

7. Decarbonisation support: a comparison with Germany

This chapter reviews policy instruments aimed at reducing greenhouse gas emissions in German industry and compares the German and Dutch policy landscapes. The German policy mix focuses strongly on energy efficiency and on recycling. Compared with the Netherlands, the German government is more reluctant to develop biomass and CCS. Germany's innovation funding policies strongly focus on fundamental research and CAPEX support, while the Netherlands provide greater support to demonstration projects and deployment. As a consequence, high operational costs are still a major barrier for large-scale investments in Germany.

This chapter reviews policy instruments aimed at reducing greenhouse gas emissions in German industry and compares the German and Dutch policy landscapes. It offers fact sheets of relevant policies, an assessment of the policy mix and a comparison with the Netherlands. Emphasis is placed on the carbon intensive industry sectors in Germany, with a particular focus on policies supporting technology innovation and diffusion in the following fields: hydrogen (including blue and green hydrogen), electrification of industrial heat (and the corresponding development of renewable energy to attain zero net emissions), carbon capture and storage (CCS), bio-based materials, recycling of materials (notably metals and plastics).

7.1. Policy fact sheets

The fact sheets below review decarbonisation policies geared towards the industry sector. Other related and cross-cutting policies and targets upon which the industrial transition also depends indirectly are discussed in the next section. Examples are support regimes for renewable energies to decarbonise electricity supply, the building of necessary infrastructure like a hydrogen transport network or the availability of green hydrogen.

The 27 policies reviewed in this chapter are listed below:

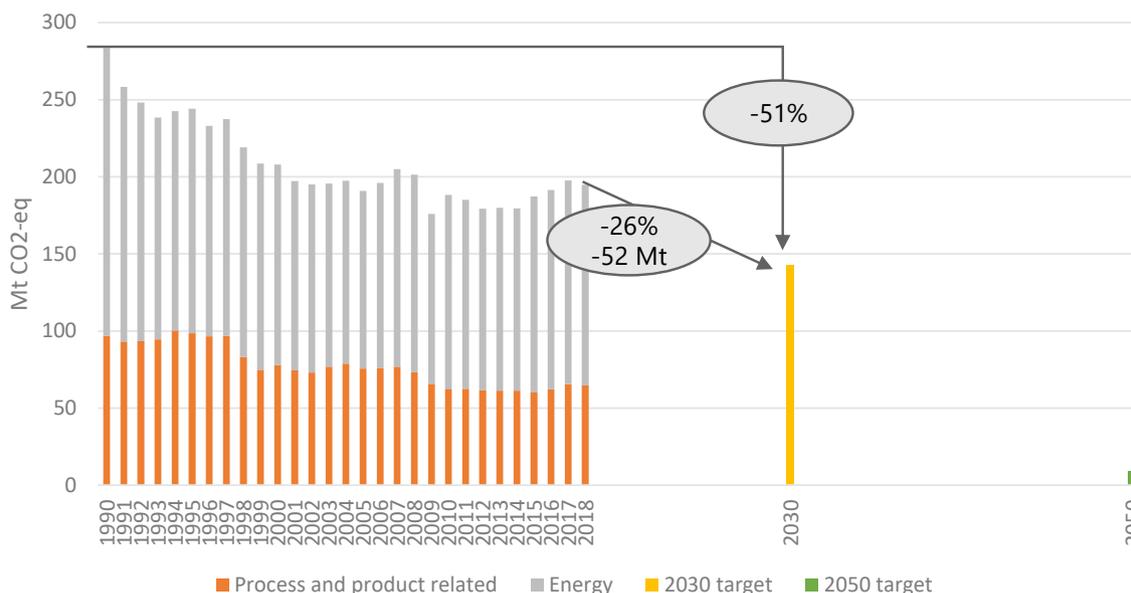
- National and sectoral greenhouse gas (GHG) reduction targets
- Carbon and energy pricing
 1. EU emissions trading
 2. National emissions trading scheme - CO₂-price for transport and heating
 3. Energy taxes and exemptions ("Spitzenausgleich")
 4. Renewable energy surcharge (Erneuerbare-Energien-Gesetz [EEG]-Umlage) and compensation scheme ("Besondere Ausgleichsregelung")
- Technology development, demonstration and market introduction programmes aimed at industry decarbonisation
 5. National Decarbonisation Programme
 6. Programme CO₂ Avoidance and Use in Basic Industries
 7. National Hydrogen Strategy: Carbon Contract for Differences (CCfD) pilot
 8. National Hydrogen Strategy: Important Project of Common European Interest (IPCEI) "Hydrogen for industrial production"
 9. EU Emission Trading System (ETS) Innovation Fund: further development of the NER300 programme
- Research and innovation
 10. 7th Energy Research Programme
 11. FONA - Research for Sustainability
 12. Programme for Rational Use of Energy, Renewable Energies and Energy Saving (Programm für Rationelle Energieverwendung, Regenerative Energien und Energiesparen - progres.nrw) - Research
- Downstream: Material efficiency and circular economy
 13. Circular Economy Act, related acts and ordinances and current amendments
 14. German Resource Efficiency Programme ProgRes III
 15. Technology Transfer Programme Lightweight Construction (TTP LB)
 16. Funding directive and research concept "Ressourceneffiziente Kreislaufwirtschaft"

17. 5) EU Circular Economy Action Plan (EU)
- Energy efficiency
 18. Federal support for energy efficiency in the economy - grant and loan
 19. Energy audits in SMEs
 20. The Kreditanstalt für Wiederaufbau (KfW) Energy Efficiency Programme: Low-interest loans for energy efficiency projects
 21. Pilot programme "Einsparzähler" (savings meter)
 22. Federal funding for energy efficiency in the economy - funding competition
 23. Energy efficiency networks for businesses
 24. Energy audit obligation for large companies (implementation of Article 8 EU Energy Efficiency Directive)
 25. Minimum energy performance standards – EU Ecodesign Directive
 - Other related policies
 26. IN4climate.NRW
 27. SME Initiative Energy system transformation and climate protection

7.1.1. Targets

The Climate Action Plan 2050,¹ adopted by the German Government in November 2016 affirms the target of the Paris Agreement to achieve CO₂-neutrality by mid-century, contains concrete actions to achieve the target and defines milestones for the year 2030 at a sectoral level. For the industry sector it sets a target of 49-51% GHG reduction compared to 1990. To achieve the sectoral target, substantial efforts on mitigation technologies are needed including large-scale investments in decarbonisation technologies, as presented in Figure 7.1. The targets were further strengthened through the climate protection law, which went into force in December 2019. It defines a (linear) path for emission reduction in all sectors towards the 2030 milestone and requires additional policy action, if the monitored emissions fall short of the minimum path in a certain year.

Figure 7.1. CO₂ emissions and reduction targets in Germany



Source: Fraunhofer Institute.

7.1.2. Carbon and energy pricing

1) EU Emissions Trading Scheme (ETS)

Description

The amendments to the Emissions Trading Directive for the fourth trading period 2021-30 came into force on 8 April 2018. The amended directive contains important innovations to strengthen EU emissions trading and its price signal. The total quantity of emission certificates auctioned and allocated free of charge will fall by 2.2% p.a. from 2021 (in relation to the reference value in 2010). With the market stability reserve (MSR), from 2019 to 2023, 24% instead of 12% of surplus certificates will be withdrawn from the market each year. From 2023, the maximum size of the market stability reserve is limited to the auction volume of the previous year. Surpluses exceeding this amount will be deleted from the MSR. In addition, member states have the option of reducing the number of certificates in circulation if fossil power plants are decommissioned as a result of additional national climate protection instruments.

In Germany, about one quarter (124 Mt CO₂) of the total emissions that fall under the EU ETS are from industry installations with refineries, chemicals, iron and steel and cement being emitting sectors.

The ETS sets a CO₂-price for large emitters and an overall emissions cap and is, thus, a central element of the EU policy mix addressing the decarbonisation of industry. However, industrial companies in energy-intensive trade-exposed sectors receive a substantial number of emissions permits for free via the benchmarking procedure and electricity price compensation (EPC).

Installations for production and heat generation receive partly free allocations, which falls from 80% of allocated certificates in 2013 to 30% in 2020, according to EU rules. However, to compensate for disadvantages in international competition, most industry installations receive nearly 100% free allocation, defined by a product-specific carbon leakage list published by the European Commission.

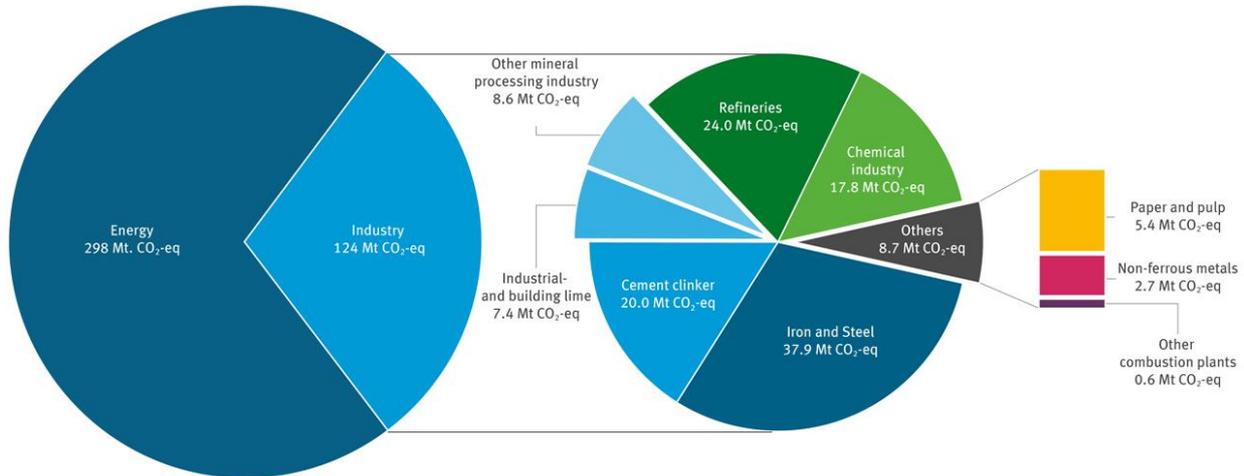
The EPC intends to lower the burden on sectors in international competition by (partly) compensating the increase in electricity prices due to the ETS. The EPC is defined according to EU guidelines. However, CO₂ costs for the purchase of one gigawatt-hour of electricity per year per installation are subtracted from the EPC. In 2018, the EPC in Germany amounted to EUR 219 million in total, with the largest share requested by the chemical industry. For 2019, substantially higher EPC cost occurred (EUR 546 million) because of the higher emission price on the ETS.

Sources

https://www.dehst.de/SharedDocs/downloads/DE/spk/Auswertungsbericht_2018.pdf?__blob=publicationFile&v=3

https://www.dehst.de/SharedDocs/downloads/DE/spk/Auswertungsbericht_2019.pdf?__blob=publicationFile&v=4

Figure 7.2. Emissions in the EU Emissions Trading Scheme in Germany by sector in 2019



Source: German Emissions Trading Authority (DEHSt), German Environment Agency.

https://www.dehst.de/EN/european-emissions-trading/understanding-emissions-trading/implementation/implementation_node.html

2) National Emissions Trading Scheme - CO₂-price for transport and heating

Description

In its climate protection programme 2030, the German government has advocated the introduction of CO₂ pricing for the transport and heating sectors (non-ETS) from 2021 onwards. The Bundestag decided to introduce the CO₂ pricing system as early as December 2019 by implementing the national emissions trading scheme (nETS). The nETS is an upstream system and covers emissions from the combustion of fossil fuels, in particular heating oil, liquid gas, natural gas, coal, petroleum and diesel. Until 2025, fuel or heat suppliers will need to buy certificates at a fixed price. From 2026 onwards, the system translates into cap and trade system with a predefined price corridor. This should create a reliable price path that enables private households and companies to anticipate and adapt to the development. The sectors affected by this law are mainly buildings, transport and industry. Industry installations that participate in the EU ETS are exempt from the nETS. Either the industry companies can apply for compensation or the upstream seller of fossil fuels can reduce its obligation to render emissions allowances by the respective amount sold to an EU ETS installation. Then, the total quantity of emissions under the scope of the nETS is resulting from EU ETS coverage and the overall emissions of the German industry sector and can be estimated as follows. In 2019, the total industry sector emissions (according to German sectoral target definition) accounted for about 195 Mt CO₂-equivalent. Of these, about 100 Mt CO₂ fall under the scope of the EU ETS and thus are out of scope for the nETS. Therefore, less than 50% of all industry emissions fall under the nETS, probably substantially less, as these emissions include product-related F-gas emissions, which are also outside the nETS. Thus, a realistic estimate is that 20-40% of industry sector emissions fall exclusively under the nETS.

The CO₂ price is set initially at EUR 25 per tonne in 2021 and will rise gradually to EUR 55 per tonne in 2025. For the year 2026, a price corridor of at least

	<p>EUR 55 and at most EUR 65 per tonne applies. After that, the price will be determined by the market. The CO₂ prices in the EU ETS and the nETS are independent and will likely differ substantially, because mitigation measures in the non-ETS are expected to show higher marginal abatement costs.</p> <p>The basis for the nETS is the Fuel Emission Trading Act (Brennstoffemissionshandelsgesetz, BEHG).</p>
CAPEX/OPEX	n.a.
Technology maturity	n.a.
Target group/sector/technology	Upstream energy suppliers in entire non-ETS heating and transport sectors
Typical grant/project size	n.a.
Eligibility	n.a.
Budget available	n.a.
Evaluation	n.a.
Sources	<p>https://www.dehst.de/SharedDocs/downloads/DE/nehs/nehs-hintergrundpapier.pdf?__blob=publicationFile&v=6.</p> <p>Fuel Emission Trading Act (BEHG)</p>

3) Energy taxes and exemptions ("Spitzenausgleich")

Description	<p>With the law on the introduction of the ecological tax reform of 24 March 1999 and the corresponding follow-up laws, the taxation of various fossil fuels and electricity was increased to incentivise energy efficiency improvements. At the same time, the tax revenues were used to decrease non-wage labour costs. The Electricity Tax Act and the Energy Tax Act provide for differentiated tax rates according to energy sources. Some energy consumers are fully exempt from energy taxation, as are most of the large consumers from the heavy industry, as they receive exemptions for energy use in specifically defined energy-intensive processes and the tax reliefs discussed under the heading "Spitzenausgleich" below.</p> <p>Current discussions on reforming the energy taxes direct towards the high price of electricity, which is a major barrier for the diffusion of sector coupling technologies such as heat pumps. Lower taxes on electricity and EEG-levy (see below separate fact sheet 4), financed by higher taxes for fossil fuels according to their CO₂-intensity is an option on the table.²</p> <p>Energy tax reliefs ("Spitzenausgleich"):</p> <p>Under the so-called "Spitzenausgleich", companies in the manufacturing sector receive reliefs on energy taxes. In 2013, the "Spitzenausgleich" was</p>
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readjusted and continued beyond 2012 for another ten years. Accordingly, two conditions must be met by companies to receive tax discounts:

- ▶ The applying company must prove that it has introduced an energy management system in accordance with DIN EN ISO 50001 or an environmental management system in accordance with the Eco-Management and Audit Scheme (EMAS) that is operational as of end 2015.
- ▶ The energy intensity of manufacturing industry in Germany must decrease overall by a legally defined target value. This target value is 1.3% per year for the reference years 2013 to 2015 (application years 2015 to 2017) and 1.35% per year for the reference years from 2016 (application years 2018 to 2022). The new regulation of peak balancing is designed for a period of ten years.

4) The EEG-Levy and compensation scheme ("Besondere Ausgleichsregelung"))

Description

In order to finance the support (feed-in-tariffs and permit) of renewable energy technologies for electricity generation a levy was introduced as a mark-up on the electricity tariff for all electricity consumers. In recent years, the mark-up reached up to EUR 0.06 per kWh for typical household consumers (large industry companies receive major discounts).

A sharp increase in the EEG levy (renewable energy act) is expected for 2021. The main reason for this is the decline in economic output and the associated fall in the price of electricity at the stock exchange. In order to ensure greater reliability of the state electricity price components, a subsidy from federal budget funds is planned for the "gradual and reliable reduction" of the EEG levy, so that it will be EUR 0.065 per kWh in 2021 and EUR 0.06 per kWh in 2022. This measure will also be financed by government revenue from the new national emissions trading. After 2022, revenues from emissions trading will continue to be used to reduce the EEG levy. The necessary adjustments to the Renewable Energies Act have already been implemented in the amendment of 15 July 2020. The new EEG, which has also been amended, came into effect on 1 January 2021 ("EEG 2021") and will be notified in parallel as a subsidy.

The high mark-up on the electricity price provides on the one side substantial incentives for energy-efficiency improvements, and, on the other side, is a strong barrier for electrification and sector coupling technologies (heat pumps, electric industrial furnaces, electric cars).

Compensation scheme (BesAR) of the Renewable Energy Sources Act (EEG):

Under BesAR, companies in electricity and trade-intensive industries with high electricity consumption are receiving discounts to the EEG levy. The aim of BesAR is, among other things, to protect the international competitiveness of the beneficiary companies. To receive discounts, companies have to apply and belong to electricity and trade-intensive industries. They must also prove that their electricity costs account for a high proportion of the gross value added. Furthermore, in order to qualify for the corresponding benefits, applicant companies' electricity consumption must exceed 1 GWh/y and have

a certified energy or environmental management system. Companies with an annual electricity consumption of more than 5 GWh have to prove the operation of an energy or environmental management system (ISO 50001 or EMAS), companies with 1-5 GWh can also prove the operation of an alternative system for the improvement of energy efficiency in the sense of the Peak Energy Efficiency System Ordinance (SpaEfV). As a result, the compensation scheme has strongly contributed to the role-out of ISO 50001 energy management schemes in Germany.

7.1.3. Technology development, demonstration and market introduction programmes aiming at industry decarbonisation

5) National Decarbonisation Programme

Description

The national Decarbonisation Programme is currently being implemented, as well as part of the Climate Protection Programme 2030. It is a support programme addressing technology development, demonstration and market uptake. The programme particularly aims for the reduction of process-related emissions in hard-to-abate sectors and thus addresses key production facilities in these sectors. For this purpose, projects in the area of emission-intensive industries with process-related emissions are supported via grants. The projects under scope range from application-oriented R&D and industrial-scale testing to the broad market introduction of mature or emerging technologies.

The programme does not focus on a narrow definition of process-related emissions only, but also aims at reducing hard-to-abate emissions from fossil fuel combustion. The programme will provide grants to finance a share of the upfront costs of the investments in new plants, development of climate-neutral processes, switch from fossil to electricity-based fuels, innovative combinations of processes, development of climate-neutral product substitutes as well as bridge technologies. Applications are evaluated technically and economically. Current programme design focuses on capital expenditures only and does not foresee financing of operational costs. However, in order to add operational expenses (OPEX) support, it is possible to combine the grants with potential support from the EU Innovation Fund or the CCfD pilot from the German Hydrogen Strategy.

In total, the programme aims to reduce annual GHG emissions in the industry sector by about 2.5 Mt eq CO₂ by the year 2030.

The programme is overseen by the Ministry for the Environment (BMU) and the official funding directive was published on 16 December 2020 and went into force on 1 January 2021. In anticipation of this, the Environmental Innovation Programme (UIP) set up a funding window "Decarbonisation in Industry" for a transitional period until the new directive came into force to provide a basis for project proposals throughout 2020. The programme is implemented by the Competence Center Climate Protection in Energy-intensive Industries (KEI) based in Cottbus.

CAPEX/OPEX	Only Capital Expenditures (CAPEX) support (but combination with other programmes possible to add OPEX support).
Technology maturity	From applied research to demonstration and industrial-scale market introduction of emerging technologies (TRL 4-9).
Target group/sector/technology	CO ₂ -intensive processes in the basic materials industry (steel, cement, chemicals, others).
Typical grant/project size	Up to now (January 2021), one project is selected for a grant: The Salzgitter AG received a EUR 5 million grant for the construction of a small scale demonstrator direct reduction ironmaking (DRI) plant that can flexibly use natural gas and hydrogen as fuel.
Eligibility	All companies located in Germany with process-related emissions that fall under the scope of the EU ETS.
Budget available	EUR 2 billion for 2020-24, thereafter EUR 0.5 billion per year is expected. The programme was announced in advance, so that companies could prepare proposals in time.
Evaluation	No evaluation available - programme started in 2021.
Sources	Directive for the support of research, development and investment-projects targeting greenhouse gas neutrality in the industry sector. ³ Press release BMU. ⁴ Temporary funding guidelines. ⁵

6) CO₂ avoidance and use in basic industries

Description	<p>The focus of this programme, which is part of the Climate Protection Programme 2030, is the reduction of process-related GHG emissions in the basic materials industry. The main objective is to further develop central components of the process chain in the field of CO₂ capture, storage and utilisation (Carbon Capture and Storage - CCS and Carbon Capture and Utilisation - CCU) towards market maturity and thereby creating the necessary technical prerequisites for a permanent reduction of process-related greenhouse gas emissions. This involves the entire value chain covering CO₂ capture, transport and storage.</p> <p>The programme is administered by the German Ministry for Economics (BMWi). The related support directive is currently under development and not yet published.</p>
CAPEX/OPEX	Focus on CAPEX (for CCS, OPEX support is also possible).

Technology maturity	Starting from TRL 5-6 with goal to achieve industrial-scale market introduction
Target group/sector/technology	All sectors with process-related emissions, however, focus on cement, limestone and chemicals.
Typical grant/project size	Projects are expected to be very large, only a few projects will be financed (grant size probably >EUR 100 million per project).
Eligibility	n.a.
Budget available	~ EUR 0.5 billion total budget (2021-25), ~EUR 0.1 billion annually
Evaluation	n.a.
Sources	German climate protection programme 2030 Exchange with BMWi

7) National Hydrogen Strategy: Pilot programme Carbon Contracts for Difference

Description	<p>The National Hydrogen Strategy (NWS) of the Federal Government was adopted by the Federal Cabinet on 10 June 2020. For the consistent implementation and further development of the strategy, it is planned to create a flexible and result-oriented governance structure. The central point is the establishment of a National Hydrogen Council, which held its constituent meeting on 9 July 2020.</p> <p>While there is a strong commitment to hydrogen produced from renewable energy sources ("green hydrogen"), the NWS acknowledges the role of CO₂ neutral hydrogen produced within a European hydrogen market. As Germany is tightly connected to a European energy market, CO₂ neutral (blue/turquoise) hydrogen is likely to be used on an interim basis. However, it is stated that only green hydrogen is sustainable in the long-term.</p> <p>In the German government's economic stimulus package of 3 June 2020, it was decided to massively expand the promotion of hydrogen and fuel-cell technology. The economic stimulus package thus fully supports the measures defined in the NWS. A total of EUR 7 billion has been earmarked for national measures of which roughly EUR 2 billion are foreseen for the use of hydrogen to decarbonise industry. Several individual measures can be assigned to the industry sector. For example, the introduction of a pilot programme for CCfD is scheduled for 2021. Other measures, such as demand quota for climate-friendly raw materials, e.g. green steel, tendering models for the production of green hydrogen, which serves as an example for the decarbonisation of the steel and chemical industry, are also examined.</p> <p>An important instrument for the implementation of the NWS is the IPCEI Hydrogen. Here the German government plans to promote integrated projects along the entire hydrogen value chain and has offered co-ordination at</p>
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	<p>EU level. Currently the German expression of interest procedure is being prepared, in which companies can submit appropriate proposals.</p> <p>A pilot programme for carbon contracts for difference (CCfD) is planned as part of the national hydrogen strategy published in June 2020. The programme is dedicated to the steel and chemical industries and has an allocation of around EUR 500 million of the national budget. Companies are to sign contracts with the government for low-carbon industrial production, and in return the government assures a fixed carbon price, a so-called strike price. As long as the ETS price is lower than the strike price, the difference will be covered by the Government. If the ETS price is higher than the strike price, then companies must pay back the difference between the two prices. Other cost components such as higher costs for different raw materials or higher CAPEX could be included in the design.</p> <p>CCfDs are designed to offset the higher operating costs of low-carbon production processes compared to the fossil fuel-based reference process. Thus, they address the operating costs, while the investment costs can be covered by other programmes, such as the National Decarbonisation Programme.</p> <p>CCfDs are to be selected through a tender. A first draft plan was published in April 2021 but issues such as conflicts with European state aid law or the determination of reference costs still need to be clarified..</p>
CAPEX/OPEX	OPEX (CAPEX)
Technology maturity	All
Target group/sector/technology	Steel and chemicals industry
Typical grant/project size	(not specified)
Eligibility	n.a.
Budget available	~EUR 0.5 billion in total until 2023
Evaluation	n.a.
Sources	<p>National Hydrogen Strategy</p> <p>Deutscher Bundestag (2020): Antwort der Bundesregierung auf die Kleine Anfrage zu Pilotprogramm Carbon Contracts for Differences.⁶</p>

8) National Hydrogen Strategy: IPCEI "Hydrogen in industrial production"

Description As part of the National Hydrogen Strategy a support programme to develop hydrogen technologies in the form of an IPCEI was agreed upon. The

	<p>expression-of-interest procedure was published on 11 January 2021 and also covers the support of projects for hydrogen use in industry.</p> <p>While the entire IPCEI addresses all parts of the hydrogen value chain, the BMWi administers a part that particularly addresses the industrial application of hydrogen. For this part, about EUR 1.5 billion are expected to be available as funding for the period until 2026. This includes the use of hydrogen in industry as well as the development and production of fuel cell systems.</p> <p>Support is only given for the differential costs, i.e. the additional costs for a low-CO₂ process compared to the conventional CO₂-intensive process. Funding is for CAPEX, while OPEX can be funded in exceptional cases when the operation of the plant is needed for research purposes.</p> <p>IPCEI are transnational projects partly funded by governments to achieve European strategic objectives and improve its competitiveness. These projects are also expected to have a spill over effect on other countries, other companies and/or other sectors. Nine strategic fields have been identified, including hydrogen technologies and systems and low-carbon industry, as well as microelectronics and battery manufacturing.</p>
CAPEX/OPEX	CAPEX (OPEX only for research projects)
Technology maturity	Starting from TRL 5-6 with goal to achieve industrial-scale market introduction
Target group/sector/technology	Hydrogen use in all sectors, however, steel and chemicals are in the focus. Technologies to make industrial processes "hydrogen ready"
Typical grant/project size	Large scale projects (>EUR 10 million)
Eligibility	Particular requirements of IPCEI projects
Budget available	~ EUR 1.5 billion total for period 2021-26 (Only industry-sector funding)
Evaluation	n.a.
Sources	<p>"Expression of interest for the planned support in the field of hydrogen technologies and systems" (Bekanntmachung des Interessenbekundungsverfahrens zur geplanten Förderung im Bereich Wasserstofftechnologien und -systeme)⁷</p> <p>BMWi (2020): Häufig gestellte Fragen zum "Important Project of Common European Interest (IPCEI)".⁸</p> <p>National Hydrogen Strategy</p>

9) EU ETS Innovation Fund: further development of the NER300 programme

Description	<p>Within the framework of the European Emissions Trading Scheme, the innovation fund supports the commercial demonstration of innovative low-carbon technologies. It is a continuation of the former NER300 programme, but extends the funding scope by also including technologies addressing the reduction of GHG emissions in the energy-intensive industries. Additionally, it covers the following technologies similar to the NER300 programme: Carbon capture and utilisation (CCU), construction and operation of CCS, innovative renewable energy generation, energy storage.</p> <p>The Innovation Fund is part of the Emissions Trading System (EU-ETS) and is financed by revenues from the auctioning of CO₂ allowances. In the time period 2020 to 2030, a total of 450 million allowances will be used to finance the Innovation Fund. Currently, a resulting total budget of about EUR 10 billion is expected, however, it depends on the actual allowance price in the EU ETS.</p> <p>The first call of the EU Innovation Fund was published by the European Commission on 3 July 2020. This call for proposals addresses large projects with capital costs of >EUR 7.5 million. For large-scale projects funding is available for capital and operational costs. Small-scale projects will receive funding for capital costs only.</p>
CAPEX/OPEX	<p>CAPEX and OPEX</p> <p>(funding up to 60% of the additional capital and operational costs).</p>
Technology maturity	TRL 6-9 ("commercial demonstration").
Target group/sector/technology	Energy-intensive industries, CCS, CCU, renewable energies and energy storage.
Typical grant/project size	<p>Large-scale projects: > EUR 7.5 million capital costs.</p> <p>Small-scale projects: < EUR 7.5 million capital costs.</p>
Eligibility	n.a.
Budget available	~EUR 10 billion total until 2030 (EU wide, all technologies).
Evaluation	n.a.
Sources	https://ec.europa.eu/clima/policies/innovation-fund_en .

7.1.4. Research and innovation**10) 7th Energy Research Programme (7. Energieforschungsprogramm)**

Description	In 2018, the BMWi published the "7. Energieforschungsprogramm" (7 th energy research programme) of the Federal Government under the heading
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	<p>"Innovationen für die Energiewende" (Innovations for the Energy Transition). The fundamental aim of the research programme is the technology and innovation transfer facilitating the energy transition. Besides institutional research funding and project funding in areas as energy generation, system integration as well as system-wide research topics, focus lies on the energy transitions in the consumption sectors. In total a budget of about EUR 6.4 billion is provided by the Federal Ministry for Economic Affairs and Energy, the Federal Ministry of Education and Research and the Federal Ministry of Food and Agriculture in the years 2018 to 2022. The major part - about EUR 4.2 billion - is assigned to the funding of projects. In the consumption sector comprising industry as well as trade, commerce and services the following research topics are supported:</p> <ul style="list-style-type: none"> • energy-intensive basic materials industry (e.g. efficiency, electrification) • sector-specific measures (e.g. circular economy, efficiency) • cross-cutting topics (e.g. digitalisation, process heat).
CAPEX/OPEX	More details on the funding modalities are published in department-specific funding guidelines and funding announcements.
Technology maturity	TRL 1-9.
Target group/sector/technology	SMEs, enterprises, higher education and research institutions.
Typical grant/project size	Depending on the individual funding guideline and funding announcement.
Eligibility	More details on the funding modalities are published in department-specific funding guidelines and announcements.
Budget available	EUR 4.2 billion in total for the years 2018 to 2022, about EUR 0.9 billion annually.
Evaluation	The energy research programme is evaluated in retrospect, thus the evaluation of the fifth version is currently available.
Sources	<p>https://www.bmwi.de/Redaktion/DE/Artikel/Energie/Energieforschung/energieforschung-7-energieforschungsprogramm.html.</p> <p>https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/7-energieforschungsprogramm-der-bundesregierung.pdf?__blob=publicationFile&v=14.</p> <p>https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/evaluation-der-forschungsfoerderung-des-bundesumweltministeriums-im-rahmen-des-5-energieforschungsprogramms.pdf?__blob=publicationFile&v=3.</p>

11) FONA: Research for sustainability

Description	<p>Based on the UN Sustainable Development Goals the Federal Ministry of Education and Research has developed a strategy for the "Forschung für Nachhaltigkeit" (FONA, research for sustainability) in 2005. The 4th Framework Programme (FONA4) will be effective from 2020 to 2024 and has a budget of EUR 4 billion in total. Research projects in the field of green hydrogen, circular economy, climate protection and bioeconomy are funded in specific funding guidelines and funding announcements. Besides a funding directive and research concept for resource-efficient circular economy (described in a separate policy fact sheet), individual projects and funding guidelines are of high relevance for the decarbonisation of the industrial sector.</p> <p>The funding guideline "Impulse für industrielle Ressourceneffizienz" (r+Impuls, impetus for industrial resource efficiency) is supported by the expiring FONA3. Between 2016 and 2021 26 joint projects are funded with EUR 22.3 million in the field of industrial resource efficiency. The funding is exclusively applicable from TRL 5 and thereby closing the gap between R&D projects and the broad market introduction.</p> <p>The funding guidelines "Epigenetik - Chancen für die Pflanzenforschung" (Epigenetics - opportunities for plant research) and "Zukunftstechnologien für die industrielle Bioökonomie" (future technologies for the industrial bioeconomy) are supported by FONA4. While the first one focuses on the food production, the second supports technologies in the field of bioeconomy in general. The funding volume is currently not published.</p> <p>The research project Carbon2Chem tests the capture and utilisation of CO₂-emissions (CCU) from metallurgical gases from the steel industry. The captured CO₂ will be used for the production of precursors for fuels, plastics or fertilisers. EUR 60 million was provided by the Federal Ministry of Education and Research as part of FONA3 during the first phase (2016-20) and about EUR 75 million will be provided in the second phase (2020-24).</p> <p>The funding guideline "Vermeidung von klimarelevanten Prozessemissionen in der Industrie" (Klim-Pro-Industrie, avoidance of climate-relevant process emissions in the industry) contributes to the implementation of the Klimaschutzplan 2050 (climate protection plan 2050), Hightech-Strategie 2025 (high-tech strategy 2025) and FONA3 are focussed on carbon direct avoidance, CCU and CCS. In total, up to EUR 80 million will be provided until 2025.</p>
CAPEX/ OPEX	
Technology maturity	
Target group/sector/ technology	More details on the modalities are published in funding guidelines and funding announcements.
Typical grant/project size	
Eligibility	

Budget available	EUR 4 billion in total for the years 2020 to 2024.
Evaluation	The FONA Framework Programme is evaluated in retrospect, thus the evaluation of version 1 and 2 (2005-09 and 2020-14) is available.
Sources	https://www.bmbf.de/upload_filestore/pub/Forschung_fuer_Nachhaltigkeit.pdf . https://www.fona.de/de/ueber-fona/FONA-Strategie.php . https://www.isi.fraunhofer.de/content/dam/isi/dokumente/ccp/2020/BMBF_FONA_Evaluation_Abschlussbericht_2020.pdf . https://www.isi.fraunhofer.de/content/dam/isi/dokumente/ccp/2020/BMBF_FONA_Evaluation_Abschlussbericht_2020.pdf . https://www.fona.de/medien/pdf/Projektmappe_rplus_Impuls_2020_0.pdf . https://www.fona.de/de/massnahmen/foerdermassnahmen/epigenetik_biooekonomie.php . https://www.fona.de/de/massnahmen/foerdermassnahmen/zukunftstechnologien_biooekonomie.php . https://www.fona.de/de/massnahmen/foerdermassnahmen/carbon2chem.php . https://www.fona.de/de/vermeidung-von-klimarelevanten-prozessemissionen-in-der-industrie- .

12) Progress.nrw - Research

Description	Progress.nrw - Research is a funding instrument established by the Ministry of Economic Affairs, Innovation, Digitalisation and Energy of the State of North Rhine-Westphalia as part of the “Energieforschungsoffensive.NRW”. It supports the transition from basic to applied research on new products, processes or services in the field of energy system transformation and carbon-neutral industry.
CAPEX/OPEX	Purchase of research equipment (CAPEX) use of research equipment, personnel expenses, material expenses, travel expenses, overhead expenses (OPEX).
Technology maturity	Transition from basic to applied research (TRL 2-4).
Target group/sector/technology	Higher education and research institutions.
Typical grant/project size	EUR 2 000 to EUR 70 000.
Eligibility	Non-economically viable projects with a duration up to six months.
Budget available	No information available.

Evaluation	No evaluation available.
Sources	https://progres-nrw-research.ptj.de/lw_resource/datapool/items/item_95/Flyer_progresNRW.pdf . https://progres-nrw-research.ptj.de/lw_resource/datapool/items/item_96/RL_progres_nrw_research.pdf .

7.1.5. Material efficiency and circularity

13) Circular Economy Act, related acts and ordinances and current amendments	
Description	<p>The current version of the Circular Economy Act from 2012 and its October 2020 amendment constitute the legal framework for waste management in Germany and implements the EU Waste Framework Directive. The national regulation goes beyond the EU regulation by implementing a duty of care and by determining preferences for sustainable public procurement. Besides the definition of the terms waste and by-product, the determination of a waste hierarchy and the extended producer responsibility shapes the German waste management. In practise, the regulation introduces the separated collection of waste and recycling quotas.</p> <p>For specific product wastes (packaging, end-of-life vehicles, batteries, electrical devices, reclaim wood, waste oil etc.) additional acts and ordinances have been implemented in line with EU waste-specific directives. The new Packaging act from 2019 and the Commercial Waste Ordinance from 2017 are of particular importance. Both legislations are intended to further strengthen recycling.</p> <p>The Packaging Act introduces stricter quota requirements, monitoring and further developments, which will lead to increases in the recycling volumes of plastics and metals. Additionally, current amendments from November 2020 and January 2021 ban plastic bags by 2022 and define a minimum recycled share for PET bottles by 2025. Furthermore, a mandatory deposit for all non-refillable plastic bottles is implemented by 2022 and reusable options must be offered for to-go drinks by 2023.</p> <p>The new Commercial Waste Ordinance will have similar effects through requirements for stricter separate collection and the sorting and recycling of mixed commercial waste. Several studies show that this will save about 1 million t CO₂. This reduction is supported by waste prevention and resource conservation measures (e.g. increasing reuse), as described in the national Waste Prevention Programme (AVP) and the German Resource Efficiency Programme (ProgRes III).</p> <p>An overview of the recycling quotas in force as well as target values up to 2035 originating from the described legislation is given in Table 7.1.</p>
CAPEX/OPEX	No financial support
Technology maturity	Not technology specific

Target group/sector/technology	Waste management
Typical grant/project size	No financial support
Eligibility	Producers and owners of waste, operators of waste pretreatment and processing plants
Budget available	No financial support
Evaluation	No evaluation available for recycling measures
Sources	https://www.gesetze-im-internet.de/krwg/ . https://www.verpackungsgesetz.com/ https://www.gesetze-im-internet.de/gewabfv_2017/BJNR089600017.html https://www.umweltbundesamt.de/themen/abfall-ressourcen/abfallwirtschaft/abfallrecht

Table 7.1. Recycling quotas in Germany

	Current	2022	2025	2030	2035
Residential waste	50%	n.a.	55%	60%	65%
Packaging	55%	n.a.	65%	70%	n.a.
Glass	80%	90%	n.a.	n.a.	n.a.
Paper	85%	90%	n.a.	n.a.	n.a.
Ferrous metals	80%	90%	n.a.	n.a.	n.a.
Aluminium	80%	90%	n.a.	n.a.	n.a.
Beverage cartons	75%	80%	n.a.	n.a.	n.a.
Other composite	55%	70%	n.a.	n.a.	n.a.
Commercial waste	30%	n.a.	n.a.	n.a.	n.a.

Source: Fraunhofer Institute

14) German Resource Efficiency Programme ProgRess III

Description

The German Resource Efficiency Programme ProgRess III updates the previous ProgRess II from 2020 to 2023. The update is based on an evaluation of ProgRess II as well as current environmental policy challenges. Nevertheless, the objective of ProgRess II of doubling the raw material productivity from 1994 until 2020 is expected to be missed by a wide margin. In contrast to its predecessor, ProgRess III mentions the relevance of resource efficiency and digitalisation for achieving climate goals.

The current ProgRess III includes 118 measures for improving resource efficiency in Germany. The measures cover the following areas:

- resource protection in value chains and material cycles
- cross-cutting instruments

	<ul style="list-style-type: none"> • resource protection at the international level • resource protection at the municipal and regional levels • resource protection in everyday life. <p>For monitoring the impact of ProgRess II, a set of indicators is defined considering the total raw material productivity, the raw material consumption, the secondary raw material use and the material stock change.</p> <p>The German Resource Efficiency Programme and its current version ProgRess III are setting the framework for goals, ideas and approaches to protect natural resources. Hence diverse policy instruments addressing material efficiency and circular economy are based on this programme.</p>
CAPEX/OPEX	
Technology maturity	
Target group/sector/technology	
Typical grant/project size	The modalities depend on the respective policy design.
Eligibility	
Budget available	
Evaluation	Evaluation of ProgRess II included in ProgRess III.
Sources	https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Ressourceneffizienz/progress_iii_programm_bf.pdf .

15) Technology Transfer Programme Lightweight Construction (TTP LB)

Description	<p>Based on the German Sustainability Strategy and the Industry Strategy 2030, the TTP LB focuses on lightweight construction for increasing growth and competitiveness as well as climate protection and sustainability. The Federal Ministry for Economic Affairs and Energy is providing around EUR 300 million in funding. Within the framework of the TTP LB, R&D projects relating to lightweight construction in five programme lines are funded. The first three programme lines have a thematic focus while the last two consider technology readiness (demonstration project or standardisation phase). The following three areas are considered, of which the last two are relevant for decarbonisation:</p> <ul style="list-style-type: none"> • technology development to strengthen economy • new design techniques and materials
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	<ul style="list-style-type: none"> • resource efficiency and substitution. <p>The aim of the second programme line is to develop and promote material-related GHG reduction options. The measure is very broad and covers material efficiency, material substitution and product design with regard to new construction techniques. Between 2020 and 2024, the Energy and Climate Fund has earmarked funds of around EUR 0.15 billion, which will be continued in subsequent years.</p> <p>The third programme line is an accompanying anchoring of material efficiency issues and not a decidedly new measure. The measure builds on the approaches mentioned in the German Resource Efficiency Programme. The aim of increased resource efficiency and substitution is to anchor the principle of recycling in production processes and thus tap into previously untapped potential for reducing emissions. Priority target group are SMEs.</p> <p>From the first outline cut-off date of the TTP LB on 1 May 2020, 24 joint projects with more than 137 project participants will be launched promptly. This means that a total of EUR 49 million in funding will be drawn down over the next three years. The next cut-off date on 1 October 2020 is similarly well received.</p>
CAPEX/OPEX	Research infrastructure (CAPEX)/ project-related costs (OPEX).
Technology maturity	R&D (TRL 3-8).
Target group/sector/technology	Enterprises, higher education and research institutions, non-profit organisations, public institutions/ lightweight construction.
Typical grant/project size	EUR 2 million.
Eligibility	Projects with a duration up to three years, up to 50% funding for enterprises and up to 100% for higher education and research institutions.
Budget available	EUR 60 million in 2020 and EUR 70 million from 2021 onwards (financed via Energy and Climate Fund).
Evaluation	Based on ex ante evaluation which identified the economic and environmental relevance of lightweight construction.
Sources	<p>https://www.bmwi.de/Redaktion/DE/Downloads/B/bekanntmachung-foerderung-ttp-lb.pdf?__blob=publicationFile&v=4.</p> <p>https://www.bmwi.de/Redaktion/DE/Artikel/Technologie/technologietransfer-programm-leichtbau.html.</p> <p>https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/ex-ante-evaluation-technologietransfer-programm-leichtbau.pdf?__blob=publicationFile&v=6.</p>

16) Funding directive and research concept "Ressourceneffiziente Kreislaufwirtschaft"

Description	<p>Based on the second German Resource Efficiency Programme (ProgRess II) and funded by the Framework Programme for Research for Sustainability (FONA3) the Federal Ministry of Education and Research published the research concept "Ressourceneffiziente Kreislaufwirtschaft" (resource-efficient circular economy). The concept supports R&D in the field of resource efficiency considering eco-design, digitalisation, innovative product cycles and business models as well as specific relevant products (plastics, economically critical raw materials, mineral materials). Since 2017, three funding directives have been announced covering the following topics:</p> <ul style="list-style-type: none"> • innovative product cycles (ReziProK, pub. 2017), • construction and mineral material cycles (ReMin, pub. 2018) and • plastics recycling technologies (KuRT, pub. 2020). <p>The funding measure ReziProK started in 2019 with 25 joint projects and a transfer and networking platform hosted by the chemical industry association (DECHEMA). The funding periods ends in December 2022 and has a total budget of about EUR 30 million.</p> <p>The funding phase of ReMin started in February 2021. Consequently, information on the number of projects and budget is not yet available. Even though the measure KuRT was published subsequently, the funding phase started already in November 2020. Nevertheless, information about projects and budget are not available for KuRT either, even though the funding phase started in November 2020.</p>
CAPEX/OPEX	Purchase of research equipment (CAPEX) personnel expenses, travel expenses, material expenses, subcontracts, services (OPEX).
Technology maturity	R&D (TRL 3-8).
Target group/sector/technology	Enterprises, higher education and research institutions, non-profit organisations, public institutions.
Typical grant/project size	ReziProK: EUR 1.2 million.
Eligibility	Projects with a duration up to three or five years, up to 50% funding for enterprises and up to 100% for higher education and research institutions.
Budget available	EUR 150 million in total from 2018 to 2023.
Evaluation	No evaluation available.

Sources	https://www.bmbf.de/upload_filestore/pub/Ressourceneffiziente_Kreislaufwirtschaft.pdf . https://www.ptj.de/projektfoerderung/fona/produktkreislaeufe . https://www.ptj.de/projektfoerderung/fona/mineralische-stoffkreislaeufe . https://www.ptj.de/projektfoerderung/fona/kurt . https://www.bmbf.de/upload_filestore/pub/Bufi_2020_Hauptband.pdf . https://dechema.de/36_2019_d.html . https://www.fona.de/de/massnahmen/foerdermassnahmen/ressourceneffiziente-kreislaufwirtschaft-innovative-produktkreislaeufe.php . https://www.fona.de/de/massnahmen/foerdermassnahmen/ressourceneffiziente-kreislaufwirtschaft-bauen-und-mineralische-stoffkreislaeufe.php . https://www.fona.de/de/massnahmen/foerdermassnahmen/recycling-kunststoffe.php .
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17) Circular Economy Action Plan (EU)

Description	<p>As part of the European Green Deal the European Commission adopted the new Circular Economy Action Plan in March 2020 to enable sustainable economic growth. The plan includes 35 actions until 2022 in the fields of sustainable products, value chains, waste and crosscutting activities on regional, national and global level. Most of the proposed activities aim at the adaption of the legislative framework to foster the transformation to a circular economy. Additionally, a profound monitoring system (Circular Economy Monitoring Framework) is part of the proposed action plan.</p> <p>A first milestone was the proposal for modernisation of the EU legislation on batteries in November 2020. Further proposals in 2021/22 are intended to focus on waste management of electronic devices, end-of-life vehicles, packaging, plastics, textiles and construction materials. Additionally, legislation for sustainable design and lifetime extension shall be proposed. Especially relevant for the industry decarbonisation is the launch of an industrial symbiosis reporting and certification system by 2022.</p> <p>Nevertheless, circular economy is not a new topic at the EU level and has been implemented via an initial Circular Economy Action Plan in 2015. All 54 measures proposed in the plan have been adopted or are currently being implemented. Part of the efforts were the establishment of a Circular Economy Stakeholder Platform and the Circular Economy Package in 2018. Among others, the EU Strategy for Plastics in the Circular Economy was published in this course. At the EU level, the topics were additionally addressed by large funding budgets by Horizon 2020.</p>
CAPEX/OPEX	No financial support.
Technology maturity	Not technology specific.

Target group/sector/technology	EU member states.
Typical grant/project size	No financial support.
Eligibility	EU member states.
Budget available	No financial support.
Evaluation	Circular Economy Monitoring Framework.
Sources	https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN . https://ec.europa.eu/environment/circular-economy/pdf/implementation_tracking_table.pdf . https://ec.europa.eu/environment/circular-economy/first_circular_economy_action_plan.html .

7.1.6. Energy efficiency

In the following, measures addressing energy efficiency improvement are briefly summarised to provide a complete overview. While some of the programmes also address topics beyond energy efficiency like renewable energies or material efficiency, the main focus of these programmes is clearly on energy efficiency.

18) Federal support for energy efficiency in the economy (grant and loan)

The programme represents a reorganisation of a number of previously individual support programmes. The programmes for the promotion of highly efficient cross-sectional technologies (e.g. electric motors), the Waste Heat Directive, the promotion of energy-efficient and climate-friendly production processes, the promotion of energy management systems and the promotion of renewable process heat in the Market Incentive Programme expired in December 2018 at the latest. They were relaunched as a joint promotion package with adapted promotion conditions and rates of support in January 2019. The programmes were bundled in the form of four modules and their application procedures were aligned. The aim of the restructuring is to offer an integrated energy efficiency support package for the industry, to reduce obstacles in the application process and to eliminate overlaps between programmes.

In the new funding programme "Federal funding for energy efficiency in the economy", funding is possible in four selectable and combinable modules:

- Module 1: Cross-cutting technologies (e.g. electric motors, pumps, fans)
- Module 2: Process heat from renewable energies
- Module 3: Reflective surfaces, sensor technology and energy management software
- Module 4: Energy-related optimisation of plants and processes.

The extent to which technologies and measures to increase material efficiency in Modules 1, 3 and 4 can also be promoted more intensively is being examined, provided that they demonstrably support the

achievement of the relevant funding objectives. These activities also relate to the German Resource Efficiency Programme III (promoting material and energy-efficient production processes).

It is expected that the EUR 300 million budget for the programme set for 2020 will also apply to subsequent years.

19) Energy audits in SMEs

Small and medium-sized enterprises (SMEs) are offered the support of qualified energy consulting within the framework of the BMWi programme "Energy Consulting for SMEs" (Directive on the Promotion of Energy Consulting for SMEs of 11.10.2017, BAnz AT 07.11.2017 B1, [EBM]). Qualified energy consultants identify potentials for energy saving and make concrete proposals for energy-efficiency measures for the respective company. The proposed measures can be used, for example, to create concepts for waste heat utilisation. The directive complies with the EU requirements for energy audits according to the EU Energy Efficiency Directive (2012/27/EU). The programme is administered by the Federal Office of Economics and Export Control (BAFA). The maximum funding amount per audit is EUR 6 000.

Identified energy-efficiency measures should also include material efficiency with the aim of saving energy in industrial processes. Corresponding training courses for auditors to identify material and resource efficiency measures are recognised. These activities also serve the implementation of measure 29 of the German Resource Efficiency Programme III, which aims, among other things, to improve the co-ordination of the content and structure of consulting services on material and energy efficiency and to avoid duplication of consulting services.

20) KfW Energy Efficiency Programme: Low-interest loans for energy efficiency projects

With the KfW Energy Efficiency Programme, the KfW grants low-interest loans to commercial enterprises for the implementation of energy efficiency measures. The programme promotes energy-efficient production facilities/processes including cross-sectional technologies with a relatively highest energy-saving potential. As the programme was further developed, both a new entry-level standard (10% savings) and a new premium standard (30% savings) were introduced. Thus, the funding intensity is aligned to the amount of energy savings, regardless of the size of the company. Projects with premium standard receive particularly favourable conditions. The improved funding conditions became effective in July 2015. By 2019, 219 commitments were made with a funding volume of EUR 974 million. The programme is financed from KfW's own funds.

21) Pilotprogramm "Einsparzähler" (Savings meter)

The pilot programme "Einsparzähler" aims to foster innovations in digitalisation to improve energy efficiency. Funding is available to companies that want to test and demonstrate innovative digital systems and related business models. The companies will receive funding of up to EUR 2 million. Within the pilot projects, energy consumption data must be metered precisely and assigned to individual devices or systems (groups). The current funding announcement "Pilotprogramm Einsparmeter" of the BMWi is dated 18 February 2019 (BAnz AT 21.02.2019). It is limited until 31 December 2022 and replaces the funding announcement "Pilotprogramme Einsparzähler" of 20 May 2016. BAFA is the granting authority. The pilot projects to date have achieved energy savings in the private household, commercial, trade, services, industry and transport sectors.

22) Federal funding for energy efficiency in the economy - funding competition

The programme promotes the implementation of energy efficiency projects in companies in a competitive process that is open to all actors, sectors and technologies with the objective to finance projects with the best cost/use-efficiency. The programme supports investment measures to optimise the energy efficiency

of industrial and commercial plants and processes that contribute to increasing energy efficiency or reducing fossil energy consumption in companies, including measures for the provision of process heat from renewable energies and energy audits. This programme is a further development of the "Promotion of electricity savings within the framework of competitive tenders" programme introduced in 2016 with a budget of EUR 35 million for 2020.

23) Energy efficiency networks for businesses

Energy Efficiency Networks (EEN) are networks of companies that set common energy efficiency and CO₂ reduction targets and want to learn from each other. After a successful pilot phase of the EEN concept, the German government has decided in 2014 to implement EEN as a main pillar of the National Energy Efficiency Action Plan. Up to 500 new networks should be established by 2020. For this purpose, a voluntary agreement "Initiative Energy Efficiency Networks" on the introduction of EEN was signed in 2014 between the Federal Government (BMWi and BMU) and 22 business associations and organisations.. Based on the agreement extended in September 2020, 300-350 additional networks are to be created by 2025.

Companies participating in networks need to conduct an energy audit at company level and set a savings target at network level based on individual company targets. The networks are supported by a qualified energy consultant. The implemented measures are recorded in the context of an annual monitoring. As of 10 September 2020, 282 networks were established.

24) Energy audit obligation for large companies (implementation of Article 8 EU Energy Efficiency Directive)

"Large" companies are obliged to conduct energy audits as required by Article 8, Paragraph 4-7 of the EU Energy Efficiency Directive (2012/27/EU; EED). The energy audits should be carried out by qualified and/or accredited experts. The directive requires that the first energy audit be conducted by 5 December 2015 at the latest. In order to implement these requirements, the Energy Services Act (EDL-G) has been amended accordingly with effect from 22 April 2015. According to this, large companies (non-SMEs, i.e. companies that do not fall under the European Commission's definition of SMEs [<250 employees or turnover <EUR 50 million or annual balance sheet total < EUR 43 million]) are obliged to have carried out an energy audit according to DIN EN 16247-1 by 5 December 2015 and thereafter a further audit at least every four years. Companies that have an energy management system certified according to DIN EN ISO 50001 or an EMAS environmental management system are exempt from the obligation to conduct energy audits.

As part of the amendment in 2019, a threshold of 500 MWh total energy consumption was introduced. Below this threshold, a simplified energy audit can be carried out through a declaration of energy consumption and energy costs to the BAFA.

25) Minimum energy performance standards – EU Ecodesign Directive

All energy-related products are potentially covered by the EU Ecodesign Directive (2009/125), which sets general and specific requirements for 27 product groups, some of which are relevant for the industry (e.g. electric motors, industrial fans and ventilation units, water pumps or professional refrigerating appliances). Compliance is monitored through both physical and documentary checks as products are placed on the market.

Looking forward, the EU Ecodesign Directive includes opt-in material-related requirements regarding reparability, durability and recyclability but these have not been implemented to any significant extent.

7.1.7. Others

26) IN4climate.NRW	
Description	<p>IN4climate.NRW is a platform for the sharing of knowledge, dialogue and collaboration between industry, science and politics for the decarbonisation of the industrial sector. Currently the platform consists of about 30 companies and associations from the following sectors: steel and metal, cement, glass, paper and construction materials as well as six research institutions and is supported by the Ministry of Economic Affairs, Innovation, Digitalisation and Energy of the State of North Rhine-Westphalia.</p> <p>Focussing on topics such as circular economy, hydrogen, carbon economy, heat or framework conditions, the platform strives to maintain the viability of North Rhine-Westphalia as industry location. For this purpose, the development of financial and technical strategies based on technology studies and innovation road maps as well as research projects is envisaged. In addition to the economic objective, the superordinate goal is the transition to a carbon-neutral industry.</p> <p>In 2019 and 2020 the platform released a hydrogen study as well as five papers discussing the issues of hydrogen, climate-friendly revitalisation of the economy, chemical plastics recycling, expansion of renewable energies and unavoidable GHG emissions. Furthermore, IN4climate.NRW carried out diverse events partly in co-operation with its scientific competence centre SCI4climate.NRW. This competence centre published, in addition, diverse reports and papers supporting the work of IN4climate.NRW.</p>
CAPEX/OPEX	No financial support.
Technology maturity	Not defined (TRL 1-9).
Target group/sector/technology	Industry (especially steel and metal, cement, glass, paper, construction materials).
Typical grant/project size	No financial support.
Eligibility	Industrial companies in North Rhine-Westphalia, relevant research institutions.
Budget available	No financial support.
Evaluation	No evaluation available.
Sources	<p>https://www.in4climate.nrw/en/index/.</p> <p>https://www.wirtschaft.nrw/treibhausgasneutrale-industrie.</p>

27) SME Initiative Energy system transformation and climate protection

Description

The SME initiative is a joint project of BMWi, BMU, Deutscher Industrie- und Handelskammertag (DIHK) and ZdH. The first funding period expired on 31 December 2015. The second phase of the SME initiative was launched on 1 January 2016 and ran until 31 December 2018. Seven environmental centres of the crafts sector, which support regional development workshops in their districts, were included. In addition, around 10 000 company contacts were made throughout the federal Government to raise awareness of the topic of energy efficiency and 375 companies were visited directly. On 1 January 2019, a further period of the SME initiative was launched to continue the projects already started and to design new measures such as digitalisation, the development of a roadmap for SMEs and mobility-related topics. The measures are implemented on the basis of action plans co-ordinated with the environment centres and the ZdH, which are part of the approvals.

7.2. Assessment of the German policy mix

This section discusses the effectiveness of the overall policy mix to induce the low-carbon transition in the heavy industry in Germany, with a particular focus on the following technologies:

- hydrogen for process heating and feedstock (including blue and green hydrogen)
- electrification of process heating
- carbon capture and storage (CCS)
- bio-based materials
- recycling of materials (notably metals and plastics).

7.2.1. Decarbonisation technology developments

In recent years, the German policy mix has been extended by several instruments aiming at the development and large-scale market introduction of decarbonisation technologies in heavy industries. Five instruments can be particularly mentioned in this category (numbers refer to the list in the previous section and are used for the analysis):

- 5) National Decarbonisation Programme
- 6) Programme CO₂ Avoidance and Use in Basic Industries: Under preparation (effective 2 January 2021)
- 7) National Hydrogen Strategy: CCfD pilot
- 8) National Hydrogen Strategy: IPCEI "Hydrogen for industrial production"
- 9) EU ETS Innovation Fund: further development of the NER300 programme.

While all instruments aim at decarbonisation of heavy industry, they differ substantially in technology focus (Table 7.2). The *EU Innovation Fund* shows the broadest technology coverage and even includes switch to new low-carbon products. While the *Decarbonisation Programme* was first planned to only address process-related emissions, it was finally published with a broader technology scope. However, downstream activities like material efficiency or recycling are out of scope. The *Programme for CO₂ avoidance* was still under preparation and not finally published as of January 2021. It is currently intended to address

CCS/CCU as well as transport technologies. The *IPCEI for hydrogen* and the *CCfD Pilot* both aim at building large-scale industrial installations using hydrogen (green or blue) to replace fossil fuels. Overall, the programmes show a relatively complete technology coverage for the major decarbonisation options: hydrogen, electrification and CCS/CCU.

Table 7.2. Overview of technology scope of key technology development policies

2/dark green= high relevance; 1/light green = relevant; 0/white = out of scope

Technology focus of policy	TRL	Mitigation technologies						
		Hydrogen	Electrification	CCS/CCU	Bio-based materials	Circularity	Material efficiency	Energy efficiency
5) Decarbonisation Programme	4-9	2	2	1	1	0	0	0
6) CO ₂ Avoidance and Use	8-9	0	0	2	0	0	0	0
7) Hydrogen CfDs	8-9	2	0	0	0	0	0	0
8) IPCEI Hydrogen	8-9	2	0	0	0	0	0	0
9) EU ETS Innovation Fund	6-9	2	2	2	2	2	2	0

Source: Fraunhofer Institute.

The three programmes *CO₂ Avoidance and Use*, *Hydrogen CCfDs* and *IPCEI for Hydrogen* mainly target large-scale industrial plants, while the *Decarbonisation Programme* and the *EU Innovation Fund* are also open for smaller demonstration projects.

The potential impact of these programmes can be estimated based on the available budget. This is summarised in Table 7.3 for the time horizon foreseen in the programmes' current planning. However, it is likely that the programmes continue beyond the currently planned time horizon, which will substantially increase the total budgets available until 2030.

The total budget of the programmes sums up to about EUR 5 billion, cumulated over the respective planned time horizon of the individual programmes, which ends between 2025 and 2030. The first programmes started to accept applications in 2020 (*EU Innovation Fund* and *Decarbonisation Programme*). However, it is likely that most of the programmes will run longer than today's budget planning indicates. More specifically, a continuation of the programmes on the currently planned level towards 2030 would increase the total cumulated budget to EUR 12 billion.

From the total budget of about EUR 5 billion, about EUR 4 billion are directed exclusively towards CAPEX funding, EUR 550 million address OPEX (CCfDs) and EUR 800 million are more flexible (EU Innovation Fund). The total CAPEX funding seems a relevant amount, when compared to costs of industrial scale projects like a new DRI steel plant (EUR 0,4 billion invested for DRI+Electric Arc Furnace (EAF) plant of 1 Mt/y of crude steel production), a cement clinker kiln equipped with carbon capture (EUR 0.15 billion invested for 1 Mt/y clinker production). Thus, the estimated budgets are sufficient to support financing of several industrial-scale installations.

However, while the CAPEX funding seems substantial, the available funding for OPEX seems rather insufficient to close the gap between the traditional fossil-based processes and low-carbon production processes. Operational costs of low-carbon production processes can outweigh capital expenditures in these technologies within a few years, especially at low or exempted carbon prices, compromising the business case for low-carbon installations. In particular, hydrogen-based technologies show very high OPEX costs compared to fossil fuel alternatives. Assuming an emission quota price increase of about EUR 30 on average and hydrogen costs of EUR 150 per MWh, the OPEX cost gap is often several times

higher than CAPEX costs for technologies like DRI steelmaking or the use of hydrogen for methanol/ethylene production. On the other side, assuming electricity costs of EUR 40 per MWh (today's tariff for very large electricity consumers) direct electrification options like electric glass melting might become cost-competitive without additional OPEX funding. CCS also requires comparably little OPEX funding.

Table 7.3. Estimate of planned budgets for the technology development programmes

Programme	CAPEX/OPEX?	2020	2021	2022	2023	2024	2025	> 2025	Total
5) Decarbonisation Programme	CAPEX	80	310	500	500	500			1 890
6) CO ₂ Avoidance and Use	CAPEX	-	120	120	100	80	80		500
7) Hydrogen CfDs	OPEX		-	250	300				550
8) IPCEI Hydrogen	CAPEX	-	250	250	250	250	250	250	1 500
9) EU ETS Innovation Fund	CAPEX & OPEX	-	80	80	80	80	80	400	800
Total		80	760	1 200	1 230	910	410	650	5 240
CAPEX		80	680	870	850	830	330	250	3 890
OPEX		-	-	250	300	-	-	-	550
CAPEX & OPEX		-	80	80	80	80	80	400	800

Note: Budgets show only the share that is addressing industry decarbonisation, in case programmes also target other sectors such as energy. Estimates for the budget of the EU Innovation Fund based on the total projected available budget of ~EUR 10 billion in the EU, the population share of Germany and the assumption that 50% of the projects goes to the industry sector. For the IPCEI for Hydrogen, only the share going to the industry sector is taken into account.

Source: Fraunhofer Institute.

In summary, the recent introduction of specific programmes aimed at the development and industrial upscaling of key technology solutions for industry decarbonisation can be regarded as central milestones in establishing a policy mix for the transformation of the German industry sector towards GHG neutrality. The foreseen overall budgets are relevant and the technology scope covers the most important options. However, with the current regulatory frame (energy prices, hydrogen production costs and EU ETS), the budgets are most likely not sufficient to close the OPEX gap and make hydrogen-based technologies cost-competitive with today's fossil fuel-based technologies. Approaches to close this gap can include an ambitious minimum price path in the EU-ETS, higher budgets for CCfDs - if the instrument is working - or a supply-side approach that makes (green) hydrogen available at lower prices to industrial consumers. In addition, the creation of lead markets could generate higher product prices.

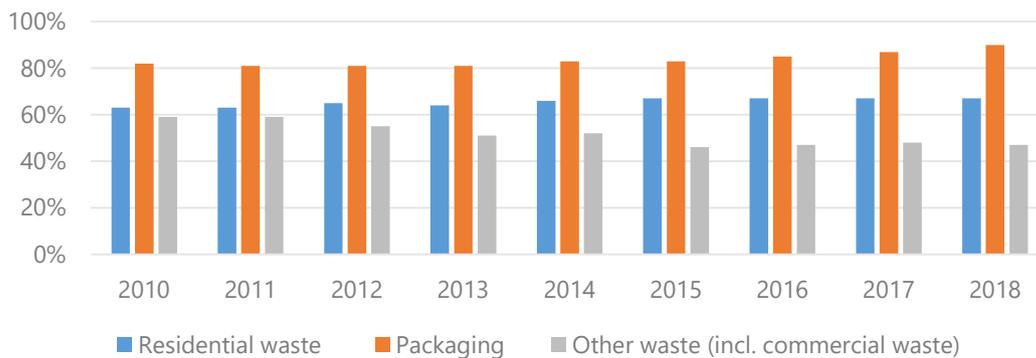
7.2.2. Material efficiency and circular economy

The relevance of material efficiency and the circular economy for achieving national and EU climate goals is well established.⁹ In this context, increasing material efficiency is considered desirable to trigger the decarbonisation of the German industrial sector, although the implementation of material-based strategies does not necessarily mean a reduction in emissions due to, e.g. higher energy demand. Consequently, these strategies and the related policies need further assessment and evaluation against adequate targets, which lies beyond the scope of this report.

The German policy mix addressing material efficiency and circular economy is framed by the *German Resource Efficiency Programme ProgRes III* and comprises legislative as well as financing instruments. The implemented legislation in Germany is mostly a one-to-one implementation of the *EU Waste Framework Directive* and hence, the *EU Circular Economy Action Plan*. On a few aspects, the national legislation goes beyond the EU requirements. The financing instruments, with a total budget of EUR 490 million from 2018 to 2024, are mostly focussed on the funding of R&D projects in construction and plastics. An exception is the *r+Impuls funding guideline*, which helps bring technologies to the market.

Similar for decarbonisation technology support, the funding of CAPEX is more common during the implementation phase. In general, the effectiveness of these policies is questionable since the aim of the *German Resource Efficiency Programme Progress II* of doubling the resource productivity from 1994 to 2020 is expected to be missed. Nevertheless, recycling quotas defined by the relevant legislation have been achieved.

Figure 7.3. Comparison of recycling rates of residential waste, packaging and other waste



Note: Abfallbilanz - 2018 - Statistisches Bundesamt, <http://www.destatis.de>.

Source: Fraunhofer Institute

The Circular Economy Act defines recycling as the recovery of waste for the original or other purposes excluding energetic recovery, which therefore includes the preparation for recycling and the storage of waste. The calculation of recycling rates is obtained from an input-based method, which consists of comparing the input of the recycling processes with the total quantity of waste. In practice, the input that is actually recycled varies widely from 10% to 90%. In particular, incorrect sorting leads to the energetic recovery and disposal of the remaining quantities. The relevant waste types and the associated recycling rates are shown in Figure 7.3. While packaging stands out due to a high and increasing recycling rate, the rate for other waste has been decreasing since 2010.

The much-discussed plastic waste recycling rate is about 47% in 2017 and 2019.¹⁰ Even though this information is used frequently, e.g. by the Parliament, the Environment Agency or the plastic packaging industry association,¹¹ its accuracy is questioned because the input-based calculation method does not consider losses during recycling. Additionally, exported waste is considered to be recycled even though the actual implementation is not tracked.¹² To overcome these challenges the recycled share of plastic processing is proposed as an indicator. This key figure compares plastic products from recycling with the total amount of processed plastics in Germany. Consequently, exported recycled plastics and quality losses during recycling are not considered. In Germany, recycled plastics are typically used in the construction sector, in agriculture and for the production of packaging. In 2017 the recycling share was about 12% and in 2019 about 14%. Historical data are not available for comparison.¹³

A similar approach calculating the share of secondary pre-materials is used for aluminium, copper and steel recycling as shown in Figure 7.4. The shares of secondary aluminium, copper and steel scrap are more or less constant over time. The highest share of recycled material is used for aluminium production.

Figure 7.4. Comparison of secondary pre-material share for aluminium, copper and steel



Note: For details see https://www.bgr.bund.de/DE/Themen/Min_rohstoffe/Produkte/produkte_node.html.

Source: Fraunhofer Institute.

The challenges of the input-based calculation method of recycling rates have been considered in the amendment of the EU Waste Framework Directive in 2018.¹⁴ The new rules require an output-based calculation method, so that the output of the recycling plants is accounted for in the calculation. Hence the losses are taken into account. The required recycling quotas were lowered accordingly in the *Circular Economy Act*. Due to the newly introduced output-based calculation method the recycling rates shown in the preceding sections cannot be compared with the recycling quotas directly. A transfer of input-based recycling rates for residential waste in 2015 has shown, however, that the output-based recycling rates are significantly lower (input-based recycling rate for residential waste in 2015: 67%; output-based recycling rate for residential waste in 2015: 36-40%). In practice, a share depending on the specific waste type of the input material is used for energetic recovery.¹⁵ Compared to the current legislation the quotas would consequently not be fulfilled. Nevertheless, the actual recycling rates for the relevant time period are not yet available. Hence, an assessment of the effectiveness of the policy mix from this perspective is currently not possible.

Recent Fraunhofer-ISI work evaluates the ability of the policy mix to facilitate the circular economy innovation system in Germany (Gandenberger, 2021_[1]). The conclusion is that ProgRes III does not enable the transformation from a linear to a circular economy for two reasons: non-existent markets for secondary products and insufficient financial resources for innovations. Therefore, ProgRes III would not achieve its objectives as framing for the circular economy. Recent amendments to the legislative framework and especially the Packaging Act, as well as further emerging technologies and innovations, are not considered in this evaluation. Two major approaches in this context are the chemical recycling of plastics and the transformation to a bioeconomy. In 2020 the National Bioeconomy Strategy was published by the German Government. The strategy includes general objectives and action fields focussing on the potential assessment and (inter-)national collaboration. The use of biogenic materials in industry is also mentioned, but limited by land availability.¹⁶ The topic was additionally mentioned in *ProgRes III*, part of *FONA4* and to a smaller extent considered in funding guidelines. Nevertheless, the topic is less present in the societal and political discourse about industry decarbonisation - in contrast to chemical recycling of plastics.

The 2018 European Strategy for Plastics discusses chemical recycling as a promising option for the recycling of plastic waste. Chemical recycling summarises different technology options for the depolymerisation of plastic as preparation for recovery.¹⁷ In accordance with the *EU Waste Framework Directive* and the national *Circular Economy Act*, chemical recycling contributes to the recycling quota achievement. In contrast, according to the German Packaging Act, chemical recycling is classified as recovery and not as recycling - just like the energetic recovery. Consequently, it can contribute to the

recovery quota defined in the Packaging Act (90%) but not to the recycling quota (65%). Chemical recycling can thus substitute energetic use prospectively.

The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety currently supports this legislative design. On the one hand, chemical recycling is perceived less ecologically reasonable due the high process energy demands. On the other hand, the incentives induced by the Packaging Act shall be ensured and risks avoided for extended sorting and recycling capacities. Thus chemical recycling is assessed exclusively as an alternative to the energetic recovery of contaminated plastic waste if economically and ecologically feasible.¹⁸ A comparable position is taken by the Federal Environment Agency. However, it emphasises the need for further research to assess economic and ecologic advantages of chemical recycling.¹⁹ Especially the liberal opposition party is challenging the position of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and thereby the Federal Government against the backdrop of the intensification of the recycling quotas and technology openness.²⁰

While environmental organisations such as the Nature and Biodiversity Conservation Union and Greenpeace support the current position of the Federal Government,²¹ the national and the European chemical industry associations are pointing to barriers for technology development.²² The legislative demands of the environmental organisations include the delimitation of chemical recycling to processes which again produce plastic and the inclusion of chemical recycling in the waste hierarchy between recycling and energetic recovery. On the contrary, the industry associations demand the full classification of chemical recycling as recycling. The development of this discourse will have an influence on the decarbonisation of the industry - even if the direction has not yet been determined.

In a nutshell, the German policy mix in the field of material efficiency and circular economy does not currently seem to have a strong impact on industry decarbonisation. In the evaluation of the innovation system for circular economy, Gandenberger (2021^[1]) proposes dynamic standards for the use of secondary materials to create markets as well as product design standards enabling repair and recycling. He underlines the importance of accompanying measures to establish new business models.²³ Similar aspects have also been identified at the international level (IRP, 2020^[2]). Particularly, steel and cement but also plastics, paper, glass and metals are relevant and should be targeted directly.²⁴ Technologies such as chemical recycling of plastics but also an increased share of secondary steel as well as an increased cement/concrete recycling are key solutions for the decarbonisation of the industry. Downgrading of materials should be avoided widely. Also the use of alternative or bio-based materials in the construction sector can have a significant impact. Additionally, an overall policy strategy focussing on decarbonisation via material efficiency and circular economy would benefit from co-ordinating the efforts on the national and the EU levels.

7.2.3. Overall assessment

An overall assessment of the policy mix and possible ways forward to make it more effective for decarbonisation are laid out below. Table 7.4 offers an overview of all policies in scope and their respective technology focus.

Traditionally, the policy mix to decarbonise the industry sector in Germany focused strongly on **energy efficiency** support policies like audit schemes or grants of efficiency improvement projects. These mostly addressed SMEs and lighter industries. A second major traditional pillar of the policy mix are regulations for **recycling** and the sorted collection of consumer waste. This resulted in high recycling rates for products like paper or glass. The main policy addressing **decarbonisation in the heavy industry** was for a long-time the EU ETS. **Energy taxes** and the EEG-levy are relevant mainly for small companies, while large energy consumers receive large tax exemptions.

GHG reduction targets have also evolved over the past decade. The Climate Action Plan 2050,²⁵ adopted by the German Government in November 2016 sets out concrete actions to achieve the target of the Paris

Agreement to achieve CO₂-neutrality by mid-century and defines milestones for the year 2030 at the sectoral level. For the industry sector it sets a target of 49-51% GHG reduction compared to 1990. To achieve the sectoral target, substantial efforts on mitigation technologies are needed, including large-scale investments in decarbonisation technologies. The targets were further strengthened through the climate protection law, which went into force in December 2019. It defines a (linear) path for emission reduction in all sector towards the 2030 milestone and requires additional policy action, if the monitored emissions fall short of the minimum path in a certain year. Overall, the sectoral target and the clear commitment to GHG neutrality by 2050 have facilitated activities to decarbonise industry from private, but also public actors, as it becomes obvious that the industry sector also needs to reduce emissions drastically to achieve the overall reduction target.

Two important milestones for the industrial transition were the publication of the Hydrogen Strategy (June 2020) and the Climate Action Programme 2030²⁶ (October 2019). Among others, they initiate several major **technology development programmes** (see policy fact sheets) providing investment support for the industrial-scale market-introduction of decarbonisation technologies in heavy industry sectors.

Despite this recent amendment, the policy mix is in several aspects not sufficient to put the industrial transition on track towards decarbonisation by 2050. These mainly relate to the fact that it does not provide a clear and robust perspective for the competitive operation of large-scale low-carbon plants in the medium term (towards 2025/2030). Here, policy initiatives could address the following issues:

- Technology development programmes currently focus on CAPEX support and lack **OPEX support**, which is particularly important for hydrogen-based technologies in the short and medium term. Expanding the pilot CCfD programme - if successful - can be a way forward. Alternatively, the supply of hydrogen at lower costs could also reduce this OPEX gap.
- **Lead markets for green products** that allow for a price-premium on products made from CO₂-neutral basic materials, like a car made from CO₂-neutral steel or a building from CO₂-neutral concrete, do not exist. Among others, public procurement could close this gap and induce niche markets.
- The EUA price in the ETS is too low to make key decarbonisation technologies like hydrogen, electrification or CCU/CCS cost-competitive and lacks a clear perspective that allows considering increasing CO₂-prices in cost-benefit assessments for new investments. A **minimum CO₂-price path** could solve both issues and provide a clear perspective for low-carbon investments towards cost-competitiveness.

Furthermore, the huge amounts of **CO₂-neutral energy carriers** required to operate CO₂-neutral industrial-scale plants (electricity, hydrogen, green gas) are not yet available. Even more, there is still a huge uncertainty by when and if such energy carriers will be sufficiently provided at a competitive price. For companies to make investments worth of several hundred million euros, the supply of such critical energy carriers needs to be ensured. This also includes the local availability of e.g. hydrogen and the needed **infrastructure** for generation/import and transport. For instance, investors in large-scale DRI-steel plants need to know if there will be access to a hydrogen network at a certain date in the future and if hydrogen is a strategic part of Germany's industry decarbonisation strategy. Thus, the industry policy mix also links to infrastructure planning.

In some sectors, **process emissions** cannot be mitigated by switching energy carriers or process routes. Cement and limestone production are the most prominent and relevant examples. Deep decarbonisation of these sectors most likely requires **CCS** or **CCU**. While the *Programme for CO₂ Avoidance and Use in Basic Industries* is currently being implemented, there is still a huge uncertainty for investors due to the public opposition towards CO₂ storage in Germany. Although this opposition was initially directed towards CCS for coal-fired power plants, it is not evident that the public opinion can distinguish CCS for process-related emissions. For CCU, a major challenge will be to find uses with a long-term storage - substantial R&D is still needed.

Another area where the current policy mix needs amendment to come on track towards industry decarbonisation is the entire field of **material efficiency and circular economy** along the industrial value chains down to the end-user sectors. CO₂-prices are not included in the prices of most end-consumer products. Consequently, CO₂ is not factored into investment decisions when for example materials are used to construct buildings or cars.

Circular Economy policies still show a rather traditional focus on the collection and recycling of waste. While some improvements were made (e.g. including stricter regulations on commercial waste), particularly materials with a very high emission intensity still show very low shares of secondary production routes. Circular economy policies can more effectively contribute to decarbonisation if amended in the following directions:

- Stronger focus on circularity of **plastics** products in order to close carbon cycles by including chemical recycling and avoid downgrading.
- Further replacing primary **steel** production by secondary production is a very effective decarbonisation measure, but would require improved collection of steel scrap and also use secondary steel for high-quality products, e.g. in the automobile industry.
- Development and use of alternative materials to decarbonise the construction sector and especially **concrete** production.

These goals require the creating of **markets for recycled products** and implementation of uniform product standards on the national and the European level.

Table 7.4. Overview of the German policy mix towards industry decarbonisation and respective technology focus

(2/dark green= high relevance; 1/light green = relevant; 0/white = out of scope)

Policy Instrument	Industry type		Mitigation technologies							TRL
	Heavy industry	Light industry	Hydrogen	Electrification	CCS / CCU	Bio-based materials	Circularity	Material efficiency	Energy efficiency	
Carbon and energy pricing										
1) EU emissions trading (EU)	2	0	1	1	1	0	0	0	1	-
2) National emissions trading	0	2	0	0	0	0	0	0	1	-
3) Energy taxes	0	1	0	0	0	0	0	0	1	-
3) Energy taxes: Exemptions and EMS	1	1	0	0	0	0	0	0	2	-
4) EEG-levy	0	1	0	0	0	0	0	0	1	-
4) EEG-levy: Exemptions and EMS	2	1	0	0	0	0	0	0	2	-
Technology development										
5) Decarbonisation Program	2	0	2	2	1	1	0	0	0	4-9
6) CO ₂ Avoidance and Use	2	0	0	0	2	0	0	0	0	8-9
7) Hydrogen CfDs	2	0	2	0	0	0	0	0	0	8-9
8) IPCEI Hydrogen	2	0	2	0	0	0	0	0	0	8-9
9) EU ETS Innovation Fund (EU)	2	0	2	2	2	2	2	2	0	6-9

Research and innovation										
10) 7th Energy Research Program	1	1	1	1	1	1	1	1	2	All
11) FONA - Research for Sustainability	2	1	2	1	2	1	2	2	0	n/a
12) Progres.nrw - Research	1	0	1	1	1	1	1	1	0	2-4
Material efficiency and circular economy										
13) Circular Economy Act	2	2	0	0	0	1	2	1	0	-
14) ProgRes III	2	2	0	0	0	2	2	2	0	n/a
15) TTP LB - Lightweight Construction	2	2	0	0	0	0	2	2	0	3-8
16) Funding directive "Resource efficient CE"	2	2	0	0	0	1	2	2	0	3-8
17) EU Circular Economy Action Plan (EU)	2	2	0	0	0	1	2	2	0	n/a
Energy efficiency										
18) Federal support for energy efficiency	1	1	0	0	0	0	0	0	2	9
19) Energy audits in SMEs	0	2	0	0	0	0	0	1	2	9
20) Low-interest loans for energy efficiency	2	2	0	0	0	0	0	0	2	9
21) Pilot program "Einsparzähler"	2	2	0	0	0	0	0	0	2	9
22) Funding competition for energy efficiency	2	2	0	0	0	0	0	0	2	9
23) Energy efficiency networks	1	2	0	0	0	0	0	0	2	9
24) Energy audit obligation for LEs (EU)	2	1	0	0	0	0	0	0	2	9
25) Minimum energy performance standards (EU)	1	2	0	0	0	0	0	0	2	9
Other related policies										
26) IN4climate.NRW	2	0	2	2	2	0	0	0	0	
27) SME Initiative Energy transformation	0	2								

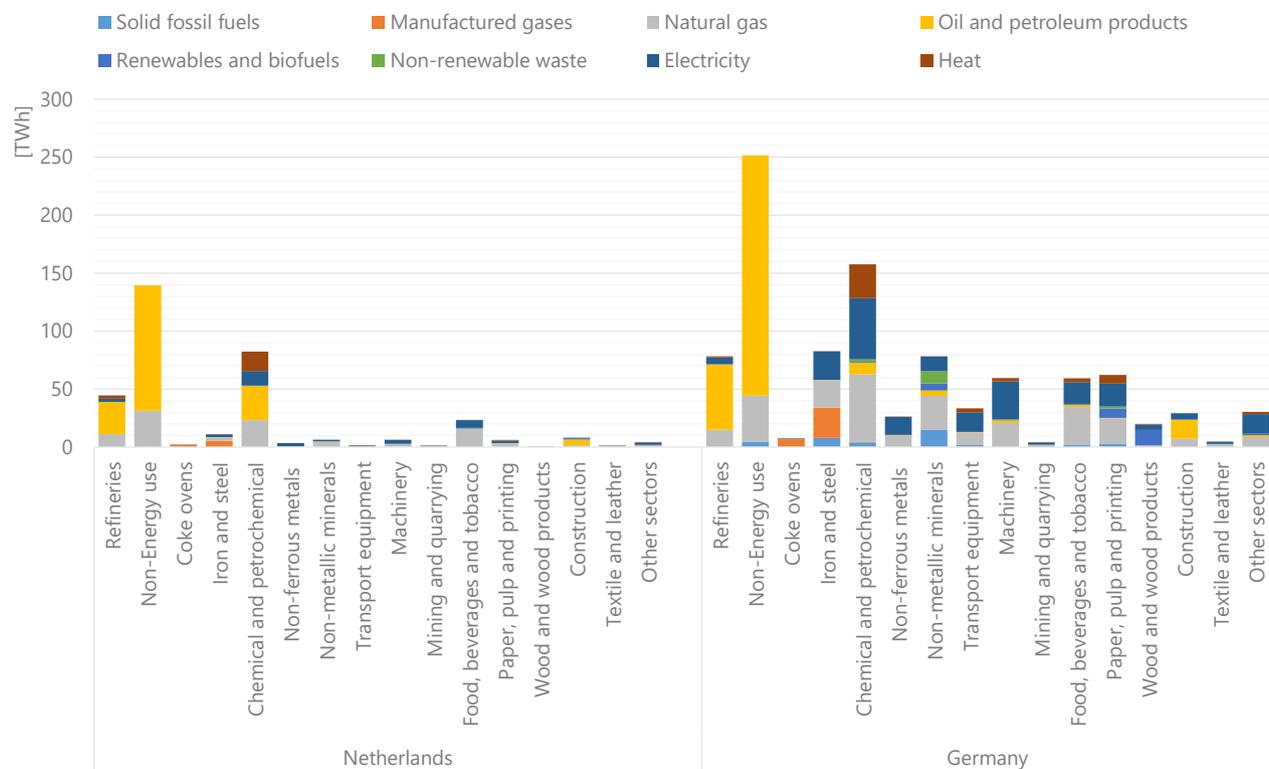
Source: Fraunhofer Institute.

7.3. Comparison with the Netherlands

7.3.1. Overall

Major differences are explained by structural differences in the industrial production between the two countries. Energy consumption by industrial sector is a useful indicator to illustrate such structural differences. Figure 7.5 compares the industrial energy demand of Germany with the Netherlands by 2019. The high relative importance of refineries and the chemical industry including feedstock use of energy carriers in the Netherlands stands out. While in Germany, the chemical and refineries industries are also important, energy demand is more equally spread across many sectors. The steel and cement production are highly important in Germany and disproportionately contribute to emissions due to their use of CO₂-intensive energy carriers and process-related emissions. SME-dominated sectors like transport equipment, machinery, food, paper and others show a high contribution to the overall energy demand in Germany.

Figure 7.5. Energy consumption in industry sectors in Germany and the Netherlands in 2019



Source: Eurostat.

Major differences in the policy mix between the Netherlands and Germany include:

Sectoral focus

- The chemicals and refineries sectors play an important role in the Netherlands, which explains the important role of hydrogen and bio-based materials.
- The German policy mix has a broader sectoral focus and relies less on bio-based materials. It reflects a high importance of the primary steel production as a major expected buyer of green

hydrogen. Further SMEs are particularly addressed by several energy-efficiency policies, reflecting the strong SME basis in the German industry.

Infrastructure

- The built-up of hydrogen infrastructure is a central requirement for the large-scale roll-out of hydrogen based processes. Here, the current approach taken by Germany is mainly to finance hydrogen infrastructure on project basis (e.g. via IPCEIs). Currently, a strong public role in co-ordinating, planning and operating such infrastructure cannot be observed.

CCS

- In Germany, CCS (for power plants) has experienced strong public opposition and storage of CO₂ is even forbidden in several states. Still, the Government realises the need for CCS (or CCU) to decarbonise the large cement industry. Accordingly, an innovation funding programme with a total budget of about EUR 500 million (cumulated until 2025) for CCS and CCU is currently being prepared to support large-scale demonstration projects.

Electrification

- In Germany, electric process heating is part of CAPEX funding programmes. However, with the current EU ETS CO₂ price, it is not cost-effective, as abatement costs are in the order of magnitude of EUR 200 per tonne of CO₂ and above.

Hydrogen-based solutions: OPEX competitiveness gap

- In Germany, innovation funding policies strongly focus on CAPEX support and high operational costs are still a major barrier for large-scale investments. However, as part of the Hydrogen Strategy, a pilot programme for Carbon Contracts for Difference addressing green hydrogen use has been implemented. The foreseen budget, however, would need to be extended significantly if the entire industry should benefit.

Biomass and bio-based materials

- While the German Industry Association sees a very large role in biomass as a relatively low-cost energy carrier to decarbonise industrial process heating, the Government is more reluctant and the Ministry for the Environment even rather opposes the expansion of biomass use for process heating and other uses. Main arguments are low-costs and CO₂-neutrality on the one hand and on the other, scarcity and competition of biomass potentially needed in many sectors.

7.3.2. Material efficiency and circular economy

The differences and commonalities between the national decarbonisation policies of Germany and the Netherlands can also be identified for specific policy areas such as material efficiency and circular economy. In general, both countries are relying on the given EU framework for product standards. Similar to the Netherlands, Germany has implemented rules for sustainable public procurement by establishing an obligation to give preference to sustainable products. In contrast to these similar legislative instruments and hence similar weaknesses of the policy mix, the financing instruments vary to some extent. In the Netherlands, support is mostly provided via broader policy tools addressing multiple areas as shown in Table 7.5. Consequently, the three major aspects of the policy mix for the industry decarbonisation in the Netherlands identified in this report also apply to the policy tools relevant in the field of material efficiency and circular economy.

Firstly, the financial instruments at the national level in the Netherlands are focussing on demonstration projects rather than on fundamental research. In contrast, the policies in Germany have a stronger focus on R&D projects and fundamental research. Secondly, within R&D the policy tools in the Netherlands - and also in Germany, the policy instruments are mainly untargeted and thereby potentially ineffective on the deployment of radically new technologies. The third aspect considers the large number of R&D policy tools in the Netherlands, with little individual funding potentially leading to a high administrative burden but also a tailored funding. In contrast, the German policy tools comprise larger budgets and hence a lower administrative burden.

Table 7.5 Dutch Financing instruments in the field of material efficiency and circular economy

	Area	Type	Stage	Target group
Circular Economy Implementation Programme	Circular economy in biomass and food, plastics, manufacturing industry, construction and consumer good	Subsidy	Not defined	Industry
DEI+ CE	Reuse; recycling; bio-based raw materials	Subsidy	Pilot projects	Companies, knowledge institutions
Green project loan facility	Environment-friendly, circular economy and sustainable construction projects	Subsidised loan	Not defined	Companies
KIEM GoChem scheme	Sources and raw materials; processes and technology; molecules and materials; processing and application; chain and business models; recycling and upcycling	Subsidy	Innovations	SME, knowledge institutions
MIA/ Vamil	Circular economy and raw materials; CCU; bio-based economy; electrification; reduction of nitrogen and related emissions; greenhouse gas emission reductions	Tax allowance	Not defined	Companies
MOOI (mission-driven research, development and innovation)	CO ₂ -free electricity system; CO ₂ -free built environment; climate-neutral raw materials; circular products and processes	Subsidy	R&D leading to first market application	Companies
NWO funding instruments for the Knowledge and Innovation Covenant (KIC)	Climate and energy; Circular economy	Subsidy	Fundamental and practice-oriented research	PPP
TKI/ PPP allowance	Bio-based economy; chemistry; energy	Subsidy	Fundamental research, industrial research and experimental development	Companies, PPP
Top Sector Energy Studies Industry	Closure of industrial chains; CO ₂ -free industrial heating system; electrification; CCUS; other CO ₂ -reducing measures	Subsidy	Pilot and demonstration projects	Companies
TSE industry	Closure of industrial chains; CO ₂ -free industrial heating system; electrification; radically new processes	Subsidy	R&D leading to first market application	Companies
VEKI	Energy efficiency; recycling and reuse of waste; local infrastructure; other CO ₂ -reducing measures	Subsidy	Technology implementation after demonstration	Companies

Source: Fraunhofer Institute.

Besides these general aspects, the policy mix for circular economy and material efficiency are characterised by more specific differences and commonalities. The application of financial instruments in this field in Germany is usually implemented as subsidies while the Netherlands also includes tax allowances and subsidised loans for a more diverse policy design (Table 7.5). Also the target areas of the financial instruments vary. Even though both countries usually do not implement technology specific tools, the funding programmes in Germany are typically sector specific (construction or plastics). Besides the broader policy tools in the Netherlands without sector focus, the Circular economy Implementation

Programme presented in 2019 addressed five sectors in particular (biomass and food, plastics, manufacturing industry, construction and consumer good). Both countries provide measures targeting larger companies, SMEs and knowledge institutions, whereas the Germany policy mix for material efficiency and circular economy focuses more intensely on partnerships between knowledge institutions and companies.

The two emerging technologies described above – chemical recycling and bioeconomy – are promoted more specifically in the Netherlands than in Germany. Especially the bioeconomy is of high relevance for the refinery and the chemical sector in the Netherlands. For the same structural reason, chemical recycling of plastics is also part of the Dutch policy mix. A roadmap for the implementation of chemical recycling of plastics has been established in the Netherlands. Based on a comparable legislative policy mix, it seems that the Dutch financing policy mix enables more targeted actions in the field of material efficiency and circular economy. Nevertheless, both countries lack specific product design standards.

References

- Gandenberger, C. (2021), “Innovationen für die Circular Economy - Aktueller Stand und Perspektiven: Ein Beitrag zur Weiterentwicklung der deutschen Umweltinnovationspolitik”, *Umwelt, Innovation, Beschäftigung*, No. 2021/01, Fraunhofer-ISI, Karlsruhe. [1]
- 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, <http://dx.doi.org/10.5281/zenodo.3542681>. [2]

Notes

- ¹ [Climate Action Plan 2050 – Principles and goals of the German government's climate policy \(bmu.de\)](https://www.bmu.de/Climate-Action-Plan-2050).
- ² <https://www.umweltbundesamt.de/publikationen/effiziente-ausgestaltung-der-integration> and <http://publica.fraunhofer.de/dokumente/N-599450.html>.
- ³ <https://www.bundesanzeiger.de/pub/publication/sPdNMCSOJMQCRSvn4qr/content/sPdNMCSOJMQCRSvn4qr/BAanz%20AT%2015.01.2021%20B5.pdf?inline>.
- ⁴ <https://www.bmu.de/themen/forschung-foerderung/foerderung/foerdermoeglichkeiten/details/31/>.

- ⁵ https://www.klimaschutz-industrie.de/fileadmin/user_upload/KEI_download_pdf/20200709_Hinweisblatt_Foerderprogramm_Foerderungserfenster.pdf.
- ⁶ <https://dipbt.bundestag.de/dip21/btd/19/236/1923624.pdf> (2020-01-13).
- ⁷ https://www.bmwi.de/Redaktion/DE/Downloads/II/ipcei-bekanntmachung-interessenbekundungsverfahren.pdf?__blob=publicationFile&v=16.
- ⁸ Available at: <https://www.bmwi.de/Redaktion/DE/FAQ/IPCEI/faq-ipcei.html> (2020-01-13).
- ⁹ For instance, increasing material efficiency in residential buildings and light duty vehicles constitutes is a key opportunity to achieve the aspirations of the Paris Agreement (IRP, 2020_[2]).
- ¹⁰ https://www.conversio-gmbh.com/res/Kurzfassung_Stoffstrombild_2017_190918.pdf and https://www.conversio-gmbh.com/res/Kurzfassung_Stoffstrombild_2019.pdf.
- ¹¹ <http://dipbt.bundestag.de/doc/btd/19/046/1904634.pdf>
<https://www.umweltbundesamt.de/daten/ressourcen-abfall/verwertung-entsorgung-ausgewaehelter-abfallarten/kunststoffabfaelle#kunststoffe-produktion-verwendung-und-verwertung> and
<https://kunststoffverpackungen.de/wp-content/uploads/2020/11/IK-Jahresbericht-2020-online.pdf>.
- ¹² <https://www.gruene-bundestag.de/themen/umwelt/deutschland-ist-nicht-recyclingweltmeister>,
<https://www.sueddeutsche.de/wirtschaft/plastik-dm-rossmann-recycling-1.4552045> and
<https://www.nabu.de/umwelt-und-ressourcen/abfall-und-recycling/26205.html>.
- ¹³ https://www.conversio-gmbh.com/res/Kurzfassung_Stoffstrombild_2017_190918.pdf.
- ¹⁴ <https://www.umweltbundesamt.de/indikator-recycling-von-siedlungsabfaellen#wie-ist-die-entwicklung-zu-bewerten>.
- ¹⁵ https://www.vivis.de/wp-content/uploads/EaA15/2018_EaA_059-078_Obermeier.
- ¹⁶ [Nationale Bioökonomiestrategie – Zusammenfassung \(bmbf.de\)](#).
- ¹⁷ [Chemisches Recycling von gemischten Kunststoffabfällen als ergänzender Recyclingpfad zur Erhöhung der Recyclingquote | SpringerLink](#).
- ¹⁸ [2020_EaA_065-070_Janz.pdf \(vivis.de\)](#).
- ¹⁹ [Chemisches Recycling \(umweltbundesamt.de\)](#).
- ²⁰ [Drucksache 19/20175 \(bundestag.de\)](#) [Drucksache 19/21432 \(bundestag.de\)](#).
- ²¹ [Chemisches Recycling von Kunststoffen - NABU Das Wegwerf-Prinzip | Greenpeace](#).
- ²² [VCI-Vorlage \(bayerische-chemieverbaende.de\)](#).
- ²³ [Innovationen für die Circular Economy - Aktueller Stand und Perspektiven: Ein Beitrag zur Weiterentwicklung der deutschen Umweltinnovationspolitik \(umweltbundesamt.de\)](#).
- ²⁴ [Resource Efficiency and Climate Change | Resource Panel](#).
- ²⁵ [Climate Action Plan 2050 – Principles and goals of the German government's climate policy \(bmu.de\)](#).
- ²⁶ [Klimaschutzprogramm 2030 der Bundesregierung zur Umsetzung des Klimaschutzplans 2050](#).



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