control. If necessary, hybrid systems that combine price and quantity control or flex-cap[3] mechanisms should also be considered.

If the administrative coal phase-out is implemented, it is important to provide security for companies. The question of how to deal with the EU ETS allowances released by the German coal phase-out must be answered promptly. To ensure the greatest possible security, the certificates should ideally be withdrawn from the market completely. Otherwise, under the rules of the current MSR, the EU ETS allowances released could lead to companies across Europe saving fewer allowances for the future and thus increasing their short-term emissions. As a result, the MSR withdraws fewer allowances from the system (fewer allowances will be cancelled) and the long-term emissions cap will decrease only slightly or may even increase.

(3) Make the transition to a low-carbon economy in Europe socially acceptable and learn from the various efforts made by Member States, such as the coal phase-out in Germany.

In the sense of a “Just Transition”, the desired climate-neutral industrial transformation in Europe should be examined for its social effects, and striving towards the desired goals should be encouraged. A correct understanding of transnationally organised production and consumption along value chains is also important for this purpose (cf. Chapter 1). The core issue is the protection of particularly vulnerable population groups. In principle, these include people whose income depends on fossil fuels, who are affected by energy poverty or who have no access to secure energy supplies (Newell and Mulvaney, 2013).

The Commission “Growth, Structural Change and Employment” (2019) appointed by the Federal Government and the Expert Commission, have made numerous recommendations to cushion socially undesirable effects of the energy transition in Germany. In order to secure value creation, employment and future prospects in regions particularly affected by the phase-out, additional regional instruments - such as targeted structural assistance in the fields of renewables, synthetic fuels and hydrogen, batteries and climate-neutral technologies - can be used (Heinisch et al., 2019; cf. Chapter 1, Chapter 5, Chapter 6 and Chapter 7). In Germany, important structural policy impulses for coal regions are implemented through the Structure Strengthening Act (Strukturstärkungsgesetz). Furthermore, from the perspective of security of supply in the electricity market, the reliable investment signals mentioned above are necessary (e.g. EU ETS price signals and approval procedures for new gas-fired power plants). In addition, the possibilities for energy price reform must also be supported at the European level (cf. Chapter 2). The urgency of these recommendations will be intensified by the Corona crisis, if unemployment and thus the risk of poverty in EU households should rise as a result. Since conditions in the EU member states differ, transferability must be examined and recommendations must be adapted. Germany should also make use of the experience gained in other regions of Europe.

[3] This involves determining the quantity of allowances to be auctioned as a function of price. If the price is high, more allowances are auctioned, i.e. the cap is expanded. If the price is low, fewer allowances are auctioned, i.e. the cap is reduced. Compared to an emissions trading system with a fixed cap, the adjustments described above stabilise certificate prices.

5 Expand renewable energies more quickly

The implementation of the long-term climate targets and the Green Deal require a significant increase in the expansion targets for renewable energies. The expansion of renewable electricity generation in Germany currently does not show the necessary momentum to achieve the 65% target by 2030. The increase in targets required by the Green Deal is therefore all the more challenging for Germany. One of the main reasons is the sharp decline in the expansion of onshore wind energy. This in turn is attributable to several causes: amongst them is the low number of approved sites for wind energy. The constellation of problems is sufficiently well known, analysed and discussed so that the very well-founded proposals from many parties could have been systematically examined and put together in a package of measures to accelerate the expansion. Instead, political discussion has been caught in a dilemma for a long time: there has been intense resistance to the introduction of nationwide uniform distance regulations for wind energy proposed by politicians with the aim of increasing acceptance of this form of energy production, partly because there is no scientifically proven connection between distance regulations and the acceptance of wind turbines. This was proven in a study by DIW which found that the introduction of mandatory minimum distances does not automatically lead to greater acceptance (DIW, 2019). A stalemate has thus ensued since the introduction of the distance regulations was politically linked to the implementation of the long since agreed abolition of the 52 GW cap for photovoltaics. This has now been resolved by shifting responsibility for the implementation of distance regulations to the level of the federal states. The Expert Commission expressly welcomes this development and furthermore underlines the need for a rapid, comprehensive amendment of the EEG. Germany must make improvements as quickly as possible in order not to fall behind in the European context. The following comments focus on the possibilities of supporting the accelerated expansion of renewable electricity generation at European level, as the Expert Commission sees the greatest need for action here.

(1) The Green Deal requires the development of renewable energies in a new dimension throughout Europe, which requires a considerable increase in the pace of expansion.

The implementation of the European Green Deal requires the expansion of renewable energies at a much higher pace than previously envisaged by the member states in their National Energy and Climate Plans (NECPs). This applies in particular to renewable electricity generation, because the Green Deal not only aims at a rapid phase-out of coal-fired power generation and a defossilisation of gas-fired power generation, but will also require a significant increase in electricity demand. The need for climate-neutral production alone will greatly increase the direct demand for renewable electricity. This also applies to the substitution of fossil fuels by electricity applications such as electrical process heat supply or heat pumps and also to the strategies formulated in the Green Deal for the climate neutrality of basic industries and the envisaged use of green hydrogen as a starting product for the chemical industry, refineries and a new type of steel production. For example, a study of the German Chemical Industry Association (VCI) for the chemical industry in Germany indicates a transformation path to climate neutrality by 2050, which implies an increase in electricity demand from 54 TWh in 2020 to 685 TWh in 2050 (VCI, 2019). In addition to industry, demand for renewable electricity will also increase in the transport and buildings sectors, since a large part of the climate protection efforts in transport can only be realised by expanding renewable energies. Not least for reasons of energy efficiency, the use of electric vehicles and electric heat pumps will be further promoted by the Green Deal measures.

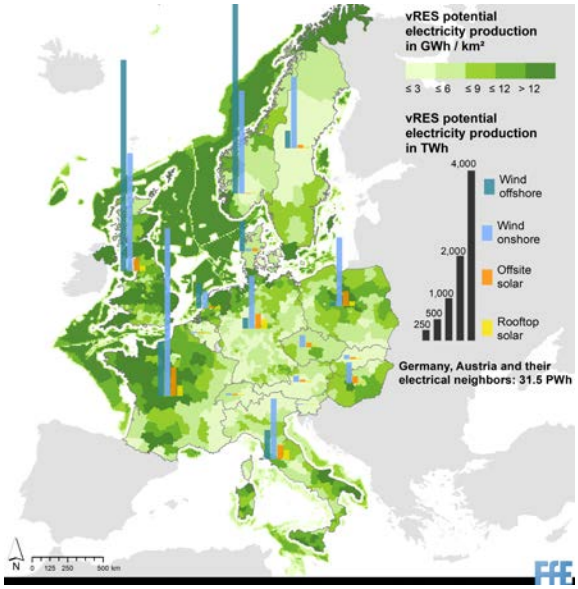
Without a much more ambitious expansion of renewable energies, which must go hand in hand with stricter energy efficiency requirements, it will not be possible to raise the greenhouse gas reduction targets to -50 to -55% in 2030. Scenario analyses carried out on behalf of DG Energy in 2018 show that with a share of renewable energies in gross final energy consumption of 45%, combined with an energy efficiency target of 40%, a

greenhouse gas reduction of 53% compared to 1990 could be achieved in 2030.[4] This includes a renewable share of 79% of electricity supply, which underlines its great importance (DG Energy, 2018).

(2) Since there would be sufficient generation potential for a climate-neutral Europe, the main concern is to provide impetus for increased expansion. Especially for the development of renewable energies, European solutions need to be strengthened in their implementation (e.g. through an EU-wide coordinated offshore wind strategy in the short term in the context of the German EU Council Presidency) in order to better complement national activities.

As Figure 5 illustrates, Europe has extensive potential for electricity generation from wind and solar power. The underlying analysis assumes a generation potential of 31,500 TWh/a in Germany, Austria and its electrically directly linked neighbouring countries alone. In contrast, a transformation to climate neutrality would result in an electricity demand of almost 3,600 TWh/a for the region under consideration. This shows that Europe's climate neutrality will not fail because of the renewable generation potential, although mobilising the necessary expansion is by no means without obstacles. The dynamic and level of implementation required for 2030 will be a considerable challenge, as will the unequal distribution of potentials among the European regions. While the coastal regions of the North Sea, Baltic Sea and Atlantic can draw on large offshore potentials, the landlocked countries can only rely on onshore wind energy - usually in complex terrain - and photovoltaics for additional growth.

Figure 5: Potential renewable electricity production per country/NUTS-3 and energy source



Source: FfE (2019)

The model calculations of DG Energy identify the greatest possible increase for offshore wind, closely followed by onshore wind energy and photovoltaics. In order to achieve the required doubling of the annual offshore capacity from 3.6 GW in 2019 to 7 GW annually from 2020 onwards for the above-mentioned climate protection target for 2030, an EU-wide coordinated offshore strategy is required. It should initiate cooperation across

[4] The current targets include a 32% share of renewable energies in gross final energy consumption, an energy efficiency target of 32.5% and a greenhouse gas reduction of at least 40%, whereby the first two targets would trigger a higher greenhouse gas reduction if implemented consistently.

national borders and requires a stable legal framework, including maritime spatial planning, which reliably regulates the multiple use of waters and provides incentives for transnational spatial planning. It is also necessary to clarify the distribution of cost coverage and the responsibility of national grid operators in the case of offshore wind farms developed jointly and connected to the grid in several countries. The German Council Presidency offers the opportunity to set the course for offshore expansion, that is so important for Europe and also for Germany, because it can also be linked in perspective with the expansion of electrolysis capacity for green hydrogen (cf. Chapter 6), which in turn supports a European hydrogen economy.

(3) The centralised development of renewable energies has to go hand in hand with decentralised concepts in order to ensure an expansion of the grid throughout Europe that is adequate for expansion and thus for an optimal grid integration. In addition, incentives should be created for those Member States that have particularly high potential and favourable starting conditions to accelerate the expansion.

In addition to offshore wind energy, which can be considered more as "centralised" generation due to the large capacities obtained in wind farms, an acceleration of the expansion of "decentralised" generation from onshore wind energy and photovoltaics is at least as important. The aim has to be to combine both principles intelligently: Central capacities must be developed at preferred locations to provide electricity for large consumers at low prices. Meanwhile, decentralised grid beneficial expansion helps to optimise costs of grid expansion and management. An intelligent regional distribution of plants can thus reduce the overall costs of the energy transition (Grimm et al., 2017). It is important to provide incentives for increased European cooperation in grid expansion planning and implementation (cf. Chapter 8), and in particular to establish an interaction between grid development and storage development with the aim of achieving an optimal balance between costs and security of supply (Grimm et al., 2020).

In addition to the ongoing activities at national levels, it is necessary to increasingly create options that enable regions with particularly favourable conditions and/or comparatively few reservations about wind turbines and photovoltaic ground-mounted systems to benefit from a much stronger expansion of renewable electricity generation. However, this requires further development of the existing regulatory framework: financing mechanisms, support mechanisms and, in particular, eligibility in the respective Member States must be clarified. For example, cross-border tenders for the promotion of renewable electricity are so far only possible with countries which are directly connected. This has a counterproductive effect, not least because no crediting is made to the renewable electricity share of the country that bears the costs of the support.

(4) The development of support mechanisms such as combinatorial auction mechanisms or Contracts for Difference can help accelerate the development of renewable energies in line with the Green Deal.

Although the large number of different funding instruments takes into account the diversity of the Member States, it seems to be rather a hindrance to the envisaged high level of expansion throughout Europe. For this reason, joint support mechanisms should be considered, at least for the additional expansion of renewable electricity generation required by the Green Deal, which take into account Europe-wide experience with, for example, Contracts for Difference as well as cross-border and technology-neutral tenders. Combinatorial auction mechanisms could be an attractive way of achieving different regional expansion targets and appropriate conditions while at the same time allowing competition between regions. Furthermore, transparency of regulations is also important in this context; as far as possible uniform regulations with regard to the land scopes, possible (financial) participation opportunities for the local population affected and the activation of common social values for the Green Deal should be included.

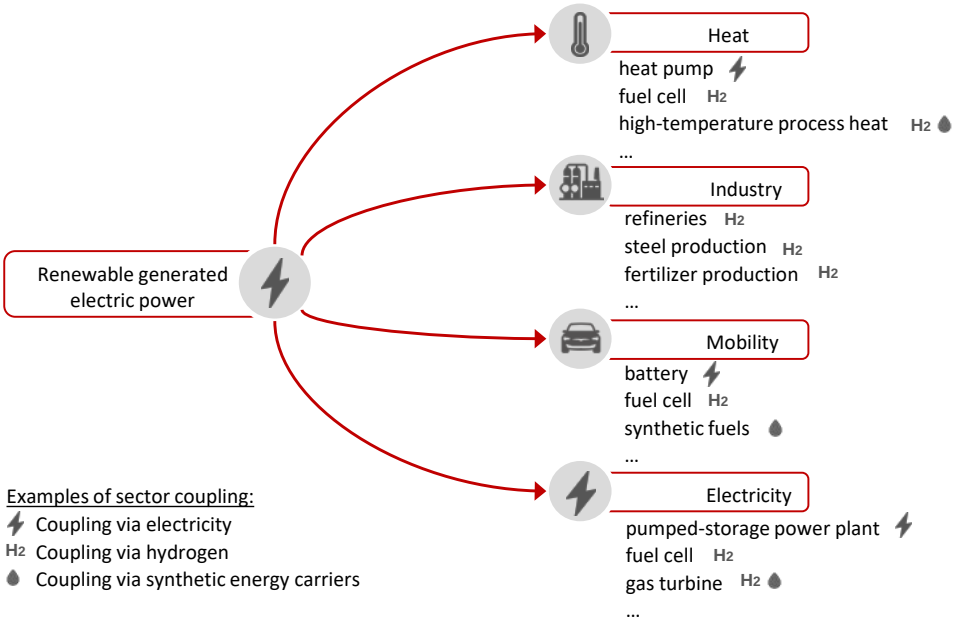
At the same time, the expansion and use of renewable energy sources creates additional value-added potential (cf. Chapter 1). Especially in the wake of the Corona crisis, an accelerated expansion of renewable electricity

generation appears to be a "no-regret" strategy. In this way, both plant manufacturers and their suppliers would be given a plannable future perspective, supply chains within Europe can be consolidated or newly established, in order to ensure greater protection against future crises. The construction and operation of plants creates added regional value and future-proof employment. In times of crisis, participation options in particular can play an important role in stabilising society. For this reason, the course should be set for the additional expansion of renewable energies in accordance with the Green Deal objectives and the economic stimulus packages aimed at overcoming the Corona crisis should be explicitly used for this purpose.

6 Develop key global technologies for hydrogen and synthetic energy carriers

Renewable hydrogen, the industrial raw materials based on it, and synthetic energy carriers (synFuels) play a key role in achieving climate neutrality by 2050. They can be used in a variety of ways. Applications can be found in the transport sector, the storage of electricity, industry, and the heating sector (cf. Figure 6). In the transport sector, synthetic fuels can be used especially in areas where neither battery nor fuel cell drives are technologically feasible, at least in the medium term, e.g., in air and international maritime transport (NPM, 2019). For the defossilisation of important areas of energy-intensive industry, such as the steel industry or the chemical industry, hydrogen is the only reasonable alternative. Also, for seasonal electricity storage, only hydrogen or synthetic methane are practical. Numerous European countries, and even individual German states, are currently developing hydrogen strategies and roadmaps. A functioning interaction of these envisaged roadmaps, support programmes and coordination mechanisms is central to the success of a European perspective and is therefore of the utmost importance.

Figure 6: Hydrogen and synthetic energy carriers as a crucial link in the defossilisation of many sectors via the electricity sector



Source: Own representation based on H2.B (2020)

(1) In order to achieve climate neutrality, and from an industrial policy perspective, the transformation and supplementation of existing value chains is necessary. At the international level, existing but also new energy partnerships must be strengthened.

In order to be able to use hydrogen and synthetic energy carriers on a large scale, the transformation and supplementation of existing infrastructures, supply and value chains is necessary. A central prerequisite is the rapid ramp-up of the industrial production of key components for a future hydrogen economy in Germany and Europe. This is also an absolute necessity for industrial policy reasons (cf. Chapter 1 and Chapter 7). Expansion and planning should be started as soon as possible in order to cushion delays caused by approval and possible legal proceedings and to achieve the ambitious climate protection goals of the Green Deal.

In the medium and long term, only part of the demand in Germany can be covered from the domestic market. Large quantities of renewable energies will therefore have to be imported from European and non-European countries. Some of Germany's imports will come from European countries where favourable conditions for renewable energies prevail. Imports may also come from countries outside Europe from those countries where energy partnerships already exist today. However, there are also numerous regions worldwide where hydrogen can be produced under favourable conditions and with which new energy partnerships are conceivable (cf. Fraunhofer, 2017). In some cases, interesting co-benefits exist, especially in this context.

Electrolysis plants and other plants for the production of synthetic energy carriers such as synthesis plants etc. should be built at locations and in regions with favourable conditions for the production of renewable electricity. In Germany, high government-induced price components and uniform electricity prices throughout the country are currently preventing a profitable operation of electrolysis plants (Runge et al., 2019). Adjustments in the form of an energy price reform are urgently needed here (cf. Chapter 2). Power Purchase Agreements (PPAs) may also contribute to a better use of preferred locations under certain circumstances.

The development of comprehensive logistics for hydrogen and hydrogen-based synthetic energy carriers is a central prerequisite for their large-scale use (cf. Chapter 8). This includes the modernisation and adaptation of port facilities (for imports), infrastructure for transport to the centres of consumption as well as distribution logistics. Wherever possible, existing infrastructure should be used to keep the costs of the transition low. This may require technological innovation. The distribution of hydrogen and hydrogen-based synthetic energy carriers can possibly be organized competitively to a large extent due to a wide range of logistics options. However, decisions on technology and standardization are necessary at certain places to trigger necessary investments of the private sector. This includes, and is not limited to, the filling station infrastructure for hydrogen.

Without the application of technologies in practice, competitive products cannot be established on the markets in the long run. It is therefore absolutely necessary to increase domestic activities along the entire value chain. The energy policy framework is crucial here: the more ambitious the CO_2 price and the lower the government-induced price components, the smaller the scope of the necessary support measures. However, the energy policy framework is not only important for keeping the costs of the necessary subsidies as low as possible. Establishing the right incentives via price signals also leads to the necessary coordination of the market participants. After all, the development of the entire value chain is essential for the profitability of individual business models. In order to prepare for independent market development, coordination via the IPCEI ("Important Project of Common European Interest") programmes throughout Europe is reasonable and target-oriented. This way, operating costs could also be subsidised proportionately. National support programmes should interact well with this measure.

(2) In order to achieve the climate targets in the transport sector, it is essential to address the acceptance of alternative drives at an early stage and to develop measures to promote acceptance.

In the field of mobility, green hydrogen and synthetic fuels are not yet competitive compared to hydrogen based on fossil energy carriers and conventional fuels. In the medium term, however, this can be achieved by certifying the produced CO_2 emissions, combined with an appropriate pricing of CO_2 emissions. In addition to biofuels, whose further potential is very limited, electricity-based fuels already offer a medium-term opportunity to contribute to the defossilisation of the transport sector. While these fuels are compatible with existing drives, the use of hydrogen requires a new approach. Given the fact that greater capacities for the production of hydrogen/fuel cell vehicles are only just being established, both nationally and internationally, it is currently unclear how the availability of fuel cell vehicles will develop in the coming years. Up to 100,000 commercial vehicles (out of approx. 680,000 vehicles) are expected in Germany by 2030, while a maximum of 350,000 vehicles (out of

approx. 46 million vehicles) are expected to be part of the national vehicle fleet (cf. NPM, 2020a). The infrastructure required in the medium term must be considered now (cf. Chapter 8).

Although the share of vehicles with a hydrogen/fuel cell drive will be comparatively small for the time being - especially in passenger transport -, questions of acceptance by end customers/end users should be taken into account at the early stages, since, in addition to basic availability, the acceptance of new fuels and vehicle drives will play a major role in the introduction and use of this technology. This also applies to commercial transport, where, however, economic criteria will be paramount. In (individual) passenger transport, it has been shown several times in the past (introduction of E10, LNG/CNG drives, electric vehicles) that price alone does not provide a sufficient incentive if the change to other fuels or drives is associated with uncertainties regarding their usability or if a change in routines and usage habits is necessary. Acceptance-promoting measures cover a broad spectrum ranging from communication and infrastructure development to regulation. The investment and operating costs for fuel supply on the supply side and handling during refuelling on the user side are relevant for the infrastructure expansion. The need for research in this area is considerable.

(3) An adaptation of the Renewable Energy Directive (REDII) in the transport sector should be aimed at and promoted by Germany in order to achieve the more ambitious goals of the Green Deal.

Within the framework of the Green Deal, a corresponding adaptation of the Renewable Energy Directive (REDII) in the transport sector should be aimed for. Under the current version, each Member State obliges fuel suppliers to ensure that the share of renewable energy in final energy consumption in the transport sector is at least 14% (including multiple crediting) by 2030 according to an indicative trajectory set by the respective Member State. If more ambitious climate targets are set in the course of the Green Deal, a significantly higher share of renewable fuels is likely to be necessary. Against this background, the lower limit should be raised uniformly, e.g., to 20% or higher (without multiple crediting). However, from aspects of direct and indirect land use change, higher quotas of fuels from cultivated biomass should be largely avoided. The minimum proportion of renewable fuels to be adjusted should hence be achieved by using fuels from waste and residual materials, waste oils and electricity. In addition, the current version of the REDII allows for multiple crediting of the energy content of certain renewable fuels. For example, the share of renewable electricity can be calculated as four times its energy content if it is provided for road vehicles. By comparison, the energy content of hydrogen and other synthetic fuels of non-biogenic origin can only be credited once. Moreover, the recognition of synthetic fuels imported from outside Europe is still open. These unequal crediting possibilities for renewable energies can, among other things, lead to wrong incentives in the commercial vehicle sector. A more differentiated approach should be taken here, which would incentivise a more efficient choice of sustainable drives depending on the transport sector (e.g., individual transport, freight transport, or aviation and international shipping). A penalty for failure to reach the target value could, for example, be based on the existing penalties that apply explicitly to missed targets in the biofuels sector (€470/CO_2eq, Section 37c of the Federal Immission Control Act) and implicitly to the CO_2 fleet limits for passenger cars (EU Regulation 2019/631).

(4) The long-term target of climate neutrality must also be kept in mind during the transition phase with bridging technologies.

In the near future, green hydrogen and synthetic energy carriers will not yet be available in sufficient quantities at low cost. In order to enable a rapid ramp-up of the use of these fuels in all sectors, the use of emission-neutral hydrogen not produced by electrolysis or from biomass (CCS, CCU, nuclear power) should be considered in a transitional phase. In this context, it is important to make a clear commitment to the use of green hydrogen as soon as possible in order to provide sufficient renewable energy carriers for the transport and industry sectors. In addition, it is important to ensure that only infrastructures are built which can be fully used for green hydrogen and synthetic energy carriers in the end.

7 Accelerate industrial transformation through climate-neutral production

The industrial sector accounts for approximately 20% of total greenhouse gas emissions in the European Union (2017), which is of the same order of magnitude as transport (EEA, 2020). The realisation of climate-neutral production is therefore a central field of action for the implementation of the European Green Deal. There are essentially three levels (cf. Figure 7): emissions that are directly within the sphere of influence of companies, such as their own production facilities, processes, vehicles, etc. (scope 1), purchased energy sources such as electricity, energy sources for building and process heating/cooling or fuels (scope 2) and all emissions associated with the entire product-related value added on the procurement side (upstream activities) and on the sales side up to the recycling or disposal of products (downstream activities) (scope 3; GGP, 2011). The significance of the levels varies greatly depending on the company and the depth of value added. Whereas in sectors such as steel or cement production the focus is on process-related emissions, scope 3 may well account for 90% of emissions at OEMs in the automotive industry (Roland Berger, 2019).

(1) Market introduction instruments such as carbon contracts for difference are intended to enable replacement investments in innovative production processes, because the incremental development of technologies is not sufficient to achieve climate neutrality in important areas.

The scope 1 level is particularly important for energy-intensive basic industries, which are characterized by particularly capital-intensive plants and long investment cycles. For this reason, replacement investments must already be designed to meet the requirements of climate neutrality today. Incremental improvements in production processes alone will not be sufficient; the implementation of disruptive innovations must be initiated now. Key technologies include, for example, the direct reduction of iron ore with hydrogen in the steel industry (cf. Chapter 6), capturing of CO_2 in cement production or the chemical recycling of plastic waste as feedstock for the chemical industry (Agora, 2019). The demonstration projects already underway, many of which are publicly funded, provide important practical insights, but they will come to nothing if no market perspective is created. Only in a long-term business case, will companies make strategic decisions and invest in climate-neutral technologies. However, in many, if not all, processes the GHG abatement costs are significantly higher than the current and expected CO_2 price in the European emissions trading scheme, which covers the vast majority of relevant companies. In order to provide appropriate investment incentives, an extension of the range of instruments that can be applied upstream, midstream and downstream should be examined. An interesting midstream option are the so-called carbon contracts for difference, which are based on the production processes and in which differential costs are compensated by operating subsidies over a fixed period of time; this is only the case, however, if the differential costs are higher than the certificate prices in the emissions trading scheme.

For the industry, long-term resilient appropriate conditions should be initiated. At present, the risk of stranded assets is very high for investments in both conventional and green technologies. The implementation of carbon contracts for difference in pilot projects for selected areas of the energy-intensive industry can offer an entry point for this, in order to avoid lock-in effects from investments in fossil-based technologies. A green industrial transformation, which is now to be initiated with commitment, also offers the opportunity for international technology leadership in key sectors and secures the industrial base of the European Union. Such a lead market can set (technology) standards for global development and creates additional opportunities for European companies in global competition. For example, establishing the value chains of a hydrogen economy creates very good chances of assuming a leading position on the world market for both German and European industry (cf. Chapter 6).

(2) Own initiatives by enterprises are to be seen positively and should be supported and strengthened by the appropriate regulatory framework.

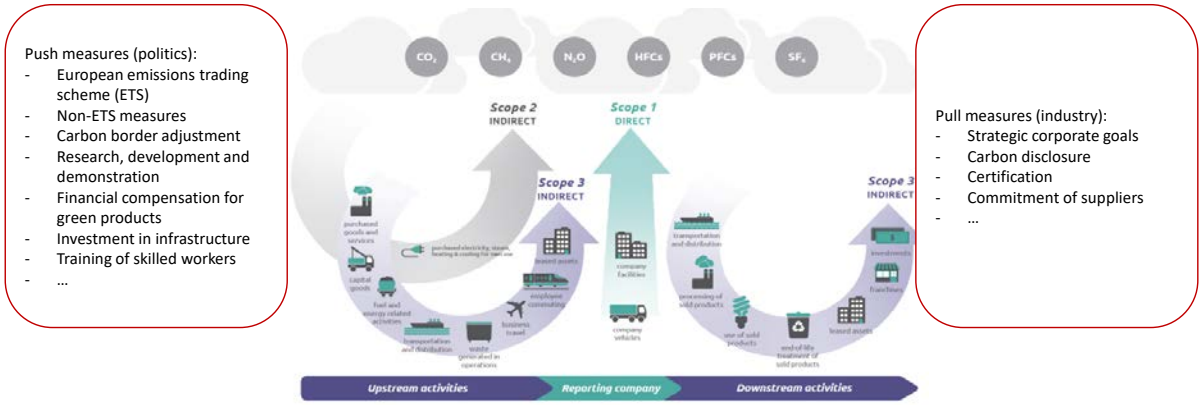
Many companies have also taken their own initiatives to achieve climate-neutral production (pull measures). This is not only a matter of reducing emissions in production and supplying renewable energies or, in the longer term, green hydrogen or so-called eFuels (see 6). In some cases, CO_2 compensation measures are also used. With this combination, Bosch for example, aims to make itself CO_2-neutral worldwide as early as this year (scope 1 and 2; Bosch, 2019).

The motivation of the companies is manifold and ranges from adaptation to the current or an anticipated possible regulatory framework for emission reduction (push measures of politics, e.g. inside and outside the European emissions trading scheme), cost reductions and a reduction of price risks on the procurement (e.g. energy costs) and sales side as well as an improvement of competitiveness against competitors (e.g. in the procurement of capital) to public pressure and image cultivation.

(3) The long-term establishment of climate-neutral supply chains requires the development and implementation of transparent and practicable CO_2 certification as well as support for small and medium-sized enterprises.

In the short and medium term, the predominant measures in companies address scopes 1 and 2, but also scope 3 on the longer time scale. Mercedes-Benz Cars, for example, is aiming for a CO_2-neutral new car fleet along the entire value chain by 2039 (Daimler, 2019). Scope 3 is particularly important because the goal of global climate neutrality can only be achieved by including internationally interlinked supply chains. In the context of the European Green Deal, it is therefore not only necessary to take appropriate measures to make production in Europe climate-neutral (especially scope 1 and 2), but also to take this into account in the design of the so-called border carbon adjustment mechanisms. Therefore, the various corporate initiatives should be used and approaches that are in the common interest of politics and industry should be supported and actively promoted. For example, appropriate certification systems (cf. Chapter 3) which can be based on relevant standards, such as ISO 14067 (Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification). The comprehensive revision of the existing European standard (EN16258) for the certification of CO_2 of transport chains in freight transport towards a globally applicable ISO standard under the Vienna Agreement should also be supported. Due to permanent changes in supply and value chains on internationalised markets, certification systems need to be established which are globally applicable, reflect the status quo as best as possible and at the same time guarantee permanent flexibility. Various practicable methods are already available for emissions accounting at company level, but these are likely to quickly reach their limits, especially in the case of complex products and supply chains (vehicles, smart phones, etc.). It should therefore be examined whether in the longer term extended methods such as blockchain technologies can be used, which companies are already testing for mapping their supply chains. A further field of action concerns support for small and medium-sized enterprises which, due to their own resources, will not easily be able to provide appropriate verifications to generate a competitive advantage. This applies above all to suppliers of large companies.

Figure 7: Climate-neutral production in industry - emissions along the value chain and push and pull measures



Source: Own illustration. Graphic: Greenhouse Gas Protocol: Corporate Value Chain (Scope 3) Accounting and Reporting Standard -Supplement to the GHG Protocol Corporate Accounting and Reporting Standard. World Resources Institute and World Business Council for Sustainable Development, September 2011. https://ghgprotocol.org/standards/scope-3-standard.

8 Expand infrastructures in a coordinated manner

In order to achieve climate neutrality of the European economy and society, a comprehensive restructuring of the transport, distribution and storage infrastructure for energy is necessary. In addition to the existing electricity and gas networks, infrastructures for the transport, distribution and storage of hydrogen and synthetic energy carriers must be adapted and expanded. Long-term and, above all, integrated planning between the various energy carriers is central to this. In addition, storage facilities with different volumes are needed to enable independence of generation and consumption over time, especially in the area of electricity supply. The transport infrastructure for material energy carriers, such as pipelines, ships, trains or trucks, already has an inherent storage function. Furthermore, a rapid and long-term coordinated expansion of the electricity grid at European level is necessary in order to align it with the requirements of the future energy system and to achieve the expansion targets for renewable energies. In the transport sector, the Europe-wide expansion of filling station systems for renewable fuels and charging infrastructure along the trans-European transport network must be developed. An important question here is also which parts of the infrastructure are to be regulated and which can be left to free market competition.

(1) Major investments in infrastructure (electricity, gas and hydrogen supply networks, as well as electrical charging infrastructure and filling stations) are necessary to achieve climate neutrality by 2050. Greater coordination at the European level must be ensured in this context.

Germany is experiencing severe delays in implementing the expansion plans for the electricity grid. The reasons for this are questions of acceptance as well as uncertainties on the part of companies regarding energy policy, which are slowing down investment decisions. Possible options for accelerating infrastructure expansion include (a) legal measures to speed up implementation, (b) clear energy policy decisions with a focus on implementing the goals formulated in the Green Deal, and possibly (c) a dialogue process that overcomes obstacles.

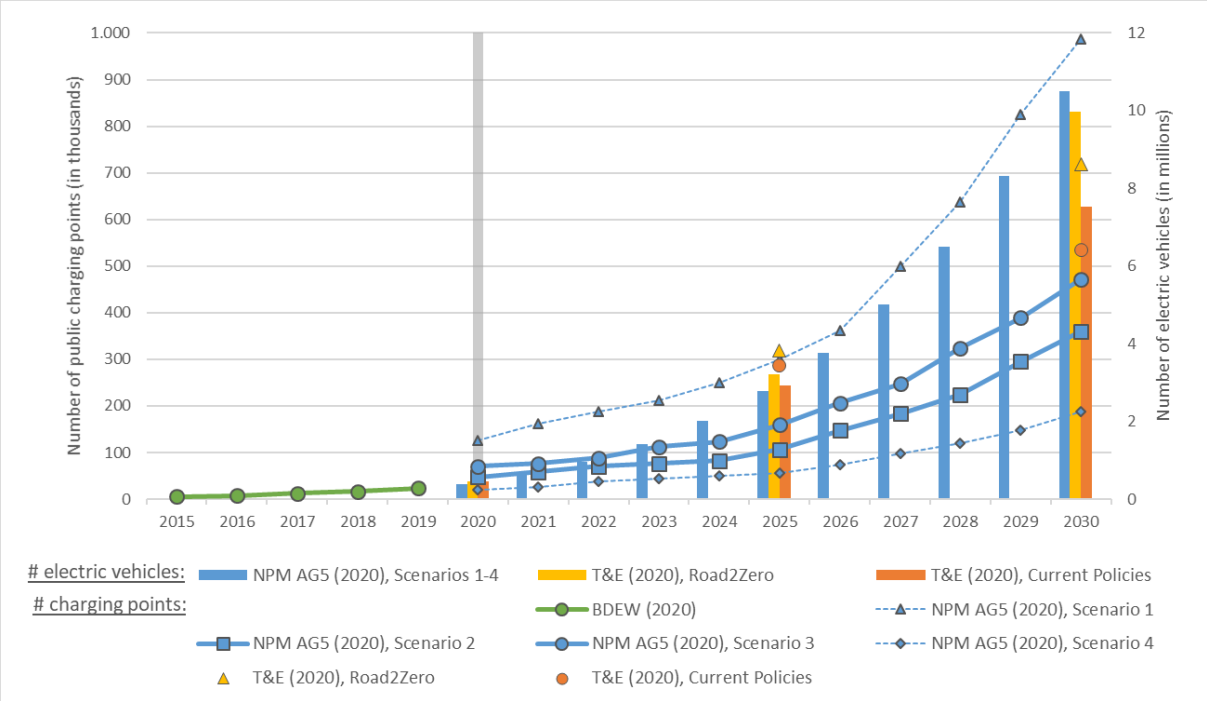
In the transport sector, the transition to alternative drives and fuels requires a gradual conversion and/or expansion of the charging and filling station infrastructure. It is essential to expand the charging infrastructure for battery electric vehicles and to increase the number of hydrogen filling stations. The use of CO_2-neutral synthetic fuels has the advantage that a comprehensive infrastructure is already in place. However, the disadvantages are the lower energy efficiency compared to hydrogen and the comparatively high production costs of the fuel itself.

At the European level, the Alternative Fuels Infrastructure Directive (AFID) of 2014 calls for adequate infrastructure for the alternative fuels of electricity, hydrogen and natural gas in all EU states (European Parliament, 2014). A revision of the directive is necessary with regard to the climate policy objectives of the European Green Deal in order to enable the market ramp-up of passenger cars with alternative drive systems. However, in the long term, the development of a comprehensive natural gas infrastructure currently being pursued by AFID is at odds with climate-neutral mobility unless care is taken to convert the natural gas networks to accommodate climate-neutral gases at the same time. In general, when promoting transition technologies, it is important to consider the potential for further use of the established infrastructures.

For the initial market ramp-up of battery electric vehicles, binding quotas of public charging infrastructure for each member state in relation to the number of battery electric vehicles are conducive, especially for the development of fast-charging infrastructure (see Transport & Environment, 2020). The required number of public normal charging points can, however, be differentiated regionally and should be designed depending on the availability of private charging infrastructure (cf. Figure 8). In order to increase the attractiveness of battery electric mobility, customer-friendly charging should be possible throughout Europe, i.e., simple, available everywhere and at all times, transparent and safe (cf. NPM, 2020b). This concerns fields of action such as

standardisation, usability, payment, interoperability, real-time information on the charging process, error correction and data protection.

Figure 8: Historical and forecasted development of public charging points and electric vehicle fleet (BEV and PHEV) in Germany



Source: Own representation. Historical values of public charging points from BDEW (2020) in green. Forecasts of public charging points and electric vehicle fleet from NPM (2020c) [5] in blue and Transport & Environment (2020)[6] in yellow and orange.

The expansion of hydrogen filling station infrastructure must also be pursued on the European level. Here, particular attention must be paid to the compatibility of the hydrogen filling station infrastructure for cars and trucks. Germany is currently leading the way with 84 hydrogen filling stations (compared with 50 in the rest of Europe), with a further expansion to 100 by the end of 2020 and even 400 by the end of 2023 (cf. H2 MOBILITY, 2020). However, the market potential of fuel cell vehicles for heavy-duty transport can only be exploited if a comprehensive hydrogen filling station infrastructure is available along the European main traffic arteries.

[5] Assuming 10.5 million electric vehicles in 2030, AG5 of the "National Platform Future of Mobility" (NPM) uses four different scenarios to indicate the possible range for the demand for public charging points in Germany. Scenario 1 shows the highest demand for charging infrastructure in the public sector. Assumptions are that 40% of charging takes place in public spaces and 90% of this at charging points with low charging capacity (AC charging points). An average demand for public charging points is forecasted for scenarios 2 (public charging 15% and AC charging points 90%) and 3 (public charging 40% and AC charging points 67%). In scenario 4, the lowest demand for public charging points results from a high proportion of private charging (85%) and the increased development of charging infrastructure with high charging capacity (33% DC charging points). Considering attractiveness of the charging infrastructure and economic efficiency, an expansion of the charging infrastructure in the range of scenario 2 or 3 should be aimed at.

[6] The Transport & Environment (2020) study forecasts charging infrastructure requirements for all EU countries for the years 2025 and 2030. The charging infrastructure forecasts differ in a more progressive market ramp-up of electric vehicles in the "Road2Zero" scenario compared to "Current Policies". The "Current Policies" scenario assumes an EU-wide demand of 1.2 million charging points by 2025 and 2.2 million charging points by 2030.

Given the high volume of transit traffic and with Germany as the key economic hub in Central Europe, an isolated solution in Germany would not be appropriate. Germany should advocate a binding, uniform design of the infrastructure for alternative fuels along Europe's transport routes.

(2) The efficient development of infrastructure requires long-term and integrated planning of infrastructure for electricity, gas and hydrogen. Wherever possible, existing infrastructures are to be used and expanded.

In the field of electricity networks, the Ten Year Network Development Plan (TYNDP) is already effectively coordinating network development at the European level (see https://tyndp.entsoe.eu/) The E-Highway2050 research project contracted by the European Commission (carried out from 2012 to 2015) provides detailed long-term perspectives, on the basis of which the medium-term plans are developed (see e-Highway2050, 2015). At the European level, coordination in the expansion of electricity grids is thus already well advanced and well established. However, so far there has been little interaction with the plans to expand the gas and hydrogen infrastructure. Against the background of the more ambitious climate targets acoording to the Green Deal, (a) the planning of electricity, gas and hydrogen infrastructures should be interlinked so that the interfaces between the different energy networks can be taken into account in the planning at an early stage. And (b) the plans, especially the long-term perspective for 2050, should be adjusted to provide guidance for the preparation of the medium-term expansion paths.

When setting up the extensive new infrastructures, the aim should be to use existing infrastructure wherever possible. This can be done, for example, in the gas network by converting currently unused pipelines for the transport of hydrogen. In the current version of the Gas Network Development Plan, a hydrogen network with a length of 1294 km is proposed for Germany, 88% of which is to be achieved by converting existing gas pipelines (cf. FNB Gas, 2020).[7] The use of existing capacities is necessary for cost reasons, but also increases the acceptance of the expansion and conversion of the infrastructure.

(3) In the medium term, a decision must be made regarding which parts of the new infrastructure are to be regulated and which parts are to be operated on a competitive basis.

Various technologies are available for hydrogen logistics, which are not mutually exclusive but can also be used in combination. In general, all common road, rail or water-based means of transport are suitable for transport. For compressed and cryogenic hydrogen, however, only road transport is currently established. For compressed hydrogen and hydrogen chemically bound in a liquid, transportation via a pipeline network is also attractive. For reasons of acceptance and high investment costs, the implementation of a comprehensive European or German pipeline network is likely to pose major challenges. Alternatively, it is conceivable that hydrogen arriving, for example, at European seaports as cryogenic liquid or in chemically bound form could be transported via European backbone pipelines to the major centres of consumption. There, regional redistribution could then take place alternatively via pipelines or by rail or road. In this context, it remains open whether all logistics levels need to be standardised and regulated or whether, especially in the area of distribution logistics, different suppliers and variants of logistics can compete with each other. When regulating new infrastructure, an integration into the existing regulatory and planning framework should be aimed at.

[7] However, the implementation of these measures is subject to the transfer of the existing legal regulations for (natural) gas supply networks to hydrogen networks. In addition, the transmission system operators for gas have drawn up a vision for a first Germany-wide hydrogen infrastructure, which is to be continuously developed on the basis of new findings, see https://www.fnb-gas.de/media/erlaeuterungen_zur_visionaeren_h2-karte.pdf.

9 Deal systematically with energy efficiency

In addition to the growing use of electricity from renewable energy sources, measures to increase energy efficiency are another important pillar for defossilisation in the building and transport sector in Germany as well as in Europe. Both areas directly affect the end consumer: the average home ownership rate in Europe is close to 70% (Bode and Wiest, 2017); around 13% of disposable household income in the EU is spent on mobility and transport, including almost EUR 860 billion on the purchase and operation of vehicles (EU-KOM, 2019). Accordingly, measures with a direct impact on prices are subject to a high level of public attention due to the conflict between climate protection, which is recognised as necessary at the level of society as a whole, and the cost burden at the level of individual private households. This makes measures politically challenging in terms of their implementation. Energy efficiency measures in particular can protect the end consumers directly affected in the long term from further increasing cost burdens due to the development of energy and CO_2 prices. The corresponding investment decisions of end consumers should be supported by the measures and the legal framework of the Green Deal. The necessary conditions for the transformation will be created by certification and efficient governance structures and - especially in transport - by Europe-wide harmonised accompanying incentive and control measures. It is not only in the transport sector that cost savings can lead to rebound effects that compensate or even overcompensate for efficiency gains, these must be avoided by flanking regulation. In this context, the topic of "energy efficiency" must be considered in a systemic way: Efficiency is not only generated by more output per energy used, but also by avoidance or relocation strategies while satisfying existing needs for heating or cooling and mobility.

Building:

(1) The timely further development of the European framework is an absolute prerequisite for the implementation of the objective of a European climate-neutral building stock for 2050.

Energy- and resource-saving construction and renovation have always been at the centre of European objectives, even if the annual renovation rates of the Member States, which range from 0.4% to 1.2%, show that the potential for climate and resource protection in this sector has not yet been sufficiently activated. The large number of actors with their different interests as well as country-specific characteristics may be important for this. However, the regulations of the EU Building Efficiency Directive and their respective implementation in national law are decisive for the degree of refurbishment, which is at least as important for the implementation of a climate-neutral building stock as the number of energy-related refurbishments. There is an urgent need for action here, as the example of the German law on energy savings and the use of renewable energies for heating and cooling in buildings (Gebäudeenergiegesetz - GEG) shows. The GEG draft states: "The current energy requirements for new buildings and existing buildings continue to apply". The main basis for this is the economic efficiency requirement in the sense of so-called cost optimisation, which requires CO_2 prices to be set, but which is based on the price projections of the emissions trading system and thus does not provide the necessary impetus in the heating market. It is therefore recommended to check whether the applicable cost-optimality criteria are in line with the long-term goal of a climate-neutral building stock. This applies in particular with regard to the temporal dynamics of the CO_2 price development in order to avoid lock-in effects due to the long lives of building components in buildings.

In view of the threatening effects of the corona pandemic on the economic development of the member states, this is all the more important, due to the risk that the necessary funds cannot be activated, especially for the necessary investments in a climate-neutral building stock. Accordingly, when designing economic stimulus packages, the transformation of the building sector should be supported towards climate neutrality in a targeted manner throughout Europe. This is also confirmed by a recent SSCE paper (Hepburn et.al., 2020), which identifies

building efficiency retrofits as one of five policies with high potential as both an economic multiplier and an effective climate protection measure.

Transport:

The particular challenge in the transport sector is that the primary objective must be to reduce the absolute amount of energy-intensive transport, i.e. especially motorized road transport. Increasing vehicle efficiency alone can be counterproductive to this end, and may even lead to rebound effects in terms of efficiency savings[8]. Any support for passenger cars discussed against the background of the effects of the corona pandemic should therefore be based primarily on the existing promotion of electric vehicles, to provide the necessary contribution of private transport to the implementation of the CO_2 reduction targets.

(2) The sustainability of a purely technical and economic approach to energy efficiency in transport should be reconsidered. In passenger transport in particular, mobility is defined not only by the number of kilometres travelled, but also by the number of journeys made, regardless of their length.

People do not travel distances for their own sake, but to reach a destination where an activity can be carried out. In passenger transport, therefore, there is considerable potential for increasing the efficiency of the overall system and the energy used in it in the choice of transport mode, i.e. in the selection of available mobility options. With the substantial expansion of sustainable mobility options (public transport, cycling, walking), attractive alternatives can be created in the implementation of routes that provide a positive incentive to shift from motorised private transport to means of transport with low (or even no) per capita energy consumption. In the European context, it is above all necessary to expand the range of rail services in cross-border long-distance transport. The initiatives for the substitution of motorised (private) transport, which exist and are being developed at the European level, predominantly with a focus on cities,[9] should take up energy efficiency targets across transport modes as an explicit part of the CO_2 reduction targets. The necessary backing for this can be found in Chapter 2.1.5 of the European Green Deal, where it is explicitly stated: "Multimodal transport needs a strong boost. This will increase the efficiency of the transport system". Furthermore, innovation impulses can be derived from such an approach (cf. introduction of vehicles with alternative drive systems or alternative fuels in public transport). This would also counteract the rebound effects resulting from the efficiency gains. Savings in passenger car operating costs[10,11] usually contribute to keep the modal split unchanged and to increase the per capita kilometres travelled. Additional efficiency gains that can be achieved through transport avoidance are essentially subject to local and regional integrated urban and transport planning in the respective national framework. By actively supporting relevant bodies and initiatives at European level, such as the Mission Board for climate neutral and smart cities or the EU Action Plan for Cycling (European Committee of the Regions, 2017), the German government can provide important strategic impetus in this area.

[8] Cf. already 2016: Expert Commission on the Monitoring Process "Energy of the Future" (2016): Statement on the Fifth Monitoring Report of the Federal Government for the Reporting Year 2015, p. Z-3

[9] Since 2019, the EU Mission Board on Climate Neutral and Smart Cities has been in place.

[10] Efficiency gains at the level of the individual vehicle are recorded for all passenger car classes except SUVs, sports cars and off-road vehicles.

[11] Germany, for example, has for years been recording a growth in the number of passenger cars by around 500,000 per year. The increase in SUVs is particularly strong. From 2018 to 2019 alone, new registrations rose by 19.9% and, in the case of SUVs, by an additional 8.6% (together this represents around 12% of the total fleet (excluding motor homes)), while new registration figures in all other vehicle segments stagnated or rose only slightly (source: KBA https://www.kba.de/DE/Statistik/Fahrzeuge/Bestand/Segmente/segmente_node.html).

(3) In order to increase the energy efficiency of road transport, a road map at European level is needed to achieve common objectives beyond the current system of CO_2 limits for new car fleets. Within this framework, the expansion of electromobility must be further promoted, especially for passenger cars and light commercial vehicles.

Greenhouse gas emissions from road transport in Europe have been growing steadily since 1990. The reasons for this growth are the increasing number of vehicles on the road and the rising volume of both passenger and freight transport[12]. In order to reduce the consumption of fossil energy and increase the overall energy efficiency of road transport, an EU regulation stipulates that from 2021 the average limit value of 95 g CO_2/km for passenger cars and 147 g CO_2/km for light commercial vehicles up to 3.5 t will apply. Manufacturers who fail to meet the target values will have to expect substantial fines from 2021 (PA Consulting, 2020). The target value for 2030 was further tightened by the European Parliament last year compared to the original plan (GHG reduction of 37.5% compared to 2021). At the same time, there are plans by a number of EU countries to completely ban new vehicles with combustion engines (Wissenschaftlicher Dienst des Deutschen Bundestages, 2019; see Table 1).

In order to provide planning certainty for both vehicle manufacturers and consumers, the national targets should become part of an EU-wide integrated target system[13]. This also applies to the future crediting of plug-in hybrids. The current calculation basis for fuel consumption and thus CO_2 emissions for heavy vehicles is significantly higher than the values specified by the manufacturers, so that the expected contribution to reducing the CO_2 emissions of the fleet does not materialise or is even reversed (van Gijlswijk and Ligterink, 2018; Seibt et al., 2020). Currently, incentives to promote PHEV driving in E-mode are missing. Fuel cards for company cars even counteracts this. Against this background, the development of an integrated target system should be initiated and the crediting problems should be solved.

Table 1: Planned bans for passenger cars with combustion engine calculation in EU countries

Country	Date	Subject of the prohibition
Denmark	2030 / 2035	new petrol and diesel / new hybrid cars
Finland	2035	new petrol and diesel engines
France	2040	new petrol and diesel engines
Ireland	2030 /2045	new petrol, diesel and new hybrid cars / all combustion engines
Netherlands	2030	new petrol and diesel engines
Norway	2025	new gasoline and diesel and light commercial vehicles
Latvia	2040	new petrol and diesel engines
Scotland	2032	new petrol and diesel engines
Sweden	2030	new petrol and diesel engines
Slovenia	2030	New car > 50g CO_2/km
Spain	2040 / 2050	new petrol and diesel / all combustion engines
United Kingdom	2035	new petrol, diesel and new hybrid cars and trucks

Source: Own synthesis based on Wissenschaftlicher Dienst des Deutschen Bundestages (2019) and Auto-Motor-und-Sport (2020)

[12] Eurostat gives the following annual growth rates: (1) passenger transport (including intra-European air transport): 1995-2017 1.2% with 2.4% from 2016-2017; (2) freight transport 1995-2017 1.2% with 2.0% from 2016-2017 (source: Statistical Pocketbook EU Transport 2019, p. 21).

[13] In general, national targets are expected to result in a high proportion of zero-emission vehicles in new registrations by 2030, so that in some cases no reductions in CO_2 emissions from internal combustion vehicles are required to meet the CO_2 fleet limits. In this case, it cannot be excluded that the current design of the CO_2 fleet limits will not contribute to emission savings for internal combustion vehicles.

(4) The efficiency improvements of newly registered heavy goods vehicles, which are to be expected in view of the CO_2 emission standards introduced by the European Commission in 2019, should be supplemented by a toll on heavy goods vehicles that is also spread across emission classes.

In today's heavy goods vehicles, about one third of the CO_2 reduction potential can be achieved via the vehicle drive system; the remaining two thirds result from measures such as improved aerodynamics, technical aids through driver assistance, energy-optimized driving or platooning. Since the vehicles are available in a wide range of variants with functional equipment for different areas of application - such as waste collection vehicles, street cleaning vehicles, articulated trailers with different weighted loads - the measurement and comparison of vehicle-specific fuel consumption and CO_2 emissions is[14] a major challenge. Although there is software approved by the EU Commission for these measurements, its use is very costly and complex. For this reason, simpler methods of differentiation based on the procedure for the EURO standard are also being considered. An EU-wide harmonisation of incentive systems could support the increase in efficiency of vehicles and thereby not only cover new vehicles but also the existing fleet. In view of the limited possibilities for shifting freight transport to rail - expectations for Germany are that this will account for a maximum of one third of the volume - it is therefore essential to improve energy efficiency in road freight transport. An important impetus for this could come from the introduction of a toll for trucks differentiated by emission classes[15].

(5) The necessary reduction of CO_2 emissions in freight transport makes efficiency-improving transport systems that are consistently regulated throughout Europe indispensable. In long-distance road freight transport, the high capacity truck could make an important contribution to this in the coming years.

Notwithstanding the urgency to make rapid and substantial progress on measures to strengthen the competitiveness of rail freight, road will continue to play the most important role for freight in terms of transport performance. Increased efficiency in the freight transport system must therefore also address road freight transportation. An important instrument in this respect could be the high capacity truck,[16] which has been tested in Germany from 2012 to 2016 with regard to technical-infrastructural feasibility and modal shift effects and has led to the authorization of high capacity trucks on a so-called positive network. There is also a long experience in other EU member states (e.g. Sweden, Finland and the Netherlands). The expectations expressed in older studies, that cheaper road transport could increase the demand for freight transport and at the same time lead to a shift of freight from rail to road, have not yet been confirmed. The assumptions regarding considerable additional infrastructure costs have also not been confirmed. More recent studies - also within the framework of EU-funded projects (cf. https://aeroflex-project.eu/) - have come to the conclusion that developments in vehicle technology (especially to improve the general safety and manoeuvrability (through the use of dollies with an electric drive)

[14] The EU Commission has had the simulation tool VECTO (Vehicle Energy Consumption Tool) developed for the uniform calculation of CO_2 emissions from heavy commercial vehicles (EC/JRC 2014). With the help of VECTO, specific fuel consumption and CO_2 emissions can be calculated for commercial vehicles of any configuration and defined areas of application; the EU Commission Regulation 2017/2400 introduced VECTO as a calculation tool.

[15] The truck toll is a distance-related road user charge - valid on federal highways and motorways in Germany - for trucks with a total weight of 7.5 t or more in commercial freight traffic. It generates financial resources that are used in particular to maintain and expand the federal road infrastructure; at the same time, the toll provides incentives to reduce emissions by increasing the energy efficiency of vehicles (see also Federal Office for Goods Transport (BAG) https://www.bag.bund.de/DE/Navigation/Verkehrsaufgaben/Lkw-Maut/lkw-maut_node.html). It is legally embedded at European level in the Eurovignette Directive (1999/62/EC), which specifies the appropriate conditions under which road tolls may be levied in Europe (cf. also https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Al24045b).

[16] The so-called long truck has a length of up to 25.25 m. Conventional sidecars may be a maximum of 18.75 m long, conventional articulated lorries 16.50 m.

and the ever better control possibilities offered by digitalisation (especially for efficient loading, but also for controlling access to and use of infrastructure) could make the high capacity truck an instrument of a more efficient freight transport system. Against this background, it is necessary to examine which Europe-wide uniform regulations are necessary that would fundamentally enable the use of the high capacity truck as a vehicle for long-distance road haulage and at the same time provide a framework that optimally implements the potential for efficiency increases.

10 Intensify activation of private capital for Green Finance

Achieving the EU's climate and energy targets requires substantial investment in climate mitigation activities: For the period 2021 to 2030, the EU Commission anticipates an additional investment requirement of around 2.6 trillion euros.[17] The European Green Deal provides for a further tightening of the targets, which will further increase the need for investment.[18] This underlines that the investment and financial resources of the public sector can and should only provide a basis for this development. It is therefore necessary to intensify the activation of the required capital from private sector investors.

While institutional investors and listed companies are associated with a focus on short-term economic results, there are positive signs of a fundamental willingness on the part of institutional investors to invest more in the European energy transition. In December 2019, for example, the IIGCC, a group of institutional investors managing assets of more than 28 trillion euros, supported the EU target of climate neutrality by 2050 at the latest in an open letter to European governments (IIGCC, 2019). In May 2020, another group of institutional investors of roughly the same size published a global appeal to governments to make economic stimulus packages to cope with the economic consequences of the Corona crisis absolutely sustainable and geared to the goal of climate neutrality (The Investor Agenda, 2020). In addition, there is increasing evidence in the USA that the market value of capital market-oriented companies (partly) reflects their CO_2 intensity amounting to 79 up to 212 USD/t CO_2. Similar indications are also emerging for Europe. In addition, climate-neutral technologies and products will open up great potential for private sector investment and business models in the coming years. The growth of sustainable financial products is also sending positive signals. For example, emissions of green bonds and green loans rose from USD 45 billion to USD 255 billion between 2015 and 2019 (Climate Bonds Initiative, 2020). In addition, there are a large number of other sustainable financial instruments. On the financial market, however, these products still play a comparatively small role. For example, at the beginning of 2019 green bonds accounted for only 2.5% of all bond issues worldwide (Finance, 2019). This is partly due to the fact that sustainable corporate bonds have so far had only very limited sectoral coverage, as corresponding standards are available primarily for renewable energies but not yet for emission-intensive industries.

There are many reasons why investors are reluctant to invest in sustainable financial instruments (Green Finance). In order to mobilise the capital required for the transformation, the Expert Commission recommends the following measures:

(1) Implement the EU taxonomy swiftly and deal decisively with possible softening of criteria.

Major obstacles to the necessary dissemination of sustainable financial products are the lack of uniform criteria for sustainable investments (cf. also SFSG, 2018; Bioy and Stuart, 2020) and a considerable asymmetry of information between the various market players regarding the climate impacts of the projects and companies financed by these products. Although there are some standards for sustainable financial products at international level (e.g. Climate Bonds Initiative, Green Bond Principles), their application is not mandatory. The EU Commission is countering this with the draft of a uniform and binding framework ("EU taxonomy"), a taxonomy

[17] Scenario EUCO32-32.5 vs. EU Reference Scenario 2016. EUCO32-32.5 is based on the current targets 32% share of renewable energies (RES) in gross final energy consumption and an increase in energy efficiency of 32.5%. This means a reduction of greenhouse gas emissions by 45.6% compared to 1990. In the reference scenario, the share of renewables in gross final energy consumption in 2030 is 24%, energy efficiency is increased by 24% and greenhouse gas emissions are reduced by 35% compared to 1990.

[18] In addition to the climate-related measures, the EU has set itself ecological goals that require further investments of 100 to 150 billion euros per year.

regulation and a detailed expert proposal for a "sustainable finance" taxonomy. The regulation lays down disclosure obligations for financial market players and large capital market-oriented companies with regard to their activities in the field of climate and environmental protection, i.e. they must report on the extent to which their economic activities are in line with the EU taxonomy (TEG, 2020; European Commission, 2020c).[19] The report provides a detailed definition of the conditions under which economic activities are considered taxonomy compliant. This framework also serves as a basis for mandatory reporting, which should be implemented in the upcoming revision of the “non-financial reporting directive” (NFRD).

The increased transparency will reduce the considerable information asymmetries in order to ensure a more efficient allocation of capital. Financial market players receive reliable information on the "climate performance" (and especially within the framework of the further development of the taxonomy, also on other important sustainability risks), specifically from companies, which should stimulate the creation of sustainable financial products. At the same time, the additional information is intended to increase investor confidence and thus also make it easier for companies to attract additional sources of finance for sustainable investments. In addition, the disclosure requirements under the EU taxonomy increase the pressure on companies to operate more sustainably (see also Chapter 7). This can already lead to a significantly higher emission reduction of the companies concerned. Finally, the uniform EU taxonomy enables the creation and further development of certification systems (cf. Chapter 3). Specifically, an application of the taxonomy to financial products is currently being tested under the EU Ecolabel.

In the further procedure, technical screening criteria for classifying technologies and activities with regard to their contribution to environmental and climate protection objectives are to be defined by means of delegated acts. In this respect, an active role in implementation should be taken. Specifically, a revision of the NFRD in the light of the taxonomy should be advocated. In this context, especially against the background of the Corona crisis, demands for a relaxation of environmental and climate requirements within the scope of economic reconstruction should be countered.

(2) Continually extend the envisaged disclosure obligations for companies to smaller capital market-oriented and non-capital market-oriented companies.

This extends on the afore-mentioned incentives to a wider group of companies. The expansion of the disclosure requirements under the application of the taxonomy should also be accompanied by a standardisation of reporting (Sustainable Finance, 2020). This could increase transparency for financial market players even more and at the same time limit the effort required for compliance, especially for smaller companies. In view of the important role of non-listed companies (e.g. in Germany or Italy), an immediate implementation makes sense, in particular for larger non-listed companies (as defined by the NFRD).

(3) Include the obligation to take into account sustainability risks in risk management processes of financial actors.

A more comprehensive consideration of (financial) risks of climate change within risk management processes could promote the activation of private sector capital for the European energy transition. In some cases, risk management currently focuses only on compliance with environmental and sustainability requirements, with the emphasis on avoiding image risks (Hafner et al, 2020). Although the EU taxonomy can support an extension of risk management processes, it is appropriate to take up approaches - as described in "Merkblatt zum Umgang

[19] The Taxonomy Regulation provides for the introduction of measures and penalties by Member States for breaches of reporting obligations. These must be "effective, proportionate and dissuasive" (European Commission, 2020c).

mit Nachhaltigkeitsrisiken" (guidance notice on dealing with sustainability risks) of the German Federal Financial Supervisory Authority (BaFin), and expand them throughout Europe.

(4) The Member States must consistently set an example.

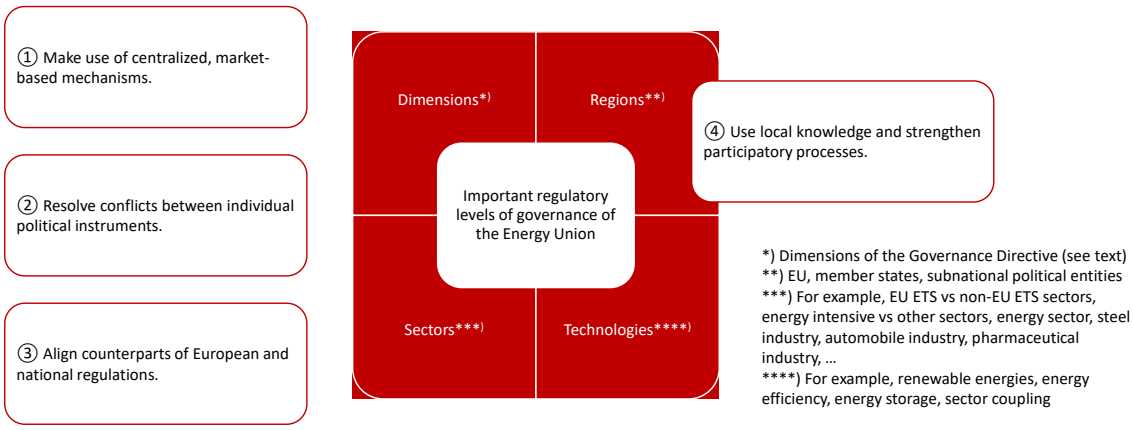
The EU states, as customers of capital and consumer goods, as financiers of projects and as financial market players, should act consistently in line with the climate policy goals they have set. This includes taking sustainability criteria into account in capital investments (e.g. pension funds) and in investment and procurement measures. The taxonomy can provide the necessary frame of reference for this.

In summary, it is therefore recommended that previous efforts to activate private sector capital should be continued and continuously expanded. Moreover, a rapid and consistent implementation of the European Green Deal can send a strong signal to the financial market and create the necessary consistent and long-term appropriate conditions.

11 Formulate governance of the Energy Union coherently

The Governance of the Energy Union and Climate Action is largely determined by the EU regulation of the same name, which was adopted at the end of 2018 as part of the broader policy package "Clean Energy for all Europeans". On this basis, complementary and coherent policies of the European Union and its member states are to be used to achieve the objectives of the Energy Union in line with the Paris Climate Change Agreement. This includes in particular the medium-term energy and climate objectives up to 2030, but also applies to the long-term objectives. To ensure that the EU Governance Regulation and other legislation in the energy and climate sector of the member states that is important for governance work well together, the Commission recommends focusing on the following four options (see Figure 9):

Figure 9: Options for a more coherent governance of the Energy Union



Source: Own representation

(1) Ensure good interaction between the different governance structures at EU, member state, regional and local levels. Implement EU-wide, market-based mechanisms to achieve easy coordination across the dimensions of the Energy Union, regions, sectors and technologies.

There is currently a great need for coordination in order to ensure that all regulatory levels are coherently designed. The Governance Directive defines five dimensions of the Energy Union: energy security, the internal energy market, energy efficiency, decarbonisation, and research, innovation and competitiveness. Depending on the regulations, these affect different regions, sectors and technologies. To ensure that the high level of coordination required does not slow down the transformation, EU-wide, market-based mechanisms are recommended, above all a uniform and comprehensive CO_2 pricing system as a guiding instrument for the energy transition that achieves climate targets cost-effectively and addresses all regulatory levels (cf. Chapter 2). For example, a standardisation of European energy taxes or an extension of the EU ETS affects all regions (EU countries) and a large proportion of emitters in the EU (especially in the heating and transport sectors), stimulates climate-neutral technologies and has effects on all dimensions of the Energy Union (e.g. more uniform design of the internal energy market, incentives for energy-efficient technologies and strengthening competitiveness through lower energy prices where appropriate). The corona crisis increases the urgency of flexible coordination: market instruments offer the advantage of being able to adapt to new situations without additional legislative procedures (or without detailed specifications in advance).

However, centralised pricing mechanisms or a general uniform CO_2 prices are not sufficient on their own. Complementary instruments are needed to address other market imperfections besides greenhouse gas emissions.

These include market imperfections in the expansion of infrastructure relevant to energy use (cf. Chapter 8) and the promotion of future technologies (cf. Chapter 5) (Löschel et al., 2017).

The National Energy and Climate Plans to be drawn up within the framework of the Governance Directive are certainly a useful instrument for achieving national and European objectives; however, they are not sufficient per se for coordination at member state level. For example, in some cases the achievement of national targets has proved to be more complex than originally expected (e.g. in the case of petrol station infrastructure). An increasing use of pricing mechanisms is needed to cope with this complexity. Moreover, especially with the planned tightening of the European reduction targets, coordination should be supplemented by additional European measures.

(2) Resolve conflicts between individual (energy and climate) policy instruments.

The creation of appropriate conditions for market-based instruments instead of many small measures is useful to avoid conflicts in achieving political goals. Hence the above proposal for a lean, market-based set of instruments with complementary instruments (only) where necessary to achieve energy and climate targets. However, if several instruments addressing the same goals exist (this may also be due to historical developments or political feasibility), inconsistencies or conflicts of objectives should be reduced as much as possible.

An example of conflicting objectives and possibilities for complementary measures will be described for the transport sector: On the one hand, fleet limit values have probably been the most effective measure for reducing emissions from transport to date. On the other hand, a general CO_2 pricing system is likely to activate more options for emission reduction in transport, reduce rebound effects and achieve cost savings in emission reduction (Paltsev et al., 2018). The introduction of complementary CO_2 pricing should therefore be taken into account in the further development of CO_2 limits, which contribute to technical progress. Another complementary policy concerns the transport infrastructure to be built (cf. Chapter 8). For in the case of long-term emission reduction strategies, it may be optimal to “pull forward” options that would be, according to CO_2 marginal avoidance costs, found at a later stage (Voigt-Schilb et al., 2018). A Europe-wide design of the support framework for renewable energies is also better suited to stimulate technological learning and economies of scale, thus complementing the CO_2 pricing in EU emissions trading. Despite the importance of complementary instruments, the non-ETS sectors in particular require much stronger market coordination than before. Nor can coordination through the National Energy and Climate Plans under the Governance Directive replace this.

It can be assumed that strong impulses for the transformation of industry will come from the very design options (1) and (2) (cf. Chapter 7).

(3) Coordinate counterparts of European and national regulations.

Although many instruments at national and European level have the same objectives and are to be regarded as counterparts in this sense, they are currently inconsistent in their design. Improved integration of national and European instruments and measures must also be achieved with respect to the other important energy transition issues, such as national emissions trading (see Bundes-Klimaschutzgesetz above) and the EU ETS expansion, the national energy tax law and the EU Energy Tax Directive (to be amended), the national coal phase-out law and the ambitions of the Green Deal (cf. Chapter 4), etc.

(4) Better integrate energy policy measures at regional level with national approaches in order to successfully implement the higher requirements of the Green Deal. Include local specificities through participatory measures.

In the EU governance system as well as in the German context (e.g. through the Bundes-Klimaschutzgesetz), subnational units such as federal states, municipalities or cities play only a subordinate role. Although this can easily be explained by the federalism principle in Germany, it must nevertheless be viewed critically, since actors in

subnational entities are essential for the effective implementation of energy transition measures. These actors have a better knowledge about local conditions and also have unique features, so that they can contribute to aspects of the industrial transformation (cf. Chapter 7). The existing coordination mechanisms between the federal levels must therefore be made more coherent and be used to promote acceptance (acatech et al., 2019; Oppermann and Renn, 2019).

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Figures

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