German Council for SUSTAINABLE Development

Leopoldina
Nationale Akademie der Wissenschaften

Climate neutrality

Options for setting the right course and ambitious delivery

POSITION PAPER

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About the Leopoldina

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It is the role of the Leopoldina, in co-operation with other national and international organisations, to identify and analyse scientific issues of social importance. The Leopoldina presents its policy recommendations in a scientifically qualified, independent, transparent and prospective manner, ever mindful of the standards and consequences of science.

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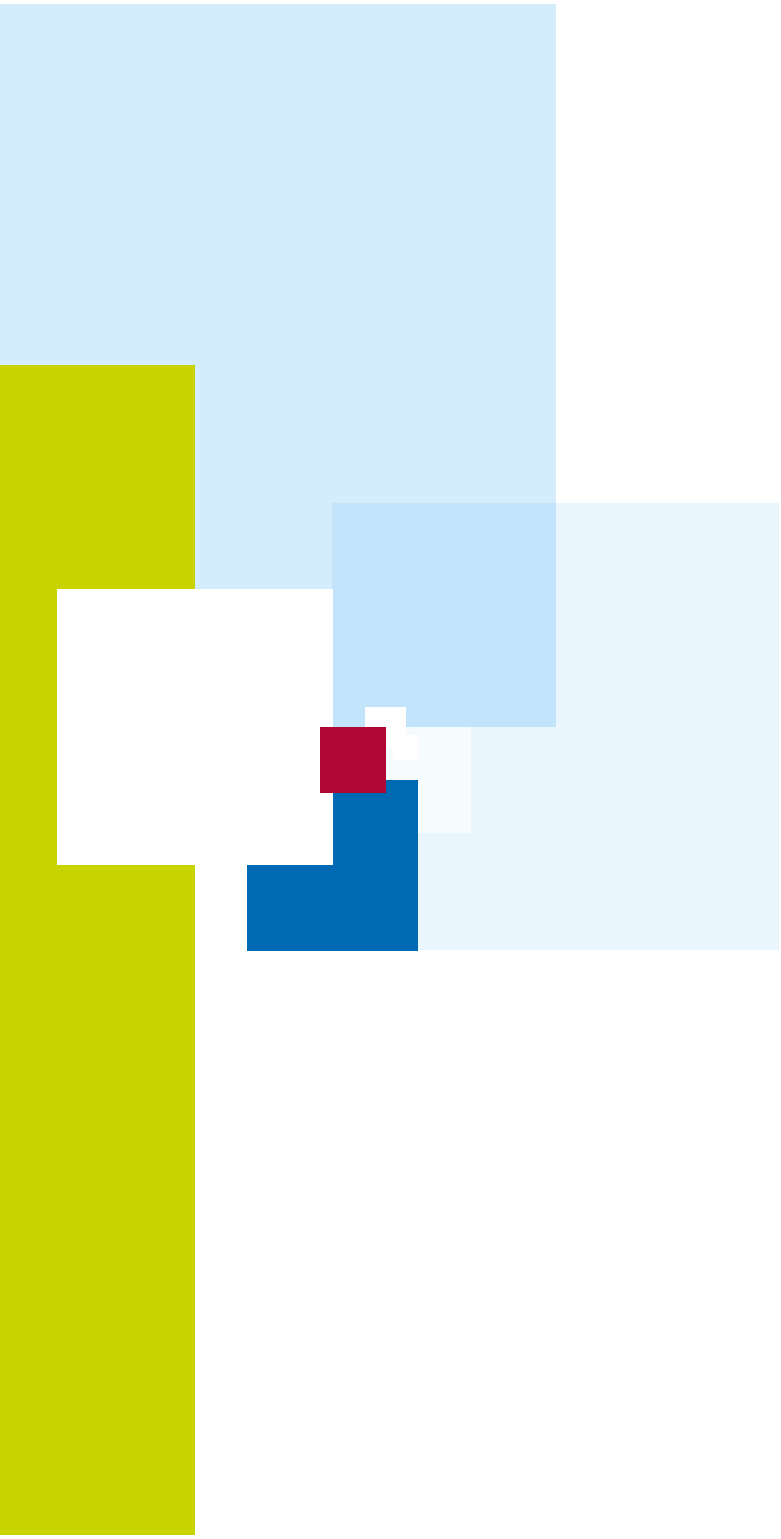

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Preamble

In view of the epochal challenge of the climate crisis, the German Council for Sustainable Development (RNE) and the German National Academy of Sciences Leopoldina have jointly developed a position paper that specifies select overarching options to make a success of the necessary major transformation of the ways in which we live and do business on the path to climate neutrality. Its intention is not to pre-empt the concrete measures now expected from the policymakers.

This paper draws on the definition of greenhouse gas neutrality as laid out in Germany's Federal Climate Change Act (KSG) and uses this term synonymously with the term "climate neutrality": climate neutrality has been achieved for an individual region when the greenhouse gas emissions caused there anthropogenically and the greenhouse gases extracted from the atmosphere are balanced at zero. Emission credits purchased from other regions around the world are not taken into account.

Executive summary

We are living in an age of multiple global crises – the climate and environmental crises, increasing inequality around the world and the coronavirus pandemic, to name but a few, are complex, systemic and closely interwoven. **Humankind's actions are destabilising the earth system in a way which jeopardises the existence and the chances of current and future generations as well as the diversity of life on earth.** The situation in poorer and especially vulnerable countries deserves consideration in particular. People's relationship with the planet needs to be redefined in order to minimise irreversible losses and damage and to sustain a safe climate, in which all people can live a healthy life. **But time is our scarcest resource.**

The path we have trodden to date has already resulted in global warming of 1.2 °C in comparison to the pre-industrial age. There is a remaining **carbon budget** of less than two decades for us to limit global warming to significantly below two degrees, as set out in the climate targets of the Paris Agreement. If we fail to fundamentally change direction, the remaining greenhouse gas emissions budget to prevent global warming from exceeding 1.5 degrees will already have been exhausted by 2030. **Irreversible tipping points**, for example for coral reefs, ice sheets, permafrost and rainforests, could soon be reached. Global climate neutrality must be achieved by the middle of the century at the latest if we are to stabilise the climate and preserve a habitable planet. Climate protection has an impact on practically all of the UN's 17 Sustainable Development Goals and is a necessary contribution to resolving the interdependent crises.

The major transformation needed in the direction of climate-neutral business and lifestyles can only be made a success with **collaboration** between nations, the business world and society. **Systemic action**, i.e. an integrated approach across policy fields and sectors, is crucial. This action must recognise that human societies are inextricably linked with the biosphere that they call home. Action must also be taken promptly in order for us to have at our disposal options with which to meet the future challenges of the transformation. What's needed are a systematic and effective climate protection policy covering all transformation areas, an absolute reduction in the consumption of resources, and a systematic application of the principles of avoidance, reduction and efficiency increase with regard to final energy consumption.

This calls for significant progress to be achieved in reducing emissions in the **next legislative period (2021–2025)** and, at the same time, for key foundations to be laid for the future. In light of the Federal Constitutional Court's Climate Change Order, a considerable portion of the reduction in emissions must be achieved in this decade so as not to impose an excessive reduction burden on the youth of today and subsequent generations. In the interests of intergenerational equity, it is the responsibility of all generations to play their part in mobilising society, the business world and policy-makers to achieve the goal of climate neutrality.

In view of this, the **German Council for Sustainable Development (RNE)** and the **Leopoldina German National Academy of Sciences** are jointly presenting options for action by policymakers. The **core messages** are:

1. Promote strong alliances and global climate partnerships

The Paris Agreement serves as the framework for the global community jointly overcoming the climate crisis. The momentum generated by the European Green Deal, the new US administration and additional climate commitments made by, for example, China and the G7 should be exploited in order to establish and reinforce **transatlantic and international climate alliances**. **Climate partnerships** with the countries of the Global South should be initiated or strengthened. These include agreements on the protection of natural carbon sinks, **adaptation to climate change**, the transformation of existing or establishment of new energy trade relations, a **green recovery,** and **compensation for loss and damage.** The **Green Climate Fund** should be comprehensively strengthened as a central multilateral instrument. To create the conditions for the poorest countries of the Global South to take climate action and to follow the path of a green recovery after the pandemic, Germany's Federal Government should advocate for these countries' public budgets being stabilised, for example by means of debt relief.

2. Interweave the European Green Deal and the new climate targets with the overall legal framework

The cross-sector transformation process introduced with the European Green Deal combines the goal of climate neutrality with a new growth strategy and social balance. The new EU-wide emission reduction target of at least 55% by 2030 compared with 1990 requires a comprehensive update of Germany's climate protection legislation. The new **German emission reduction target of 65% by 2030** is an important step on this path and must be **underpinned with concrete implementation measures that have a swift, effective impact.** Climate neutrality can be achieved as a **goal for all sectors and areas of responsibility across multiple legislative periods** on the basis of implementation measures which preserve liberty and have a reliable climate effect. This design challenge is the responsibility first and foremost of the parliament. Building on the Climate Cabinet, comprehensive and concerted coordination within the Federal Government is needed.

3. Allow as much market as possible and implement as much regulation as necessary

As the lead instrument of European climate policy, **carbon emissions trading** with a continuous reduction of the emission volumes will result in rising carbon prices. These will bring about a cost-effective reduction in emissions and will trigger innovations in the area of climate-friendly business models and technologies. In the context of an overall climate policy strategy, carbon emissions trading must be **combined with a regulatory framework and policies for funding and governance**. Firstly, arrangements would need to be made to preserve the **conditions for fair competition**, for example for the energy-intensive industries that compete globally. Secondly, any **burden placed on low-income households** should be offset as far as possible. And lastly, in as short a **transitional period** as possible to a comprehensive cross-sector pricing mechanism, the carbon price in the building and transport sectors should not fall below the carbon price for emissions trading in industry and the energy industry.

4. Foster acceptance and promote commitment to climate neutrality among citizens and municipalities

For comprehensive societal transformation to be initiated, there needs to be acceptance of the related changes and as many **citizens** as possible need to be engaged. **"Pioneers of change"** who develop models for achieving climate neutrality have an important part to play here. A regulatory framework underpinned by funding programmes should generate as many approaches as possible in order to enable municipalities, non-governmental agents and innovative entrepreneurs to actively protect the climate. Within municipalities, **climate protection should be obligatorily enshrined as a responsibility of the municipal public services**. An innovative example is citizen energy communities, which, as both a generator and user of energy, are an important part of decentralised energy supply. These should be supported in order to increase acceptance of the energy transition and should be explicitly enshrined in law with the implementation of the relevant EU directives.

5. Shape structural change to be socially balanced and strengthen a "just transition" globally

A diverse array of **synergy potential** for reducing social inequality presents itself when the negative effects of climate change are tackled, these frequently affecting those who are the poorest. It is therefore of crucial importance that social balance and climate protection are considered together and that transformation to climate neutrality be tackled systemically. Germany can play its part in a socially balanced transformation to climate neutrality – a **just transition** – by achieving climate targets which are compatible with the Paris Agreement. Social aspects, health, the future of work, mobility and living, the distribution effect of national and international measures, and socially balanced funding of the necessary expenses must be considered at all times. Germany must also make an adequate contribution to international climate funding.

6. Expedite the restructuring and transformation of the energy system

Climate neutrality can only be achieved on the basis of a radical restructuring **of the entire global energy system**, which includes the transformation of global energy trading and entering into new energy trading relationships. However, global transformation of the energy system has only just begun. For example, currently only approximately 1.6% of global final energy usage and 6.9% of electricity consumption are based on wind energy and photovoltaics. Globally, therefore, **renewable energies must be massively expanded**, **efficiency and avoidance potential** must be leveraged, processes must be largely electrified, and a green hydrogen industry must be developed. Green electricity being made available via the **electrical energy grid** in **as large volumes, as quickly and as affordably as possible** will be crucial here, meaning preparations for this will need to be made as swiftly as possible.

7. Accelerate the transformation of industry

Large parts of German industry are facing far-reaching transformation over the next decade in order to **establish climate neutrality while at the same time strengthening the competitiveness of Germany as a location for industry**. Between now and 2030, up to 50% of the plants in many sectors will need to be replaced as part of reinvestment cycles. This offers a huge opportunity for a transformation towards climate neutrality. Long investment cycles require direct action and concrete road maps, for example in the energy-intensive primary industry, in order to secure the industrial basis and jobs.

8. Foster the transformation of mobility, buildings and land use

Particular effort is needed to **transform the mobility, building** and **land use** sectors. In the area of transport, diverse **intermodal mobility services** are needed, as are a swift transition to **alternative drives** and a **corresponding infrastructure**. Energy taxation exemptions and subsidies for diesel, petrol, kerosene and marine fuels should be abolished. In the area of buildings, the rate of refurbishment should be at least doubled and decarbonisation paths that can be implemented locally should be developed. The agricultural sector in general needs to become more environmentally friendly and more sustainable. For example, marshlands used for arable farming need to be waterlogged once again and nitrogen surpluses should be reduced by means of more efficient fertilisation. In addition, the entire food system needs to be incorporated into emissions trading. The restoration of ecosystems is especially important in order to re-establish and safeguard them as carbon sinks.

9. Define investment paths for realisation of the Paris Agreement

Sizeable private funds need to be mobilised in order to implement the Paris Agreement. Looking at the EU, it is assumed that gross investments of around 28 trillion euros will be needed across all the sectors up to 2050. Broken down to Germany, this equates to investment requirements of up to six trillion euros through 2050. Around 23 trillion euros of the total sum for the EU relate to investments which would have been made anyway, but which now need to be redirected to climate-neutral alternatives. There would need to be an additional approximately five trillion euros of spending on clean technologies and techniques up to 2050 in the EU, equating to an average of 180 billion euros a year. In all likelihood, the transformation challenges will vary greatly from sector to sector with regard to **investment time frames and the technological maturity of climate-friendly innovations and due to the interdependencies of the different sectors**.

10. Strengthen industry's ability to compete through climate-friendly innovation markets

Innovation markets (e.g. the circular economy, energy, food and transport systems) have **above-average growth potential**. These markets offer a great many business opportunities as Germany and Europe are technology leaders in many sectors. There is currently still a competitive edge over other regions such as China and the USA. If this lead is not exploited in a targeted way to quickly tap new markets and thereby create new jobs, it is likely to evaporate within the space of just a few years.

11. Initiate a transition to a climate-friendly circular economy

The provision and use of resources are responsible for a considerable share of greenhouse gas emissions and for the majority of biodiversity losses. **A systematic transition to a circular economy** with closed-cycle material use from design through to recycling can make a key contribution to climate protection and preserving biodiversity. Among other things, what's needed is a systemic circular economy strategy for Germany with an absolute reduction in the consumption of resources and a reduction of energy consumption as its goals.

12. Significantly accelerate foresighted investments in the infrastructure of the future

Large-scale and foresighted infrastructure expansion is urgently needed, in particular of the transmission and distribution systems, of green electricity storage and of an infrastructure for transporting and storing green hydrogen. To expedite infrastructure expansion, approval procedures need to be made more efficient and faster. Comprehensive planning and participation processes must be initiated at an early stage, planning procedures must be improved using standards for reports, and the existing opportunities offered by infrastructure and planning law need to be exploited. Administrations and courts must be afforded sufficient capacity for this conversion.

13. Position education, research and development correctly

Research and development create fundamental prerequisites for all transformation processes. Systemic action calls for **collaboration across ministries and departments** within the Federal Government, greater **inter- and transdisciplinary collaboration** of the natural sciences and engineering with sociological and social science **research, and the increased transfer of know-how.** Highly qualified professionals are crucial for the transformation to succeed. To gain these, an extensive retraining and qualification drive is needed within industry, the skilled trades, commerce and trade, and this needs to be supported by all the companies, chambers of commerce, trade unions, employers' associations and Länder (federal states).

14. Realise innovative financing solutions for a transformational climate strategy

Alongside public investments, **financial contributions from the private sector need to be activated on a large scale**. Just like government investment, capital investments made by insurance companies and pension funds and increasingly also venture capital should increasingly be acquired for climate-friendly investments, and any existing obstacles to investment should be systematically examined and dismantled. Innovative forms of investment that include emission reduction incentives should be promoted. As a member of or shareholder in multilateral organisations and development banks, the Federal Government as well as federal institutes should work towards **transformational climate neutrality strategies, an attractive funding ecosystem and putting a stop to the public funding of fossil fuels**. Compulsory climate-related reporting for investors and companies could support this process.

A. Why systemic action is necessary and urgent

We are living in an age of multiple global crises. The climate and environmental crises, increasing inequality around the world and the coronavirus pandemic, to name but a few, are complex, systemic and closely interwoven. **Humankind's actions are destabilising the earth system in a way which jeopardises the existence and the chances of current and future generations as well as the diversity of life on earth** – in poorer, especially vulnerable countries in particular. People's relationship with the planet needs to be redefined in order to minimise irreversible losses and damage and to sustain a safe climate, in which all people can live a healthy life. **But time is our scarcest resource.**

Since 1980, the **concentration of the greenhouse gas carbon dioxide in the earth's atmosphere** has increased from 330 ppm (parts per million) to the current level of 420 ppm. There have been comparable rises in other greenhouse gases caused by humankind. The path trodden to date has already resulted in global warming of 1.2 degrees in comparison to the pre-industrial age.[1] The remaining greenhouse gas emissions budget needed to prevent global warming from exceeding 1.5 degrees will already have been exhausted by 2030 if we continue on this path.

Irreversible tipping elements within the earth and climate system, for example in relation to coral reefs, ice sheets, permafrost and rainforests, are resulting in **climate change possibly becoming irreversible**. For example, Siberian permafrost is increasingly being hit by heatwaves. The uppermost layer of soil is thawing for an increasingly lengthy period and to a greater depth every summer. It is then easier for microorganisms to break down plant-based and animal biomass in the thawing soil, resulting in the release of the greenhouse gases methane and CO_2. The consequence of this is **a self-reinforcing process:** the released greenhouse gases increase climate change, which in turn increases the release of greenhouse gases. It is estimated that there is approximately twice as much carbon sequestered in the Arctic permafrost as currently exists in the atmosphere.[2]

Climate change is already resulting in an **increase in extreme weather events and the direct consequences of these**. These include the devastating bush fires in Australia in 2020, ongoing drought in southern Africa and temperatures of up to 38 °C at the Arctic Circle in Siberia. With temperatures rising, climate zones shifting and extreme weather events, climate change is having a negative impact globally on **agricultural,**

1 Statement "Our Planet, Our Future – An Urgent Call for Action" (as at 16 May 2021), *https://www.nationalacademies.org/news/2021/04/nobel-prize-laureates-and-other-experts-issue-urgent-call-for-action-after-our-planet-our-future-summit* (viewed on 16 May 2021).

2 Leopoldina German National Academy of Sciences (2021): "Klimawandel: Ursachen, Folgen und Handlungsmöglichkeiten", Halle (Saale), *https://www.leopoldina.org/uploads/tx_leopublication/2021_Factsheet_Klimawandel_web_01.pdf* (viewed on 19 May 2021).

livestock farming and fishing yields. In Germany, too, the effects and costs of climate change have been tangible for many for some time now, such as those involved in inland shipping, winter tourism, power plants, agriculture and forestry, and water utilities. There is already evidence of there being negative impacts on people's health.[3] Climate change has serious **biodiversity** consequences. For example, it is highly likely that 70–90% of coral reefs will be jeopardised by a global temperature increase of 1.5 °C. Coral reefs are highly diverse and play an important part in ocean productivity and in the lives and incomes of many people. If there is a temperature increase of 2 °C, 99% of coral reefs will be affected. The increasingly rapid melting of the Greenland and Antarctic ice sheets would cause sea levels to rise by several meters within 100 years, thus forcing hundreds of millions of people to move.[4]

Climate change is resulting not only in massive environmental impacts, but also in considerable economic and societal challenges and costs. In addition to climate change, a further **three of the nine planetary boundaries have already been exceeded**.[5] These are biosphere integrity, land system change and biogeochemical flows. The global community must resolutely counter these existing crises and, in accordance with the **precautionary principle**, must also tackle developments which are especially disadvantageous and irreversible in good time. A great deal of hope is pinned on the various crises being overcome by means of multilateral policies through the **Paris Agreement** and the **2030 Agenda for Sustainable Development**.

Global climate neutrality by the middle of the century at the latest is a prerequisite for our stabilising the climate and preserving the planet's habitability in its current state. Extensive emission reductions and crucial groundwork are required over the next five years if we are to decelerate climate change in good time; otherwise the window of opportunity for preventing even greater emergencies will close. The climate crisis is, after all, **an existential global challenge of the present day**. In many regions around the world, it is not only **people's livelihoods, but also the diversity of life in general that is at stake**.[6] Climate protection has an impact on practically all of the UN's 17 Sustainable Development Goals and is therefore a key contribution to resolving the interdependent crises.

A **fundamental transformation of the global economy** towards eco-friendly, resource-conserving and greenhouse gas-neutral development is therefore urgently required in order to safeguard the civil liberties of future generations. Globally speaking, however, this transformation has only just started. Currently only approximately

3 Federal Environment Agency (no year of publication): "Climate Impacts Germany", Dessau-Roßlau, *https://www.umweltbundesamt.de/en/topics/climate-energy/climate-change-adaptation/impacts-of-climate-change/climate-impacts-germany* (viewed on 19 May 2021).

4 Leopoldina German National Academy of Sciences (2021): "Klimawandel: Ursachen, Folgen und Handlungsmöglichkeiten", Halle (Saale), *https://www.leopoldina.org/uploads/tx_leopublication/2021_Factsheet_Klimawandel_web_01.pdf* (viewed on 19 May 2021).

5 Stockholm Resilience Centre (no year of publication): "Planetary boundaries", *https://www.stockholmresilience.org/planetary-boundaries* (viewed on 19 May 2021).

6 Settele, J. (2020): "Die Triple-Krise: Artensterben, Klimawandel, Pandemien: Warum wir dringend handeln müssen", Hamburg.

1.6%[7] of global final energy usage and 6.9%[8] of electricity consumption within the energy system as a whole are based on wind energy and photovoltaics.

At the same time, there is a need to combat global poverty and hunger and to enable poorer economies to enjoy sustained, inclusive and sustainable economic growth as well as participation in prosperity. This must be made possible on the basis of climate-neutral technologies. A paradigm shift is needed across all sectors in order to rise to this challenge. **Global, far-reaching transformation** at the political, economic and societal level **calls for a systemic, inclusive and innovative approach** as well as additional **funds**.

The major transformation needed in the direction of climate-neutral business and lifestyles can only be made a success through **collaboration** between nations, the business world and society. **Systemic action**, i.e. an integrated approach across policy fields and sectors, is required. This action must recognise that human societies are inextricably linked with the biosphere that they call home. Prompt action is also needed to limit global warming and irreversible damage as much as possible and in order for us to have at our disposal solution options with which to meet the future challenges of the transformation. What's needed are a systematic and effective climate protection policy covering all transformation areas, an absolute reduction in the consumption of resources, and a systematic application of the principles of avoidance, reduction and efficiency increase with regard to final energy consumption.

At the SDG Summit in September 2019 and in the **Global Sustainable Development Report**[9] published at the same time, it was made clear that the progress actually made to date with regard to many of the Sustainable Development Goals (SDGs), not least in the areas of climate protection and biodiversity, was totally unsatisfactory. The heads of state and government at the SDG Summit therefore agreed on a **"decade of action and delivery"**[10] because the global community is far behind schedule, in particular regarding the implementation of measures in these **transformation areas**, but also with the provision of funds for poorer countries. At the same time, the assessment and special reports of the Intergovernmental Panel on Climate Change (IPCC) offer a deeply concerning picture of the current and potentially catastrophic future impacts of climate change caused by humankind.

7 The greenhouse gas emissions relate to the use of 156,700 TWh of energy (based on data for 2018: BP World Statistical Energy Index 2019). 2,480 TWh or 1.6% of this comes from wind energy and PV. A further 4,193 TWh or 2.7% is generated with hydroelectric power. The hydroelectric power proportion cannot be significantly increased any further. Germany accounts for 3,768 TWh or 2.4% of global consumption (with 1.1% of the global population and 4% of global GDP). Together, the PV and wind power installations generated 157 TWh or 4.1% of Germany's gross energy consumption. In addition, the use of biomass accounts for approximately the same proportion as technically renewable energy sources. This biomass proportion can likely be only moderately increased due to systemic usage limitations and due to advancing climate change. Cf. BP Statistical Review of World Energy (2019), London.

8 International Energy Agency (2020): "Electricity Information: Overview", Paris, *https://www.iea.org/reports/electricity-information-overview* (viewed on 20 May 2021).

9 United Nations (2019): "The future is now: Science for achieving sustainable development", Global Sustainable Development Report 2019, New York, *https://sustainabledevelopment.un.org/content/documents/24797GSDR_report_2019.pdf* (viewed on 20 May 2021).

10 German Council for Sustainable Development (RNE) (2020): "Globale Nachhaltigkeitsziele: Tempo, Tempo, Tempo", Berlin, *https://www.nachhaltigkeitsrat.de/aktuelles/globale-nachhaltigkeitsziele-tempo-tempo-tempo/* (viewed on 20 May 2021).

Moreover, everything considered in order to achieve climate neutrality must take the **consequences of the coronavirus pandemic** into account, as the pandemic is influencing politics, business and society in numerous ways and will continue to do so in the future as well. To turn this crisis into an opportunity and to exploit the current momentum, **recovery and the recovery packages in Europe** should be intelligently combined with the **European Green Deal** (EGD) to achieve an effective **transformation for sustainable development and climate neutrality**. Additionally, lessons are to be learned for the future not least from the successes achieved and the identifiable shortcomings in management of the coronavirus crisis – in particular with regard to the provisioning of sustainable structures in good time.

The **next legislative period (2021–2025)** will be crucial for the transformation to climate neutrality. In light of the Federal Constitutional Court's Climate Change Order, a considerable portion of the reduction in emissions must be achieved in this decade so as not to impose an excessive reduction burden on the youth of today and subsequent generations. In the interests of intergenerational equity, it is the responsibility of all generations to play their part in significantly mobilising society, the business world and policymakers to achieve the goal of climate neutrality. As such, what is known as the intergenerational contract should be extended to include future generations not yet born in order to leave a liveable, ecologically balanced environment for them too.

B. International alliances, political decisions, societal participation and ownership

B.1. Promote strong alliances and global climate partnerships

Some of the **largest economies** and emitters of greenhouse gases have announced that they will considerably tighten their **climate targets** and have drafted concrete steps in this direction. In addition to the EU (climate neutrality by 2050, minimum 55% reduction by 2030 compared with 1990), they are in particular **China** (carbon neutrality by 2060), all the members of the G7, South Korea and South Africa (carbon or climate neutrality by 2050). The new **US** administration, Japan and Canada announced ambitious targets for 2030 at the Leaders' Summit on Climate in April 2021. US President Joe Biden additionally promised concrete implementation steps "as a priority for national security";[11] the USA wishes to assume a leading role in multilateral climate change diplomacy once again. These developments are affording international political debate **a great deal of momentum** with which to take important steps **in the direction of global climate neutrality**.

However, the **window of opportunity** for this is **relatively small**. Concrete **international and transatlantic collaboration** and climate protection partnerships should therefore be expedited, in particular in areas that represent **important levers for a climate-neutral society**. These include **sustainable finance**, the implementation of green investment and economic programmes, the use of **technologies** (expansion of networks and storage systems, development of infrastructures for a hydrogen industry, digitalisation) and their further development on the basis of **basic and applied research**.

A clear **commitment to a joint mix of instruments** should be sought in the medium term and should then **take the form of effective, coordinated action** such as joint emissions trading, thereby making a material contribution to global climate governance. For this to be achieved, **climate change diplomacy** must be lastingly embedded at the highest level such as in G7/G20 processes. Climate neutrality should be made an integral part of government consultations. There should also be a concerted effort to establish stronger cooperation of the G7/G20 with other partners such as with the African Union and with **global pioneers** and potential **regional multipliers** such as

11 Executive Order on Tackling the Climate Crisis at Home and Abroad, 27 January 2021, *https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/* (viewed on 27 May 2021).

South Africa, Costa Rica and Morocco. Further, **close collaboration with China and India as well as with existing energy partners such as Russia and Saudi Arabia** would be key. New energy partnerships could enable developed countries to diversify their energy dependencies and the countries of the Global South to realise co-benefits.

In addition to negotiations on common carbon pricing systems, it would generally be wise to promote the formation of new or the strengthening of existing **strategic, subject-specific alliances in the context of climate neutrality – what are known as clubs of the willing**. There are concrete cooperation opportunities in, for example, the area of sustainable finance and the phasing out of fossil fuels. This is conceivable as, for example, part of **development, export credit and infrastructure funding** established as an alternative to China's Belt and Road Initiative. International cooperation is also essential with regard to the topic of **green recovery**. International organisations, central banks and NGOs can play an important part here. Additionally, considerably greater support in the areas of adaptation to climate change, resilience, transformational reduction and leapfrogging should be agreed on in cooperation with the G77.

In line with these global initiatives, Germany and the EU should now increasingly deploy their own diplomatic capacities in the context of **"Green Deal diplomacy"** – including as an opportunity to play a decisive part in **geopolitical competition among systems**. In particular the **culture of trusting transatlantic collaboration** which has been established for decades and which can therefore be revived relatively easily can serve Europe as solid foundations for identifying common interests in the area of climate protection and then boosting their realisation. The fact that the Foreign Affairs Council decided in January 2021 to embed climate policy as a common central objective of **the diplomatic activities of the EU and its member states** at all levels is therefore to be welcomed. In accordance with these decisions, the topic should be very high on the agenda in bilateral relations with the USA and China for the EU as a member of multilateral organisations and development banks as well as in cooperation with candidate countries for EU accession.

International trade agreements can promote global climate neutrality too. There is the **potential for reduction effects to be achieved**, for example on the basis of agreements on the dismantling of trade barriers for "climate-friendly" goods or the **phasing out of subsidies for fossil fuels**. It is more likely that environmental and climate clauses in trade agreements would carry significant weight if the signatory countries each had a **constant political and economic interest in this which was as aligned with the others as possible** – a situation which is not currently the case with regard to the as yet unratified EU-Mercosur Trade Agreement. For new and follow-up negotiations regarding trade agreements, this means basing the agreements on the goal of climate neutrality and on the SDGs.

As part of international climate negotiations, the developed countries made a commitment to mobilising **at least 100 billion US dollars a year for climate funding** in the Global South from 2020. Fulfilment of these commitments and the countries' own

ambitious efforts in the direction of climate neutrality are the basis for credibility and cooperation. The Federal Government and the EU should therefore agree to significantly increase their contributions to international climate funding. The **multilateral Green Climate Fund should be comprehensively strengthened as a central instrument**. Binding bilateral climate partnerships can effectively complement multilateral engagement by contributing to the development of transformation capacities. These should be established for the long term and should include mutual transformation obligations. Lenders and development banks should make all measures, transfers and loans subject to climate policy coherence. In the case of **bi- and multilateral climate partnerships**, for example with African countries, transformational reduction, adaptation, prevention and resilience should be funded with the SDGs in mind.

What is more, not even successful climate protection endeavours can prevent climate change from advancing – they can only limit it. In addition to reducing greenhouse gas emissions, it is therefore important that **timely adaptation** to climate change be supported more than ever before as this plays a part in reducing the damage caused. The Federal Government already committed to providing additional funds at the Climate Adaptation Summit in January 2021; more international endeavours are needed here as well.

This includes agreements regarding the protection of natural carbon sinks and the **compensation of losses and damage.** There needs to be support for **phase-out scenarios and just transition plans** for countries **the economies of which are dependent on the extraction of fossil fuels** (e.g. Nigeria) as well as for countries with energy generation based primarily on fossil fuels in order to counter the problem of stranded assets.[12] It is recommended that direct and indirect support for an infrastructure based first and foremost on fossil fuels, for example in the form of development funding, other public funding or export credit, be immediately discontinued in order to avoid lock-in effects and the resultant stranded assets. This would strengthen the position of western democracies within the global competition among systems.

The **debt level of many developing countries** is already high and is increasing due to the massive economic contraction caused by the coronavirus pandemic.[13] Many countries which are vulnerable because of climate change pay considerable risk premiums in the capital markets.[14] The additional climate-related capital costs incurred by the countries amount to around 150–170 billion US dollars a year.[15] It can therefore not be assumed that developing and emerging countries will be in a position to **finance their post-pandemic recovery and transformation** using domestic funds or the capital markets. The debt relief for 25 of the world's poorest countries agreed upon as part of

12 International Energy Agency (2021): "Net Zero by 2050 – A Roadmap for the Global Energy Sector", *https://iea.blob.core.windows.net/assets/ad0d4830-bd7e-47b6-838c-40d115733c13/NetZeroby2050-ARoadmapfortheGlobalEnergySector.pdf* (viewed on 21 May 2021).

13 International Monetary Fund (2020): "Sub-Saharan Africa: A Difficult Road to Recovery", Regional Economic Outlook, October 2020.

14 Kling et al. (2020): "The impact of climate vulnerability on firms' cost of capital and access to finance", in: World Development, Vol. 137.

15 Volz, U. (2021): "Avoiding too little, too late: debt relief for a green and inclusive recovery", in: Kevin P. Gallagher, Gao Haihong (eds.): Building Back a Better Global Financial Safety Net, Boston.

the Catastrophe Containment and Relief Trust of the International Monetary Fund (IMF) and the debt moratorium agreed upon by the G20 states and the Paris Club address this problem to a degree. The G20 should adopt a broader approach, additionally include middle-income countries and involve private creditors in debt restructuring and should oblige both the creditors and debtors to use the financial scope they are afforded to realise the SDGs and the goals of the Paris Agreement.[16]

The Federal Government could **advocate for more far-reaching debt relief/debt restructuring** that would stabilise the affected countries' public budgets once again. This would allow the countries to use **domestic funds for a green recovery** after the pandemic and to combine this with a stable system of social security. The Federal Government should explore avenues for ensuring together with other IMF members that the funds benefit the poorest developing countries when the IMF's special drawing rights are increased.

B.2. Interweave the European Green Deal and the new climate targets with the overall legal framework

The European Union (EU) is amplifying a far-reaching transformation process in the direction of climate neutrality by 2050 with the **European Green Deal (EGD)** and its climate protection legislation that includes a tighter reduction target for 2030. To achieve this, it is focusing on a new growth strategy which aims to sever the link between economic growth on the one hand and the consumption of resources and environmental impact on the other. The EU is striving for a **climate-neutral, resource-efficient and competitive economy**. The EGD seeks to combine emission reduction in all the relevant areas with measures for the preservation of biodiversity, the circular economy, sustainable mobility, good employment, a social balance of the burdens related to transformation and the sustainable orientation of the financial markets. These intentions will form the **framework for climate protection policy** in the EU and its member states in the future. The EU now faces the challenge of achieving the EGD's ambitious climate targets while making **the use of economic resources as sparing as possible** ("efficient").

Climate protection in the EU is currently shaped by a **large number of national and European instruments** and supporting measures. In particular, businesses and citizens are to be encouraged to cause fewer greenhouse gas emissions via financial incentives and price signals. However, in the multi-level legal system, these diverse measures are currently **not sufficiently coherently coordinated**, thus resulting in investment and innovation obstacles. With the new climate protection targets for 2030/2050 in mind, the EU should therefore select a distinct **lead instrument** which

16 Volz, U. (2021): "Avoiding too little, too late: debt relief for a green and inclusive recovery", in: Kevin P. Gallagher, Gao Haihong (eds.), Building Back a Better Global Financial Safety Net, Boston.

is effective across all sectors, e.g. comprehensive **carbon pricing**, and should initiate a foresighted expansion and conversion of the necessary **infrastructure**. **Concrete strategies for economic sectors and financial markets** have already been developed or are currently being negotiated. Further, agreement has now been reached on a **common seven-year financial framework** and on a **recovery and resilience programme** (NextGenerationEU), each with a mandatory proportion of green investments. The EU and its member states informed the UNFCCC Secretariat of a tighter climate protection target for 2030 of an at least 55% reduction in greenhouse gas emissions compared with 1990.[17] The European Commission has announced a Fit for 55 package for the realisation of this target, due in July 2021.

With regard to the legal framework, the fundamental **paradigm shift** initiated at the European level from a sector-specific **to a cross-sector perspective** is to be welcomed. This finds its expression in the binding **EU-wide climate protection targets** adopted in spring 2021, **EU climate law** and the member states' obligation as per the Governance Regulation to develop **integrated national energy and climate plans**. However, clarifying the European measures up to 2030 is not enough; the period after this up to climate neutrality must likewise urgently be given concrete form through EU-wide targets and measures.

In terms of formulating future climate protection legislation in Germany, in addition to European law requirements, something which is to be taken into account in particular is the stipulation of the Federal Constitutional Court that the current generations should not excessively exercise their freedoms at the expense of future generations.

With its Climate Change Order dated 24 March 2021, the **Federal Constitutional Court** derives an obligation of intertemporal guarantees of freedom from the basic rights and the government objective of environmental protection (Art. 20a Basic Law [GG]), with this obligation needing to be clarified by the legislature ("specification prerogative").[18] Germany's Basic Law requires the legislature to apportion opportunities of freedom reasonably across generations as well, i.e. conservationally in the interests of the constitutional objective of climate neutrality. For this **principle of intergenerational equity**, the court stipulates the key points of a fair intergenerational spread of burdens and thus also benchmarks for an "intergenerational contract" for the protection of the earth's climate system.

Germany's Federal Climate Change Act (KSG) of 2019 does not adequately live up to the **required obligation of guarantees of freedom** as it does not sufficiently spread the remaining national greenhouse gas budget up to climate neutrality across the generations in a way which protects freedom and is reasonable.[19]

17 Germany and the European Union: Submission by Germany and the European Commission on behalf of the European Union and its Member States, 17 December 2020, *https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Poland%20First/EU_NDC_Submission_December%202020.pdf* (viewed on 20 May 2021).

18 Federal Constitutional Court, Order dated 24 March 2021, 1 BvR 2656/18, headnote 4.

19 Federal Constitutional Court, Order dated 24 March 2021, 1 BvR 2656/18, 78/20, 96/20, 288/20, margin number 216.

The first draft of the bill to amend the Climate Change Act is a response to the Order of the Federal Constitutional Court: it increases **Germany's reduction target** to at least **65%** by 2030 (compared with 1990) and develops the cornerstones of the necessary long-term strategy by setting as standards a reduction target of at least 88% by 2040, corresponding annual emission volumes for 2031 to 2040 and the target of greenhouse gas neutrality by 2045.[20]

In the next legislative period, this transformation path must be underpinned with concrete and swiftly effective measures with which to achieve climate neutrality.[21] The aim should be **cross-sector implementation measures with a reliable climate impact.**

The new climate protection targets are to be continuously aligned with the European targets, which will be tightened every five years on the basis of the dynamic international climate protection process established in the Paris Agreement. As agreed in international law, national and European emission reduction targets are subject to tightening with the aim of achieving the climate protection targets of the Paris Agreement.

Finally, when **the climate policy instruments are formulated**, attention should be paid to their coherently complementing the EU instruments. As such, the national long-term strategy (Climate Action Plan 2050), Germany's integrated energy and climate plan and the Climate Action Programme should be accordingly promptly revised and coordinated, with their relationships to one another being explained in the Federal Climate Change Act (KSG).

The emission reduction path should be subject to **science-based monitoring** which obliges the Federal Government to establish emergency programmes and implement effective measures if target attainment is in jeopardy.

Climate neutrality will only be achieved in time if implemented as a **target for all sectors and areas of responsibility which spans multiple legislative periods**. In addition, building on the Climate Cabinet, there is a need for the **concerted and centralised coordination and management of climate policy** within the Federal Government. Moreover, **all the ministries** should mandatorily expedite implementation in their various areas. All the transformation activities should be accompanied by **strict monitoring**.

20 Parliamentary Publication BR-Drs. 411/21.

21 Prognos, Öko-Institut, Wuppertal Institute (2020): "Towards a Climate-Neutral Germany", Executive Summary commissioned by Agora Energiewende, Agora Verkehrswende and Stiftung Klimaneutralität, Berlin.

B.3. Allow as much market as possible and implement as much regulation as is necessary

The basis for a system of management of the potential climate policy instruments should be a **systematic focus on their climate impact**. All existing instruments should be examined regarding their climate impact. If they are harmful to the climate, as e.g. subsidies for fossil fuels are, they should be abolished.

Additionally, greater consideration should be given when selecting the instruments to the fact that the **transformation represents a cross-sector task** and as such requires societal sponsorship. While the overall result is the primary objective, reduction endeavours must be resolutely expedited in all sectors in order to relieve the remaining carbon budget and, above all, to safeguard the timely achievement of the overarching goal.

Incentives need to be set for **all the relevant stakeholders**, i.e. households, companies and governmental organisations, in such a way that the targeted reduction in greenhouse gas emissions is effectively achieved. One efficient market economy solution is **uniform emissions pricing.** Through carbon pricing, there is a chance that the transformation costs incurred will be relatively low.

In particular if not only the current price, but also the imminent price development is known, a carbon price will result in stakeholders all along the process chain making investments and thereby lowering their emissions simply due to the expectation of higher carbon prices in the future. Further, the **technology-neutral nature** of a carbon price stimulates the search for innovations.

European and national climate policy should therefore aim to establish cross-sector and cross-stakeholder carbon emissions pricing which is, ideally, embedded at the European level. To this end, it would make sense to expand the **EU Emissions Trading System** (ETS) to sectors not previously covered by it (in particular transport and buildings) as part of the planned Fit for 55 legislative package, as unlike, for example, a standardisation of the taxation system, only a majority vote within the European Council would be needed. Germany would already be well prepared for this thanks to its Fuel Emissions Trading Act (BEHG), which introduced a carbon price for heating fuels in buildings and fuels in the area of transport. Above all, if cross-sector, EU-wide carbon pricing does not appear to be politically enforceable in the short term, a start could be made for a transitional period with a coalition of willing EU member states.

Choosing market-based **carbon emissions trading as the lead instrument** of European climate policy does not mean pricing would be enough. Rather, this needs to be combined **with a regulatory framework and policies for funding and governance** as part of an overall climate policy strategy. On the one hand, there may be a need for additional instruments of promotion, support, and decree or prohibition where the market fails for structural reasons or where not enough incentive is offered to trigger

a technology change. Arrangements would need to be made here to preserve the conditions for **fair competition**, for example for the energy-intensive industries that compete globally. Secondly, any **burden placed on low-income households** should be offset as far as possible. And lastly, in as short a **transitional period** as possible to a comprehensive cross-sector pricing mechanism, the carbon price in the building and transport sectors should not fall below the carbon price for emissions trading in industry and the energy industry.

The present system of energy-relevant levies and taxes, which has evolved over time, is no longer adequate for the necessary transformation. Fundamental reform is therefore needed – a reduction in the current complexity as well as improved transparency and controllability are worthwhile aims in addition to the approach mentioned above. Above all, there is an urgent and important need for a decision to be made regarding reducing the price of electricity for households and businesses. **Electricity should be made much more affordable in order to accelerate coupling of the electricity, transport and heating sectors, which has until now been blocked by high electricity prices.**

At the heart of this system is the **Renewable Energy Sources Act (EEG). At its core is the EEG support mechanism**, which promotes the generation of renewable energy with photovoltaic systems and wind turbines by means of feed-in tariffs that are then added to the price of electricity by the distribution network operators. The EEG was a great success in terms of developing and making renewable technologies available as well as, linked to this, the extensive Germany-wide ramp-up of renewable electricity generation. There were fears that there might be a negative impact on the ability of German energy-intensive companies to compete, which is why the EEG levy was waived for them, among other things.

On the other hand, all **citizens and many businesses are saddled with electricity prices which are high compared with elsewhere in Europe**. Charges, taxes and levies currently account for 51.4% of the household electricity price, while regulated grid charges account for 23.5%.[22] At 20.4%, the EEG levy is the largest of the taxes, charges and levies, followed by value added tax (16%) and electricity tax (6.4%). The electricity costs incurred by households and businesses urgently need to be lowered via reforms of all the elements of the electricity price. The electricity price should swiftly be made more flexible in order to offer incentives for investing in storage technologies and sector coupling. The EEG levy could conceivably be reduced by using income from higher carbon pricing. From an economic perspective, the EEG levy could be financed on the basis of taxes in the future. From a legal perspective, however, there are doubts regarding the reconcilability of this with Union law (Art. 107 TFEU) and this needs to be carefully examined.

22 BDEW (2021): "Strompreisanalyse Januar 2021", Berlin, *https://www.bdew.de/media/documents/BDEW-Strompreisanalyse_no_halbjaehrlich_Ba_online_28012021.pdf* (viewed on 20 May 2021).

In addition, there are discussions at the European and national level regarding the introduction of **project-based carbon contracts for difference** to complement the ETS. These models of carbon contracts for difference (CCfD) could balance out the cost difference of climate-friendly production compared with conventional production and, by focusing on switching large-scale, energy-intensive production processes and energy projects with high initial investment costs to climate-neutral technologies, could make eco-friendly industrial production marketable.

B.4. Foster acceptance and promote commitment to climate neutrality among citizens and municipalities

For **comprehensive societal transformation** to be initiated, there needs to be acceptance of the related changes and as many citizens as possible need to be engaged. In addition, **pioneers of change** who develop models for achieving climate neutrality are needed everywhere, such as in the areas of energy, homes and buildings, and mobility. A regulatory framework underpinned by funding programmes should generate as many approaches as possible in order to enable municipalities, non-governmental agents and innovative entrepreneurs to actively protect the climate.

Municipalities are key agents and multipliers in the area of sustainability and deserve a great deal more consideration and support in this transformation than has previously been the case. Many municipalities have formed an alliance called Bündnis 100% Erneuerbare Energien[23] or are involved in the Master Plan Municipalities programme funded by the Federal Ministry for the Environment (BMU).[24] In order for structures to be lastingly and fundamentally changed, municipal climate protection needs to be effectively embedded throughout the country. This objective could be bolstered by **climate protection being enshrined as an obligatory responsibility of the municipal public services**, comparable with other municipal responsibilities such as supplying water and energy. Accordingly, in line with the principle of subsidiarity, municipalities could be provided with **additional funds for climate protection realisation** to advance sustainable infrastructures as well as demand for climate-friendly products and services and to be even more effective as **multipliers at the local level**.

Citizen energy communities, towns and cities, and municipalities are increasingly controlling and setting up renewable energy plants and energy storage systems and are promoting a transformation towards decentralised energy supplies, for example with "citizen wind farms". Active involvement of this kind and the financial advantages of operating renewable energy plants are contributing to acceptance of and the realisation of the energy transition as a collaborative effort. The engagement of

23 Cf. Bündnis 100% Erneuerbare Energien, *http://www.100ee.de/* (viewed on 20 May 2021).

24 Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU): Master Plan Municipalities project, *https://www.klimaschutz.de/masterplan-kommunen* (viewed on 20 May 2021).

civil society can be effectively boosted through the increased **promotion of the joint federal/Länder task of sustainability**.

Article 16 of **Directive (EU) 2019/944 on the internal market for electricity**, which obliges member states to allow individuals and municipalities that adopt the form of citizen energy communities to generate, store, use and trade in electricity themselves, is giving the **citizen energy movement additional momentum**. The example of Germany shows that citizen energy can make an important contribution to the electricity mix – 30.2% of the renewable energy capacity installed in Germany in 2019 is owned by individuals, with farmers accounting for a further 10.2%.[25] Referencing the existing legal forms such as cooperatives, the Federal Government does not deem it necessary to enshrine citizen energy communities in German law.[26] There needs to be an examination as to whether this assessment of the Federal Government is reconcilable with EU law. Citizen energy communities should otherwise be immediately and explicitly enshrined in German law, for example in energy industry law.

There needs to be broad public debate regarding trade-offs in order to arrive at solutions which are backed by everyone. Target group-specific **climate and sustainability communication** should therefore serve as the basis for dialogue and for the negotiating of compromises among the different stakeholder groups, and the implementation of **societal participation processes** should be made an integral part of political decision-making. To facilitate structured knowledge exchange and discourse among the stakeholder groups, there needs to be clear and unbureaucratic framework conditions, access to science-based know-how, structural parameters for model development and long-term funding programmes for the scaling up of functioning models. In particular the field of science has a pioneering role in this regard.

Climate-friendly decisions and behaviour have a strong social component.[27] Studies show that climate-friendly decisions, for example to invest in corresponding technologies, are often fostered by **emotional and role-based factors** – irrespective of the demographic, socio-economic or cultural context.[28] Communication which focuses on individual cost-benefit considerations is much less likely to lead to environmentally friendly decisions.[29]

Acceptance of the energy transition also increases if citizens do not merely consume passively, but actively shape the energy transition, for example as **prosumers**. Among

25 trend:research (2017): "Eigentümerstruktur: Erneuerbare Energien" study, Bremen.

26 Federal Ministry for Economic Affairs and Energy (BMWi): draft bill for the implementation of European Union law and for the regulation of a pure hydrogen network within energy industry law, Berlin, *https://www.bmwi.de/Redaktion/DE/Downloads/Gesetz/gesetzentwurf-en-wg-novelle.pdf?__blob=publicationFile&v=4* (viewed on 20 May 2021).

27 Weber, E. U., Lindemann, P. G. (2007): "From intuition to analysis: Making decisions with our head, our heart, or by the book", in: H. Plessner, C. Betsch, T. Betsch (eds.): Intuition in Judgment and Decision Making, Mahwah, New Jersey.

28 Reeck et al. (2021): "How we decide shapes what we choose: Decision modes predict consumer decisions about environmentally-friendly electrical utility rates and plans", in: Journal of Marketing (in print).

29 Reeck et al. (2021): "How we decide shapes what we choose: Decision modes predict consumer decisions about environmentally-friendly electrical utility rates and plans", in: Journal of Marketing (in print).

other things, this is subject to the swift digitalisation of the energy supply systems. Diverse involvement and information opportunities also boost acceptance, such as knowledge platforms for the preservation of biodiversity and environmental protection. In addition, decentralised non-governmental neighbourhood solutions, for example in the area of electricity supply, can help to boost acceptance.

B.5. Shape structural change to be socially balanced and strengthen a "just transition" globally

A diverse array of **synergy potential** for reducing social inequality presents itself when the negative effects of climate change are tackled, these frequently affecting those who are the poorest. If climate policy fails to adequately accommodate social issues, this can lead to increasing inequality and social upheavals, and can even reinforce them in times of crisis. This is clearly illustrated both nationally and globally by the coronavirus and climate crises.

The transformation needed to a climate-neutral economy will affect all areas of society. It is therefore essential that social balance and climate protection be linked. Germany can contribute to a socially balanced transformation to climate neutrality, to a **"just transition",** by achieving climate targets which are compatible with the Paris Agreement and by taking social aspects such as the distribution effect of national and international measures and in international climate funding into account. For example, the carbon price could have social compensation attached to it, such as per capita payment of the revenues from carbon pricing to citizens, a refund due to the abolition of the EEG levy and the reduction of the tax on electricity or sector-specific measures.[30]

In the buildings sector, the costs of energy-efficiency modernisation need to be distributed evenly. To achieve this, the allocation of modernisation costs could be amended in tenancy law, government aid for hardship cases could be increased and funding programmes should be aligned with the goal of climate-neutral building stock. An energy-efficiency drive for private households, municipalities and businesses which is based on advice initiatives such as the free Energy Saving Check would also be expedient.[31]

A systemic approach also takes into account not only the benefits and costs of action, but also the **impacts of non-action,** such as the increasing physical and health

30 Preuss, M., Reuter, W.H., Schmidt, C.M. (2019): "Verteilungswirkung einer CO_2-Bepreisung in Deutschland", Working Paper 08/2019, German Council of Economic Experts, Wiesbaden.

31 Cf. e.g. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (2018): written report on the 61st Conference of Secretaries of State of the Federal Government and Länder and the 90th Conference of Environment Ministers from 6–8 June 2018 in Bremen, agenda item 18, *https://www.umweltministerkonferenz.de/documents/top_18_energieeffizienz_bericht_1533022450.pdf* (viewed on 20 May 2021).

impacts of climate change. Acceptance of an ambitious climate policy could also be increased if it visibly also addressed other challenges such as participation, good work, affordable housing, adequate nutrition, affordable and reliable energy supplies and clean air, and if corresponding narratives for prosperity and quality of life were reinforced.

Above and beyond Germany's Structural Development Act for coal-mining regions and the EU's Just Transition Mechanism, the policymakers can **proactively take up structural change** (which is often disruptive) in regions and sectors which are especially affected by climate policy measures, for example to lessen the social hardships for workers and to create prospects through **qualification drives**, the expansion of renewable energies and the promotion of new value chains and jobs, among other things. Strategies should be developed early on for the industries and regions affected in particular by transformation and structural change, such as the automotive, steel and cement industries, in order to open up new future opportunities for workers.

C. Technological, economic and financial transformation

C.1. Expedite the restructuring and transformation of the energy system

One of the biggest challenges in converting the energy system and industrial processes to achieve climate neutrality is the need for policymakers to make decisions involving **crucial commitments lasting decades,** which are difficult or extremely costly to correct. At the same time, the costs arising from anticipated climate damage are increasing. The objective is to avert these, both by investing globally in low-emission infrastructures and by making adjustments. A long-term commitment paves the way for investors and operators to incorporate lengthy depreciation periods into their planning and thereby achieve viable cost structures. When it becomes necessary to **expand infrastructures or build new ones**, it is frequently more cost-effective in macroeconomic terms to put in place a single system instead of setting up several parallel systems using different technologies. Proposals of this kind are often countered with a demand for **technological neutrality**.

Technological neutrality is advantageous for large transformation projects – especially in the initial phase – as a means of avoiding making commitments early on which may prove erroneous. This is because there is no such thing as a static, optimum solution, as the technological, economic and societal environment is constantly changing. However, when it comes to tackling the complete overhaul of the energy system, there are **only a handful of fundamentally different technological options** to meet the ambitious climate targets for 2030/2050. Completely new, **currently unheard-of technologies** will not assume a significant role in the energy system until several decades' time. Researching these remains an essential contribution to the future; however, they will have little impact on reaching the 2050 climate targets to limit global warming. Considering the long time frames involved in implementing technologies on the scale of the whole energy system, the conversion of the energy system must be **expedited simultaneously along all major identifiable lines of development**.

Enhancing **energy and materials efficiency** remains a **key area** for research and development. As well as tapping efficiency potential, approaches based on the circular economy, sufficiency and alternative indicators of prosperity[32] should be considered

32 High-Tech Forum (2020): "Sustainability in the innovation system – a discussion paper from the High-Tech Forum", Berlin, *https://www.hightech-forum.de/wp-content/uploads/high-tech_forum_discussion_paper_sustainability.pdf* (viewed on 20 May 2021).

in an emissions prevention strategy.[33] However, viewing efficiency improvements and sufficiency alone as a key lever would fall short of the mark because the success of these efforts cannot be planned and considerably larger amounts of energy are needed to transform Germany as a seat of industry and for digitalisation. Significant cost savings are primarily achieved by economies of scale in industry.

Reputable scientists and engineers currently consider the measures and technologies discussed below to be both feasible from a technical and economic viewpoint and absolutely essential for achieving the climate targets (**no-regret measures**).[34] It is therefore advisable to start implementing them without delay and to ensure that all criteria that are developed can be revised.

If energy is to be made available without significant carbon emissions, it is essential that fossil fuels are phased out rapidly. **Expanding renewables is therefore a central, prime objective** of Germany's climate policy. The only alternatives which are expandable and suitable for large-scale use in Germany and which also possess the necessary technological maturity are **photovoltaics (PV)** and **wind power**. There will not be any more cost-effective technologies in this country in the foreseeable future which offer comparable scalability. **Bioenergy, geothermal energy and hydroelectric power** have limited potential but may play an important supplementary role both locally and in cross-regional networks. Additional output corresponding to the current peak load (70 GW) can be sourced from available gas power plants which initially continue to operate using **natural gas** and can be switched to green **hydrogen** or synthetic fuels later on. The expansion of wind energy and repowering of existing facilities should be accelerated considerably. Greater use must also be made of photovoltaics. This applies to decentralised systems on roofs and facades, but also large solar parks. There is no doubt that the energy supplied by these will be needed in the future.

As renewable electricity is increasingly becoming the mainstay of the energy supply, **new electrical applications must also be expanded** further with a view to increased sector coupling. In particular, **heat pumps** to supply heat (heating, hot water, process heat) and (battery-)electric, intermodal **mobility** – including the necessary infrastructure – must be ramped up as a matter of urgency, without stimulating the use of fossil-based power.

A green hydrogen economy must be established immediately and reliably in order to decarbonise energy-intensive industries such as steel and chemical manufacturing. Rapidly scaling up green hydrogen production and distribution is a critical factor here. In the interests of setting up a hydrogen economy quickly and accelerating the rate at which production processes are switched to hydrogen, blue and – if applicable –

33 German Council for Sustainable Development (RNE) (2020): "Making hydrogen a sustainable decarbonisation option", Berlin, *https://www.nachhaltigkeitsrat.de/wp-content/uploads/2020/06/20200617_RNE_Recommendation_Hydrogen.pdf* (viewed on 20 May 2021).

34 Leopoldina German National Academy of Sciences, acatech – National Academy of Science and Engineering, Union of the German Academies of Sciences and Humanities (2020): "Energy transition 2030: Europe's path to climate neutrality", Berlin, *https://www.leopoldina.org/uploads/tx_leopublication/2020_Energiewende_2030_En_Final.pdf* (viewed on 20 May 2021).

turquoise hydrogen could also be used for a transitional period, which should be kept as short as possible. To prevent lock-in effects and stranded assets, greenhouse gas neutrality should be monitored regularly, including via life-cycle analysis.

In the future, **green fuels** will be needed as an alternative to fossil fuels for aviation, international shipping and off-road vehicles including agriculture. Intense research and development efforts are required for their **cost-optimised, sustainable production** based fundamentally on existing technologies to achieve technological leadership and reduce emissions in Germany. Compared with other countries, Germany is in a very favourable position to achieve this, provided the initiated support measures continue and feed through into an economically viable environment. Attention must also be paid to potential conflicts of aims with regard to food security, land use and the interests of countries which are producing these fuels. To achieve the cost reductions which are urgently needed, regulatory risks must be minimised, and systems expanded continuously in order to achieve economies of scale.

It is essential that investments are made in global energy partnerships as it will be extremely difficult to provide the energy needed for Central Europe solely by ramping up PV and wind power in Europe. International **energy imports** will therefore remain necessary long-term. In the next few decades, **hydrogen could be manufactured and distributed globally** from countless locations around the world – such as Australia, Morocco or Chile – at relatively low cost with the aid of sun and wind. Corresponding **pilot plants** should be realised now to enable Germany to share economically in this global trend as a technology supplier.

C.2. Accelerate the transformation of industry

Germany is **currently the biggest emitter of greenhouse gases in the EU** and with all sectors taken together caused 739 million tonnes of CO_2 equivalent in 2020.[35] Due to the coronavirus crisis, this figure was considerably lower than in 2019 (810 million tonnes of CO_2 equivalent). In 2020, 30% of the emissions were generated by the energy sector, followed by industry, which accounted for 24%. Approximately 20% of Germany's CO_2 emissions stemmed from mobility, 16% from buildings and 9% from agriculture.[36]

Among the **energy-intensive industries**,[37] the lion's share of carbon emissions originate from the following sectors: iron and steel (approx. 30%), refineries (approx. 19%),

35 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2021): press release "Greenhouse gas emissions fell 8.7 percent in 2020", Berlin, https://www.bmu.de/en/pressrelease/greenhouse-gas-emissions-fell-87-percent-in-2020/ (viewed on 20 May 2021).

36 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2021): press release "Greenhouse gas emissions fell 8.7 percent in 2020", Berlin, https://www.bmu.de/en/pressrelease/greenhouse-gas-emissions-fell-87-percent-in-2020/ (viewed on 20 May 2021).

37 Industrial emissions arising from energy consumption and processes.

cement clinker production (17%) and chemicals (14%).[38] The energy-intensive **primary industry** faces a **far-reaching transformation** in the next decade to safeguard Germany's competitiveness as a location for industry. The shift towards climate neutrality calls for extensive, targeted investments which go beyond the necessary efficiency measures.[39] **Long investment cycles and the need for considerable investments** mean that action must be taken straight away. Between now and 2030, up to 50% of the plants in important branches of industry will need to be replaced as part of reinvestment cycles.[40] This offers a huge opportunity for a transformation towards climate neutrality. A number of important technologies for decarbonisation (e.g. in the steel, cement and chemicals industry) are already available or are on their way to achieving market maturity. Others, meanwhile, are still in the R&D phase and need to be scaled up consistently (e.g. e-furnace, recycling technologies, etc.). Conceivable steps would be switching to green hydrogen, closing materials loops by means of technology (circular economy), and storing and utilising CO_2 if no other technologies are on the horizon (e.g. in the cement industry). A corresponding **policy framework** must be put in place to achieve this and also to prevent stranded assets in conjunction with plants whose useful lives stretch far beyond 2050. Such a framework might include tools such as Carbon Contracts for Difference or quotas for green hydrogen that increase over time.

The energy sector is elementary to and takes priority for the economic transformation of all sectors because many industrial conversion processes rely on a supply of renewable electricity for both direct ('electrification') and indirect (power-to-X) use to enable a rapid switch to new technologies. It is important that **policymakers, industry and society agree on concrete sectoral roadmaps and an overall mix of energy sources** at an early stage. The time frame for the provision of renewables will be a critical factor – as well as dovetailing energy with the conversion pathways for industry – in facilitating the successful transformation of energy and industry. The long-term climate strategy, the German integrated energy and climate plan, and the principle of avoiding subsidies that hinder the transformation define the framework of objectives and the timescale.

38 German Emissions Trading Authority (2019): "Greenhouse Gas Emissions in 2019", Berlin, *https://www.dehst.de/SharedDocs/downloads/EN/publications/2019_VET-Report.pdf?__blob=publicationFile&v=2* (viewed on 20 May 2021).

39 Agora Energiewende, Wuppertal Institute (2019): "Climate-Neutral Industry: Key Technologies and Policy Options for Steel, Chemicals and Cement", Berlin.

40 Agora Energiewende, Wuppertal Institute (2019): "Climate-Neutral Industry: Key Technologies and Policy Options for Steel, Chemicals and Cement", Berlin.

C.3. Foster the transformation of mobility, buildings and land use

A **fundamental transformation of the energy system** to achieve climate neutrality is technically feasible and **closely linked with decarbonisation pathways in other carbon-intensive sectors and key areas of transformation** such as mobility, buildings and land use (including agriculture and forestry). Citizens have direct experience of these areas, so they are highly relevant for participation and communications. The available solutions are constantly changing. Furthermore, sector coupling and the growing number of players in decentralised systems will make energy supply networks much more **complex**.

The **mobility sector** accounts for approximately 20% of Germany's greenhouse gas emissions and has barely reduced its emissions in recent years.[41] This means that **particularly great efforts are needed** here to achieve climate neutrality. As well as establishing **a varied, affordable, intermodal mobility offering that prioritises cycling, walking and public transport**, a **structural change is needed in vehicle drive technologies** and by means of digitalisation and automation.

Switching to climate-friendly drive systems is crucial for the automotive industry's international competitiveness. Furthermore, with respect to **road traffic of individuals**, Germany must forge ahead with expanding the charging infrastructure and gradually electrifying private vehicles with battery-electric drives. Fuel cells or overhead cables are worth considering for **goods transport on roads**. **Aviation and shipping** cannot be electrified in the foreseeable future and should be switched to synthetic fuels from renewable sources. In addition, international aviation and shipping should be included in European emissions trading; exemptions from energy tax and **subsidies for diesel, petrol, kerosene and marine fuels should be abolished**.

Public transport, cycling infrastructure and rail transport must be given a considerable boost and expanded – in both urban and rural areas – as an **alternative to private cars**. **Goods transport** must also make greater use of rail. This could be achieved, for example, by removing bottlenecks in the rail network, reactivating sidings and making it more expensive to transport goods using HGVs. In many European cities, road space is being redesignated to encourage people to switch from private cars to climate-neutral forms of mobility. More support should be given to municipalities in Germany to help them develop and implement sustainable, attractive **mobility and urban planning concepts**.

Heat (space heating, process heat, hot water, process cooling and air-conditioning) accounts for more than half of the total final energy consumption (approx. 1,400 TWh in 2019). 69% of the final energy consumption for heat is still covered by natural gas,

41 Leopoldina German National Academy of Sciences (2019): "Climate targets 2030: Towards a sustainable reduction of CO_2 emissions", Halle (Saale).

oil and coal. Gas is the dominant fuel for heat generation with a share of 597 TWh. Oil (213 TWh) and coal (116 TWh) also play significant roles. 229 TWh stem from electricity and district heating, though still largely generated using fossil fuels. Renewables make up just over 14% of heat generation.[42] In light of the EU's ambitious target-setting, efforts to reduce emissions must be stepped up considerably in the **buildings sector** as well by 2030. The European Commission's goal of doubling the **refurbishment rate** in the next ten years should therefore be implemented consistently – or even exceeded – in Germany and elsewhere. In this context, closer attention must be paid to conflicts of aims between property refurbishment, rent trends and the conservation of historic buildings. Tapping **efficiency potential** presents a **large number of pathways and options**, for example by means of refurbishment and facility modernisation, making greater use of electricity-based solutions with heat pumps, utilising solar thermal energy or waste heat from cogeneration, and using climate-neutral hydrogen and green gases for district heating generation and the gas distribution network. Due to considerable local differences – including the process heat requirements of some 1.6 million companies in the distribution networks – it is currently impossible to say with certainty which possible route to decarbonisation is preferable. With this in mind, we recommend an in-depth analysis examining the development of possible pathways for achievement of the climate protection targets. These must be efficient, socially balanced and actionable at local level.

Agriculture must become more ecologically minded and sustainable as a whole in order to reduce the emissions associated with farming. Taking steps to protect the climate must be worthwhile for farmers. This calls for a fundamental change in the provision of subsidies and in specific targets. For consumers, the focus is on shifting food systems towards climate-friendly, affordable alternatives.[43] The whole food system should be incorporated into emissions trading to enable a sustainable food reform. In agriculture, **excess nitrogen** can be reduced by means of more efficient fertilisation and by growing more legumes. Sustainable management and the resulting humus formation ensure that farmland functions as a carbon sink. **Keeping carbon in the soil** helps to protect ecosystems and the climate. Permanent pasture and conservation areas should be preserved and enlarged; organic soils used for farming[44] can be re-wet and used as grassland or for paludiculture[45] to substantially reduce emissions of greenhouse gases.

Land-based measures to reduce and store emissions have the potential to become greenhouse gas sinks themselves. However, attention must be paid to possible negative **knock-on effects for biodiversity and food security**. Possible means of

42 Federal Ministry for Economic Affairs and Energy (2021): "Dialog Klimaneutrale Wärme", Berlin, *https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/dialog-klimaneutrale-waerme-zielbild-bausteine-weichenstellung-2030-2050.pdf?__blob=publicationFile&v=14* (viewed on 20 May 2021).

43 Cf. e.g. Federal Environment Agency (2019): "RESCUE – Resource-Efficient Pathways to Greenhouse-Gas-Neutrality", Dessau-Roßlau. Cf. also German Advisory Council on Global Change (2020): "Rethinking Land in the Anthropocene: from Separation to Integration", Berlin.

44 Organic soils are those which contain more than 30% organic matter. In Germany, this is almost exclusively (former) marshland.

45 Paludiculture means farming on wet moorland and fens.

preserving and **restoring natural ecosystems** include reforestation and restoring degraded forests, promoting grassland ecosystems, and restoring lakes, rivers and marshes. Grassland ecosystems and wetland/marshes sequester very large quantities of carbon, especially in the soil.[46] **Carbon sinks in coastal areas** – so-called blue carbon ecosystems such as coastal marshes, seagrass beds, salt marshes and mangrove forests – should be conserved and restored around the world. An undisturbed seabed also serves as a carbon sink, but practices such as bottom trawling and mineral extraction substantially reduce its ability to perform this function.

C.4. Define investment paths for realisation of the Paris Agreement

Sizeable private funds need to be mobilised in order to implement the Paris Agreement. At EU level, a study estimates that cross-sectoral gross investments of around 28 trillion euros will be needed by 2050 to achieve climate neutrality.[47] Broken down to Germany, this equates to investment requirements of up to six trillion euros through 2050.[48] Around 23 trillion euros of the total sum for the EU relate to investments which would have been made anyway, but which now need to be redirected to climate-neutral alternatives. There would need to be an additional approximately five trillion euros of spending on clean technologies and techniques up to 2050 in the EU, equating to an average of 180 billion euros a year.[49]

An economic assessment of the net additional expenditure must take into account considerable **cost savings and co-benefits** in a large number of areas, e.g. decreased energy costs, industry policy **opportunities**, new jobs and impetus for value creation, and the reduction of climate damage.[50] Accelerating technological progress could also drive down the net costs further.[51] Other factors – such as additional expenditure arising from more rapid structural change or to substitute the remaining non-energetic use of fossil resources – may counteract this, however. In all likelihood, the **transformation challenges** will vary greatly **from sector to sector** with regard to investment time frames and the technological maturity of climate-friendly innovations, as well as due to interdependencies between sectors.

46 German Advisory Council on Global Change (2020): "Rethinking Land in the Anthropocene: from Separation to Integration", Berlin.

47 Derived from McKinsey & Company (2020): "Europe's path to decarbonization", *https://www.mckinsey.com/business-functions/sustainability/our-insights/how-the-european-union-could-achieve-net-zero-emissions-at-net-zero-cost* (viewed on 20 May 2021).

48 Derived from McKinsey & Company (2020): "Europe's path to decarbonization", *https://www.mckinsey.com/business-functions/sustainability/our-insights/how-the-european-union-could-achieve-net-zero-emissions-at-net-zero-cost* (viewed on 20 May 2021).

49 Derived from McKinsey & Company (2020): "Europe's path to decarbonization", *https://www.mckinsey.com/business-functions/sustainability/our-insights/how-the-european-union-could-achieve-net-zero-emissions-at-net-zero-cost* (viewed on 20 May 2021).

50 National Academies of Sciences, Engineering, and Medicine (2021): "Accelerating Decarbonization of the U.S. Energy System", Washington.

51 Prognos, Öko-Institut, Wuppertal Institute (2020): "Towards a Climate-Neutral Germany", Executive Summary commissioned by Agora Energiewende, Agora Verkehrswende and Stiftung Klimaneutralität", Berlin, p. 10.

For instance, switching industrial production and manufacturing processes depends crucially on the transformation of the energy sector. In 2020, approximately 251 billion kWh of electricity was generated from renewable sources.[52] **As much as four times this amount of renewable power must be produced** to decarbonise industry alone – meaning that 1,000 TWh/a must be available in the 2030s.[53] In the coming two decades, investments must primarily be made in the electrification of industrial production and manufacturing processes and in the switch from fossil fuels to hydrogen and electric technologies in the chemicals and steel industries. Depending on the availability of renewables, it is therefore to be expected that most plants will be converted to this energy mix between 2030 and 2040 since research timescales in the industrial sector average approximately eight to ten years and innovations should have reached the necessary technological maturity by then.

C.5. Strengthen industry's ability to compete through climate-friendly innovation markets

As part of the **European Green Deal**, extensive regulatory adjustments will be made relating to food systems, the energy sector, sustainable transport systems and the circular economy. These will **gear markets more strongly towards sustainable innovations**.

Innovation markets include recycling markets, biodegradable packaging solutions, carbon farming in agriculture, sustainable aquaculture and alternative proteins for the food systems of the future. In addition to this, there are widely discussed topics such as hydrogen technologies, heat reflection and insulation technologies in the buildings sector, lightweight construction, and new leasing and sharing models for modern transport systems or household goods.

On the one hand, regulation will render whole product and technology categories obsolete, but at the same time this transformation will **create a host of new innovation markets** as we move towards a new, efficient resource-based economy which adds concrete value to more sustainable economic output. Against the backdrop of this historically unique **transformation**, it is all the more important for policymakers to remove obstacles to innovation, heavily promote research and development for sustainability, and establish a climate policy framework that **provides reliable planning periods and time frames for industry.**[54] At the same time, there is an opportunity to **proactively leverage the capital market as a source of finance for the transformation** and relieve pressure on the national budget by grouping the innovation markets

52 Federal Environment Agency (no year of publication): "Renewable energies in figures", Dessau-Roßlau, *https://www.umweltbundesamt.de/en/topics/climate-energy/renewable-energies/renewable-energies-in-figures* (viewed on 20 May 2021).

53 Based on calculations by the authors of the policy paper Saori Dubourg and Robert Schlögl.

54 High-Tech Forum (2020): "Sustainability in the innovation system – a discussion paper from the High-Tech Forum", Berlin, *https://www.hightech-forum.de/wp-content/uploads/high-tech_forum_discussion_paper_sustainability.pdf* (viewed on 20 May 2021).

together into categories (sustainable transport, energy management, food systems, etc.) and linking them with innovative financing instruments.

These **new innovation markets** have **much higher average growth rates than current industrial markets** (between 2% and 15% per annum).[55] There is also an opportunity to position Europe as a front runner in these markets. As well as a sharp increase in domestic demand for such solutions, it is safe to assume that the USA and China will also invest heavily in these fields in the coming years.

Europe and Germany should utilise their technological edge vis-à-vis climate-friendly products and technologies to achieve ambitious climate targets and secure substantial slices of the market. It is particularly **important to keep the relevant value creation in Europe** in order to link international competitiveness and economic independence and to **safeguard jobs** long-term. Failure to proactively use the technological edge to rapidly tap new markets and thereby create new jobs would cause this advantage to disappear in just a few years' time (approximately three to five years).

C.6. Initiate a transition to a climate-friendly circular economy

Around the world, the structures of production and consumption are based on a **linear way of thinking.** As a consequence, products are designed for a single, often very short useful life and subsequently discarded. At its core, **the established economic model** rests on maximising the throughput of raw materials. The indirect environmental impact of this is becoming more and more severe. This model is **reaching its limits**: in 2020, for the first time, mankind extracted more than 100 billion tonnes of raw materials from global ecosystems. According to the International Resource Panel (IRP), their provision and use is responsible for a substantial proportion of greenhouse gas emissions and a large share of biodiversity loss.[56] A **systematic transition to a circular economy** with closed-cycle materials use from design through to recycling can make a key contribution to climate protection and preserving biodiversity.[57] To achieve this, Germany needs a systemic circular economy strategy which aims to reduce resource consumption in absolute terms along with energy consumption. This strategy must go far beyond the waste legislation which has governed this area to date and integrate aspects of fiscal, financial and foreign trade policy as well, for example.

55 BASF (no year of publication): Global Foresight Database.

56 IRP (2020): "Resource Efficiency and Climate Change: Material Efficiency Strategies for a Low-Carbon Future. A report of the International Resource Panel", United Nations Environment Programme, Nairobi, *https://www.resourcepanel.org/reports/resource-efficiency-and-climate-change* (viewed on 20 May 2021).

57 Material Economics (2019): "Industrial Transformation 2050: Pathways to Net-Zero Emissions from EU Heavy Industry", Stockholm, *https://materialeconomics.com/publications/industrial-transformation-2050* (viewed on 20 May 2021).

Sufficiency-based approaches also offer a great deal of potential for new business ideas and innovations whilst helping to protect the climate.[58]

A circular economy incorporates a wide range of measures which start with **thoughtful product design**. This includes making the materials used easier to **separate and reuse** (circularity by design) and **designing products to last, be repairable** and withstand intense use. Reuse, remanufacturing, and mechanical and chemical recycling are also crucial tools which lend themselves to being combined – for example, in the case of plastics to substantially increase the proportion of secondary plastics, which currently stands at 13.7%.[59] A circular way of thinking aims to reduce the use of resources and energy and to preserve the value of products and the raw materials they contain. Steps for this therefore need to be taken and integrated at various levels:

At **technical level**, a Circular Economy 4.0 must be created with the aid of digitalisation. This would be able to pass on information about products, how they were made, their use and their final whereabouts, e.g. via digital product passports throughout the value chain. New technologies and processes which conserve resources need to be developed on this basis. Planning usage cycles and recycling processes right from the outset is particularly important for the availability of crucial rare metals. This is critical for the rapid transformation of infrastructures, especially in the energy sector. At **economic level**, incentives can be created for new circular business models founded on waste minimisation and resource efficiency (e.g. by expanding individual manufacturers' responsibilities, imposing compulsory deposits or taxes on primary raw materials, and introducing quotas for 'circular products' in connection with public procurement). Rebound effects must be taken into consideration by means of sustainable circular business models. At **political level**, the steps to be taken include creating a framework environment that promotes innovation[60] and appropriate product design. With the amendment of the Ecodesign Directive in March 2021, the EU has taken its first few steps to concretely embed the importance attached to the circular economy in the European Green Deal.[61] Public procurement practices could play an exemplary role in this context. At **societal level**, greater support must be given to consumers who want to make an active contribution to the use of circular products. A modernisation and training initiative is also needed – especially for the skilled trades and SMEs – to ensure that the necessary skilled workers are available. To implement a circular economy, exporting waste of any kind to other countries outside Europe should be prohibited.

58 Fraunhofer ISE (2020): "Paths to a Climate-Neutral Energy System", Freiburg, *https://www.ise.fraunhofer.de/en/publications/studies/paths-to-a-climate-neutral-energy-system.html* (viewed on 20 May 2021).

59 Federal Environment Agency (no year of publication): "Kunststoffabfälle", Dessau-Roßlau, *https://www.umweltbundesamt.de/daten/ressourcen-abfall/verwertung-entsorgung-ausgewaehlter-abfallarten/kunststoffabfaelle#kunststoffe-produktion-verwendung-und-verwertung* (viewed on 20 May 2021).

60 High-Tech Forum (2021): "Eine offene Innovationskultur für eine nachhaltige Zukunftsvorsorge", Berlin, *https://www.hightech-forum.de/wp-content/uploads/ideenpapier_innovationskultur_und_zukunftsvorsorge_2021.pdf* (viewed on 20 May 2021).

61 The new directive requires fridges, dishwashers, washing machines, televisions and other products to meet stricter repairability requirements. The aim of the directive is to promote longer-lasting products.

C.7. Significantly accelerate foresighted investments in the infrastructure of the future

Faster, forward-looking infrastructure expansion, such as of power networks or charging infrastructure, is essential to the achievement of climate protection targets. **Infrastructure planning for the period to 2030 and to 2050** is based on **realistic prognoses** of the electricity required for direct consumption and power-to-X usage and the need for green chemical energy sources. A **timely, comprehensive package of infrastructure investment** is advisable here.

The **energy supply** relies on high-performance **transmission and distribution infrastructures**. The lead times involved in planning and constructing these are long – usually in excess of ten years at present – and their operating lives and depreciation periods typically span several decades. However, without the considerable expansion and further technical development of the low-, medium- and high-voltage networks for **electricity**, it will be impossible to switch to carbon-free power generation. Likewise, gas network capacities for **hydrogen** must be ramped up in line with demand and requirements. The National Hydrogen Council is developing concepts to this end.

Germany's **gas infrastructure** consists of a high-performing, heavily fragmented natural gas network. It has considerable **storage capacity** of approximately 234 TWh in domestic underground gas storage facilities. Climate policy target-setting will cause the demand for natural gas to decline sharply by 2050. However, in the future, some of the infrastructure could also be used to transport and store **hydrogen** and in the heating market. During the green hydrogen set-up and start-up phase, the Federal Government should quickly identify which parts of the natural gas infrastructure are suitable for future use and should therefore be upgraded for green hydrogen so as to ensure cost efficiency and avoid stranded assets arising as a result of misdirected investments in gas infrastructure.

Other important elements of the energy infrastructure are its **interfaces with neighbouring countries** via cables and pipelines and its overseas links via efficient energy ports that enable hydrogen and its secondary products to be imported. A functioning infrastructure also includes **long-term gas storage facilities** for the provision of public utilities along with access to sufficient cross-sectoral **flexibility** with regard to generation and consumption to offset short-term fluctuations. A high-performance **data and communication structure** is needed alongside the electricity and gas infrastructure in order to achieve the greatest possible technical and economic efficiency by utilising network capacity as evenly as possible.

Germany's 'hidden champions' already include numerous market leaders and global market leaders in highly specialised areas such as linking production technologies, mechanical engineering and materials development with digitalisation technologies. In the long term, these companies can grow and succeed internationally with product- and process-oriented solutions. They already show how **efficiency potential can**

be tapped in the course of the transformation towards an efficient, climate-friendly, resource-based economy **particularly by expanding digital infrastructure**. For example, consistently interconnecting energy efficiency and digitalisation could enable industry to save approximately 0.6 million tonnes of carbon emissions from mechanical energy and one million tonnes of carbon per annum from process heat by 2050.[62]

Data on the consumption of relevant process media such as heat, cold or compressed air can pave the way for reducing energy costs through digitally optimised process automation, load shedding management and weekend switch-offs. **Digitalising the distribution networks for renewables** is therefore a crucial prerequisite for avoiding energy losses that can arise from large-scale compensation for the volatility of renewables. Issues relating to security of supply and data security must also be taken into account. For the expansion and conversion of the required infrastructure, it is also necessary to **make planning law more flexible, speed up approvals processes, increase human resources and expertise within the judiciary and the relevant authorities**, and consistently digitalise procedural and public participation. The recommendations of the **Regulatory Control Council** contain a wide range of reform options which deserve to be paid far more attention.[63]

Any expansion of infrastructure and facilities for renewable energy often conflicts with efforts to protect biodiversity and the individual interests of citizens affected by the proposal. Clear processes must be defined for assessments, prioritisation, the consideration of interests, and safeguarding biodiversity. To achieve this, comprehensive planning and participation processes must be initiated at an early stage, planning procedures must be improved using standards for reports, and the existing opportunities offered by infrastructure and planning legislation need to be exploited. Legal proceedings could be accelerated by introducing a requirement to identify relevant issues early on and a procedural roadmap, which must likewise be drawn up at an early stage.

It is highly probable that carbon dioxide will have to be removed from the atmosphere in order to achieve the Paris climate targets; all of the modelling in the IPCC Fifth Assessment Report includes removal.[64] The slower greenhouse gas emissions are reduced, the greater the need to **use negative emission technologies** will become. These include the worldwide protection and establishment of natural sinks, e.g. by means of reafforestation. Technological means of carbon capture, storage and utilisation (CCSU) may also be necessary. However, CCSU is considered controversial in Germany due to **conflicts of interest**, for example with regard to land use. Pilot projects in connection with German coal-fired power plants have not succeeded in either financial or technological terms.

62 Boston Consulting Group (2018): "Climate Pathways for Germany", Munich.

63 Cf. National Regulatory Control Council (2020): "Opportunities for speeding up administrative court proceedings pertaining to projects for the construction of infrastructure facilities and industrial installations", Berlin, *https://www.normenkontrollrat.bund.de/resource/blob/656764/1604366/202e6db27b62db8bd5b133602aa9c6e0/2019-04-30-gutachten-englisch-data.pdf?download=1* (viewed on 20 May 2021).

64 IPCC (2014): "AR5 Synthesis Report: Climate Change 2014", Geneva, *https://www.ipcc.ch/report/ar5/syr/*.

However, based on the IPCC's scenarios, it is necessary to **explore elements of uncertainty surrounding negative emissions technologies in pilot projects,** in addition to rapidly reducing greenhouse gases. In particular, questions relating to land use, environmental impacts, costs and public acceptance must be addressed urgently. At the same time, alternatives should be examined and further developed on an ongoing basis. These include, for instance, using alternative substances such as wood and lightweight materials, the potential of the circular economy and – where possible – avoiding new construction.

A policy framework would be important to ensure that, in the future, the potential of CCSU technologies is particularly utilised in areas where residual emissions are currently unavoidable. These include the steel and cement industries and agriculture. Due to long investment cycles – e.g. in the primary industry – it is necessary to provide **investment and planning reliability early on so that infrastructure can be put in place**. Furthermore, carbon must also be integrated in line with the principles of a circular economy. CCS partnerships should be investigated in this context, perhaps with countries such as Norway or Iceland.

C.8. Position education, research and development correctly

Many technologies for material energy conversion, reuse in a circular process and the provision of high-performance materials need to be **researched more intensively** before they can be used on a large scale. Research and development create fundamental prerequisites for all transformation processes. This is particularly true if Germany wants to assume a leading role in Europe as a **supplier of climate-friendly technologies**. What is more, a greater focus should be placed on system innovations – and therefore also **social, institutional and organisational innovations**. Given the systemic nature of supplying energy and raw materials, collaboration within the Federal Government must be coordinated across units and departments. Furthermore, greater **interdisciplinary and transdisciplinary collaboration** is needed between science and engineering on the one hand and sociological and social science **research** on the other. Know-how sharing must also be stepped up.

Germany has the necessary structures and substantial resources to conduct R&D processes of this kind. However, considerable **problems arise in coordination** and at the interfaces between the many different players. Coordination is necessary because the R&D process is not linear: in many cases, progress is **simultaneous and disruptive**. Striving to reduce these problems is therefore critical to succeeding in the international race for technological innovations. The **necessary creative diversity** of research can be dovetailed more efficiently if the **state funding providers work together in a project structure spanning both national and regional bodies (Länder) rather than with department-based responsibilities**. Such a structure can foster the translation

of new ideas into market-oriented solutions that serve the whole system by taking an interdepartmental approach throughout R&D chains and **incorporating advice** from the many fora and councils based on a **roadmap of R&D priorities**.[65]

Research and development must be provided with **plannable, reliable resources** and need a stable, transparent **regulatory environment**. Confidence in this can be bolstered significantly by adjusting the legislation pertaining to subsidies and state aid so that **public funding providers and private operators** share the risks entailed in **demonstration projects** and ensure continuity of use together. Independent checks ensure that such partnerships are not abused. This attracts investors. The **new jobs** created at the interfaces of research and technology and between the players encourage a sufficiently large number of people to **complete professional training** in this field.

Highly qualified professionals are crucial for the transformation to succeed. To gain these, an **extensive retraining and qualification drive** is needed within industry, the skilled trades, commerce and trade, and this needs to be supported by companies, chambers of commerce, trade unions, employers' associations and the Länder. **Training and professional development** is extremely important to enable Germany to hold its own in the international competition to attract businesses. Its competitors include European partner countries which will produce green power and hydrogen at much lower cost in the future as the basis for industrial processes. Training and professional development is also a key means of actively shaping structural change in the spheres of energy, mobility, buildings and housing, industry and agriculture in line with the relevant regions' interests.

C.9. Realise innovative financing solutions for a transformational climate strategy

Given the huge amount of investment needed, it is particularly important to mobilise private capital in addition to public funding. To achieve this, greater use must be made of **innovative financing instruments from the private sector**, including venture capital. The strong growth in **sustainable investments** underlines the fact that the willingness to take sustainability – and especially climate issues – into account in investment decisions is a factor of relevance. This willingness can be found among institutional investors, high-net-worth individuals and small-scale investors alike. The **Sustainable Finance Committee** has already developed important recommendations for a number of areas, which have largely been adopted in the Federal Government's sustainable finance strategy.

65 High-Tech Forum (2020): "Paths to the 3.5 percent target", Berlin, *https://www.hightech-forum.de/wp-content/uploads/high-tech_forum_discussion_paper_3-5__target.pdf* (viewed on 20 May 2021).

Possible financing instruments based on the **EU taxonomy**, for instance, include **green bonds**, **themed funds** and **sustainability-linked bonds**, where dividend payments are explicitly linked to the achievement of certain sustainability targets at corporate level. **Benchmarks** for carbon emissions from taxonomy-compatible activities must be reduced at regular intervals to enable the target of European climate neutrality by 2050 to be achieved. In connection with the **taxonomy**, **transitional periods** must be defined for the phase-out and alternative usage of existing infrastructure, e.g. in the gas sector, to reduce investment risk without jeopardising the goal of climate neutrality. As a result of **new European reporting obligations for financial institutions (Regulation [EU] 2019/2088)**,[66] there is a great deal of capital market interest in such transparent, sustainability-related products.

Ultimately, the contribution made by big businesses to achieving climate neutrality will be reflected on the capital market. Transition risks arising from the climate policy framework – along with physical risks – mean that **a revaluation of company assets in sectors that are particularly affected** is unavoidable. In the future, these risks will have a major impact in the financial sector at portfolio level as well.[67] Major financial market players have already started restructuring their portfolios, often in response to pressure from investors. The German Federal Financial Authority (BaFin) and the Federal Government recommend incorporating **sustainability risks into company-specific stress tests**[68] and this should form a compulsory part of future regulations.

In addition, the government could promote private investment to fund climate neutrality by linking the carbon price with the interest payable on loans, thereby giving private investors a reliable decision-making basis relating to the future price of CO_2.[69] Furthermore, **funds could conceivably be structured explicitly in line with the innovative markets set out in the European Green Deal**. These include, for example, sustainable food and energy systems or the circular economy. This would allow investors to participate directly in financing new markets that are needed for climate neutrality.

Safeguarding the financial basis of the state includes a fiscal policy that prevents tax evasion and money laundering. The Federal Government should therefore commit to setting up **publicly accessible, globally linked transparency registers** (beneficial ownership registers) and help to establish tax transparency by requiring big businesses to report their tax payments publicly, on a country-by-country basis. These firms must be taxed on the basis of their global consolidated profits. The funds released in this way should also be used to finance climate neutrality.

66 Cf. Regulation (EU) 2019/2088 on sustainability related disclosures in the financial services sector and Regulation (EU) 2020/852 (Taxonomy) on the establishment of a framework to facilitate sustainable investment and to amend Regulation (EU) 2019/2088.

67 Cf. Stefano Battiston et al. (2017): "A Climate Stress-Test of the Financial System", in: Nature Climate Change 7, No. 4 (April 2017), pp. 283–88, https://doi.org/10.1038/nclimate3255.

68 Federal Ministry of Finance, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Federal Ministry for Economic Affairs and Energy (2019): "German Sustainable Finance Strategy", Berlin, https://www.bundesfinanzministerium.de/Content/EN/Downloads/sustainable-finance-strategy.html (viewed on 20 May 2021).

69 Edenhofer et al. (2020): "How the 'Green Deal' Can Provide the Right Incentives: A Proposal for The Design of a Fund for Public Financing of Sustainable Businesses and Real Investments", available at: https://ssrn.com/abstract=3673811 or http://dx.doi.org/10.2139/ssrn.3673811.

As investments in climate neutrality projects require short-term decisions with a long-term investment horizon, they are also suitable for long-term investors **such as European pension funds and insurance companies**. Together, these manage just over ten trillion euros.[70] At present, only a relatively small proportion of this (significantly less than 10%) is invested in infrastructure. Utilising life insurance and pension assets could be considered in order to meet the huge investment requirements, provided the regulatory requirements are met. We strongly recommend systematically examining and dismantling obstacles to investment (e.g. due to Solvency II).

The Federal Government, Länder and many municipalities have considerable assets, which have scarcely been used to finance the transformation to date. There is **no shared sustainability strategy** for the federal assets in the various **pension and annuity funds** to support the Federal Government's climate targets. Currently, the German Nuclear Waste Management Fund (KENFO) is the only vehicle to invest its 24 billion euros in an integrated fashion in line with sustainability criteria. It would be conceivable for a large number of public investment funds to take climate goals into account, e.g. by reducing the carbon footprint, in addition to risk and return objectives. A **central management system for federal assets** (sovereign wealth funds) and the **alignment of investments with the Federal Government's climate objectives** would put strong momentum behind the funding of climate neutrality. What is more, this would allow the state to lead by example and motivate private-sector financial market players to consider climate neutrality when making investment decisions. **Municipal and regional climate protection funds** should also be bolstered considerably.

The **Federal Government** is a **member or shareholder** of various multilateral organisations and development banks (such as the European Central Bank and the IMF) as well as state-owned institutions like KfW. In its capacity as such, it should use its voting rights to help bring about **transformational climate neutrality strategies** and **an attractive financing ecosystem** and to **stop the public funding and export credit financing of fossil energy sources**, in line with the **financing policy of the European Investment Bank**. Compulsory climate-related reporting for investors and companies could support this process. In this context, the KfW's concepts for transitioning towards a transformational development bank and the process for a sustainable finance roadmap are important points of reference for achieving the climate targets.[71] A review is also needed to examine the extent to which current monetary policy at the European Central Bank, the Deutsche Bundesbank and the German Federal Financial Authority (BaFin) supports fossil energy sources and how this could be changed. **Multilateral development banks** could play a pioneering role in trialling new financing instruments to mobilise and redirect private and institutional capital for sustainable purposes and present ambitious climate neutrality strategies.

70 Insurance Europe (no year of publication): "5 key facts about the European insurance industry", *https://www.insuranceeurope.eu/statistics* (viewed on 20 May 2021).

71 Cf. e.g. KfW (no year of publication): "KfW and Sustainable Development Goals", Frankfurt am Main, *https://www.kfw.de/nachhaltigkeit/KfW-Group/Sustainability/Strategie-Management/KfW-und-SDG/* (viewed on 20 May 2021).

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