



Federal Ministry for the
Environment, Nature Conservation,
Building and Nuclear Safety

Climate Action Plan 2050

Principles and goals of the German
government's climate policy

2020

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2050



Summary of the Climate Action Plan 2050

Principles and goals of the German government's climate policy

- *Executive Summary* -

Origins of the Climate Action Plan

In their coalition agreement of 2013, the CDU, CSU and SPD agreed that “in the light of the European targets and the outcomes of the 2015 Climate Change Conference in Paris, in Germany we want to define an emissions reduction pathway with a final target of 80 to 95 percent lower greenhouse gas emissions compared to 1990 by 2050. We will augment this target with concrete measures, drawn up through a broad dialogue (Climate Action Plan).”

From June 2015 to March 2016, the Länder, municipalities, associations and citizens compiled joint proposals for strategic climate measures to be effective by 2030. In March 2016 they presented the resulting catalogue containing 97 proposals for measures to the Federal Environment Minister.

In drafting the Climate Action Plan 2050, the German government considered this catalogue alongside the findings of scientific reports and scenarios in the light of the Paris Agreement. The German Cabinet adopted the Climate Action Plan 2050 in November 2016.

What the Climate Action Plan 2050 represents

The Climate Action Plan provides guidance to all areas of action in the process to achieve our domestic climate targets in line with the Paris Agreement. These areas of action are energy, buildings, transport, trade and industry, agriculture and forestry.

Key elements are:

- Long-term target: based on the guiding principle of extensive greenhouse gas neutrality in Germany by the middle of the century
- Guiding principles und transformative pathways as a basis for all areas of action by 2050
- Milestones and targets as a framework for all sectors up to 2030
- Strategic measures for every area of action
- Establishment of a learning process which enables the progressive raising of ambition envisaged in the Paris Agreement

Anchoring in international climate action

The agreement adopted at the international climate summit in Paris in December 2015, which entered into force on 4 November 2016, is the first climate agreement which places obligations on all countries. Under the Paris Agreement, the international community made a binding commitment to the goal of keeping global warming well below 2 degrees Celsius above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 degrees Celsius.

The agreement gives all parties the clear task of consistently implementing the necessary climate measures. For the European Union (EU) and Germany this means resubmitting or updating their Nationally Determined Contributions (NDC) by 2020 and, as of 2025 for the post-2030 period, making their NDCs progressively more ambitious.

The EU climate and energy policy directly affects Germany's climate policy. Greenhouse gas emissions in the EU are dealt with equally by the European

Emissions Trading Scheme (ETS) and the EU Effort Sharing Decision (ESD).

The German government recognises effective emissions trading as a key climate action instrument of the EU for the energy sector and (some areas of) industry. Therefore, at EU level, Germany will advocate strengthening the ETS.

The goal: extensive greenhouse gas neutrality by 2050

In 2010, the German government decided to reduce greenhouse gas emissions by 80 to 95 percent by 2050 compared to 1990 levels. The German government reaffirms this long-term target and in pursuing it will make an appropriate contribution to implementing the commitment made in Paris, also with a view to the goal set out in the Paris Agreement of achieving global greenhouse gas neutrality in the second half of the century.

As a leading industrialised nation and the EU member state with the strongest economy, we have already geared our Climate Action Plan to the guiding principle of extensive greenhouse gas neutrality by the middle of the century. Germany's per capita greenhouse gas emissions are higher than the EU average, and considerably higher than the global average. It must also be borne in mind that the sum of the NDCs that are the backbone of the Paris Agreement is not yet enough to keep global warming below 2 degrees. Therefore, the onus is on all parties to go beyond their current targets.

Strategy for modernising the national economy

In the framework of the agreed targets, the German government is taking a technology neutral and innovation friendly approach. The government firmly believes that open competition to produce the best ideas and technologies will advance Germany further along the path towards greenhouse gas neutrality. The Climate Action Plan 2050 is a strategy for modernising our economy and provides guidance for all areas of action up to 2050 and for upcoming investments, especially for the period up to 2030. By specifying clear framework conditions, the strategy will help avoid stranded investments and structural breaks.

The Climate Action Plan introduces a paradigm shift. In future, renewable energies and energy efficiency will be the standard for investments. In this way, the Climate Action Plan 2050 creates the necessary conditions to keep Germany's economy competitive in a decarbonising world.

Guiding principles for 2050 and milestones for 2030

Based on the climate targets for 2050 the Climate Action Plan formulates guiding principles, milestones and measures for all areas of action. Like the Climate Action Programme 2020, the Climate Action Plan 2050 defines the areas of action on the basis of the source principle generally used in international greenhouse gas reporting. Under this principle emissions arising, for instance, through the use of electric household appliances are attributed to the energy sector as the "source" of the electricity and hence of the emissions. The Climate Action Plan 2050 addresses the areas of action energy, buildings, transport, industry, agriculture, land use and forestry. It also sets out overarching targets and measures.

The guiding principle presents a 2050 vision for each area of action, while milestones and measures focus on 2030. An evaluation of available climate scenarios and analyses of the transformation needed in the different areas of action helped inform these guiding principles and milestones. Under the interim target for 2030, Germany's total greenhouse gas emissions need to be reduced by at least 55 percent compared to 1990 by 2030 at the latest (reference value: 1,248 million tonnes total emissions of CO₂ [Carbon dioxide] equivalent). In the Climate Action Plan 2050 the German government has agreed for the first time on sectoral targets which set the framework up to 2030 for the proportional reduction of greenhouse gases in the areas of action considered. A comprehensive impact assessment will be carried out for these, the results of which will be discussed with the social partners, thus allowing adjustments to the sectoral targets in 2018.

Table 1: Emissions from areas of action set out in definition of the target:

Area of action	1990 (in million tonnes of CO ₂ equivalent)	2014 (in million tonnes of CO ₂ equivalent)	2030 (in million tonnes of CO ₂ equivalent)	2030 (reduction in % compared to 1990)
Energy sector	466	358	175 – 183	62 – 61 %
Buildings	209	119	70 – 72	67 – 66 %
Transport	163	160	95 – 98	42 – 40 %
Industry	283	181	140 – 143	51 – 49 %
Agriculture	88	72	58 – 61	34 – 31 %
Subtotal	1,209	890	538 – 557	56 – 54 %
Other	39	12	5	87 %
Total	1,248	902	543 – 562	56 – 55 %

Source: Climate Action Plan 2050 of the Federal Government

Selected strategic measures

Below is a description of some of the strategic measures contained in the Climate Action Plan 2050:

- The German government will set up a commission for growth, structural change and regional development. This commission will be based at the Federal Ministry for Economic Affairs and Energy and will work together with other government ministries as well as with the Länder, municipalities, trade unions and representatives of affected businesses, branches of industry and regional stakeholders. Realistic prospects for the necessary transformation process need to be established for affected businesses and regions. Strategies derived from this and concrete steps for implementation need to be agreed on and the prerequisites for financing established. To enable the commission to begin its work at the start of 2018 and present results preferably by the end of 2018, preparatory work should commence in the current legislative period. To support the structural change, the commission is to develop a mix of instruments targeting economic development, structural change, social compatibility and climate action. This will include the investments required in sectors and regions affected by the structural change and the financing of these investments.
- The Climate Action Plan contains a road map towards an almost climate-neutral building stock. A key component here is the gradual further development of energy standards for new buildings and existing stock undergoing extensive refurbishment. Another important aspect is to focus funding on heating systems based on renewable energy sources.
- A climate strategy for road transport will outline how greenhouse gas emissions can be reduced by 2030, taking into consideration the corresponding proposals made at EU level. The strategy will address emissions from cars, light and heavy commercial vehicles and issues related to GHG- (Greenhouse gas-) free energy supply, the requisite infrastructure and the interlinking of sectors (through electric mobility).
- Working together with industry, the German government will launch a research and development programme aimed at reducing greenhouse gas emissions from industrial processes and guided by the target of greenhouse gas neutrality. The option of industrial CO₂ recycling (carbon capture and

utilisation, CCU) will be taken into account in this context.

- Together with the Länder, the German government will advocate the complete implementation and stringent execution of provisions laid down for fertilisers, in particular the Fertilisers Ordinance and the planned statutory ordinance on good professional practice regarding the handling of nutrients in agricultural processes. This is to ensure that the target value of 70 kilogram of nitrogen per hectare, set out in the German National Sustainable Development Strategy, will be reached between 2028 and 2032.
- Focus in land use and forestry is on the preservation and improvement of carbon sequestration through carbon sinks in forests. To achieve this, efforts will be geared towards expanding Germany's forests. In addition, the German government will advocate that in the Joint Task for the Improvement of Agricultural Structures and Coastal Protection, the funding area "forests" should place greater emphasis on combating climate change.
- Finally, a review will be carried out on ways to gradually further develop Germany's tax system with a view to achieving the climate targets for 2050. The German government will strengthen economic incentives which encourage polluters to reduce their environmental pollution and move towards more sustainable production and consumption patterns. In order to do so, climate-damaging incentives of various taxes will also be reviewed.

A learning process

The Climate Action Plan 2050 outlines a gradual transformation in technology, industry, society and culture. This transformation will be achieved through a learning process involving the scientific community and accompanied by a public dialogue process.

The Climate Action Plan 2050 will be regularly updated in accordance with the Paris Agreement. In line with the mechanism set out in the Paris Agreement for progressively raising the ambition of national climate policies, the interim targets and milestones, the

transformative paths chosen and the measures they entail will be continuously reviewed for consistency with target achievement. If necessary, measures will be adapted to keep up with technical, societal, political, social and economic developments and changes and with the latest scientific findings.

Programmes of measures

The plan will be fleshed out with programmes of measures which will be drawn up in collaboration with the German Bundestag. The first programme will be adopted in 2018 and quantified in terms of its greenhouse gas emission reduction effects. The programmes of measures will be designed in participation with the existing Climate Action Alliance. The work will include assessing and politically evaluating economic, social and ecological impacts of suggested measures.

The status of implementation of the respective programmes of measures will be presented in the annual climate action report, first submitted in 2015, thus allowing swift policy adjustments to be made if necessary.

The German version of the German Climate Action Plan 2050 can be downloaded from:

www.bmub.bund.de/N53483/



Climate Action Plan 2050 – Cabinet resolution



The coalition agreement for the 18th legislative period includes a stipulation to produce a Climate Action Plan 2050, which would make Germany's existing climate targets for 2050 – and the interim targets agreed – more specific and align them with the outcomes of the 2015 Climate Change Conference in Paris. The Plan would also detail measures to achieve those targets.

The Climate Action Plan 2050 outlines the basic principles for implementing Germany's long-term climate action strategy, thus providing essential guidance for all actors in the economy, society and the scientific and academic community. Designed to be a process capable of incorporating new insights and developments, its basic philosophy centres on regular reviews, continuous learning and constant improvement. In this sense, it cannot and does not seek to be a detailed master plan for decades to come.

The Paris Conference set the global climate change efforts on a completely new and ambitious footing: all 196 Parties to the UN Framework Convention on Climate Change agreed on a common goal and approach to combatting climate change. We intend to keep global warming well below 2 degrees Celsius above pre-industrial levels and are aiming to limit the temperature increase to 1.5 degrees Celsius.

Back in 2010 – well before the Paris Conference – the German government decided to reduce greenhouse

gas (GHG) emissions by 80 to 95 percent compared with 1990 levels by 2050. It has reaffirmed this long-term target and in pursuing it will make an appropriate contribution to implementing the commitment made in Paris, also with a view to the goal set out in the Paris Agreement of achieving global greenhouse gas neutrality in the second half of the century.

At the G7 (Group of Seven) summit in Elmau in June 2015 we, in conjunction with the other leading industrialised nations, pledged to make our contribution to decarbonising the global economy over the course of this century. One of the ways of achieving that would be by developing and using innovative technologies. In May 2016, the G7 countries also underpinned their leading role by committing to early, transparent and robust implementation of their Nationally Determined Contributions (NDCs) under the Paris Agreement and by promoting increased ambition over time. Germany has already achieved a great deal within this process, by supporting renewable energy technologies for example. This has made it possible for quantum

technological leaps to be taken that have also made a positive contribution to international climate action. Germany will continue in the future to meet its special responsibility as an industrialised country in the field of climate action. Because of our particular responsibility as the strongest economy in the EU, one of the goals we are already aiming for with this Climate Action Plan is to be largely greenhouse gas neutral by mid-century. It is important to bear in mind here that the sum of the NDCs (national climate change pledges) that are the backbone of the Paris Agreement is not enough to keep global warming below 2 degrees. It is therefore crucial that all parties surpass their current pledges.

Germany has achieved a great deal in terms of climate action and in progressing its Energiewende without compromising industry's competitiveness. Notwithstanding the structural adjustments and "learning costs" associated with these processes of change, it has also created new economic opportunities and innovations. The German government intends to continue on its chosen path, which will include consistently implementing the objectives that are part of the Energiewende. While doing this, it will focus attention on making sure German industry remains competitive and has well-functioning, innovative and closed-loop value chains.

The Climate Action Plan 2050 does not contain any rigid targets; the goals it sets are characterised by a technology-neutral and innovation-friendly approach. It provides guidance for upcoming investments, especially for the period up to 2030. The Bundestag will put specific legislative measures in place. A successful climate policy must be systematically geared to creating future opportunities, define a clear framework, promote research and innovation, and help businesses to invest in future-proof sustainable technologies and therefore avoid stranded investments. We are seeking to instigate the changes needed without structural breaks. We need to make use of the strength and creativity of Germany's market economy, combined with the forces of competition, to ensure we achieve the existing national, European and international climate targets. German industry's strength in innovation and research has huge potential to develop new technologies. The existing climate targets need open competition to elicit the best ideas and technologies and we intend to support that.

The Climate Action Plan 2050 is both the basis and a guideline for identifying and fleshing out climate action strategies and measures in the different areas of action. How exactly they are to be fleshed out should be explored with the active participation of the business sector and civil society actors. There is no doubt that the government will assess and politically evaluate the economic, social and environmental impact of any specific measures. This will ensure that the German business sector maintains its ability to compete internationally. It will also create planning certainty for enterprises, private households and consumers and ensure that it is possible to respond flexibly to technological innovations, for example.

In the Climate Action Plan 2050, the German government has agreed on sectoral targets which describe the pathway up to 2030 for the proportional reduction of greenhouse gases. Since the sectoral targets may in some cases have a far-reaching impact on our economic and social development, they will undergo a comprehensive impact assessment, the findings of which will be discussed with all social partners and which will enable us to modify the sectoral targets in 2018.

The Climate Action Plan 2050 will be modified at regular intervals to ensure it takes societal, political, social, economic and environmental developments and changes into account. It will therefore be regularly updated, in keeping with the Paris Agreement and reflecting the learning process. The aim is to regularly check the effectiveness of the measures and modify them wherever necessary. This will be carried out transparently and through a process of dialogue with all stakeholders.

2050

1

Introduction



Tackling climate change calls for a long-term approach. The German government's climate policy is guided by the Paris Agreement, which was adopted in December by the Parties to the United Nations Framework Convention on Climate Change. The Agreement, which was ratified by Germany and the European Union on 5 October 2016 and entered into force on 4 November 2016, also serves as a benchmark for the government's climate policy. It includes the legally binding target, agreed upon by the international community, to keep global warming well below 2 degrees Celsius above pre-industrial levels and endeavour to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels. The aim is that this should prevent the worst impacts of climate change and stop the possibilities for adaptation from disappearing. This aim is based on the fact that, as the IPCC (International Panel on Climate Change) has repeatedly stressed, even at a temperature two degrees higher than preindustrial levels, local and global ecosystems will be threatened in their ability to

function and adapt, which in turn would jeopardise both biodiversity and the livelihoods of millions of people. This would seriously compromise the basis underpinning our economic activity, food security and social cohesion worldwide. Agenda 2030 and its 17 global Sustainable Development Goals (SDGs), which were adopted in September 2015, are also important for climate action.

Unless we take rapid and ambitious action, there is a danger of the global temperature rising by four degrees or more. This would cause a severe decline in the possibilities for people, societies and ecosystems to adapt to the level of climate change that we are already experiencing. The impacts of climate change and the associated increase in extreme weather events such as droughts and heavy rainfall would cause flooding in many regions of the world but also water scarcity and therefore crop failures, aggravate the situation of people at risk of poverty and hunger and severely jeopardise the global

supply of food and clean water. It would no longer be possible to meet the Sustainable Development Goals which the international community is striving to achieve. This could lead to more intense conflicts and trigger refugee movements. A development of this kind would also counteract global development cooperation efforts and result in considerable associated costs. This is illustrated in the reports by the IPCC and the World Bank. Thus, climate action is crucial to successful economic, development, foreign and security policies.

Comprehensive societal and economic changes are necessary if the climate target set out in the Paris Agreement is to be achieved. The Paris Agreement stipulated that a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases should be achieved in the second half of the century, which is tantamount to global greenhouse gas neutrality or net zero emissions.

That means that we must achieve a complete shift to an economy that does not produce greenhouse gas emissions over the course of the century. This will only be possible if all the world's economies step up their endeavours to tackle climate change. In particular – as the IPCC's scenarios show – the world's energy systems must be almost completely decarbonised by the middle of the century at the latest, such as converted in a way that means they no longer emit the principal greenhouse gas CO₂; otherwise it will not be possible to achieve the goal of greenhouse gas neutrality. There is international consensus that the industrialised countries should lead the way in reducing GHG emissions. This goal requires fast and decisive action to make sure the right course is set in time and to avoid the significant additional costs that a delayed transition would incur. Climate-related damage already increased four-fold to 100 billion US dollars a year between 1992 and 2014. In the light of this, Germany instigated the G7 Climate Risk Insurance Initiative at the G7 summit in Elmau in June 2015.

The German government sees the content of its Climate Action Plan 2050 as a way of providing guidance for the process to achieve national climate targets in compliance with the Paris Agreement – in the field of energy provision, the buildings and transport sector, in industry and business and in agriculture and forestry.

To do that, the Plan must be an integral part of a sustainability strategy that covers all three dimensions of sustainability (environmental, economic and social) and also take into account Agenda 2030's Sustainable Development Goals. Germany will only be able to develop the collective strength needed to successfully shape the change with innovation and investment on the scale needed if there is a consensus in society.

The climate targets will be on a par with economic and social development goals. By setting a longer-term framework, we will create planning and investment certainty. We will set out socially and economically responsible pathways to ensure we meet our national and European climate targets while maintaining our level of prosperity. To stimulate the technological developments needed, we intend to increase German industry's innovative strength and its investment activity. The targets the EU has set for 2020 – 20 percent reduction in greenhouse gases, 20 percent increase in energy efficiency and raising industrial production's share of investments to 20 percent – have to go hand in hand. Part of our modernisation strategy will be about basing our infrastructure on renewable resources, energy and materials, which will stimulate innovation and investment on a scale that will far outstrip the European target that 20 percent of investment should be in industrial production in the long term.

The German government's Climate Action Plan 2050 also looks at the social impact of the planned transition towards making Germany greenhouse gas neutral. The government believes that transparent monitoring of implementation of the Nationally Determined Contributions (NDCs) towards meeting the targets of COP 21 in Germany and Europe, but also in countries and regions that are of key importance for German competitiveness, is just as important as carefully analysing economic and social effects. The government's climate policy also attaches great importance to international cooperation in reducing greenhouse gases and to further developing global emissions trading.

With the German government's Climate Action Plan 2050, we are at the beginning of a process of setting a framework and outlining a transformation pathway involving all the sectors affected, their businesses, the trade unions their workforces belong to, associations

and civil society. We will refine this process in a way that is scientifically sound, has democratic legitimisation and includes broad and continual participation of the scientific and academic community. We will also continually review the existing mix of instruments and modify it where necessary. The technologically neutral approach taken by the Climate Action Plan is of great significance. New technologies – ranging from energy storage or innovative industrial processes through to carbon capture and utilisation (CCU) can help us to meet our climate targets in a cost-effective and economically acceptable way in the long term. The government therefore intends to work with the business sector to advance the fields of technology that are important to achieving a greenhouse gas-neutral economy.

It is becoming increasingly essential to think about different sectors and the interaction between them in an integrated way – an approach that is known as “sector coupling.” At the same time, focusing on climate targets clearly helps to identify scope for action and proposals for action, which should be realised in conjunction with the global Sustainable Development Goals and other goals – such as those set out in the National Policy Strategy on Bioeconomy – in order to fully harness any synergy effects.

The Climate Action Plan 2050 is not a rigid instrument; it points to the direction needed to achieve a greenhouse gas-neutral economy. In line with the Paris Agreement, it will be modified at regular intervals in response to technical, societal, political, social and economic developments and changes, and new scientific findings. This regular updating of the Climate Action Plan 2050 is part of a learning process that makes it possible to comprehensively check the effectiveness of the measures adopted and review the transformation pathways selected and modify them if necessary – also bearing in mind the mechanism to regularly raise the level of ambition in national climate policies as stipulated in the Paris Agreement.

With its Climate Action Plan 2050, the German government is underlining the fact that it takes seriously the necessity to bring about a long-term transformation of climate-relevant structures and processes in Europe and internationally. By incorporating that conviction into its domestic policies it is also playing an active part in shaping European and international processes.

Two factors are key here: structural change and modernisation are integral parts of economic activity and essential

to remaining internationally competitive. Strategic climate action, which focuses on innovation and modernisation – thus actively shaping the changes that are happening anyway – has a decisive influence on quality of life and drives prosperity and employment. The earlier this transformation is tackled and the more cost-effective it is, the lower the social burden and economic risks will be. It is therefore indisputable that instigating structural change early on will strengthen Germany’s competitive position in a world economy that is aiming for greenhouse gas neutrality before the end of the century.

The Climate Action Plan 2050 is able to build on a climate policy that is already well developed and uses a broad mix of instruments. In particular, it can build on the experience and success of Germany’s *Energie-wende* and on the comprehensive measures that began to be put in place back in December 2014 as a result of the Climate Action Programme 2020.

Building on the experience of Germany’s climate policy to date, the Climate Action Plan 2050 heralds a paradigm shift: a far-sighted climate policy can make a decisive contribution to preventing stranded investments. Thus far, technologies based on renewable energy and energy efficiency, which are of particular significance in combating climate change, were introduced into existing fossil – and to some extent nuclear – energy markets, sometimes with conditions attached, sometimes with direct or indirect subsidies. Now the logic has to be reversed: renewables and energy efficiency will in future be the standard for investment. And the following principle must be applied: first of all, energy demand must be significantly and permanently reduced in all sectors (“efficiency first”); secondly, renewable energy must be directly used in all sectors whenever it is feasible and makes economic sense to do so; and thirdly, electricity from renewable sources must be used efficiently for heat provision, the transport sector and industry (sector coupling). With the new electricity market design, the digitisation of the *Energie-wende* and the reform of the Renewable Energy Sources Act, which enters into force on 1 January 2017, we have created the electricity generation framework needed to achieve this. Research and innovation play an important role in ensuring new technologies are developed to achieve greenhouse gas neutrality. It is important that any goals set are based on a technologically neutral approach so that research funding is in line with market requirements and conducive to innovation, which in turn will ensure there is latitude for new disruptive innovations.





The Climate Action Plan 2050 implements this modernisation strategy on three levels:

1. It develops specific guiding principles for the individual areas of action for 2050, creates space for innovation and strives to maximise sustainability.
2. It outlines robust transformation pathways for all areas of action, examines critical path dependencies and describes interdependencies.
3. It underpins goals, in particular the interim GHG target for 2030, with specific milestones and strategic measures, and includes impact and cost analyses.

It links climate action – as an integral part of a national sustainability policy – with other environmental, economic and social goals without

predetermining public budgets. The measures set out in the Climate Action Plan 2050 will be funded from the individual budgets when the relevant federal budget is drawn up. It is also crucial that electricity and other forms of energy remain affordable to avoid compromising economic development and social participation. With this in mind, we have a particular responsibility when implementing the Energiewende to create a regulatory framework for our energy and climate policy which guarantees affordability and a fair distribution of costs.

The content of the Climate Action Plan 2050 is based on the goal of becoming largely greenhouse gas neutral by 2050. It involves all the relevant sectors – reflecting the intention of Agenda 2030 – thus making it possible to identify early on conflicting goals, critical interactions and path dependencies, as well as potential opportunities and risks.

Even a full and ambitious implementation of the Paris Agreement will not prevent the level of climate change which is already inevitable. It is therefore essential to make use of synergies with the existing German Strategy for Adaptation to Climate Change wherever possible. That also applies to other areas of action of a transformative environmental policy such as conservation of natural resources and increased replacement of fossil resources with sustainably produced biogenic ones.

The success of climate action depends crucially on the acceptance of necessary measures and on broad-scale public participation. The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) therefore set up a comprehensive ex ante dialogue and participation process in order to give representatives of the Länder (federal states) and local authorities, business and industry and civil society associations, and the general public the opportunity to play an active role in developing the Climate Action Plan 2050 and make suggestions for specific measures. We will continue the dialogue with the affected sectors and their businesses, the trade unions their workforces belongs to, associations and civil society on the basis of the Climate Action Plan 2050 as it now stands.

2

Climate action as a strategy to modernise our economy





Our climate action strategy is designed to provide substantial guidance for the process needed to achieve the climate targets. It is a strategy that aims to modernise our economy, and one of its main features is that it neither focuses on nor rules out any particular technology. It is a strategy that is designed to promote and develop new technologies, in the field of renewable energy, for example, and to increase energy efficiency. This is a way of conserving resources and using them more efficiently and at the same time improving the performance and competitiveness of our economy and its businesses.

Climate action is thus tantamount to increased economic performance and competitiveness. Decarbonisation means restructuring industry; it does not mean deindustrialisation. On the contrary: only if highly industrialised countries such as Germany provide living proof that meeting national climate targets does not have a negative impact on a country's economic and industrial success will other countries follow our lead.

To make sure this transition towards a largely greenhouse gas-neutral society in the next decades becomes a success story, not only for climate policy but also for economic policy, we need to take a broader view. National, European and international climate targets are at the centre of the climate action strategy. This strategy must also take economic and social concerns into account: economic concerns because ultimately only economic success will make climate action an attractive proposition worldwide, and social concerns because one of the principles of climate action on a national as well as international level is that "strong shoulders must carry more than weaker ones." Climate action will only enjoy the broad social acceptance it needs in Germany if economic success and social balance are achieved. This will make the modernisation of our economy a beacon of success. Here again, guidance can be found in Agenda 2030: its 17 goals reflect all three dimensions of sustainability equally.

But, first and foremost, the regulatory framework must be reliable in the medium and long term. The main concern here is to avoid stranded investments. We

are seeking to achieve the transition by 2050, which means we still have three and a half decades to make further adjustments to our course. Investments in fossil structures with a service life beyond 2050 are at risk of becoming what are known as stranded assets for the companies concerned, with the associated risk of job losses for their employees.

A far-sighted modernisation policy that seeks to avoid lock-in effects and subsequent destruction of capital and job losses must ensure the right steps are taken now. It would make sense for investors to take their cue from the fact that national, European and international efforts to combat climate change are also increasingly focusing on energy efficiency and renewable energy. Investments in fossil structures will become the exception and should only be made in cases where there are still no technological alternatives or those available are disproportionately expensive.

So what do efficiency and renewable energy sources as the new investment standard mean for the different sectors? Let us begin with electricity generation, which currently accounts for by far the greatest share in terms of greenhouse gas emissions. Electricity generation plays a key role because, once they have increased their energy efficiency and direct use of renewables, other sectors will only be able to decarbonise if they increase their use of electricity. In the future, we will most probably drive electric cars and also use electricity to meet our highly efficient buildings' small remaining heat demand. That is first and foremost a piece of good news for producers of electricity: the electricity market is growing despite efficiency measures. It is growing both in terms of volume but also qualitatively as a result of the Digital Revolution, which is stimulating the installation of smart applications and networks in houses and factories. That is opening up new fields of business and also new employment prospects in the electricity industry.

All of this only makes sense if the electricity is generated from renewable sources. Continued investment in these technologies is vital. On the way to an economy that is entirely based on renewable energy, we will still



need gas-fired power stations because they are highly efficient, have relatively low CO₂ emissions and are controllable, which makes them essential for our supply security. Over the coming decades, we must replace natural gas with CO₂-neutral gas from renewable sources. We must avoid any new investment in fossil energy infrastructure and the resulting lock-in effects (in line with Article 2.1(c) of the Paris Agreement).

Of all investments that are relevant for greenhouse gas emissions, buildings have the longest service life – approximately 100 years – and their integrated buildings services are also often in use for over 20 years. We should therefore define an efficiency standard for all new buildings which, in conjunction with direct use of renewable energy and electricity, would produce zero CO₂ emissions. We already have cost-efficient technologies, so that this new standard could be introduced without delay.

The challenges presented by the stock of existing buildings are incomparably greater. It consists largely of only moderately well insulated buildings that are heated for the most part by gas and oil-fired boilers. Converting these systems to run on efficient condensing boilers could vastly reduce CO₂ emissions. However, we need a timetable for the existing building stock, showing from

what point in time we should completely stop investing in fossil fuel heating systems. It is important here to take consumer interests and their economic situation into account, be they owners of existing properties or tenants. It is essential to prevent any further price hikes, which are already making housing increasingly unaffordable for people with average incomes, especially in urban areas. The German government is therefore dedicating considerable expenditure to preventing such price hikes.

The other relevant issue in the buildings sector, alongside the necessity of an efficient electricity and heat supply, is the question of construction materials and whether they are based on fossil or renewable raw materials. Even at the design stage for constructing new buildings or modernising existing buildings, basing the choice of construction materials on the primary and secondary raw materials they contain and including a life cycle analysis of buildings and materials in decision-making has a decisive impact on their effects and potential for reducing CO₂ emissions.

Alongside the buildings sector, the sector most likely to pose the greatest challenge is transport. Although rail transport is to a great extent already electrified, passenger and freight transport by road, air and waterways



is almost entirely dependent on fossil fuels. Electric mobility offers the opportunity to achieve the Energiewende in private motor traffic. But, in the long term, we need to switch to alternative CO₂-neutral fuels in aviation and maritime shipping too. To achieve this we have to create the right incentives to stimulate the development of new technologies. If we want to meet the climate targets set for 2050, we need a road map for industry and climate policy, which the government and industry can use to devise an ambitious investment strategy for the transport sector.

The proposal for taking a broader perspective put forward here, under which the Energiewende becomes a strategy for modernising our economy, is not applicable to all fields. Emissions caused by industrial or methane emissions in agriculture cannot be prevented by energy efficiency and switching to renewable energy sources. These emissions will continue unless we succeed in developing technological alternatives or finding other solutions. This is the point of departure for the bioeconomy.

In this modernisation strategy we also take a number of different competitive conditions into account in climate action. We will reduce carbon leakage, such as the displacement of greenhouse gas emissions from

Germany to other countries that have a less stringent climate policy. We will do this by granting exemptions from further reduction targets in areas where the best global standards are already being met. This also has the effect of ensuring we work towards ambitious climate action on an international level and put coordinated policies and measures in place, and also systematically gear industrial production to highly efficient technologies to an even greater extent.

To be cost-efficient and work towards the goal of a high degree of decarbonisation by mid-century, the Energiewende needs to be aligned with investment cycles. Investment in efficiency and renewable energy has to become the norm and investment in fossil structures a temporary exception with clearly defined target time frames for transitioning. With this far-sighted modernisation policy, we will prevent stranded investments and lock-in effects. In this way, Germany can embark on a sustainable growth and investment pathway.

As a consequence of the Paris Agreement, a rivalry among countries is developing over who can come up with the most intelligent and cost-efficient modernisation policy. Germany's Energiewende has given it a head start over the competition. We will have to work hard to maintain that lead.

3

International context (global and EU)



3.1 Multilateral framework

The agreement adopted at the international climate summit in Paris in December 2015, which entered into force on 4 November 2016, is a watershed for international climate action. It is the first climate agreement which places obligations on all countries. So far 195 countries have submitted their Nationally Determined Contributions (NDCs) to the United Nations. With the entry into force of the Paris Agreement and ratification by individual countries, the international community has made a binding commitment to the goal of keeping global warming well below 2 degrees Celsius above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 degrees Celsius. This goal exceeds the previous one, agreed to as a guiding principle, of maximum global warming of 2 degrees Celsius – recognising that this would considerably reduce the risks and effects of climate change. The Paris Agreement also enshrines for the first time the goal, now binding under international law, of strengthening resilience and reducing vulnerability to climate change and making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resistant development, which is also the intention of Agenda 2030.

Countries all over the world have also set themselves the goal of achieving greenhouse gas neutrality in the second half of the century, which means that only as much greenhouse gas will be emitted as can be balanced with an equivalent amount of removals. This means, according to the scenarios of the IPCC, that decarbonisation of energy systems all over the world will be necessary by midcentury. However, more is involved, because the stated goal includes all greenhouse gas emissions, even if some, such as those from agriculture, cannot be reduced to zero.

Fast, deliberate action will be required if global warming is to be kept well below 2 degrees Celsius above pre-industrial levels. The agreed efforts to limit the temperature increase to 1.5 degrees Celsius include taking the intended steps, such as decarbonisation of the global energy supply, faster than previously planned.

The Agreement gives all parties the clear task of consistently implementing the necessary climate measures. Like Agenda 2030, it breaks down the previous rigid division into industrialised countries on the one hand and developing countries and emerging economies on the other, while still emphasising the leadership role of the industrialised countries.

To regularly verify whether the countries' NDCs are adequate, the Agreement contains a five-year review and ambition mechanism. It also applies to the European Union (EU), which will mean resubmitting or updating NDCs by 2020 and, as of 2025, making NDCs in the post-2030 period progressively more ambitious. A uniform, robust transparency system for reporting emissions, progress in implementing NDCs, and climate financing are also intended to ensure that the goal of greenhouse gas neutrality can be achieved.

The Agreement offers particular support for vulnerable countries in the areas of climate action and adapting to climate change – in the form of financing, technology transfer and capacity building.

The Paris Agreement sends an important signal to society and the global economy, and therefore to all private- and public-sector stakeholders. It also reflects important demands by Germany and the EU and requires the German government to work nationally and at the EU level to ensure that it is implemented.

The Paris Agreement means that all countries must take action and are committed to doing so. A great deal has already happened worldwide: for example, in 2014 carbon dioxide emissions did not exceed the previous year's level for the first time. Increasing numbers of stakeholders in Germany's Länder, local authorities and the private sector are recognising the opportunities offered by the transformation away from fossil fuels and towards renewables and energy efficiency.

Germany is making a comprehensive contribution to financing climate-neutral development all over the world as part of its national climate policy and its cooperation in the areas of climate and development

(bilaterally and through the multilateral development banks). Mobilising private climate finance is also a central issue for the German government. Additional steps will be needed to implement the Paris Agreement's core aim of making all financial flows consistent with a pathway toward low-emission, climate-resilient development, including appropriately taking climate policy objectives into account in all investment decisions by the public and private sectors and in corresponding development plans. This is an important issue for the German government. Against that background, the government created a global partnership for the implementation of national climate action plans in 2016. The aim is to maintain or increase momentum in this area in developing countries and emerging economies and to ensure that international cooperation on National climate action plans is effective and partner-oriented.

Other aspects of the Paris Agreement have profoundly influenced Germany's commitment to international climate policies and its work on economic, development and security policies. This relates particularly to the implementation of reduction targets, adaptation to climate change, and the importance of technological development and the transfer of technology for climate change mitigation and adaptation. Germany will accordingly work to expand the Technology Mechanism of the United Nations Framework Convention on Climate Change (UNFCCC). Germany will also contribute intensively to redefining the mechanisms of the carbon market.

The German government appreciates the importance of forests for climate action and associated measures for maintaining and improving sinks and reservoirs for greenhouse gases (see Section 5.6). It emphasises the key role played by protecting, maintaining and restoring terrestrial ecosystems and by the sustainable management of forests in combating climate change and therefore stresses the importance of additional actions and the involvement of the private sector and civil society in this area. It recognises the importance of cooperative approaches, including those designed to avoid climate risks and devise insurance schemes to provide cover against those climate risks that cannot be avoided. It also supports the development of approaches for dealing with the displacement caused by climate change. Against that background, a G7 initiative for insurance against climate risk ("Insu-Resilience") has been established at the instigation



of the German government. The aim of the initiative is to increase access to insurance cover against the impacts of climate change for up to 400 million of the most vulnerable people in developing countries and emerging economies by 2020. The USD 420 million in support promised by the G7 in Paris will make it possible to insure 180 million more people against risks related to climate change, thereby reducing incentives to migrate.

Two other key steps toward more equitable and environmentally compatible global development in 2015 sent out an important message, which may have played a role in the success of the UN Climate Change Conference in Paris. The first was adoption of the Addis Ababa Action Agenda to support the financing of development and provide a global framework for sustainable development, and the other was the resolution on the 2030 Agenda for Sustainable Development in New York, in which the UN agreed on Sustainable Development Goals (SDGs) that clearly show the interdependence between different fields of action

and goals. The goals contained in SDG 13, which relate to action to combat climate change, are also reflected in the Paris Agreement and create a comprehensive multilateral framework for taking all aspects of climate change mitigation and adaptation into account. SDGs 14 and 15, on conserving oceans and protecting terrestrial ecosystems, are also of vital importance for tackling climate change. Effective climate action will not be possible unless the essential climate-regulating functions of marine and terrestrial ecosystems are maintained and enhanced.

Another important signal that impacted on multilateral negotiations was the 2014 decision by the EU Member States to progressively reduce emissions of fluorinated greenhouse gases in Europe by around 80 percent to about 35 million tonnes of CO₂ equivalent by 2030. Germany is also working to bring about corresponding multilateral action in the context of the Montreal Protocol.

Germany actively pursued a legally binding multilateral agreement at all levels in the run-up to the UN Climate Change Conference in Paris. The Sixth Petersberg Climate Dialogue and the German presidency of the G7 offered particularly good opportunities to promote Germany's vision of an ambitious, universally-valid climate agreement and to take specific initiatives to create confidence in the areas of renewable energy and climate risk insurance. International climate financing was a key factor before and during the Paris conference. German Chancellor Merkel announced at the 2015 Petersberg Climate Dialogue that Germany aims to double international climate finance by 2020 based on the 2014 level. Germany is endeavouring to get the international financial institutions (including the World Bank), to make a considerable increase in their contributions to international climate finance while ensuring projects use incentives to promote positive effects on climate action and development. At their summit in Elmau in 2015, the G7 countries agreed on the objective of decarbonising the world economy during this century, thereby making a commitment to the joint vision of a worldwide target to reduce greenhouse gas emissions to between 40 and 70 percent below 2010 levels by 2050 in accordance with the upper end of the most recent IPCC recommendations. This sends a clear signal to investors and stakeholders all over the world that there will be a paradigm shift in investments in the direction of consistent transformation of the affected sectors, particularly energy systems.

3.2 EU climate targets for 2050 and 2030

The EU has undertaken to reduce its greenhouse gas emissions by 80 to 95 percent compared with 1990 by 2050. That decision is compatible with the reductions that, according to the Intergovernmental Panel on Climate Change (IPCC), the group of industrialised countries must make if the global temperature increase is to be limited to two degrees Celsius above pre-industrial levels. This target must be reviewed in the light of the long-term global targets specified in the Paris Agreement. Like the world's other major economic regions, Europe must also raise its ambitions.

Germany acknowledges its responsibility for making an appropriate, fair contribution to reaching the European climate target. Economically strong Member States should make contributions in accordance with their abilities, within the range of the EU climate target. Where Germany is concerned, it must be remembered that, because the reference year is 1990, the decrease in greenhouse gas emissions in eastern Germany following reunification can be included in the calculation.

The long-term climate target is intended as both a driver and a benchmark for target-setting by the EU over the medium term. The European heads of state and government agreed on the targets for 2030 in October 2014. The European Council agreed to a reduction in greenhouse gas emissions within the EU of at least 40 percent by 2030 compared with 1990. The binding target for increasing the use of renewables was set at a minimum of 27 percent of final energy consumption. The target for improving energy efficiency is also at least 27 percent (compared with the business-as-usual scenario). The German government supports raising the EU energy efficiency target for 2030 to 30 percent.

The EU climate target for 2030 was forwarded to the Secretariat of the UN Framework Convention on Climate Change as an NDC for the EU and its Member States in March 2015. The climate target is deliberately stated as a minimum, leaving open the option to increase it.

The German government believes that the medium-term target must be scientifically reviewed in light



of the long-term targets in the Paris Agreement. The implications for European climate policy of the decisions made in Paris, which are enshrined in international law, must be thoroughly examined. Based on scientific analyses, the EU will take a position before 2020 as to whether its contribution for 2030 must be revised. In any event, the previous specification of “at least 40 percent” must be fulfilled.

3.3 The Climate Action Plan 2050 in the context of European climate policies

EU climate and energy policies directly affect national climate policies. Greenhouse gas emissions in the EU are covered about equally by the European Emissions Trading System (ETS) and the EU Effort Sharing Decision (ESD). There are several additional climate instruments, such as the CO₂ and Cars Regulation or the Ecodesign Directive for energy-related products. Effective protection against carbon leakage – also in order to safeguard investment in energy-intensive industries in Germany – must continue to be provided after Paris.

German industry, with its innovative technologies and system solutions – in mechanical and plant engineering, in the electronics industry as the forerunner of an efficiency revolution in the global economy, or in smart control technology and the storage technology that makes it possible to use decentralised energy supply systems based on renewables – is contributing all over the world to achieving the long-term greenhouse gas neutrality agreed on in Paris.

The German government is committed to effective emissions trading as an important EU instrument for climate action for the energy sector and some parts of industry. It advocates strengthening emissions trading. Emissions trading is an instrument available throughout the EU; it is not structurally designed to achieve targeted emissions reductions in individual countries and sectors and thus ensure national climate targets are met. Nonetheless, this instrument does offer a way to use the price of CO₂ to create centralised price incentives to reduce CO₂ emissions, thereby supporting the achievement of national climate targets. For that reason, it is very important to intensify the pricing signals sent by emissions trading. If fewer price incentives come through the ETS, it will be increasingly necessary to use national



measures to make “readjustments” so that national targets can be reached. The German government will work at the European level to make the ETS more effective.

The EU Climate and Energy Framework 2030 for reaching the reduction target of at least 40 percent must be consistently implemented in the light of the Paris conclusions. To that end, emissions trading must be further strengthened in the context of the ongoing reform at the European level and during the review process in accordance with the Paris Agreement. One important step in that regard was the introduction of the Market Stability Reserve (MSR), and it must be followed by other steps to create a pricing signal based on scarcity. It will also be necessary to ensure that the sectors in which reductions are covered by the Effort Sharing Decision – primarily transport, buildings and agriculture – are also ambitious in implementing the target for 2030. Sectors outside of emissions trading must also contribute to decarbonising the economy and make progress in modernisation.

The land use, land-use change and forestry (LULUCF) sector is being included in the EU Climate Framework for the first time. From the viewpoint of the German government, it is particularly important to establish incentives for climate action measures in the LULUCF sector and not to call into question the climate targets and level of ambition in the 2030 Framework in other sectors. It will be necessary to keep the particular role of this sector in achieving greenhouse gas neutrality firmly in mind.

In addition to emissions trading and the Effort Sharing Decision, EU targets for renewable energies and energy efficiency for 2030 are also of vital importance for climate action in Europe. Those targets must thus be achieved without fail. Further expansion of renewable energies in Europe must be supported by a robust legal foundation and pursued by the Energy Union that the EU plans to set up. The German government will advocate raising the energy efficiency target from 27 to 30 percent.

4

The path toward greenhouse gas neutrality in Germany



4.1 Transformation of the economy and society by 2050

The economy and society are subject to constant and accelerating change. No-one knows what Germany will look like in 2050. A great deal remains to be seen. Patching up long-standing structures is not a promising strategy for preparing for change and achieving the goal of making Germany greenhouse gas neutral. Proactively planning and deliberately taking

advantage of new capabilities – including technical capabilities – will make it possible for us to create a liveable future. A strategy of this kind is wiser than responding to the need for climate action later with expensive repair work and the associated destruction of capital – which would have high added economic and social costs.

The objective of bringing about a transformation into an economy and society that are largely greenhouse gas neutral by mid-century is a major challenge, but it is within reach. Time is of the essence

– and the climate system with its inherent inertia will not tolerate further delays. Moreover, decisions and investments being made in many areas of the economic infrastructure today will pave the way for development up to 2030, 2050 or even beyond. This applies in particular to the energy supply, industrial production, mobility and development in rural and urban areas and therefore to the basis of a sustainably high standard of living. That makes it even more important to keep the goal firmly in mind today and take systematic action now – as part of a learning process – to shape the technical and economic, as well as societal and cultural, transformation that is necessary to achieve this.

As a matter of principle, the German government will do its utmost to ensure the best possible coordination of all individual measures contained in draft national, European and international legislation on climate, renewable energy or other areas that will influence the energy complex.

In that regard, an evaluation of numerous studies and scenarios shows that the German climate target is technically and economically achievable, in most cases based on known technologies. At the same time, other technologies will have to be developed, which is why research and development are particularly important.

Germany has already achieved a great deal with its Energiewende. German greenhouse gas emissions are estimated to have fallen by 27.2 percent to about 908 million tonnes of CO₂ equivalent between 1990 and 2015. Five times as much electricity is being generated from renewable energy sources as it was 16 years ago, a trend that was not predicted back then. Germany can now construct buildings that consume only half as much energy as buildings did 20 years ago. And technologies for renewable energies and energy efficiency are being developed all over the world much faster than predicted in most scenarios.

New technologies and digitisation are in some cases making it possible today – across conventional sectors

– to generate greenhouse gas-neutral electricity, live comfortably, ensure mobility, and provide modern services to homes and businesses. Effective climate action simultaneously reduces emissions that pollute the air, thereby reducing the number of illnesses and early deaths and damage to ecosystems, along with the associated losses to individuals and national economies.

The guiding principle behind Germany's transition to greenhouse gas neutrality is a comprehensive modernisation strategy that sees change as an opportunity and actively shapes it. In that regard, investments will be made in greenhouse gas-neutral technologies, production processes and infrastructure to take advantage of opportunities to promote prosperity, innovation, employment and environmental protection. Current research and development activities are already making important contributions to this.

To achieve broad public support, the measures of the Climate Action Plan 2050 must include social justice, affordability and economic efficiency, participation and a vibrant democracy as fundamental criteria. This will also succeed thanks to active participation. We are counting on the enormous innovative ability of an open society and will promote this through targeted support for diverse initiatives and stakeholders. This transformation will therefore become an important societal and political project in coming decades.

The Climate Action Plan 2050 is addressing this.

It will be necessary to take advantage of the challenge of climate change by developing a comprehensive investment and modernisation programme for the German economy. Security of supply and affordable, competitive energy prices are accorded the same priority as national targets for reducing emissions.

We are no longer alone in taking this approach. Many countries have chosen the path of a climate-compatible economy. Increasing numbers of countries all over the world are recognising the need to take

action. And it is becoming increasingly clear that the competitiveness of a national economy in this century will decisively depend on its ability to decarbonise in a timely fashion without the fear of emissions, investment and jobs shifting to other countries. Development that takes place as early as possible, is politically well managed and avoids structural breaks can offer advantages on the world market to an innovative national economy like Germany's. The global market for environmental and efficiency technologies is already 2.5 trillion euros, and current estimates indicate that this will at least double by 2025. The German economy can secure a promising starting position for itself in international competition in this area. Germany can rely on the strengths of an economic model that is strongly dependent on a competitively organised market, on research and development, on innovation and on a broad and diversified basis for value creation. Consistently and efficiently orienting policies to technological, social and economic innovation will be decisive for successfully transforming Germany into a country that is greenhouse gas neutral.

One essential element in that transformation is to intelligently structure the enabling environment, for example by ensuring that legislation takes the investment cycles of businesses and the economy into account, internalising external costs, creating appropriate economic incentive structures, establishing the necessary legal basis and offering opportunities for dialogue and participation. This will also mean scrutinising and progressively improving the mix of instruments used in previous climate and energy policies as required by the transition. The German government continues to rely on the precautionary principle and simultaneously on continued development of the knowledge base by providing strategic funding for research and innovation. This is particularly the case in areas such as industrial process emissions where it is still difficult to discern where the potential for reduction can be found and ultimately also harnessed.

The IPCC has repeatedly pointed to the need for ambitious climate action. The international community recognised this in Paris and approved the corresponding measures. Now it is a matter of all Parties keeping their word. It is not possible or necessary at present – including for Germany – to specify in detail how all aspects of climate targets are to be achieved by 2050. But it is important to put milestones, consistent pathways and strategic measures in place.

4.2 Target setting and description of the pathway up to 2050

The German government's climate target is based on the EU's goal of reducing greenhouse gases by 80 to 95 percent by 2050. This will not fundamentally change. However, it is clear that, given the Paris Agreement and its goal of reducing global greenhouse gas emissions to net zero during the second half of the century, today's industrialised countries – including the EU and Germany – will have to achieve the goal of greenhouse gas neutrality early. The German climate policy is therefore oriented to the guiding principle of becoming largely greenhouse gas neutral by 2050.

The German government is orienting its first Climate Action Plan in the medium term to the target of reducing greenhouse gas emissions in Germany by at least 55 percent compared with 1990 no later than 2030. According to the First Progress Report on the Energiewende (2014) and the Fourth Monitoring Report on the Energiewende (2015), greenhouse gas emissions are to be reduced by at least 70 percent no later than 2040.

The Paris Agreement also states that all signatories will regularly review how they can increase their NDCs. The targets enshrined in the Agreement are therefore to be reviewed and raised if necessary when developing additional national climate action plans.

The interim goal of reducing greenhouse gas emissions by at least 55 percent no later than 2030 is backed by milestones in the individual areas of action in the Climate Action Plan. This provides guidance for reducing emissions and further structuring strategies for the individual areas of action and also improves the coherence of contributions by the various sectors to the necessary overall reduction.

An evaluation of the available scenarios and studies shows that the long-term potential for reductions is much greater for energy-related emissions than for non-energy emissions (which come primarily from agriculture).

To achieve the long-term overall climate target for 2050, it will be necessary to prevent most emissions in the energy sector and energy-related emissions in the building and transport sectors, as well as in industry and business.

This will require taking advantage of potential efficiencies (“efficiency first”) and directly using renewable energy sources in the various sectors to the extent this is possible and environmentally and economically feasible. The remaining energy requirement will be covered by CO₂-free renewable electricity (sector coupling). This is succeeding in the transport sector due to the introduction and increased popularity of direct electric drive technologies and – prospectively – the use of electricity-based fuel sources, including for aviation and shipping, based on a CO₂-neutral power supply. In the buildings sector, electricity from renewable energy sources (used in heat pumps, for example) is playing an increasingly important role – along with other renewable energy sources – in supplying heat. This offers additional options for making electricity demand by the buildings and transport sectors more flexible (for example by storing electricity in vehicle batteries or heat in heating plants), thereby improving the ability to use renewables in energy systems. As Germany makes further progress in implementation, there will be more interaction among the energy, transport and buildings sectors, and industry (sector coupling). The German government will actively work to influence this interaction. Generating electricity will play a key role in CO₂-neutral development of the buildings, transport, and industrial sectors.

Continuous improvements in energy efficiency and energy conservation are an integral part of the decarbonisation strategy that will make it possible to meet the additional need for renewable power generation as part of further expanding renewable generation capacities. This will also make an important contribution to an Energiewende that is resource-efficient and environmentally friendly.

The German government’s climate targets have previously included only emissions that can be directly attributed to the parties under the rules of the Kyoto Protocol. They do not include carbon dioxide emissions (or sequestration) from land use and forestry, or those emissions from international aviation and shipping which are attributable to Germany.

Accounting for emissions from land use and forestry is subject to considerable methodological difficulties. Therefore, the German government does not include this sector directly in the national climate targets. However, this sector also has the potential ability to avoid emissions and to sequester carbon dioxide in forests and soil. This sector is of long-term importance,

particularly given the objective of greenhouse gas neutrality no later than the second half of the century as specified by the Paris Agreement. The German government will therefore include the future development of this sector in its Climate Action Plan.

Emissions from international aviation and shipping are anthropogenic emissions that must be part of the effort to achieve the long-term goal of greenhouse gas neutrality as specified by the Paris Agreement. The German government supports ongoing processes taking place as part of international cooperation at ICAO (International Civil Aviation Organization) and the IMO (International Maritime Organization) and is committed to ensuring that both sectors make an ambitious contribution to achieving global greenhouse gas neutrality. Although international emissions will not be directly included in future national climate targets, the German government will keep emissions by those sectors which are attributable to Germany in mind when assessing the achievement of climate targets and take appropriate steps to reduce them within the limits of what is feasible at the national level.

Climate action is an important principle, but it is not the only long-term principle guiding the German government’s policies. When deciding how to transition to a greenhouse gas-neutral economy and society, it will be particularly necessary to take the management rules, targets, and other requirements of the government’s sustainability strategy into account. Climate action that is successful over the long term must go hand in hand with sustainable use and conservation of resources and must not threaten the preservation of biodiversity. With a view to meeting the 17 Sustainable Development Goals (SDGs) of the United Nations, the focus should be on reducing greenhouse gases by increasing energy efficiency. Social and economic requirements must be considered when structuring the transformation.

The German government’s climate policy will support economically successful development in Germany and Europe – driven, for example, by businesses stepping up their innovation activities, increased investment in climate-friendly technologies, and greater company productivity based on increasing efficiency while simultaneously reducing burdens on the environment.

4.3 Promoting climate action at all levels – Climate action as a societal project

Broad swaths of the population in Germany consider climate action and environmental protection to be essential for competitiveness, prosperity and solving global problems. The 2014 environmental awareness study confirms that there is great interest in areas such as new forms of mobility in cities, energy-efficient products, green investment, and green electricity – important parameters on the way to greenhouse gas neutrality. Broad agreement by the public is and will remain a crucial element underpinning German climate policy. The burdens of climate action measures must be balanced in a way that is fair to all sections of society. The voluntary nature of measures that change aspects of people's lives can be supplemented by targeted regulation. Many examples show that this can help advance innovation in both the public and the private sectors.

Future climate action will be successful only if it is considered and implemented at all levels and by all stakeholders. Intensive research efforts and new approaches to research and innovation will be needed in along with efforts by the public, businesses and politicians.

For Germany it is self-evident that, commitments in the area of climate action at the European and international levels must be taken seriously. The German government is also working to get other countries involved in the transition to a green economy and to set transformation processes in motion.

The German government supports international climate activities as part of bilateral and multilateral programmes and funds; funding activities in the context of development cooperation relevant to climate (Federal Ministry for Economic Cooperation and Development) and climate financing provided by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) are cohesive and complementary. Most international climate financing is provided by the Federal Ministry for Economic Cooperation and Development. German climate financing includes projects to reduce greenhouse gases, adapt to climate change, and protect forests and biodiversity, including as part of REDD+. Cooperation with the private sector and civil society is increasingly important, both in Germany

and internationally. Germany is a major partner in international development cooperation and is among the largest donors in the field of international climate action. German development cooperation work promotes reform processes in multilateral organisations in line with Agenda 2030 and the Paris Agreement. The German government plans to provide some 2.4 billion euros in international climate finance through the federal budget in 2016.

The NDC Partnership, a global partnership initiated by the German government in 2016 to support the implementation of Nationally Determined Contributions, is to play a central role in orienting climate and development financing to the targets of the Paris Agreement. Developing countries and emerging economies will receive the support they need to implement their climate commitments, paving the way to making the revised NDCs more ambitious.

In the field of development cooperation, the Federal Ministry for Economic Cooperation and Development supports measures that will allow climate action and sustainable development to be achieved together. Initiatives are currently concentrated in the areas of energy (including the energy transition in Africa through the Africa Renewable Energy Initiative, AREI), climate risk insurance, forests (African



Forest Landscape Restoration Initiative, AFR100), marine and coastal protection (ten-point action plan for marine protection and sustainable fisheries), transport (particularly funding for sustainable mobility systems in urban areas), and adaptation to climate change (NAP [National adaptation plan] Global Network). Approaches to development cooperation are also consistently oriented to the implementation of NDCs. The Federal Ministry for Economic Cooperation and Development also supports partner countries in promoting a circular economy and resource efficiency in industrial production, thereby contributing to sustainable, climate-friendly economic development.

The German government created the International Climate Initiative (IKI) in 2008 to provide additional support for cooperation with developing countries and emerging economies in the areas of climate change mitigation and biodiversity protection. As an instrument for climate financing, the IKI serves as a catalyst for both local measures and the UNFCCC process – with a funding volume totalling some 1.7 billion euros since the programme was created in 2008. The IKI's current programme planning focuses on supporting the NDCs agreed to by partner countries at the Climate Change Conference in Paris.

The German government also supports many different national climate action activities, particularly through the National Climate Initiative (NKI). The NKI includes funding programmes for target groups such as local authorities, educational institutions, companies, and consumers, as well as strategic projects to provide information, advice and support to those groups and help them build capacity. A key task of the NKI is to reinforce climate action by local authorities. The Local Authorities Guideline offers financial support for a wide range of climate action measures and has funded some 8,000 projects in 3,000 local authorities since 2008. One area of emphasis is “masterplan local authorities,” which receive special funding to enable them to reach their climate targets (funding is subject to achieving a 95 percent decrease in greenhouse gases compared with 1990 by 2050 and a 50 percent reduction in energy use compared with 1990 by 2050).

It will also be essential at the national level to include the Länder, local authorities, and associations, as well as the public, in climate action strategies and measures at an early stage (see Section 6). When updating the Sustainable Development Strategy and preparing the German report on the implementation of Agenda 2030, it became apparent that early public participation is particularly important for improving the acceptance of outcomes and leads to stronger identification with individual projects. This is also confirmed by experience with informal participation processes involving the Länder, local authorities, associations, and the public in preparing this plan. The German government will continue to develop a culture of participation in the context of climate action, thereby initiating and strengthening learning and innovation processes. It is guided in particular by the criteria of certain UN Sustainable Development Goals: achieving gender equality (SDG 5), reducing inequality (SDG 10), and effective and inclusive public institutions (governance; SDG 16).

In addition to opportunities for participation, the public needs easily accessible ways to participate, for example at the district or neighbourhood level, because this enhances understanding of and commitment to climate action. It will be important for local authorities, the Länder, businesses, and organisations – in some cases with financial support from the German government – to provide information, offer education and training programmes and strengthen ongoing efforts by giving them appropriate recognition. Going beyond this, innovative research and development projects are serving as models for increasing the awareness of all members of society and helping to change behaviour over the long term (for example the Efficiency House Plus). Those that are successful must be permanently established and expanded. At the national and international levels, the German government supports initiatives to help continue environmental and social improvements along supply chains (such as the Sustainable Cocoa Forum and the Partnership for Sustainable Textiles) and to minimise Germany's participation in practices that have detrimental effects on climate at the local level.

2050

5 | Targets and measures



Based on the climate targets for 2050 (see Section 4.2), the Climate Action Plan formulates guiding principles, milestones and measures for all areas of action. Like the Climate Action Programme 2020, the Climate Action Plan 2050 defines the areas of action on the basis of the source principle generally used in international greenhouse gas reporting. Under this principle, emissions arising, for instance, from the use of electric household appliances are attributed to the energy sector as the “source” of the electricity and hence of the emissions. Assuming that sector coupling is successfully achieved, this will have to be taken into account when measuring reductions made in the energy sector. The Climate Action Plan 2050 addresses the areas of action concerned with energy, buildings,

transport, industry, agriculture, land use and forestry. It also sets out overarching targets and measures.

The guiding principle outlines a vision for 2050 for each area of action, while milestones and measures focus on 2030.

An evaluation of available climate scenarios and analyses of the transformation needed in the different areas of action helped inform these guiding principles and milestones.

In line with the interim target for 2030 already set by the German government (First Progress Report on the Energiewende, 2014 and Fourth Monitoring Report

Table 2: Emissions from areas of action set out in definition of the target:

Area of action	1990 (in million tonnes of CO ₂ equivalent)	2014 (in million tonnes of CO ₂ equivalent)	2030 (in million tonnes of CO ₂ equivalent)	2030 (reduction in % compared with 1990)
Energy sector	466	358	175 – 183	62 – 61 %
Buildings	209	119	70 – 72	67 – 66 %
Transport	163	160	95 – 98	42 – 40 %
Industry	283	181	140 – 143	51 – 49 %
Agriculture	88	72	58 – 61	34 – 31 %
Subtotal	1,209	890	538 – 557	56 – 54 %
Other	39	12	5	87 %
Total	1,248	902	543 – 562	56 – 55 %

Source: Climate Action Plan 2050 of the Federal Government

on the Energiewende, 2015), Germany's total greenhouse gas emissions need to be reduced by at least 55 percent compared with 1990 by 2030 at the latest (reference value: 1248 million tonnes total emissions of CO₂ equivalent). The table below gives a breakdown for each area of action, showing their envisaged contributions to achieving that target. Some of the sector targets below could have a far-reaching impact on our economic and social development. A comprehensive impact assessment will therefore be carried out, the results of which will be discussed with the social partners, thus allowing adjustments to be made to the sectoral targets in 2018.

The measures developed were informed by a broad-based process of dialogue and participation, in which a range of different groups were able to feed in their proposals and familiarise themselves with the points of view of the other groups. Participants included the Länder, local authorities, associations and members of the public. Together they developed a catalogue with almost 100 proposals for measures. (compare www.bmub.bund.de/P3915-1/).

Based on the Climate Action Plan 2050, we will now continue the dialogue with the affected sectors,

businesses, employees and trade unions, underpinned by a broad scientific knowledge base. In 2018, we will analyse the results, carry out impact assessments and identify potential opportunities, risks and uncertainties to ascertain what options for action we have and where modifications are necessary. We will also work towards ensuring that the individual sectors take responsibility for meeting the reduction targets set in this Climate Action Plan by 2030.

The Climate Action Plan will be updated at regular intervals. We will also review whether technical progress and economic developments that cannot currently be foreseen and the sector coupling happening in these reduction corridors indicate that adjustments between the corridors need to be made. In this way, we are building in flexibility without jeopardising the possibility of meeting the climate targets. For that reason, we have not spelt out in detail all the measures to be taken by 2030. To that end, the Plan will be fleshed out at a later date with a detailed programme of measures (see Section 6). The regular updating process makes it possible for the German government's first Climate Action Plan 2050 to focus on taking the key steps and putting the necessary strategic measures in place.

5.1 Climate action in the energy sector

Initial situation

Climate policy and energy policy are inextricably linked. Effective climate action is inconceivable without a sustainable energy policy because the energy sector accounts for some 40 percent of Germany's greenhouse gas emissions (as at 2014). The greenhouse gas neutrality goal, which is enshrined in the Paris Agreement, underlines the necessity of gradually phasing out the combustion of fossil fuels to produce energy. The energy supply must be almost completely decarbonised by 2050 at the latest.

The Energiewende has triggered an unparalleled change in the energy sector. Within just a few years, renewable energy has ceased to be a niche technology and is now Germany's principal source of electricity. We intend to continue to drive forward this development. Renewable electricity will be the key energy source in Germany's future energy system. That means that it will also be used in the heat and transport sector to operate heat pumps and drive electric cars, for example.

The modernisation of the energy sector resulting from the Energiewende is one of our country's major investment projects. For example, in 2014, new investments worth some 19 billion euros were made in renewable energy facilities. Another eight billion euros were invested by grid operators in grid infrastructure.

Germany's Energiewende and the gradual restructuring of its energy supply towards more renewable energy and a higher level of energy efficiency has set the course for future development. Despite the associated structural adjustments and "learning costs" new economic opportunities have evolved and innovations have been developed. Renewable energy accounted for 32 percent of electricity demand in 2015, the majority coming from wind power (13.3 percent) and photovoltaics (6.5 percent). That makes renewables the most important source of electricity in Germany.

The energy sector's emissions include all emissions arising from the combustion of fossil fuels in power stations used to supply electricity and heat to the public. Therefore, emissions from the energy industry are also influenced by the electricity and heat demand of

other sectors. The degree to which the energy sector's provision of electricity and heat from renewable energy sources contributes to the decarbonisation of other sectors depends on the extent to which the switch to renewable energy sources succeeds. In this process the following principle must be applied: first of all, energy demand must be significantly and permanently reduced in all sectors ("efficiency first"), secondly renewable energy must be directly used in all sectors insofar as it is feasible and makes economic sense, and thirdly electricity from renewable sources if used for heat provision, the transport sector and industry (sector coupling) it must be used efficiently.

At 358 million tonnes of CO₂ equivalent, the energy sector's emissions in 2014 were about 23 percent below 1990 levels (466 million tonnes of CO₂ equivalent). Germany's 2015/16 Projection Report shows that, if the climate measures already agreed – including the Climate Action Programme 2020 and the National Action Plan on Energy Efficiency – were systematically implemented, emissions could fall to approximately 295 million tonnes of CO₂ equivalent by 2020 (such as by about 37 percent compared with 1990).



Guiding principle for 2050 and transformation pathway

Renewables will be the principal source of energy in the future. The energy demand of buildings, transport and industry will drop sharply as a result of increasingly efficient use of energy. The remaining demand will be met by renewables – directly in the individual sectors or indirectly in the form of renewable electricity. This will mean that the electricity sector will be increasingly “coupled” with the buildings sector, transport sector and industry. Renewable fuels (for example biomass) will increasingly be used wherever it is not feasible to use electricity, especially in aviation and shipping and some parts of industry.

Based on current knowledge, greater sector coupling will mean that electricity demand will in the long term be significantly higher than today. Even allowing for simultaneous efforts to improve energy efficiency, a perceptible rise is anticipated, especially after 2030, as a result of the increasing electrification of the transport sector and the heat supply to buildings. Current forecasts on long-term electricity demand vary greatly because they are based on widely differing assumptions, in particular with regard to the extent to which energy efficiency will rise. The German government works on the basis of an “efficiency first” principle, seeing it as the only way to adequately limit demand and ensure that the increased use of renewable energy can be carried out in a way that conserves resources and does not impact negatively on nature.

In the long term, electricity generation must be almost entirely based on renewable energy sources. By 2050, biomass will contribute to energy provision to a limited extent, largely based on obtaining energy from waste and slurry, fermentation products and residues, in local applications to provide thermal energy for industry, commerce, trade, and services and the heat sector. The biological processes involved in crop cultivation mean it is not possible to reduce emissions from the production of cultivated biomass to zero. Because the energy supply has to be almost entirely decarbonised by 2050 at the latest and because land is needed to produce food, the significance of the contribution to mitigating climate change made by bioenergy from cultivated biomass will be limited. By contrast, the use of bioenergy from residues and waste products will make an important contribution to cross-sectoral energy provision and it will be possible to fully harness its sustainable potential. Here it is important to develop efficient

strategies for using biogenic resources, with energy recovery only occurring at the end of a cascade of uses.

The transformation of the electricity supply towards a system based on renewable energy sources by 2050, while maintaining supply security, is technically feasible. The key challenge is to balance production and consumption at all times, while at the same time ensuring that electricity remains affordable for consumers. This requires efficient smart grids to connect the centres of generation and consumption and balance supply and demand. With its new Electricity Market Act, the German government has created a regulatory framework to balance generation and consumption flexibly and efficiently. This framework facilitates fair competition among the various flexibility options. On the basis of effective price signals, market players have a free choice of which flexibility option to use. This keeps the overall costs of the electricity supply low and is an incentive for innovation.

As transitional technologies low-CO₂ natural gas power stations and the most modern existing coal-fired power stations have an important function, especially combined heat and power generation that is geared to the electricity market and can be ramped up or down flexibly depending on the availability of electricity from solar or wind power at any given moment.

The impact on the regional economy of all measures resulting from the Climate Action Plan are taken into account and flanked with regional policies.

It will only be possible to meet the climate targets if coal-fired electricity production is gradually reduced. When steering this development, it is essential to take the economic outlook and jobs in the affected regions into account. Above all, it is necessary to open up tangible prospects for these regions before definite decisions about gradually pulling out of the lignite industry can be taken. To do this, we need a regional and industrial policy strategy, which proactively shapes structural change and supports businesses and their workforce in adapting to new regional structures. The German government will therefore work at European Union level to ensure that European competition law does not present an obstacle to public funding being used to encourage investment and attracts companies to former lignite mining areas. This funding will be made available through relevant regional funds. It is after all in the interest of Europe as a whole that Germany makes its disproportionately large contribution to

Europe's climate action. But this can only succeed if the affected regions and workforce acquire new employment prospects and an opportunity for economic success and social security. Otherwise the Energiewende will lose credibility – both within Germany and also on a European and international level. The German government already reached an agreement with the Länder in 2016 to allocate funding totalling 7.3 million euros in the next four years to districts in the Lausitz region as part of the Joint Task for the Improvement of the Regional Economic Structure. That means that the first regional development projects in the Lausitz can begin as early as the beginning of 2017. This funding will have to be extended and/or made available by using existing instruments.

Today, global investment in renewable electricity generation capacity is significantly higher than that in additional fossil fuel power stations. This trend will rise in the next years and will bring about further cost reductions. The signs of a turnaround in trends can currently be seen, especially with regard to coal-fired power stations, the leading source of greenhouse gas emissions in the energy sector worldwide: numerous projects on which planning began in the last ten years have now been shelved. An increasing number of investors are withdrawing their capital from the coal industry. German development cooperation is no longer providing support to build new coal-fired power stations or retrofit those that have already been mothballed. Providing finance to modernise coal-fired power stations is permitted only in exceptional cases, if stringent criteria are fulfilled and if it can be reconciled with the partner country's ambitious climate strategy. The fact that electricity is gaining importance worldwide as a means of decarbonising the transport and heating sectors is boosting investment in renewable energy. Furthermore, the potential for sustainable use of bioenergy is currently thought to be far lower than it was a few years ago, both outside and within Germany. The global increase in demand for agricultural commodities for a wide range of uses is also limiting the potential for sustainable use of bioenergy.

Since the majority of pollutants and greenhouse gases emitted by the energy sector come from the same sources, there are distinct synergies here between climate change mitigation and air quality control.

Milestones for 2030

With regard to the 2030 target, it is obvious that the energy sector has to make an appropriate contribution to the overall reduction target. Here the additional electricity demand from the buildings and transport sector, resulting from sector coupling, needs to be taken into account. In line with the interim target for 2030, the energy sector has to cut its greenhouse gas emissions to between 175 and 183 million tonnes of CO₂ equivalent by 2030. Further reductions are also needed in the period after 2030 to meet the climate target for 2050.

All future measures will have to take the structural change in the energy sector into account. They will have to be designed in such a way that the energy sector can guarantee a secure and affordable energy supply both now and in the future and provide high-quality jobs.

Wind and solar electricity's share in overall electricity production is rising significantly. Because these technologies currently hold a great deal of cost-effective potential they are being massively expanded in line with the German government's goals. They dominate and characterise the system.



Combined heat and power production, preferably based on natural gas, will continue to play an important role. It is also becoming increasingly flexible, producing lower emissions and incorporating renewable heat production, so that it will be gradually become possible to completely phase out fossil fuels in this sector too.

Businesses' investment cycles should in future take the medium and long-term climate targets into account in order to avoid stranded investments or high adaptation costs. This has consequences for investment decisions. Conversely, it is important for investment decisions that regulatory decisions relating to the implementation of climate targets remain predictable and that they do not intervene at short intervals in businesses' investment cycles. The reduction in coal-fired electricity production should be organised in such a way that structural breaks in the affected regions, especially the lignite mining areas in North Rhine-Westphalia, the Lausitz and the Central German Coalfield, are avoided and new prospects for industry in these regions are developed. To achieve that, we need a dialogue with the actors involved from the business sector, the regions and the trade unions.

The EU Emissions Trading System remains the key European climate instrument and ensures that European climate targets are met. Many EU member states, including Germany, use a broad portfolio of different climate policy measures to achieve higher national climate targets. For example, funding for renewable energy, the Combined Heat and Power Act, the plans to transfer a certain capacity of lignite-fired power stations into a reserve before being phased out completely four years later (decommissioning/standby), or measures to improve energy efficiency have an impact on the energy sector's emissions. National climate change mitigation measures in this sector need to take the effect on European climate policy into account.

Electricity will continue to be a "precious resource" because the increased use of renewable energy necessitates land and public support and is to some extent at odds with nature and landscape conservation concerns. This is why the German government prioritises energy efficiency, which makes a major contribution to ensuring that the country's Energiewende can take place in a resource-efficient and nature-friendly way. This includes ensuring that gross electricity consumption falls below today's level by 2030.



The energy supply of the future will be digital. Digitisation applies to all stages of the energy value chain. New efficiency potential is being identified as increasingly large volumes of data are analysed. Modern technologies can be used to create smart connections between electricity grids and electricity generation and consumers, for example. This may reduce the need for new grids.

With its Act on the Digitisation of the Energy Transition, the German government has laid the foundation for the infrastructure of the future. Smart grids and smart metering systems are the future. Data protection and data security, along with reliable standards, are crucial elements in successfully digitising the Energiewende. The high standards of the Digitisation Act takes this into account.

In terms of conserving energy and resources, digitisation will also harness great potential. This is particularly true of smart buildings, opportunities for optimising transport, and smart production systems.

The Energiewende will only succeed if we significantly and permanently continue to increase energy efficiency. With the National Action Plan on Energy Efficiency (NAPE), in December 2014 the German government presented a comprehensive raft of measures to increase energy efficiency and has now implemented all the key measures.

Energy efficiency is a cross-cutting issue that plays an important role in every area of action; for that reason specific measures are detailed in the corresponding sections.

Measures

The key national measures for the energy industry adopted by the German government are the increased use of renewable energy and combined heat and power generation, and the provisions under the Electricity Market Act on decommissioning/standby for lignite-fired power plants. The Emissions Trading System remains the key instrument at European level.

These instruments are supported by all the measures on the demand side that limit electricity, heat and cooling demand from power stations in the public supply system by increasing energy efficiency. That



includes implementation of the Climate Action Programme 2020 and the National Action Plan on Energy Efficiency (NAPE).

■ Green Paper on Energy Efficiency – a milestone for an ambitious efficiency strategy

With its Green Paper on Energy Efficiency, the Federal Ministry for Economic Affairs and Energy (BMWi) initiated a broad-based consultation process (www.bmwi.de/Redaktion/EN/Dossier/energy-efficiency.html). The process will culminate in a medium to long-term strategy for efficient energy use in Germany aimed at reducing consumption.

At the heart of the consultation is the question of how the principle of prioritising avoidance and reduction of energy consumption can be enshrined in the planning and steering processes of energy policy and the energy market. It also explores questions such as what set of instruments is needed and to what extent digitisation and sector coupling impact on the development of energy efficiency.

Based on the consultation process, conclusions and recommendations for action will be compiled in a White Paper on Energy Efficiency. These recommendations for action will subsequently be updated at regular intervals to reflect the progress made in implementing them.

■ Increasing the use of renewable energy

The increased use of renewable energy will continue to play a key role in the years to come. Any measures taken will be mindful of the goals of nature conservation. The 2017 Renewable Energy Sources Act reaffirmed Germany's ambitious goals in this area.

Achieving these goals will require further effort. In particular, further progress on developing the grid is needed for the integration of renewable energy into the electricity supply system.

With its 2017 Renewable Energy Sources Act, the German government has introduced a paradigm shift. The level of payments which producers of renewable electricity receive will in future no longer be stipulated by the government. Instead it will be ascertained on the basis of a tendering process. This competitive approach will make it possible to continue along the renewables pathway while keeping costs as low as possible and controlling the level of expansion.

Local community energy projects contribute a great deal to public understanding and support for the Energiewende and the expansion of renewable energy use. For that reason, it is crucial to maintain the diversity of actors involved.

On the basis of reports on experience and monitoring reports, the German government will ensure that the medium and long-term climate targets are met.

■ Electricity 2030 – a milestone on the path towards an energy system fit for the future

The next years will see the course for 2050 being set in the energy sector. Buildings, power stations and industrial installations are often in use for over 40 years. Investments made in the 2020s and 2030s will therefore influence the energy system in 2050.

The Federal Ministry for Economic Affairs and Energy (BMWi) has launched a comprehensive consultation process entitled Electricity 2030. The idea is to ascertain the tasks to be tackled on the basis of twelve trends that have been identified. The aim is to ensure that the transition to an overall system in which renewable electricity is the major source of energy is cost-efficient both for the national economy and for individual businesses.

The basis of the consultation is the Energiewende "triad" consisting of energy efficiency, directly used renewable energy and efficient use of renewable electricity for the heating and transport sector, and industry.

The consultation process addresses the decisive issues that arise on the path towards the energy system of the future. They include, for example, the integration of electricity generated by wind and solar power, the declining importance of fossil fuels and how to organise sector coupling.

The consultation process serves to take note of where there is consensus among the actors involved and, in cases where positions diverge, to record the entire spectrum of opinion.

■ Advancing sector coupling

The strategy on decarbonising the electricity sector depends on energy efficiency and increasing the use of renewable energy. But also the heat and cooling sector and the transport sector (drive systems) will only be able to make the emission reductions required by 2050 if renewable electricity (for example heat pumps, electric vehicles) is used – after efficiency potential has been harnessed and direct sources of renewable energy exhausted (for example heat from solar thermal or geothermal sources) is met in the future. Sector coupling can also bring greater flexibility into the electricity market, if consumers in the heat and transport sector adjust their demand by many gigawatts very quickly. Fluctuating electricity provided by wind or solar power can be balanced in this way.

In order to achieve extensive decarbonisation in these sectors by 2050, efficient technologies must be used which maximise the replacement of fossil fuels while using as little renewable electricity as possible. One of the key factors here is to improve the competitive conditions for renewable electricity in the heat and transport sector. Thus far, fossil fuels for transport and heat have been less expensive for consumers than electricity, because through surcharges, taxes and levies, electricity makes a greater contribution to financing the Energiewende. Key questions of developing sector coupling are being discussed in the consultation processes for the Green Paper on Energy Efficiency and Electricity 2030.

■ Transformation of the financing system and contributions to revenue

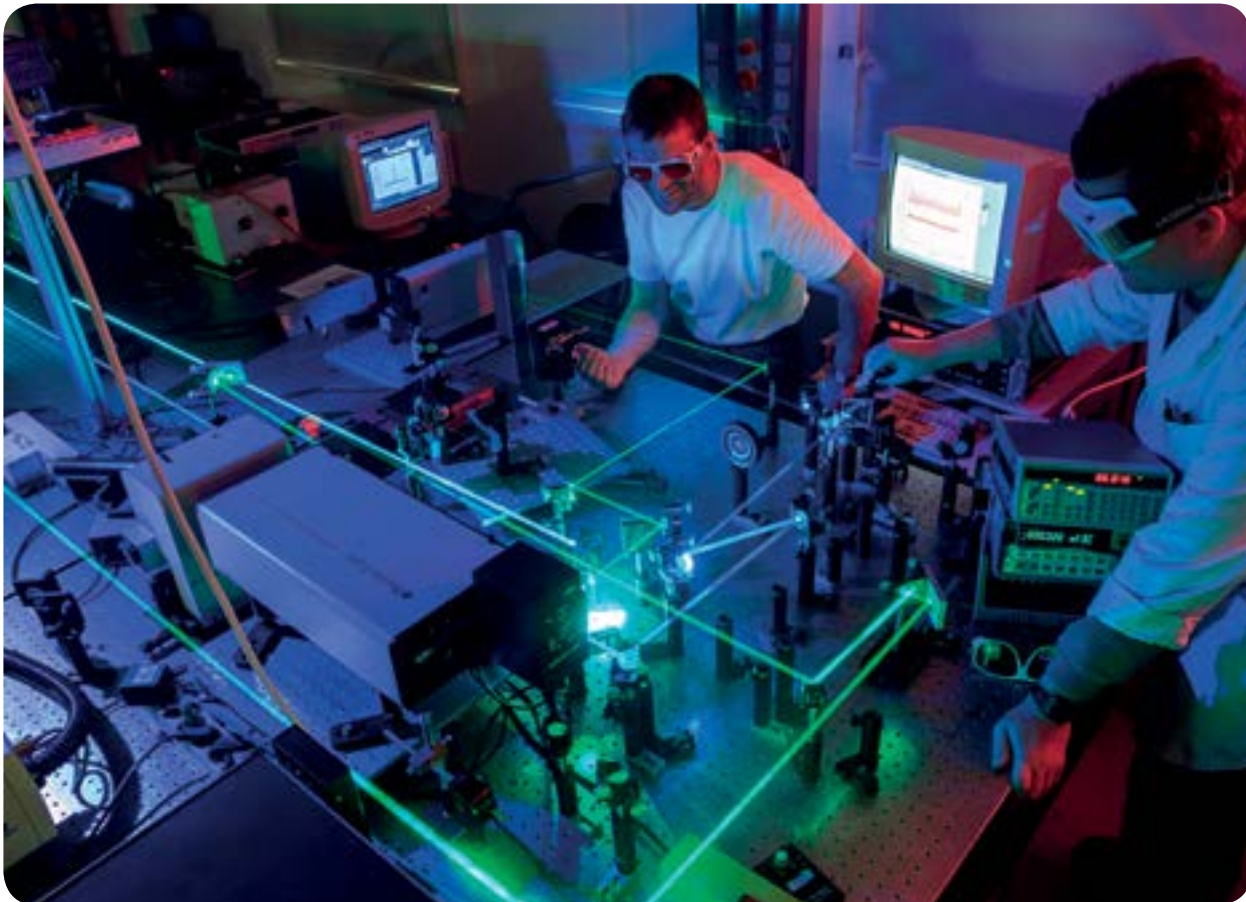
The future model for financing an energy supply based on renewables, including the necessary infrastructure, needs to ensure that all energy-consuming sectors make an appropriate contribution to financing it. This will create more sustainable revenue potential for renewable electricity generation, improve the competitive conditions for renewable electricity and facilitate a market-driven breakthrough renewable electricity into other sectors (sector coupling). The more closely the electricity, heat and mobility sectors grow together, the more important it will become to achieve a pricing policy which embraces the different types of energy (for example natural gas, heating oil, vehicle fuels, electricity) in their different applications (conversion/storage, transport or direct consumption) that is consistent with mitigating climate change. The German government intends to review the incentive and steering effect of the current components of energy prices in the form of levies, surcharges and taxes imposed by the state.

■ Research and development

Funding research and development is of key importance to the success of the Energiewende. Building on and expanding existing funding programmes and initiatives, a greater proportion of research funds must be allocated to areas such as renewable energy technologies, grids, storage systems, technologies needed for sector coupling (including power-to-gas and power-to-liquid) and technologies and measures to increase energy efficiency. There is a considerable need for research, especially of a systemic kind. Our work will also focus on applying research outcomes in practice.

■ Commission for growth, structural change and regional development

The transformation process must be based on a policy aiming for stable growth, sustainable structural change and future-oriented regional development. For that reason, realistic prospects for the branches and regions affected by this transformation process



must be developed, the resulting implementation strategies must be agreed and the necessary financial conditions created. The German government is therefore appointing a commission for growth, structural change and regional development. The commission will be set up at the Federal Ministry for Economic Affairs and Energy and will involve other government departments, along with the Länder, local authorities, trade unions, representatives of affected businesses and sectors and regional actors. Preparatory work is scheduled to begin in the current legislative period to enable the commission to begin its work at the start of 2018 and present results preferably by the end of 2018. To support the structural change, the commission will develop a mix of instruments targeting economic development, structural change, social compatibility and climate action. This will include the investments required in branches and regions affected by the structural change and the financing of these investments.

■ Strengthening the Emissions Trading System (ETS)

The Emissions Trading System is an EU-wide instrument; it is not structurally designed to achieve targeted emissions reductions in individual countries and sectors and thus ensure national climate targets are met. Nonetheless, this instrument does offer a way to use the price of CO₂ to create centralised price incentives to reduce CO₂ emissions, thereby supporting the achievement of national climate targets. For that reason, it is very important to intensify the pricing signals sent by emissions trading. The German government will work at European level to make the ETS more effective.

The idea behind strengthening emissions trading at European level is to ensure there are adequate incentives for decarbonising the energy supply and creating planning certainty for investment decisions.

For Germany to remain an attractive location for businesses, it is crucially important that the 10 percent most greenhouse gas-efficient installations in the sectors liable to carbon leakage receive 100 percent of the benchmark-based free allocation of emission allowances. Furthermore, a correction factor must be ruled out and higher requirements resulting from production growth must be compensated for.

For this purpose, the industry cap will be raised to 45 percent of the total volume of emission allowances within the ETS (plus the 2.6 percent for the innovation fund). The industry cap will be adjusted if that is necessary to prevent a correction factor. Basically, the benchmark is set on the basis of real data and actual emissions from the ten percent most greenhouse gas-efficient installations. There is no across-the-board reduction as suggested in the EU Commission's proposal.

We support the EU Commission's proposal to endow the New Entrants Reserve (NER) with 400 million emission allowances. Furthermore, we believe that no further emission allowances should be withdrawn from the MSR. We support proposals that the New Entrants Reserve (NER) emission allowances should be taken not from the MSR, but from the budget for the 4th trading period, on the condition that the industry cap is correspondingly increased by an equivalent number of allowances.

We support the idea of distributing emission allowances on the basis of certain criteria. This aims at creating a fair balance between safeguarding competitiveness and ruling out windfall effects. We are seeking to prevent arbitrariness resulting from statistical reporting on gross value added.

The carbon leakage list should be reviewed every five years to take into account changes in the competition situation.

We also support the European Commission's plans to continue to allow energy-intensive industries to be compensated, to open the innovation fund to industrial projects and make the allocation of emission allowances more closely dependent on actual production. Furthermore, we advocate a revision clause to take account of the Paris Agreement.

Furthermore, a regular review process that follows the stipulations set out in the Paris Agreement is needed. The German government advocates reviewing the success of the already adopted Market Stability Reserve (MSR) and ensuring it has the best possible impact. This includes its impact on the competitiveness of industries covered by the Emissions Trading System. Coordinated national measures by Member States to help strengthen the incentive effect of the Emissions Trading System should also be considered.



5.2 Climate action in the buildings sector

Initial situation

Germany's towns and cities already offer a high quality of life. In light of the climate targets that have been set for 2050, it is also likely that all these towns, cities, villages, neighbourhoods and buildings will steadily change. This is because, taking all direct and indirect emissions into account, buildings are currently responsible for up to 30 percent of Germany's greenhouse gas emissions (direct emissions only: 13 percent). The German government's Energy Concept calls for a virtually climate-neutral building stock by 2050. The aim of the Climate-Friendly Building and Housing Strategy set out in the government's Climate Action Programme 2020 is to achieve virtually climate-neutral towns and cities by 2050 and to further improve the quality of life in the process. The UN's Sustainable Development Goal to "make cities and human settlements inclusive, safe, resilient and sustainable" (SDG 11) provides sound guidance here.

To this end, the government's Climate-Friendly Building and Housing Strategy takes into account the findings of the Strategy on Energy Efficiency in Buildings and the Alliance for Affordable Housing and Building.

The Strategy on Energy Efficiency in Buildings, which has already been adopted, illustrates how the goal of achieving a virtually climate-neutral building stock by 2050 can be achieved through a combination of energy efficiency and renewable energy. The key goal of the Alliance for Affordable Housing and Building is to retain and build affordable housing, in particular for families with children and people in the low to medium income bracket. Given the key importance of both affordable housing and climate change mitigation, the impact of the rising costs of providing housing must be considered with great sensitivity.

The solutions needed here have to be reconciled with the social and economic circumstances and the current challenges in such a way that the necessary investments are made without disproportionately increasing the cost of housing.

In addition to the affordability of housing for tenants, the economic situation of owner occupiers and small private landlords, who own about two thirds of all rental housing, must be taken into consideration. The majority are already of pensionable age and that trend is rising.

The Climate-Friendly Building and Housing Strategy addresses primarily those emissions caused directly by the operation of residential and non-residential buildings (space heating, cooling and hot water). In greenhouse gas



reporting, these emissions are predominantly allocated to the household and industry, commerce, trade and services sectors. In addition to these direct emissions, a significant volume of emissions are produced in upstream and downstream sectors such as the energy sector, as a result of district heating being supplied to buildings and electricity for heat pumps, ventilation, operating cooling and air conditioning systems and lighting in buildings. However, these emissions are not discussed here but in the section on the energy sector. The Climate Action Plan addresses the totality of heat, cooling and electricity consumption needed to operate both residential and non-residential buildings.

If we look at the historical development in the two sectors relevant for direct emissions from buildings, it can be seen that the household sector, where there was a reduction from 131 million tonnes of CO₂ equivalent in 1990 to 85 million tonnes in 2014, and the industry, commerce, trade and services sector, where emissions fell from 78 million tonnes to 34 million tonnes of CO₂ equivalent, have already witnessed a significant reduction in direct emissions (not adjusted for weather conditions). This means that overall the buildings sector accounted for 119 million tonnes of CO₂ equivalent in direct emissions in 2014.

The German Projection Report for 2015/16 indicates that, given extremely ambitious implementation of the

climate measures decided to date – including those detailed in the Climate Action Programme 2020 and the National Action Plan on Energy Efficiency – emissions could fall to approximately 100 million tonnes of CO₂ equivalent (such as about 52 percent of 1990 levels) by 2020.

Guiding principle for 2050 and transformation pathway

In 2050 towns and cities will be attractive places to live, offering a high quality of life for people of all ages and income groups – with comfortable and age-appropriate housing, adequate green space, attractive social meeting places and everything within easy reach. Modern technologies, use of sustainable building materials and intelligent spatial and urban planning can help to create places of this kind, while at the same time drastically reducing the output of greenhouse gases. The German government's goal here is to create a liveable, affordable and virtually climate-neutral building stock. The latter refers to buildings with a very low energy demand which is met by renewables, and which avoid direct greenhouse gas emissions. The German government's Energy Concept aims to lower the primary energy demand in the buildings sector by at least 80 percent compared with 2008 levels by 2050 through a combination of increasing efficiency and using renewable energy. This will be based on three components of the energy policy set out for guidance in the Green Paper on Energy Efficiency: efficiency first, direct use of renewable energy and sector coupling.

Greenhouse gas reduction involves working towards creating compact, energy-saving settlement structures. Spatial planning will make an important contribution to achieving this and avoiding rebound effects caused by long distances between home and the place of work.

If Germany is to achieve its goal of making its building stock virtually climate-neutral by 2050, it is crucial that the available potential for avoiding emissions be fully exploited over the next years and decades and that stranded investments are avoided. Compared with many other types of investment, buildings have a long service life of many decades and their fixed building services, which are energy and climate-related investments, also have long service lives of over 20 years. It is therefore exceptionally important to construct new buildings in a way that means they no longer have to rely on fossil fuels

in the future, ensuring that switching to renewable energy sources is as simple, economical, and cost effective as possible. It is important that federal government funding programmes also create incentives to invest in energy efficiency and renewable energy in buildings. Climate action in the buildings sector primarily involves the necessity of a long-term, reliable and extensive investment and modernisation programme, accompanied by research and development funding to close technology gaps.

It is important to take into account that individual ownership is a key feature of the ownership structure of residential buildings in Germany and that these private individuals are to be targeted with incentives. It is crucial that the mix of small private landlords, housing companies, groups of owners of different types, and housing cooperatives is preserved and that social housing is not neglected. Modernisation activities by private owners are usually dependent on their level of wealth, stage of life, and the use of the property. Numerous private owners of houses and flats are already of pensionable age and that trend is rising.

The Strategy on Energy Efficiency in Buildings, which the German Government adopted in 2015 as part of the country's *Energiewende*, focuses on all types of energy consumption relevant to buildings with the aim of achieving a virtually climate-neutral building stock by 2050. The Climate-Friendly Building and Housing Strategy also integrates urban design, social and spatial planning aspects that are just as important as energy issues for housing in the future. Climate action in the buildings sector therefore has to target emissions produced by operating a building on the one hand, while being careful to bear in mind the time before the building's service life begins and after it ends.

The Strategy on Energy Efficiency in Buildings sets out a robust pathway towards achieving a virtually climate-neutral building stock, which relies on a combination of two major policy components: energy efficiency and use of renewable energy. It focuses on primary energy demand and outlines two pathways as margins to work within: an efficiency pathway and a renewable energy pathway. The result is that in 2050 the entire residential building stock will need on average only just less than 40 kilowatt hours per square metre per year (kWh/m²a). For non-residential buildings this average target value, which is based on primary energy demand, is approximately 52 kWh/m²a. These values should be seen as targets and are averages for the entire building stock.

The Strategy on Energy Efficiency in Buildings also highlights the fact that different types of buildings have to be rated very differently. For example, the energy profiles for heating, cooling, ventilation, lighting and hot water demand in residential buildings differs significantly from that of non-residential buildings. The differences also apply to what type of energy is used for what purpose: whereas energy in residential buildings is used primarily for heating, electricity consumption is often the predominant feature of energy profiles in non-residential buildings. For that reason, the values cited above should be seen as averages and should be broken down by type of building so that specific efficiency and renewable energy measures can be developed.

The Strategy on Energy Efficiency in Buildings also shows that for the period from 2030 onwards, the longevity of structural components, building materials and technical systems will be crucial in deciding what constellation of efficiency and use of different renewable energy sources is needed to achieve a virtually climate-neutral building stock by 2050 and avoid lock-in effects. Further progress on a significant scale will also be needed on both levels – efficiency and the use of renewable energy. Solid, liquid or gaseous biomass can only be sustainably used to a limited extent because interactions within the overall system must be taken into account (see Sections 5.5 and 5.6). When using solid bioenergy fuels, care must be taken to ensure that they are from legal and sustainable sources. If wood is used as a source of energy it is vital to ensure that it comes from legal and sustainable



forestry operations and the carbon sink function of forests should also be borne in mind. Solid bioenergy fuels will also play a significant role in decarbonising the heat sector in future, especially in older buildings that are difficult to retrofit.

Furthermore, climate action requires not only energy-efficient, low-emission ways of using the building but also building designs that conserve resources and use sustainable building materials that likewise conserve resources as far as possible. Finally, greenhouse gases are emitted when these materials are manufactured, used and removed during demolition and part of the goal must be to prevent those emissions too. Construction products should be labelled with information about their impact on the environment, resource use and health; building designs need to be optimised, flexibility and service life increased and high-quality recycling facilitated. This will make it possible to build in a more resource and energy-efficient way. At the same time, the affordability of buildings, in particular housing, must not be ignored.

The key elements in achieving a virtually climate-neutral building stock are energy efficiency and the integration of renewable energy into individual buildings. However, concentrating on energy optimisation in individual buildings is not enough. The use of highly efficient heating networks, especially those of the 4th generation (low-temperature district heating networks), based to a high degree on renewables, will also play an important role. Furthermore, the trend towards increasing networking, particularly using information and communications technology, is making inroads into buildings too. That will make it increasingly necessary to take an integrated view which goes beyond individual buildings and takes into account interactions with the energy and transport sectors. That kind of integrative concept makes it possible to tackle emissions from the energy supply system and direct emissions of fluorinated greenhouse gases (for example heating networks that use natural cooling agents). Synergies with other sectors – such as smart systems linking fixed building services with electric mobility, as demonstrated by a project on an Efficiency House Plus with electric mobility – can be better exploited. In the German government's view, climate-friendly smart city and smart community concepts which, in the light of growing urbanisation, are increasingly becoming a focus of attention especially in the international context, should be supported and funded. Current population trends in Germany also need to be taken into account when developing concepts of this kind.

Sustainable green urban development must include providing environmentally friendly transport options that are (easily) accessible and within walking distance. Towns and cities and their surrounding regions must be more closely linked by green corridors that also act as fresh air corridors. Greening buildings (roofs and facades) and keeping the amount of land sealed over as low as possible mitigates the negative impacts of climate change.

In all the transformation pathways towards a virtually climate-neutral building stock described here it is vital that the instruments used are flexible and not limited to any one technology. They must be open to all so that anticipated technological developments can be taken into account. Important factors such as income trends, affordable rents, the population's age structure and migration movements must also be considered in measures put in place for buildings.

Milestones for 2030

2030 marks an important stage on the way to achieving a virtually climate-neutral building stock; the longevity of buildings means that it is particularly crucial in this area of action to ensure that the foundation for meeting the target of a virtually climate-neutral building stock by 2050 is firmly in place by 2030. To meet the interim target for 2030, greenhouse gas emissions in the buildings sector have to be reduced by 70 to 72 million tonnes of CO₂ equivalent.

To achieve a virtually climate-neutral building stock in the long term, it is vital that significantly more is invested in optimising today's building stock and that this happens quickly. By 2030 at the latest, the regulatory framework must be such that any work to improve the energy performance of existing buildings meets the virtually climate-neutral benchmark.

For new buildings completed up to 2030 this means that the energy performance standard for residential and non-residential buildings must be gradually but significantly improved from today's level. The requirement for economic efficiency is not questioned here. The German government is therefore putting considerable funds into monitoring implementation of the standard. Prime examples include the CO₂ Building Rehabilitation Programme, the Market Incentive Programme Promoting Renewable Energies, information services and competence centres.

At the same time as significantly increasing energy efficiency, renewable energy's share in final energy



consumption in buildings in 2030 must be gradually increased in order to meet the target of achieving a virtually climate-neutral building stock by 2050. Further milestones must be defined on the basis of the results achieved by 2020 and the measures needed to enable targets to be met must be put in place.

This must also be accompanied by a significant reduction in direct combustion of fossil fuels to provide space heating and hot water. In a transitional phase, highly efficient condensing boilers that use fossil fuels only can make an important contribution to increasing efficiency, providing energy and cutting emissions. To avoid lock-in effects, the funding conditions will be designed to make heating systems that use renewable energy a far more attractive option than those that use fossil fuels.

Systems that use renewable energy sources directly and also those that use them indirectly, such as power-to-gas (sustainable combustion gases that are fed into the gas grid, for example) or power-to-liquid, are another option that can help achieve the target set.

One of the primary tasks that still remains to be tackled is to improve the inadequate data situation

with regard to use, characteristics and energy demand of non-residential buildings. This was already addressed by the German government's Climate Action Programme 2020. On this basis, and taking into account the highly diverse uses of non-residential buildings, the government will continue developing the energy requirements that non-residential buildings have to meet in order to achieve the 2050 target. Things such as providing air conditioning for buildings that does not use fluorinated greenhouse gases is of key importance here.

The energy used to manufacture and recycle buildings must in future be minimised as far as possible, taking aspects of resource recovery into account. Environmental, economic and health impacts must also be taken into consideration.

Measures

Achieving the goal of making Germany's building stock virtually climate-neutral by 2050 relies on putting in a place an intelligent and balanced mix of instruments over the next years and decades, including research and innovation, providing information advice, and support and creating the regulatory framework needed to drive forward the introduction of sustainable buildings, focusing equally on existing and new buildings. There is already a broad range of regulatory provisions, funding programmes such as the CO₂ Building Rehabilitation Programme, the Market Incentive Programme Promoting Renewable Energies and many other existing or planned measures to provide funding for climate-friendly buildings. The economic feasibility of the measures and the need to ensure building and housing remain affordable must be taken into account. To ensure the costs arising from buildings having to comply with climate regulations do not prevent owners from refurbishing them, a programme of government incentives should be continued.

When developing and refining this mix of instruments, it is crucial to find the right balance between an appropriate market-based framework, funding programmes, regulatory law and information activities. A balance between measures to increase energy efficiency and others to promote the use of renewable energy is important here. It is crucial to prevent lock-in effects and also to take social aspects into account adequately. Training and continual professional

development are a key factor in meeting the climate targets for buildings (see Section 5.7).

■ Roadmap for achieving a virtually climate-neutral building stock

Achieving the goal of a virtually climate-neutral building stock by 2050 depends on ambitious standards for new buildings, long-term strategies for refurbishing the building stock and a gradual phase out of fossil-fuel heating systems.

- The zero-energy building standard for new buildings, which will apply from 2021, will therefore be progressively developed until in the medium term a virtually climate-neutral standard is reached. That means that by 2030 at the latest the energy standard for buildings must be gradually changed until the maximum energy demand specified is significantly lower than that required by today's Efficiency House 55 standard.

This will make installing new heating systems that use renewable energy sources efficiently a far more attractive option than those that run on fossil fuels.

- To support this goal, appropriate incentives for using and constructing buildings that generate more energy than they need to run on should be reviewed. To this end, technology-neutral approaches were developed through the Efficiency House Plus standard, solar house designs or the first pilot projects to feed solar thermal energy into heating networks, which – always in conjunction with highly efficient thermal insulation – combined the two mainstays of the policy: energy efficiency and use of renewable energy. Surplus energy from buildings of this kind can be distributed within networked neighbourhoods or fed into the heating network or electricity grid so that they have the added bonus of compensating for less efficient buildings.
- By 2050, energy efficiency measures and increased use of renewable energy should mean that existing buildings are upgraded to an extent that enables them to comply with the standards required of a virtually climate-neutral building stock. The energy requirements to be met by existing buildings will therefore be gradually developed in an economically feasible way by 2030. Incentives must be created to ensure that, when heating

systems in existing buildings are installed for the first time or old ones replaced, as high a percentage of the heat as possible is supplied from renewable energy sources. The possibility of introducing a statutory requirement to use a certain proportion of renewable energy during extensive refurbishment in cases where it is economically feasible is being reviewed.

- In the near future, the German government will use existing energy-saving legislation to develop a system for the building stock that will make it possible for building owners to have their building classified into different energy performance categories.
- Individual voluntary refurbishment timetables, which are already a firm part of the Strategy on Energy Efficiency in Buildings and will be introduced in the near future, will identify to what extent energy-efficient refurbishment work is needed to make a building virtually climate-neutral. As was decided in the German government's Energy Concept, this would make it possible to bring the refurbishment timetable for existing buildings gradually closer to the target standard, which is a "virtually climate-neutral building" by 2050. It is important to consider consumers' interests when dealing with existing buildings and avoid asking too much of them. The German government will consider to what extent it would be possible to introduce incentives to support those owners wishing to carry out energy-efficient refurbishment work at an earlier date, using the tried and tested CO₂ Building Rehabilitation Programme, for example, the Market Incentive Programme Promoting Renewable Energies or the Energy-Efficient Urban Redevelopment programme to promote energy-efficient development on a neighbourhood scale.
- There are also plans to work with the Länder, which are responsible for enforcement of the legislation, to explore options for further strengthening enforcement.
- Decarbonisation of buildings, which includes avoiding as far as possible the use of fossil fuels and resources, means not only saving energy but also gradually switching to renewable energy sources to provide heating, cooling and electricity. Electricity-based components, such

as ventilation and air-conditioning systems and lighting in non-residential buildings, must be taken into consideration. The German government will therefore phase out its funding for replacing heating technology based exclusively on fossil fuels by 2020 and at the same time improve funding for renewable heating technologies with the aim of making renewable heating systems significantly more attractive than those using fossil fuels.

■ Sustainable building

Factors such as a pleasant indoor climate, efficient room layouts and high-quality, sustainably produced materials are as important for many people as the energy performance of buildings. Having said that, environmentally sound, climate-friendly building materials and modern building design often fulfil several criteria at the same time. For example, renewable insulation materials help to mitigate climate change and at the same time their moisture-regulating effect can create a pleasant indoor climate in the home.

The German government will therefore consider whether and to what extent incentives can be created in the future to:

- Strengthen the use of sustainable building and insulation materials. Upstream and downstream impacts on the climate – such as emissions that are produced when building materials are manufactured, used, disposed of or recovered – are to be taken into account based on freely available life cycle data. Furthermore, instruments to take the entire life cycle of building materials into account to a greater extent (“cradle to grave” or “cradle to cradle”) will be reviewed and integrated more closely into building design practice.
- Support modular, series-designed buildings and funding for flexible, multigenerational, fully or partially accessible housing to meet the housing demand more quickly.

■ Towns, cities and regions of the future

Because buildings’ impact on the climate and their attractiveness are always connected with their physical surroundings, the German government will further step up its activities in the field of practical and

application-focused research in the fields of spatial and urban development in order to make examples of good practice in problem-solving available to cities and regions. They include its spatial planning pilot project and experimental housing and urban development project (ExWoSt). Among the key questions are the importance that modern information and communications technology (ICT) be accorded in the future and how use of ICT can be helpful in climate action and in networking all relevant sectors. It is also important to consider how to ensure the design of towns and cities is as flexible as possible in order to be able to respond to demographic changes, for example. To deal with questions connected with this in a cross-departmental way, the German government will use, among other things, the inter-ministerial working group, which was set up in 2015 on sustainable urban development from a national and international perspective and its subgroups working on implementing the UN Sustainable Development Goals and smart city concepts, for example.

■ Sector coupling and district heating for neighbourhoods

In the future, it will become increasingly important to link up buildings to transport and industry, and to the energy sector. For example, some of the electricity generated close to buildings will be increasingly used to charge electric vehicles, and waste heat from nearby industrial installations or heat generated by CHP (Combined heat and power) plants, large-scale heat pumps or solar thermal systems will be used to heat neighbourhoods using district or local heating grids. One thing is already certain: renewable electricity will play an even greater role in the future, including in buildings. At the same time, developments in renewable heat – produced close to buildings or as a result of increased use of renewable energy in heating networks – will also gain in importance.

- To support the necessary decarbonisation of the energy supply, the German government will drive forward research, development and market launch of inexpensive and innovative technologies that make it possible to switch entire systems to low-emission heat provision. This includes, for example, low-temperature systems that are combined with renewable energy sources, concepts for storing energy in a way that is useful for the system, or methods of producing, distributing and using sustainable fuels based on power-to-gas or power-to-liquid technologies.



- To incentivise greater integration of renewable energy in buildings, it is crucial to eliminate existing obstacles, for example for housing and property businesses, housing associations and building owners. The German government will continue to bear this in mind.
- Furthermore, there are plans to enhance and evaluate model neighbourhoods, in which new forms of networking and sector coupling are being tried out, including smart control of building services, for example.

5.3 Climate action and mobility

Initial situation

Mobility is both a basic human need and an indispensable necessity in a modern society based on division of labour within a globalised world. It facilitates economic exchange and participation in society, safeguards employment and prosperity, and promotes equal opportunities.

However, mobility in its current form is not sustainable. Vehicle efficiency has increased, but all the efficiency gains have been offset by the constant rise

in traffic volume. Transport energy consumption in Germany has more than tripled since 1960. Almost 30 percent of the country's final energy consumption is accounted for by the transport sector and 90 percent of that is oil based. Germany alone spent some 50 billion euros on oil imports in 2014.

The picture for GHG emissions is similar. Although the steady rise in emissions over decades was halted in 2000 and levels are now dropping slightly, the trend in CO₂ emissions from transport is nevertheless nowhere near as positive as that in other energy-consuming sectors. For example, at 160 million tonnes of CO₂ equivalent, GHG emissions in 2014 were roughly the same as in 1990 (when they were 163 million tonnes of CO₂ equivalent). This equates to an 18 percent share in Germany's total GHG emissions.

In fact, specific final energy consumption (measured in passenger and tonne kilometres) has fallen in the transport sector by about ten percent since 2005. However, the sharp increase in traffic volume has ultimately brought about a slight rise in final energy consumption in absolute terms. For example, passenger and freight traffic volume has increased fourfold since 1960.

The individual modes of transport have different shares in passenger and freight traffic volume. At around 76 percent, cars and motorised two-wheelers have the largest share of passenger transport. The share accounted for by mainline and suburban trains is 7.2 percent and public road passenger transport (a category which in Germany includes buses, trams and underground railways) accounts for 6.5 percent. Aviation's share in passenger traffic volume is 4.7 percent. Bicycle traffic accounts for 2.9 and pedestrian traffic for 2.8 percent. In freight transport, heavy goods vehicles are out in front with a 73 percent share of transport volume, rail accounts for 17.7 and inland waterways 9.3 percent.

The German Projection Report for 2015/16 indicates that given prompt and extremely ambitious implementation of the climate measures decided to date – including those detailed in the Climate Action Programme 2020 and the National Action Plan on Energy Efficiency – emissions in the transport sector could fall to approximately 137 million tonnes of CO₂ equivalent (such as about 16 percent of 1990 levels) by 2020.



However, this calls for prompt and far-reaching progress in implementation. Furthermore, the estimates of GHG emission trends in the transport sector – especially up to 2030 – are fraught with uncertainties, because factors such as fuel prices, for example, have a considerable influence on vehicle kilometres and therefore on emissions. Current world market prices and medium-term expectations for oil prices are significantly lower than the values assumed in the Projection Report.

In GHG reporting, emissions from international civil aviation and international maritime shipping are not accounted for under Germany's transport sector. The rapid growth in emissions from international aviation and shipping must be addressed. The German government is advocating vigorously for a reduction in these emissions in the relevant UN organisations – ICAO and IMO. In particular, it is supporting the ICAO's measure based on the global market, which will ensure that growth in aviation from 2020 onwards will be climate neutral. Synergies with existing instruments and the UNFCCC process (for example in the case of market-based instruments, reduction targets and reporting cycles) are to be taken into account. Emissions from aviation within the EU are covered by the EU Emissions Trading System. CO₂ emissions from international maritime shipping are to be recorded from 2018 on the basis of the MRV Regulation (on monitoring, reporting, verification) and the IMO's data collecting system.



Guiding principle for 2050 and transformation pathway

As a modern economy based on division of labour, we depend on reliable, economic, affordable and environmentally sound mobility. At the same time, a secure energy supply, conservation of resources and climate change mitigation are also key areas of action for the transport sector.

Transport makes an ambitious contribution to achieving national climate targets. The transport system in Germany will be virtually decarbonised by 2050, such as will not depend on fossil fuels containing carbon, which means it will also be largely greenhouse gas neutral. Based on the service life of vehicles, this sets the benchmark for the GHG-reduction requirements for future generations of new vehicles. The guiding principle also includes a transport system in which noise and air pollutant emissions and land take will be significantly lower than they are today.

A transport system that emits virtually no greenhouse gases guarantees a high degree of mobility for the public and ensures the movement of goods needed for economic development. It exploits the potential for modal shifts by providing needs-based infrastructure, a fair intermodal competitive environment and smart multimodal integration of the different modes of passenger and freight transport.

Transport helps to preserve and enhance the quality of life in urban centres and rural areas alike – and to conserve natural resources. Carefully planned integrated urban development reduces the distances between the home and key services (for example work, education, shopping). A needs-oriented remodelling of the street environment and an urban development policy based on the model of the compact city, where everything is within easy reach, bring about a significant increase in walking and cycling as means of transport. Smart public transport networks and new mobility services, such as car and bike sharing, make key contributions to environmentally sound mobility. A decisive role is played here by transport and mobility concepts that are based on the particular features of the spatial structure and infrastructure (urban centres, rural areas) and take into account their transport, spatial and environmental impacts.

Automation and networking will change mobility fundamentally. The rapid advance of digitisation makes it possible to increase efficiency. Increasingly automated and networked mobility optimises traffic flows, helps to avoid traffic congestion, reduces the volume of traffic seeing a parking space and thus helps to save energy. Rush hour traffic is reduced as a result of modern ways of working (home office, mobile working). Travel becomes smarter, which in turn produces energy savings. Logistics processes are further optimised and will reduce the number of trips required.

In the target scenario, the energy supply for road and rail transport, and to some extent for aviation and maritime and inland shipping, will be based on bio-fuels, provided it is environmentally sound to do so, and otherwise as far as possible on electricity from renewable sources and other GHG-neutral vehicle fuels.

This will make it possible to achieve greenhouse gas neutrality even for transport operations that still need to use motorised modes of transport. The GHG efficiency of the individual modes of transport and of the transport system as a whole is high, because the possibilities for technological and logistical optimisation will be consistently exploited. Modern, digitally aided transport technologies help to enhance the attractiveness of public transport and any other transport services used by the public. Those modes of transport that have the lowest environmental impact are used most frequently.

In terms of motorised road traffic, it will no longer be possible in the future to meet ambitious fleet targets for new cars simply by improving the energy efficiency of internal combustion engines. The use of lightweight body technology and the integration of alternative drive systems, in particular electric drives, into series production, combined with further developments in this field, is a technical and economic challenge for the automobile industry. Germany and the EU are pursuing an active, demand-driven policy here in order to support this new, forward-looking technology, including in the field of charging infrastructure, for example.

Furthermore, we will strengthen the role of technologies in the field of electric mobility in Europe. We need battery cell manufacturing capacity in Europe that can compete in the global market and will drive forward research and development in battery and storage technologies. During the switch to alternative

drives and fuels, the use of e-fuels/power-to-X, for example, mean that the internal combustion engine remains an indispensable option, which we will keep open. In the field of biofuels, the GHG quota creates incentives to use fuels with relatively high GHG reduction values. This promotes a transition towards progressive biofuels, especially those based on residues and waste that have high GHG reduction values.

Biogenic fuels can play a role in applications where it is not possible to use electricity directly, for example in aviation. However, the potential of sustainable biomass is limited. It could therefore make sense to convert renewable electricity into hydrogen and possibly in further processes to synthetic methane and synthetic liquid fuels. The hydrogen produced in this way will be used in fuel cells, the synthetic hydrocarbons primarily in ships and aircraft.

This energy system based on renewable electricity will combine the electricity, transport and heat sectors – which are currently still separate sectors – to form an efficient overall system, in which the different kinds of energy infrastructure are also coordinated (sector coupling).

Milestones for 2030

The transport sector can and will make a sustainable contribution to achieving the climate targets. To achieve the interim target for 2030, greenhouse gas emissions from transport have to be cut to between 95 and 98 million tonnes of CO₂ equivalent by 2030. According to the Federal Ministry of Transport and Digital Infrastructure's transport interdependence forecast for 2030, the vehicle kilometres for cars will rise by roughly ten percent between 2010 and 2030 – from 599 billion to 657 billion vehicle kilometres per annum. For heavy goods vehicle (HGV) traffic, an increase in vehicle kilometres of about 28 percent during the same period is forecast – from 77.6 billion to 99.7 billion vehicle kilometres per annum. Since HGV and car transport are meant to contribute to achieving the greenhouse gas reduction target for 2030, a reduction in their GHG emissions per vehicle kilometre is essential. CO₂ targets for the new car fleet are set under a European Regulation, for which a draft version has been announced for early 2017. The German government is advocating for ambitious development of the targets to ensure a reduction in GHG emissions from the transport

sector to between 95 and 98 million tonnes of CO₂ equivalent will be achieved by 2030. The required reduction in greenhouse gas emissions from road traffic will be achieved through a combination of increasing vehicle efficiency and stepping up the use of GHG-neutral types of energy. Here the individual technical options for the different vehicles must be taken into account, along with the economic impact on the affected stakeholders.

The German automobile industry has now developed drive technologies for the majority of car segments, which permit an appropriate reduction in direct GHG emissions from car traffic without the need to accept restrictions in the driveability of these vehicles compared with the vehicle fleet to date. They include plug-in hybrid drive and increasingly pure electric vehicles with a greater range, and fuel cell drive systems. The automobile industry has announced that the price of plug-in hybrid drive vehicles will be roughly the same as diesel vehicles from 2020. The German government is aiming to achieve a significant reduction in emissions from cars by 2030. The electrification of the new car fleet will make a decisive contribution to this and should be given priority. The majority of drive technologies developed for cars and existing lightweight body technologies can also be used for light commercial vehicles, which account for about 62 percent of commercial vehicle miles, so that these vehicles too will be able to achieve the required reduction in GHG emissions per vehicle kilometre. The reduced weight resulting from the lightweight design technologies can be used both to increase the vehicle's payload and to extend the range of electric vehicles.

There is still potential for reducing GHG emissions per vehicle kilometre from heavy goods vehicles of around 30 percent by 2030 as a result of further efficiency increases for combustion engines and transmissions, hybridisation, better aerodynamics, the use of optimised rolling resistance tyres, modifications to vehicle length and the use of hydrogen, liquefied natural gas (LNG) and renewable methane in optimised gas engines. Here, too, the other emission reductions required can be achieved by using electric drives. These are currently already being trialled in heavy goods vehicles for regional delivery services.

The potential of digitisation, especially new developments in the field of real-time data communication between vehicles, or between vehicles and

infrastructure, will increase transport safety and result in more efficient use of transport infrastructure. Digitally connecting trucks (known as platooning) is an example of this.

According to the transport interdependence forecast for 2030, the volume of rail passenger transport (in passenger kilometres) will rise by 19.2 percent between 2010 and 2030, with the volume of public road passenger transport (buses, trams, underground railways) by six percent. Appropriate measures such as additional vehicles, adaptations in transport infrastructure planning, and further improvements to energy efficiency will significantly increase the share accounted for by these modes of transport, which are already relatively climate-friendly. Digitisation – to make access easier, for example – also makes a key contribution to this. The volume of rail freight and inland shipping continues to rise. The Federal Ministry of Transport and Digital Infrastructure's transport interdependence forecast puts the increase in rail freight transport at 43 percent and in inland shipping at 23 percent between 2010 and 2030. In particular for rail freight transport, targeted investments in the rail network (including rail electrification) are being made and an appropriate framework created to ensure that the conditions needed to shift transport from road to rail are in place, and that at least the forecast transport volume can actually be achieved. Equally essential for successfully bringing about a modal shift is effectively improving the intermodal competitive conditions so that they favour climate-friendly rail transport.

The potential of cycling as a means of transport – both for short and long distances – should be fully harnessed, to enable its share in overall traffic volume to exceed that indicated in the transport interdependence forecast (2.6 percent in 2030). This can be achieved by creating attractive cycle infrastructure in towns and cities and their surrounding areas and, more particularly, by introducing better connections to public transport. This could make it possible for more and more trips within cities or in the surrounding regions to be made by bicycle or pedelec.

More widespread use of cargo bikes also offers potential for reducing greenhouse gases. They can be used both for express parcel courier services and for other small-scale transport services. The volume of





freight transport can also be reduced by enhancing local production and consumption structures.

Attractive streets can be inviting places that encourage people to walk more. This can also cut emissions, especially if all facilities are within easy reach. Climate-friendly transport options will be included in planning considerations.

Attempts are also being made to achieve emission reductions in aviation and maritime transport through alternative drive technologies and design modifications. Since both sectors will continue to rely on liquid fuels for the foreseeable future, options for blending biogenic fuels and those based on renewable electricity are being considered. The gradual replacement of fossil electricity generation by renewables is a crucial criterion that must be met if these vehicle fuels are to achieve a good climate footprint. Biobased vehicle fuels are also being considered, provided it can be guaranteed that they have been sustainably produced.

To promote the use of low-greenhouse gas or greenhouse gas-neutral modes of transport (non-motorised road traffic or motorised road traffic based on renewable energy) the question of how levies and surcharges on transport can be gradually

redesigned without impacting on revenue, so that transport behaviour that causes as little greenhouse gas production as possible also delivers financial benefits for individuals and businesses.

Measures

A great deal of work has been done in recent years on the basic technology needed to make mobility virtually greenhouse gas neutral, especially for road-based means of transport. Thus, over the next few years, a large number of car models will be launched on the market with electric, plug-in hybrid or hydrogen-fuel-cell drive systems. The German government has to date put over 2.6 billion euros of funding into research and development in this field. The German automobile industry has for its part invested more than 15 billion euros in the development of electric mobility.

The German government has also provided appropriate financial support and achieved a great deal in the field of electricity-based vehicle fuels. For example, a number of demonstration facilities for producing hydrogen by electrolysis and producing synthetic methane were set up and their operation is now being carefully analysed. An initial pilot plant to produce electricity-based liquid fuels (power-to-liquid) also went into operation in 2014. One of the next necessary steps is to achieve cost parity with biofuels, which depends above all on intensifying research into materials and surface engineering aspects of electrolysis. The first steps to increase the use of methane in maritime and inland shipping have also been taken.

The German government will continue in the future to make a significant contribution to developing public transport by providing considerable financial resources.

The German government is supporting cycling as a means of transport with no or low-cost measures, some of them as part of its implementation of the National Cycle Paths Plan.

With its Mobility and Fuels Strategy adopted in 2013, the German government provided an initial overview of the technologies used and the energy and fuel options associated with the different modes of transport. It is seen as a “learning strategy” and identifies ways of implementing the *Energiewende* in the transport sector in the long term.

The German government's continuing support for the National Hydrogen and Fuel Cell Technology Innovation Programme makes a further contribution to driving forward the innovation process needed for the Energiewende.

Achieving the climate and energy targets the German government has set depends on rapidly establishing an effective charging and fuelling infrastructure for alternative fuels. The government has drafted a national strategy framework to implement the EU directive on this subject. It includes equipping motorway service stations with rapid charging points by 2017. The government will roll out a funding programme worth 300 million euros from 2017 to 2020 for the further expansion of a needs-based charging infrastructure network.

As part of its work to continue developing its Mobility and Fuels Strategy without restricting it to any particular technology, the government is also considering fast-tracking the introduction of alternative drive systems and vehicle fuels. An initiative targeting heavy goods vehicles is one option. Hydrogen is an alternative fuel that can be used both in fuel cells and internal combustion engines. The possibility of storing it in liquid organic hydrogen carriers (LOHC) could make this easier in the future. LNG in conjunction with new optimised gas engines can also help to reduce emissions. In the medium term, the use of synthetic vehicle fuels based on renewable energy will also bring about GHG reductions. The government sees natural gas as playing a key role in the transition to mainly electricity-based mobility and in reducing emissions of greenhouse gases and other pollutants.

To continue to consolidate Germany's role as a pioneer in the field of automated and networked mobility, the government supports applications-oriented research and development projects, such as the world's first fully digitised test field on the A9 motorway.

The German government will develop concepts without delay to ensure the 2030 milestone and ultimately the overall target of virtually greenhouse gas-neutral transport by 2050 are met. The measures proposed during the participation process for the Climate

Action Plan make a significant contribution to developing these concepts.

The next step that needs to be taken now to work towards the 2030 GHG reduction target is to identify conditions that are conducive to the launch and market penetration of the necessary drive technologies and fuels. This includes questions such as the latest date by which they should be brought onto the market and what degree of market penetration they should have reached by what point in time. Furthermore, the question of how to further increase the share of already low-emission or zero-emission modes of transport must also be considered.

The German government will address any still unresolved questions on sector coupling and technologies such as alternative drives within its research programmes.

■ A concept for climate policy in the road transport sector

In order to implement the milestones outlined above, the German government intends to present a concept for reducing GHG emissions from road transport by 2030. This concept will take into consideration:

- the communication published by the EU Commission in July 2016 entitled "A European Strategy for Low-Emission Mobility;
- the proposal for an Effort Sharing Regulation presented by the EU Commission in July 2016;
- the proposal announced by the EU Commission for a post-2020 target for CO₂ emissions from cars and light commercial vehicles;
- current plans by the EU Commission for reducing CO₂ emissions from heavy goods vehicles;
- progress in achieving a GHG-free energy supply and in the infrastructure needed to deliver it in the transport sector;
- the availability of the relevant energy and potential in sector coupling.



■ Funding electric mobility

Due to the central importance of electric mobility in reducing GHG emissions from motorised road traffic, the German government will review its funding measures at regular intervals and adapt them to developments.

■ Financial incentives

To meet the targets set in the Climate Action Plan 2050, it will be necessary to consider all the options for revenue-neutral modification of levies and surcharges in the transport sector, with the aim of creating clear financial incentives to choose environmentally friendly modes of transport and vehicles and to use electricity from renewable energy sources in the transport sector.

■ Modal split

The German government will present a concept for how the shares accounted for by public transport, rail freight transport and inland shipping can be increased above the level indicated in the transport forecast for 2030. In this connection, target corridors for their shares in the modal split that are in line with the long-term climate target for transport are to be developed. It is important here to take into account the networking of all modes of transport within an efficient overall system, in which each mode of transport inputs its particular strengths.

The government's existing funding programmes designed to shift transport from the road to the railways or inland waterways will be strengthened.

To sustainably boost investments in climate-friendly local public transport, funds from the federal programme provided for in the Community Transport Financing Act will be continued on a permanent basis. New technological developments in bus and rail transport and further integration of transport services will continue to be funded.

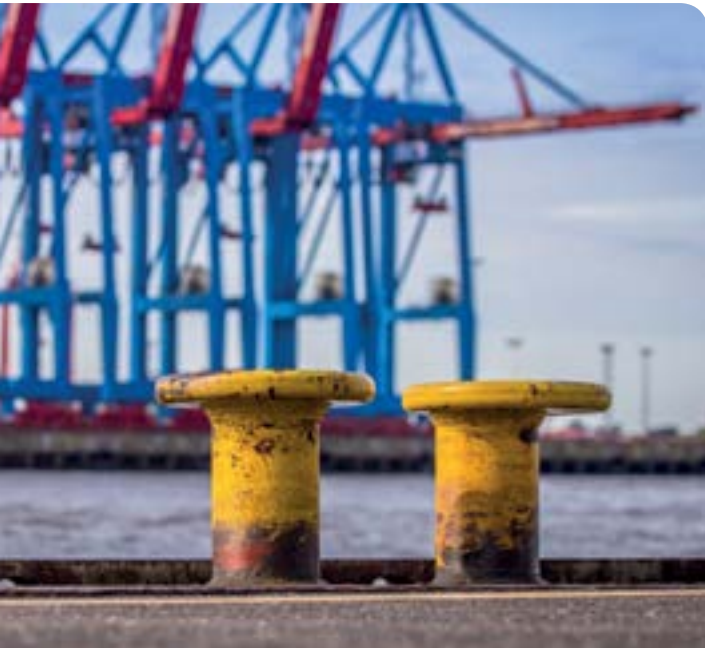
■ Rail transport

The German government is developing a concept for rail transport 2030/2050 to ensure that the potential for shifting road traffic onto the railways is fully exploited. In this context, the possibility of introducing network-wide coordination of connections between mainline and local rail passenger transport will be considered. The extent to which accelerating work to upgrade infrastructure can shift freight transport onto the railways is also being explored (including control command and signalling technology and combined transport terminals).

■ Cycling and walking

The German government intends to continue to update the National Cycle Paths Plan (NRVP) beyond 2020 and in this context support local authorities by creating an appropriate regulatory framework and financial funding for specific activities to boost cycling as a means of transport. Within the possibilities provided for by the law, government and non-government actors involved in promoting cycling as a means of transport will receive continued support, for example by implementing integrated model projects to trial innovative measures. The government intends to become even more closely involved in building cycle expressways within the framework of opportunities provided for under constitutional law. As part of the work to update the National Cycle Paths Plan, specific goals on developing cycling as a means of transport that are in line with the medium and long-term climate target in the transport sector will be formulated. The German government is also working towards promoting walking as a means of transport.





■ Air and maritime transport

The German government will address the current research need and – depending on the outcome of the research – will present a concept for expanding the use of electricity-based fuels in national and international air and maritime transport and launching them on the market. The role of waste and residue-based biofuels should also be explored in this context.

■ Digitisation strategy for the transport sector

The German government is advocating for a clear regulatory framework at national, European and international level and is driving forward the development of common standards. In view of the digitisation of all areas of life, the government intends to develop a digitisation strategy for the transport sector, which includes exploiting the potential for reducing greenhouse gases as far as possible. It will explore how this can take place in connection with work to make its digital agenda more specific. In addition to this, standards for smart roads are to be trialled and conclusions drawn about how road infrastructure can be designed in a way that is pioneering and ensures it is fit for purpose.

5.4 Climate action in industry and business

Initial situation

The industry sector includes all emissions from combustion processes and generation of its own power by the manufacturing industry, as well as emissions from industrial processes and the use of fluorinated gases in products (direct emissions). This section also addresses emissions from the trade, commerce and services sector with measures that are not related to heat supply to buildings. Based on the source principle, emissions caused by electricity purchased from external suppliers are included in the energy sector (Section 5.1). Measures relating to the industry and business area of action can therefore reduce emissions in the energy sector as well as in industry sector and in trade, commerce and services.

The industry sector was the second-largest source of greenhouse gas emissions in Germany in 2014. It was responsible for 181 million tonnes of CO₂ equivalent, some 20 percent of all greenhouse gas emissions in Germany. This sector purchases large amounts of electricity, so it is also an important area of action for reducing emissions from the energy sector. Direct emissions by this sector have fallen 36 percent since 1990. At the European level, some 60 percent of those emissions are covered by the Emissions Trading System and around 40 percent by the



Effort Sharing Decision. Process-related emissions by industry have fallen by almost 27 percent since 1990.

The development of waste management into a circular economy has also made a considerable contribution to climate action by Germany's industry. Around 20 percent of the reductions of greenhouse gas emissions from 1990 to 2012 which were agreed to under the Kyoto Protocol are the result of waste management measures (particularly the decision to end landfilling of biodegradable waste and expand recycling).

A significant percentage (about 38 percent) of industrial emissions do not result from energy use but are instead directly attributable to production processes in the raw materials industry, for example, the production of lime and cement, steel and basic chemicals. This sector is particularly challenging in terms of reducing emissions, and there are generally various options available. For example, these processes can be replaced by new technologies and methods in the industry or CO₂ emissions can be reduced using carbon capture and utilisation (CCU). If emissions are unavoidable, it may be necessary to lower them through long-term carbon capture and storage (CCS).

Information on the historical and predicted emission trend for the trade, commerce and services sector can be found in the chapter on buildings.

The greatest challenge for the industry sector is to make a contribution to cutting CO₂ emissions which takes full advantage of its reduction potential.

Guiding principle for 2050 and transformation pathway

The goal of greenhouse gas neutrality will require fundamental changes over the long term. Climate action drives efficiency and innovation and it must therefore be maintained – in addition to Industry 4.0, Germany's drive to digitise industry – as an essential component of a modernisation strategy whose goal is to achieve economic success and maintain the international competitiveness of industrial production and the manufacturing industry in Germany, especially under the conditions imposed by an ambitious climate policy. The German economy is highly innovative and strong in the area of research and development, not just at the level of large companies, but also in small and medium-sized enterprises. Research in universities, applied and industrial research, and innovative companies are strongly networked. Germany also has good infrastructure, a high level of education and a stable labour market. Those factors give it a competitive advantage as a place to do business, enabling it to put the corresponding technologies to work in real applications and allowing its economy to benefit from the transformation. With our strategy for modernising our national economy, the right enabling policy environment and active regional and structural policies to support structural change, we intend to create reliable conditions for the German economy which will allow a prompt adjustment to this transformation process and make it possible to take advantage of the opportunities it offers. More stringent climate requirements are a challenge for businesses. However, climate action can also be a driver of innovation for a modern high-tech country like Germany. Production and demand are inextricably linked in the economic process, so the influence of demand and sustainable consumption on the trend for greenhouse gas emissions must also be taken into account in the transformation process. It will be crucial to increase the awareness of all stakeholders and empower them to take action and having the necessary knowledge and data base will be indispensable. The UN Sustainable Development Goal of ensuring sustainable consumption and production patterns (SDG 12) offers guidance for this.

An important element in this modernisation pathway is a high-efficiency strategy for reducing the amount of resources and energy needed for production, including continuous research and development to tap additional potential. This means that the technological and organisational factors of success and areas of action such as corporate environmental management must be taken into account. More intelligent linking of production and economic processes as digitisation progresses and Industry 4.0 can contribute to more efficient use of resources. Emission-intensive raw materials should be used more efficiently along the entire value chain, combining material flows across industries can increase energy and resource efficiency and innovations in materials science can help to find substitutes for emission-intensive materials. Reducing industry's need for useful energy by taking advantage of innovative process methods and technologies – such as preventing or reusing waste heat offers great potential.

Another key element is replacing fossil fuels with CO₂-free or CO₂-neutral fuels. This includes renewable energy options (electricity, biomass, and hydrogen from power-to-X) and a circular economy for CO₂ (CCU; see Section 5.1).

Waste already replaces a high percentage of primary raw materials in Germany. Energy-saving recovery of these secondary raw materials and the replacement of primary raw materials reduce greenhouse gas emissions to a considerable extent. There is still major potential for climate action in this area. Technological development is also making an important contribution. Dynamic innovation and innovative progress should not be inadvertently restricted. For example, the resource biowaste must be put to greater cascade use as a material and to produce energy (SDG 2). To take advantage of the potential offered by the circular economy between now and 2050, it will be essential to recover secondary raw materials of this kind from waste, because they emit fewer greenhouse gases than using primary raw materials does (that is the case for metals such as secondary aluminium, for example). The water supply and wastewater management sectors also offer obvious potential that must be systematically used, for example by putting efficiency measures in place or using sewage gas, which simultaneously prevents methane gas emissions, and other renewable energy sources when treating wastewater. Secondary raw material recovery in the form of

recycling should receive stronger political support at the European and international levels, such as greater efforts to tackle illegal waste exports and binding European standards for final consumer products.

Milestones for 2030

In line with the interim target for 2030, greenhouse gas emissions by industry must be reduced to between 140 and 143 million tonnes of CO₂ equivalent by 2030. This means that industry and the trade, commerce and services sector will have to increase their efficiency by 2030. At the same time, it will be necessary to combine the material and energy efficiency of industry and business to a greater extent. Efforts to avoid rejects and adopt circular economy practices in production must be stepped up as far as possible by 2030.

This will mean developing a long-term strategic approach before 2020, based on the National Action Plan on Energy Efficiency, implementing it after 2020 and effectively optimising it by 2030. This will establish clear, reliable background conditions for the affected companies and provide a sound basis for planning. The focus will be on cross-cutting technologies and production technologies, with particular attention being paid to the reduction and reuse of waste heat at all temperature levels. The many barriers to taking advantage of the economic potential offered by efficiency must be strategically addressed, and helpful factors must be identified and likewise addressed.

Production facilities in industry, particularly the emission-intensive raw materials industry, generally have a very long useful life lasting several decades, sometimes more than 50 years. That is why early action is necessary to avoid destruction of value. Any retrofits to production facilities or commissioning of new production facilities must be based on the best available technology with regard to their specific effect on climate.

Achieving the necessary reductions in process emissions by industry will require defining further steps in implementation no later than the 2020–2030 period. Specific measures for implementing those solutions must be in place by 2030. This will require immediate major research and development work targeted to specific process innovations and to CCU, which builds on current activities; a potential role for CCS in this context must then be examined if that turns out to be necessary and acceptable.

The German government aims at a continuous improvement in resource efficiency; indicators and measures for this are specified in the German Resource Efficiency Programme (currently ProgRes II), which is regularly updated. The government is endeavouring in particular to continue the 2000–2010 trend for total raw material productivity up to 2030. This indicator includes both abiotic and biotic raw materials and includes imported goods along with all raw material quantities used during the production process.

The EU Emissions Trading System will continue to be an essential instrument for climate action in the industry sector. It is particularly important to ensure that a reliable framework is in place to give affected companies a solid basis for planning over the medium and long term. Market mechanisms that use a cap to send a pricing signal based on scarcity, thereby providing reasonable incentives to reduce emissions and make investments, play a decisive role. Emissions trading must be designed in such a way that emissions are reduced all over Europe in order to meet the target. That is why the German government advocates sustainably strengthening the emissions trading system. In the government's view, it is essential for the most efficient and climate-friendly technologies to be used as a benchmark. The top ten percent of plants in that regard must be granted an exemption from further requirements to reduce CO₂. There must also be reasonable rules on what is known as "direct and indirect carbon leakage" to prevent any shifting of CO₂ emissions to countries outside of Europe.

The transition to greenhouse gas neutrality will require the economy to be sustainable in all senses, including for example socially responsible action along the supply chain and transparent reporting on sustainability by companies. The Elmau declaration expressly refers to the role of the governments and economies of all G7 states in ensuring responsible supply chains; the obligation to report on sustainability was clarified in the EU in 2014. Finally, the opportunities and risks of climate change are now an integral part of management systems, for example the revised environmental management standard DIN EN ISO 14001:2015.

A reliable enabling environment is a prerequisite for a socially and economically plannable – and profitable – transition to a climate-neutral economy. That environment must therefore be established as soon as possible. The measures described below are designed to do that.

Measures

Several measures are already having an effect in the industry and business area of action. European emissions trading should be mentioned at this juncture; it is already implementing the EU targets for 2020 and will implement those for 2030 in the sectors it covers. The German government is working to obtain further reforms to strengthen emissions trading. A series of measures will increase efforts to take advantage of the potential for improving efficiency, such as mandatory instruments (audit required by the Energy Services Act) and instruments based on financial incentives to promote the introduction of energy and environmental management systems, along with support for capital investments. An instrument mix to increase the dissemination of energy-efficient products has been established which includes both mandatory elements (Ecodesign Directive) and voluntary elements (product labelling such as the Blue Angel and the EU eco-label). Emissions of fluorinated greenhouse gases (known as Fluorinated greenhouse gases [F-gases]) are addressed in the EU FGas Regulation (Number 517/2014). The Act on the Prevention of Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibration and Similar Phenomena requires facilities subject to permitting to be built and operated in a way that uses energy economically and efficiently. Measures to increase resource efficiency are also making a decisive contribution to climate change mitigation. They are



grouped together in the German Resource Efficiency Programme (currently ProgRes II).

■ Extending the useful lives of products and avoiding waste

Using products for a long time generally offers considerable advantages in terms of environmental protection and climate action and at the same time conserves natural resources. The right balance must be struck between resource conservation resulting from sufficiently long useful lives and resource conservation resulting from leaps in innovation, keeping in mind the “rebound effect.” Ever-shorter consumption cycles can be seen in some product groups (such as electrical appliances and electronics equipment). The aim of this measure is therefore to extend the useful lives of the relevant product groups, for example in the context of the EU Ecodesign Directive.

- Important starting points include making improvements to the enabling environment to encourage repair of products and ensuring the greatest possible transparency at the point of sale about how long products will last. The German government will review measures and specific instruments for implementation of this.
- At the European level, the German government also supports the identification of measures to provide information on the availability of spare parts and repair guides, particularly for independent workshops.
- However, the best option is the overall avoidance of waste, because this prevents climate-damaging emissions that would otherwise be generated during production and disposal. The German government will update its Waste Prevention Programme in 2019.

■ Research, development and market introduction programme to reduce industrial process emissions

The German government will work with industry to develop a research and development programme oriented to reducing industrial process emissions that affect climate. It is tailored to specific sectors and oriented to the goal of bringing about a transition to greenhouse gas neutrality. This will also include the

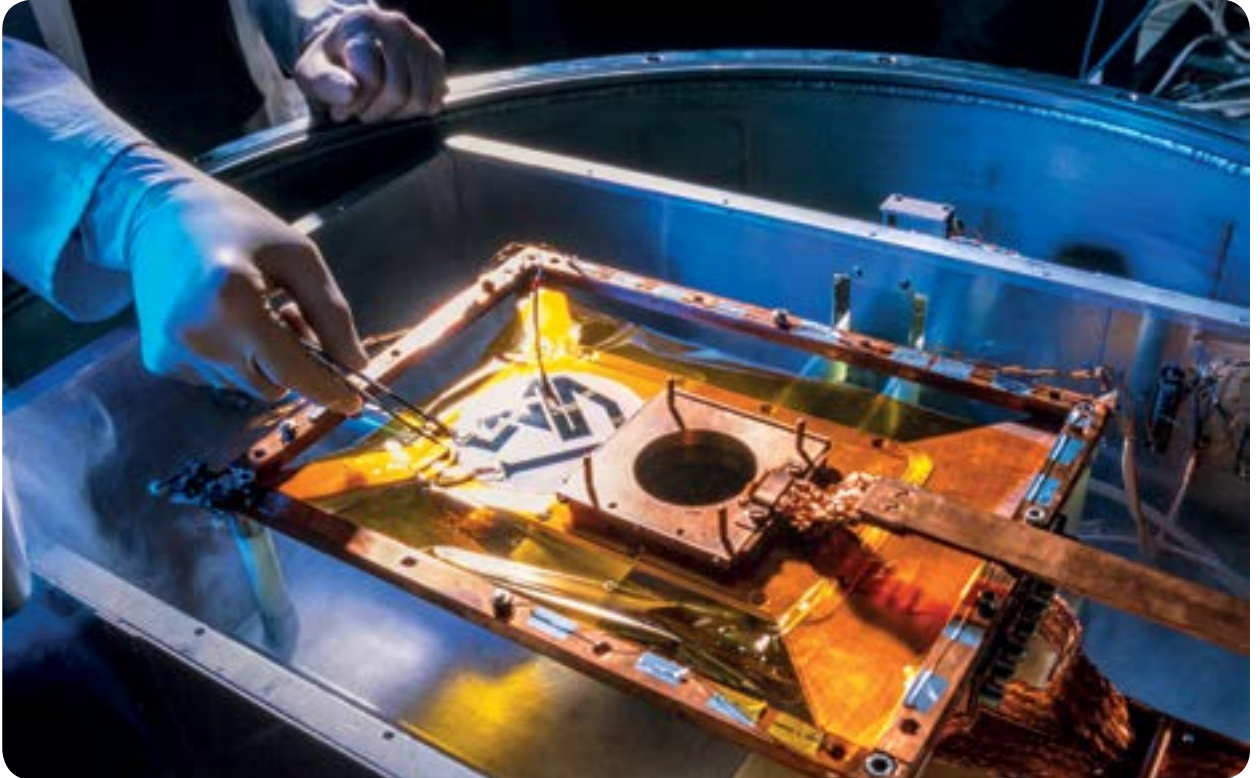
option of a circular carbon economy for industry (using CCU, for example). The Federal Ministry of Education and Research (BMBF) is funding innovative R&D projects in the area of CO₂ use (CCU) as part of the CO₂Plus – Material use of CO₂ to broaden the raw materials base programme. The BMBF funding programme entitled r+Impuls – innovative technologies for resource efficiency – impetus for industrial resource efficiency to promote resource efficiency is also providing support that will help get implementation-oriented, industrially-driven CCU projects on their way to market. To determine what shape the research and development programme will take, the German government will soon begin an industry-specific dialogue process with the affected industries. Support for launching mature technologies on the market will build on that. The BMUB’s Environmental Innovation Programme is already funding demonstration projects that implement technology to lessen environmental impact on an industrial scale for the first time. In this way, the programme is helping to bring advanced technologies of this kind to market.

■ Consistent, strategic effort to take advantage of the potential offered by industrial and commercial waste heat

At this time almost 70 percent of industry’s final energy demand is for fuel. This means that large amounts of heat and therefore waste heat are produced. That waste heat should be consistently and strategically used for both industry and homes. All options are being considered, including power generation and use in local heating systems and district heating networks. This will take into account existing programmes and measures. All economic and non-economic barriers are being addressed with an appropriate mix of instruments. Research and development of new options for using waste heat, such as power generation from waste heat, will receive support, and the possibilities for avoiding waste heat are also receiving more attention. The aforementioned points will be defined as part of a strategy to be implemented as soon as possible.

■ Continuous optimisation of the knowledge base concerning high-efficiency technologies in and for companies

Knowledge about high-efficiency technologies in the area of energy use by industry and business is



expanding. However, such knowledge must also be continuously made available to companies so they can put it to good use. This relates to both company employees and outside service providers such as consultants and installation and maintenance companies. The German government will therefore work with stakeholders in the field of vocational and university training and continuing professional development, as well as the relevant associations and institutions, to develop long-lasting mechanisms to accelerate the dissemination and use of new technical knowledge by 2020 at the latest. One area of emphasis will be training for employees of small and medium-sized enterprises.

■ Climate reporting by companies

Thanks to international and European initiatives like the Carbon Disclosure Project (CDP), comprehensive systems for voluntary climate reporting by companies already exist. Systematic climate reporting ensures transparency with regard to a company's emissions, strategic orientations and future investments, and can be an important source of information for decisions by investors, consumers and companies themselves. It will require little effort to build on existing reporting

requirements and formats, thereby helping to avoid risks and costs. The German government will further strengthen uniform climate reporting based on existing reporting instruments, thereby ensuring the use of uniform reporting standards. It will provide advice and support for implementation by small and medium-sized enterprises.

■ Technological transformation in industry

Germany must continue to be an attractive location for industry, including the manufacturing industry. To test and demonstrate the feasibility of the modernisation pathway at an early stage based on practical examples, the German government will increasingly focus the use of National Climate Initiative (NKI) funds on enabling particularly energy-intensive sectors and companies to introduce new technologies that are available on the market and new business models to reduce production's resource and energy demand and strengthen the circular economy. To accelerate the dissemination of best practices, these measures will be backed by public relations work aimed at specific target groups, and it will be determined whether funding for this work is necessary.



5.5 Climate action in agriculture

Initial situation

Agriculture is particularly affected by climate change, but it also emits greenhouse gases. At the same time, it can make an important contribution to climate change mitigation by sustainably producing biogenic raw materials. The primary task of agriculture is to produce food on a sustainable basis. In addition to adapting agriculture to climate change, it is also the goal of the German government to take full advantage of its potential to contribute to climate change mitigation. Agriculture protects the natural resources that sustain life and also performs other tasks. The government funds research and development projects that will tap further potential for adapting to climate change and reducing greenhouse gas emissions in agriculture.

Greenhouse gas emissions from agriculture were 72 million tonnes of CO₂ equivalent in 2014, which equates to eight percent of all greenhouse gas emissions in Germany. The largest source is emissions of nitrous oxide due to the use of nitrogen in fertiliser (25 million tonnes of CO₂ equivalent), methane emissions from the digestive processes of ruminants (25 million tonnes of CO₂ equivalent), emissions from slurry management (10 million tonnes of CO₂

equivalent) and greenhouse gas emissions from the use of fuel in agricultural machinery and vehicles (six million tonnes of CO₂ equivalent). Emissions from agriculture in 2014 were about 18 percent below the 1990 level. The substantial declines from 1990 to 1994 were primarily due to the reduction in livestock farming following structural changes in the former East Germany. Additional reductions come from improvements in fertiliser management, for example.

Most agricultural greenhouse gas emissions are caused by natural physiological processes, so the ability of technical measures to reduce them is limited.

Guiding principle for 2050 and transformation pathway

Ensuring a reliable food supply, protecting the climate, supplying renewable raw materials and conserving the natural resources that sustain life are among the important tasks performed by agriculture. The German government is therefore doing its utmost to ensure that those tasks go hand in hand as far as possible and that conflicting goals do not arise. A reduction to zero emissions as in other sectors will be impossible due to the biological processes involved in crop cultivation and livestock farming. The emphasis of climate action efforts in agriculture up to 2050 will be on measures to reduce emissions and increase resource efficiency as part of sustainable agricultural production.



Agriculture cannot completely avoid its greenhouse gas emissions over the long term, either. But it must also make further reductions from the 2030 interim target by 2050, remembering that sufficient emission allowances need to be available especially for non-avoidable emissions from industrial processes. This target also involves a series of challenges – including maintaining the level of agricultural production for a growing world population – in view of the UN Sustainable Development Goal of ending hunger, achieving food security and improved nutrition and promoting sustainable agriculture (SDG 2). It will require intensive research in many areas and research activities must be stepped up both at national and international levels.

One important pathway for achieving the climate action target is to cut nitrogen surpluses in the short term and reduce levels permanently over the long term. Among other things, this will mean a substantial reduction in ammonia emissions from agriculture. The reduction requirements set out in the NEC Directive (EU National Emission Ceilings Directive) must be fulfilled as soon as possible, and further reductions will be needed if the goals of the NERC Directive, which specifies the national emission reduction commitments for the period up to 2030, are to be achieved.

For the sake of climate action, progress must be made in changing into a sustainable economy that is more biobased and – in accordance with the National

Bioeconomy Strategy – uses fewer fossil fuels or phases them out entirely. A sustainable bioeconomy contributes to achieving climate targets as well as various Sustainable Development Goals under Agenda 2030.

Due to the biological processes involved in crop cultivation, it will be impossible to reduce emissions from the production of agricultural biomass to zero. The energy supply must be almost entirely decarbonised by 2050 at the latest but, because land is needed to grow food, agricultural biofuel's contribution to climate change mitigation will be limited. By contrast, the use of bioenergy from residues and waste materials will make a major contribution to supplying energy to multiple sectors, so full advantage must be taken of the available potential over the long run. No increase in the amount of land used to grow renewable raw materials beyond current levels is anticipated, even during a transition period, due to restrictions on land use and sustainability considerations. For example, the fermentation of plant biomass by the biogas industry has been responsible for rising ammonia emissions in Germany over the past few years.

Because of the problem of agricultural biomass competing with other land uses, this transformation pathway also supports the UN Sustainable Development Goals in the areas of food (SDG 2) and biodiversity (SDG 15).

Cascade use and combined use must be the objective whenever possible. Compliance with the Ordinance on Small and Medium-Sized Firing Installations will be required to minimise particulate pollution from the use of wood and straw.

Milestones for 2030

According to the intermediate target for 2030, greenhouse gas emissions from agriculture must be reduced to 58 to 61 million tonnes of CO₂ equivalent by 2030.

To cut emissions of reactive nitrogen in agriculture, there will have to be a considerable reduction in surplus nitrogen as part of efforts to make fertiliser use more efficient. The nitrogen surplus in the gross nutrient balance is to be reduced to 70 kilogram of nitrogen per hectare (kg N/ha) between 2028 and 2032, with a further clear reduction by 2050. An integrated nitrogen report by the German government in 2017 will contain a presentation of nitrogen emissions from the various sectors and describe approaches to tackling the need to reduce reactive nitrogen emissions. Ammonia emissions from agriculture

must also be substantially reduced. It will be necessary to comply with the reduction obligations of the NEC Directive in a timely fashion. Additional reductions will be needed if the NERC Directive, which specifies the national emission reduction commitments up to 2030, is to be transposed. For example, reduction measures that relate to management practices and technology will be necessary.

Additional synergies between air quality and climate action result from the fact that lower methane emissions help to reduce ozone pollution over large areas.

Twenty percent of land used for agricultural should be organically farmed, up from 6.3 percent in 2014. The steadily rising demand for organic produce is another reason for expanding organic farming.

The next reform of the EU Common Agricultural Policy (CAP) will be the subject of discussions in the period up to 2020. The structure of the CAP and the way it is transposed into national legislation will considerably influence the intensity of agricultural practices and the resulting greenhouse gas emissions. The EU Commission introduced the “greening” of direct payments as part of the CAP reform in 2013 in an effort to make EU agricultural policy more environmentally friendly. It looks as if the CAP is set to make an even greater contribution to climate action targets, which means that any elements it may include in future would have to be reviewed in light of their effectiveness for climate change mitigation. The requirement for climate-friendly production methods should be oriented to the principle of “public funds for the public good.”

Measures

■ Support under the Common Agricultural Policy

One way of reducing greenhouse gas emissions from agriculture is to use financing instruments under the Common Agricultural Policy. The German government is constantly doing its utmost during negotiations – and will continue to do so between now and 2020 – to ensure that funding policies are oriented to the EU’s decisions on climate policy.

The current amendment of the Joint Task for the Improvement of Agricultural Structures and Coastal

Protection Act will include enhanced measures to promote environmentally sound land and forest management that is appropriate for the market and location, including contractual nature and landscape conservation. They contribute to climate change mitigation in the form of direct climate measures as well as indirectly through environmental protection and nature conservation measures, and also contribute to landscape management.

The German government is reviewing the possibility, which is allowed under current EU law, of reallocating funds from the first to the second pillar (promoting rural development) of the CAP.

■ Further reduction of nitrogen surpluses

The German government will work with the Länder to ensure full implementation and consistent enforcement of legislation on fertiliser, particularly the Fertiliser Application Ordinance and the planned ordinance on good nutrient management practice on farms, thereby ensuring that the German Sustainable Development Strategy’s target of 70 kg N/ha between 2028 and 2032 is achieved. Targeted funding programmes under the CAP and the Joint Task for the Improvement of Agricultural Structures and Coastal Protection are intended to support farmers in implementing their adaptation strategies. The German government will promote targeted research and further development into nitrogen reduction measures. Research and development will be needed to further improve nitrogen utilisation and to encourage innovative new measures for avoiding ammonia emissions. The focus should be on innovative approaches to managing farm manure and improving the utilisation of nitrogen from organic fertilisers in order to reduce nitrous oxide emissions. Other measures are intended to improve the efficiency of nitrogen in livestock feed.

■ Increasing the percentage of land used for organic farming

Organic farming, along with conventional farming, is an important pillar of Germany’s agriculture and agri-food sector. Based on its principles (such as circular economy, appropriate stocking density and particularly animal welfare), the conversion to organic agriculture offers a promising outlook for future development, particularly for small and medium-sized family



farms. Organic farming practices are oriented to the principle of sustainability and contribute to the public good, particularly in the areas of environmental protection, climate change mitigation and resource conservation. It is therefore a stated goal of the German government that 20 percent of the total land used for agriculture be organically farmed.

In a participatory process involving the organic agri-food sector – with the participation of the Länder, scientists and associations – a strategy for the future of organic farming will be developed to ensure that the goal of using 20 percent of agricultural land for organic farming can be achieved in the foreseeable future. The policy environment will be analysed and strategies will be developed to improve the relative advantages of particularly sustainable production methods such as organic farming. In view of the complex interactions involved, selected primary areas of action should be combined and interlinked in the future strategy. The choice of those areas of action should be pragmatically oriented to the key question of “what can be done in particular at the national level?”

Proposals that will lead to greater growth of organic farming and further improve the contribution of organic practices to sustainability will take centre stage. In that respect, the future strategy is intended to ensure that other approaches also receive effective



support from the national level. These include measures by the Länder to strengthen local organic farming and action programmes or model regions for organic farming.

The food-related proposals and measures in the National Programme for Sustainable Consumption are also appropriate for promoting organic farming. The German government will therefore do its utmost to ensure that an ambitious effort is made to implement the programme. The goal is far from being reached, so the government will also look into what other measures it can use to promote organic farming. This will also include the coherence of any measures taken.

■ Increasing the fermentation of farm manure and agricultural residues

More manure from livestock farming is to be used to produce biogas. The German government will determine the extent to which the use of livestock manure to generate energy can be funded beyond current levels. However, the possibility of this contributing to a poorer climate performance must be ruled out.

■ Reducing emissions from livestock farming

A considerable percentage of the greenhouse gas emissions from agriculture is due to the production of animal-based food. However, using permanent grassland to ensure food security is inconceivable without livestock farming. Against that background, funding to increase scientific and technical knowledge and innovation and ensure that it is put into practice more quickly will be essential. Research on the development of more climate-compatible livestock farming is needed, for example in the areas of feed, breeding and farm management.

The German government is focusing its funding more on ensuring that the number of animals being raised does not exceed a maximum of two livestock units per hectare.

The government is developing an overall strategy to reduce emissions from livestock farming by 2021 and will intensify research in this area.

■ Avoiding food waste

Almost one-third of all food in Germany is lost in the form of avoidable and unavoidable food waste. Most of the losses occur at the level of private households (61 percent) and large-scale consumers (the restaurant and outside catering business), as well as at the retail level. It is estimated that two-thirds of food waste in homes could be avoided. The possibilities for avoiding food waste in other sectors of the value chain have not yet been exhausted, and research is being done on this issue.

The German government plans to expand the “Too good for the bin” campaign launched by the Federal Ministry of Food and Agriculture in March 2012 into a national strategy for reducing avoidable food waste and losses. The aim of the strategy is to halve food waste and losses in Germany by 2030.

■ Developing innovative climate action concepts in the agricultural sector

Agricultural research occupies a key position. Opportunities for agricultural production and use will result from a systematic consideration of agricultural production and all upstream and downstream areas.

5.6 Climate action in land use and forestry

Initial situation

Land use, land-use change and forestry (LULUCF) are combined according to the nomenclature of the UN Framework Convention on Climate Change. To date, emissions (such as those from the degradation of humus)



and carbon sequestration (for example by forests) have not been included in assessments of whether climate action targets are being reached. Land use offers outstanding potential, not only because emissions can be reduced but also because it is possible for carbon to be stored (sink function). At the same time, however, there is a great deal of variability in this sector, and it is subject to the influence of a range of natural and human factors.

Approximately 58 million tonnes of net CO₂ equivalent were sequestered in German forests in 2014. Wood products can also store carbon, tying up some two million tonnes of CO₂ equivalent. In contrast, emissions from drained peatlands (arable land and grassland) totalled 38 million tonnes of CO₂ equivalent due to the release of organic matter. Additional greenhouse gas emissions result from peat extraction (two million tonnes of CO₂ equivalent) and settlements on peatlands (3.5 million tonnes of CO₂ equivalent). The total net amount sequestered in the LULUCF sector was 16.5 million tonnes of CO₂ equivalent. This sector is currently a net sink, and additional measures will be taken to safeguard it.

When accounting for forestry's contribution to climate change mitigation, it must be kept in mind that emissions avoided by producing materials and energy from wood that are directly related to the raw material supplied by the forestry sector are not classified under that source group. Instead, the reduced emissions are reflected in the energy sector, construction and housing, transport and industry and business sectors or source groups.

For example, it is estimated that the use of biogenic solid fuels to generate electricity and heat reduced CO₂ emissions in Germany by 31 million tonnes in 2014. The Thünen Institute also estimates that replacing energy-intensive raw materials with wood brought about similar reductions in emissions that are attributed to other sectors. However, both estimates also include biogenic solids of foreign origin. Emissions associated with supplying them may therefore be reported in the greenhouse gas inventories of other countries.

Guiding principle for 2050 and transformation pathway

The focus for this area of action in the guiding principle for 2050 is on maintaining and improving the ability of forests to act as a sink. As described in the

objectives of the Forestry Strategy 2020, other aspects include using sustainable forestry management to take advantage of the potential for reducing CO₂ and the closely-associated use of wood, permanent grassland conservation, protection of peatlands and potential of natural forest development to mitigate climate change.

The guiding principle for 2050 is closely aligned with the findings of the Intergovernmental Panel on Climate Change (IPCC), according to which forest conservation and sustainable forest management are an appropriate and cost-effective way to reduce greenhouse gas emissions. This simultaneously has positive ancillary effects on adaptation to climate change and sustainable development. At the same time, climate action measures must take into account the importance of forests as habitats for flora and fauna, places for water storage, economic factors, suppliers of raw materials and spaces where people can engage in recreational activities or simply enjoy the peace and quiet they offer.

Wood is a renewable raw material that can store carbon over the long term when it is used as a material, for example in the building sector, and it can also replace materials with more detrimental greenhouse gas or environmental footprints, as well as fossil fuels. If wood is used as a source of energy, it must be ensured that it comes from legal, sustainable forestry and that the sink function of forests is not impaired (see Section 5.2). The cascade use of wood should have priority whenever possible and appropriate. It should also be kept in mind that wood is a renewable resource that can be used only within the limits of sustainable forest management, and care should be taken to ensure that wood imports were produced using forestry practices that are legal and as sustainable as possible.

To protect peatlands, peat extraction should be progressively reduced with a view to shutting it down one day. There should be no further conversion of peatlands, and permanent grassland should not be ploughed up.

The increase in land developed for settlement and transport infrastructure (land take) should be reduced to 30 hectares per day by 2020 and then further reduced so that by 2050 at the latest land use is also part of the circular economy and there is “no net land take” as set out in the EU Roadmap to a Resource Efficient Europe.

Milestones for 2030

Achieving the guiding principle for 2050 will require making every effort to successfully implement the climate action guiding principle of the Forestry Strategy 2020 and the following milestones between now and 2030:

Adapting forests to climate change is particularly important for safeguarding and expanding the contribution of forestry to climate change mitigation. Sustainably managed, productive forests that are appropriate for their location, vital, near-natural and adapted to climate change – and primarily made up of native tree species, a target specified in the Forestry Strategy 2020 – will be able to safeguard all functions of forests, including climate change mitigation.

Work will continue to convert forests to climate-compatible mixed forests made up of tree species appropriate for their location. When wood is used to generate energy it must, whenever possible and appropriate, be either residual or waste wood that can no longer be used as a material or be at the end of cascade use. It is also crucial to ensure that it is not detrimental to the forest's function as a sink.

The German government advocates adding solid bio-fuels to the scope of current EU sustainability criteria to ensure that imports of wood into Germany do not cause forest degradation in the various countries of origin as a result of non-sustainable forms of use.

Issues related to increasing forests' contribution to climate change mitigation, sustainable forestry and intelligent use of wood must be closely intermeshed with the requirements of resource and material efficiency. In its new edition of the Charter for Wood, the Federal Ministry of Food and Agriculture plans to develop measures to enhance the contribution made by the sustainable use of wood to achieving climate action targets.

To reduce emissions from organic soil, the lack of research on alternatives to replace the types of use causing them must be remedied and a corresponding impact assessment must be done. Particular attention must be paid to local conditions and conflicting targets (property rights, food production, use of grassland, strengthening rural areas, conserving the cultivated landscape, etc.). Initial progress in counteracting the heavy emissions by organic soils on drained peatlands must be made by 2030. An agreement between

the federal government and the Länder on peatland protection and a strategy to preserve peatlands (organic soils) will be developed and implemented to that end. In addition to effective greenhouse gas reduction, the planning process must take into account aspects of nature conservation and the ability to implement measures in a way that is compatible with the needs of society and the economy. A grassland strategy is also being developed and will soon be implemented.

Land take is to be reduced to less than 30 hectares per day by 2030.

Measures

Various climate action measures are already starting to take hold in the area of land use, land-use change and forestry (LULUCF). For example, in the context of the Joint Task for the Improvement of Agricultural Structures and Coastal Protection, German government funds are being used to support forest conversion measures that will also take climate change into account. The measures are aimed at forest adaptation based on growing a climate-tolerant and climate-adapted mix of tree species.

The German government's Forest Climate Fund is funding measures to maintain and expand the potential of forests and wood to reduce CO₂ and to help German forests adapt to climate change. This is intended to support achievement of the German government's climate targets.

Both sets of measures have proven themselves and are being further developed. Additional government measures include the following:

■ Conservation and sustainable management of forests

- We aim to increase the amount of forested land in Germany. New forests primarily made up of native tree species will be planted wherever it is suitable and sustainably managed in a near-natural way. Offsetting and compensatory measures following the clearance of forests, for example in connection with infrastructure projects, must include reforestation of an area that is at least equal to the size of the cleared area.
- The German government will work to ensure that greater attention is paid to climate action in the





forests funding area of the Joint Task for the Improvement of Agricultural Structures and Coastal Protection. The aim is to fund and maintain more near-natural, productive forests that are adapted to climate change and are primarily made up of native tree species. The question of how forestry associations can be funded under this Joint Task to provide advice on climate action to private forest owners will be examined.

- The German government considers the reinforcement of international cooperation in the areas of conserving, restoring and sustainably managing forests to be a primary instrument for counteracting continued global deforestation and for maintaining the diverse functions of forests in the interest of people and nature, such as climate action and species protection, and as a vital supplier of raw materials over the long term.
- The German government will support the widespread use of certification as an instrument for providing proof that wood products are the result of legal, sustainable forestry practices. It also advocates including solid fuels in the scope of current EU sustainability criteria. Bilateral agreements, for example with the aim of importing wood from legal and sustainably managed forests only, could be negotiated by 2040 on that basis. The government will review the current structure of incentives for using wood as an energy source to determine whether they are effective with regard to climate and sustainability targets.
- Atmospheric inputs of nitrogen and acids that threaten the important functions of forest soils for the vitality of forests, climate change mitigation and biodiversity should be progressively reduced. In addition, forest peatlands should be restored whenever possible, drainage should be stopped and wood harvesting methods should be improved to protect soils.
- Given the limits to forested land and the availability of raw materials, wood should be used to extend carbon cycles wherever possible and appropriate, and should be used as a material before it is used to generate energy. This is known as cascade use and, since resources in the wood and paper industry are scarce, it should be further expanded to take advantage of additional potential.
- Barriers to the use of durable wood products, such as building regulations or the technical characteristics of materials, should be eliminated. The German government is working to ensure that legal requirements in the building sector are brought up to the current state of the art and scientific knowledge. With regard to using wood as a material, additional applications for products made of hardwood must be developed, and research on possible combinations of wood and mineral or fossil materials must be intensified. New, innovative uses for wood products and materials must also be researched and developed.
- Improvements in the efficiency of using wood to produce materials and energy will help to enhance the effects of wood use on climate change mitigation. Material and business cycles should be closed by optimising the practice of recycling recoverables from production processes or using waste wood from many different applications (product design, used wood collection, “urban mining,” and so on). This can be promoted by appropriate incentives and funding for research and development, doing feasibility studies and conducting demonstration projects.
- Reaching climate action targets very much depends on climate-conscious consumer behaviour. Information, education and the transfer of knowledge about sustainable forest management and intelligent use of wood for many different applications



will be intensified and provided to individual target groups using appropriate media.

■ Conservation of permanent grassland

Conserving grassland protects the high level of carbon stored in the grassland soil. During the reform of the EU Common Agricultural Policy (CAP), conservation of permanent grassland was made an integral part of the greening requirements of its first pillar. Specifying areas of emphasis for agri-environmental and climate measures at Länder level is also promoting the conservation of permanent grassland. Permanent grassland in Habitat Directive sites in Germany has been declared environmentally sensitive, which means that grassland within these areas may not be converted or ploughed. Conversion of the remaining permanent grassland is subject to official approval, which as a matter of principle is granted only when no other legal provisions prevent it, and is generally subject to the requirement of establishing permanent grassland at another location. This provision is intended to ensure that permanent grassland does not decrease by more than five percent in a single region (Land).



- The German government will make increased use of possibilities under EU legislation to protect permanent grassland on carbon-rich soils.
- The German government will work at the EU level for more effective protection of grassland. The ban on ploughing grassland on carbon-rich soils will be a particular priority.
- Protecting carbon-rich soils is very important for climate change mitigation, so it has now been transposed into national legislation as the Bio-fuel Sustainability Ordinance and the Biomass Electricity Sustainability Ordinance based on a provision in the EU Renewable Energy Directive which applies throughout Europe. This level of protection for carbon-rich soils such as permanent grassland, peatlands and wetlands has also been expanded beyond the energy sector and defined with a view to the climate action targets for 2050. Measures at the level of the Länder, such as laws on the conservation of permanent grassland, would be appropriate for this, particularly where carbon-rich grassland (peatlands and moor soils, wet meadows) is concerned. The



German government is examining the possibility of creating incentives for this.

■ Protection of peatlands

Considerable quantities of greenhouse gas emissions can be absorbed by sinks over the long term thanks to the increased orientation of peatland conservation to climate action, the expansion of funding programmes to conserve peatlands, and management practices that are appropriate for local conditions. Germany's federal government is working toward an agreement with the Länder on the conservation of peatlands whose aim would be to conserve existing peatlands and create incentives for investments in water management to protect peatlands.

The German government will examine the possibility of consistent, permanent funding for paludiculture at the same time.

Pilot projects and measures to protect peatlands and promote climate-compatible management of water levels can also be discussed and implemented, along with the establishment of appropriate,

environmentally friendly, climate-compatible land use. It must be ensured that projects to protect peatlands are implemented with the participation of all stakeholders in a way that balances the interests of society and the economy.

From the viewpoint of climate action, reducing the use of peat as a growing medium also offers great potential for lowering greenhouse gas emissions, which is why the practice should be severely wound down. Sharp reductions in the use of peat by home gardeners, horticulture and landscape architecture can be achieved by providing advisory services and information. To that end, the German government will implement requirements for the use of peat substitutes in guidelines on awarding public procurement contracts for gardening and landscape architecture. To reduce peat extraction, the government will institute measures to provide advice and information on the use of peat substitutes for gardening. It will create a research programme on peat substitutes and expand the advisory and information measures.

■ Reducing land take

The increase in land development for settlement and transport infrastructure (land take) is to be reduced to 30 hectares per day in accordance with the national Sustainable Development Strategy. Actions by the German government will include improving the relevant planning instruments and examining the implementation of new instruments.

5.7 Overarching goals and measures

Transforming the German economy and society to make them greenhouse gas neutral will require more than just an integrative, systematic approach. A long preparation will be required in many cases, for example when decoupling growth and the consumption of resources or improving the fiscal and financial system to make it more climate-friendly. Overlaps with megatrends such as demographic change or the Digital Revolution must be the focus as much as current challenges, some of which require action in the short term. It will therefore be important to integrate the transformation process into a fundamental dialogue, design that process so it is cohesive and acceptable to society and structure a framework for it wisely to ensure a climate-conscious society and economy.

Primary overarching aspects and instruments

Moving beyond the fundamental dialogue, it is already possible to consider and develop certain specific multi-sectoral measures that will help orient the regulatory framework more to future needs. While taking other existing targets into consideration, those multi-sectoral measures can serve as an overarching basis for the implementation of climate action targets.

One important multi-sectoral instrument is the European Emissions Trading System (see Sections 3.3, 5.1, and 5.4).

■ Improving the system of taxes and levies to make it climate-friendly

Environmental taxes and environment-related charges can also serve as cost-efficient incentives for a climate-friendly economy. They make resource consumption more expensive and, when properly configured, create cost-effective incentives for a climate-friendly economy. They have proven to be an effective instrument for reducing greenhouse gas emissions, so future efforts will build on them. The German government's environmental tax reform in 1999 is an important example of this. It will therefore also have to be determined how the system of taxes and levies can be improved in a way that will allow climate action targets to be progressively achieved by 2050. In that regard, it must be remembered that environmental damage caused by individuals, as well as the failure of society and business to protect the environment, usually result in higher costs than those associated with improving the system of taxes and levies. In some cases, those external costs have not been adequately passed on to polluters; in other words, they have not been internalised. The government will increase the economic incentives for polluters to reduce environmental damage and move in the direction of sustainable production and consumption. The adverse environmental impacts of some taxes will also be considered. The effects of any changes on low-income households and on the international competitiveness of the affected industries will also be appropriately taken into account.



■ Eliminating environmentally harmful subsidies

Making our financial and fiscal framework climate-friendly includes continuing to eliminate environmentally harmful subsidies. They place a two-fold burden on public budgets as a result of increased government spending or lower government revenue now and high costs of remedying damage to health and the environment in the future.

The German government will work at the national, European and international levels to ensure that environmentally harmful subsidies are eliminated with due regard for the interests of consumers and other aspects of the national economy. Alternatively, those subsidies may be diverted into future-oriented investments that will benefit society and the environment.

■ Climate-friendly investments and efficient financial markets

Immense investments in energy, transport and housing infrastructure; education and health; and urban development and public services in rural areas are needed to help advance the economy and society. It is important to keep the UN Sustainable Development Goal of building resilient infrastructure, promoting inclusive and sustainable industrialisation and fostering innovation (SDG 9) in mind in that regard.

■ Efficient financial markets to encourage climate-conscious investment decisions

Global financial flows must also be reconciled with internationally agreed climate targets. The German government is part of a G20 study group on this issue. The G20 finance ministers have asked the Financial Stability Board (FSB) to analyse the financial risks resulting from climate change. The industry-led Task Force on Climate-Related Financial Disclosure created in that context has the potential to create greater transparency concerning the climate risks to which individual companies and investors are exposed. The German government supports the work of the FSB.

■ Promoting and providing incentives for climate-friendly investments

Inappropriate incentives to make certain investments must be avoided.

- The German government will endeavour to ensure that investments in infrastructure are climate-friendly and in the interest of sustainable regional public services and that infrastructure is designed to be sustainable.
- To that end, the government will examine how the structure of incentives to encourage climate-friendly investment can be improved (see measures on climate reporting in the section on industry and business).
- The government will work to improve the prerequisites for preventing the misallocation of capital.
- The government will make it known that there are increasing opportunities on the market for making environmentally and climate-friendly investments and examine the extent to which they can be applied to public-sector investment.
- Sustainable investment needs investors who are interested in sustainability and it needs appropriate financing instruments and products. The German government will do its utmost in multilateral contexts to ensure that sustainability goals play a greater role, for example in funding provided by the multilateral development banks. The multilateral development banks should make a greater contribution to the mobilisation of private resources for sustainable investment than has previously been the case.

■ Sustainable trade

International trade also causes external costs. The fuel used for aviation and maritime shipping is subsidised and/or mostly exempt from taxation. Germany should advocate the elimination of subsidies and appropriate taxation in this area. Principles of sustainability should also play a greater role in trade agreements.

Trade in sustainable products and services should be preferred. Germany will work to achieve this within the EU and WTO.

■ Assessing societal progress

The pending transformation processes must be socially responsible. The criteria of the UN Sustainable Development Goal of ending poverty in all its forms everywhere (SDG 1) play an important role in this. Stable prosperity and social progress are the result

not just of the material components but also the intangible components of social prosperity and individual well-being. This means that any consideration and assessment of prosperity must include the combined use of economic goods and infrastructure, abilities and relationships in society and above all a country's available wealth of ecosystems and the natural resources that sustain life. This means that models other than gross domestic product (GDP) must be considered. The German government will examine whether and to what extent it is possible to add different benchmarks for prosperity.

■ Harmonising environmental monitoring

The Länder have particular responsibility for collecting and providing environmental data. Some of that responsibility has been passed on to local authorities. Statistical and georeferenced environmental data make a particularly important contribution to transparency when implementing measures. The assessment and management of the implementation of the Climate Action Plan 2050 also rely on a uniform basis for data throughout Germany and on the provision of uniform data. Relevant data is sometimes not available for the entire country, and quality sometimes varies (for example, some Länder offer atlases on energy, climate action and heat requirements which contain information on the distribution of the use of renewable energy and the heating demand of residential buildings; geoportals containing information on the status of the cycle path network and plans to expand it and on the infrastructure needed for electromobility; summaries of forest and land use with changes in forest and land areas over time; and an emission register showing the type and location of emissions). Georeferenced data's value is not limited to providing support for monitoring. It can also be very helpful in visualising progress in implementing the Climate Action Plan 2050 locally, which receives a strong response and increases public support for activities.

In the interest of an effective, broad-based participation process and efficient monitoring, the German government will work to ensure successful implementation of the Climate Action Plan 2050 by harmonising appropriate data records for all of Germany and making them available electronically. Standards for the configuration of a European geo-data infrastructure (INSPIRE) will be used for this, with due regard for the requirement, pursuant to federal and Land laws on environmental information, to facilitate access to available environmental

data and provide appropriate levels of information about the environment to the public. One comprehensive approach to current monitoring of this kind throughout Germany is "monitoring the bio-economy," whose focus is on data and analyses related to agricultural and general biogenic resources and an assessment of their sustainability.

■ Research and development as a driver of innovative climate action

Climate research provides major stimulus for societal and technical innovations, reveals options for action and sheds light on new decision-making pathways. Funding for research links socio-economic competencies and competencies in the natural sciences, facilitating cooperation between research and actual practice, which in turn keeps research applications-oriented. The Paris Agreement has created specific new challenges for research if it is to play a proactive role in the transformation that was agreed to and mapped out in Paris.

- Ambitious climate action targets require a corresponding broadening of the knowledge and decision-making base. Consequently, the necessary climate model analyses, multi-sector climate research, development of integrated scenarios for possible sustainable development pathways and local or regional analyses must be initiated if the necessary structural change is to take place.
- The transformation into a society that is greenhouse gas neutral must be economically and socially responsible. This means integrated research in the natural and social sciences must continue to be funded and reinforced in order to identify and comprehensively assess options for action.
- To give the necessary boost to technological and societal innovations, partnerships for sustainable innovations in Germany and throughout the world must be established to allow the expansion of those development pathways that are most promising and compatible with climate action.

The German government leads by example

Climate action must also be reflected in administrative activities. One way of doing this is for the public sector to lead by example, while activities of the federal administration itself are relevant for reducing emissions and thus for achieving Germany's climate targets.





■ Making the federal administration greenhouse gas neutral

As progress is made toward a climate-neutral federal administration, the German government is also actively contributing to climate action with its own measures. The Programme of Sustainability Measures, which was approved in December 2010 and amended in May 2015, has paved the way in areas including federal properties, energy supply, environmental management, procurement, mobility and information technology (IT).

- To show progress that has been made, the German government will systematically record energy consumption, the share of renewable energy sources and CO₂ emissions for federal properties and mobility, explain changes from the prior year and tighten up any measures where necessary to achieve the goal of greenhouse gas neutrality.
- The government will also initiate an exchange of best practices among the various levels of the public sector.
- The government will prepare the energy-efficient refurbishment timetable for federal properties to improve the energy performance of the federal government's civil buildings and follow it for any future building activities. That is also the German government's objective for the upcoming refurbishment of military buildings, paying attention to the

particular characteristics of military use and limits to the available financing.

- The government will introduce sustainable mobility management for the federal administration.
- Measures are quickly being implemented under the Programme of Sustainability Measures in the area of mobility, including video conferencing, "job tickets" (season tickets paid for by the employer under an arrangement with the local public transport provider), company bicycles, electric bicycles, offsetting schemes for unavoidable business trips and an energy-efficient vehicle fleet.
- The programme will be reviewed and upgraded in 2019.

■ Sustainable procurement

Public procurement that complies with sustainability standards can reduce adverse environmental impacts such as CO₂ emissions, water and energy consumption and deforestation along the entire lifecycle of the items procured.

Since 2011, Federation, Länder and local authorities have been working together under the chair of the German government in the Alliance for Sustainable Procurement to achieve a substantial increase in the share of sustainable products and services purchased by the public sector.

The Competence Centre for Sustainable Procurement within the Procurement Office of the Federal Ministry of the Interior, which was created as part of the German government's Programme of Sustainability Measures, materially supports the implementation of the government's emission reduction targets by providing centralised advice, information and training on economic, social and environmental aspects of procurement for the various procurement offices of the federal government, the Länder and local authorities. As part of the national Sustainable Development Strategy and the Programme of Sustainability Measures, the government has also committed to procuring 50 per cent of the textiles it purchases (not including special textiles) on the basis of social and environmental criteria wherever possible by 2020. A knowledge database developed by the Competence Centre is intended to counteract the risk of a loss of knowledge and allow a faster response to inquiries.

The German government will support the work of the Alliance for Sustainable Procurement and the further

development of the Competence Centre for Sustainable Procurement within the Federal Ministry of the Interior.

■ Green-IT-Initiative

The German government's Green IT initiative represents the ambition of the federal administration to make the use of information technologies energy efficient and sustainable. The initiative has already reduced energy consumption by IT operations in all federal departments by 40 percent compared with the year of maximum consumption prior to 2009. The government will continue the initiative.

Cooperation in the area of climate action

Climate action can only be successful in the future if it is considered and implemented at all levels and by all stakeholders.

Specific opportunities to participate with low barriers to entry will be key for making the public more aware of their own responsibility for climate action and increasing their resilience to negative changes. This can also contribute to inclusion and empowerment. These opportunities – some of which already exist or can be expanded – include the provision of information and a variety of ways for people to change their consumption behaviour, play a proactive role, and become involved in networks in their own lives. The German government therefore supports “change agents,” people who will help society to move in the direction of sustainability, including in the context of the National Climate Initiative (NKI). The government will fund studies under real-life conditions to test sustainable lifestyles, forms of work and economic approaches. It will also continue to develop and promote a culture of participation.

■ Education and training

Effective action to achieve transformative climate action that will help shape societal changes requires more than knowledge about interconnections and interactions. It also requires an opportunity to test and improve that knowledge in actual practice. When climate competence is taught at all points in a person's formal educational path using many different methods, know-how can be continuously updated. In addition to schooling, training, university studies and work, opportunities to gain additional knowledge in people's personal or professional life

are an important addition, and may take the form of vocational training and continuing professional development, extracurricular projects, adult education programmes or practical activities based on mutual learning. Day-to-day consumer decisions also allow consumers to influence production conditions, the environment and climate.

The reference point for comprehensive education on climate action is the UN's Agenda 2030, adopted in 2015, which contains 17 Sustainable Development Goals. The goal of ensuring inclusive and quality education for all and promoting lifelong learning (SDG 4) emphasises the transformative power of education and the particular importance of the skills offered by Education for Sustainable Development (ESD) in the implementation of all SDGs. ESD courses about climate action cover diverse themes and dimensions of daily life and develop possibilities for action by individuals and society. They are carefully tailored to specific target groups, are appropriate for the groups being addressed and are designed to foster participation.

Given the diversity of Germany's federally structured educational system, networking and cooperation by stakeholders, a willingness to participate in organisational learning and a timely transfer of scientific knowledge to teaching and learning practices at all levels are a prerequisite for effective training and education in the area of climate action.

- The German government will maintain and improve its support for stakeholders and training and education about climate action provided along the entire educational chain in the framework of federal educational structures.
- The government will integrate training and education about climate action into its current and future funding lines.
- As part of the National Climate Initiative (NKI), funding will continue for climate action projects in schools and non-school educational facilities to increase the awareness of children, adolescents and young adults about climate action and promote opportunities to participate in climate action.
- The government will do educational work in the area of international development policies to promote critical engagement with development and climate policy issues and encourage personal commitment.



■ Information

The German government is examining how to implement a long-term overarching information campaign – Climate Action 2050 – that will provide ongoing information for specific target groups concerning climate targets, ways to achieve them and the implementation of current climate action measures. This overarching campaign will be coordinated with federal educational and information campaigns in specific sectors to avoid duplicate efforts and to pinpoint interactions among them.

The German government will seek a dialogue with society on key areas of life and provide funding for the provision of information and advice (such as the Information and Competence Centre for Sustainable Building/Efficiency House Plus with Electromobility; climate-friendly investing, the promotion of sustainable consumption, and sustainable public procurement using information platforms such as “siegelklarheit.de,” which explains the meaning of environmental labels, and the Sustainability Compass, which provides information on sustainable public procurement.

■ Climate action in companies

Climate action also takes place within companies and as a result of their efforts. A great deal of information,

advice and training is already available in this area, including the SME Initiative for Energy Reforms and Climate Change Mitigation or the “Klimaprofi für den Mittelstand” project, which offers free advice to small and medium-sized businesses. Climate action projects for companies will also be funded through the NKI.

- The German government will continue to fund projects that fulfil one of the following criteria: contribute to increasing the level of awareness and to the implementation of knowledge relevant to climate issues in all occupations recognised as requiring official qualifications; implement planning and production processes in day-to-day work; encourage the acquisition of additional qualifications needed to implement climate action measures at work (particularly those that enhance recognised job profiles instead of – as is often the aim – creating new ones); support measures to promote climate action in the area of career counselling.
- The government will continue to pursue measures that have proven successful, update them where applicable and also use them as a blueprint for new activities.
- The government is taking advantage of multi-stakeholder initiatives by business and civil society to support the implementation of environmental and social welfare standards along global supply chains (such as the Sustainable Cocoa Forum and the Partnership for Sustainable Textiles).

■ Climate action by local authorities

Climate action is not considered to be an integral part of local public services. It is true that many towns and cities in Germany have been very dedicated to climate action and energy efficiency for years now. However, it is not always self-evident for local authorities to specifically take climate action into account in the context of their self-government responsibilities (such as land use planning or the management of any property they own). Yet active involvement at the regional and local levels is important for many climate action efforts. The federal government will therefore examine how regional and local authorities can successfully be persuaded to accord greater importance to climate action and how the activities of those authorities can be reinforced.



6

Implementing and updating the Climate Action Plan



The German government's Climate Action Plan is reviewed and updated in accordance with the five-year reviewing cycle of NDCs under the Paris Agreement. The first update will take place when the Parties to the Paris Agreement must submit new NDCs, by late 2019 or early 2020 at the latest.

The intermediate targets and milestones, the relevant transformation pathways and the associated measures will be continuously reviewed as part of a learning process to ensure that they are consistent with achieving the targets that have been set. If necessary, they will be adapted in response to technical developments and societal, political and economic trends and changes, as well as the latest scientific findings.

This is intended to establish a comprehensive framework for the German climate action strategy which will be reliable over the short, medium and long term. The update will define targets for reducing greenhouse gas emissions, specify measures and adjust them where necessary, make implementation transparent and create a framework for climate action policies as a task for the country as a whole under Germany's federal system of government.

■ Programmes of measures

To ensure that the 2030 targets are achieved, in 2018 the Climate Action Plan 2050 will be underpinned with a programme of measures having quantifiable

effects on reductions. The environmental, social and economic impacts of each programme of measures will be assessed. This means that the update of the Climate Action Plan will be followed by a revision of each applicable programme of measures. The latter will underpin each upcoming reduction step and milestone with specific measures, where possible quantified in terms of their impact on emissions reduction. The programmes of measures will be developed in consultation with the Bundestag (lower house of parliament).

■ Scientific support process

Reviewing and updating the Climate Action Plan and developing and revising programmes of measures requires scientific analyses of scenarios and of the effectiveness, costs, results and ancillary effects, as well as the economic and social opportunities and risks of the chosen pathways and strategic measures that are implemented.

A scientific platform made up of selected institutions doing research in the natural and social sciences will perform that task as part of a broad science-based support process. The platform will prepare scientific experts' reports and assessments of issues relevant to climate action for the review and updating of the Climate Action Plan and the revision of the programmes of measures, thereby generating knowledge that will offer guidance and support decision-making.

■ Public dialogue process

The Climate Action Plan will be reviewed and updated as part of a public dialogue process with broad participation by the Länder, local authorities, the private sector, civil society and the public. The dialogue will also include the formulation of guiding principles and transformation pathways ("Vision 2050") to achieve the goal of making Germany largely greenhouse gas neutral. The decision on how the public

dialogue process will be organised will be taken following evaluation of the broad dialogue on the Climate Action Plan 2050 held in 2015/16. The participatory processes associated with the Climate Action Plan 2050 are regularly evaluated and improved.

The implementation and revision of the programmes of measures are also to include broad-based participation. The Climate Action Alliance, made up of representatives of groups from all parts of society, the Länder and local authorities, which was created by the German government in 2015, will be continued for that purpose. It will support the implementation of measures that have been approved and of the Climate Action Programme 2020, as well as the programmes of measures for the Climate Action Plan 2050; facilitate the activation of existing potential, including as a result of networking with individual participants in the Climate Action Alliance; and identify additional possibilities for action.

■ Monitoring

The German government prepares climate action reports every year so that it can regularly examine the implementation and fulfilment of goals, and it will continue to do this after 2020 so that any necessary adjustments can be made. The climate action reports follow the existing format to show progress in implementing measures under the current programmes of measures, current trends for emissions in the various areas of action and an estimate of the reductions expected from upcoming steps. The preparation of climate action reports is appropriately linked to revision of the programmes of measures, which avoids duplicate effort as far as possible. Any current reporting requirements and formats are properly taken into account.

Regular reports are made to the Bundestag.



Annex to the Climate Action Plan 2050

Abbreviations

AFR100	African Forest Landscape Restoration Initiative
AREI	Africa Renewable Energy Initiative
BVT	Best available techniques
CAP	EU Common Agricultural Policy
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CDP	Carbon Disclosure Project
Cf.	Compare, refer to
CHP	Combined heat and power
CO₂	Carbon dioxide
CO₂ equivalent	Standard unit used to compare the emissions from different greenhouses gases based on their global warming potential (GWP).
COP 21	21 st Conference of the Parties to the UN Framework Convention on Climate Change
DIN	DIN standard (developed by DIN, the German Institute for Standardization)
eFuels	Electricity-based vehicle fuels
ESD	Education for Sustainable Development (UN)
ESD	Effort Sharing Decision; a decision to share the burden of reducing those emissions not covered by the Emissions Trading System across EU Member states in order to achieve the 2030 climate target (EU)
ETS	Emission Trading System (EU)
EU	European Union
ExWoSt	Experimental housing and urban development project

F-gases	Fluorinated greenhouse gases
FSB	Financial Stability Board; an international body that monitors and makes recommendations about the global financial system
G7	Group of Seven; informal forum of countries comprising Canada, France, Germany, Italy, Japan, the United Kingdom and the United States of America
GDP	Gross domestic product
GHG	Greenhouse gases
ha	Hectare
HGV	Heavy goods vehicle
ICAO	International Civil Aviation Organization
ICT	Information and communications technology
IKI	International Climate Initiative
IMO	International Maritime Organization
INSPIRE	“INfrastructure for SPatial InfoRmation in Europe; Project to create a European Union spatial data infrastructure to support EU environmental policies”
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
IT	Information technology
kg	Kilogram
kg N/ha	Kilogram of nitrogen per hectare
kWh/m²a	Kilowatts hours per square metre per annum
LNG	Liquefied natural gas
LOHC	Liquid organic hydrogen carrier
LU	Livestock unit
LULUCF	Land use, land-use change, forestry
MRV	Monitoring, reporting, verification
MSR	Market Stability Reserve (Emission Trading System)
N	Nitrogen
NAP	National Adaptation Plan (UNFCCC)
NAPE	National Action Plan on Energy Efficiency
NDC	Nationally Determined Contributions (UNFCCC)
NEC Directive	EU National Emission Ceilings Directive
NER	New Entrants Reserve (Emission Trading System)
NERC Directive	EU Directive on National Emission Reduction Commitments
NKI	National Climate Initiative
Pkm	Passenger kilometres

REDD+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
SDG	Sustainable Development Goals
SMEs	Small and medium-sized enterprises
t	Tonne (metric)
TWh	Terawatt hours
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
WTO	World Trade Organisation

Glossary

Agenda 2030	The aim of the United Nation's Agenda 2030 (formerly Post-2015 Agenda) is to make global development environmentally and economically sustainable and in doing so ensure future generations have the opportunity to lead fulfilled lives.
Ambition mechanism	The global reductions achieved – such as the sum of all the targets of the parties to the UNFCCC – will be reviewed every five years from 2020 onwards. National climate targets must be as ambitious as possible and the level of ambition must be ratcheted up with each review.
Benchmark	A reference value that makes it possible to continually compare products, services, processes and methods with those of competitors. The aim is to close the gap to the best example in each category.
Bike sharing	See car sharing.
Bioeconomy	An economy that relies on renewable instead of fossil resources.
Biogenic solid fuels	Solid biomass that can either be directly burned (wood, straw) or processed to make it combustible (for example as pellets).
Car sharing	Catch-all term for various models for shared use of vehicles. They are based on the realisation that, as a rule, cars in Germany are driven for one hour a day on average and parked for the remaining 23 hours. There are similar models for bike sharing.
Carbon capture and storage (CCS)	Carbon dioxide is captured and then stored. There is a lack of consensus about how many potential storage sites are available in Germany. The use of CCS has been subject to regulation in Germany under the Carbon Dioxide Storage Act (Gesetz zur Demonstration der dauerhaften Speicherung von Kohlendioxid) since 24 August 2012.
Carbon capture and utilisation (CCU)	Carbon dioxide is captured and used, in particular as a chemical raw material (cascade use). Pilot projects are currently running in Germany.
Carbon leakage	Shifting industrial production and the resulting greenhouse gas emissions from Germany to other countries. The effects of this on emissions, and hence on the global climate, depend on the conditions under which production at the new site takes place and is regulated.
Carbon sink	See sink.
Cascade use	Use of a resource over different stages, for example first as a material and only then to produce energy.

CO₂ Building Rehabilitation Programme	A federal government funding programme, which consists of a number of elements including an energy-efficient construction and energy efficiency modernisation programme. Private individuals, housing companies and cooperatives, developers and owners of residential homes, and local authorities can submit applications to KfW Development Bank.
CO₂ equivalent	The global warming potential of emissions of different gases is calculated as a carbon dioxide equivalent to make it possible to compare them. See also fluorinated gases.
Common Agricultural Policy (CAP)	The EU Common Agricultural Policy provides funding both for farmers and rural regions. A total of 6.2 billion euros per year in EU agricultural funding is available in Germany from 2014 to 2020.
Compact cities	Urban development paradigm which prefers a mix of uses and compact development so that great distances do not have such a prominent influence on mobility needs. If destinations (for example shops, cinemas, parks, childcare facilities) are close by, people do not have to travel as far to reach them but their mobility is just as great. Shorter distances save time and money.
Combined use	Use of a by-product in addition to a principal raw material or product, especially in the case of agricultural raw materials.
Culture of participation	Establishing the continuous participation of interest groups and individual members of the public ahead of key policy decisions.
Decarbonisation	Decarbonisation is achieved by all sectors of the economy switching to a mode of operation that does not produce carbon dioxide emissions. This usually happens by switching to a different fuel or changing the energy source used.
Digital Revolution	The change triggered by digitalisation and the widespread use of computers, which has brought a change in virtually all areas of life since roughly the turn of the millennium.
Digitisation of the Energiewende	The Act on the Digitisation of the Energy Transition (Gesetz zur Digitalisierung der Energiewende) regulates in particular the launch of smart metering systems. It defines how costs are dealt with and sets price caps for the installation of a smart metering system, which will be installed initially for large-scale consumers and generation facilities. Only when this phase has been completed will it be installed for small-scale electricity consumers.
Disruptive innovation	Innovation that displaces existing technology, products or services, possibly completely.
Ecodesign Directive	European legal framework that can be used to stipulate requirements concerning the environmentally sound design of energy-related products.
Ecosystem	A dynamic complex of communities of flora, fauna and microorganisms and their inanimate environment, which interact with one another as a functional entity.

Effort Sharing Decision, ESD	Decision within the EU on how to distribute reduction obligations across the Member States in order to meet the EU climate target for 2030. The ESD applies only those emissions not covered by the EU Emissions Trading System (ETS).
Electric vehicle	A vehicle driven by electricity using a battery that can be externally charged. A distinction is made between pure battery-electric vehicles, plug-in vehicles and plug-in-hybrid vehicles, which have a conventional combustion engine as well as an electric motor. Hybrid vehicles that run only on petrol or diesel and cannot be externally charged are not included in this category.
Electricity market design	The purpose of the electricity market is to guarantee supply at all times, such as meet the demand for electricity. Since the electricity market was liberalised, electricity can be traded on the European Energy Exchange (EEX) in Leipzig. This exchange not only trades electricity but also coal, gas and CO ₂ allowances. The various options for trading electricity are referred to as electricity market design.
Emissions Trading System (ETS)	An EU-wide instrument that puts a market price on emissions by limiting the total number of permissible emissions and issuing emission allowances accordingly. If the price of CO ₂ is high enough, incentives to reduce emissions are created.
Empowerment	Strategies and measures to give individuals and groups greater opportunities for autonomy and self-determination. This is meant to enable them to better defend their own interests (once more).
Energiewende	Transition from using fossil fuels (especially coal, gas, oil, uranium) to an energy supply based on renewables. Increasing energy efficiency and energy saving are central elements.
Energy efficiency	Rational use of a given amount of energy, in other words using less energy to provide the same service at all conversion stages. See also Energiewende.
Environmental Innovation Programme	A BMUB programme which funds demonstration projects that implement innovative technology to lessen environmental impact on an industrial scale for the first time.
ESD	See Effort Sharing Decision.
ETS	See Emissions Trading System.
Existing buildings	Buildings that exist and are in use, such as not newly constructed or still at the planning or design stage.
Farm manure	Organic substances such as slurry or dung that occur in agriculture and forestry and can be used as fertilisers.
Fleet (motor vehicles)	In this context: the entire range of vehicles of any given manufacturer.

Fluorinated gases	Chlorofluorocarbons and (halogenated) hydrofluorocarbons (CFCs and HFCs) and sulphur hexafluoride (SF ₆). The global warming potential of F-gases is 100 to 24,000 times higher than that of CO ₂ .
Food security	Availability and continuous access to food, along with an understanding of what constitutes a healthy diet and the opportunity to put that into practice.
Fuel cell drive systems	A drive system for vehicles based on hydrogen. Hydrogen and oxygen react in the fuel cell, releasing energy from the hydrogen in the form of electricity and heat.
German Resource Efficiency Programme	This programme was adopted in 2012 and contains targets, guiding principles and approaches to conserving natural resources. Its update – ProgRes II – was adopted in 2016.
Greenhouse gas emissions	Release of gaseous compounds that absorb and emit radiation, thus contributing to the greenhouse effect. The Kyoto Protocol cites six greenhouse gases: carbon dioxide (CO ₂), methane (CH ₄), nitrous oxide (N ₂ O) and the fluorinated gases (F-gases): hydrofluorocarbons (HFCs) perfluorocarbons (PFCs) and sulphur hexafluoride (SF ₆). From 2015, nitrogen trifluoride (NF ₃) also has to be included as a greenhouse gas. In Germany, carbon dioxide accounts for over 80 percent of greenhouse gases emitted.
Greenhouse gas neutrality	The net of all greenhouse gas emissions and removals must be zero. Any remaining emissions must be offset appropriately – for example absorbed by plants.
Growing medium	Material that provides a space in which the roots of plants can grow and be supplied with nutrients, air and water.
Impact assessment	A procedure meant to structure and support the development of policy measures. In the EU, an impact assessment includes: Recording and evaluating the problem and targets; Identifying the principal options for achieving the targets and analysing the likely economic, environmental and social consequences; Obtaining an overview of the advantages and disadvantages of each option and investigating possible synergies and compromises.
Inclusion	Ensuring individuals feel part of society. The term is mostly used to refer to including all individuals – both those with disabilities and those without disabilities.
Industry 4.0	Process of linking industrial production with information and communications technology.
Internalisation of external costs	Allocation of external costs to the party causing the external effect in keeping with the polluter pays principle (see separate entry). This would eliminate the misallocation of these costs which impact on the national economy.
International Climate Initiative (IKI)	German climate finance instrument; funding has totalled approx. 1.7 billion euros since the programme was launched in 2008.
Investment cycle	An investment cycle describes the period between an investment being made and being fully written down. The length of an investment cycle therefore varies across sectors. Different macroeconomic factors also play a role and can influence the beginning and length of an investment cycle.

Joint Task for the Improvement of Agricultural Structures and Coastal Protection	The Joint Task for the Improvement of Agricultural Structures and Coastal Protection is the principal national instrument for funding agriculture and forestry to ensure it is efficient, competitive and can meet any future requirements. It also funds coastal protection and vital rural areas. A total of more than one billion euros per year in funding is available through this instrument.
Life cycle assessment	A procedure for recording and evaluating all processes that impact on the environment. Originally developed chiefly to evaluate products, it is now also used for processes, services and behaviour patterns.
Lock-in effect	The third phase of path dependency (see separate entry), in which even plainly evident alternatives to the path embarked upon are not chosen.
Material flows	The directed movement of materials and mixtures of materials. There are natural material flows such as nutrient cycles in ecosystems and materials flows instigated or altered by people such as raw material flows and waste flows.
Mobility	The ability to move from one place to another. Mobility does not depend on distance travelled but on the accessibility of destinations and the available modes of transport to reach them.
Mobility and Fuels Strategy	Adopted in 2013. An overview of technologies and alternative fuels for different modes of transport, it is seen as a “learning strategy” pointing to possible pathways to achieving the Energiewende in the transport sector.
Modal split	The percentage share of each mode of transport in passenger and freight transport. (See also passenger kilometres and tonne kilometres).
National Action Plan on Energy Efficiency (NAPE)	A comprehensive package of measures to increase energy efficiency, adopted by the federal cabinet in December 2014. It is also an important element of the Climate Action Programme 2020, which was also adopted in December 2014.
National Climate Initiative (NKI)	An instrument for funding domestic climate action projects. Target groups include local authorities, educational institutions, businesses and consumers.
National Cycle Paths Plan	Strategic policy document by the federal government, in which it sets out its cycling policy.
Nationally Determined Contributions (NDCs)	All Parties to the UNFCCC were called upon at the 2015 Climate Change Conference in Paris to submit INDCs – Intended Nationally Determined Contributions. They are now obliged to submit actual, not merely intended, pledges which are known as Nationally Determined Contributions (NDCs). These set out the countries’ greenhouse gas emission targets and details of how they intend to go about fulfilling their pledges. The UNFCCC Secretariat reviews the submissions and ascertains the overall climate benefit.
National Sustainable Development Strategy	Since the National Sustainable Development Strategy was adopted in 2002 it has set the course for sustainable development in our country. The strategy is reviewed and updated at regular intervals.

Nitrogen surplus	<p>The quantity of nitrogen in farmland soil over and above the amount theoretically needed to replace the amount removed from that soil by agricultural use.</p> <p>The German government will publish an integrated nitrogen report in 2017, which will give a breakdown of the nitrogen emissions from the various sectors and describe possible approaches to reducing emissions of reactive nitrogen.</p>
Non-residential building	All buildings that are not principally intended for residential use.
Open society	<p>Karl Popper's social model that aims to "release people's critical faculties."</p> <p>The idea is that state power should be shared as broadly as possible to prevent abuse of power.</p>
Paludiculture	Agricultural use of wet raised bogs and fens.
Passenger kilometres or tonne kilometres	The distance travelled by the total number of passengers or tonnes of freight. This distance has quadrupled in passenger and freight transport since 1960. Passenger and tonne kilometres are the crucial influence on energy consumption and greenhouse gas emissions from transport. The number of trips made does not say anything about their length. In terms of number of trips, the cycle and pedestrian share in the modal split of many towns and cities is often very high, but since these trips are usually relatively short, cycling and walking do not play a major role when the modal split is considered in terms of passenger or tonne kilometres.
Path dependency	A concept from the social sciences, which says that established pathways "reinforce" themselves as a result of positive feedback. This makes it increasingly difficult to deviate from an established path even if an alternative path proves to be better.
Pedelec	Short for pedal electric cycle: an electric bike that has a motor to assist cyclists as they pedal.
Petersberg Climate Dialogue	A dialogue to facilitate informal intergovernmental discussion of international climate policy. It has been held annually since it began in 2010.
Plug-in-hybrid drive	See electric vehicles.
Precautionary principle	A key element in German and EU environmental policy which states that negative impacts or harm to human health or the environment must be either prevented or minimised.
Primary industry	Industries that obtain raw materials and make them into basic products in the industrial value chain. Examples include converting coal into coke, refineries converting crude oil, or iron ore being processed to make steel.

Procurement, public	Purchase, leasing or rental of goods and services by the public sector. It is subject to budgetary and competition law. The key requirements are economically effective use of public money and prevention of preferential treatment and corruption. Estimates indicate that the public sector's procurement volume is at least 300 billion euros per year.
Public procurement	See procurement.
Public services	The government guarantees a basic provision to the public of essential goods and services. They include waste disposal, water supply and wastewater management, energy supply and public transport.
Raw material efficiency	Ratio between a benefit or result and the input of raw materials needed to produce it. It is often used in the sense of raw material productivity.
Resource efficiency	Ratio between a benefit or result and the input of (natural) resources needed to produce it. Not to be confused with raw material efficiency.
Retrofitting	Modernisation or upgrading existing installations such as wind turbines.
Sector coupling	Interaction between the different sectors described in the Climate Action Plan 2050. Electricity generation plays a major role in the ability of the buildings, transport and industry sectors to move towards CO ₂ neutrality.
Sink	Reservoir that absorbs and stores carbon – either temporarily or permanently. The storage capacity of sinks can increase or decrease, which means that the amount of stored carbon varies.
Social innovation	The creation, establishment and spread of new social practices in different areas of society. An example of this is what is known as the “sharing economy,” such as the move towards sharing everyday items instead of needing to own them.
Source principle	Principle in UNFCCC accounting rules, by which greenhouse gas emissions are accounted for “at the source.” Emissions caused, for example, by using electrical household appliances, are accounted for in the energy sector, which is the “source” of the electricity and hence of the emissions.
Stranded investments	Investments that have become unprofitable due to a change in market conditions.
Structural break	In contrast to a lengthy process of economic structural change, a structural break refers to the economy having to make a sudden structural adjustment with serious consequences for (regional) employment and prosperity.
Structural change	A long-term change in the structure (of the economy) in contrast to a structural break, which happens spontaneously or at very short notice.

Total resource productivity	<p>Production-related indicator for the German economy's resource efficiency. It is the ratio of the imported resources and those extracted from nature to the sum of gross domestic product and import expenditure.</p> <p>The indicator includes both abiotic and biotic resources and covers all imported goods and the total volume of raw materials used during production processes.</p>
UNFCCC	<p>At the 1992 United Nations Conference on Environment and Development, popularly known as the Earth Summit, which was held in Rio de Janeiro, 154 countries signed the United Nations Framework Convention on Climate Change (UNFCCC). This multilateral agreement entered into force in 1994.</p>
Urban mining	<p>Concept by which densely populated urban areas are regarded as huge "raw material mines" (for secondary raw materials). The aim is to find, identify and recover these raw materials. This is already happening to some extent for scrap metal, building rubble, glass and paper.</p>
Waste Prevention Programme	<p>A programme launched by the federal government and Länder in 2013. It consists of a compilation of existing and potential measures for avoiding waste at federal, Land and local authority level and an assessment of these measures against environmental, economic and social criteria.</p>

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