Green Bond Impact Report 2022

Federal Ministry of Finance

impact

Green Bond Impact Report

2022

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I. Overview

This impact report relates to the Green German Federal securities issued in 2022. The report first provides a summary of the main impacts before going on to look at each budget item individually (Chapter II).

Green German Federal securities were issued in 2022 with a volume of €14.5 billion (see following table). The equivalent amount of this issuance volume was allocated to the 2021 expenditures identified as green (hereinafter: eligible) in the Green bond allocation report[1]. The proceeds of the 2022 issuances of Green German Federal securities were fully allocated. This impact report therefore concludes the reporting for the 2022 issuances in accordance with the Green Bond Framework.[2]

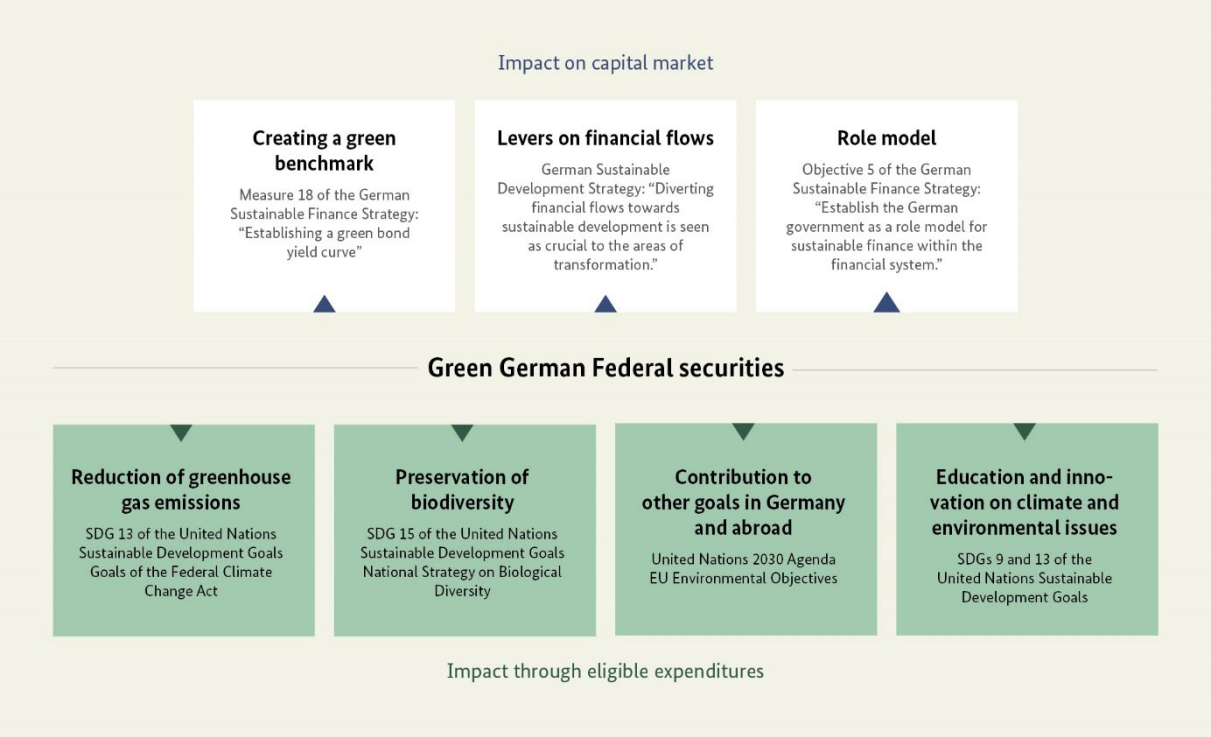
Issuance date	Type of issue	Type of security	ISIN	Issuance volume
02.03.2022 20.07.2022	Tap	10-year Green Federal bond ("Green Bund (Aug2030)")	DE0001030708	€3.0bn
04.05.2022 02.11.2022	Tap	10-year Green Federal bond ("Green Bund (Aug2031)")	DE0001030732	€2.5bn
01.06.2022	Tap	30-year Green Federal bond ("Green Bund (Aug2050)")	DE0001030724	€4.0bn
31.08.2022	New issue	5-year Green Federal note ("Green Bobl (Oct2027)")	DE0001030740	€5.0bn

The Core Green Bond Team, which consists of the Federal Ministry of Finance (BMF) (Chair), the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU[3]) and the Federal Republic of Germany – Finance Agency, identified eligible expenditures of around €16.8 billion from 93 items in the 2021 federal budget. The auditing firm Deloitte conducted an external audit of the allocation and confirmed the allocation of the issuance proceeds to the eligible expenditures (third-party verification).

[1] Green bond allocation report 2022 of 30 March 2023 (deutsche-finanzagentur.de)
[2] Tap issuances of the 2022 newly issued Green German Federal securities in subsequent years are transparently reported in the allocation and impact reports for the year of the taps. This is in line with section 4.3 of the Green Bond Framework of 24 August 2020.
[3] The names and responsibilities of the ministries correspond to the 2021 fiscal year.

Green German Federal securities manifest their impact in various and multifaceted ways, both directly on the capital markets and indirectly through the underlying expenditures at national and international levels.

Figure 1: Goals and impacts of Green German Federal securities



Source: Federal Ministry of Finance

Capital markets

On the capital markets, Green German Federal securities directly transfer Germany's established market approach to the green segment, offering a reliable green investment with maximum price transparency. Combined with the aim of creating and maintaining a liquid green Bund market with a diversified maturity spectrum for different types of investors, this will attract new investors and new issuers to the green bond market. This is expected to accelerate the development of sustainable capital markets overall and serve as a catalyst to channel more public and private investment into a greener economy.

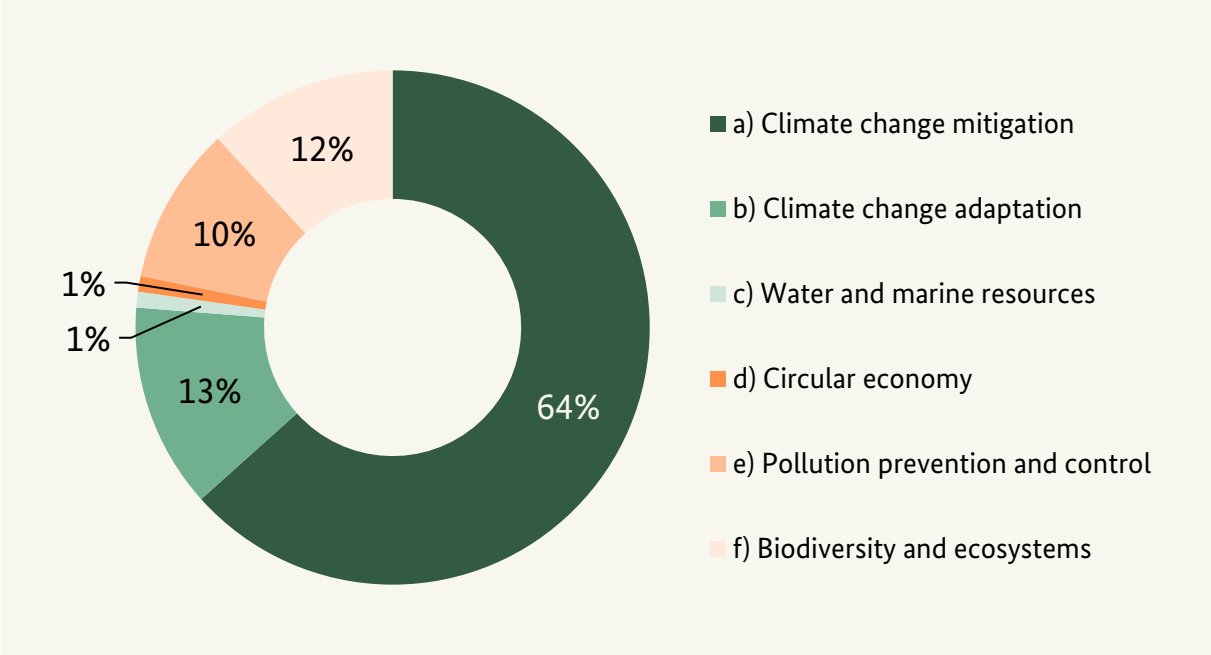
With the firm intention of establishing a green Bund curve, the Federal Republic of Germany is signalling that it will issue Green German Federal securities on a permanent and long-term basis. This is based on the eligible expenditures of the federal budget (including the Energy and Climate Fund[4]), through which Green German Federal securities achieve their indirect effect.

EU environmental objectives

In accordance with the Green bond allocation report 2022, the eligible expenditures in 2021 are distributed among the environmental objectives of the EU taxonomy for environmentally sustainable economic activities as follows:

[4] With the entry into force of the Second Act Amending the Act Establishing a Special Energy and Climate Fund (*Zweites Gesetz zur Änderung des Gesetzes zur Errichtung eines Sondervermögens "Energie- und Klimafonds"*) on 22 July 2022, the Special Fund was renamed "Climate and Transformation Fund" (see Federal Law Gazette I no. 26 of 21 July 2022). For the purposes of the Impact Report 2022, the name as it stood in the 2021 fiscal year will be used.

Figure 2: Breakdown of eligible expenditures in 2021 in accordance with the EU's environmental objectives



Source: Allocation report 2022

National commitment

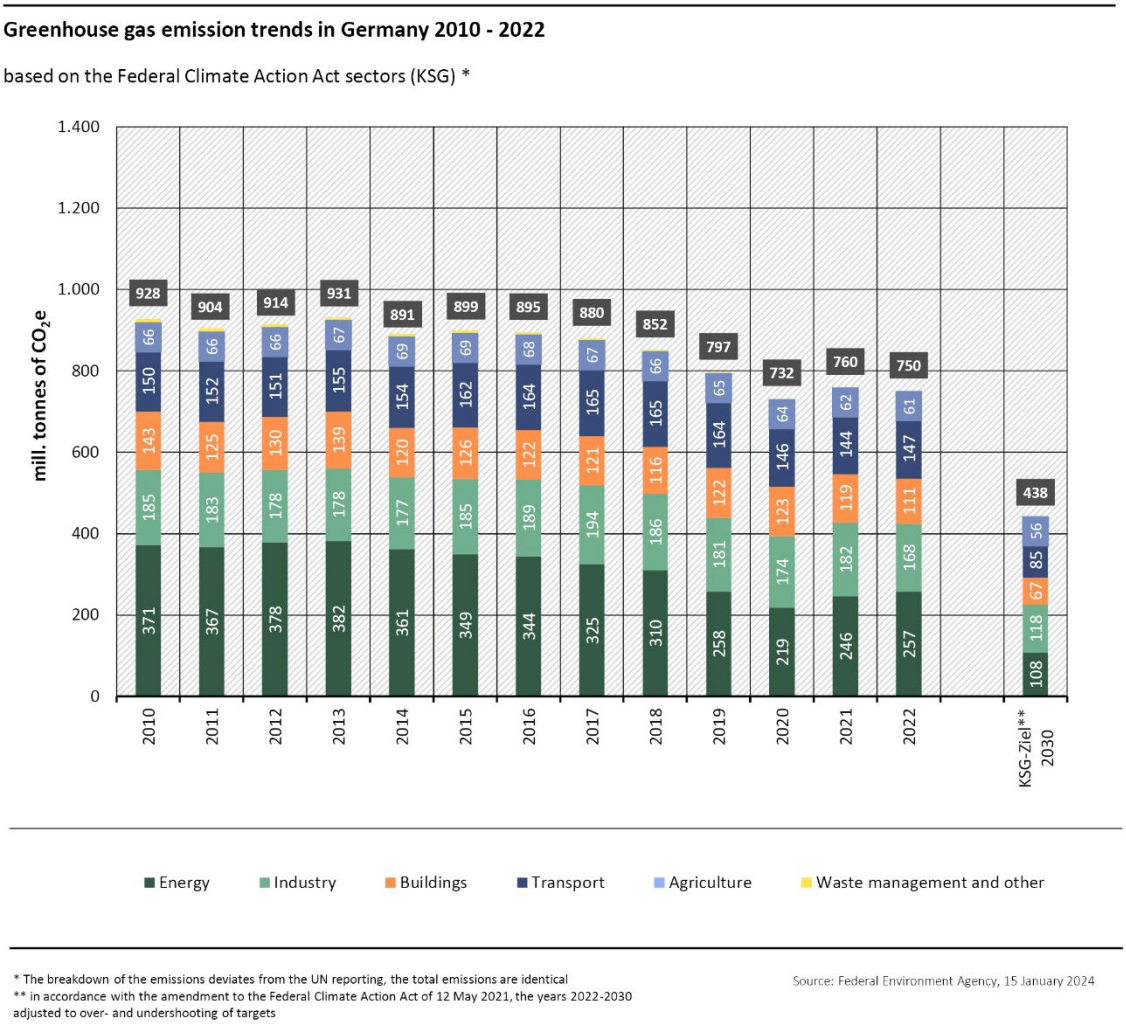
Germany is committed to the Paris Agreement and the 17 United Nations Sustainable Development Goals (SDGs). Its goal of becoming greenhouse gas neutral by 2045 was enshrined in the amended Federal Climate Change Act (*Klimaschutzgesetz*) in 2021.[5]

In 2022, about 750 million tonnes of greenhouse gases were released – about 10 million tonnes or 1.3% less than in 2021. Compared to 1990, there was a 40% reduction in greenhouse gas emissions.[6] The reduction targets are 65% for 2030 and 88% for 2040.

[5] https://www.bundesregierung.de/breg-de/schwerpunkte/klimaschutz/climate-change-act-2021-1936846. In the second amendment to the Climate Change Act in 2024, the climate protection targets and the transparency of the emissions sectors were retained while strengthening cross-sectoral target achievement: https://www.bundesregierung.de/breg-de/themen/tipps-fuer-verbraucher/klimaschutzgesetz-2197410

[6] For the Impact Report 2022, the data of the Climate Action Report 2023 and the final greenhouse gas emissions balance 2022 is used: see https://www.umweltbundesamt.de/en/press/pressinformation/detailed-greenhouse-gas-emissions-figures-for-2022. The Climate Action Report 2024 and the final greenhouse gas emissions balance 2023 will be included in the Impact Report 2023. Detailed information on this can be found at https://www.bmwk.de/Redaktion/DE/Downloads/Energie/klimaschutzbericht.html

Figure 3: Greenhouse gas emissions since 1990 according to the final climate inventory



Source: Federal Environment Agency 2024

These goals are to be achieved through numerous measures: targets, incentives, financial support and investment programmes. The German climate target for 2030 also takes into account the new, more ambitious EU climate target for 2030, which all member states agreed on under the German Council Presidency at the end of 2020. Other goals in the transition to a sustainable economy include switching to renewable energy sources, using energy more efficiently, adapting to climate change and preserving biodiversity.

International cooperation

Germany plays a key role in international cooperation for sustainable development. In this way, Germany supports developing and emerging countries in their transition towards more environmentally sustainable economies and societies. Through its participation in international bodies, its involvement in United Nations framework conventions and its bilateral and multilateral cooperation with other states, Germany emphasises the shared responsibility of all states for a healthy planet and addresses topics in the areas of climate action and climate change, the environment, nature, biodiversity and sustainable resource use.

Significant contributions of eligible expenditures

The Federal Republic of Germany's Green Bond Framework[7] dated 24 August 2020 contains possible expenditure categories that contribute to environmental protection, nature conservation and climate action and that can be assigned to Green German Federal securities. They are divided among five central thematic areas (sectors):

1. Transport
2. International cooperation
3. Research, innovation and awareness raising
4. Energy and industry
5. Agriculture, forestry, natural landscapes and biodiversity

Chapter II of this report delivers a final conclusion on the impact of the 2021 eligible expenditures of €16.8 billion on the climate, the environment and nature, broken down by these sectors. The following is an initial summary of the manifold impacts of the broad and very diversified expenditure portfolio, aggregated only when the different calculation approaches allow.

Contributions to the reduction of greenhouse gas emissions (based on methodologies used for this report)

More than 1.7 million t CO_2e p.a.

(co-financing)

In the transport sector, eligible expenditures of around €2.2 billion were used for new construction and expansion projects in the rail and waterways sectors. The rail construction and upgrading projects in the Federal Transport Infrastructure Plan 2030, which are being co-financed by this amount, will contribute to an annual reduction in emissions of around 1.4 million tonnes of CO_2 equivalents from the time the routes are opened. Together with the investments in the federal waterways, a reduction of more than 1.7 million tonnes of CO_2 equivalents per year is calculated for the transport sector after completion of the measures.

More than 1.6 million t CO_2e in 2021

The pro rata subsidy for track access charges provides incentives to safeguard existing rail freight transport and to shift transport to the railways. Without the subsidy, more than 1.0 million additional tonnes of CO_2 equivalents would have been emitted in 2021. In addition, funding for combined transport and for railway sidings reduced emissions by around 0.6 million tonnes of CO_2 equivalents in 2021.

More than 1.4 million t CO_2e p.a.

In the energy and industry sector, an annual reduction in greenhouse gas (GHG) emissions of more than 1.4 million tonnes of CO_2 equivalents can be attributed to the programmes to promote renewable energy sources and increase energy efficiency (eligible expenditures of €451 million).

Approx. 20 million t CO_2e

(impact period/ lifetime)

In addition, the measures to promote energy efficiency and the use of renewable energy sources in buildings and the measures of the National Climate Initiative (with expenditures of around €1.5 billion) are contributing to CO_2 savings of more than 20 million tonnes of CO_2 equivalents over the entire impact period of the projects or the lifetime of the systems concerned.

[7] Green Bond Framework 2020 (deutsche-finanzagentur.de)

Approx. 5.7 million t CO_2e

(co-financing, R&D, potential after project completion)

Potential GHG reductions from co-financed research and development projects for technology transfer in the area of lightweighting are estimated at around 5.7 million tonnes of CO_2 equivalents. These reductions can potentially be realised within seven years of project completion through practical implementation in marketable products and processes.

Renewal of tracks and switches

2,023 km of track
1,888 switches

With investments in the existing network from federal funds amounting to around €4.6 billion, a significant contribution was made to the maintenance of the rail network. Among other things, according to Deutsche Bahn AG (DB AG), 2,023 km of track and 1,888 switches were renewed.

Decarbonisation of the mobility sector

More than 40 infrastructure assets, 1,000 research projects, 9,200 charging points and 760 e-vehicles

Alternative drive systems and fuels are a key instrument for decarbonising the mobility sector. With eligible expenditures of around €259 million, more than 40 infrastructure assets, 1,000 research projects, 9,200 charging points and 760 electric vehicles were funded, among other things.

International support, especially for developing and emerging countries

Approx. 1,900 project

In the international cooperation sector, eligible expenditures of more than €3.7 billion financed or co-financed around 1,900 projects, for example to support developing and emerging countries in their transition to more ecologically sustainable economies and societies.

Education and innovation on climate and environmental issues

More than 6,000 projects

The eligible expenditures of around €1.4 billion in the research, innovation and awareness raising sector include more than 6,000 projects that enable and support education and innovation on climate and environmental issues.

Coastal and flood protection

More than 1,500 funding cases and 0.8 million ha protected area

In the agriculture, forestry, natural landscapes and biodiversity sector, numerous funding opportunities for coastal and flood protection are being implemented by the *Länder*. The eligible expenditures of the federal budget (around €236 million), which are co-financed by the *Länder*, contributed to coastal and flood protection over an area of more than 880,000 ha with more than 1,500 funding cases in 2021.

Biodiversity, natural landscapes and forests

More than 4.6 million ha grant-aided area

The eligible expenditures for the conservation of nature, landscapes, forests and biodiversity were used to co-finance protected or restored areas with a total size of more than 4.6 million ha.

II. Impact of eligible expenditures by budget item

The following section provides detailed reporting for each of the 93 budget items used. The budget items as well as the programmes and projects are very diverse. Therefore, a summary report at item level is supplemented by detailed examples and descriptions. The number of projects and/or funding recipients indicates the range of different funding measures. The assumptions and limitations of the reporting are presented transparently at the level of the budget items. The impacts presented are based on the current state of knowledge according to the available data and methods.

Impact indicators and metrics vary depending on the type of expenditure, sector, relevance and (data) availability or methodology. The impact reporting takes into account the International Capital Markets Association (ICMA) Green Bond Principles' Harmonised Framework for Impact Reporting and its core principles and recommendations.[8] The data was provided by the relevant federal ministries and is based on existing analyses and reports where possible. Special features of government expenditure categories, such as international cooperation grants or research and development projects, mean that the available impact indicators partly differ from those commonly used on the market. They therefore include all impact dimensions (output, outcome and impact indicators). The German Sustainability Strategy stipulates that legislative projects must undergo sustainability impact assessments and that subsidies must be evaluated on a regular basis.[9] This will also expand the data basis of future impact reports on Green German Federal securities issuances in subsequent years.

The Core Green Bond Team coordinated the preparation of the report. The impact report was validated by the Interministerial Working Group. The names and responsibilities of the ministries correspond to the 2021 fiscal year.[10]

a) Tabular overview of the key indicators

The following tables provide an overview of the key eligible expenditure figures which are of particular importance for the sector or the budget item. The values given are rounded in the standard manner. Indicators, examples and detailed information such as assumptions and limitations can be found in the fact sheets for each budget item (part b) directly after the tabular overview. For ease of navigation, the names of the budget items in the table are linked to the corresponding fact sheets.

[8] https://www.icmagroup.org/assets/documents/Sustainable-finance/2022-updates/Harmonised-Framework-for-Impact-Reporting-Green-Bonds_June-2022v2-020822.pdf

[9] In addition, the federal government is committed to the mandate in the 2021 coalition agreement: "Step by step, we will convert the federal budget (excluding personnel and administrative costs) to target and impact-oriented budget management, within the framework of which the political objectives of all funding and expenditure programmes will already be translated into clearly defined, measurable indicators (e.g. SMART targets) at the political decision-making stage and provided with fixed evaluation deadlines."

[10] Official order according to the announcement of the formation of the government on 14 March 2018 in the Federal Gazette of 16 March 2018. Where websites have already been changed to the current ministry names, updated abbreviations are used: BMDV (formerly BMVI), BMWK (formerly BMWi) and BMUV (formerly BMU).

Budget chapter	Budget item	Name of the budget item	Eligible expenditures (in € million)	Allocation to securities (in € million)				Selected impact indicators
				Green Bobl (Oct. 27)	Green Bund (Aug. 30)	Green Bund (Aug. 31)	Green Bund (Aug. 50)	
		1. Transport sector						
1.1. Rail transport								
1202	891 01	Construction cost subsidies for investments in the expansion of the federal rail infrastructure	2,045.0	607.3	364.4	303.6	485.8	1.408 million t CO_2e p.a. GHG reduction
1202	891 05	Measures to reduce noise pollution from existing federal railways	185.5	55.1	33.1	27.5	44.1	71 km noise-reduced route 32,783 people benefited from noise reduction
1202	891 11	Construction cost subsidies for maintaining the federal rail infrastructure	4,642.5	1,378.6	827.2	689.3	1,102.9	Investment in the existing network: 2,023 km of track, 1,888 switches, 24,255 m^3 of bridges
1210	682 51	Reducing infrastructure facility charges in rail freight transport	76.1	22.6	13.6	11.3	18.1	27 beneficiaries
1210	682 52	Reduction in track access charges in rail freight transport	344.0	102.2	61.3	51.1	81.7	0.96 million t CO_2e GHG reduction in 2021
1210	891 51	Construction cost subsidies for investments in the non-federal rail infrastructure	32.6	9.7	5.8	4.8	7.7	80 projects
1210	892 41	Subsidies to private companies for investments in combined transport	31.3	9.3	5.6	4.6	7.4	0.09 million t CO_2e GHG reduction in 2021
1210	892 42	Investment subsidies to private companies to fund the construction, expansion, reactivation and replacement of sidings and other rail freight facilities	15.7	4.7	2.8	2.3	3.7	0.559 million t CO_2e GHG reduction
1.2. Alternative drive systems and fuels								
1210	686 61	Subsidies for research, development and pilot projects for the market activation of alternative fuel use and the	5.2	1.5	0.9	0.8	1.2	6 projects

Budget chapter	Budget item	Name of the budget item	Eligible expenditures (in € million)	Allocation to securities (in € million)				Selected impact indicators
				Green Bobl (Oct. 27)	Green Bund (Aug. 30)	Green Bund (Aug. 31)	Green Bund (Aug. 50)	
		establishment of a corresponding filling and charging infrastructure						
1210	892 03	National Hydrogen and Fuel Cell Technology Innovation Programme (NIP) 2016–2026	66.1	19.6	11.8	9.8	15.7	170 ongoing R&D projects, of which 32 newly committed in 2021 44 critical infrastructure assets
6092	683 04	Measures for the expansion of electric mobility, of which						
		BMWi programmes	90.0	26.7	16.0	13.4	21.4	341 projects 5,453 charging points
		BMBF programmes	61.5	18.3	11.0	9.1	14.6	424 individual projects
		BMU programmes	30.7	9.1	5.5	4.6	7.3	74 projects 763 electric vehicles 330 charging points
6092	893 02	Subsidies for the construction of filling and charging infrastructure	5.6	1.7	1.0	0.8	1.3	3,430 charging points commissioned in 2021
1.3. Public transport								
1206	882 02	Financial assistance to the *Länder* for rail-bound local public transport infrastructure	215.5	64.0	38.4	32.0	51.2	35 projects
1206	891 01	Investment subsidies for major public transport projects to Deutsche Bahn AG and companies majority-owned by the federal government	56.3	16.7	10.0	8.4	13.4	16 projects
1210	883 81	Measures to digitalise local authority transport systems	95.6	28.4	17.0	14.2	22.7	427 ongoing projects
6092	633 01	Local-authority public transport pilot projects from 2018 to 2021 to complement the “Immediate Action Programme for Clean Air”	18.8	5.6	3.3	2.8	4.5	0.012 million t CO_2e GHG reduction

Budget chapter	Budget item	Name of the budget item	Eligible expenditures (in € million)	Allocation to securities (in € million)				Selected impact indicators
				Green Bobl (Oct. 27)	Green Bund (Aug. 30)	Green Bund (Aug. 31)	Green Bund (Aug. 50)	
1.4. Waterways								
1203	780 01	Maintenance of transport infrastructure	66.4	19.7	11.8	9.9	15.8	List of projects
1203	780 02	Replacement, extension and construction projects relating to federal waterways	131.1	38.9	23.4	19.5	31.1	0.345 million t CO_2e p.a. GHG reduction
1.5. Cycling								
1201	746 22	Construction of bike lanes including maintenance (federal highways)	99.2	29.5	17.7	14.7	23.6	158 km of newly built and repaired cycle paths
1210		Grants and subsidies in the area of cycling	13.6	4.0	2.4	2.0	3.2	189 measures
	632 91	Implementation of the National Cycling Plan – grants to *Länder* and other public-law entities						
	686 91	Implementation of the National Cycling Plan – subsidies to companies under private law						
	882 91	Grants to *Länder* for the construction of cycle highways						
	891 91	Funding of pilot projects in the area of cycling – subsidies to *Länder* and other public-law entities						
	891 92	Subsidies for the expansion of Germany's network of cycle routes (*Radnetz Deutschland*)						
1210	882 92	Financial assistance to the *Länder* for investments in cycling through the special programme "Stadt und Land"	15.8	4.7	2.8	2.3	3.8	867 measures

Budget chapter	Budget item	Name of the budget item	Eligible expenditures (in € million)	Allocation to securities (in € million)				Selected impact indicators
				Green Bobl (Oct. 27)	Green Bund (Aug. 30)	Green Bund (Aug. 31)	Green Bund (Aug. 50)	
		2. International cooperation sector						
2.1. Bilateral financial cooperation								
2301	866 11	Bilateral financial cooperation – loans	118.7	35.2	21.1	17.6	28.2	79 projects
2301	896 01	Financial cooperation with regions	378.9	112.5	67.5	56.3	90.0	31 projects
2301	896 11	Bilateral financial cooperation – grants	690.2	205.0	123.0	102.5	164.0	458 projects
2.2. Bilateral technical cooperation								
2301	896 03	Bilateral technical cooperation	771.9	229.2	137.5	114.6	183.4	706 projects
2.3. International climate and environmental protection								
1601	687 06	International climate and environmental protection – export of technologies to tackle marine litter	22.7	6.7	4.0	3.4	5.4	8 projects
1602	896 05	Investments to protect the climate and biodiversity abroad	564.5	167.6	100.6	83.8	134.1	406 projects funded in 2021, of which 70 new projects
2310	687 01	International climate and environmental protection	76.0	22.6	13.5	11.3	18.1	89 projects
2.4. Multilateral cooperation								
1601	687 01	Contributions to international organisations	23.4	6.9	4.2	3.5	5.6	33 institutions
2303	896 09	Developmentally important multilateral aid for global environmental protection, biodiversity conservation and climate protection	741.1	220.1	132.0	110.0	176.1	13 initiatives
2.5. Specific funding								
0904	687 05	Development of foreign markets	16.3	4.8	2.9	2.4	3.9	7,602 t CO_2e GHG reduction in 2021
1601	687 04	Export of green and sustainable (environmental) infrastructure	10.7	3.2	1.9	1.6	2.5	62 ongoing projects in 2021 of which 23 projects newly approved in 2021

Budget chapter	Budget item	Name of the budget item	Eligible expenditures (in € million)	Allocation to securities (in € million)				Selected impact indicators
				Green Bobl (Oct. 27)	Green Bund (Aug. 30)	Green Bund (Aug. 31)	Green Bund (Aug. 50)	
1602	532 05	International cooperation [in the area of climate action]	25.3	7.5	4.5	3.8	6.0	28 projects
2310	896 31	Special initiative ONE WORLD – No Hunger	232.0	68.9	41.3	34.4	55.1	27 projects
6092	687 02	International energy cooperation, commodity partnerships and technological cooperation	29.3	8.7	5.2	4.4	7.0	41 projects
3. Research, innovation and awareness raising sector								
3.1. Research for sustainability								
3004	683 10	Knowledge and technology transfer tools as part of the High-Tech strategy	2.3	0.7	0.4	0.3	0.5	23 projects funded
3004	683 40	Bioeconomy	116.1	34.5	20.7	17.2	27.6	408 beneficiaries 1,154 projects
3004	685 40	Climate research and Earth's natural habitats – R&D projects	84.2	25.0	15.0	12.5	20.0	318 beneficiaries 862 projects
3004	685 41	Energy technologies and efficient energy usage, green hydrogen – R&D projects	176.4	52.4	31.4	26.2	41.9	513 projects
3004	685 42	Environmental technologies, resources and geological research	106.3	31.6	18.9	15.8	25.3	1,545 beneficiaries
3004	685 43	Social sciences for sustainability	43.5	12.9	7.8	6.5	10.3	342 beneficiaries 534 projects
3004	685 44	Ocean, coastal and polar research	51.0	15.1	9.1	7.6	12.1	89 beneficiaries 383 projects
3.2. Environmental protection, nature conservation and climate change adaptation								
1601	544 01	Research, studies, etc. [in the area of environmental protection]	52.0	15.4	9.3	7.7	12.4	148 projects newly committed in 2021

Budget chapter	Budget item	Name of the budget item	Eligible expenditures (in € million)	Allocation to securities (in € million)				Selected impact indicators
				Green Bobl (Oct. 27)	Green Bund (Aug. 30)	Green Bund (Aug. 31)	Green Bund (Aug. 50)	
1601	685 04	Subsidies for organisations in the areas of environmental protection and nature conservation	9.6	2.9	1.7	1.4	2.3	145 funded projects
1601	892 01	Investments to reduce pollution [environmental innovation programme, Germany]	17.4	5.2	3.1	2.6	4.1	75 funded projects in 2021 of which 13 projects newly committed in 2021
1602	685 05	Funding of climate change adaptation measures	11.1	3.3	2.0	1.6	2.6	182 projects
1604	544 01	Research, studies, etc. [in the area of nature conservation]	15.3	4.5	2.7	2.3	3.6	41 projects newly committed in 2021
3.3. Aerospace, energy, transport and digitalisation								
0901	683 12	Maritime technologies – research, development and innovation	15.5	4.6	2.8	2.3	3.7	158 projects 97 beneficiaries
0901	683 32	National programme for space and innovation – R&D projects	87.0	25.8	15.5	12.9	20.7	11 events held 29 publications
0901	685 31 894 31	German Aerospace Center (DLR) – operation and investments	521.1	154.7	92.8	77.4	123.8	308 projects
6092	683 05	Hybrid electric aviation	37.1	11.0	6.6	5.5	8.8	71 projects
3.4. Technology transfer – lightweighting								
0901	683 15	Technology transfer programme – lightweighting	13.9	4.1	2.5	2.1	3.3	Potential for 5.71 million t CO_2e GHG reduction
6092	686 15	Resource efficiency and substitution						82 projects
6092	686 17	New construction technologies and materials for low-emission industry						
4. Energy and industry sector								
4.1. Energy research								
0903	683 01	Energy research	564.3	167.6	100.5	83.8	134.1	4,720 ongoing projects

Budget chapter	Budget item	Name of the budget item	Eligible expenditures (in € million)	Allocation to securities (in € million)				Selected impact indicators
				Green Bobl (Oct. 27)	Green Bund (Aug. 30)	Green Bund (Aug. 31)	Green Bund (Aug. 50)	
4.2. Renewable energy								
0904	896 02	Foreign Trade Strategy for Hydrogen – International Cooperation on Hydrogen	35.5	10.5	6.3	5.3	8.4	2 projects
6092	686 13	Energy transition programmes and measures in the areas of renewable energy sources, electricity and power grids, digitalisation and energy infrastructure	16.4	4.9	2.9	2.4	3.9	155 beneficiaries
6092	882 01	Improving framework conditions for shore-to-ship power supply in German ports	21.8	6.5	3.9	3.2	5.2	1,000 t CO_2e p.a. GHG reduction 9 shore-to-ship power systems
6092	893 10	Funding to promote energy efficiency and renewable energy measures in buildings	1,334.7	396.3	237.8	198.2	317.1	14.6 million t CO_2e GHG reduction
4.3. Energy efficiency								
6092	686 08	Energy efficiency in industry and businesses	352.6	104.7	62.8	52.4	83.8	0.95 million t CO_2e p.a. GHG emissions avoided 3,227 GWh p.a. end-use energy savings
6092	686 14	Providing advice on energy efficiency	98.8	29.3	17.6	14.7	23.5	0.50 million t CO_2e p.a. GHG emissions avoided 1,951 GWh p.a. end-use energy savings
6092	893 04	Industrial production of mobile and stationary energy storage units	54.8	16.3	9.8	8.1	13.0	10 beneficiaries
4.4. National Climate Initiative								
6092	686 05	National Climate Initiative	173.0	51.4	30.8	25.7	41.1	5.01 million t CO_2e GHG reduction over the entire impact period
6092	686 23	National climate action measures	13.6	4.0	2.4	2.0	3.2	15 projects

Budget chapter	Budget item	Name of the budget item	Eligible expenditures (in € million)	Allocation to securities (in € million)				Selected impact indicators
				Green Bobl (Oct. 27)	Green Bund (Aug. 30)	Green Bund (Aug. 31)	Green Bund (Aug. 50)	
5. Agriculture, forestry, natural landscapes and biodiversity								
5.1. Agriculture								
1005	686 43	Subsidies to fund organic farming and other sustainable forms of agriculture (BÖLN)	12.9	3.8	2.3	1.9	3.1	199 subprojects
1005	686 31 893 31	Funding of innovation in the area of food, agriculture and health-related consumer protection	45.2	13.4	8.1	6.7	10.7	793 subprojects
6092	686 22 893 07	Subsidies to fund measures for improving energy efficiency in agriculture and horticulture (including investments)	25.3	7.5	4.5	3.8	6.0	0.028 million t CO_2e p.a. GHG reduction 876 beneficiaries
5.2. Land use, land use change and forestry (LULUCF)								
1005	686 11 893 11 686 15	Subsidies to fund research, development and demonstration projects in the area of renewable resources and to fund national sustainable forestry projects (including investments)	47.6	14.1	8.5	7.1	11.3	259 beneficiaries 636 projects
Annex 1 to 1003 (1095)		Forestry measures	142.9	42.4	25.5	21.2	33.9	68,508 funding cases
	632 41	Grants to fund forestry measures (excluding investments)						9,336 ha reforested area *(as part of close-to-nature forest management)*
	882 41	Grants to fund forestry measures (investments)						297 ha grant-aided area *(for planting as part of initial afforestation (planting of new forest))*
	632 42	Grants to fund measures that combat the effects of extreme weather events in forests (excluding investments)						10.3 million m³ of processed infested wood
	882 42	Grants to fund measures that combat the effects of extreme weather events in forests (investments)						33,453 ha of grant-aided area *(under contract-based nature conservation)*

Budget chapter	Budget item	Name of the budget item	Eligible expenditures (in € million)	Allocation to securities (in € million)				Selected impact indicators
				Green Bobl (Oct. 27)	Green Bund (Aug. 30)	Green Bund (Aug. 31)	Green Bund (Aug. 50)	
6092	686 06	Forest Climate Fund	22.4	6.7	4.0	3.3	5.3	280 ongoing projects in 2021 of which 94 projects newly approved in 2021
5.3. Biodiversity and natural landscapes								
Annex 1 to 1003 (1095)	632 33 882 31	Grants for funding environmentally friendly land management geared to market and local conditions, including contractual nature conservation and landscape management (including investment in nature conservation)	119.3	35.4	21.3	17.7	28.3	155,091 funding cases 3.7 million ha of grant-aided area 410,657 grant-aided trees
Annex 1 to 1003 (1095)	632 97 882 97	Federal share of financing for the special framework programme for insect protection measures (including investments)	57.7	17.1	10.3	8.6	13.7	140,260 funding cases 720,678 ha of grant-aided area
1604	685 01	Grants to fund measures within the federal programme for biodiversity	39.7	11.8	7.1	5.9	9.4	99 projects
1604	882 01	Grants for the establishment and long-term protection of areas of nature and landscapes of national importance (chance.natur)	11.9	3.5	2.1	1.8	2.8	157,331 ha project area 19 projects
1604	893 02	Wilderness Fund	5.7	1.7	1.0	0.8	1.4	206.6 ha placed under protection

Budget chapter	Budget item	Name of the budget item	Eligible expenditures (in € million)	Allocation to securities (in € million)				Selected impact indicators
				Green Bobl (Oct. 27)	Green Bund (Aug. 30)	Green Bund (Aug. 31)	Green Bund (Aug. 50)	
5.4. Coastal and flood protection								
Annex 1 to 1003 (1095)	882 15	Grants to fund flood protection facilities, the renaturation of dykes, torrent control and the renaturation of water bodies	74.9	22.2	13.3	11.1	17.8	1,260 funding cases 175,156 ha protected area 15 ha retention area gained 5,355 km/2,991 ha funding scope for renaturation of water bodies
Annex 1 to 1003 (1095)	882 61 882 81	Grants to fund coastal protection measures Grants to fund coastal protection measures to counter the effects of climate change	101.0	30.0	18.0	15.0	24.0	256 funding cases 686,940 ha protected area
Annex 1 to 1003 (1095)	882 82	Federal share of funding the special framework programme for preventative flood protection measures	60.5	18.0	10.8	9.0	14.4	16,619 ha reclaimed floodplain area 324 million m^3 retention area gained

b) Fact sheets

The following individual fact sheets provide detailed reports on the impact on the climate, the environment and nature for each budget item used. For ease of navigation, there is a link to the tabular overview (part a) at the end of each fact sheet.

The primary objective of the Federal Climate Change Act is to reduce greenhouse gas emissions. Where available, CO_2 reduction is therefore reported as a key indicator.[11] For the other goals in the transition to a sustainable economy, including the switch to renewable energy, more efficient use of energy, climate change adaptation and preservation of biodiversity, available indicators are reported accordingly. The EU environmental objectives pursued with the expenditures are illustrated in each fact sheet.[12] The UN Sustainable Development Goals (SDGs) assigned to each of the five sectors are shown at the beginning of the sector chapters.

Current developments and forecasts of greenhouse gas emissions are published in the federal government's annual Climate Action Report and the German greenhouse gas inventory.[13] According to these, about 750 million tonnes of CO_2 equivalents were released in 2022 – about 10 million tonnes or 1.3% less than in 2021.

[11] For consistent reporting (paragraph 13 of the ICMA Green Bond Principles' Harmonised Framework for Impact Reporting), reporting is uniformly in CO_2 equivalents. In accordance with the prudence principle, CO_2 figures are reported as CO_2 equivalents.

[12] In the order they are listed in Article 9 of the EU Taxonomy Regulation: a) climate change mitigation, b) climate change adaptation, c) water and marine resources, d) circular economy, e) pollution prevention and control and f) biodiversity and ecosystems.

[13] Pursuant to section 10 (1) of the Federal Climate Change Act, the federal government's Climate Action Report contains the development of greenhouse gas emissions in the various sectors, the status of implementation of the climate protection programmes and the emergency programmes, and a forecast of the expected greenhouse gas reduction effect. The Climate Action Report is prepared annually by the federal government for the respective previous year. The final greenhouse gas emissions balance is published by the Federal Environment Agency at https://www.umweltbundesamt.de/en/press/pressinformation/detailed-greenhouse-gas-emissions-figures-for-2022.

1. Transport

The transport sector emits around 20% of Germany's greenhouse gases, with road transport accounting for the majority of transport emissions.[14] The transport sector must therefore make a significant contribution if Germany is to achieve the climate targets it has set itself. In addition, the federal government has set itself the goal of reducing air pollutants that are harmful to health and the environment, such as nitrogen oxides.[15] Accordingly, it has adopted extensive measures to, among other things, decarbonise passenger and freight transport and make it more environmentally friendly.

According to the German greenhouse gas inventory, around 147 million tonnes of CO_2 equivalents were emitted in the transport sector in 2022.[16]

The eligible expenditures of the sector amount to €8,344.1 million and are distributed across 25 budget items in the following categories:

- Rail transport (8 budget items with eligible expenditures of €7,372.7 million),
- Alternative drive systems and fuels (4 budget items with eligible expenditures of €259.1 million),
- Public transport (4 budget items with eligible expenditures of €386.2 million),
- Waterways (2 budget items with eligible expenditures of €197.5 million) and
- Cycling (7 budget items with eligible expenditures of €128.6 million).

[14] The federal government's Climate Action Report 2023 (in German): https://www.bmwk.de/Redaktion/DE/Downloads/Energie/klimaschutzbericht.html

[15] See Federal Immission Control Act (*Bundes-Immissionsschutzgesetz*) and associated ordinance (BImSchV)

[16] See p. 4 of the Climate Action Report 2023; data updated on the basis of the final greenhouse gas emissions balance published by the Federal Environment Agency, see https://www.umweltbundesamt.de/en/press/pressinformation/detailed-greenhouse-gas-emissions-figures-for-2022

1.1. Rail transport

1.1.1. Construction cost subsidies for investments in the expansion of the federal rail infrastructure

Budget chapters and items:	1202 891 01
Eligible expenditures 2021:	€2,045.0 million
GHG emission reduction:	1.408 million t CO_2e p.a.
Other indicators:	2,484 t NO_x p.a.
	11 t particulate matter (PM) p.a.
Funding share:	1.27%
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e) f)

Assumptions and limitations: The annual GHG emission reduction represents the annual GHG reduction share from route opening. Recording of the CO_2 reduction was not part of the project assessment for the 2003 Federal Transport Infrastructure Plan (FTIP); this data was only recorded for projects in the 2030 FTIP, i.e. a CO_2 reduction estimate is only available for some of the projects. The actual CO_2 reduction is therefore greater than indicated here. The stated funding share of 1.27% was determined on the basis of the data in the Transport Investment Report 2021 (2021 expenditures in relation to the total investment sum of the projects for which a GHG reduction estimate is available).

Links: https://bmdv.bund.de/SharedDocs/DE/Artikel/G/BVWP/bundesverkehrswegeplan-2030-inhalte-herunterladen.html

Methodology: https://bmdv.bund.de/SharedDocs/DE/Anlage/G/BVWP/bvwp-methodenhandbuch.pdf?__blob=publicationFile

Project details: https://www.bvwp-projekte.de/map_railroad_2018.html

The federal government provides investment subsidies for the construction and upgrading of rail projects in the requirement plan for federal railways (Annex to section 1 of the Federal Railways Expansion Act (*Bundesschienenwegeausbaugesetz*)). The 2030 Federal Transport Infrastructure Plan is the most important transport infrastructure planning tool. Further details on the projects, including the size of the CO_2 reduction in each case, are available at: https://www.bvwp-projekte.de/map_railroad_2018.html.

The following indicators can be reported for the largest projects (basis: 2021 expenditures according to the Federal Transport Infrastructure Report 2021 (VIB 2021); annual emission reduction from route opening):

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Project	GHG emission reduction (in t CO_2e p.a.)	NO_x emission reduction (in t p.a.)	Particulate matter (PM) reduction (in t p.a.)
ABS/NBS Karlsruhe – Basel	-189,701	-67	2
ABS/NBS Nuremberg – Erfurt (VDE 8.1)	-29,862	-37	0
Major hubs (Frankfurt, Hamburg, Cologne, Mannheim, Munich, Hanover)	-282,626	-190	-1

Project	GHG emission reduction (in t CO_2e p.a.)	NO_x emission reduction (in t p.a.)	Particulate matter (PM) reduction (in t p.a.)
Rhein-Ruhr-Express (RRX): Cologne – Düsseldorf – Dortmund/Münster	-16,151	-65	1
ABS Ulm-Friedrichshafen-Lindau (Südbahn)	-16,883	-169	-1
ABS/NBS Hanau-Würzburg/Fulda-Erfurt	-42,180	-48	0
ABS/NBS Hamburg – Lübeck – Puttgarden (Fehmarn Belt tunnel hinterland link)	-66,664	-270	-1
Combined transport/shunting stations	-221,251	N/A	N/A

1.1.2. Measures to reduce noise pollution from existing federal railways

Budget chapters and items:	1202 891 05					
Eligible expenditures 2021:	€185.5 million					
GHG emission reduction:	Pursues other objectives					
Other indicators:	70.98 km noise-reduced route in 2021					
	44.181 km of noise barriers erected in 2021					
	15,611 eligible housing units in 2021					
	32,783 people benefited from noise reduction in 2021					
Funding share:	N/A					
EU environmental objectives under Article 9 of the Taxonomy Regulation:					e)	

Assumptions and limitations: --

Links: https://bmdv.bund.de/SharedDocs/DE/Artikel/E/schiene-laerm-umwelt-klimaschutz/laermvorsorge-und-laermsanierung.html

The implementation of the goals for shifting traffic to the railways depends on whether the necessary public acceptance can be gained. For decades, intensive work has been done to improve noise protection on and along the railways. Noise reduction measures are being carried out on existing lines affected by rail noise. Technological progress and innovative developments help in this process. The federal government provides annual funding for the programme “Measures to reduce noise pollution from existing federal railways”. The funding is provided for buildings constructed before 1 January 2015. The same applies to residential buildings constructed on land that was designated for residential use before 1 January 2015.

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1.1.3. Construction cost subsidies for maintaining the federal rail infrastructure

Budget chapters and items:	1202 891 11
Eligible expenditures 2021:	€4,642.5 million
GHG emission reduction:	N/A
Other indicators:	Investment in the existing network:
	2,023 km of track
	1,888 switches
	24,255 m^3 of bridges
Funding share:	58.7%
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e) f)

Assumptions and limitations: The impact data relates to the €7,906 million total amount invested (i.e. including grants for construction costs from third parties, other financing from the federal government, and own funding of DB AG). The share of eligible expenditures 2021 in the total investment sum 2021 is 58.7%.

Links: Figures (on other indicators) according to the Infrastructure Status and Development Report 2021, p. 46-52:
https://www.eba.bund.de/SharedDocs/Downloads/DE/Finanzierung/IZB/IZB_2021.pdf?__blob=publicationFile&v=2

Rail transport and infrastructure are of great importance in Germany for achieving climate targets. This includes, in particular, the shift of transportation from road to rail and the increased electrification of propulsion systems and routes for decarbonisation. Under the Service and Financing Agreement III, federal funds are invested in line with requirements in measures to maintain and carry out replacement investments in federal rail infrastructure. Under that agreement, the federal rail infrastructure companies have undertaken to meet contractually specified infrastructure quality requirements and to report on this annually. The Infrastructure Condition and Development Report 2021 (IZB) prepared by DB AG and reviewed by the Federal Railway Authority contains investment examples and quality indicators that provide information on the condition of the network (link: see above).

Regarding the selected impact indicators, detailed information with investment examples is presented on the following pages in the IZB 2021: tracks: p. 46-48; switches: p. 48-50; bridges: p. 50-52. In addition, the respective investment reports of DB Netz AG (p. 41 et seqq.), DB Station&Service AG (p. 190 et seqq.) and DB Energie GmbH (p. 286 et seqq.) included in the IZB present numerous other investments in more detail.

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1.1.4. Reducing infrastructure facility charges in rail freight transport

Budget chapters and items:	1210 682 51
Eligible expenditures 2021:	€76.1 million
GHG emission reduction:	N/A
Other indicators:	27 beneficiaries
Funding share:	87.671%
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e) f)

Assumptions and limitations: The funding share is arrived at by dividing the federal funds allocated in the federal budget by the sum total of the forecast charges (in the "train formation facilities" category) payable by the applicant rail transport undertakings.

No data is yet available on the size of the reduction in GHG emissions. This is to be determined in the evaluation of the funding programme to be carried out in 2024.

Links:
https://www.eba.bund.de/DE/Themen/Finanzierung/APF/apf_node.html;jsessionid=12FECF1702773497EB5E0F987AD03BC3.live11291

The funding of infrastructure facility charges in rail freight transport, with the focus on wagonload freight, is provided as part of the implementation of the Climate Action Programme 2030. In the funding of infrastructure facility charges, the federal government part-subsidises the service facility usage charges (net of value added tax) that are invoiced by rail freight transport service facility operators, in particular in wagonload freight, and are charged on the charge schedules published with the current Usage Conditions for Service Facilities (NBS).[17] The charges eligible for funding are for the usage of marshalling yards and train formation facilities, including shunting facilities. The funding provides a significant incentive to make rail freight transport more competitive relative to road freight transport and, in furtherance of the Climate Action Programme 2030, to stabilise or increase the rail traffic volume in Germany, particularly in wagonload freight.

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[17] Funding guidelines available at: https://www.eba.bund.de/DE/Themen/Finanzierung/APF/apf_node.html

1.1.5. Reduction in track access charges in rail freight transport

Budget chapters and items:	1210 682 52
Eligible expenditures 2021:	€344.0 million
GHG emission reduction:	0.96 million t CO_2e in 2021
Other indicators:	69 beneficiaries with subsidies over €500,000
Funding share:	Indicator relates to 100% of eligible expenditures
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e)

Assumptions and limitations: Model calculations from the evaluation carried out in 2021 show that without the funding, 2.4 million tonnes more CO_2 would have been emitted in the 2.5 years of the previous funding period (1 July 2018 to 31 December 2020). The evaluation does not cover funding in 2021. However, as no other suitable data is available to determine the impact, the 2021 impact is approximated from the ratio of the funding in 2021 to the funding over the funding period covered by the evaluation.

Links:
https://www.eba.bund.de/SharedDocs/Downloads/DE/Finanzierung/Foerderung_anteiliger_Trassenentgelte/41_Bekannntgabe_Beihilfe_2021.pdf?__blob=publicationFile&v=5

The partial subsidy of track access charges in rail freight transport creates a significant incentive to keep existing rail freight transport volumes on the railways as well as incentives to shift freight transport from road to rail. To this end, federal budget funding is made available via DB Netz AG to companies operating in the area of rail freight transport.[18] Funding is available for all transport operations that serve the national or cross-border carriage of goods within the scope of DB Netz AG's system of track prices. Funding is provided for the DB Netz AG track charge, which is levied per kilometre. Measurement runs and movements of construction machinery and breakdown trains are excluded from the subsidies. The subsidy amount relates to the track charge net of value added tax. The grant recipients with grants of more than €500,000 are published in accordance with section 6 (5) of the funding guidelines for the 2021 working timetable period: https://www.eba.bund.de/SharedDocs/Downloads/DE/Finanzierung/Foerderung_anteiliger_Trassenentgelte/41_Bekannntgabe_Beihilfe_2021.pdf?__blob=publicationFile&v=5.

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[18] Funding guidelines available at: https://www.eba.bund.de/DE/Themen/Finanzierung/Foerderung_anteiliger_Trassenentgelte/foerderung_anteiliger_trassenentgelte_node.html

1.1.6. Construction cost subsidies for investments in the non-federal rail infrastructure

Budget chapters and items:	1210 891 51
Eligible expenditures 2021:	€32.6 million
GHG emission reduction:	N/A
Other indicators:	80 projects
Funding share:	max. 50% federal funding
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e) f)
Assumptions and limitations: --	
Links: --	

In the Long-Distance Rail Freight Network Funding Act (*Schienengüterfernverkehrsnetzförderungsgesetz*) of 7 August 2013[19], the federal government created the legal basis for funding the upgrading and maintenance of non-federal public rail infrastructure serving long-distance rail freight and not exclusively local rail freight and/or passenger rail transport. Up to a maximum amount of 50% of investment spending on the replacement of non-federal public rail infrastructure is financed by the federal government in line with available federal budget funds in the form of non-repayable construction cost subsidies. The costs of maintaining and repairing their rail infrastructure are borne by the non-federal public railways.

The eligible expenditures in 2021 (part-)funded 80 projects. The majority of this funding (around 79%) was earmarked for replacement investments in superstructure renewal (i.e. renewal of tracks, sleepers and switches, including related measures). Approximately 12% of the federal funding was spent on adapting control and safety systems (such as partial renewal of signal boxes), around 7% on renewing bridges/culverts and a further 2% on measures at level crossings (among others, bringing barrier opening and closing systems up to the latest standards and renewing track base plates) and rail yard lighting.

The aim of the funded projects, as before, is the renewal/adaptation of existing, outdated rail infrastructure in order to safeguard long-distance rail freight for the future and prevent line closures due to outdated infrastructure causing freight to shift from rail to road. The measures consist of replacement investment with adaptation to today's technology.

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[19] Full text of the act available at: https://www.gesetze-im-internet.de/sgffg/BJNR311510013.html

1.1.7. Subsidies to private companies for investments in combined transport

Budget chapters and items:	1210 892 41
Eligible expenditures 2021:	€31.3 million
GHG emission reduction:	0.09 million t CO_2e in 2021
Other indicators:	1.29 billion tkm freight transport performance
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: Source: Report on the evaluation of the "Guidelines on the promotion of transhipment facilities for combined transport by non-federally owned companies". The relief effect of 40.95 tkm per euro of funding used, on which the calculation is based, is an average figure calculated from the relief effect due to the additional transhipment volume of all CT terminals funded in the period 1998-2019. It is not possible to calculate the relief effect on the basis of the funding measures implemented in 2021.

Links: https://bmdv.bund.de/EN/Topics/Mobility/Freight-Transport-Logistics/Combined-Transport/combined-transport.html

In order to shift more freight transport from road to rail and inland waterways, the federal government funds investment in combined transport (CT) transhipment facilities of private-sector companies. The promotion of combined transport contributes to an additional transhipment volume in combined transport and thus at the same time to a reduction of transport on the roads.

For the year 2021, the additional transhipment based on the subsidies for CT terminals used in 2021 is assumed to have had a relief effect on freight transport performance of 1.29 billion tkm. This relief effect comprises 0.83 billion tkm for road-rail CT and 0.46 billion tkm for inland waterway-road CT. Assuming that, per tkm, 73.7 g CO_2 are avoided for road-rail CT and 61.9 g CO_2 are avoided for inland waterway-road CT, a total relief of 0.09 million tonnes of CO_2e was achieved in 2021 via the subsidised CT terminals.

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1.1.8. Investment subsidies to private companies to fund the construction, expansion, reactivation and replacement of sidings and other rail freight facilities

Budget chapters and items:	1210 892 42
Eligible expenditures 2021:	€15.7 million
GHG emission reduction:	0.559 million t CO_2e
Other indicators:	-
Funding share:	Indicator relates to 100% of eligible expenditures Co-financing: Up to 50% of eligible costs for sidings, feeder lines and industrial lines and up to 80% for multifunctional facilities.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e) f)

Assumptions and limitations: The CO_2 reduction figures are based on the findings of a 2019 evaluation of the sidings funding guidelines. This put the average reduction at 35,600 tonnes of CO_2 per €1 million of subsidy funding used.

Links: --

The federal government provides grants for the construction, reactivation, upgrading and replacement of sidings, multifunctional facilities, feeder lines and industrial lines to the extent that they are necessary for the achievement of the funding objectives.[20] There is no entitlement to the grants. The Federal Railway Authority, which is the granting authority, decides at its due discretion based on the available budget funding. For new sidings, the focus is on shifting freight from road to rail, and construction of a new siding is associated with the generation of more traffic via an existing siding. The basic aim of funding sidings is to increase rail traffic volumes. The calculation is based on a 2019 evaluation of the sidings funding guidelines over an evaluation period from August 2004 (when the funding was introduced) to September 2019 (the assessment cut-off date) and an evaluation scope of 125 projects (funded sidings) with a funding volume of €91.7 million. In terms of rail transport performance, new and additional traffic totalling 38,900 million tkm was generated in the evaluation period. This means an average 424 million tkm transport performance was shifted to rail or generated in addition for each €1 million in funding. Likewise in 2019, on the basis of the TREMOD project, the Federal Environment Agency published a comparison of greenhouse gas emissions from the various modes of freight transport. This showed that rail freight can reduce greenhouse gas emissions by an average of 84 g/tkm compared to road freight. Based on the 424 million tkm transport performance generated in the above evaluation period, this corresponds to a total reduction in CO_2e emissions by 35,600 tonnes per €1 million in funding.

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[20] Funding guidelines available at: https://www.eba.bund.de/DE/Themen/Finanzierung/Gleisanschluesse/gleisanschluesse_node.html

1.2. Alternative drive systems and fuels

1.2.1. Subsidies for research, development and pilot projects for the market activation of alternative fuel use and the establishment of a corresponding filling and charging infrastructure

Budget chapters and items:	1210 686 61
Eligible expenditures 2021:	€5.2 million
GHG emission reduction:	N/A
Other indicators:	6 projects
Funding share:	82.64% (Subsidies co-financed due to beneficiaries' own contribution)
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: The impact data relates to a total investment sum (comprising the federal funding and the beneficiaries' own contributions) of €6.3 million. The share of eligible expenditures 2021 in the total investment sum 2021 is 82.64%.

Links: --

The subsidies for pilot projects under the Mobility and Fuels Strategy relate to research and development projects to establish charging infrastructure for public transport, convert vehicles to alternative propulsion systems and fund a planning tool to identify infrastructure needs throughout Germany.

Programme name	Number of projects Number of beneficiaries/main contractors
Infrastructure projects for stationary and in-motion charging of local transport buses (e.g. "BOB Solingen" joint project for in-motion charging of trolleybuses)	5 projects 11 beneficiaries
Vehicle conversion ("HyBat-Truck" joint project for hybrid hydrogen/battery trucks)	1 project 2 beneficiaries

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1.2.2. National Hydrogen and Fuel Cell Technology Innovation Programme (NIP) 2016–2026

Budget chapters and items:	1210 892 03
Eligible expenditures 2021:	€66.1 million
GHG emission reduction:	N/A
Other indicators:	44 critical infrastructure assets and one mobile H_2 supply facility
	170 ongoing R&D projects in 2021
	of which 32 R&D projects approved in 2021
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: --

Links: An overview of funded measures can be found on the BMVI's interactive funding map under the National Hydrogen and Fuel Cell Technology Innovation Programme: https://bmdv.bund.de/SharedDocs/DE/Artikel/foerderlandkarte-bmvi-iframe.html

Hydrogen and fuel cells are a useful complement to battery-powered vehicles in the transport sector. With the National Hydrogen and Fuel Cell Technology Innovation Programme (NIP), the Federal Ministry of Transport and Digital Infrastructure (BMVI) has an established programme to promote research and development (R&D) measures and to support investments in the area of market activation in the transport sector. The use of green hydrogen in fuel cell vehicles would enable all modes of transport to become completely carbon-free. The measures under the NIP include fuel cell and hydrogen applications in the road, rail, water and air transport sectors and in special applications.

A neutral third-party interim evaluation of the programme was completed in December 2023. The findings of the interim evaluation (which reviewed implementation, target achievement, impact and cost-efficiency) show the NIP to be a well-established, broad-based funding programme with strengths and features that set it apart. According to the interim evaluation, the underlying framework encompasses both industrial policy and climate policy objectives. The market analysis shows that while the German industry is highly competitive along the entire value chain by EU standards, at global level it faces a strong challenge from Asian rivals. With a view to the funding objectives, NIP generally focuses on the key optimisation factors and is successful in market activation. The impact review shows the programme to be instrumental in and suited to achieving its objectives. As the strong instrumental impact of NIP and the degree to which beneficiaries rely on it clearly show, the programme successfully closes the gap between application-oriented research and market readiness. The funding conditions appear well-selected and merely require some strategic focusing with regard to the subjects of funding. For example, there is still untapped potential due to the high demand and need for hydrogen infrastructure to be established at scale.

Sample projects from 2021:

DirectCCM: Development of highly scalable production technologies for catalyst-coated membranes (CCMs) and membrane electrode assemblies (MEAs) for fuel cells

DirectCCM is a project for the development of innovative catalyst materials and processes to

produce such materials for fuel cells in the automotive sector. The project aims to develop catalyst materials with improved long-term stability and performance characteristics and integrate them into CCMs and MEAs for large-scale production lines in automotive manufacturing processes. An important additional aim of the project alongside product innovation is the development of highly scalable, large-volume production processes for the long-term establishment of a national supplier industry. The main focus here is on developing and establishing production processes that can serve the automotive mass market on a long-term basis.

ELEKTRA-II: Realisation and testing of a push boat as a test vehicle for a fuel cell and battery hybrid drivetrain for use on inland waterways

The initial aim of the ELEKTRA-II project is to develop a test vessel with a hybrid energy and propulsion system combining hydrogen-powered fuel cells with lithium-ion batteries. The interoperation and long-term performance of the components are being analysed and optimised in a trial phase that began in 2021. Their onboard handling and electricity and hydrogen bunkering are also being assessed and improved. To open up additional application areas, other inland waterway and inshore shipping vessel types with similar operating profiles are being examined as to their suitability for installing an innovative energy and propulsion system. Developing and testing the innovative battery and fuel cell system on the test vehicle will provide a proof of concept so that it can be made market-ready as a hybrid propulsion system for inland waterway vessels towards the end of the next decade.

FC-Truck: Development and testing of a fuel cell system as well as a mobile and self-sufficient refuelling device in the area of heavy commercial vehicles

The aim of this joint project is to develop a zero-emission long-distance truck with fuel cell technology in order to help achieve a significant reduction in carbon emissions. The fuel cell system is intended to meet the requirements placed on a heavy commercial vehicle in terms of range and performance. In order to better realise future electric vehicle concepts in trucks, a vehicle design will be used that is adapted to electric drivetrains. A sustainable and rapidly implementable solution for the hydrogen infrastructure for refuelling commercial vehicles will also be developed and made available. Finally, the fuel cell truck will be operated under real conditions in order to gain experience and advance future developments.

X-EMU: Development and validation of a high-performance fuel cell drive for electric hybrid multiple units in a modular traction system

X-EMU (for “electric multiple unit”) is a development project for the integration of a fuel cell into a modular traction system for rail vehicles. The developed fuel cell propulsion technology is intended to enable diesel-powered rail vehicles to be replaced with zero-emission vehicles, thus contributing to a climate-friendly mobility transition.

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1.2.3. Measures for the expansion of electric mobility

Budget chapters and items:	6092 683 04
Eligible expenditures 2021:	€182.2 million
GHG emission reduction:	N/A
Other indicators:	424 individual projects in 146 consortia (BMBF) 341 projects (BMWi) 74 projects (BMU)
	5,453 charging points in BMWi-funded "Elektro-MobiL" projects 763 electric vehicles and 330 charging points (BMU)
Funding share:	33% As a rule, the project duration is three years, hence the funding share is stated as 33%. Third-party financing is not taken into account.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) | d) | e)

Assumptions and limitations: Most of the projects are multi-year. As a rule, the project duration is three years, hence the funding share is stated as 33%. Third-party financing is not taken into account.

Links: https://www.batterieforum-deutschland.de/projektdatenbank/

General

The federal government aims to develop Germany into a leading market for and provider of electric mobility. Automotive production is shaped by the overarching global trends towards digitalisation, electrification and decarbonisation. On top of these, there are new, innovative business areas that will make it possible in future to continue generating added value throughout a vehicle's operating life, rather than only during the production stage. The federal government is contributing to ensuring the success of the radical transformation to electric mobility with R&D funding for various facets of electrification according to the departmental division of responsibilities. The research covers a vast range of different thematic areas, as reflected in the submitted project outlines. Examples include innovative and high-performance powertrains, battery research, system integration and charging infrastructure – including bidirectional charging, where electric vehicles become a bridge between mobility and energy systems.

Programmes funded by the Federal Ministry for Economic Affairs and Energy (BMWi) (eligible expenditures: €90.0 million)

Five sample projects:

- NEFTON consortium

The NEFTON project aims to develop an ultra-fast charging system for battery-powered commercial vehicles. It involves, firstly, the development of a highly efficient, bidirectional charging pole with a capacity in the megawatt range. Secondly, a prototype truck is being developed that fully meets both the technical and customer-specific requirements.

- OptiWIRE consortium

The project aims to improve the process chain in the manufacture of electric motors in terms of the highly exacting requirements in the

automotive industry with regard to cycle time, quality and flexibility in manufacturing. Major scope for optimisation has been identified in stator winding coil and rotor magnet assembly. For these two process steps, the project aims for product improvements to electric motors and for production improvements by adapting new processes.

- unIT-e² consortium

The unIT-e² project aims to develop and demonstrate an approach for the fully optimised integration of electric vehicles into the energy system. To this end, players from the industries involved share ideas and work together to develop interoperable solutions.

- Transportation in Charge

The Transportation in Charge project comprises a one-year field trial of 140 electric commercial vehicles to test the practical suitability of available vehicles and charging infrastructure for a range of logistics purposes. A further aim is to create an e-truck charging infrastructure that is consequently cost-efficient and meets business needs by serving all enterprises in a business park.

- finalize!

The finalize! project is trialling large utility vehicles with battery electric propulsion at Stuttgart Airport. Operating data gathered while the vehicles are in deployment is used to carry out a life cycle analysis and compare with alternative technologies. The project also includes the development and analysis of charging strategies for energy system integration and grid support. Lessons learned from the operating phase will then be used to initiate technical standardisation processes for electric vehicle refuelling and the development of an all-vehicle charging infrastructure for airport vehicles.

Programmes funded by the Federal Ministry of Education and Research (BMBF) (eligible expenditures: €61.5 million)

The federal government aims for the establishment of a European battery ecosystem with sustainable battery cell manufacturing facilities and Germany as a catalyst and driving force. The BMBF is furthering this aim with its umbrella concept for battery research by creating the conditions on the research side for the establishment of a competitive yet sustainable battery value chain ensuring technological sovereignty. The funding measures under the umbrella concept aim, among other things, to curb the dependence on resources from beyond Europe and significantly reduce the energy footprint of battery cell production, thus securing the necessary resilience for the battery cell production sector and dynamically growing electric mobility. In the case of electric cars, a large proportion of the emissions occur during production, and primarily in the production of the batteries. Batteries account for 30 to 60% of the carbon emissions in vehicle production. Reducing this carbon footprint is therefore a key factor in increasing the sustainability of electromobility.

Alongside further development and upscaling with regard to lithium-ion batteries, the BMBF funding also focuses on the development of promising new battery technologies such as sodium-ion and solid state batteries and on the optimisation of process technologies and battery materials along the entire, ideally circular, value chain. This will enable the more efficient use of resources such as lithium and nickel or their substitution with more readily available alternatives. In parallel, energy efficiency is being improved in production and application. For example, intelligent, digitalised production processes reduce production scrap and carbon emissions. A further funding objective is to reduce resource dependency by means of second use applications and recycling.

A focus of the BMBF's battery funding in 2021 was the implementation of battery competence clusters. The BMBF funded seven battery competence clusters in 2021 covering thematic areas along the entire battery value chain (projects and publications can be found on the website of each competence cluster):

- The "ExcellBattMat" competence cluster develops, characterises and tests new

material solutions for battery systems of the future.[21]

- The focus of the "FestBatt" competence cluster is on material-specific issues relating to solid state batteries as a battery technology of the future.[22]
- "ProZell" and "InZePro" focus on issues relating to (intelligent) battery cell production. This involves research into battery cell production processes, including their influence on battery material, component and cell properties, product manufacturing costs and greenhouse gas emissions. Production system optimisation using "Industry 4.0" solutions also play a major role here. [23]
- Complementing these efforts, "AQuA" aims to develop strategies and standards for analysis and quality assurance in battery and battery cell production.[24]
- The "greenBatt" cluster focuses on the systematic design of the battery life cycle, incorporating and improving efficient recycling technologies and integrating recovered materials into battery cell production.[25]
- Finally, the "BattNutzung" ("Battery Utilisation Concepts") competence cluster is developing a deeper understanding of battery conditions and the performance of battery cells and batteries over their lifetime. Consideration is also being given to the resulting influence on the various battery applications, including second use applications.[26]

Programmes funded by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (eligible expenditures: €30.7 million)

- "Erneuerbar Mobil" ["renewable mobile"] funding program[27]

On March 26, 2021, the "Fifth Guideline for the Promotion of Research and Development in the Field of Electromobility" was published, for the second time as a joint funding initiative of the BMWi and the BMU. The funding initiative continues to focus on research projects that tap into the energy and climate policy potential of electromobility and at the same time contribute to strengthening the competitive position of German industrial sectors

In 2021, 74 projects already approved in previous years were funded with a funding volume of €22.2 million.

- "Social & Mobile" fleet replacement program[28]

On 3 June 2020, the Coalition Committee decided to launch a funding programme for companies and organizations in the healthcare and social services sector to promote the market penetration of electric vehicles. Eligible for funding are organizations and companies active in the health and social care sector (according to economic sector classification Q) as well as lessors who lease vehicles to such organizations and companies, among others. The above-mentioned joint BMWi and BMU funding guideline was used to implement the fleet replacement program.

763 purely battery-electric new vehicles and 330 charging points were funded in 2021.

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[21] https://www.uni-muenster.de/ExcellBattMat
[22] https://festbatt.net
[23] https://prozell-cluster.de und https://www.inzepro-cluster.de
[24] https://www.aqua-cluster.de
[25] https://www.greenbatt-cluster.de
[26] https://www.battnutzung-cluster.de
[27] https://www.erneuerbar-mobil.de/en
[28] https://www.erneuerbar-mobil.de/en/node/1328

1.2.4. Subsidies for the construction of filling and charging infrastructure

Budget chapters and items:	6092 893 02
Eligible expenditures 2021:	€5.6 million
GHG emission reduction:	N/A
Other indicators:	14,918 charging points commissioned by the end of 2021
	of which 3,430 charging points commissioned in 2021
	2,762 grant decisions issued by the end of 2021 for charging infrastructure in planning
Funding share:	max. 60% funding rate
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: No GHG reductions are achieved by charging points themselves, but installing them paves the way for future GHG reductions.

In addition to the charging points commissioned in 2021, the eligible expenditures for 2021 also include charging points commissioned in the previous year for which the funding was not disbursed until 2021.

Links:
https://www.bav.bund.de/DE/4_Foerderprogramme/6_Ladeinfrastruktur_fuer_Elektrofahrzeuge/6_3_Ladeinfrastruktur_2017/LIS2017_node.html;jsessionid=D98299C8A9D687E5FE7345A3A9DCEAD0.live11293.

Expenditures relate to the funding guidelines for electric vehicle charging infrastructure in Germany (*Förderrichtlinie Ladeinfrastruktur für Elektrofahrzeuge in Deutschland*) dated 13 February 2017 and amended 28 June 2017. The funding guidelines aim to initiate a nationwide, demand-oriented and user-friendly charging infrastructure network.

In addition to the procurement of charging infrastructure, the funding has been used for upgrading and replacing existing charging infrastructure where there is demonstrable additional benefit, and for upgrading charging point grid connections.

The maximum funding rate under the funding guidelines is 60%. On average, charging points were funded as follows:

- A normal charging point with up to 22 kW received 40% funding on average.
- A fast charging point with up to 100 kW was subsidised with an average of 50% in an insufficiently covered area and with an average of 33% in the remaining areas.
- A fast charging point with more than 100 kW received up to 50% in an insufficiently covered area, otherwise an average of 33%.
- For low- and medium-voltage connections, an average of 40% of the cost were covered.
- Modernisations of existing charging points were subsidised with 40% funding.

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1.3. Public transport

1.3.1. Financial assistance to the *Länder* for rail-bound local public transport infrastructure

Budget chapters and items:	1206 882 02
Eligible expenditures 2021:	€215.5 million
GHG emission reduction:	N/A
Other indicators:	35 projects
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)
Assumptions and limitations: --	
Links: --	

Due to its high energy efficiency and high degree of electrification, public passenger transport is associated with significantly lower greenhouse gas emissions per person-kilometre than private motorised transport. Shifting from private motorised transport to public transport can therefore reduce greenhouse gas emissions from the transport sector. This requires attractive and user-friendly local public transport (LPT). However, shifting private motorised transport to public transport is not only aimed at reducing greenhouse gas emissions; it also plays an important role in making cities and communities more environmentally friendly.

As regional and local transport is the responsibility of the *Länder* and local authorities, the federal government provides indirect support in the form of financial assistance. Impact indicators are not available in the aggregate. An example from Hamburg is provided below; further examples can be found in the 2021 Impact Report.

Hamburg, extension of the U4 to Horner Geest (Hamburg)

The extension of the U4 U-Bahn (subway) line to Horner Geest will link this Hamburg district to the subway network. Starting from the Horner Rennbahn subway stop, a 1.9 km stretch of line is to be built with two new stops. This will provide around 13,000 people with pedestrian access to the rail-based public transport network. Residents of Wandsbek, Jenfeld and Billstedt will also benefit from the new stretch of line as they will be able to board the subway earlier and to get around the city more quickly overall. The new section is scheduled to open in late 2026, enabling passengers to travel from Horner Geest to Hamburg Central Station in just 13 minutes.

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1.3.2. Investment subsidies for major public transport projects to Deutsche Bahn AG and companies majority-owned by the federal government

Budget chapters and items:	1206 891 01
Eligible expenditures 2021:	€56.3 million
GHG emission reduction:	N/A
Other indicators:	16 projects
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: Most of the funded projects are long-term in nature and require substantial funding over a number of years, as a result of which they have already been described in the 2021 Impact Report. Further projects have been funded in the ensuing years and will be covered in future reports.

Links: --

Due to its high energy efficiency and high degree of electrification, public passenger transport is associated with significantly lower greenhouse gas emissions per person-kilometre than private motorised transport. Shifting from private motorised transport to public transport can therefore reduce greenhouse gas emissions from the transport sector. This requires attractive and user-friendly local public transport (LPT). However, shifting private motorised transport to public transport is not only aimed at reducing greenhouse gas emissions; it also plays an important role in making cities and communities more environmentally friendly.

As regional and local transport is the responsibility of the *Länder* and local authorities, the federal government provides indirect support in the form of financial assistance. Impact indicators are not available in the aggregate. An example from the Rhine-Neckar region is provided below; further examples can be found in the 2021 Impact Report.

Rhine-Neckar region rapid transit network (S-Bahn), second construction phase

The "S-Bahn Rhine-Neckar" integrated transport plan is being implemented to better connect the various subregions of the Rhine-Neckar region spanning parts of the four *Länder* Baden-Württemberg, Hesse, Rhineland-Palatinate and Saarland. In the process, the existing rail infrastructure is being comprehensively upgraded by modernising and electrifying rail lines, upgrading existing stops and building new ones, and giving the system a uniform and contemporary visual identity. This will also ensure attractive timetable improvements for passengers, such as new and more direct connections, a longer service day and higher frequencies.

The upgrading works in the second phase complement the lines already in operation to form an overall S-Bahn network meeting high standards. This involves upgrading around 90 stops, mainly on north-south lines, first and foremost to make platforms and trains fully accessible for all passengers. In addition, all stations and stops in the Rhine-Neckar S-Bahn network are to be fitted out to have largely uniform, modern amenities with the best available technology that complies with the latest safety standards.

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1.3.3. Measures to digitalise local authority transport systems

Budget chapters and items:	1210 883 81					
Eligible expenditures 2021:	€95.6 million					
GHG emission reduction:	N/A					
Other indicators:	427 ongoing funding projects (multi-year)					
Funding share:	54% federal share to co-finance local authority measures					
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)				e)	

Assumptions and limitations: The 427 digitalisation measures funded in 2021 improve local transport systems and increase the efficiency of public transport and the attractiveness of eco-mobility. They also promote the interconnection and digitalisation of local mobility as a whole.

Their GHG reduction impact is therefore achieved indirectly. However, the funded projects are so varied in subject matter and scale that it is not possible to precisely quantify the reduction impact of all the measures taken together.

The funding rate under the applicable funding guidelines was 50% in 2021, and up to 70% in exceptional cases. This results in a 54% federal share of funding on average across all 427 listed measures.

Links: Project examples

https://bmdv.bund.de/DE/Themen/Mobilitaet/Urbane-Mobilitaet/DKV-Projektsteckbriefe/dkv-projekte.html

Funding calls: www.bmdv.bund.de/dkv

Overview of the funding programme: https://www.foerderdatenbank.de/FDB/Content/DE/Foerderprogramm/Bund/BMVI/digitalisierung-kommunaler-verkehrssysteme.html

With the “Digitalisation of local authority transport systems” funding programme, the federal government is supporting the digital transformation of urban mobility. This will boost transport system efficiency, help avoid congestion through smart mobility solutions, streamline chained intermodal journeys with demand-driven, multi-provider digital services and make public mobility services more attractive for increased take-up. By reducing greenhouse gas emissions and air pollution, the projects contribute indirectly to climate change mitigation and to environmental and health protection. A wide range of project profiles are available here: https://bmdv.bund.de/DE/Themen/Mobilitaet/Urbane-Mobilitaet/DKV-Projektsteckbriefe/dkv-projekte.html.

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1.3.4. Local-authority public transport pilot projects from 2018 to 2021 to complement the "Immediate Action Programme for Clean Air"

Budget chapters and items:	6092 633 01					
Eligible expenditures 2021:	€18.8 million					
GHG emission reduction:	0.012 million t CO_2e					
Other indicators:	30 t NO_x reduction					
Funding share:	N/A					
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)				e)	

Assumptions and limitations: In addition to model-related uncertainty, the change in user behaviour due to the Covid-19 pandemic had an impact on the implementation and evaluation of the measures.

Links: --

With the aim of improving air quality in inner cities, transport projects in five representative model cities with nitrogen oxide pollution were funded from October 2018 to June 2021 in addition to the "Clean Air Emergency Programme 2017-2020". The selected model cities – Bonn and Essen in North Rhine-Westphalia, and Herrenberg, Mannheim and Reutlingen in Baden-Württemberg – implemented measures to improve public transport and bicycle use. In addition to bicycle lanes, measures were implemented in the areas of service improvement (e.g. increased frequency, introduction of new lines), tariff adjustments and pricing (e.g. improved conditions, new tickets), traffic management (e.g. dynamic speed control on main traffic routes) and digital networking (e.g. a mobility app). The evaluation examined to what extent the funded measures brought about an improvement in air quality in the cities, in particular in terms of reducing nitrogen dioxide pollution.

All of the cities' packages of measures had a positive effect on local air quality. The effectiveness of the individual measures varied due to factors such as the size of the city, the scope and expansion of the public transport system and the design of the measures implemented. Overall, in all model cities, the measures analysed can potentially save an average of 82,000 car trips per day. This can potentially lead to daily savings of 264,000 car km, 165 kg NO_x and 66 tonnes of CO_2 and annual savings of around 60 tonnes of NO_x and around 24,000 tonnes of CO_2. As the programme ended on 30 June 2021, the reported quantities are 12,000 tonnes of CO_2 and 30 tonnes of NO_x. Local authorities have continued a number of the projects since the funding expired. Infrastructure measures and a mobility app continue to make a difference in any case. However, it is not possible to quantify the impact of such measures.

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1.4. Waterways

1.4.1. Maintenance of transport infrastructure

Budget chapters and items:	1203 780 01					
Eligible expenditures 2021:	€66.4 million					
GHG emission reduction:	N/A					
Other indicators:	N/A					
Funding share:	N/A					
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)	b)			e)	f)

Assumptions and limitations: According to a comparison of emissions by the Federal Environment Agency (see https://www.umweltbundesamt.de), the current amount of freight moved (i.e. the mass of the goods transported multiplied by the distance they cover) on waterways results in savings of around 4 million tonnes of CO_2 per year. Structural maintenance and replacement measures on the federal waterways serve to keep freight transport on the waterways and to maintain the emission savings. Every additional tonne of freight traffic shifted from road to water transport through measures such as upgrading projects results in a further reduction of CO_2 pollution in the transport sector. It is not possible to quantify impacts and attribute them to specific projects.

Links: Transport Investment Report 2021

Funding is provided for the structural maintenance of waterways in the required state for use as an environmentally friendly mode of transport. This includes dredging to maintain waterways in the required navigable condition. Impact indicators are not available in the aggregate. Examples are therefore provided of infrastructure measures on federal waterways (structural maintenance and upgrading investments) in the Transport Investment Report 2021.[29]

- Western German canal network: page 324 of the Transport Investment Report 2021
- Moselle: page 327 of the Transport Investment Report 2021
- Elbe Side Canal: page 322 of the Transport Investment Report 2021
- Dortmund-Ems Canal (northern section): page 319 of the Transport Investment Report 2021
- Kiel Canal: page 312 of the Transport Investment Report 2021

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[29] Extract from the Transport Investment Report 2021: https://bmdv.bund.de/SharedDocs/DE/Anlage/G/verkehrsinvestitionsbericht-2021.html. Expenditures stated in the report include expenditures that were not eligible for Green German Federal securities.

1.4.2. Replacement, extension and construction projects relating to federal waterways

Budget chapters and items:	1203 780 02
Eligible expenditures 2021:	€131.1 million
GHG emission reduction:	0.345 million t CO_2e p.a.
Other indicators:	--
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e) f)

Assumptions and limitations: According to the Environmental Report on the 2030 Federal Transport Infrastructure Plan (FTIP) (p. 143), the implementation of the first priority federal waterways projects under the 2030 FTIP leads to the stated reductions.

Information on CO_2 savings and reductions in air pollutants is available from the FTIP evaluation in relation to upgrading projects only. This relates in all instances to the entire completed project and is based on the assumptions on the emission factors for the individual modes of transport applicable at the time of the FTIP forecast. It is not possible to infer information on CO_2 savings from the annual proportion of financing spent in an upgrading project. There is no project-specific information relating to structural maintenance and replacement projects and no methodology for determining direct CO_2/air pollutant reductions. However, the environmental and climate friendliness of waterways as a mode of transport can be seen in the overall balance of the annual greenhouse gas emissions of the modes of transport. According to a comparison of emissions by the Federal Environment Agency (see https://www.umweltbundesamt.de), the current amount of freight moved (i.e. the mass of the goods transported multiplied by the distance they cover) on waterways results in savings of around 4 million tonnes of CO_2 per year.[30]

Structural maintenance and replacement measures on the federal waterways serve to keep freight transport on the waterways and to maintain the emission savings. Every additional tonne of freight traffic shifted from road to waterway through measures such as upgrading projects results in a further reduction of CO_2 emissions in the transport sector. It is not possible to quantify impacts and attribute them to specific projects.

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[30] Per tonne-kilometre (tkm), inland navigation saves around 80 g of CO_2 compared to road transport (emissions table for freight transport, UBA 2020), meaning that existing transport by waterway (around 50 billion tkm/year) saves around 4 million tonnes of CO_2 per year compared to transport by road (around 500 billion tkm).

1.5. Cycling

1.5.1. Construction of bike lanes including maintenance (federal highways)

Budget chapters and items:	1201 746 22					
Eligible expenditures 2021:	€99.2 million					
GHG emission reduction:	N/A					
Other indicators:	158 km of newly built and repaired cycle paths					
Funding share:	N/A					
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)					

Assumptions and limitations: No km figures are available for maintenance measures on existing cycle paths.

Links: --

The federal budget finances the construction and maintenance of cycle paths on federal roads. A total of 158 km of newly constructed cycle paths on federal roads were completed in the 2021 fiscal year. In addition to new construction measures, maintenance measures were also financed, although no km figures are available.

Project examples: Federal highway B 53, construction of a cycle path and footpath between Klüsserath and Trittenheim

The B 53 serves the southern Moselle valley from Trier to Bullay. It is the main artery along the Moselle and connects the towns and communities along the river. Between Klüsserath and Trittenheim, the B 53 runs between the Moselle and the directly adjacent vineyards. Cyclists currently share the carriageway of the B 53 with motorised traffic, which poses a major accident risk given the popularity of cycle tours along the Moselle. The main aim is therefore to improve road safety by creating a new footpath and cycle path. The works cost approximately €11 million over a length of 4.235 km.

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1.5.2. Grants and subsidies in the area of cycling

- Implementation of the National Cycling Plan – grants to *Länder* and other public-law entities
- Implementation of the National Cycling Plan – subsidies to companies under private law
- Grants to *Länder* for the construction of cycle highways
- Funding of pilot projects in the area of cycling – subsidies to *Länder* and other public-law entities
- Subsidies for the expansion of Germany's network of cycle routes (*Radnetz Deutschland*)

Budget chapters and items:	1210 632 91, 1210 686 91, 1210 882 91, 1210 891 91, 1210 891 92
Eligible expenditures 2021:	€13.6 million
GHG emission reduction:	N/A
Other indicators:	189 measures
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)
Assumptions and limitations: --	
Links: --	

The federal government supports cycling through measures for the implementation of the National Cycling Plan 3.0, through the promotion of innovative model cycling projects and through grants for the expansion of Germany's cycling network. In addition, financial assistance is given to the *Länder* for the planning and construction of cycle highways.

These measures for the implementation of the National Cycling Plan are very wide-ranging. They include the construction and conversion of cycle paths, cycle path underpasses, overpasses and intersections, the removal of unsignalised right-turn lanes, the construction of bicycle parking facilities (bicycle racks, bicycle boxes and bicycle parking garages) and the organisation of the National Cycling Congress, the Bicycle Climate Test and the German Bicycle Award. The National Cycling Plan is able to initiate multifaceted improvements that boost cycling as a whole. The recommended measures for the expansion of cycling infrastructure improve conditions for cycling and thus contribute to an increase in bicycle use.

Under the **funding guidelines for non-investment measures for implementing the National Cycling Plan 3.0**, non-investment cycling-related projects are funded that advance the objectives of the National Cycling Plan 3.0 and thus the implementation of the cycling strategy. The projects are required either to deliver outcomes that are transferable to similar applications – that is, they serve as a model and are not just a one-off activity that can only be implemented at a single location – or to produce new knowledge about the thematic area concerned. Eligible projects of this kind notably include research and development projects, information and communication campaigns, competitions and other suitable projects geared to coordinating and promoting cycling.

One project example is the further development of cycling education in schools with a special focus on safe cycling for

children in real traffic scenarios – "**VeloKids**". The aim of the project is to investigate under what conditions school cycling education could take place in real road traffic and what support schools need in order to integrate this form of education. This serves the purpose of improving children's road cycling proficiency and thus their road safety.

The **funding guidelines for innovative projects to improve cycling in Germany** produce "cycling beacons" (innovative and exemplary structures or engineering measures) that serve as a model, boost cycling and enhance the attractiveness of cycling in Germany. The aim is to test models and apply them in practice in order to develop new ideas and approaches that can also make valuable contributions to improving cycling elsewhere in Germany. The federal funding gives impetus, creates incentives and – as the results are transferable – helps create equivalent living conditions, for example through the provision of cycle overpasses, underpasses, fully automated cycle parking garages and cycle-friendly crossing solutions at major intersections. A further possibility consists of measures and mobility approaches that combine cycling with other climate-neutral or climate-friendly modes of transport.

An example is the **Ballindamm cycle route upgrade** in Hamburg. Along the Ballindamm road, the street has been remodelled to make it more cycle- and pedestrian-friendly. In line with the aim of a car-reduced city centre, motorised traffic now has one lane in each direction. The freed-up space was used to create generous cycle lanes and a pedestrian promenade.

The aim of the **German Cycling Network** funding programme is to create a safe, comprehensive and attractive network of long-distance cycle routes across all German *Länder* and to make Germany a "land of cycling" in everyday life and for leisure and tourism. The German Cycling Network consists of the German Unity Cycle Route, the Iron Curtain Trail and 12 D-Routes – an extensive network of long-distance cycle routes running through the whole of Germany and integrated into EuroVelo, the European cycle route network.

Until the end of 2030, under section 5b of the Federal Trunk Roads Act (*Bundesfernstraßengesetz*), the federal government can grant financial assistance to the *Länder* for the **building of cycle highways** within the road construction remit of the *Länder*, local authorities and local authority associations. For this to be implemented, an administrative agreement with committed funding amounts was entered into with the *Länder* in 2017. In the 2021 fiscal year, approximately €2.88 million was spent on cycle highway projects, of which around €1.07 million was for construction works. Approximately 1.1 km of cycle highway was completed in the 2021 fiscal year.

One sample project is the Ruhr cycle highway, "RS1". This will run for a total of 101 km across the Ruhr region. €0.7 million was spent on construction of the 1.1 km Gelsenkirchen section in the 2021 fiscal year.

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1.5.3. Financial assistance to the *Länder* for investments in cycling through the special programme "Stadt und Land"

Budget chapters and items:	1210 882 92					
Eligible expenditures 2021:	€15.8 million					
GHG emission reduction:	N/A					
Other indicators:	867 measures					
Funding share:	N/A					
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)					
Assumptions and limitations: --						
Links: --						

In the special programme "Stadt und Land", the federal government provides the *Länder* with substantial financial assistance for investment in cycling infrastructure.

The aim is to make cycling more attractive and safer while promoting the development of cycling infrastructure with maximum geographical coverage. To this end, the *Länder*, local authorities and local authority associations are provided with financial assistance for the construction, conversion and upgrading of extensive cycling networks that are as safe as possible and preferably separated from motorised transport, including separate cycle paths, cycle priority streets, cycle overpasses and underpasses, cycle stands and cycle garages. The special programme is implemented by the *Länder* on the basis of their own guidelines, criteria and priorities.

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2. International cooperation

Global challenges such as climate action and species and resource conservation require global responses. Germany is highly committed to sustainable development in international cooperation and hence supports developing and emerging countries in their transition towards more environmentally sustainable economies and societies. This is done within the framework of the United Nations Sustainable Development Goals, the Paris Agreement and other relevant international agreements and initiatives. Key areas of focus include:

- Climate change mitigation and adaptation
- Transition to low-emission, sustainable energy systems, including the development of renewable energy generation infrastructure
- Improvements in energy and resource efficiency in production and buildings
- Protection of marine and terrestrial habitats and biodiversity
- Sustainable use of natural resources and sustainable agriculture

Key outcomes of development cooperation are presented in the federal government's 16th Development Policy Report[31]:

- The federal government has advocated internationally for more ambitious climate action. Its contribution to international climate finance more than doubled from 2014 to 2020 – from €2 billion to more than €5 billion.
- 350 million people in over 100 developing and emerging countries are covered by climate risk insurance as a result of the initiative launched by Germany.
- At the multilateral level, Germany is one of the largest donors to the Green Climate Fund (GCF) and the Global Environmental Facility (GEF).
- Germany supports more than 70 countries in their transition to sustainable energy. Germany is one of the largest bilateral donors in the energy sector.
- In total, the federal government supports 660 protected areas covering an area of two million square km, six times the size of Germany.
- In total, the federal government contributes to the protection of 130 million ha of forest worldwide.

Germany is also working with other industrialised countries to jointly accelerate the energy transition and exploit the potential for innovation and sustainable growth. Examples of this include the federal government's 21 global energy partnerships and dialogues with countries such as Australia, Japan and the USA, which focus on exchange and cooperation on energy transition issues.

The sector's eligible expenditures amount to €3,701.0 million and are distributed across 14 budget items in the following categories:

- Bilateral financial cooperation (3 budget items with €1,187.8 million in eligible expenditures),
- Bilateral technical cooperation (1 budget item with €771.9 million in eligible expenditures),

[31] https://www.bmz.de/en/news/publications/100882-100882

- International climate and environmental protection (3 budget items with €663.2 million in eligible expenditures),
- Multilateral cooperation (2 budget items with €764.5 million in eligible expenditures) and
- Specific funding (5 budget items with €313.6 million in eligible expenditures).

2.1. Bilateral financial cooperation

2.1.1. Bilateral financial cooperation – loans

Budget chapters and items:	2301 866 11
Eligible expenditures 2021:	€118.7 million
GHG emission reduction:	N/A
Other indicators:	79 projects
Funding share:	CO_2 impacts are already scaled to the 2021 eligible expenditures
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e) f)

Assumptions and limitations: CO_2 impacts are scaled to eligible expenditures in 2021; other indicators apply to the overall project; ex-ante estimates, internal BMZ calculations

Links: See project name in list of sample projects

The eligible expenditures of bilateral financial cooperation loans are used to support Germany's development cooperation partner countries. Loans support projects that contribute to climate change adaptation and mitigation, environmental protection and resource conservation and/or support for biodiversity in countries with appropriate debt sustainability.

The expected impact is only reported for a selection of projects for which quantitative indicators can be estimated. The eligible expenditures relating to the sample projects correspond to around 45% of the eligible expenditures of the entire budget item.

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	GHG emission reduction (in t CO_2e p.a.)	Other indicators
Green Bonds Partnership Facility – Colombian Window	17.5	18,060	Additional generation capacity provided: 3 MW Energy generated annually: 15,050 MWh p.a.
Renewable Energy Programme	15.0	11,086	Additional generation capacity provided: 15 MW Energy generated annually: 21,000 MWh p.a.
Windfarm Gulf of Suez	6.5	32,110	Additional generation capacity provided: 200 MW Energy generated annually: 650,000 MWh p.a.
Renewable Energy – Solar Power Plant	6.1	6,268	Additional generation capacity provided: 50 MW Energy generated annually: 90,000 MWh p.a.

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	GHG emission reduction (in t CO_2e p.a.)	Other indicators
Energy Efficient Housing – Fiduciary Holding Namibia (IHS SSA)	4.6	118	Construction of 2,100 energy-efficient residential units for middle and low income earners
Renewable Energy Programme: Pilot Photovoltaic Project	3.3	663	Additional generation capacity provided: 12 MW Energy generated annually: 17,000 MWh p.a. Number of people with indirect access to energy: 41,197

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2.1.2. Financial cooperation with regions

Budget chapters and items:	2301 896 01
Eligible expenditures 2021:	€378.9 million
GHG emission reduction:	N/A
Other indicators:	31 projects
Funding share:	CO_2 impacts are already scaled to the 2021 eligible expenditures
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e) f)

Assumptions and limitations: CO_2 impacts are scaled to eligible expenditures in 2021; other indicators apply to the overall project; ex-ante estimates, internal BMZ calculations

Links: See project name in list of sample projects

The eligible expenditures of bilateral financial cooperation with regions are used to finance regional approaches, as well as provide funding for regional stakeholders for which there are no partners with international legal capacity. The projects are intended to contribute to climate change adaptation and mitigation, environmental protection and resource conservation and/or support for biodiversity in the regions.

The expected impact is only reported for a selection of projects for which quantitative indicators can be estimated. The eligible expenditures relating to the sample projects correspond to 76% of the eligible expenditures of the entire budget item.

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	GHG emission reduction (in t CO_2e p.a.)	Other indicators
Legacy Landscapes Fund, initial commitment, additional first tranche and second tranche	110.0	1,525,979	Contribution to the preservation of conservation areas totalling 34.7 million ha
Caucasus Nature Fund (CNF) VI	40.0	150,000	Contribution to the preservation of conservation areas totalling 620,766 ha
Clean Energy and Energy Inclusion for Africa (CEI Africa) Foundation: Crowdlending/Smart Outcomes Fund	35.0	41,078	Additional generation capacity provided: 18 MW Energy generated annually: 24,000 MWh p.a. Number of people with indirect access to energy: 353,000
Prespa Transboundary Biosphere Reserve (PONT) VIII	20.0	N/A	Contribution to the preservation of conservation areas totalling 61,007 ha
Regional Energy Efficiency Fund Western Balkans and Neighbourhood Regions (GGF VIII)	20.0	33,049	Energy saved annually: 128,124 MWh p.a.

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	GHG emission reduction (in t CO_2e p.a.)	Other indicators
Regional Energy Efficiency Fund Western Balkans and Neighbourhood Regions (GGF IX)	15.0	24,788	Energy saved annually: 96,093 MWh p.a.
AfricaGoGreen Fund for Renewable Energy and Energy Efficiency	13.0	11,050	Number of borrowers supported by access to needs-based financing: 4,160
Climate Smart Agriculture and Food Systems Fund (CSFSF)	12.0	53,880	--
Prespa Transboundary Biosphere Reserve (PONT) VII	12.0	37,506	Contribution to the preservation of conservation areas totalling 61,007 ha
Green Bonds Partnership Facility – Regional Investment Window, Phase I	10.0	10,320	Additional generation capacity provided: 4 MW Energy generated annually: 21,500 MWh p.a.

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2.1.3. Bilateral financial cooperation – grants

Budget chapters and items:	2301 896 11
Eligible expenditures 2021:	€690.2 million
GHG emission reduction:	N/A
Other indicators:	458 projects
Funding share:	CO_2 impacts are already scaled to the 2021 eligible expenditures
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) f)

Assumptions and limitations: CO_2 impacts are scaled to eligible expenditures in 2021; other indicators apply to the overall project; ex-ante estimates, internal BMZ calculations

Links: See project name in list of sample projects

The eligible expenditures in bilateral financial cooperation are used to support Germany's development cooperation partner countries. The projects are intended to contribute to climate change adaptation and mitigation, environmental protection and resource conservation and/or support for biodiversity in the partner countries.

Due to the large number of projects, the expected impact can only be reported for a selection. The eligible expenditures relating to the sample projects correspond to 21% of the eligible expenditures of the entire budget item.

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	GHG emission reduction (in t CO_2e p.a.)	Other indicators
Sustainable resource management in Cameroon	4.8	53,502	Contribution to the preservation of conservation areas totalling 316,668 ha
Modernisation of Power Distribution – Smart Grids Phase I	11.5	8,798	New or modernised transmission and distribution lines: 900 km Quantity of energy transmitted, distributed and transferred: 5,577,082 MWh p.a. Number of people with indirect access to energy: 102,153
Renewable Energy Programme – IDCOL – grant component	5.4	769	Additional generation capacity provided: 2 MW Energy generated annually: 1,872 MWh p.a. Number of people with indirect access to energy: 5,550

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	GHG emission reduction (in t CO_2e p.a.)	Other indicators
Regional Liquidity Support Facility	6.4	18,289	Additional generation capacity provided: 20 MW Energy generated annually: 77,500 MWh p.a.
Climate-friendly Urban Mobility III	10.8	1,656	Length of urban roads: 62 km Number of people benefiting from sustainable urban transportation systems: 391,402
Energy Reform Programme India	8.8	6,554	Quantity of energy transmitted, distributed and transferred: 6,935,000 MWh p.a. Number of people with indirect access to energy: 105,000
Biodiversity and Sustainable Forest Management Programme IV	5.9	217,766	Contribution to the preservation of conservation areas totalling 7.0 million ha
Renewable Energy Programme – Small IPP Support Programme, Phase III	8.0	190,000	Additional generation capacity provided: 80 MW Energy generated annually: 120,000 MWh p.a. Number of people with indirect access to energy: 35,000
Contribution to the Madagascar Protected Areas and Biodiversity Fund (FAPBM)	15.1	135,177	
Regional Programme for the Improvement of Living Conditions of Palestinian Refugee Camps (REPAC XI) (VPT)	6.5	1,110	Additional generation capacity provided: 3 MW
Results-based programme for sustainable operations in the water sector	18.6	8,700	
West African Power Pool (WAPP) Côte d'Ivoire-Liberia-Sierra Leone-Guinea (CLSG) II transmission line	29.0	7,959	Number of people with indirect access to energy: 5,100
Programme for the promotion of energy efficiency and access to energy	13.7	2,956	Number of people with indirect access to energy: 129,825

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2.2. Bilateral technical cooperation

2.2.1. Bilateral technical cooperation

Budget chapters and items:	2301 896 03
Eligible expenditures 2021:	€771.9 million
GHG emission reduction:	N/A
Other indicators:	706 projects
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e) f)
Assumptions and limitations: --	
Links: --	

Through bilateral technical cooperation (TC), the federal government helps to increase the technical, economic and organisational knowledge and skills of people and organisations in partner countries and to support them in achieving national climate and environmental goals through the effective, efficient and sustainable use of resources. Bilateral TC mainly consists of consulting provided by the deployment of technical personnel (e.g. in government bodies or other partner country organisations), the funding of consulting services and the limited provision and funding of goods and equipment. Most technical cooperation projects are implemented by the government-owned Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). Eligible expenditures contribute to climate change adaptation and mitigation, environmental protection and resource conservation and/or support for biodiversity.

No aggregated data on eligible expenditures is available. The following selection of projects represents exemplary impacts (approx. 5% of eligible expenditures).

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Qualitative description of impacts
Transboundary biosphere reserve of the WAP region	2.7	The WAP region transboundary biosphere reserve project supports the protection and sustainable use of five national parks and fragile ecosystems around the W-Arly-Pendjari region in Niger, Burkina Faso and Benin. By the end of 2021, 300,000 local residents had been trained in ecological value chains and €35 million in additional income had been generated. Reforestation measures covering 43,000 ha sequestered 895,000 tonnes of CO_2.
Energising Development (EnDev) global programme	12.8	EnDev grows and strengthens local markets for the dissemination of renewable energy and more efficient technologies for households, social institutions and businesses. EnDev is currently active in 21 partner countries on three continents (Africa, Asia and Latin America). Between the project's launch in 2005 and 2021, access to climate-friendly energy has been provided for 25.8 million people (2 million in

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Qualitative description of impacts
		2021), 30,900 social infrastructures (2,400 in 2021) and 81,700 micro, small and medium-sized enterprises (8,170 in 2021). The carbon dioxide emission savings directly associated with the EnDev measures amount to 19.5 million tonnes of CO_2e (2.55 million tonnes of CO_2e in 2021) and have been steadily increasing.
Implementation-oriented environmental and forest management (ProAmbiente)	4.1	The project supports the management of nature conservation areas according to international standards in order to conserve biodiversity in protected areas and buffer zones. The marketing of environmentally friendly products and sustainable tourism improves the living conditions of the local population and the public acceptance of nature conservation. The project helped to improve the protection of a total of 10.3 million ha in Peruvian protected areas in 2021. It also improved the incomes of 1,788 families living in and around protected areas. It additionally helps to support legal and sustainable forestry in Peru and cooperates with state institutions, the private sector and indigenous communities. Economically and ecologically sustainable forest management is crucial to reducing deforestation in the Amazon, as it provides viable economic alternatives for the local population. In 2021, the project helped enable the sustainable and legal use of 4.9 million ha of forest in Peru. This prevented deforestation and resulting greenhouse gas emissions totalling 621,361 tonnes of CO_2e.
Renewable Energies Programme (PEERR II)	1.7	The project improves the technical basis for integrating renewable energy sources into the Bolivian electricity system and for improving Bolivia's energy efficiency. Due to its gas reserves, Bolivia is highly dependent on fossil fuels. The country is also strongly reliant on heavily subsidised fossil fuel imports. This situation represents a fundamental risk to Bolivia's economy and energy security. In response, Bolivian policymakers have placed energy transition high on the political agenda and have begun to significantly increase and promote the use of renewable energy sources and climate-friendly technologies. With the aid of the project, a total of 108 MW of wind energy was integrated into the electricity system and efficiently operating by 2021. The operating availability of the country's wind farms was increased to 94%. The project also helps promote energy efficiency through the development of an electric mobility strategy for public transport, working together for this purpose with government institutions, the private sector and civil society. In 2021, the measures under the project indirectly prevented greenhouse gas emissions totalling 406,332 tonnes of CO_2e.
Governance and sustainable management of natural resources in the Comoé and Taï area, Côte d'Ivoire (Pro2GRN)	3.2	The Pro2GRN programme provides capacity building for the Côte d'Ivoire parks and reserves agency (OPRI) to improve national park management efficiency for the Comé National Park (PNC) and the Taï National Park (PNT). In 2021, these measures prevented deforestation and associated greenhouse gas emissions totalling 870,000 tonnes of CO_2e. The programme also aims to improve the management of natural resources around the PNC and increase the agricultural productivity of smallholdings. This has included supporting the negotiation of 11 local agreements on the sustainable management of resources around the Comoé National Park and helping 3,960 producers (including 2,692 women) to improve their incomes through sustainable farming methods in onion, rice and cashew cultivation. In addition, the introduction of an agroforestry system with acacia trees is enabling the regeneration of depleted soils. To date, 683 producers (including 24

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Qualitative description of impacts
		women) have been assisted in establishing 816 ha of agroforestry plots in the Comoé region.
Forest and Environment Programme, Cameroon	8.3	The programme aimed to create economic incentives for the sustainable use and exploitation of the environment and forest resources in Cameroon by applying the "conservation through utilisation" approach. This included sustainable forest management by communities, value chain development, environmental education and strengthening of the legal framework. To this end, the programme worked with local stakeholders and placed a focus on the integration of women, young people and indigenous groups. Measures such as the use of efficient cooking stoves and producing charcoal from sawmill waste saved an estimated 131,779 tonnes of CO_2e in 2021. Other project outcomes in 2021 included supporting the validation of the country's first forest landscape restoration plan (24,348 ha) and the preparation of three further restoration plans (totalling 57,617 ha). In addition, six community or village forest management plans were under preparation or nearing completion in 2021. These cover 70,500 ha of forest and are designed to help communities use and manage forest resources in a sustainable way.
Strengthening ecological connectivity in the Taï–Grebo-Krahn–Sapo forest complex between Côte d'Ivoire and Liberia	0.3	Working in the border region between Liberia and Côte d'Ivoire, the project aims to create ecological corridors and connecting zones between the various forest areas of the Tai-Grebo-Krahn–Sapo (TGS) complex. The project provides skills and capacity building for various stakeholders with regard to the joint management of natural resources and biodiversity. It supports the organisation of regular meetings of the bilateral steering committee, which includes representatives of government institutions and other relevant stakeholders from Côte d'Ivoire and Liberia. Protected areas authorities have been trained in the application of a number of internationally recognised management tools. In 2021, the various measures prevented deforestation and associated greenhouse gas emissions totalling an estimated 130,000 tonnes of CO_2e.
Conservation and sustainable use of natural resources (PAGE 2) in Madagascar	5.5	The project supports the sustainable use of natural resources around selected protected areas in the Boeny and Diana regions of Madagascar, thereby contributing to their conservation. To this end, the project targets areas such as value chain development, developing natural resources and conserving biodiversity, sustainable natural resource management and climate change adaptation. With a view to good environmental governance, it also provides capacity building for government and operators in the value chain in the fight against corruption. In 2021, this enabled the sustainable management of 600 ha of land and the conservation through sustainable management of 160,000 ha of forest. Around 170,000 people benefited from the improved safeguarding of ecosystem services, some 18,000 gained access to modern energy sources, approximately 6,000 benefited from the project's climate change adaptation measures, and 17 stakeholders on the partner side applied methods supported by the project for addressing the impacts of climate change. The project also saved a total of around 120,000 tonnes of CO_2e.

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Qualitative description of impacts
Energy Systems of the Future in Brazil (Phase II)	0.9	Over the period 2018-2021, the project supported the integration of renewable energy sources and energy efficiency into the Brazilian energy system in order to reduce greenhouse gas emissions from energy generation and use. Improved conditions for the integration of renewable energy sources and energy efficiency led to an increase in the installed capacity of photovoltaic solar power from 2,416 MW to 14,231 MW. Over the project period, renewable energy sources (excluding hydropower) grew 12% faster than conventional energy sources in the Brazilian electricity matrix. To improve energy efficiency, the project supported the adoption of energy management systems, which almost doubled in number from 62 to 116. The implementation of Energy Efficiency Learning Networks for public buildings and industrial enterprises led to quantifiable energy efficiency gains of 43 GWh and 2,653 tonnes of CO_2e as a result of measures to reduce consumption (EPE Relatório Síntese 2023 using 2020 data basis to calculate CO_2 emissions). As a result of initial and further training for professionals in the renewable energy and energy efficiency sector, the number of newly qualified professionals increased almost threefold from 1,768 to 4,822. 44% of these were already employed in the labour market in 2021.

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2.3. International climate and environmental protection

2.3.1. International climate and environmental protection – export of technologies to tackle marine litter

Budget chapters and items:	1601 687 06					
Eligible expenditures 2021:	€22.7 million					
GHG emission reduction:	Pursues other objectives					
Other indicators:	8 projects funded					
Funding share:	N/A					
EU environmental objectives under Article 9 of the Taxonomy Regulation:			c)	d)	e)	f)
Assumptions and limitations: --						
Links: https://www.z-u-g.org/meeresmuell/						

The oceans are important ecosystems for countless species of animals and a vital source of life for humans. Every year, approximately 13 million tonnes of plastic waste is washed into the oceans. As a result, marine animals mistake plastic debris for food or become entangled in it and die. In addition, plastics ingested by animals can reach humans through the food chain.

With the "Marine Debris Framework – Regional Hubs around the Globe" (Marine:DeFRAG) funding programme, the Federal Environment Ministry supports international projects that help to collect plastic debris at source or prevent it from entering the oceans.

Funding is provided both for activities to reduce the amount of plastic waste in the medium term and for activities to establish and develop effective waste and recycling management systems in the short term. In addition to countries and regions along rivers that transport plastic waste from inland areas to the sea, the project also focuses on coastal regions and island nations.

List of projects in the grant programme against marine litter:

Project name	Eligible expenditures (in € million)	Duration	Description
Contribution to PROBLUE fund	11.0	-	PROBLUE is an Umbrella Multi-Donor Trust Fund (MDTF) administered by the World Bank, designed to help countries chart a course towards the sustainable and integrated development of coastal regions and the oceans.
Contribution to Basel-Rotterdam-Stockholm (BRS) Secretariat	5.0	-	The Secretariat supports the implementation of the Basel, Rotterdam and Stockholm Conventions on environmental protection.
Mitigating Marine Plastic Debris in Vietnam	1.1	2019-2026	The project aims to reduce the quantity of waste released into the oceans, primarily by establishing the infrastructure for a

Project name	Eligible expenditures (in € million)	Duration	Description
			sustainable waste management sector. Core elements include extended producer responsibility (EPR) and a law in force since 2018 prohibiting the issuance of new licences or the extension of existing licences to import plastics for recycling.
Prevention of Marine Litter in the Caribbean Sea (Promar)	0.4	2020-2026	Four community-based projects are being implemented in the Dominican Republic, Costa Rica and Colombia with a focus on plastic reduction, reuse and recycling. This will lead to the development of best practices for collaboration between national governments, civil society and the private sector to implement resource-efficient approaches in waste and plastics management. The geographic scope of the project has been extended to five additional partner countries: the British Virgin Islands, Guyana, Suriname, Saint Kitts and Nevis, and Trinidad and Tobago. These are particularly affected by marine litter due to factors such as inadequate waste collection, lack of recycling infrastructure, illegal dumping, insufficient resources and capacity for waste and recycling management, in some cases low public awareness of marine litter, and inadequate regulatory approaches to marine litter prevention.
Cities Combating Plastics Entering the Marine Environment	1.8	2020-2024	The project aims to prevent marine litter at source through sustainable waste management in cities and communities while also promoting resource efficiency. It pursues a comprehensive approach at all political and administrative levels – local authority, state and national – as well as involving recyclers and producers. A combination of technological/digital solutions and capacity building is to be used to improve waste separation, collection, transportation, treatment and disposal in communities.
Circular Economy Solutions Preventing Marine Litter in Ecosystems	1.7	2020-2026	The purpose of the project is to present and demonstrate technical solutions to close the resource loop in relation to marine litter. Circular economy and resource efficiency approaches are to be promoted among civil society and public and private partners. For example, regulatory authorities such as the Central Pollution Control Board are to be supported in the use of digital technologies for surveying and quantifying marine litter, for monitoring gaps in the selected marine and river basin ecosystems and for implementing extended producer responsibility.

Project name	Eligible expenditures (in € million)	Duration	Description
Global sector project to support BMUV in implementing the Marine:DeFRAG programme	0.7	2020-2026	The aim of the global sector project is to promote the policy integration of the grant programme against marine litter. In addition to implementing specific measures in target countries, the project also aims to enable stakeholder networking and knowledge and experience sharing.
Contribution of Sustainable Waste Management System in Tourism Sector to the Protection of Marine Ecosystems	0.2	2021-2024	The aim of the project is to reduce marine litter in the Mediterranean by developing and implementing a sustainable waste management system for the tourist regions in the North African Mediterranean coastal states (Algeria, Egypt, Morocco and Tunisia). In addition to technical solutions (such as separate waste collection in hotels and the establishment of recycling centres), sustainable approaches are being developed for the private sector, environmental protection, tourism and the residential population in tourist regions.

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2.3.2. Investments to protect the climate and biodiversity abroad

Budget chapters and items:	1602 896 05
Eligible expenditures 2021:	€564.5 million
GHG emission reduction:	Direct GHG emission reduction over the course of the project: 7.83 million t CO_2e *(total for 22 International Climate Initiative projects over the project duration up to and including 2021)*
Other indicators:	Land area with improvements/improved ecosystem protection: 16.13 million ha *(total for 40 International Climate Initiative projects over the project duration up to and including 2021)*
	Number of people assisted in ecosystem adaptation and protection: 1,049,293 *(total for 61 International Climate Initiative projects over the project duration up to and including 2021)*
	406 projects funded in 2021
	– of which 70 new projects
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) c) d) e) f)

Assumptions and limitations:

– The projects with direct GHG reduction effects that have already been achieved and are plausible account for a small part of the International Climate Initiative portfolio. The disbursements to the 22 projects in 2021 amounted to only 3.01% of the total eligible expenditures.

– The GHG reduction figures relate exclusively to mitigation effects obtained during the project period (ex-post). They do not include projected savings generated by, for example, the ongoing use of new technologies.

– The three indicators reflect project impacts that are the direct result of measures under the project. The figures do not include indirect impacts through activities such as capacity building or policy advice, although these are widespread approaches in the International Climate Initiative portfolio.

Links: Further information on the International Climate Initiative: https://www.international-climate-initiative.com/en/about-iki/

Information on standard indicators used in the International Climate Initiative and evaluation figures (including completed projects): https://www.international-climate-initiative.com/en/about-iki/impact-and-learning/

The International Climate Initiative (IKI) funds a wide variety of projects that help developing and emerging countries to reduce greenhouse gas emissions in any sector (funding area I), adapt to the consequences of climate change (funding area II), preserve natural carbon sinks

such as forests and peatlands (funding area III) and protect or restore ecosystems and biodiversity (funding area IV).

A large variety of approaches to climate action and biodiversity conservation are applied in the project portfolio. For example, International Climate Initiative projects advise partner policymakers, authorities and the private sector on the development of strategies and action plans or laws at all levels (from small villages to metropolitan regions right up to the multilateral level), provide capacity building, and develop financing instruments. Quantifiable impacts in terms of the above three standard indicators will not materialise until these plans and instruments are implemented. Since this does not normally take place until after project completion, they are not included in the assessment of the direct impacts of the International Climate Initiative.

With these measures, many projects therefore aim to improve the political and regulatory framework and to overcome structural barriers and barriers to investment. In this way, they help partner countries to independently adopt and sustainably pursue climate-friendly and biodiversity-friendly development paths. While impacts cannot usually be measured during the lifetime of such projects in terms of indicators such as land area with improved ecosystem protection, they act in the longer term as key drivers of large-scale and measurable effects with regard to climate change mitigation and biodiversity conservation, as well as paving the way for further investments in areas such as GHG-mitigating infrastructure after project completion. The post-project follow-up effects can no longer be quantified and counted as eligible in the International Climate Initiative (and are therefore not included in the following indicators).

The following projects provide an insight into the various approaches and impact pathways in the International Climate Initiative portfolio that cannot be tracked using the above indicators:

Project name	Eligible expenditures (in € million)	State government	Qualitative description of impacts
Clean, Affordable and Secure Energy for Southeast Asia (CASE)	2.8	Indonesia, Philippines, Thailand and Vietnam	The project aims to promote evidence-based solutions for the energy transition and ambitious climate targets in the region. To this end, it develops evidence-based solutions to energy challenges with broad stakeholder involvement, builds up a knowledge platform, participates in the South East Asian Energy Transition Partnership and provides technical and policy support.
Linking Market Mechanisms and Climate Finance in Africa	0.45	Ethiopia, Senegal and Uganda	The project promotes the use of financing mechanisms for climate change mitigation and adaptation in implementing countries. To this end, it pilots climate financing models in partner countries that contribute to their NDCs. It also assists governments and the private sector in formulating GCF proposals. Project findings feed into climate negotiations and the public debate, thus helping to shape policy instruments.
Climate Action Tracker	0.65	-	The purpose of the Climate Action Tracker is for relevant stakeholders to possess knowledge about the adequacy of national

Project name	Eligible expenditures (in € million)	State government	Qualitative description of impacts
			mitigation activities to achieve long-term goals so that they can contribute to meeting ambitious climate targets. To this end, it conducts regular, transparent, independent investigations and assessments of the national and global implementation of the Paris Agreement in around 40 countries that account for over 85% of global emissions.
Climate friendly technologies and capacity development for the implementation of the Brazilian National Waste Policy	0.71	Brazil	The project aims to improve the conditions for a climate-friendly and resource-efficient circular economy in Brazil. This includes integrating climate-relevant criteria into rules, regulations and laws, carrying out wide-ranging capacity-building measures for various different target groups and assisting with the introduction of climate-friendly waste management measures in courses of study.
Supporting the design and first implementation steps of the new global framework for biological diversity	1.2	Costa Rica, Indonesia and South Africa	The project supports partner countries in the design and first implementation steps of the new global framework for biological diversity beyond 2020. To this end, it assists project partners in preparing for CBD COP 15, promotes integrated approaches to biodiversity and climate change, and identifies funding instruments to implement the goals of the new biodiversity framework. It also advises on issues such as nature-based solutions for climate action and biodiversity conservation.
Western Africa Alliance on Carbon Markets and Climate Finance	0.84	Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo	The project seeks to deepen sub-regional cooperation in the West African Alliance on Carbon Markets and Climate Finance and to improve countries' resources and capabilities for implementation of Article 6 of the Paris Agreement. Member participation in international negotiations on Article 6 ensures that African priorities are taken into account in the design of new carbon market approaches. In addition, a platform for bringing together strategic partners (such as financiers and project developers) supports the launch of carbon market projects. The development of institutionalised regional cooperation structures will raise awareness, promote knowledge transfer and encourage replication in the region.
Transparent policymaking: The Caribbean Cooperative MRV Hub (CCMRVH)	0.64	Caribbean small island developing states	The CCMRVH assists Caribbean countries in developing and using measurement, reporting and verification (MRV) systems that can collect and process data, compile greenhouse gas inventories, model climate policies and track progress toward national

Project name	Eligible expenditures (in € million)	State government	Qualitative description of impacts
			climate goals. It offers a wide range of capacity development and support measures for this purpose. The aim is to build national expertise, make MRV systems more efficient and reduce dependence on experts from elsewhere.
RESTORE+: Addressing Landscape Restoration on Degraded Land in Indonesia and Brazil	0.91	Indonesia and Brazil	The project promotes land-use and degradation monitoring, modelling, policymaking and land-use planning for degraded landscapes in Brazil and Indonesia. In Indonesia, it combines mapping campaigns (in collaboration with the local population) with land-use and supply chain modelling. In this way, the project identifies areas that are suitable for restoration while analysing impacts on production, biodiversity, GHG emissions and society. In Brazil, it supports existing land monitoring and modelling technologies and the implementation of the Bonn Challenge.
Enabling Long Term Defossilisation Pathways through Power-to-X (PtX Pathways)	0.77	Argentina, Morocco and South Africa	PtX Pathways supports the development of sustainable Power-to-X (PtX) and hydrogen markets as a building block for the energy transition in Morocco, South Africa and Argentina. The project supports the competent ministries for energy and the economy in the development of allocation scenarios for PtX, including the analysis of value chains. Working jointly with the partners, the team identifies business development opportunities and derives recommendations for improving the regulatory framework for PtX. In Morocco, a power-to-liquid pilot plant demonstrates the entire PtX value chain, paving the way for upscaling and capacity development. Good practices, tools and guidelines are disseminated to other countries via the International PtX Hub and thus fed into the PtX debate in other markets.
Establishing Sustainable Consumption and Production – a South-South Transfer (“SCP South-South”)	1.3	Indonesia, Colombia, Paraguay, Philippines and Thailand	The project promotes sustainable consumption and production methods through a variety of measures and strategies. Among other things, it provides support for national governments in the development of mitigation strategies in the agro-food sector, promotes the implementation of sustainable business models and uses information campaigns to raise awareness about sustainable approaches to production and consumption.

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2.3.3. International climate and environmental protection

Budget chapters and items:	2310 687 01
Eligible expenditures 2021:	€76.0 million
GHG emission reduction:	N/A
Other indicators:	89 projects
Funding share:	See list of sample projects
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b)

Assumptions and limitations: The funding share is calculated as a share of the total costs of the project (excluding third-party funding).

Links: See list of sample projects

The International Climate and Environmental Protection (IKU) budget item funds new and particularly innovative climate change mitigation and adaptation approaches that contribute to the implementation of the Paris Agreement in developing and emerging countries. The budget item is not limited to specific instruments. Funding can be provided to projects carried out by international organisations, GIZ, KfW, churches, political foundations and local authorities or to research projects.

Due to the large number and heterogeneity of the projects, it is not possible to aggregate at budget item level. A description of the impact is therefore reported for a selection of projects (approximately 40% of eligible expenditures). The funding share is calculated as a share of the total costs of the project.

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Description	Funding share
Konrad-Adenauer-Stiftung (KAS): Regional Programme Energy Security and Climate Change in Sub-Saharan Africa	1.2	Contribution to climate change mitigation and adaptation by strengthening target groups, notably in subregional and transregional dialogue on energy, climate and environmental policy. Specifically, the programme includes events and training programmes for young people, decision makers, knowledge disseminators, diplomats and KAS partner party members in various countries.	48%
World Resources Institute: Support for the Integrated Implementation of the Nationally Determined Contributions (NDCs) in South Africa	3.6	Support for South Africa in implementing the NDCs, reforming the electricity sector and phasing out coal in a socially responsible manner. Specific activities included supporting and financing studies, holding high-level discussion events together with the Department of Environmental Affairs and developing a plan for implementation of the NDCs together with a corresponding project preparation facility.	100%
Multi-Actor Partnership on Climate and Disaster Risk	1.2	Project with three German and around ten local non-governmental organisations. Establishment and	40%

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Description	Funding share
Financing and Preparedness in the Context of the InsuResilience Global Partnership		expansion of multi-actor dialogue platforms at national (in selected developing countries) and global level to develop and implement gender-equitable, pro-poor and human rights-based approaches to climate risk financing. Increased cooperation and knowledge exchange and generation achieved in all countries by means of studies, libraries, platforms, events, etc.	
IUCN: Independent Third Party Monitoring and Evaluation of the Government of Pakistan's Ten Billion Tree Tsunami Programme	2.5	The Ten Billion Tree Tsunami Programme (TBTTP) aims to facilitate Pakistan's transition to climate resilience by ensuring that climate change adaptation and mitigation are taken into account throughout in environmentally oriented initiatives, including afforestation, biodiversity conservation and the creation of an enabling policy environment. In addition to internal monitoring, the Pakistani government has also requested independent third-party monitoring and evaluation by a consortium of the IUCN, the WWF and the FAO. Specific activities have included financing the preparation, publication and discussion of the annual monitoring reports for the years 2021 to 2024.	100%
UNEP: V20 Sustainable Insurance Facility (SIF) Acceleration and Global Shield V20 Support	1.2	As part of SIF-related activities, the provision of financial protection instruments for micro, small and medium-sized enterprises is to be further accelerated and V20-related activities are to be stepped up – both nationally and internationally – in the area of climate risk financing following the outcome of the G7 on the implementation of the Global Shield. Funding for, among other things, consulting, technical capacity building, studies and consultations.	81%
IISD: Monitoring, Evaluation and Learning for National Adaptation	2.5	Support for developing countries in measuring national progress on adaptation as part of the development of National Adaptation Plans (NAPs) to improve the effectiveness of adaptation investments and measures.	100%
UNEP: Development and implementation of a framework to accelerate the supply and uptake of climate-friendly building materials in the Global South	2.0	Creation of a framework (primarily guidelines and specific tools) to develop and test responsible building material procurement in selected countries in Africa and Asia.	36%
Development and Climate Alliance Foundation	1.8	Funding to help non-governmental actors promote sustainable development and international climate action. The aim is to implement, in developing and emerging countries, increasing numbers of high-quality projects that help improve the living conditions of the local population, improve the global carbon footprint and conserve biodiversity.	33%

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Description	Funding share
		Includes the establishment of a network, information for the public and non-governmental actors and strengthening the supply of carbon allowances.	
Blue Action Fund (BAF) – Phase V	12.7	Through co-financing, the BAF enables international NGOs to improve the management of globally important marine and coastal protected areas. Project areas include ecologically valuable coastal and marine areas in selected regions of Africa and the Asia/Pacific and Latin America/Caribbean regions.	52%
Provision of the secretariat for the Cities Climate Finance Leadership Alliance (CCFLA); funding of sustainable carbon-neutral construction	1.7	Since the Climate Policy Initiative (CPI) took over provision of the Alliance secretariat in 2019, the Alliance has seen strong mobilisation of its membership, structural consolidation and an overall increase in its activities. The Alliance's committee-level policy work is ensured by the establishment of a steering committee and thematic action groups. Funding in 2021 was used to extend the CCFLA's work to the area of green building. This included the establishment of a focus on carbon-neutral sustainable buildings and construction in the CCFLA and the promotion of regional priorities for projects in the field of climate-neutral buildings and structures. It also covered the development of a focus on carbon-neutral buildings and construction projects in the Global Innovations Lab for Climate Finance.	100%

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2.4. Multilateral cooperation

2.4.1. Contributions to international organisations

Budget chapters and items:	1601 687 01
Eligible expenditures 2021:	€23.4 million
GHG emission reduction:	N/A
Other indicators:	33 supported institutions
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) c) d) e) f)
Assumptions and limitations: --	
Links: --	

Environmental protection, climate action and nature conservation must be globally successful in order to achieve the Sustainable Development Goals (SDGs). Effective organisations are needed to implement, monitor and further develop international agreements on environmental protection and nature conservation. To support these, the federal government makes annual contributions. Examples of organisations are:

Montreal Protocol for the Protection of the Ozone Layer

With the Montreal Protocol of 1987, a precise timetable was agreed for the global phase-out of the production and use of substances such as CFCs that destroy our ozone layer. Since 16 September 2009, the Montreal Protocol has been one of the first two agreements in the history of the United Nations to be ratified by all states in the world. The results of the agreed goals are clearly visible: worldwide, the quantities of ozone-depleting substances being produced and consumed fell drastically in just a few years. At the same time, the agreements under the Montreal Protocol prevented an additional increase in greenhouse gas emissions.

The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) also supported the following international organisations, among others, in 2021:

- Permanent Secretariat of the International Commission for the Protection of the Rhine
- Permanent Secretariat of the International Commission for the Protection of the Saar and the Moselle
- Protocol on Further Reduction of Sulphur Emissions (Oslo) (1994)
- International Council for the Exploration of the Sea (ICES)
- Permanent Secretariat of the International Commission for the Protection of the Meuse
- Permanent Secretariat of the Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area
- Permanent Secretariat of the International Commission for the Protection of the Elbe
- Permanent Secretariat of the International Commission for the Protection of the Oder
- Basel Convention (Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal)

- Permanent Secretariat of the International Commission for the Protection of the Danube River
- Strategic Approach to International Chemical Management (SAICM)
- United Nations Environment Fund
- UNEP/UNESCO/BMU Education Programme
- World Health Organisation (WHO)
- Vienna Convention for the Protection of the Ozone Layer
- Secretariat of the Cooperation Plan for the Implementation of Regional Sustainable Development at the Council of the Baltic Sea States (Baltic 21)
- Alpine Convention Secretariat (Protection and Sustainable Development of the Alps)
- Stockholm Convention (prohibition and restriction measures for certain persistent organic pollutants)
- Rotterdam Convention (prior informed consent procedure for certain hazardous chemicals; pesticides in international trade)
- International Panel for Sustainable Resource Management (International Panel on Resources)
- Transfer of funding for the UNEP Life Cycle Initiative
- Minamata Convention on the Control of Mercury
- United Nations Economic Commission for Europe (UNECE)
- OECD Programme on Chemical Safety and Biosafety
- WHO environmental and health projects
- OECD GREEN Action Task Force for Central and Eastern Europe
- Special Programme (Chemicals and Waste Management Programme)
- Contribution to the Protocol on Pollutant Release and Transfer Registers (PRTR Protocol)
- Contribution to the EU Aerosols, Clouds, and Trace gases Research Infrastructure (ACTRIS)
- Circular & Fair ICT Pact (CFIT)
- United Nations Institute for Training and Research (UNITAR)
- Secretariat of the Geneva Convention on Long-Range Transboundary Air Pollution

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2.4.2. Developmentally important multilateral aid for global environmental protection, biodiversity conservation and climate protection

Budget chapters and items:	2303 896 09
Eligible expenditures 2021:	€741.1 million
GHG emission reduction:	N/A
Other indicators:	Contributions to 13 international initiatives
Funding share:	Variable according to beneficiary
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) f)

Assumptions and limitations: Outcomes of funding provided by the institutions listed below are not recorded on a provider-specific basis. The contributions are made under international agreements. There are various beneficiaries with differing tasks and objectives. The outcomes cannot be aggregated.

Links: --

Multilateral organisations implement large programmes of considerable scope in developing and emerging countries and coordinate the contributions of various donors for this purpose. They are important players in supporting transformation processes in partner countries. Germany therefore contributed to 13 multilateral initiatives in 2021. Quantitative impact indicators are not available. The initiatives are therefore each described in qualitative terms.

Initiative (click on the project name to visit the website)	Eligible expenditures (in € million)	Description
Global Environment Facility (GEF)	91.0	Up to the end of 2021, the Global Environment Facility (GEF) financed projects with a total volume of just under USD 3 billion, leveraging USD 7.9 in co-financing per dollar of GEF grant. This enabled more than 87 million ha of marine area to be brought under sustainable use and 1,328 marine protected areas to be established and, on land, more than 8 million ha of habitat to be restored and 167 million ha to be brought under sustainable use. It also prevented approximately 1.44 billion tonnes of CO_2e in emissions.
Least Developed Countries Fund (LDCF)	50.0	The Least Developed Countries Fund primarily supports adaptation measures in countries heavily affected by climate change but lacking the resources to address it. By the end of 2021, nearly USD 1.6 billion in funding had been disbursed and funding committed for around 360 projects. These are expected to increase resilience for more than 51 million people and around 6 million ha of land.
Multilateral Fund (MLF) under the Montreal Protocol for the Protection of the Ozone Layer	17.7	The Multilateral Fund for the Implementation of the Montreal Protocol covers additional costs incurred by developing countries in complying with the Protocol to phase out the use of substances that deplete the ozone layer. Up to 2022, the fund has already co-financed more than 8,600 projects with nearly USD 4 billion.

Initiative (click on the project name to visit the website)	Eligible expenditures (in € million)	Description
Green Climate Fund (GCF)	200.0	The Green Climate Fund is an instrument of the UN Framework Convention on Climate Change with the aim of providing financing for both greenhouse gas emission reduction and climate change adaptation in developing countries. In 2021 alone, the Fund approved 32 projects in developing countries for nearly USD 3 billion. This means that by the end of 2021, a total of USD 10 billion was approved for 190 projects in 127 countries. Approximately 2.4 billion tonnes of CO_2e emissions were avoided by the beginning of 2022.
Contributions to climate risk insurance/the Global Shield	124.0	Germany contributed to various climate risk insurance funds in 2021. In particular, this included contributing to the implementation and onward development of the InsuResilience Global Partnership for Climate and Disaster Risk Finance and Insurance, an initiative of the G7. Building on this, the Global Shield against Climate Risks (GS) was established at COP27 in November 2022. The aim of the Global Shield is to provide vulnerable people and countries with financial protection against the impacts of extreme weather events.
City Climate Finance Gap Fund	6.0	This World Bank fund helps cities prepare projects for sustainable and climate-friendly urban development. It officially started work in September 2020 and has supported projects in 183 cities in 67 countries.
Climate Support Facility (CSF)	37.5	One of the World Bank's central climate change Umbrella Trust Funds, the CSF was initiated by, among others, Germany in 2020. It supports the carbon-neutral and climate-resilient development of World Bank partner countries after COVID-19 and the development and implementation of nationally determined contribution (NDCs) and long-term strategies (LTSs). Germany contributes to two pillars: the Green Recovery Initiative and the NDC and LTS Support Programme.
Central African Forest Initiative (CAFI)	82.1	The Central African Forest Initiative promotes sustainable forest management and agricultural practices together with good governance and land use reforms in six countries. This serves to protect the Central African forest, which absorbs 4% of the world's CO_2 emissions. The Initiative has supported over 40 projects through to 2022 with 75 million tonnes of anticipated CO_2 emission reductions. The reductions achieved vary according to the type of measure (e.g. forest conservation, agroforestry or natural regeneration) and range from 0.04 t CO_2 to 0.5 t CO_2 per USD.
Multi Donor Partnership for Sustainable Landscapes – PROGREEN	48.0	PROGREEN supports projects for the protection, sustainable use and restoration of terrestrial ecosystems and primarily forests and productive landscapes.
Forest Carbon Partnership Facility (FCPF) – EnABLE (Enhancing Access to Benefits while Lowering Emissions)	4.8	The World Bank launched EnABLE in 2020 to improve the participation of indigenous and local communities in results-based emission reduction programmes. Germany is so far the only donor to the trust fund. EnABLE builds on the experience of the Forest Carbon Partnership Facility (FCPF) Capacity Building Programme (CBP) for forest-dependent indigenous peoples and civil society organisations. It is currently working to support the 15 countries in the FCPF Carbon Fund (CF) portfolio.

Initiative (click on the project name to visit the website)	Eligible expenditures (in € million)	Description
African Development Bank Green Baseload Initiative	20.0	The African Development Bank's Green Baseload Initiative helps African countries transition from coal and other fossil fuels to renewable energy, with a strong focus on power system stability. It covers one of the strategic priorities of the Sustainable Energy Fund for Africa (SEFA).
Climate Investment Funds (CIFs)	55.0	The CIFs consist of the Clean Technology Fund (CTF) and the Strategic Climate Fund (SCF). Germany pledged further contributions to the CTF in 2021. The CTF helps middle-income countries adopt low-carbon technologies with significant emission reduction potential. It primarily invests in renewable energy, energy storage technologies, energy efficiency, sustainable transport and the socially equitable coal transition.
PROBLUE	5.0	PROBLUE was launched in November 2018 as a World Bank multi-donor trust fund with a seven-year term. Its aim is to develop integrated, sustainable and healthy marine and coastal resources as a contribution to SDG 14 ("Conserve and sustainably use the oceans, seas and marine resources for sustainable development"). The funds disbursed in 2021 are earmarked for the management of marine litter and pollution and of coastal and marine areas.

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2.5. Specific funding

2.5.1. Development of foreign markets

Budget chapters and items:	0904 687 05
Eligible expenditures 2021:	€16.3 million
GHG emission reduction:	7,602 t CO_2e in 2021
Other indicators:	--
Funding share:	34.8%
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) c) d) e)

Assumptions and limitations: The GHG emission reduction in 2021 relates in its entirety to the Renewable Energy Solutions (RES) programme, under which five renewable energy reference installations were built in various countries. The entire GHG reduction relates to reduction effects obtained during the project period (ex-post). It does not include projected savings generated by, for example, the ongoing use of renewable energy sources.

Investment by German companies in the construction of five reference installations under the dena RES programme in 2021: €7.7 million; funding amount in eligible expenditures in 2021: €2.682 million; this results in a funding share of 34.8%.

Links: https://www.german-energy-solutions.de/GES/Redaktion/DE/Standardartikel/Ihr-Export/dena-res-programm.html

https://www.gtai-exportguide.de/de/auslandsmaerkte/markterschliessungsprogramm/ueber

https://www.german-energy-solutions.de/

The "Development of foreign markets" budget item finances various funding programmes to support German companies in developing foreign markets. These include the Energy and Environmental Technologies Export Initiatives and the Market Development Programme covering the following sectors: renewable energy, energy efficiency, environmental technologies, infrastructure, rail technology, smart transport, smart city, public transport, and mining/resources. Data on GHG emissions is only available for the Renewable Energy Solutions (RES) programme, which accounts for 16.45% of the eligible expenditures. In addition, a qualitative description of the impact is reported for a selection of projects in the above programmes (accounting for approximately 83.55% of the eligible expenditures).

157 business missions for SMEs under the Energy and Environmental Technologies Export Initiatives and the Market Development Programme in 2021 (eligible expenditures: €9.83 million)

Selected B2B meetings enable German SMEs to present their products and services to interested foreign parties and apply for local projects. The resulting business deals enable the transfer of environmentally and climate-friendly technologies to the countries concerned.

GIZ Project Development Programme (PEP) for German SMEs in various emerging and developing countries (eligible expenditures: €3.79 million)

The PEP complements the foreign trade promotion measures comprising the established instruments of the RE export initiative with development cooperation measures such as capacity building and policy advice, which in many cases help to open up and strengthen markets in developing and emerging countries. Part of the programme involves identifying potential target country

investment projects that could be suitable for implementation by German companies. The PEP identified 268 economically viable projects of this kind in 2021.

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2.5.2. Export of green and sustainable (environmental) infrastructure

Budget chapters and items:	1601 687 04
Eligible expenditures 2021:	€10.7 million
GHG emission reduction:	N/A
Other indicators:	62 ongoing projects in 2021
	of which 23 projects newly committed in 2021
	34 publications
	38 events held
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) c) d) e) f)
Assumptions and limitations: --	
Links: https://www.exportinitiative-umweltschutz.de/	

Since 2016, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has been supporting German green tech companies, including SMEs, in the internationalisation of their "green" innovations, products and services with its "Export Initiative Environmental Protection" (previously the "Export Initiative Environmental Technologies" (EXI))[32]

Since its inception, EXI has supported 173 projects in 97 countries.

Modern, efficient and resource-saving technologies are not only drivers of growth and innovation – they also contribute to raising environmental standards, disseminating environmental knowledge and thus sustainably improving ecological foundations and local living conditions. In addition, changing lifestyles and consumption habits contribute to increasing prosperity (addressing SDGs), and raising awareness of German environmental technologies and know-how promotes Germany's position as a competent development partner (building trust).

Projects in 2021 are divided into categories as follows:

Thematic category	Number of newly committed projects	Number of projects funded
Green hydrogen and fuel cell technology	6	6
Circular economy	9	20
Sustainable urban and regional development	-	1
Sustainable mobility	-	2
Cross-sectional technologies	3	9
Water/wastewater management	4	16
Contract award projects	1	8

[32] Renamed the Export Initiative Environmental Protection in 2022

The regional breakdown is available on the EXI website (https://www.exportinitiative-umweltschutz.de/fileadmin/downloads/Exportinitiative/Ziellaender-EXI-2022.pdf). Project profiles are also provided. Further information can be found in the 2021 Impact Report.

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2.5.3. International cooperation [in the area of climate action]

Budget chapters and items:	1602 532 05
Eligible expenditures 2021:	€25.3 million
GHG emission reduction:	N/A
Other indicators:	28 EUKI projects
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: The projects generally fund non-investment measures, and direct GHG emission reductions cannot be quantified.

Links: www.euki.de

The international climate action budget item funds climate action measures across the EU and worldwide as well as mitigation projects in developing and emerging countries where the projects contribute to the implementation of the Paris Agreement. The budget item is not limited to specific instruments. Funding can be provided to projects carried out by the GIZ and KfW, private institutions, churches, political foundations and public authorities or to research projects. Due to the large number and heterogeneity of the projects, it is not possible to aggregate at budget item level.

European Climate Initiative (EUKI)

The European Climate Initiative was launched in 2017 and supports climate action and knowledge transfer, primarily in eastern and southern Europe. EUKI funding measures focus on non-investment climate action projects. The objectives of EUKI are:

(a) Strengthening knowledge and awareness-raising with regard to the drivers of climate change and the ecological, social and economic opportunities arising from climate action

(b) Promoting the sharing of good practices, intensifying the transfer of knowledge and experience and creating networks to support transformative processes and good conditions for reducing greenhouse gas emissions

(c) Promoting European integration by better connecting stakeholders; reflecting on and supporting European climate policy.

A total of 613 project outlines were received in the annual calls for project ideas between 2017 and 2021, from which EUKI selected 118 for funding. An additional 39 further projects were awarded or funded directly by the responsible ministry. One example is the **Young Energy Europe (YEE)** project, which aims to raise awareness of climate change among nearly 500 young professionals from companies in Bulgaria, Greece, the Czech Republic, Hungary, Croatia, Serbia, Poland and Slovakia, train them as energy scouts in the areas of energy and resource efficiency, and encourage them to actively contribute to climate action in companies by developing projects and putting them into practice. In total, such projects developed by the 2021 energy scout cohort identified a reduction potential of around 45,000 tonnes of CO_2 per year.

Carbon market mechanisms

The main purpose of the carbon market under the Paris Agreement is to increase the ambition of nationally determined contributions (NDCs). Under Article 2.1.c of the Paris Agreement, one of the aims of the Agreement is to make finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

In support of this aim, funded international activities are oriented towards leveraging various financial incentives, regulatory frameworks and alliances e.g. through carbon pricing, climate finance and phasing out fossil finance. Activities are also directed at securing Germany's position as one of the most important players in aligning finance flows to the Paris Agreement and in the carbon market internationally at the intersection of business, science, politics and the public administration.

Measures to create an international carbon market

Germany is committed to developing emissions trading, as a key climate action instrument, into a global carbon market. To this end, it is taking initiatives to link regional emissions trading systems (ETS). Funding has been provided for, among other things, the International Carbon Action Partnership (ICAP) secretariat. Germany launched the ICAP in 2007 as an initiative to align and link the EU Emissions Trading System with other regional ETSs. Bilateral activities have also been pursued with various countries to link emissions trading systems at international level.

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2.5.4. Special initiative ONE WORLD – No Hunger

Budget chapters and items:	2310 896 31
Eligible expenditures 2021:	€232.0 million
GHG emission reduction:	N/A
Other indicators:	27 projects
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e) f)

Assumptions and limitations: --

Links: All projects of the GIZ special initiative are described in more detail here (without a breakdown of projects by annual expenditure and without a separate presentation of the "green" projects).

The ONE WORLD – No Hunger special initiative finances projects that contribute to reducing hunger and malnutrition in the world or support rural development as an important prerequisite for food security. Eligible expenditures include projects that aim at the environmentally sound use of natural resources and land areas and contribute to climate change adaptation.

Quantitative impact indicators are not available for all projects. The available information is therefore reported only for a selection of projects (accounting for approximately 81% of eligible expenditures):

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Impact indicators	Description
Global project on soil protection and rehabilitation for food security (Pro Soil)	24.4	Verifiable emission reductions of 314,525 tonnes of CO_2e in 2021 from the adoption of sustainable land use practices (soil cover crops, composting, agroforestry) in Ethiopia and Benin. 4,238 direct beneficiaries in the intervention regions (Benin, Burkina Faso, Ethiopia, Kenya, India, Madagascar and Tunisia). 145,582 ha protected area in the intervention regions.	The aim of the project is to implement sustainable approaches to soil protection and rehabilitation in selected partner countries. Soil degradation has a direct impact on the food security of smallholder farmers in developing countries as it reduces the amount of arable land available for cultivation. The programme works in consultation with relevant ministries and promotes sustainable land use through agroecological practices and the involvement of affected smallholders. Other stakeholders such as researchers, the private sector and civil society are also involved. Since its inception, the programme has protected or rehabilitated nearly 500,000 hectares of land, and smallholder yields have increased by an average of 39%.

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Impact indicators	Description
Green Innovation Centres for the agriculture and food sector (GIAE)	77.3	1,798,868 direct beneficiaries 95% average income increase for direct beneficiaries over the overall term 50% average productivity increase for direct beneficiaries over the overall term 1,037,451 small-scale farms using the funded climate-smart innovations Creation of 15,709 new employment opportunities (new jobs and expansion of existing employment), including 10,651 for young people and 6,789 for women	In the course of the project, Green Innovation Centres were established in 14 countries in Africa and in India and Vietnam. The focus of the work is on smallholdings in 21 selected value chains. These farms are supported primarily through the provision of advisory services and of educational and training courses with the goal of enabling them to use input-based, technical, knowledge-based and organisational innovations to improve their productivity, income and climate resilience in the long term. This will also create new jobs in the area of food processing, ensuring that a greater portion of the added value from agricultural production remains in the countries, especially in rural areas. The new employment opportunities will benefit young people and women in particular. At global and at local level, the project cooperates with over 150 partner organisations from civil society, producer associations, academia, research institutions and the private sector.
Global Programme on Food and Nutrition Security, Enhanced Resilience	34.1	In 2021, the nutrition of 2.6 million food-insecure people was improved, including nearly 800,000 women and 200,000 young children. Around 180 million food-insecure people benefit from the contribution to strengthening governance with regard to hunger and malnutrition. Training in agroecology and maternal and child nutrition has reached some 5,000 agricultural workers and 15,000 health workers.	The programme aims to improve the situation of food-insecure people – and especially women of reproductive age and young children – and to increase their resilience to food crises. To this end, it combines interventions across sectors such as agriculture, health, education, social protection, and water, sanitation and hygiene (WASH). This helps increase the year-round availability of a wide range of healthy foods, change behaviour to promote balanced diets, support policies that enhance food security and resilience, and collect and share lessons learned and evidence on how to improve nutrition.

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Impact indicators	Description
Trilateral resilience enhancement in the Ethiopian lowlands (Afar region)	0.1	400 (agro-)pastoralists (subsistence, traditional form of agriculture combining crop and livestock farming) – 25% of whom are women – have planted 150,000 multipurpose trees and fruit trees. More than six hectares of orchards have been established to produce shoots, buds and seeds in order to improve regional availability.	TREE was a trilateral partnership between the Ethiopian government, the State of Israel and the German government. It comprised a support project for the drought resilience programme in arid and semi-arid lowland areas, targeting 350,000 people. The main aim of the project was to enable the population and participating institutions to secure productive livelihoods and nutrition in the long term, while increasing resilience to climate-related weather extremes. The project established tree nurseries to train Afar (agro-)pastoralists in the planting and care of fruit/multipurpose trees with nutritional value and soil-stabilising properties. In addition, training was provided to strengthen the partners' agricultural development institutions so that they can continue to support communities in implementing the project.
Global Programme Sustainable Fisheries and Aquaculture	14.5	88,000 tonnes of fish from sustainable fisheries and aquaculture made available to food-insecure people 20,000 additional registered and licensed fishing boats 20% productivity increase in sustainable aquaculture Training content applied by 65% of the 25,000-plus participants	The project supports small-scale aquaculture enterprises and artisanal fishermen in seven countries in Africa and Asia in providing more sustainably produced fish products for local markets and the food-insecure population. It promotes the implementation of the UN Food and Agriculture Organization's guidelines to combat illegal, unreported and unregulated (IUU) fishing, together with technical innovations and hygiene training to reduce post-harvest losses. Technical and business training increases productivity in aquaculture, while innovations reduce production risks. In this way, the project contributes to food security, increased productivity and higher incomes. Information campaigns raise awareness of the nutritional value of fish. In the value chain, additional jobs are created in rural areas and the role of women is strengthened in processing and distribution.

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Impact indicators	Description
Programme for climate-smart livestock systems	3.3	A media-based training strategy reached 4.9 million people with information on climate-smart livestock strategies. In the three priority countries of Ethiopia, Kenya and Uganda, climate change adaptation and mitigation have been incorporated into five relevant sector strategies. Climate-smart livestock approaches have also been mainstreamed in 15 World Bank investment projects outside the three priority countries.	Working with livestock farmers in sub-Saharan Africa in smallholder mixed cropping (arable and livestock farming) and pastoral systems, the programme has developed climate-resilient and low-emission practices for selected livestock systems. At the policy level, potential development paths for the livestock sector have been identified and research outcomes synthesised so that they can be taken into account in policy frameworks, strategies and investment projects. In addition, partner countries have been provided with support to improve their monitoring systems for greenhouse gas emissions and climate adaptation in the livestock sector, which form the basis for reporting under the Paris Climate Agreement. The World Bank has taken the project's findings into account in the design and implementation of major investment projects.
Global project "Knowledge Centre for Organic Agriculture and Agroecology in Africa"	5.9	Throughout the period, 3 million people reached with information on organic farming/agroecology 850 knowledge products produced in 18 countries and more than 20 languages, in formats appropriate to local audiences 18,000 smallholder farmers supported with practical knowledge on organic farming/agroecology 26,000 ha farmed along agroecological principles Networking for 91 civil society organisations in the field of organic farming/agroecology	The project established knowledge hubs in the five regions of the African continent to link up and strengthen civil society organisations and stakeholders in the field of organic farming and agroecology and to support them in knowledge dissemination. Access to knowledge on organic farming and agroecology is improved for local people by the collection of traditional knowledge, the preparation of information in local languages and formats, and the dissemination of knowledge products via a digital knowledge platform. Through a multi-stage training approach, knowledge disseminators support smallholder farmers in 18 countries in sustainably farming their land and the local marketing of their products. This protects ecosystems, builds resilient food systems and helps smallholder farmers adapt to climate change.

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Impact indicators	Description
Sustainability and Value Added in Agricultural Supply Chains	25.6	Area under cultivation with sustainably produced cash crops increased by 265,000 ha 13 global companies implementing gender-sensitive sustainability policies 17 innovations such as automated pest traps and weather stations introduced for purposes such as improving local processing and protecting biodiversity. More than 131,500 people have the knowledge needed to produce sustainably, of whom 12% are women and 27% young adults. Some 42,000 people, of whom 24% are women and 33% young adults, benefit from new jobs, higher wages and better working conditions. Despite the pandemic, 185,000 smallholder farmers increased their income by 3.5%.	The project enhances the sustainability of selected agricultural supply chains in close cooperation with global companies, international organisations and civil society. Socio-ecological change along supply chains protects the environment and climate, boosts social justice and promotes corporate responsibility. Practical measures at the point of production implement sustainable farming practices that conserve forests and biodiversity and are adapted to climate change. Improvements in production, processing and access to international markets increase incomes, secure the livelihoods of smallholders and create good jobs. The project advocates and promotes corporate responsibility and due diligence and works with companies to implement these aims for the benefit of people and nature. International exchange, networking and learning enable the approaches and impacts to be scaled up worldwide.
Climate adaptation and soil rehabilitation in watersheds in India	1.3	Number of people supported in coping with the impact of climate change: ex-ante target value: 77,000; pro-rata value: 20,790 Sustainably managed area: ex ante values: 18,000 ha; pro-rata value: 4,907 ha The impact indicators show ex-ante estimated target values over the entire project duration. The pro-rata figure for disbursements in 2021 has been added on the basis of the total funding volume. This is a rough approximation as target group reach is not linear to disbursements in the project period.	
My Agro	2.6	Number of people with access to agricultural finance: ex-ante target value: 139,000; pro-rata value: 30,163. The impact indicators show ex-ante estimated target values over the entire project duration. The pro-rata figure for disbursements in 2021 has been added on the basis of the total funding volume. This is a rough approximation as target group reach is not linear to disbursements in the project period.	

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2.5.5. International energy cooperation, commodity partnerships and technological cooperation

Budget chapters and items:	6092 687 02
Eligible expenditures 2021:	€29.3 million
GHG emission reduction:	N/A
Other indicators:	41 projects
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: --

Links: https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/jahresbericht-energiepartnerschaften-2020.pdf?__blob=publicationFile&v=1

International energy cooperation is being supported with €29.3 million in funding. This includes measures to support and continue bilateral and multilateral cooperation, especially with the aim of promoting the German and international energy transition and finding new partners, supporting partner countries in developing a sustainable energy supply and ensuring security of supply for energy resources. The cooperation takes the form of, for example, the work of secretariats in partner countries, training courses, studies and events featuring international participants.

The nature of the cooperation in energy partnerships, energy dialogues and multilateral forums means that it is not possible to establish a direct causal link with quantifiable CO_2 savings. The reporting is provided in the understanding that the measures will contribute substantially to global climate change mitigation.

Further information and project examples can be found in the Energy Partnerships and Energy Dialogues 2020 Annual Report.

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3. Research, innovation and awareness raising

Social, ecological and economic challenges cannot be overcome without research and development. Germany has a highly effective academic and research system that has made a major contribution over many years to building resilience for the future, both nationally and internationally. These research activities identify long-term trends and risks and propose concrete solutions for social and political processes. With its innovative capacity, the German research landscape advances the development of new solutions and products for achieving the SDGs in Germany and around the world. A key factor driving this innovative capacity consists of participative, interdisciplinary and transdisciplinary research approaches that foster exchange between academia, politicians, civil society and business.

The eligible expenditures in the research, innovation and awareness raising sector include projects to enable and support education and innovation on climate and environmental issues. In particular, the funds are used to develop solutions to combat climate change, conserve ecosystems and biodiversity, and protect resources. This includes projects to develop innovations for the sustainable transformation of energy systems and to promote sustainable mobility, sustainable urban and regional development, and a circular economy.

The sustainability effects of research and development projects are not directly quantifiable or scalable for the entire sector, notably because the utilisation of research results is uncertain at the time of expenditure. Where possible, however, expected quantitative impacts are given, or at least the number of funding recipients and/or the number of funded projects. In addition, objectives and impacts are described for project examples in the budget items in order to make transparent the sustainability of research expenditures in the precompetitive phase.

The eligible expenditures of the sector amount to €1,359.8 million and are distributed across 20 budget items in the following categories:

- Research for sustainability (7 budget items with eligible expenditures of €579.8 million)
- Environmental protection, nature conservation and climate change adaptation (5 budget items with €105.4 million in eligible expenditures)
- Aerospace, energy, transport and digitalisation (5 budget items with €660.7 million in eligible expenditures)
- Technology transfer – lightweighting (3 budget items with €13.9 million in eligible expenditures)

Note: Research programmes are also assigned to other sectors – in accordance with the Green Bond Framework – especially if there is a clear connection to a specific sector.

3.1. Research for sustainability

3.1.1. Knowledge and technology transfer tools as part of the High-Tech strategy

Budget chapters and items:	3004 683 10
Eligible expenditures 2021:	€2.3 million
GHG emission reduction:	N/A
Other indicators:	23 projects funded
Funding share:	33% As a rule, the project duration is three years, hence the funding share is stated as 33%. Third-party financing is not taken into account.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e)

Assumptions and limitations: --

Links: https://www.forschungscampus.bmbf.de/forschungscampi/flexible-elektrische-netze
https://www.forschungscampus.bmbf.de/forschungscampi/mobility2grid

The eligible expenditures of the budget item serve the two research campuses Flexible Electrical Networks (FEN) and Mobility2Grid. Further impact indicators are not available.

FEN (eligible expenditures: €0.4 million; 12 projects)

A precondition for a new electricity supply system based on environmentally friendly energy sources is the development of a new grid infrastructure. Numerous decentralised energy sources produce electricity that has to be distributed throughout the country. At the same time, the electricity grid must respond flexibly to changes in electricity supply and demand. This renders it necessary to make the transmission, distribution and storage of energy more efficient and flexible. Flexible power grids ensure future energy supplies in the presence of a large proportion of decentralised and renewable energy sources. This is where the Flexible Electrical Networks (FEN) research campus comes in. The transdisciplinary research at FEN focuses on the integration and development of direct-current technology. In addition to technological issues, questions of social acceptance and digitalisation are also taken into account.

Mobility2Grid (eligible expenditures: €1.9 million; 11 projects)

Implementation of the energy and transport transition is one of the biggest challenges of our times. The research partners in the Mobility2Grid research project at the EUREF campus in Berlin-Schöneberg are working together to develop new solutions for micro smart grids, short-term storage and new charging technologies. Another area of research is the social and economic acceptance of technological solutions. Research is also being carried out into the currently lacking but necessary economic and legal framework for sector coupling. In total, more than 30 different institutions and companies are involved in the Mobility2Grid living lab on the EUREF site.

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3.1.2. Bioeconomy

Budget chapters and items:	3004 683 40
Eligible expenditures 2021:	€116.1 million
GHG emission reduction:	N/A
Other indicators:	408 beneficiaries
	1,154 projects
Funding share:	33% As a rule, the project duration is three years, hence the funding share is stated as 33%. Third-party financing is not taken into account.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) c) d) e) f)

Assumptions and limitations: --

Links: Future Research and Innovation Strategy – Research and Innovation
https://www.bmbf.de/bmbf/de/forschung/zukunftsstrategie/zukunftsstrategie_node.html
Brochure "Tools of the Bioeconomy":
https://www.bmbf.de/SharedDocs/Publikationen/de/bmbf/7/31659_Die_Werkzeuge_der_Biooekonomie.html
Brochure "Bioeconomy in Germany":
https://www.bmbf.de/SharedDocs/Publikationen/de/bmbf/7/30936_Biooekonomie_in_Deutschland.html
National Bioeconomy Strategy (summary):
https://www.bmbf.de/SharedDocs/Publikationen/de/bmbf/7/31561_Nationale_Biooekonomiestrategie_Kurzfassung.html
Website of Projektträger Jülich (PtJ): Bioökonomie
https://www.ptj.de/fokusthemen/biooekonomie
Website of the 10th anniversary of the Bioeconomy International funding line
https://10-jahre-bioökonomie-international.de/

In the area of bioeconomy research, a large number of projects are funded on topics such as the use of residual and waste materials, innovative methods of plant research and the use of biomass as feedstock, with the aim of providing sustainable solutions for the transition to a bio-based economy in all application areas and sectors of the economy. Areas with potential include:

- Replacement of fossil raw materials with renewable raw materials, co-products and waste products
- Cascading use of substances and materials
- Reduction in the use of inputs generated on the basis of fossil raw materials (e.g. fertilisers)
- Adaptation of crops to climate change
- Increasing sustainability in crop production
- Development of more sustainable biotechnological methods and processes

The above areas are illustrated below with project examples. A monitoring system has been piloted that will track the status quo together with developments and areas of potential. A publicly accessible data explorer

makes it possible to research and analyse bioeconomy biomass flows and global footprints (e.g. land use and water consumption). The monitoring is to be further consolidated so that it can be transferred to an institutionalised setting.

Online: https://www.monitoring-biooekonomie.de/en/

Replacement of fossil raw materials with renewable raw materials, co-products and waste products

Chitin is the second most abundant biopolymer on earth. It can be obtained from fungi, insects and shellfish. For example, the processing of crustaceans (such as shrimps, crabs and lobsters) in Canada alone resulted in over 130,000 tonnes of shell waste containing around 33,000 tonnes of chitin in 2016. The **ChitoMat** project aimed to exploit chitin from lobster shells as a precursor for new biobased materials. In the project, Canadian partners turned chitin into a bioplastic for 3D printing applications as well as creating other biobased products that can be used, for example, to produce high-quality pet food additives. For the biochemical processing of chitin, an extraction-based cleaning method was identified that has greater potential for commercial application. In addition, the project successfully developed various chemical process development steps to impart specific thermoplastic properties in chitin compounds. The commercial application potential has since led to additional support with EU funds for the follow-up project, "Valuable". Because their availability is assured, the chitin compounds used are now extracted from fungal waste mycelia from industrial bioeconomy processes.

Online: https://www.igb.fraunhofer.de/en/reference-projects/chitomat.html

Cascading use of substances and materials

In the "Bioeconomy in the Metropolitan Area – BioBall" innovation space, scientists have joined forces with municipally owned companies in the Frankfurt/Rhine-Main metropolitan region in the **SynBioTech** project to develop a process that uses CO_2 to produce animal feed and products for the chemical industry. The project supports the sustainability agenda in two ways: it utilises residual materials and reduces the use of fossil raw materials in the chemical industry. The consortium partners are also building a mobile methanol synthesis plant to produce "green" methanol. On the industry side, Infraserv Höchst is contributing its expertise in planning the synthesis plant, while Wacker Chemie is playing a key role in developing production processes for extracting and processing carboxylic acids. Preliminary investigations have been completed for the recovery of carboxylic acid from the culture broth. The first polymerisation tests have now started (for the synthesis of plastics) and the use of a chemical precursor in co-polymerisation has been identified as a potential commercial use for biogenic carbonic acids. The scientific findings obtained so far have been published in several scientific journals and disseminated in various communication formats, including a podcast.

Online: https://biooekonomie-metropolregion.de/bioball/synbiotech_de.html

Adaptation of crops to climate change

The adaptation of crops to the impacts of climate change is urgently necessary in order to feed the world in future. Cassava (*Manihot esculenta* Crantz) is a globally economically important crop used in, among other things, the production of high value added products such as starch and sweeteners and also to produce bioethanol. Working with partners in Thailand, the **CASSAVASTORe** project has the purpose of performing genetic and phenotypic analyses to improve cassava storage root development and starch accumulation. Storage root development was investigated in a total of 600 different cassava genotypes. The results from CASSAVASTORe provide an important basis for understanding the genetic mechanisms underlying the storage root development and the quality and quantity of cassava yields. Industry interest in the project outcomes is promising and could lead to more sustainable packaging based on starch compounds in the next five years. The results

of the CASSAVASTORe project were presented at a science evening at the German Embassy in Bangkok; for the long term, they will be made available to interest groups and published by the National Biobank of Thailand.

Online: https://www.international-bioeconomy.org/index.php?index=9

Increasing sustainability in crop production

Rice is one of the most important staple foods worldwide. However, it is also a source of arsenic, which at higher concentrations is carcinogenic for humans and animals. A hitherto unknown fact is that certain processing methods (such as those used in the production of rice wafers) and environmental stress factors can lead to the formation of arsenic compounds that are far more toxic than those previously found. The aim of this project was to understand how thioarsenates are formed abiotically and microbially in soil, and how they are taken up and transformed by plants. A novel analytical method for the characterisation of arsenic in paddy soils and rice plants was successfully developed for the purpose and published. The scientific findings have been submitted to the European Food Safety Authority (EFSA) for consideration in the relevant regulatory processes. A large number of high-ranking scientific papers have been published on the subject.

Online: http://www.umweltgeochemie.uni-bayreuth.de/umweltgeochemie/en/pub/pub/publikation.php

Development of more sustainable biotechnological methods and processes

Finite phosphate resources, high energy consumption in fertiliser production and water and soil contamination pose major challenges for the agricultural sector. The aim of SUSKULT is therefore to implement an innovative food production system based on hydroponics, in which plants grow and develop in an indoor cultivation system using mineral nutrient solutions. The resources needed – water, nitrogen, phosphorus, potassium, CO_2 and heat energy – come from a sewage treatment plant. The SUSKULT research consortium brings together water supply and treatment operators with academic research institutes and other research centres; private-sector project partners carry out marketing and commercialisation analyses, while the Research Institute for Regional and Urban Development (ILS) develops corresponding trend scenarios and an action plan. A long-term aim is a pilot project in the Rhine-Ruhr metropolitan region demonstrating the process of transforming a conventional sewage treatment plant into a "NEWtrient® centre" producing 40 tonnes of vegetables a year. Alongside science communication events and attendance at international conferences, four scientific papers were published in the 2021 project year with five to six further papers to follow in the subsequent years. In addition, a milestone and major project goal is the commissioning of a demonstration plant on the site of a sewage treatment plant operated by the water management association Emschergenossenschaft in Dinslaken in September 2022.

Online: https://suskult.de/

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3.1.3. Climate research and Earth's natural habitats – R&D projects

Budget chapters and items:	3004 685 40
Eligible expenditures 2021:	€84.2 million
GHG emission reduction:	N/A
Other indicators:	318 beneficiaries
	862 projects
Funding share:	33% As a rule, the project duration is three years, hence the funding share is stated as 33%. Third-party financing is not taken into account.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) f)
Assumptions and limitations: --	
Links: https://www.fona.de/en/topics/climate.php	

The research funding programme addresses the key challenges of global change in the research areas "Climate change trends and impacts", "Enabling conditions for climate action", "GHG reduction", "CO_2 removal", "Climate change adaptation" and "International climate partnerships". The research and development projects develop a knowledge base and explore actionable options. The funding thus makes important contributions to the implementation of the BMBF-FONA strategy "Research for Sustainability".

The main research areas are presented below. Selected examples are then described.[33]

Research area	Eligible expenditures (in € million)	Number of projects
Climate change trends and impacts	15.0	151
Enabling conditions for climate action	16.0	171
GHG reduction	6.0	95
CO_2 removal	0.05	26
Climate change adaptation	18.0	198
International climate partnerships	28.0	221

KMU-innovativ: Energy Efficiency and Climate Protection[34]

The "KMU-innovativ" ("Innovative SMEs") funding measure supports industrial research and precompetitive development projects to boost innovation in German small and medium-sized enterprises. In particular, SMEs are encouraged to step up research and development efforts and are equipped to be more agile in responding to change and to actively shape the necessary transformation.

[33] Further examples can be found in the 2021 Impact Report.

[34] KMU-innovativ: Energieeffizienz und Klimaschutz (only in German)

Innovative research projects are supported that could not be carried out without funding. The "Energy efficiency and climate protection" funding area covers research and development (R&D) projects in fields such as system-related technologies, processes and services for increasing energy efficiency in industry, emission-reducing technologies and approaches for industrial processes and climate-relevant cross-cutting technologies.

Economics of Climate Change[35]

The "Economics of Climate Change" funding priority addressed the specific knowledge and decision-making needs of policymakers and businesses in facing the challenges of climate change, with integrated assessment of, for example, climate-related damage and adaptation costs, research into the impact and financing of climate policy instruments, and the assessment of distributional, competitive and social effects of ambitious climate policies. Funding was provided for a total of 29 collaborative research projects with more than 80 individual sub-projects. This has bolstered economic research in Germany and focused it on common goals, enabling it to make a significant and lasting contribution to addressing climate change. An accompanying dialogue process, "Dialogue on the Economics of Climate Change", supported exchange between researchers, policymakers and other practitioners and provided a platform for transfer, communication and interaction.[36] An example is the CliDiTrans research project described below.

Climate Protection Potential of Digital Transformation: Micro- and Macroeconomic Evidence on the Role of Demand Effects and Production in the Use of ICT (CliDiTrans)[37]

The increasing availability and performance of information and communication technologies (ICT) are constantly enabling novel applications and leading to the increasing digitalisation of the economy and society. The focus of the CliDiTrans project was on whether digitalisation and its effects in terms of changes in behaviour and production processes would lead to an overall decrease or increase in global carbon emissions. The project used case studies and macroeconomic analysis to analyse the climate change mitigation impacts of digitalisation. Its findings show that digitalisation does not so far contribute on its own to climate change mitigation. What is needed are active policies for climate change mitigation through digitalisation. A sustainable digital policy needs to be established in order to steer the digital transformation in a sustainable direction and achieve significant improvements in climate change mitigation and sustainability through digitalisation.

Climate Adaptation, Flood Resilience (KAHR)[38]

The floods in July 2021 caused extreme damage along the Erft, Inde, Vichtbach and Wupper rivers in North Rhine-Westphalia and along the Ahr in Rhineland-Palatinate. The KAHR project supports the reconstruction process and makes a scientific contribution to flood risk management in the aftermath of a flood disaster in order to make the affected regions more resilient. The joint project, which brings together 13 partners from academia and practice and runs until the end of 2024, develops solutions for climate adaptation, risk-based spatial planning and flood protection. The aim is to develop specific measures for climate-resilient and future-oriented reconstruction and redevelopment in the affected regions.

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[35] Ökonomie des Klimawandels (Phase II) – FONA (only in German)
[36] https://www.ifw-kiel.de/institute/dialogue-on-the-economics-of-climate-change/
[37] Research for sustainability (FONA) – FONA (only in German)
[38] https://hochwasser-kahr.de/index.php/en/about-kahr

3.1.4. Energy technologies and efficient energy usage, green hydrogen – R&D projects

Budget chapters and items:	3004 685 41
Eligible expenditures 2021:	€176.4 million
GHG emission reduction:	N/A
Other indicators:	513 funded projects
Funding share:	33% As a rule, the project duration is three years, hence the funding share is stated as 33%. Third-party financing is not taken into account.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) e)

Assumptions and limitations: --

Links: All projects are presented at https://www.fona.de/de/.

The federal government's energy research makes a decisive contribution towards building a sustainable energy system in Germany. Key areas of focus here are energy technologies, efficient energy use, green hydrogen, electricity grids and storage systems, industrial processes and sector coupling. The following projects supported these research areas and delivered important results in 2021.

iNEW 2.0

The decision to phase out coal power has been made. Aside from the need to expand renewable energy to meet electricity demand, there is also the question of what the future holds for Germany's coal mining regions. iNEW 2.0 focuses on the transformation of the Rhenish lignite mining region into a region of the future centred on sustainable industry. The researchers aim to develop novel electrolysis processes for use in power-to-X (P2X) value chains. P2X technologies are technologies that convert electricity into high-quality energy sources. As key technologies for sector coupling and a circular carbon economy, they are predestined for shaping structural change and the transition to a successful carbon-neutral post-coal era. In addition, iNEW 2.0 aims to secure existing jobs in energy-intensive industries by switching to climate-friendly P2X technologies while also creating new jobs in technology development and plant engineering.

MeSa-Zuma

Photovoltaics is considered the future of renewable energy. In order to further increase the share of electricity generated from solar energy, one thing that needs to be improved is the efficiency of solar cells. However, the potential of pure silicon photovoltaics has already been largely exhausted. The focus has consequently shifted to a class of materials known as metal halide perovskites, which can substantially improve efficiency when combined with silicon in what are called tandem solar cells. The MeSa-Zuma research group studied perovskite thin films and, together with other researchers, set a new efficiency record of 29.8% in 2021 – close to the 30% mark targeted in research. A follow-up project, PEROWIN, launched in August 2021, is dedicated to new process and characterisation methods leading to high-efficiency tandem solar cells.

MOLIBE – Metal- and Liquid-free Organic Lithium-Ion Batteries for Sustainable and Safe Energy Storage

Efficient energy storage systems are critical to the success of the energy transition. Lithium-ion batteries provide efficient reversable energy storage and have become the standard in electric mobility. High cost and certain safety concerns stand in the way of their universal use. The high cost results among other things from the materials cobalt, nickel and also lithium itself. The fact that the liquid electrolytes are easily flammable and have low stability means that the batteries are not safe enough. MOLIBE, a Franco-German research project, is therefore developing completely solid-state, metal-free rechargeable batteries based on organic active materials and polymer electrolyte systems. The researchers made a major advance in 2021. They produced an organic full cell that is stable for several hundred cycles, but still contains lithium ions. One of the two half cells even remains stable for over 5,000 cycles. This is an important element with regard to the potential commercialisation of the technology.

PSUMEA

An important part of the energy transition is the decarbonisation of the transportation sector and thus the electrification of transport. In the case of long-distance and heavy-goods transport, hydrogen-powered fuel cells present themselves as a solution due to their relatively long range. For widespread adoption, however, the technology needs to become more efficient and cost-effective. This also applies to the core element of PEM fuel cells. The two projects PSUMEA-2 and PSUMEA-3 have developed a new type of membrane that is more cost-effective than those already on the market but matches them in power density and efficiency. Environmentally harmful fluorine is also avoided. The researchers have developed the membrane with partners from industry and the scientific community. These fluorine-free fuel cell components define a new state of the art that in some respects is superior to conventional technologies and is also significantly more environmentally friendly.

Wärmewende Nordwest

The heat energy transition is a central pillar of the wider energy transition. Alongside refurbishment, a key element in reducing heat energy consumption is digitalisation. The Wärmewende Nordwest (Northwest Heat Energy Transition) project investigates how the heat energy transition can be digitalised in the Oldenburg and Bremen region. A smart meter infrastructure is used to measure and optimise heat requirements in buildings, neighbourhoods, businesses and industrial plants. Smart electricity, water and gas meters are connected to a communication network. The project integrates the research areas into a digital heat transition platform and provides initial and further training for specialists. This makes it the first full implementation of the heat energy transition. The outcomes can be transferred to other regions and technologies.

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3.1.5. Environmental technologies, resources and geological research

Budget chapters and items:	3004 685 42
Eligible expenditures 2021:	€106.3 million
GHG emission reduction:	N/A
Other indicators:	1,545 beneficiaries
	23 expert panels, professional conferences and status seminars
	See below for specific objectives of the funding measures.
Funding share:	33% As a rule, the project duration is three years, hence the funding share is stated as 33%. Third-party financing is not taken into account.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) c) d) e) f)
Assumptions and limitations: --	
Links: --	

The eligible expenditures of the budget item are distributed among the programme areas as follows. Examples are described below.

Funding areas (click on the project name to visit the website)	Eligible expenditures (in € million)	Number of beneficiaries
Environmental technologies and raw material efficiency	36.0	548
Sustainable water management	40.1	573
Sustainable land management	18.0	273
Geosciences	7.5	90
Digital Green Tech	42.7	69

Resource-efficient circular economy – construction and mineral material cycles (ReMin) (https://www.remin-kreislaufwirtschaft.de/en/)

The transition from a linear to a circular economy is an enormous challenge for the construction industry with its high demand for resources, considerable carbon emissions – especially in cement production – and large quantities of mineral demolition waste. Cement production, for example, accounts for around 8% of global greenhouse gas emissions.

Making the construction industry more environmentally and climate-friendly calls for new approaches along the entire value cycle. One focus is on greater use of high-quality secondary raw materials from demolition waste. But to realise the full potential of the

circular economy it is necessary to go further, for example by using components that can be easily dismantled or by avoiding building materials that are hard to recycle. To this end, the Federal Ministry of Education and Research (BMBF) funds innovative approaches promoting circularity in construction under the funding measure "Resource-efficient circular economy – construction and mineral material cycles (ReMin)". Since 2021, 17 joint projects have been funded for a total of €22 million over three years.

Approaches already exist for closing the loop at the level of individual materials and can be trialled at scale with industrial partners. The EMSARZEM project coordinated by GKS-Gemeinschaftskraftwerk Schweinfurt GmbH, for example, is investigating the use of waste incineration slag for cement production. There is also huge potential for innovation in the reuse of building components. With this in mind, the Fertigteil 2.0 ("Precast 2.0") project is looking at the controlled dismantling of existing buildings and the manufacture of new, reprocessed precast concrete units with the aid of digitalisation and robotics.

Resource-efficient Circular Economy – Plastic Recycling Technologies (KuRT) (https://bmbf-kurt.de/kurt/en/Projects.html)

Plastics permeate our modern lives more than almost any other material. Flexible, light and versatile, they are used for countless purposes in all areas of life. In many application areas, they are key to improving energy and resource efficiency. Nevertheless, they also pose one of the biggest environmental challenges of our times. Macro and microplastics enter the environment and cause environmental problems worldwide. Compared to other materials, recycling plastics is particularly challenging and, because of this, only a small proportion of the material in existence is actually reprocessed into new, high-quality products.

"Resource-efficient Circular Economy – Plastic Recycling Technologies" (KuRT) is a funding measure directed at promoting plastic recycling by means of smart uses, improved logistics and collection, and innovative reprocessing methods for the high-quality use of recyclates. General objectives include improving the economic viability and quality of plastic recycling. Based on the conceptual phases funded from 2021, six joint projects were selected for the implementation phase from 2023 (total funding volume approximately €19 million over the full duration). These focus on, among other things, mechanical and chemical recycling processes.

ERA-NET ERA-MIN

The transformation of the economy driven by climate change mitigation and increasing digitalisation is leading today to changes in the supply and demand for raw materials, as well as surges in demand, e.g. for high-tech raw materials for electric mobility and the energy transition. Given strong import dependency, ensuring reliable supplies of such high-tech raw materials from primary resource deposits and establishing a circular economy presents a particular challenge that calls for international cooperation.

The Federal Ministry of Education and Research (BMBF) therefore regularly participates in transnational joint calls under ERA-NET ERA-MIN. Since 2014, 24 German partners have been allocated some €11 million in funding in this connection. Additional funding is provided by funding organisations from more than 20 different countries, mainly in Europe, which gives the committed funding strong leverage. The funded projects cover a wide thematic range from exploration to sustainable resource extraction and processing and from new resource-efficient products and production processes to closing the loop for end-of-life products.

A case in point is the AMTeG project. Led by a German company, supracon AG, partners from Germany, Sweden and Spain worked on the development of an airborne magnetic instrument for the exploration of deep-seated resources using minimally invasive methods. The German partners contributed their expertise, particularly in the development of the instrument, while the partners specialising in raw materials exploration (Spain) and mining (Sweden) helped to evaluate the performance of the system as a whole and make it market-ready.

Regional Phosphorus Recycling (RePhoR) (www.bmbf-rephor.de)

Under the Regional Phosphorus Recycling (RePhoR) programme, the BMBF funds large-scale approaches to phosphorus recycling and sewage sludge utilisation. Innovative economic solutions are to be used to significantly reduce Germany's dependence on phosphorus imports and support the implementation of the Sewage Sludge Ordinance (*Klärschlammverordnung*). After several years of transition periods, this requires phosphorus to be recovered from sewage sludge from larger municipal wastewater treatment plants and prohibits it from being spread directly on farmland. There is therefore an urgent need for science-based knowledge and practical experience of the (large-scale) implementation of different phosphorus recovery processes under real conditions and for various plant sizes and types. To this end, the RePhoR funding measure was launched in 2018. The aim is to develop and implement phosphorus recovery technologies within integrated regional phosphorus recycling and sewage sludge utilisation approaches. A total of seven joint projects with a total volume of around €31 million are being funded under RePhoR (duration: 2020 to 2026).

Innovative Municipalities – Supporting municipalities in the provision of services of general interest

The Innovative Municipalities ("Kommunen innovativ") funding measure aims to strengthen the role of municipalities as initiators, partners and addressees of research, development and innovation. In the third phase (2021-2024), funding focuses on new approaches to services of general interest in the context of sustainable municipal development. The support measure contributes to the achievement of equivalent living conditions and is part of the overall German support system for structurally weak regions.[39]

Stadt-Land-Plus – Strengthening Urban-Rural Connections

The Stadt-Land-Plus funding measure aims to promote the coordinated sustainable development of urban centres, urban regions and rural regions, including the development of a sustainable regional circular economy and the improvement of decision-making foundations for sustainable land management. 2021 saw the commencement of a two-year phase in which the projects are implemented and established for the longer term in the study regions. This was accompanied by knowledge transfer through a cross-sectional scientific project by the Federal Environment Agency directed primarily at municipal users of the project outcomes.

RES:Z – Resource-efficient Urban Districts for the Future

Resource-efficient Urban Districts for the Future (RES:Z) is a funding measure with the aim of improving resource efficiency in urban neighbourhoods and supporting long-term transformation management. The research projects develop approaches for the efficient use of water, space, material streams, energy and greenspace in urban areas. The main objective of the funding programme is to develop new approaches to integrated planning and sustainable management of urban neighbourhoods, involving all relevant stakeholders. In 2021, foundations were developed across all projects for indicators of sustainable neighbourhood development and for DIN SPEC 91468, "Guideline for Resource-Efficient Urban Districts" published in 2022.[40]

Geosciences – Utilisation of underground geosystems

The aim of the thematic focus on underground geosystems is to help gain a better systemic understanding of underground geological processes. Among other things, the research projects focused on the analysis and prediction of discontinuities (faults and fractures) in reservoir and barrier rocks or on transport and transformation processes in geological hydrogen storage.

[39] https://kommunen-innovativ.de/

[40] https://ressourceneffiziente-stadtquartiere.de/?lang=en

Funding was also provided for the operation of a test site for investigating gas contamination and the storage of heating and cooling energy in aquifers. Geothermal experiments were also conducted in the KTB Deep Laboratory.

Digital GreenTech – Environmental Technology Meets Digitalisation
(https://digitalgreentech.de/)

Digitalisation is a megatrend that harbours both opportunities and risks. The economy and society also face growing areas of conflict in the finite nature of resources and in structural and climate change. It is therefore important to address digitalisation and sustainable development in tandem and to promote the development of smart, resource-efficient environmental technologies. With this in mind, the BMBF has been funding the development of technologies that help to conserve natural resources and reduce environmental pollution since 2020 through the funding measure "Digital GreenTech – Environmental Technology Meets Digitalisation".

From the first call date on 30 June 2020, 23 joint projects were funded in the fields of water management, resource efficiency and circular economy, geotechnology, and sustainable land management.

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3.1.6. Social sciences for sustainability

Budget chapters and items:	3004 685 43
Eligible expenditures 2021:	€43.5 million
GHG emission reduction:	N/A
Other indicators:	342 beneficiaries
	534 projects
Funding share:	33% As a rule, the project duration is three years, hence the funding share is stated as 33%. Third-party financing is not taken into account.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) c) d) e) f)
Assumptions and limitations: --	
Links: https://www.fona.de/de/themen/gesellschaft-sozial-oekologische-forschung.php	

The eligible expenditures of the budget item are distributed among the programme areas as follows.

Names of the programmes or examples in the budget item	Eligible expenditures (in € million)	Number of beneficiaries and projects
Systemic approaches for sustainable urban mobility	6.9	103 beneficiaries 142 projects
Social-ecological junior research groups	8.1	34 beneficiaries 49 projects
Social-ecological research and economics	28.5	205 beneficiaries 343 projects

Mobility

MobileCityGame – interdisciplinary simulation game based on the city of Karlsruhe

The purpose of the MobileCityGame project is to develop a serious game that illustrates complex transport planning and urban planning interrelationships and decision choices in an easily accessible manner, among other things for practical use in local authorities. This provides a simple and easy-to-grasp platform to demonstrate complex interdependencies, options and also limits in the design of urban mobility systems.

The outcome of MobileCityGame is a fully operational, calibrated demonstrator presenting an interactive simulation game for urban sustainability and mobility policies for Karlsruhe, available free of charge as an app for Android and iOS. Application areas for the game are identified by involving potential users from public administration, mobility providers and civil society and translated into a suitable game design. Users can thus gain a rapid and valid insight into the possibilities,

limits, interdependencies and impacts of differing mobility interventions. In addition to Karlsruhe, other cities such as Berlin and Cologne have shown interest in the app.

The MobileCityGame provides urban decision makers with an easy, quick and low-cost means to test different planning approaches through to 2050 and to rate how well they work. Its great benefit is that everyone can share in shaping their city and making it more liveable. What's more, it sparks people's interest in policymaking and participation.[41]

Sustainable urban development

Green not Grey – Industrial Estates in Transition (GeWa)

Commercially used land accounts for 20% of developed land and almost every urban centre has industrial and business estates that have considerable scope for improvement in terms of amenity value, climate resilience, natural climate change mitigation and greenhouse gas reduction. The GeWa project aims to leverage this potential in direct cooperation with academia and local authorities and to contribute to the energy transition. The measures developed in the project also increase use diversity and intensity for multifunctional spaces, open space quality and biodiversity. A key to success is social innovation and the establishment of business networks that collaborate on projects for the sustainable development of the businesses' industrial estates. This includes establishing an industrial estate management approach to support businesses in efforts of this nature. Over the course of the project, which will last more than five years, six local authorities are directly involved as partners with their respective industrial estates, with many others closely engaged.

The network "Green not Grey – Industrial Estates in Transition" will transfer the accumulated experience and promising ideas for sustainable development, greening and climate adaptation tested at the model industrial estates to other local authorities after the end of the project.[42]

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[41] https://www.isi.fraunhofer.de/en/competence-center/nachhaltigkeit-infrastruktursysteme/projekte/mobilecitygame.html

[42] http://gewerbegebiete-im-wandel.de/

3.1.7. Ocean, coastal and polar research

Budget chapters and items:	3004 685 44
Eligible expenditures 2021:	€51.0 million
GHG emission reduction:	N/A
Other indicators:	383 projects
	89 beneficiaries
Funding share:	33% As a rule, the project duration is three years, hence the funding share is stated as 33%. Third-party financing is not taken into account.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) c) d) e) f)
Assumptions and limitations: --	
Links: https://www.fona.de/de/themen/meeres-und-polarforschung.php	

Federal government research programme MARE:N: Coastal, Marine and Polar Research for Sustainability

The MARE:N federal government research programme provides the framework for coastal, marine and polar research.

Activities funded under MARE:N aim to develop specific recommendations for decision makers to promote the sustainable use of the coasts, seas and polar regions.

The MARE:N programme represents a national contribution to the implementation of Agenda 2030 – specifically SDG 14 ("Conserve and sustainably use the oceans, seas and marine resources for sustainable development") and also SDG 13 ("Take urgent action to combat climate change and its impacts").

In substantive terms, the MARE:N research programme is implemented in agenda processes that define future research needs. Three agenda processes have been implemented in the areas of coastal, marine and polar research. Their outcomes form the basis for BMBF funding calls.

The MARE:N programme is designed to provide comprehensive research for preparedness, decision-making and action, and to contribute to the development of forward-looking and innovative technologies. The scientific programme consists of six major interdisciplinary, cross-cutting and socially relevant focus points. These are: Global Change and Climate Events, Ecosystem Function and Biodiversity, Global Biogeochemical Cycles and Energy Fluxes, Management of Natural Hazards, Sustainable Use of Resources, and Governance and Participation. They are supplemented by three cross-cutting activity areas: Research Infrastructures, Measurement and Observation Technology, and Data and Information Infrastructure.

The research activities that form part of MARE:N address these focal points in the three areas of coastal, marine and polar research:

Coastal research:

German Marine Research Alliance (DAM) Pilot Mission – North Sea and Baltic Sea Protected Areas: Exclusion of mobile bottom-contact fisheries (MBF) in marine protected areas – studies on the impacts of MBF exclusion on the status of waters in

accordance with the EU Marine Strategy Framework Directive (MSFD)[43]

Coastal sea research in the North Sea and Baltic Sea (KüNo) – Coasts in Transition: Investigation of the multi-factor impacts of climate change and land-use change on the integrity of coastal ecosystems, the future use of coastal areas and the protection of the natural and human environment from climate and land-use related risks, with a view to sustainable coastal protection and land-use policies.[44]

German Coastal Engineering Research Council (KFKI): Applied research in coastal and flood protection and in the maintenance and construction of waterways and ports.[45]

Marine research:

Oceans under Stress – Analysis of Direct Anthropogenic Influencing Factors on Ocean CO_2 Absorption Capacity: Analysis of direct anthropogenic influencing factors on ocean CO_2 absorption capacity and derivation of recommendations for sustainable use of the oceans.[46]

Meaning of Climate Change for Coastal Upwelling Systems: Investigation of the interactions between climate change, biodiversity and human use of the oceans to better address global challenges such as overfishing and pollution of the world's oceans.[47]

JPIO – Microplastics in the Marine Environment: Investigation of the origin and spatial distribution of microplastics in European seas and of their toxicological effects on marine organisms in order to protect marine habitats, conserve marine resources and implement international agreements.[48]

JPIO – Impacts of Deep-Sea Nodule Mining: Development of a management framework for sustainable deep-sea mining: Development of an environmental baseline, quantitative assessment of ecosystem vulnerability and resilience, evaluation of actual environmental impacts at mining sites and testing of mitigation and remediation options.[49]

Polar research:

Funding of bilateral joint projects with the United Kingdom as part of scientific and technical cooperation in marine and polar research: Investigation of the impacts of future change on biological and biogeochemical processes, productivity, species distributions, food chains and ecosystems in the North Atlantic.

Funding of grants for scientific data analysis of the MOSAiC Arctic expedition: The sharp decline in sea ice extent, thickness and volume has resulted in a new condition termed the "New Arctic", where winter ice is predominantly no more than one year old. The one-year observation and measurement programme "Multidisciplinary drifting Observatory for the Study of Arctic Climate" (MOSAiC) with the POLARSTERN research icebreaker collected data on processes coupling the atmosphere, sea ice and the oceans. With the results, the researchers are able to provide the most complete picture to date of climate processes in the Arctic, where air surface temperatures have risen more than twice as fast compared with the rest of the planet since the 1970s. The data is used in climate model calculations. A web-based online platform is being created in order to visualise the MOSAiC data and make it available on an open-access basis. In this way, the MOSAiC data will be made available online for the scientific community in an efficient and user-friendly form. This will allow easy and interdisciplinary analysis of complex, heterogeneous and very large data sets to answer questions about the causes and consequences of the changing and shrinking Arctic sea ice cover.

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[43] https://www.ptj.de/projektfoerderung/mare-n/dam-schutz-und-nutzen
[44] https://deutsche-kuestenforschung.de/
[45] https://www.kfki.de/de
[46] https://www.ptj.de/projektfoerderung/mare-n/ozeane-unter-stress
[47] https://www.ptj.de/projektfoerderung/mare-n/klimaaenderungen and https://www.projektfoerderung-geo-meeresforschung.de/kuesten-meeres-und-polarforschung
[48] https://www.jpi-oceans.eu/en/joint-call-proposals-microplastics-marine-environment
[49] https://www.jpi-oceans.eu/en/miningimpact

3.2. Environmental protection, nature conservation and climate change adaptation

3.2.1. Research, studies, etc. [in the area of environmental protection]

Budget chapters and items:	1601 544 01
Eligible expenditures 2021:	€52.0 million
GHG emission reduction:	N/A
Other indicators:	148 new commitments in 2021
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) c) d) e) f)

Assumptions and limitations: --

Links: Report on the Environmental Research Plan:
https://www.bmuv.de/fileadmin/Daten_BMU/Download_PDF/Forschung/ressortforschungsplan_gesamt_2021_bf.pdf

Environmental policy action, the development of strategies and concepts, the assessment of environmental impacts and substance risks and the observation of social, economic and technological trends all require a solid science-based decision-making foundation. Environmental rules and regulations have to be reviewed and revised, and ongoing environmental programmes and approaches accompanied by research. Bridging the gap between science and policymaking, the research conducted or commissioned by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) made a significant contribution in this respect in 2021. This research is generally geared towards supporting the ministry and its higher federal authorities in their tasks.

The departmental research included in the Green German Federal securities is divided into the areas of **environmental and climate protection** (**1601** 544 01) and **nature conservation** (**1604** 544 01).

The eligible expenditures of the "Research, studies etc. [in the area of climate and environmental protection]" budget item (1601 544 01) are spread across the following 12 research areas. The main research fields are described below the table. Further descriptions of the research areas can be found in the linked BMU Environmental Research Plan 2021.

Programme name	Number of new commitments in 2021
Climate change mitigation	17
Climate change adaptation	7
International environmental protection – further development of the climate regime	9
Resource efficiency/circular economy	19
Environment and the economy, sustainable product and consumer policy	14

Programme name	Number of new commitments in 2021
Groundwater, water, soil and marine conservation	12
Clean air/environmentally friendly technologies/noise control/environmental requirements for the mobility transition	23
Environment and health	7
Substance risks	10
Urban environmental protection – sustainable land management	6
Environmental aspects of the energy transition	4
Cooperation with social groups/cooperation partners and cross-cutting environmental policy issues	20

Brief descriptions of the main research fields:

Climate change mitigation

One area of research relating to climate change mitigation targets the development of innovative climate finance instruments. Research is also being conducted into the implementation of measures in the energy sector and into various policy areas (such as structural policy and agricultural policy) from a climate change mitigation perspective. Conceptual and technical issues are also important, as are institutional aspects of carbon market development.

Climate change adaptation

Research in the field of climate change adaptation aims to help increase the climate resilience of our society. Specifically, this involves the investigation of management tools for mitigating climate risks in government and business and the derivation of adaptation measures. This work relates in particular to areas such as soil biology, soil unsealing, flood control, stormwater preparedness and low water risk management. Research is also carried out into the impacts of climate change on water availability and groundwater replenishment.

Resource efficiency/circular economy

The BMU's research in the field of resource efficiency contributes to the transition to a circular economy. This research includes the development of tools to boost the recycling of building products and the use of recycled materials, the development of strategies for the recycling of fibrous plastics, the development of approaches for waste prevention and for the management of individual waste streams, technology transfer and the digital transformation.

Environment and the economy, sustainable product and consumer policy

Environmental protection and climate action policy instruments also have an impact on the economy and consumers. For this reason, the BMU investigates measures for making the social market economy more environmentally sustainable. This includes identifying and evaluating environmentally harmful subsidies and developing environmental policy control instruments as economic incentives to promote environmental innovations. In addition, strategies and instruments are investigated for the efficient export and transfer of environmental technologies and environmental innovations abroad (including the Environmental Technologies Export Initiative). The research also contributes to knowledge transfer, for example by developing practical tools for the implementation of the European Eco-Management and Audit Scheme (EMAS), corporate social responsibility (CSR) and environmental and sustainability reporting in companies, local authorities and other organisations.

Groundwater, water, soil and marine conservation

Water bodies are complex and fragile ecosystems. It is therefore essential to understand the pathways by which chemicals and undesirable microorganisms are

introduced, as well as detection methods and emission requirements. Measures for sustainable use of water bodies can only be established on the basis of sound knowledge.

Soils are the foundation and a central component of terrestrial ecosystems and their biodiversity. They are a vital, non-renewable natural resource providing numerous ecological services. Key challenges include safeguarding the ecological services provided by soil and remediating contaminated sites. Research needs to be carried out in this context into the effects of climate change and globalisation and also into legal developments.

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3.2.2. Subsidies for organisations in the areas of environmental protection and nature conservation

Budget chapters and items:	1601 685 04
Eligible expenditures 2021:	€9.6 million
GHG emission reduction:	N/A
Other indicators:	145 funded projects
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) c) d) e) f)
Assumptions and limitations: --	
Links: --	

The purpose of this budget item is to fund organisations, including support for standardisation activities, funding projects in the areas of chemical hazard assessment, environmental awareness and environmental action, and institutional funding for the German League for Nature and Environment (DNR) as the umbrella organisation and for the Association of German Engineers (VDI) for the VDI/DIN Clean Air Commission (KRdL). The eligible expenditures of the budget item are mainly distributed among the following programme areas. Representative examples are then described below.

Programme name	Eligible expenditures (in € million)
German League for Nature and Environment (DNR)	2.0
Support for standardisation activities	2.1
Projects to identify and assess chemicals in need of regulation	0.5
Environmental protection and nature conservation projects by associations	4.1
Association of German Engineers (VDI) for the VDI/DIN Clean Air Commission (KRdL).	1.6

Project: Cool Markets for the Climate – Sustainability Tour for Climate-friendly and Sustainable Events

The Cool Markets project launched a participatory process and encouraged exchange and networking with all involved in staging events and with civil society. A nationwide series of workshops addressed five key action areas for sustainable events: waste, mobility, catering/procurement, energy and water/sanitation.

Markets, festivals, open-air events and a wide range of other commercial, non-commercial and private events contribute to human-induced climate change because of their climate impact from resource consumption. People's travel to and from an event is a major source of carbon emissions. Most events involve considerable excess energy and water consumption and venues are mostly left with mountains of waste – mainly disposable packaging and giveaways.

The workshop outcomes were made available as documentary videos and accompanied by public relations activities in various channels and the production of related informational materials. Organisers were also encouraged to develop ideas of their own or implement

projects/campaigns in a national civil society competition.[50]

Project: Sustainable Corporate Mobility Policies

The project developed and communicated a new standard for sustainable mobility policies (policies covering all forms and circumstances of business travel). The result is a guide that provides recommendations for sustainable corporate mobility management, including corresponding mobility policies.

The MobilityPolicy project has provided impetus for sustainable corporate mobility, which should lead to significant reductions in environmental impacts in the form of pollution, greenhouse gas emissions and resource consumption. Companies have a significant impact on personal mobility, both in terms of business travel and commuting, and even influence employees' private mobility. Company car and travel policies are still widespread, but they often lack sustainability objectives and above all effective incentives for sustainability. The recommendations were developed jointly with companies and mobility specialists and associations.[51]

Project: City Meets Nature – National Agenda and Local Challenge

Urban nature is diverse and includes green spaces, trees, greened buildings and habitats for plants and animals. Its functions are equally diverse: urban nature improves quality of life and brings people into contact with and thus fosters their appreciation of nature. The EU Biodiversity Strategy that was presented in May 2020 provides for objectives and measures to protect urban nature to be transported to local level and directly addresses local authorities in this connection. Taking up this approach, the project enables experience from the implementation of the EU Biodiversity Strategy 2020 and Germany's National Strategy on Biological Diversity to be shared on the ground for the implementation of the new strategy in urban areas while also promoting the further development of regional activities by embedding them in a supra-regional context.

To this end, people involved in urban nature conservation have been provided with additional training in order to disseminate the objectives of the strategy at local level, including in cooperation with local-authority decision makers. A key project focus was on identifying the objectives of the biodiversity strategy and communicating the key points to urban nature conservation practitioners. In regional participatory workshops ("schools"), the objectives were adapted to specific local needs in order to support local implementation of the biodiversity strategy. Regular interchange and networking among the groups using online channels is expected to enable the objectives of the EU Biodiversity Strategy to be incorporated into local urban nature conservation work on a lasting basis. The project has also provided impetus from the work of civil society stakeholders involved in local biodiversity strategies for the further development of the National Strategy on Biological Diversity in the area of urban nature.[52]

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[50] https://www.umweltbundesamt.de/das-uba/was-wir-tun/foerdern-beraten/verbaendefoerderung/projektfoerderungen-projekttraeger/coole-maerkte-fuers-klima-die-nachhaltigkeitstour

[51] https://www.umweltbundesamt.de/das-uba/was-wir-tun/foerdern-beraten/verbaendefoerderung/projektfoerderungen-projekttraeger/nachhaltigkeitsorientierte-mobility-policies-in and https://www.baumev.de/News/9971/MobilityPolicyhilftbeidernachhaltigenAusgestaltungvonMobilittsrichtlinien.html

[52] https://www.bfn.de/projektsteckbriefe/stadt-trifft-natur-nationale-aufgabe-und-lokale-herausforderung

3.2.3. Investments to reduce pollution [environmental innovation programme, Germany]

Budget chapters and items:	1601 892 01
Eligible expenditures 2021:	€17.4 million
GHG emission reduction:	See sample projects
Other indicators:	75 projects funded
	of which 13 projects newly approved in 2021
Funding share:	The projects were co-financed in the amount of €7.6 million in 2021 from budget item 6092 686 23, National climate action measures
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) c) d) e)
Assumptions and limitations: see project list	
Links: https://www.umweltinnovationsprogramm.de/	

Since 1979, the Environmental Innovation Programme has helped companies to put innovative, environmentally friendly technologies into practice and to demonstrate that industrial processes and production can combine environmental and economic interests. A total of 791 projects have been funded since the programme's inception. In the last 12 years alone, the funded projects have saved a total of around 2.0 million tonnes of CO_2e.[53]

A total of 75 projects were funded in 2021. Of these, 13 were newly approved. The 11 largest projects by funding actually provided are presented below.[54]

Project name (click on the name to visit the website)	Eligible expenditures (in € million)	Duration	Projected climate change mitigation impact (in t CO_2e p.a.)	Impact indicators for other environmental objectives
Paper Machine PM5 New – Valmet OptiDry drying unit	3.0	2019-2023	80,218	--
RecyPrime plastic granules from post-consumer waste	2.8	2021-2023	33,100	Resource efficiency: 35,000 t of plastic recycled
Efficient, chromium(vi)-free galvanisation of plastics for the automotive industry	2.6	2021-2024	129	Resource efficiency: saving of 15 t of chromium trioxide p.a.
Resource-efficient charging of aluminium smelting furnaces using an automated Batch Intelligence System (BIS)	1.7	2017-2023	600,000	Resource efficiency: 45.000 t primary aluminium

[53] As of 9 December 2022

[54] As of 23 August 2024; regularly updated indicators are available at the programme website

Project name (click on the name to visit the website)	Eligible expenditures (in € million)	Duration	Projected climate change mitigation impact (in t CO_2e p.a.)	Impact indicators for other environmental objectives
Energy-intelligent wastewater treatment plant Schwarzenbruck	1.6	2018-2025	300	--
Demonstration of an industrial manufacturing process for electrodes with innovative transparent conductive layers as a basis for organic solar films (EasyCoat)	1.4	2021-2022	540	Resource efficiency: saving of 1.7 t of indium p.a.
Resource-efficient plant for the production of self-supporting wall elements made of cross-laminated timber with waste timber content	1.4	2020-2024	340	Resource efficiency: saving of 10,499 t of timber p.a.
Resource-efficient production of high-performance nanocellular polystyrene insulation using supercritical CO_2	1.2	2020-2023	10,000 [55]	--
Nereda® process at Altena wastewater treatment plant	0.7	2019-2025	130	--
Resource-efficient and highly flexible alloy wheel coating	0.6	2020-2025	597	Resource efficiency: 163 t p.a. reduction in powder waste; general environmental protection (chemical input): 148 t p.a. reduction in solvent input
Novel process for the production of fluorine-free water repellents based on renewable resources from the textile industry	0.5	2021-2023	--	General environmental protection (chemical input): saving of 1,500 t fluorine-based water repellents p.a. Reduction of 300 t mineral oil based ressources

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[55] Estimate of CO2 savings at full capacity

3.2.4. Funding of climate change adaptation measures

Budget chapters and items:	1602 685 05					
Eligible expenditures 2021:	€11.1 million					
GHG emission reduction:	Pursues other objectives					
Other indicators:	182 projects funded with funds disbursed					
Funding share:	N/A					
EU environmental objectives under Article 9 of the Taxonomy Regulation:		b)				

Assumptions and limitations: --

Links: https://www.bmuv.de/programm/foerderung-von-massnahmen-zur-anpassung-an-die-folgen-des-klimawandels

The budget item is used to, among other things, fund two funding guidelines that each target different stakeholders.

Funding guidelines on measures to adapt to climate change impacts (DAS)

The funding guidelines on measures to adapt to climate change impacts serve the purpose of implementing the German Strategy for Adaptation to Climate Change (DAS). Funding is primarily provided for local and local-authority players, and additionally associations, medium-sized companies and educational institutions in the following funding priorities:

A. Initiating local-authority adaptation management

A.1 Preparation of a sustainable adaptation strategy by climate adaptation managers

A.2 Implementation of the sustainable adaptation strategy

A.3 Selected climate change adaptation measure

B. Innovative model projects for climate change adaptation

B.1 Strategy preparation

B.2 Strategy implementation

The funding guidelines address urgent action areas by funding local-authority adaptation management and innovative model projects for climate adaptation. Grants of up to €275,000 are available in each case for the first area and of up to €500,000 for the second. In the case of innovative model projects (funding priority B), the funding guidelines prioritise outcomes that are readily transferable to similarly affected regions and actors.

Funding guidelines on climate adaptation in social institutions (AnpaSo)

The "climate adaptation in social institutions" funding guidelines are intended to make it possible to address and implement necessary climate adaptation processes in the health, nursing care and social sectors. The aim is to stimulate transformation in the sector by funding model projects that inspire others. Projects are intended to have an impact primarily in climate hotspot regions.

Funding is provided as follows:

- **Funding priority 1:** Development of sustainable climate change adaptation strategies
- **Funding priority 2:** Implementation of model climate change adaptation projects based on climate change adaptation strategies
- **Funding priority 3:** Intersectional support provided by social sector climate change adaptation officers (staff funding)

The overall focus is on nature-based solutions. This is intended to generate synergies and positive side-effects in relation to the objectives of the German Sustainable Development Strategy resulting in improvements in environmental sustainability and quality of life. In addition, the institutions granted funding are intended to disseminate the model projects beyond the region as best practice examples and encourage their replication elsewhere.

Other impact indicators

In total, funding was disbursed to 182 projects and 160 approvals were granted for disbursement in subsequent years.

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Of which:

- 41 projects for which funding was disbursed and 151 funding approvals under the AnpaSo funding guidelines
- 137 projects for which funding was disbursed and 19 funding approvals under the DAS funding guidelines
- 4 additional projects (contract awards and grants) received funding outside of the two funding guidelines in 2021.

3.2.5. Research, studies, etc. [in the area of nature conservation]

Budget chapters and items:	1604 544 01					
Eligible expenditures 2021:	€15.3 million					
GHG emission reduction:	Pursues other objectives					
Other indicators:	41 project approvals in 2021					
Funding share:	N/A					
EU environmental objectives under Article 9 of the Taxonomy Regulation:						f)

Assumptions and limitations: --

Links: Report on the Environmental Research Plan: https://www.bmuv.de/fileadmin/Daten_BMU/Download_PDF/Forschung/ressortforschungsplan_gesamt_2021_bf.pdf

Final reports of all research projects can be found at: https://www.bmuv.de/ministerium/foerderung-und-forschung/forschung/forschungs-und-entwicklungsberichte

Environmental policy action, the development of strategies and concepts, the assessment of environmental impacts and substance risks and the observation of social, economic and technological trends all require a solid science-based decision-making foundation. Environmental rules and regulations have to be reviewed and revised, and ongoing environmental programmes and approaches must be accompanied by research. Bridging the gap between science and policymaking, the research conducted or commissioned by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) makes a significant contribution in this respect. This research is generally geared towards supporting the Ministry and its higher federal authorities in their tasks.

The departmental research included in the Green German Federal securities is divided into the areas of **environmental and climate protection** (**1601** 544 01) and **nature conservation** (**1604** 544 01).

The eligible expenditures of the nature conservation budget item (1604 544 01) are distributed among the following programme areas. Three major areas are described below by way of example. Further descriptions of the research areas can be found in the linked BMU Environmental Research Plan.

Name of research area	Number of planned new projects in 2021
Fundamental issues of nature conservation policy	5
Methodologies and instruments for the protection and sustainable use of nature and biodiversity	14
National and international species conservation	5
National and international protection of ecosystems and habitats	9
Integration of nature and biodiversity into other policy areas	12
Nature conservation research accompanying the energy transition	7

Brief descriptions of the main programmes:

Fundamental issues of nature conservation policy

Research on fundamental issues of nature conservation policy supports, among other things, the implementation of the National Strategy on Biological Diversity. The economic value of ecosystems, ecosystem services and biodiversity is investigated and a relationship established with environmental economic accounting. In this way, the value of nature is taken into account in value creation. Support is also provided for international bodies, such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

Methodologies and instruments for the protection and sustainable use of nature and biodiversity

Methodology development activities mainly focus on the development and testing of additional elements of a comprehensive biodiversity monitoring system. Landscape planning and Habitats Directive assessment instruments are improved and green infrastructure proposals operationalised. Research is conducted into the nature-friendly use of floodplains and peatlands, and instruments are developed for the recording, protection and development of urban nature.

National and international species conservation

In the area of national and international species conservation, the BMU's departmental research focuses on insect populations and distributions, the causes of insect die-off and insect conservation measures. Internationally, it also contributes to the improvement of instruments for implementing the Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and to EU dossiers on subjects such as dealing with invasive species.

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3.3. Aerospace, energy, transport and digitalisation

3.3.1. Maritime technologies – research, development and innovation

Budget chapters and items:	0901 683 12					
Eligible expenditures 2021:	€15.5 million					
GHG emission reduction:	N/A					
Other indicators:	158 projects					
	97 beneficiaries					
Funding share:	33%					
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)				e)	

Assumptions and limitations: As a rule, the project duration is three years, hence the funding share is stated as 33%. There is no third-party financing.

Links: https://www.ptj.de/projektfoerderung/maritime-forschungsstrategie-2025/maritimes-forschungsprogramm

Under the funding announcement for the Maritime Research Programme, which entered into force on 1 January 2018, the Federal Ministry of Economic Affairs and Energy (BMWi) funds research and development projects with applications in the maritime sector in Germany.

The aim of the Maritime Research Programme is to strengthen maritime industry innovation in the international competitive arena by promoting innovative maritime technology solutions and applications, and to secure and expand future-viable jobs in Germany while promoting climate change mitigation and environmental protection.

This budget item is used to finance four funding priorities in the Maritime Research Programme:

- MARITIME.green (environmental protection)
- MARITIME.smart (digitalisation)
- MARITIME.safe (safety)
- MARITIME.value (resources)

Funding is provided for application-oriented projects for research, development and innovation in the precompetitive phase.

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3.3.2. National programme for space and innovation – R&D projects

Budget chapters and items:	0901 683 32
Eligible expenditures 2021:	€87.0 million
GHG emission reduction:	N/A
Other indicators:	11 events with a total of more than 3,700 participants in connection with EnMAP
	27 publications on EnMAP
	2 publications on MERLIN on the Web of Science platform
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) c) e) f)
Assumptions and limitations: --	
Links: https://www.enmap.org/ https://www.enmap.org/science/publications/ https://www.dlr.de/de/ar/themen-missionen/erde-klima/klima/merlin https://merlin-methane.space/	

MERLIN is a Franco-German collaboration project between the two space agencies CNES and DLR and was selected as a project in 2010. The satellite launch is planned for 2028. Its purpose is to monitor methane, a greenhouse gas, in the Earth's atmosphere. One of the aims is to identify methane sources and sinks. The satellite was under construction in 2021. Two publications appeared on the Web of Science platform.

EnMAP was launched from Cape Canaveral on 1 April 2022. The mission has an operating lifetime of at least five years. The main objective is to study a wide range of ecosystems on the Earth's land surface. In 2021, the satellite was under construction and approaching completion. 27 publications appeared in addition to 11 events being organised.[56]

In addition to technological developments, the missions will enable a range of scientific, commercial and government applications once they become operational.

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[56] The EnMAP project is financed from these funds with the DLR as the grant recipient. In addition, the DLR contributes a share of its own (see 3.3.3); the third-party funds are covered under 3.3.2 and DLR's own share under 3.3.3.

3.3.3. German Aerospace Center (DLR) – operation and investments

Budget chapters and items:	0901 685 31 and 0901 894 31
Eligible expenditures 2021:	€521.1 million
GHG emission reduction:	N/A
Other indicators:	308 projects
	1,496 indexed scientific publications
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: The sustainability effects of research and development projects are not directly quantifiable or scalable for the entire sector, notably because the utilisation of research results is uncertain at the time of expenditure.

Links: www.dlr.de/en

In its research fields of aerospace, energy, transport and digitalisation, the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt) conducts research into a range of topics that contribute to the federal government's climate goals.

- Aviation (eligible expenditures in 2021 approx. €155.9 million): climate research with impact assessments; eco-efficient production methods with circular economy methods; climate-efficient and climate-neutral fuels and propulsion systems; climate-optimised air traffic routing; designing ultra-efficient aircraft; and noise reduction through optimised flight procedures, aircraft designs and technologies
- Space (eligible expenditures in 2021 approx. €154.5 million): Earth observation satellites to quantify biomass and emissions (e.g. CO_2 and methane); recycling of materials; emission prevention in space travel; green/new forms of fuel: future fuels; battery development in the DLReps project; solar panels with supercapacitors (HySeS); hydrogen handling, storage and tanks
- Energy (eligible expenditures in 2021 €124.4 million): solar and wind energy generation; green hydrogen and other synthetic sustainable fuels; energy storage and transportation; decarbonising industry; system analyses and sector coupling to optimise the energy system
- Transport and digitalisation (eligible expenditures in 2021 €86.4 million): development of new mobility strategies focused on climate action and resource conservation; decarbonising transport through the integration of new propulsion systems and renewable energy in vehicles and the transport system; digitalisation of mobility through automation and "mobility as a service" concepts to protect resources and reduce land take

Examples of projects from the aviation sector

AGATA3S – investigation of the diverse effects of boundary-layer ingestion on aero engine fans

The AGATA3S project investigated the potential of a new aircraft configuration in which the engine is embedded in the far rear of the fuselage. The resulting fuselage boundary-layer ingestion has the advantage of increased fuel economy for propulsion. However, the fan blades are exposed to changing forces as they rotate in a non-uniform inflow. The researchers conducted numerical simulations and experiments for detailed analysis of the effects on fan

aerodynamics, aeroelasticity, structural mechanics and acoustics. Multidisciplinary investigations were carried out under realistic conditions using the counter-rotating CRISPMulti fan model previously derived from simulations of an A320-like aircraft with various engine embeddings. A rotor-rotor configuration in carbon-fibre reinforced plastic (CFRP) proved aerodynamically robust and showed inflow distortion to have little influence on characteristics. At the same time, optical measurement revealed significant rotor blade displacements and deformations with impacts on service life that need to be accounted for in fan design. Inflow distortion led to a considerable increase in tonal and broadband fan noise. In terms of reducing the noise sources, significant dependencies were identified with regard to the engine embedding configuration. Numerical simulations also showed the aircraft fuselage providing increasing acoustic shielding with greater embedding depth. The acquired measurement data has been used to validate modelling methods for the effects of boundary-layer ingestion and provides a unique basis for the future validation of design methods and rules for new aircraft concepts aimed at reducing fuel consumption, greenhouse gas emissions and noise.

DLR project on climate-friendly ultra-efficient long-haul flight (KuuL)

Taking into account both CO_2 and non-CO_2 impacts, aviation as a whole contributes around 5% to atmospheric warming. It may be possible for the proportion accounted for by short-haul flights to be reduced significantly in the long term by electrification. For long-haul flights, however, combustion-based propulsion will remain indispensable for the foreseeable future as energy systems such as batteries and fuel cells are not yet at the necessary technological development level. The long-term climate impact of aircraft engine emissions also depends on flight altitude. Emissions released at a lower altitudes generally result in a smaller climate impact. However, higher air density dictates adjustments to aircraft design and airspeed to maintain energy-efficiency. A compromise has to be found between energy economy, commercial viability and climate impact. The KUUL project pools DLR expertise from various disciplines in a joint design and evaluation process. It investigated how the climate impact of long-haul flights can be reduced with aircraft specially designed for flight at different altitudes and with alternative fuels. The fuels compared were kerosene, sustainable aviation fuels (SAFs) and hydrogen. Whereas kerosene and SAFs led to similar aircraft configurations, hydrogen-fuelled aircraft differ considerably from conventional aircraft because the mass of hydrogen for the same energy content is smaller but the aircraft need bigger and heavier tanks and more complex fuel systems. The findings show that even a relatively small decrease in flight altitude can deliver a significant reduction in climate impact by around 30% with only a slight (around 5%) increase in cost. Further reductions in climate impact can be obtained in combination with other flight physics technologies such as larger wingspans and laminar flow. Switching from kerosene to SAFs results in a direct 25% reduction in climate impact with only minor engine and fuel system modifications and a cost increase of around 25%. By designing new aircraft for lower altitudes and SAFs, the climate impact can be reduced by up to 65% (for a cost increase of around 30%). The investigated aircraft configuration and fuel options have a direct impact on operating costs. Based on the example of a long-haul aircraft optimised for direct hydrogen combustion, a reduction in climate impact of up to 80% can be achieved at an increase in cost of approximately 40%.

FLUID-21 project – investigating the aircraft noise situation in the 21st century

One of the major environmental problems in Germany besides global warming is aircraft noise, where people's need for protection against noise conflicts with economic interests and the general need for mobility. Considerable progress has been made in recent decades with regard to making aircraft quieter and more efficient. Modern aircraft with a new generation of turbofan engines are now available and will dominate the aircraft noise situation for the next 25 years. This makes it

possible to prepare a valid forecast of the noise pollution trend up to the middle of the 21st century in order to clarify whether technical progress can compensate for the predicted increase in air traffic. In doing so, it is also important to analyse the impact of operational noise abatement measures, as these are highly likely to be widely adopted in the future. It is even more important, however, to investigate the impact of potential regulatory measures on future noise levels and to develop improved regulatory tools and see how they work. Germany's population is increasingly ageing. To draw representative general conclusions about the future impacts of aircraft noise, it is therefore also essential to acquire knowledge about the effects of aircraft noise on the elderly. Accordingly, the DLR FLUID-21 project looks into the development of the aircraft noise situation in Germany from the turn of the millennium to around the middle of the 21st century. For the purposes of objective analysis, FLUID-21 forecasts and calculates the noise trend while also investigating measures and regulatory tools with regard to the development of aircraft noise. To this end, aircraft noise quantifications were analysed at large distances from airports. In addition, low-noise departure procedures have been developed together with the requisite pilot assistance systems and research has been conducted into the impact of aircraft noise on the elderly.

Examples of projects from the space sector

Polar Monitor project – quantification of change processes in polar regions

Global observation and quantification of changes in snow cover, mass balances, glacier and ice sheet flow rates and determination of the position of ice shelf edges/glacier grounding lines are necessary in order to observe and understand the processes that directly affect sea level rise, water availability and the global radiation budget. These were the challenges addressed by the Polar Monitor project, which ran from 2020 to 2022.

Development of the Global SnowPack Processor has been completed and the service successfully incorporated into the DLR GeoService (https://geoservice.dlr.de/web), where it has been operational with daily updated snow products since November 2021. An aerial survey in autumn 2021 successfully captured multispectral and near-infrared images. These data were georeferenced and processed before likewise being made available from late December/January.

ReFEx project – reusability in space transportation

Introducing reusable space transport systems not only has huge cost-cutting potential, but also reduces environmental impact (circular economy approach). DLR is therefore researching various technologies for the return of space transport systems. One of the projects, ReFEx, which runs from 2018-2024, aims to test controlled return flight in the hypersonic to transonic range. 2021 saw the start of the structural model and engineering model integration campaigns and the successful completion of the critical design reviews. In addition to a large number of launch preparations, work was also completed on the assembly and initial commissioning of the test setup components for the guidance, navigation and control (GNC) system, making it possible to generate an optimised flight path on board.

Future Fuels project – new fuel systems

The development of future space propulsion systems is no longer solely driven by the desire for higher performance, but increasingly also by secondary requirements such as easy handling and storage, reduced toxicity, improved handling safety and low environmental impact. With this in mind, methane/oxygen, liquid nitrous oxide/hydrocarbon blends and green gel propellants were investigated in the Future Fuels synergy project from 2018 to 2021. Preliminary investigations on the three fuel combinations and an initial feasibility study were successfully completed in 2021.

EnMAP project – satellite mission preparation

Preparations took place in 2021 for the April 2022 launch of the German EnMAP (Environmental Mapping and Analysis Programme) hyperspectral satellite mission.

This included the preparation of the ground segment. The mission's goal is the global monitoring and characterisation of the Earth's environment. EnMAP measures geochemical, biochemical and biophysical variables and provides information on the status and development of terrestrial and aquatic ecosystems.[57]

Examples of projects from the energy sector

Pegasus

Effective and economical long-term storage of solar energy is essential if fossil-fuelled power plants with annual operating times in excess of 6,000 hours are to be fully replaced with renewable energy sources. In this context, the EU-funded PEGASUS research project and the associated North Rhine-Westphalia (NRW)-funded BaSiS project investigated a novel process for electricity generation that combines concentrated solar power (CSP) with sulphur as a thermal energy storage medium. This makes it possible to decouple electricity generation in terms of time and place from the availability of solar radiation and provide round-the-clock baseload power throughout the year.

Both projects were successfully completed and the project objectives achieved in 2021. The prototype developed in the PEGASUS project was of major importance for the further development of the CentRec receiver technology and has now been permanently installed at the Jülich Solar Tower where it can be used in other projects.

CoBra

Reducing carbon dioxide emissions while continuing to provide heating and cooling for industry presents a major challenge. The DLR Institute of Low-Carbon Industrial Processes is working on technologies and solutions for industry to manage without fossil fuels in their production. It is making a major contribution to the heat energy transition in industry with the new CoBra pilot plant.[58] CoBra is a high-temperature heat pump that works with dry air and consequently offers an alternative to fossil fuels. The heat pump has the potential to enable massive CO_2 reductions. With temperatures of up to 300 °C, it supplies heat in a temperature range that meets the process heat requirements of many industrial sectors but for which there has previously been no viable technical solution.

Thermochemical lime storage

DLR is developing a pilot plant for a thermochemical lime storage system that is to be tested outside a laboratory for the first time in collaboration with the University of Stuttgart. The heat reservoir is based on quicklime, which can be used for carbon-neutral space heating in buildings. The advantage of lime storage is that there is almost no heat loss, as lime can chemically store energy for months. This type of thermochemical storage is very well suited to seasonal storage where energy generated from renewable energy sources is stored in summer and used in winter. Lime is also very inexpensive, available in large quantities and environmentally safe.

Maritime Energy Systems project – defossilisation of shipping

Carbon emissions from shipping currently account for around 3% of global greenhouse gas emissions. The newly established DLR Institute of Maritime Energy Systems therefore aims to develop technologies to significantly reduce carbon emissions from shipping. It is able to draw here on the many years of experience in the DLR Energy, Transport, Aeronautics and Space programmes. In 2021, initial investigations were launched into fuels with potential for use in shipping together with the associated energy converters and propulsion systems, taking into account safety aspects, availability and the necessary infrastructure. As well as solutions for newly built vessels, retrofit solutions were also looked at, where engines or energy systems are replaced or upgraded.

[57] The EnMAP project is financed from national programme (3.3.2) funds with the DLR as the grant recipient. In addition, the DLR contributes a share of its own; the third-party funds are covered under 3.3.2 and DLR's own share under 3.3.3.

[58] Acronym composed of **Co**ttbus, the city where the plant began operating in autumn 2022, and the **Bra**yton thermodynamic cycle on which it is based.

Examples of projects from the transport sector

Energy and Transport (EVer) project

The Energy and Transport (EVer) project identified potential developments for the German transport and energy system up to the year 2040 and evaluated them using models. It also investigated the operation of a battery-electric vehicle in combination with contactless charging and return of electrical energy. The processes involved were studied on the practical operation of a road vehicle in simulation and demonstration form. As the results show, providing different charging technologies influences the demand for charging, the flexibility of that demand and the growth in the renewables share of the energy mix. They also showed that maximum energy system flexibility can be attained if vehicles connect to a charger as frequently as possible.

Automover project

The Automover project developed scenarios for the introduction of driverless transport options over the period through to 2040. The scenarios mainly differ in terms of support for individual and for shared-use driverless transport, including automation options for urban air vehicles and in rail transport. Empirically collected data on usage as a function of price allows the effects to be determined using an extended model chain and a new analysis method. Support for shared use proves to be the sole scenario in which driverless transport options result in a sustainable transport system.

Next Generation Train project

Air conditioning systems in trains play an important role in the mobility transition in passenger transport. As such systems account for between 35% and 50% of total energy consumption, DLR researchers are working to optimise them in the Next Generation Train project. Considerable energy savings are enabled by new ventilation concepts combined with single-seat air conditioning based, for example, on infrared panels. This also improves passenger comfort and significantly reduces the transmission of germs and pathogens via interior air currents in passenger compartments. Rail travel is made more attractive as a result.

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3.3.4. Hybrid electric aviation

Budget chapters and items:	6092 683 05
Eligible expenditures 2021:	€37.1 million
GHG emission reduction:	N/A
Other indicators:	71 projects
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: The projects normally have a minimum duration of 3¼ years but may be extended in individual cases if doing so increases the likelihood of achieving the project objectives. No project outcomes are yet available as project funding began during 2020 and 2021 (LuFo VI-1 and VI-2).

Links: https://www.luftfahrtforschungsprogramm.de

Funding objective

Funding is provided for R&D projects with the aim of producing low-emission and, in the medium to long term, zero-emission (carbon-neutral) aircraft. Engineering solutions are to be developed for an aircraft that emits zero pollution in flight or on the ground. The path to zero-emission aviation will require substantial investment and major research effort for technologies in all areas.

A key focus is the development of electric propulsion systems for primary flight power. Electric propulsion systems obtain electrical energy from batteries, fuel cells or a combination of the two. Fuel cells are intended to run on zero-emission "green" hydrogen. Another technology option is the direct combustion of hydrogen in conventional gas turbines. The next major technological challenge is the technology for storing sufficient quantities of hydrogen. To ensure that the new propulsion system is not developed at the expense of functional aspects, special new aircraft configurations are needed to match the specific system characteristics. Deliberate use is made of design flexibility to enable good integration of the new technologies into the overall system. As a result, all subsystems have to be redeveloped for the new propulsion system.

Target achievement and funding efficiency

Outcomes of the aeronautical research programme are already leading to massive carbon savings, both in operations (through improvements in propulsion technology and aerodynamics) and by way of adjustments to air traffic routing. Hybrid-electric propulsion technologies combined with alternative fuels or fuel cells, and also hybrid-electric structures (cabin supply including avionics and emergency power supply) are contributing significantly to additional carbon emission reductions. Air transport is a global phenomenon, and technologies researched and developed in Germany that reach sufficient maturity have the potential to be adopted in aviation worldwide. For this reason, the programme looks beyond domestic German aviation to include the international and global dimension. 2050 is selected as the time horizon, as long development and market penetration cycles mean that the available potential in air transport can only be realised in some cases with a considerable time lag. The reported reduction potential relates to CO_2 emissions per se and CO_2 equivalents in terms of expected emissions assuming the "with existing measures" (WEM) scenario from the federal government's 2021 projection report. CO_2 equivalents are used so that the entire climate impact of air transport is adequately taken into account and can be efficiently addressed with reduction measures.

Technologies funded and operational measures enhanced through the LuFo programme have a cumulative savings potential of 19 billion tonnes of CO_2 equivalents or 500 million tonnes of CO_2 by 2030 and 206 billion tonnes of CO_2 equivalents or 24.7 billion tonnes of CO_2 by 2050. The potential annual savings relative to the "with existing measures" scenario rises to 75% for CO_2 equivalents and 16% for CO_2 by 2030 (94% and 96% respectively by 2050).

The introduction of new technologies (engines and airframes) accounts for the largest relative share of the potential savings by 2050 at around 42%, followed by the introduction of operational measures (24%) and savings from new fuels such as hydrogen (29%).

Hybrid electric aviation primarily relates to the introduction of new technologies (engines and airframes) as a key enabler for the introduction of new climate-neutral fuels such as hydrogen, meaning that, cumulatively speaking, up to 71% of the above potential savings are addressed by the "hybrid electric aviation" budget item.

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3.4. Technology transfer – lightweighting

3.4.1. Technology transfer – lightweighting

- Technology transfer programme – lightweighting
- Resource efficiency and substitution
- New construction technologies and materials for low-emission industry

Budget chapters and items:	0901 683 15, 6092 686 15 and 6092 686 17
Eligible expenditures 2021:	€13.9 million
GHG emission reduction:	Estimated potential: 5.71 million t CO_2e
Other indicators:	82 joint projects
Funding share:	8%
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) d)

Assumptions and limitations: GHG emission reduction: The "Technology transfer programme – lightweighting" funds research and development projects. Translation of project outcomes into marketable products and processes is not part of the R&D projects themselves, but takes place at a later stage. It is therefore only possible to estimate potential GHG reductions, which must be regarded with considerable caution given the R&D character of the projects and the related uncertainty concerning the implementation of market-relevant products. On a conservative estimate, it is assumed that only 10% of the projects will be commercialised. Data on potential GHG reductions from the projects is requested at various points in time in an accompanying monitoring programme. The stated potential reductions are based on data requested at an early stage of the projects. The monitoring data can be expected to become more accurate over time. The projects report on potential reductions for products and materials in the production, use and end-of-life phases. To obtain comparable data, the figures are requested at a short-to-medium-term interval after completion of the R&D projects. A summary analysis is applied for this purpose over a period of seven years after project completion.

On this basis, for the projects for which expenditures were incurred in 2021, potential GHG reductions of 2.01 million tonnes of CO_2e are estimated for the industrial sector over a period of seven years after project completion. In addition to the reductions for the industrial sector, GHG reductions of 3.70 million tonnes of CO_2-e are forecast over the same period for the transport sector.

In an evaluation as part of the Immediate Climate Action Programme, an external expert consortium attested to the plausibility of the approach described above and the assumptions made.

Funding share: The funding is provided as a rule for joint projects with varying start and end dates. For the funding share, beneficiaries' eligible expenditures in 2021 are first expressed as a percentage of the approved funding volume over the entire project duration. Funding contributed by the companies themselves is accounted for on the basis of the 69% average funding rate applicable to the projects in progress in 2021, meaning that 69% of the total of all project costs was met by the federal government and the remainder by the companies. This results in a funding rate of 8% for 2021. The third-party funding that is necessary for subsequent investment in market-ready production facilities following product development is not included.

Links: https://www.bmwk.de/Redaktion/DE/Artikel/Technologie/technologietransfer-programm-leichtbau.html

In the "Technology transfer programme – lightweighting" (TTP LB), the Federal Ministry for Economic Affairs and Energy funds application-oriented research and development projects to promote the widespread industrial adoption of lightweighting as a key technology and innovation driver for a sustainable economy.

Lightweighting is a holistic design philosophy that cuts across all phases from design to production to recycling and aims for weight optimisation, material savings and recyclability while maintaining or improving functionality. Lightweighted products primarily save material in production and thus reduce resource use. This also results in major energy savings and reductions in emissions associated with resource extraction and processing into materials and semifinished products. New approaches additionally make it possible to substitute particularly resource-intensive materials with alternatives that have a smaller carbon footprint. Lightweighting also delivers considerable energy savings in the use phase, especially in load-moving applications, as with the use of lighter components in vehicles.

A further focus of the TTP LB is on design for the recycling or reuse of lightweighted products in line with circular economy principles. This in turn reduces the use of new input materials that can be substituted with recyclates or reused components. Further energy and emission reductions in primary resource extraction follow as a result.

The TTP LB thus gives a threefold boost to climate change mitigation. Lightweighting leads to GHG reductions not only through direct energy savings, but also to a major extent through greater resource efficiency, increased recycling and lower resource use. Combined with the broad cross-sectoral application of lightweighting in numerous different products and processes, the TTP LB thus plays a key role in promoting a carbon-neutral economy.

The TTP LB comprises five programme lines reflecting the three budget items and focusing among other things on technology development, carbon emission reduction and resource efficiency.

Programme line (PL)	Number of projects in 2021	Total funding (in € million; multi-year)
1. Technology development to support German industry in lightweighting (**0901 683 15**)	8	5.3
2. Carbon emission reduction and carbon storage through the use of new construction techniques and materials (**6092 686 17**)	35	61.5
3. Carbon emission reduction through resource efficiency and substitution (**6092 686 15**)	24	34.3
4. Demonstration projects (thematically assigned to PL1-3)	10	14.3
5. Standardisation (thematically assigned to PL1-3)	5	5.0
Total	**82**	**120.4**

Project example for programme line 1:

Joint project: **FunPul**[59] – inline functionalisation of pultrusion profiles; identifier: 03LB1002A-F; partners: Hörmann Vehicle Engineering GmbH, FiberCheck GmbH, LOV – Limbacher Oberflächenveredelung GmbH, Maus GmbH Modell- und Formenbau, Modespitze Plauen GmbH, FhG – Fraunhofer Institute for Machine Tools and Forming Technology (IWU)

The overall aim of the project is to modify and utilise the pultrusion process for the cost-effective manufacture of cross-sectoral, multifunctional lightweight structures. The functionalisation takes the form in one case of integrating metal inserts and in another by embedding sensor elements for component monitoring. Two demonstration components – one for rail vehicle construction and one for wind turbines – are used for the proof of technology. Over the course of the project, a technology transfer is demonstrated between the two sector-specific functionalisation strategies. The resulting functional enhancement results in greater lightweighting and potential carbon emission reductions. The project duration was from 1 January 2021 to 31 December 2023.

Project example for programme line 2:

Joint project: **NaMiKoSmart** – conception, development and realisation of an innovative ultra-lightweight centre console made of sustainable fibre matrix composites using the xFK in 3D winding process; identifier: 03LB2030A-C; partners: Automotive Management Consulting GmbH, csi entwicklungstechnik GmbH, Deutsche Institute für Textil- und Faserforschung Denkendorf (DITF)

The aim of the project is to use the three-dimensional xFK in 3D endless fibre winding process to produce ultra-light yet high-strength and rigid truss structures based on a wide variety of fibre materials. The winding process makes it possible to deposit fibres along the load paths in a component, thus exploiting the maximum potential strength of the fibre material used with low component weight and high functional integration. Ultra-light truss structures can lead to a disproportionately large reduction in the energy needed to accelerate a vehicle. The extremely low (under 1%) fibre wastage also further reduces the carbon footprint and cost compared to existing fibre composite technologies. The new approach is demonstrated on an ultra-lightweight automotive centre console. The project runs from 1 September 2021 to 31 August 2024. In August 2022, the project won the Altair Enlighten Award[60]. This award is conferred annually for international lightweighting and sustainability solutions for the automotive industry. On presenting the award in the Future of Lightweighting category, the jury highlighted how the project team combined sustainability criteria, methodological lifecycle analysis and lightweight technology.

Project example for programme line 3:

Joint project: **CC-Mesh**[61,62] – symbiosis of two opposites – transfer of innovative design and reinforcement concepts (CARBCOMesh) from lightweight construction to concrete construction; identifier: 03LB3003A-D; partners: CARBOCON GmbH, HA-CO Carbon GmbH, Technische Universität Dresden, Leipzig University of Applied Sciences

The project's main focus is the development of market-ready components for concrete construction using innovative, large-format, load path-optimised carbon fibre reinforcing structures. Carbon fibre reinforcing structures are to be used to create durable concrete components that are optimised in terms of the distribution of forces along load paths and thus save resources. This is achieved by a symbiosis of design principles from lightweighting and conventional concrete engineering. The aim is not only to save on reinforcing by the optimum arrangement of

[59] https://www.bmwk.de/Redaktion/DE/Dossier/Leichtbau/Archiv/Archiv-Newsletter.html ; Newsletter 03/2021
[60] https://www.altair.com/newsroom/news-releases/altair-announces-winners-of-10th-annual-enlighten-award
[61] Green German Federal securities: Case study 16 in the 2023 Green Bond Investor Presentation, slide 51
[62] https://www.bmwk.de/Redaktion/DE/Dossier/Leichtbau/Archiv/Archiv-Newsletter.html; Newsletter 01/2021

such components, but also to drastically reduce the amount of concrete needed, as concrete is a resource with a large climate impact. The innovative carbon-fibre reinforcing element, CARBCOMesh, is planned as an industrial implementation of the design principles to be developed by the project partners, enabling the construction method to enter into widespread use as a resource-saving alternative to concrete construction. This can make a significant contribution to the goal of reducing carbon emissions in Germany. The project runs from 1 November 2020 to 30 April 2024.

Project example for programme line 4:

Joint project: **Aerolight**[63] – revolutionary production process for spherical, cost-effective aerogels; identifier: 03LB4006A-B; partners: PROCERAM GmbH & Co. KG, FhG – Fraunhofer Institute for Environmental, Safety and Energy Technology (UMSICHT)

The project aims to further the development of an innovative production process for aerogels to make them economically competitive in the mass thermal insulation market. If successful, the use of aerogels will more than halve thermal conductivity compared to conventional insulation materials such as polystyrene. This means that insulation can also be halved in thickness, enabling significant gains in usable building space. The project ran from 1 April 2021 to 31 March 2024. It achieved major successes in 2023, winning the Joseph von Fraunhofer Award[64] for the development of a mass production process for aerogels and, in Brussels on 11 October 2023, the European Association of Research and Technology Organisations (EARTO) Innovation Award 2023 in the "Impact Expected" category[65]. The non-profit EARTO confers this award for products and services with significant social or economic impact for the EU.

Project example for programme line 5:

Joint project: **Enabl3D**[66] – Efficient quality assurance method for bionic and resource-saving 3D printing components; identifier: 03LB5000A-C; partners: FhG – Fraunhofer Research Institution for Additive Manufacturing Technologies IAPT, VisiConsult X-ray Systems & Solutions GmbH, Imprintec GmbH

The aim of the project is to develop a new method for efficient quality assurance in order to make 3D printed lightweight metal components for the aerospace, automotive and medical engineering more cost-effective. The method is based on an intelligent combination of indentation plastometry testing, process monitoring and µCT technology. Innovative indentation plastometry testing is used to measure the relevant material properties (tensile strength, yield strength, ductility and anisotropy) directly on the component. High-resolution process monitoring data makes for verified process stability so that locally measured properties can be assumed to apply for the entire part. In addition, critical regions can be identified and examined non-destructively using µCT scans. If successful, in addition to the potential cost reduction, the project will contribute towards a halving of testing time and help monitor or reduce carbon emissions in additive manufacturing, including in lightweighting.

Further examples of projects can be found in the "Technology transfer programme – lightweighting" newsletter archive[67].

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[63] https://www.umsicht.fraunhofer.de/de/projekte/aerogel-daemmstoff-neuer-herstellungsprozess.html
[64] https://www.fraunhofer.de/de/ueber-fraunhofer/wissenschaftliche-exzellenz/fraunhofer-preisverleihung/2023/joseph-von-fraunhofer-preis-2023-gebaeudedaemmung.html
[65] https://www.umsicht.fraunhofer.de/de/presse-medien/pressemitteilungen/2023/earto-award-2023.html
[66] https://www.bmwk.de/Redaktion/DE/Dossier/Leichtbau/Archiv/Archiv-Newsletter.html; Newsletter 01/2020
[67] https://www.bmwk.de/Redaktion/DE/Dossier/Leichtbau/Archiv/Archiv-Newsletter.html

4. Energy and industry

In order to achieve its climate targets, Germany is undergoing an energy transition. The energy and industry sector encompasses measures to accelerate the transition to an economy based largely on renewable energy sources and to an eco-efficient use of energy and resources. Energy and industry are responsible for the majority of Germany's total emissions[68]:

- The industrial sector was responsible for around 22% of total emissions in 2022. This corresponds to 168 million tonnes of CO_2 equivalents. Compared to the previous year, industrial greenhouse gas emissions decreased by 7.6% or 13.7 million tonnes of CO_2 equivalents. Much of this reduction relates to a drop in output in energy-intensive sectors and (price-driven) efficiency increases.
- The energy industry is responsible for the largest share of emissions, at 34%. In 2022, its greenhouse gas emissions amounted to 257 million tonnes of CO_2 equivalents. Compared to the previous year, the sector's emissions increased by 11 million tonnes of CO_2 equivalents, or 4.5%. This was due in particular to emergency measures to secure the energy supply.
- The buildings sector was responsible for just under 15% of total direct emissions in Germany in 2022. Emissions from the sector fell by approximately 7.6% from 2021 to 2022 to 111 million tonnes of CO_2e. The reduction in emissions is mainly due to the energy crisis and the resulting increase in energy costs combined with mild temperatures, and also to efforts to save energy in private households.

Renewable energy sources are being steadily and continuously expanded. Energy efficiency is being improved in the energy industry as well as in the buildings sector and in energy-intensive industries. The generation of energy from nuclear energy and coal is being phased out in Germany.

The main funding instrument in this area is the Energy and Climate Fund (EKF). Programmes funded by the EKF play a central role in implementing the energy transition and achieving national and international climate targets.[69] The eligible expenditures of the sector amount to €2,665.5 million and are distributed across 10 budget items in the following categories:

- Energy research (1 budget item with €564.3 million in eligible expenditures),
- Renewable energy (4 budget items with eligible expenditures of €1,408.4 million),
- Energy efficiency (3 budget items with €506.2 million in eligible expenditures) and
- National Climate Initiative (2 budget items with €186.6 million in eligible expenditures).

[68] See p. 7 and 8 of the Climate Action Report 2023; data updated on the basis of the final greenhouse gas emissions balance published by the Federal Environment Agency, see https://www.umweltbundesamt.de/en/press/pressinformation/detailed-greenhouse-gas-emissions-figures-for-2022

[69] In addition, extensive funding programmes for energy-efficient building refurbishment are provided by KfW. These are taken into account for KfW green bonds. Measures earmarked in Germany's Recovery and Resilience Plan (DARP) for the European Commission's Next Generation EU European recovery instrument are excluded as eligible expenditures for Green German Federal securities.

4.1. Energy research

4.1.1. Energy research

Budget chapters and items:	0903 683 01
Eligible expenditures 2021:	€564.3 million
GHG emission reduction:	N/A
Other indicators:	4,720 ongoing projects
Funding share:	66.11%
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: The projects running in 2021 had an average funding rate of 66.11%, meaning that 66.11% of the total of all project costs was met by the federal government and the remainder by the companies.

Links: 2022 Federal Government Report on Energy Research: https://www.bmwk.de/Redaktion/EN/Publikationen/Energie/federal-government-report-on-energy-research-2022.html

The 2022 Federal Government Report on Energy Research transparently presents the goals and measures of energy research for the 2021 reporting period. Note: The Federal Government Report on Energy Research also contains projects whose expenditures are not eligible for Green German Federal securities. Project profiles for ten examples of eligible expenditures can be found in the 2022 Federal Government Report on Energy Research:

Example	Report page	Project name (further details directly in the report)	Funding (in € million; multi-year)	Identifier
1	28	FernWP – Supply of district heating and process heat from heat pumps as a substitute for coal combustion	4.5	03EN4015A-E
2	33	PV-Kraftwerk2025 – Innovations for the next generation of PV power stations: new component parts, system solutions and inverters for a cheap electricity supply that serves the grid	5.5	0324211A-F
3	35	WERAN plus – Interaction of wind turbines and terrestrial navigation/radar plus	1.3	0324252A-D
4	36	InGROW – Innovative foundation system for repowering of offshore wind turbines	0.6	03EE3003
5	40	HuKmeN – Heating and cooling in a single network: technology for geothermal infrastructure (collector weaver)	4.9	03EE4028
6	43	High Performance Solar 2 (HPS2) – Demonstration of a solar-thermal parabolic trough and steam generation system based on molten salt as a heat carrier	4.6	0324097A-C
7	45	SPANNeND – Digital coordination of voltage using reactive power between grid operators	1.9	03EI4040A-F

Example	Report page	Project name (further details directly in the report)	Funding (in € million; multi-year)	Identifier
8	50	OptiLBO – Energy-efficient and carbon-neutral steel production via the use of additive manufacturing and smart control in the electric arc furnace	2.6	03EN2069A-D
9	54	DiMA-Grids – Digital business models with self-determined users for smart distribution grids	1.2	03EI6038A-F
10	58	ACT-AC^{2}OCem – Acceleration of the market launch of CO_2 capture in cement production via the use of oxyfuel technology	1.7	03EE5024A-D

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4.2. Renewable energy

4.2.1. Foreign Trade Strategy for Hydrogen – International Cooperation on Hydrogen

Budget chapters and items:	0904 896 02					
Eligible expenditures 2021:	€35.5 million					
GHG emission reduction:	N/A					
Other indicators:	2 projects					
Funding share:	N/A					
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)					

Assumptions and limitations: --

Links:
https://www.bmwk.de/Redaktion/DE/Wasserstoff/Downloads/Fortschreibung.pdf?__blob=publicationFile&v=4

The budget item funds measures to support the global market ramp-up of the hydrogen sector. This includes the necessary pilot projects with new technical systems or facilities, feasibility studies and investment subsidies for German companies. The funding is also intended to bring about a rapid increase in the availability of green hydrogen in Germany.

Various market ramp-up stages are addressed for this purpose. At the beginning of the project phase, feasibility studies are required. These are co-financed by the H2Uppp funding instrument.

The implementation phase begins with the planning of pilot projects with new technical systems and facilities. For this purpose, the International Hydrogen Projects funding guidelines provide for investment subsidies to German companies. The Green Hydrogen Fund (GHF) of the European Investment Bank (EIB) provides investment grants and consulting services for large-scale projects along the entire value chain relating to green hydrogen and derivatives, in countries outside of the EU/EFTA. The aim is to accelerate the global market ramp-up and infrastructure development. Implementation details and the scope of funding are currently being planned.

Pilot projects cannot be upscaled to a commercially viable size without purchase agreements. H2Global is currently the only instrument worldwide to enter into such purchase agreements and resell the hydrogen in Germany and across Europe.

In 2021, the first hydrogen project was funded that meets the objectives of the National Hydrogen Strategy. This is a pilot project in Chile, the partner country, with the participation of German companies to demonstrate whether and how green hydrogen and derivatives can be sustainably produced and marketed there. The project thus contributes to the establishment of reliable import capacities and the strategic positioning of German companies in this market of the future.

The measures and funding referred to support the global ramp-up of the market for green hydrogen.

Further information on the hydrogen strategy can be found in the updated National Hydrogen Strategy.

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4.2.2. Energy transition programmes and measures in the areas of renewable energy sources, electricity and power grids, digitalisation and energy infrastructure

Budget chapters and items:	6092 686 13
Eligible expenditures 2021:	€16.4 million
GHG emission reduction:	N/A
Other indicators:	155 beneficiaries
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: This is a multi-year project (duration: 2016 to 2021). The beneficiaries received funding over several years.

Links: https://www.bmwk.de/Redaktion/DE/Dossier/sinteg/

The challenges faced in the energy transition call for smart, innovative solutions. This was precisely the purpose of the SINTEG funding programme. From 2016 to 2021, 300 companies, universities and local authorities researched and tested the technical feasibility and practicality of new technologies and processes in the areas of system integration, flexibility, system stability, smart energy grids, new market and governance structures, and social participation and acceptance.

Far from the academic ivory tower, SINTEG addressed practical real-life problems. To this end, research centres worked hand in hand with companies and public bodies. Systems were created, interconnected, digitally controlled and monitored. New software solutions were developed, along with smart home applications and storage methods. Digital market platforms and smart grids were created and tested for practicability and cost-efficiency in companies, neighbourhoods and homes.

After four years of intensive work, the project entered the review phase for results to be collated and transferred into scalable blueprints. Following the end of the funding programme, the many findings and blueprints were showcased in five synthesis areas. These help ensure that users – such as energy utilities, industrial enterprises and grid system operators – and policymakers take the key factors into account from the outset when planning and implementing measures to integrate renewable energy sources into the energy system, and that they benefit from the practical application experience gained in the five SINTEG showcase regions. The results of the SINTEG funding programme have been compiled by experts in five comprehensive, thematic synthesis reports that can be found under the above link.

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4.2.3. Improving framework conditions for shore-to-ship power supply in German ports

Budget chapters and items:	6092 882 01
Eligible expenditures 2021:	€21.8 million
GHG emission reduction:	Approx. 1000 t CO_2e p.a. estimated for two completed systems (additional systems under construction)
Other indicators:	3 shore-to-ship power systems completed
	6 shore-to-ship power systems under construction
Funding share:	Up to 75%
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) / e)

Assumptions and limitations: Up to 75% of the eligible costs under the funding provided by the *Länder* could be co-funded by the federal government from 2020 onwards. The subsidy was reduced to a maximum of 50% from 2022.

Links: --

The eligible expenditures support investment in port infrastructure to improve shoreside power supply to seagoing and inland waterway vessels while in port. The aim is to substitute fossil fuel-based on-board power generation with renewable energy and thus reduce greenhouse gas emissions, particulate matter and noise. Specifically, this avoids emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x), sulphur oxides (SO_x) and particulate matter (PM). Noise is also reduced. Specific quantitative expansion targets are set in programmes to be submitted annually by the *Länder*.

The *Länder* participating in the federal financial assistance programme for shoreside electricity are Bavaria, Baden-Württemberg, Bremen, Hamburg, Rhineland-Palatinate, North Rhine-Westphalia, Lower Saxony, Saxony-Anhalt, Schleswig-Holstein, Mecklenburg-Western Pomerania and Hesse. Under an administrative agreement, the federal government co-finances 75% of the eligible costs of expanding the provision of shoreside electricity. Shore-to-ship power systems for seagoing vessels are relatively large construction projects over multiple years.

Two shoreside electricity systems were completed with federal support in 2021: A shoreside electricity system was commissioned for port vessels at pier in Hamburg-St. Pauli and another was commissioned for river cruise vessels in Koblenz. Work commenced on the construction of additional shoreside electricity systems for inland waterway vessels (in Bamberg, Passau and Würzburg) and seagoing vessels (three for container ships and one for cruise ships in Hamburg).

It has not yet been possible to determine the precise GHG reduction for 2021 as the systems were only taken into operation partway through the year. With a total eligible cost of €215,000 (federal share: €161,215) and with passenger vessels consuming an estimated 2,250 MW p.a., the State of Hamburg expects the pier shoreside electricity system to provide potential CO_2 emission reductions of 181,616 kg of CO_2 per year. The six-berth shoreside electricity system in Koblenz is expected to deliver an emission reduction of 891,699 kg of CO_2 per year.

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4.2.4. Funding to promote energy efficiency and renewable energy measures in buildings

Budget chapters and items:	6092 893 10
Eligible expenditures 2021:	€1,334.7 million
GHG emission reduction:	14.6 million t CO_2e
Other indicators:	99,800 funding approvals
Funding share:	The indicator is based on the funding efficiency of the eligible expenditures and therefore does not take into account any third-party funding.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: The GHG reduction figure relates to the lifetime of the systems for which funding was paid out in 2021. The timing of implementation may vary from this. For a detailed description of the assumptions/methodology, please refer to the evaluation report. Please refer to the evaluations of the CO_2 building rehabilitation programme and the market incentive programme. The GHG reduction is determined by extrapolating from the funding efficiency of the MAP in 2020.

Links: https://www.bmwk.de/Redaktion/DE/Evaluationen/Foerdermassnahmen/20230619-endbericht-foerderung-massnahmen-nutzung-erneuerbarer-energien-waermemarkt-2019-2020.pdf?__blob=publicationFile&v=2

A wide range of measures are needed to achieve a near-climate-neutral building stock. The budget item therefore addresses a wide variety of funding measures to promote energy efficiency and renewable energy in buildings. Expenditures for the KfW-administered programmes for energy-efficient construction and rehabilitation (CO_2 Building Rehabilitation Programme) are not taken into account for Green German Federal securities. KfW issues green bonds of its own and allocates the proceeds, among other categories, to the energy efficiency category (KfW Energy-efficient Construction loan programme). The expenditures of the BEG federal funding programme for efficient buildings are partly refinanced from DARP funds and are likewise not taken into account for Green German Federal securities. For Green German Federal securities issued in 2022, it has been possible to maintain a clear segregation between those expenditures, together with their impacts, and the eligible expenditures included here. The expenditures under the market incentives programme (MAP) and the heating optimisation programme (HZO) are included for the first time.

The MAP provides investment incentives to support the market penetration of renewable heating technologies. It supports solar collector systems, solid biomass combustion systems, efficient heat pumps, deep geothermal systems and particularly innovative technologies for heating and cooling. The MAP was superseded by the BEG programme in 2021. Disbursements for MAP projects still approved are included in the eligible expenditures. Funding under the MAP was provided in the form of investment cost subsidies administered by the Federal Office for Economic Affairs and Export Control (BAFA) – primarily for smaller renewable heating systems in detached and semi-detached houses – and subsidies under the KfW "Renewable Energies – Premium" programme for the accelerated partial repayment of low-interest KfW loans for higher-output renewable energy systems. As KfW issues green bonds of its own, these are not included in the eligible expenditures presented here.

The original objective of the funding guidelines of 13 July 2016 on heating optimisation through high-efficiency pumps and hydraulic balancing was to support pumps and the additional optimisation of heating system operation. The HZO programme expired at the end of 2020; expenditures in subsequent years for HZO projects still approved up to that date are taken into account in the year of disbursement.

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4.3. Energy efficiency

4.3.1. Energy efficiency in industry and businesses

Budget chapters and items:	6092 686 08
Eligible expenditures 2021:	€352.6 million
GHG emission reduction:	0.95 million t CO_2e p.a.
Other indicators:	3,227,000 MWh p.a. energy savings
Funding share:	The indicators are based on the eligible expenditures and therefore do not take into account any third-party funding.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: The estimate for 2021 is based on the evaluation report on the funding programme. However, the savings identified in the evaluation report relate to the approved funding volume, which differs from the eligible expenditures that apply here. The savings are therefore converted on the basis of the funding efficiencies identified in the evaluation report for GHG savings or end-use energy savings for the applicable eligible expenditures of €352.6 million. The stated annual GHG savings and end-use energy savings apply from 2021 for an eight-year lifetime.

Links: Evaluation report for 2021 including results for 2019 and 2020: https://www.bmwk.de/Redaktion/DE/Evaluationen/Foerdermassnahmen/bundesfoerderung-fuer-energieeffizienz-in-der-wirtschaft.pdf

In order to achieve the goals of the energy transition for a comprehensive and far-reaching transformation of the energy supply and energy use in Germany, the federal government supports GHG avoidance and the reduction of energy requirements in industry and businesses through the funding programmes “Energy and Resource Efficiency in the Economy – Grant and Loan” and “Energy and Resource Efficiency in the Economy – Funding Competition”.

Key aims are to improve energy and resource efficiency and increase the renewable energy share in the provision of process heat in industry.

Energy and Resource Efficiency in the Economy – Grant and Loan

The “Energy and Resource Efficiency in the Economy – Grant and Loan” investment programme aims to promote the investments required to achieve the climate and energy efficiency targets in a cost-efficient and more effective manner.

Eligible investments are one or more investments for the replacement or new acquisition of high-efficiency systems or equipment for industrial and commercial use within the following technology criteria:

- Electric motors and drives
- Pumps for industrial and commercial use
- Fans
- Compressed air systems
- Systems for waste heat utilisation or heat recovery
- Insulation of industrial plants or plant components

Funding is also available for measures to provide process heat from solar collector systems, biomass installations and heat pumps. Funding continues to be available for the acquisition and installation of measurement and control technology and sensor technology for monitoring and efficient control of energy flows for

integration into an energy or environmental management system.

In addition to these individual measures, support is to be provided for investments in measures that are more complex and have a greater focus on systemic energy and resource-related optimisation of production processes.

Energy and Resource Efficiency in the Economy – Funding Competition

The funding competition is a funding programme that is essentially open to all participants, sectors and technologies. Investments directed at GHG emission avoidance are supported through a technology-open competitive process.

The central decision criterion for funding is the GHG reduction achieved per funding euro per year ("funding efficiency"). For this purpose, all project applications admitted to a competition round are ranked according to their funding efficiency and approved, taking into account the funds available per competition round. If the funding efficiency is the same, the project with the higher absolute GHG reduction is given preference.

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4.3.2. Providing advice on energy efficiency

Budget chapters and items:	6092 686 14
Eligible expenditures 2021:	€98.8 million
GHG emission reduction:	0.50 million t CO_2e p.a.
Other indicators:	1,951,000 MWh p.a. end-use energy savings
	5,283,333 MWh p.a. primary energy savings
	256,388 beneficiaries
Funding share:	The indicators are based on the eligible expenditures and therefore do not take into account any third-party funding.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: Evaluation of energy advice to private consumers, for residential buildings, non-residential buildings, installations and systems.

Links:
https://www.bafa.de/SharedDocs/Downloads/DE/Bundesamt/evaluation_energiesparberatung_energiechecks.html
https://www.bafa.de/DE/Energie/Energieberatung/Energieberatung_Wohngebaeude/energieberatung_wohngebaeude_node.html

The federal government provides funding for advisory services on energy consumption and corresponding measures for all end users, such as private households, small and medium-sized enterprises and public authorities. Advice is provided on topics such as increasing energy efficiency and the use of renewable energy (e.g. energy saving, insulation or modern heating technology) or optimising heating systems.

1. **Federal funding for independent energy advice for private consumers at consumer advice centres**

The energy advice service provided by consumer advice centres constitutes the largest unbiased advisory service on the subject of energy in Germany. Private households have been assisted in this way since 1978, with around 800 energy advisors at some 926 locations (nationwide coverage). In 2021, around 150,000 households received independent and unbiased advice on energy efficiency in buildings, including electricity saving, thermal insulation, modern heating technology and renewable energy. As a result of the funding, in-person, telephone and online energy consulting as well as webinars are free to residential consumers.

2. Federal funding for energy and electricity savings checkups for private households – Energy Checkups

In addition to the stationary advice, energy advisors come to consumers' homes in order to better address specific situations on site (building, system technology, including the use of renewable energy, equipment, lighting) and the needs of the consumers. In 2021, "energy checkups" were carried out on site in around 30,000 households.

3. Federal funding for energy advice for residential buildings (on-site advice, individual renovation roadmap) (EBW)

The funding is aimed at owners of residential buildings (private house or flat owners, housing associations and condominium owners' associations). A qualified energy consultant approved by the Federal Office of

Economics and Export Control (BAFA) examines the entire property and prepares a comprehensive energy consulting report (including an individual refurbishment roadmap). In addition to energy-saving potential, the report also assesses possible uses for renewable energy and the necessary investments, and shows the savings in heating costs and CO_2. Energy advice thus helps residential property owners to include energy efficiency and renewable energy sources in their planning and decision-making processes and to take advantage of energy-saving potential at the most opportune time for them. Building owners are better informed about the added value of energy modernisation measures and receive a sound basis for decision-making.

The funding is provided under funding guidelines. The improved funding conditions under the Climate Action Programme 2030 with regard to the provision of energy advice for residential properties (including on-site advice and the preparation of an individual refurbishment roadmap) and a bonus available since 1 January 2021 for implementing investment based on an individual refurbishment roadmap have resulted in a very large increase in demand. The aim is to create a strong incentive for all consumers to obtain energy advice for all refurbishment projects. Applications increased from around 10,500 in 2019 to 25,000 in 2020 and 74,000 in 2021.

4. Federal funding for energy consulting for non-residential buildings, facilities and systems (EBN)

On 1 January 2021, in accordance with the funding strategy of the Federal Ministry for Economic Affairs and Energy (BMWi), the funding for energy consulting in small and medium-sized enterprises was merged with the funding for energy consulting for non-residential buildings of municipalities and non-profit organisations. The funding guidelines expired on 31 December 2020. From 1 January 2021, the funding is provided under new funding guidelines, "Energy consulting for non-residential buildings, facilities and systems (EBN)".

The aim is to identify potential savings and support municipalities and companies in decision making on energy-efficient building refurbishment and energy-efficient construction projects. Funding is provided for measures such as:

- The compilation of a refurbishment strategy or refurbishment roadmap for commercial or municipal buildings (e.g. factory buildings, offices, schools and preschools) and for the construction of an energy-efficient (non-residential) new building (subsidy in the amount of 80% of the eligible consulting fee, up to a maximum of €8,000);
- An energy audit, i.e. a systematic inspection and analysis of the energy use and consumption of a facility, building, system or organisation in order to investigate energy flows, present the results of the analysis of the existing status, identify potential energy efficiency improvements and prepare an energy audit report on the analyses and results (subsidy in the amount of 80% of the eligible consulting fee, up to a maximum of €6,000);
- Energy consulting to assess suitability for an energy savings performance contract (contract information consulting) (subsidy in the amount of 80% of the eligible consulting fee, up to a maximum of €10,000).

In 2021, around 5,000 consultations took place.

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4.3.3. Industrial production of mobile and stationary energy storage units

Budget chapters and items:	6092 893 04
Eligible expenditures 2021:	€54.8 million
GHG emission reduction:	N/A
Other indicators:	10 beneficiaries
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) d) e)

Assumptions and limitations: Co-financing of eligible costs under IPCEI rules; projects can also be co-financed by the *Länder*. The stated expenditures relate only to the federal share.

Links: https://www.ipcei-batteries.eu/

Funding of battery cell production supports the development of innovative and sustainable processes for the industrial production of batteries for electric vehicles and other applications, together with the development of re-use and recycling systems. The funding projects, which are embedded in the Important Projects of Common European Interest (IPCEI) framework, will enable battery cells with a reduced carbon footprint to be produced in Germany and pave the way for large-scale recycling of battery raw materials. Individual projects at different stages of the battery value chain aim to improve the carbon footprint of batteries in each addressed segment.

A key funding objective in each individual project is an improvement in environmental performance (such as a GHG reduction as well as energy efficiency in battery production, resource input, etc.), which is tracked in project monitoring. The programme is accompanied by research to analyse the effectiveness of the entire funding measure in terms of the environmental objectives. This research has not yet been completed at the time of publication of the 2022 Impact Report.

Example projects:

- Umicore will contribute to the development of a sustainable battery in Europe, where key success factors include innovative technologies, responsible sourcing and closing the material loop by recycling.
- ElringKlinger will develop and industrialise an innovative cell housing design. The innovative design will reduce the number and complexity of components in the housing together with the need to consume energy-intensive resources such as aluminium and copper.

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4.4. National Climate Initiative

4.4.1. National Climate Initiative

Budget chapters and items:	6092 686 05
Eligible expenditures 2021:	€173.0 million
GHG emission reduction:	5.01 million t CO_2e over the entire impact period
Other indicators:	1,256 direct employees
	1,405 indirect employees
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b)

Assumptions and limitations: The GHG emission reduction for 2021 is estimated based on the eligible expenditures in the individual programmes of the National Climate Initiative and the net figures for the funding efficiency from the 2020/2021 evaluation report.

Links: Evaluation report 2020 and 2021: https://www.klimaschutz.de/de/ueber-die-initiative

The National Climate Initiative was launched in 2008 to actively promote climate action in all relevant target groups across society, including industry, public authorities, the education sector and consumers. To this end, it funds both information-based and investment-based greenhouse gas reduction projects. The funding covers a wide range of climate change mitigation activities, from the development of long-term strategies to specific support and financing measures in the energy sector, transport and business/industry that contribute to the reduction of greenhouse gas emissions. In particular, it enables people in civil society, local authorities, the education sector and the scientific community to develop and actively implement innovative approaches to climate action.

The eligible expenditures are distributed among 12 funding guidelines, of which the six largest programmes (corresponding to approximately 82.3% of the eligible expenditures in 2021) are as follows:

Funding programme	Eligible expenditures (in € million)	Impact and allocation of the examples below
Guidelines for the funding of climate change mitigation projects in municipalities (municipalities guidelines)	65.6	Approx. 4.55 million t CO_2e over the entire impact period
Guidelines for the funding of measures on refrigeration and air conditioning systems in business enterprises	19.9	Approx. 0.21 million t CO_2e over the entire impact period
Funding of innovative individual climate change mitigation projects in the industry, municipal, consumer and education sectors	20.9	“aktiv” electricity saving checkup only: approx. 0.03 million t CO_2e over the entire impact period
Climate Protection through Cycling funding call	20.2	Approx. 0.13 million t CO_2e over the entire impact period

Funding programme	Eligible expenditures (in € million)	Impact and allocation of the examples below
Field trials of trolleytrucks	8.1	N/A
Funding call for municipal climate protection model projects	7.6	Approx. 0.06 million t CO_2e over the entire impact period

Example of information projects:

"aktiv" electricity saving checkup (€8.0 million eligible expenditures); advice for 64,000 households and replacement of 5,200 refrigerators in the 2019-2022 funding period; CO_2 reduction of approximately 90,000 tonnes of CO_2e over the entire effective period. The funding share for 2021 is approx. 30%. Funded under the National Climate Initiative funding call for innovative individual climate change mitigation projects.

Examples of investment projects:

zeozweifrei Nah.Wärme ("CO_2-free district heat") in Bruchsal Südstadt (€0.7 million eligible expenditures); various heating systems installed in the 2018-2021 funding period (woodchip and wood pellet boilers, a solar thermal system, a combined heat and power plant and a natural gas peak load boiler). In addition, 1,400 m of district heat pipework was laid and a 100 m^3 heat storage tank installed for load balancing. CO_2 reduction totalling approximately 1,600 tonnes of CO_2e p.a. or approximately 40,000 tonnes of CO_2e over the entire impact period (15 years). The funding share for 2021 is approx. 24%. Funded under the National Climate Initiative funding call for municipal model climate change mitigation projects.

Climate-friendly bicycle station at the University of Cologne (€0.2 million eligible expenditures); a bicycle station built in the 2018-2021 funding period provides parking for some 1,000 bicycles, cycle hire, a cycle workshop and an electronic cycle guidance system that constantly tracks occupancy and guides users to free slots. The project helps promote everyday cycle use as a contribution to climate change mitigation. CO_2 reduction totalling approximately 290 tonnes of CO_2e p.a. or approximately 7,300 tonnes of CO_2e over the entire impact period (25 years). The funding share for 2021 is approx. 6%. Funded under the National Climate Initiative "Climate Protection through Cycling" funding call.

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4.4.2. National climate action measures

Budget chapters and items:	6092 686 23
Eligible expenditures 2021:	€13.6 million
GHG emission reduction:	N/A
Other indicators:	15 Projects funded in first two funding phases Mobility Competition
Funding share:	N/A
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: In 2021, projects under budget item 1601 892 01 Environmental Innovation Programme were co-financed in the amount of €7.6 million from the eligible expenditures. The impact reported here relates to the €6 million difference. Please see fact sheet 3.2.3 for the impact of the Environmental Innovation Programme.

Links: https://www.bmuv.de/mobilwandel

This budget item was used to fund measures which contribute to achieving national climate targets but which comprise single projects or pilot projects and/or have a small budget, making it impracticable to assign them a separate budget item. Projects under the Environmental Innovation Programme were also funded in the amount of €7.6 million in 2021. Their impact is reported under 3.2.3.

Projects under the Environmental Innovation Programme

Funding was provided for large-scale demonstration projects that show how plants can be adapted for the first time to an advanced state of the art to reduce pollution, how advanced processes and combinations of processes can be implemented to avoid and reduce pollution, and how environmentally compatible products and environmentally friendly substitutes can be manufactured and used.

Sustainable mobility competitions („#mobilwandel2035“)

The Future of Sustainable Mobility competition aims to help local authorities develop and visualise future mobility in the context of their urban development in as practical a way as possible, and help them take action to realise their vision. The focus is on approaches to environmentally friendly mobility that improve quality of life in cities and rural areas. Leveraging the potential of digitalisation and developments in the field of artificial intelligence, the aim is to develop a vision of what sustainable and environmentally friendly mobility in the community or region concerned could and should look like in 2035, and to derive a detailed action plan for the years ahead.

The competition in figures:

- 140 competition entries were submitted
- From these, 10 project outlines were selected by an expert jury for the 1st funding phase
- 1st funding phase lasted 10 months with funding totalling €1.5 million
- 5 projects were awarded prizes and selected for the 2nd funding phase

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5. Agriculture, forestry, natural landscapes and biodiversity

The agricultural and forestry sector, more than any other area of the economy, is under direct pressure to adapt to the impacts of climate change and to protect natural resources, ecosystems and biodiversity. In addition, the sector also plays a central role in climate change mitigation.

With around 61 million tonnes of CO_2 equivalents, the agricultural sector accounted for 8% of total German emissions in 2022. Compared to the previous year, agricultural emissions fell by 1.5%.[70] The sector also includes land use, land use change and forestry (LULUCF) measures. LULUCF takes into account all land-based sources and sinks of greenhouse gas emissions from inhabited areas, wetlands, forests, arable land and grassland. This includes, for example, the release of greenhouse gases through deforestation, soil cultivation and ploughing-up of grassland, or the removal of carbon dioxide from the atmosphere through biomass growth in forests (sinks) and through wood products. In general, the LULUCF sector acts as a sink for carbon dioxide in Germany. The LULUCF sector bound 1.8 million tonnes of CO_2 equivalent from the atmosphere in 2022.[71]

Agriculture and forestry, as a sector of the economy that covers the whole of Germany, thus play a key role in achieving Germany's overall sustainability, land use and climate goals.

The eligible expenditures of the sector amount to €767.0 million and are distributed across 24 budget items in the following categories:

- Agriculture (5 budget items with €83.4 million in eligible expenditures),
- Land use, land use change and forestry (LULUCF) (8 budget items with €212.9 million in eligible expenditures),
- Biodiversity and natural landscapes (7 budget items with €234.3 million in eligible expenditures) and
- Coastal and flood protection (4 budget items with €236.4 million in eligible expenditures).

[70] See p. 8 of the Climate Action Report 2023; data updated on the basis of the final greenhouse gas emissions balance published by the Federal Environment Agency, see https://www.umweltbundesamt.de/en/press/pressinformation/detailed-greenhouse-gas-emissions-figures-for-2022

[71] See Climate Action Report 2023, p. 31

5.1. Agriculture

5.1.1. Subsidies to fund organic farming and other sustainable forms of agriculture (BÖLN)

Budget chapters and items:	1005 686 43
Eligible expenditures 2021:	€12.9 million
GHG emission reduction:	N/A
Other indicators:	199 subprojects
	Examples: see below
Funding share:	100%
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) d) e) f)

Assumptions and limitations: Most of the R&D projects run for three years. The project participants are predominantly universities and departmental research institutions that receive 100% funding.

Links: https://www.bundesprogramm.de/
https://www.bundesprogramm.de/was-wir-tun/projekte-foerdern/foerderung-von-forschungs-und-entwicklungsvorhaben

The Federal Programme for Organic Farming and Other Sustainable Forms of Agriculture (BÖLN) is a key element in promoting and expanding organic farming and other forms of sustainable agriculture. The programme aims to remove impediments to growth along the entire value chain. To this end, a wide range of research projects and knowledge transfer, information and training activities are being developed to promote, for example, high-welfare livestock farming, particularly environmentally friendly and resource-efficient forms of cultivation and the strengthening of regional production, processing and marketing systems.

The eligible expenditures in the programme relate to research and development projects, including knowledge transfer. Funding is provided for projects on sustainable and organic cultivation and livestock farming practices. These mainly relate to the following areas:

- Environmentally friendly and organic crop production (including risk mitigation in crop protection, in particular through the use of non-chemical and biological crop protection methods, reducing erosion, soil and nutrient conservation by means of low-tillage cultivation methods, and maintenance of soil fertility, in particular by maintaining humus content on farmed land at levels characteristic of the location)
- Optimising nitrogen and energy input (including through the cultivation of legumes, efficient fertiliser and pesticide use and reductions in greenhouse gas emissions)
- Breeding research as a basis for breeding varieties that are well-suited to sustainable, organic production, processing and marketing
- Safeguarding and sustainably increasing yields by, among other things, exploiting the potential of genetic resources
- Furthering the development of high-welfare, climate-friendly livestock farming practices (such as systems for providing livestock with access to the open air)
- Development of feeding strategies suitable to the species and optimised to reduce emissions of greenhouse gases per unit of animal-based food produced

- Input/output-efficient food processing

Quantification of impacts such as CO_2 reduction potential is not possible for research and development projects where the outcomes will only be applied in the future after project completion. Areas with potential include:

- Increasing sustainability in crop and livestock production
- Resource-efficient, sustainable and climate change-adapted crops
- Soil and nutrient management as a contribution to climate change mitigation
- Reduction in the use of inputs generated on the basis of fossil raw materials (such as peat, fertilisers and pesticides)
- Ensuring sustainable nutrition of farm animals under changing climatic conditions
- Reduction of emissions

The following joint projects can be cited as examples of the eligible expenditures:

Project name (click on the project name to visit the website)	Eligible expenditures (in € million)	Number of sub-projects
NutriNet – Expert/practitioner network to improve nutrient management in organic farming (identifiers 2818OE014, 067, 068, 069, 070, 071, 072, 073, 074, 075) https://www.nutrinet.agrarpraxisforschung.de/	0.98	10
ProBio – Studies on the optimum production and agronomic use of compost from organic and green waste in organic farming (identifiers 2818OE009, 118, 119, 120, 121, 122) https://orgprints.org/id/eprint/36440/ https://www.mdpi.com/2077-0472/13/3/740	0.24	6
TerÖko: Peat-reduced and peat-free substrates for organic herb production – testing, optimisation and knowledge transfer (identifiers 2819OE070, 140, 141, 142, 146) https://orgprints.org/id/eprint/38524/	0.21	5
ÖkoHuhn2 – Dual-purpose chickens in organic farming – breeding and potential identification of suitable origins and implementation in practice (identifiers 2819OE044, 061, 086, 087, 116) https://orgprints.org/id/eprint/43317/	0.85	5
ZuchtmetPopMais – Breeding methods, yield performance and adaptability of maize populations and development of a diverse population for science, breeding and practical agriculture (identifiers 2815NA106, 169, 170, 171, 200) https://orgprints.org/id/eprint/32001/	0.15	4
ComBee – Interactions between landscape structure and combined agri-environmental measures on the diversity, population development and health status of wild and honey bees (identifiers 2819OE115, 2819OE156) https://orgprints.org/id/eprint/31278/	0.2	2
ReBIOscover – Rediscovery of regional ancient grain varieties for the sustainable production of organic food (identifiers 2819OE021, 133, 134, 135) https://orgprints.org/id/eprint/39126/	0.2	3
Total	**2.83**	**35**

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5.1.2. Funding of innovation in the area of food, agriculture and health-related consumer protection

Budget chapters and items:	1005 686 31 and 1005 893 31
Eligible expenditures 2021:	€45.2 million
GHG emission reduction:	N/A
Other indicators:	793 funded subprojects (beneficiaries)
Funding share:	Approx. 75% of project costs
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) f)
Assumptions and limitations: --	
Links: --	

The aim of the programme is to support technical and non-technical innovations in Germany. Funding is provided for projects in thematic areas such as agricultural engineering, crop breeding, crop protection, livestock breeding, livestock farming and livestock health, food safety and quality, nutrition, food production, aquaculture and fisheries.

Quantification of impacts such as CO_2 reduction potential is not possible for research and development projects where the outcomes will only be applied in the future after project completion. Areas with potential include:

- Increasing sustainability in crop and livestock production and urban farming
- Resource-efficient and climate change-adapted crops
- Soil protection as a contribution to climate change mitigation
- Reduction in the use of inputs generated on the basis of fossil raw materials (such as peat, fertilisers, pesticides (non-chemical pesticides) and plastic packaging)
- Ensuring sustainable nutrition of farm animals under changing climatic conditions
- Efficiency gains and input reduction through digitalisation and AI in production and the value chain
- Reduction of emissions in livestock farming
- Promotion of sustainable, climate-friendly and environmentally friendly aquaculture, including algae and in particular microalgae.

The following projects can be cited as examples that include eligible expenditures:

Joint project name (acronym in brackets)	Eligible expenditures (in € million)	Number of subprojects
Sensor data-based map services for soil-conserving management and environmentally friendly fertilisation by combining differently scaled geodata – cooperation with and consulting for machinery rings in transfer to practice through mobile agricultural portals (SOFI)	0.19	4
Selective control of grassland weeds with waterjets (SELBEWAG)	0.04	5

Joint project name (acronym in brackets)	Eligible expenditures (in € million)	Number of subprojects
Optimisation and production of a near-series prototype for precise placement of liquid substrates in soils with verification of increased efficiency in terms of nitrogen (LiqInject)	0.53	5
Open Circular Collaboration Platform for Sustainable Food Packaging from Plastics (COPPA)	0.06	7
Procedure for the production of a peat moss substitute from champost and residues of biogas plants (BIOTORF)	0.05	2
Agrophotovoltaics as a resilience concept for adaptation to climate change in fruit growing (APV-Obstbau-BLE)	0.08	2
Innovative and model-based agricultural tool to support subfield-specific soil organic carbon management to enhance the use of the soil as a carbon sink (CarboCheck)	0.21	3
Reduction of ammonia and greenhouse gas emissions and optimisation of nitrogen productivity through innovative techniques of slurry and fermentation-residue application in growing stocks (GuelleBest)	0.06	4
Partial deep tillage – technical and technological solutions for climate change mitigation and yield security in agriculture (CarbonTillage)	0.12	2
Reduction of ammonia emissions in open-ventilated cattle barns through the use of a urease formulation (Prax-REDUCE)	0.33	7
Total	**1.67**	**38**

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5.1.3. Subsidies to fund measures for improving energy efficiency in agriculture and horticulture (including investments)

Budget chapters and items:	6092 686 22 and 6092 893 07
Eligible expenditures 2021:	€25.3 million
GHG emission reduction:	0.028 million t CO_2e p.a.
Other indicators:	876 funding beneficiaries for professional energy consulting and investment in climate-friendly technical systems to reduce CO_2 emissions
Funding share:	Between 20% and a maximum of 50% in the case of investment in climate-friendly technology (depending on the funding area) and 80% in the case of professional energy consulting
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)

Assumptions and limitations: The data on reductions and the number of beneficiaries relates to the projects for which funding was paid out in 2021, some of which began to be implemented in 2020. The eligible expenditures comprise expenditures to fund energy consulting and investment projects. The sum total of GHG emission reductions is based on expert appraisals for each individual project and relates to the investment projects.

The applicant engages an energy consultant registered with the Federal Office for Agriculture and Food (BLE), who provides a report determining the GHG reduction that an agricultural holding can achieve by making an investment. Depending on the subject matter, methods used include measurements, analysis of technical data and full or partial surveys, including extrapolations. This consulting is also eligible for funding. The applicant submits the report when applying for the investment funding. Specific GHG reductions cannot be attributed to the funding of energy consulting for individual enterprises as the consulting only identifies an enterprise's potential reductions. In about 70% of cases, however, the funded consulting led to investment measures applied for and funded under the programme. The figures therefore relate to the sum total of the expenditures for the energy consulting and the investment projects relative to the GHG reductions from the investment projects, comprising the total funding efficiency of the programme.

Links: https://www.ble.de/energieeffizienz

The federal programme on energy efficiency and CO_2 reduction helps agriculture and horticulture to become more climate-friendly. Funding incentives are provided to support agriculture and horticulture in the transition to climate-friendly technologies and renewable energy and heat generation for primary production.

Small and medium-sized agricultural and horticultural holdings can be provided with funding incentives for investment in technical climate change mitigation measures such as purchasing or retrofitting cross-sectional technologies (exhaustively listed in a "positive list"), more complex energy efficiency projects, renewable energy installations to supply the enterprise, or the use of purchased district heating or cooling. In addition, funding can be provided for energy efficiency measures to reduce energy consumption or to convert agricultural and horticultural machinery to alternative forms of propulsion by direct electrification or switching to sustainable biofuels.

There are also funding incentives for enterprises that make climate-friendly

investments in the construction of new installations for the generation and provision of renewable energy and heating or cooling. The requirement is that the investment must lead to significant reductions in farm carbon emissions or the connecting lines and distribution networks must enable the provision of energy-efficient district heating and cooling for farm use. Funding can additionally be provided for individual measures that reduce the energy consumption or carbon emissions of agricultural and horticultural machinery by equipping it with more efficient or alternative means of propulsion.

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5.2. Land use, land use change and forestry (LULUCF)

5.2.1. Subsidies to fund research, development and demonstration projects in the area of renewable resources and to fund national sustainable forestry projects (including investments)

- Subsidies to fund research, development and demonstration projects in the area of renewable resources and to fund national sustainable forestry projects
- Subsidies to fund research, development and demonstration projects in the area of renewable resources (investments)
- Subsidies to fund the sustainable use of wood

Budget chapters and items:	1005 686 11, 1005 893 11 and 1005 686 15
Eligible expenditures 2021:	€47.6 million
GHG emission reduction:	N/A
Other indicators:	259 beneficiaries
	636 ongoing projects
	of which 174 projects newly approved
Funding share:	88.7%
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) d) e) f)

Assumptions and limitations: Beneficiaries provided with funding from multiple budget items are only counted once in the total for all beneficiaries.

Links: --

The renewable resources funding programme funds research, development and demonstration projects on renewable resources and pursues a wide variety of goals for this purpose, including efficient and environmentally friendly resource use, greenhouse gas avoidance or sequestration and biodiversity conservation.

Quantification of impacts such as CO_2 reduction potential is not possible for R&D projects where the outcomes will only be applied in the future after project completion. The following projects can be cited as examples of the eligible expenditures under the budget items:

Programme name (click on the identifier to visit the website)	Eligible expenditures (in € million)	Number of beneficiaries	Number of projects
Budget item 1005 686 11 – total	**22.7**	**150**	**281**
NAEHRWERT joint project 2220NR255A, 2220NR255B, 2220NR255C	0.1	3	3
Win-N joint project 2220NR082A, 2220NR082B,, 2220NR082C, 2220NR082D, 2220NR082E, 2220NR082F, 2220NR082G	0.2	7	7

Programme name (click on the identifier to visit the website)	Eligible expenditures (in € million)	Number of beneficiaries	Number of projects
Contura joint project 2220NR061A, 2220NR061B, 2220NR061C 2220NR061D, 2220NR061E, 2220NR061F, 2220NR061G	0.1	7	7
Budget item 1005 893 11 – total	**20.2**	**144**	**278**
DuroBast joint project (6 subprojects) 2220NR090A, 2220NR090B, 2220NR090C, 2220NR090D, 2220NR090E, 2220NR090F	0.2	5	5
IntelliWay joint project (8 subprojects) 2220NR051A, 2220NR051B, 2220NR051C, 2220NR051D, 2220NR051E, 2220NR051F, 2220NR051G, 2220NR051H	0.1	6	6
3D-NaturDruck joint project 2220NR295A, 2220NR295B, 2220NR295C, 2220NR295D	0.1	4	4
Budget item 1005 686 15 – total	**4.6**	**39**	**77**
ASKIVIT joint project 2220HV048A, 2220HV048B	0.1	2	2
KI_Wood-ID joint project 2220HV063A, 2220HV063B	0.1	2	2
BioPlas4Paper joint project 2220HV017A, 2220HV017B, 2220HV017C	0.1	3	3

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5.2.2. Forestry measures

- Grants to fund forestry measures (including investments)
- Grants to fund measures that combat the effects of extreme weather events in forests (including investments)

Budget chapters and items:	Annex 1 to 1003(1095) 632 41, 882 41, 632 42 and 882 42					
Eligible expenditures 2021:	€142.9 million					
GHG emission reduction:	N/A					
Other indicators:	68,508 funding cases					
	9,336 ha reforested area (as part of forest transformation of close-to-nature forest management)					
	297 ha grant-aided area (for planting as part of initial afforestation (planting of new forest))					
	10.3 million m³ of processed infested wood					
	33,453 ha of grant-aided area under contract-based forest nature conservation					
Funding share:	60% (federal government funding share)					
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a)	b)				f)
Assumptions and limitations: GAK reporting by the *Länder*, reporting period 2021						
Links: https://www.bmel.de/DE/themen/laendliche-regionen/foerderung-des-laendlichen-raumes/gemeinschaftsaufgabe-agrarstruktur-kuestenschutz/gak.html https://www.bmel-statistik.de/fileadmin/daten/0002000-2021.pdf https://www.bmel.de/DE/themen/wald/wald-in-deutschland/duerrehilfen-waldbesitzer.html https://www.bmel-statistik.de/fileadmin/daten/5000100-2021.pdf						

The Joint Task of the federal government and *Länder* for the Improvement of Agricultural Structures and Coastal Protection (GAK) is the most important national funding instrument for efficient, competitive agriculture and forestry geared to future requirements, coastal protection and vibrant rural areas. It contains a wide range of agricultural structure-related and infrastructure measures and thus largely covers the scope of the European Agricultural Fund for Rural Development (EAFRD).

Details on the principles, objectives and procedural issues are regulated in the Act concerning the Joint Task for the Improvement of Agricultural Structures and Coastal Protection (*Gesetz über die Gemeinschaftsaufgabe "Verbesserung der Agrarstruktur und des Küstenschutzes"*, GAK Act). To fulfil the joint task, a joint framework plan is drawn up by the federal government and the *Länder* for the period of a four-year financial plan. The GAK framework plan identifies the measures and the objectives associated with them, and describes the funding principles, funding recipients, funding requirements, and the type and amount of funding. The GAK framework plan is adopted by the Planning Committee for Agricultural Structure and Coastal Protection (PLANAK), which brings together the federal and *Länder* ministers of agriculture and the Federal

Minister of Finance. It is valid for the period of the financial plan and is reviewed annually and adapted to current developments.

With the help of the above-mentioned funds, measures in the following areas were financed in 2021 (federal share: 60%, *Länder* share: 40%) and implemented by the *Länder*:

- **Close-to-nature forest management** (17,601 funding cases; indicator: 9,336 ha reforested area): In the area of forest transformation, which is an element of close-to-nature forest management, measures that are eligible for funding include reforestation and the establishment of undergrowth and the understorey (including natural regeneration) by sowing and planting site-adapted tree and shrub species. This includes crop preparation, forest edge formation, and crop protection and care for the first five years. A sufficient proportion of native tree species must be maintained.
- Initial afforestation (5,309 funding cases; indicator: 297 ha grant-aided area for sowing and planting as part of initial afforestation): Initial afforestation includes, for example, sowing and planting, in each case including crop preparation, forest edge formation and securing the crop for the first five years. It also includes surveys such as site assessments carried out in preparation.
- **Combating the effects of extreme weather events in forests** (41,380 funding cases; indicator: 10,374,345 m^3 processed infested wood): Forest protection measures as part of measures to combat the effects of extreme weather events in forests include combating harmful organisms by locating and processing infested timber (e.g. sanitary felling, debarking, bark disposal and extracting and transporting timber) and other measures to reduce the host suitability of timber, timber waste or brushwood so that the material does not pose, or ceases to pose, a hazard.
- **Contract-based forest nature conservation** (4,218 funding cases, indicator: 33,453 ha of grant-aided area under contract-based forest nature conservation): Contract-based forest nature conservation measures aim to protect, conserve and restore forest habitats of wild animal and plant species and to improve the characteristic biodiversity of forest ecosystems. Funding is provided for the management, maintenance or set-aside of land used for, or capable of being used for, forestry.

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5.2.3. Forest Climate Fund

Budget chapters and items:	6092 686 06					
Eligible expenditures 2021:	€22.4 million					
GHG emission reduction:	N/A					
Other indicators:	112 beneficiaries					
	280 ongoing projects					
	of which 94 projects newly approved					
Funding share:	98.7%					
EU environmental objectives under Article 9 of the Taxonomy Regulation:		b)				f)

Assumptions and limitations: Specific GHG reduction figures cannot be quantified and stated due to the indirect impact of research results.

Links: https://www.waldklimafonds.de/projekte/projektdatenbank

The Federal Ministry of Food and Agriculture (BMEL) and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) use the Forest Climate Fund to support measures to preserve and enhance the carbon reduction potential of forests and timber and to adapt forests to climate change. In the 2021 fiscal year, the two ministries spent a total of around €22.5 million from the Forest Climate Fund, which is managed jointly. A total of 94 projects were newly approved in the 2021 reporting year. These are divided among the funding priorities in the funding guidelines as follows:

- Adaptation of forests to climate change (5 projects)
- Increasing timber product storage, CO_2 reduction and substitution with timber products (8 projects)
- Research and monitoring (67 projects)
- Information and communication (14 projects)

There were 280 ongoing projects in 2021 with total funding of €104 million, of which €22.4 million was disbursed in 2021. The Forest Climate Fund is intended to implement measures of special national interest that serve to adapt forests to climate change and maintain the indispensable contribution of close-to-nature, richly structured and biodiverse forests to safeguarding the natural foundations of life in the long term. The BMEL and BMU have used the Forest Climate Fund since 2013 primarily to support research, development and demonstration projects as well as communication and exchange between the scientific community and practitioners on the topics of forest climate change mitigation and adaptation.

The Forest Climate Fund funding guidelines expired at the end of 2022. They were then revised to provide funding more specifically for research and development projects on forest and timber climate change mitigation and forest climate change adaptation.

Project name	Brief description (click on the identifier to visit the website)	Eligible expenditures (in € million)	Duration
BENEATH	Carbon sequestration in the soil of close-to-nature beech forests – hydrological regime and deadwood as key regulating factors in a changing climate 2218WK53X4	0.5	1 September 2021 to 31 August 2025
RubraSelect (7 subprojects)	Joint project: Selection and characterisation of high-quality reproductive material with increased drought stress tolerance for Quercus rubra 2220WK03A4; 2220WK03B4; 2220WK03C; 2220WK03D; 2220WK03E; 2220WK03F; 2220WK03G	0.2	1 July 2021 to 30 September 2024
Survivor Oaks (2 subprojects)	Joint project: Adaptation potential of oaks to biotic and abiotic stress in the context of climate change 2220WK09A4; 2220WK09B4	0.1	1 July 2021 to 31 December 2025
PherUbS (2 subprojects)	Joint project: Development of automated pheromone traps for the monitoring of insect and quarantine pests 2220WK38A4; 2220WK38B4	0.1	1 July 2021 to 31 December 2024
Timber safety barrier (3 subprojects)	Joint project: Development of a sustainable safety barrier system consisting of high-strength timber composite elements 2218WK46A3; 2218WK46B3; 2218WK46C3	0.1	1 July 2021 to 30 June 2024
Waldcoaching inklusive (2 subprojects)	Joint project: *Waldcoaching inklusive* ("Inclusive forest coaching") – Analysis of the status of school teaching on the subject of forests and enhancing urban school students' affinity to forests 2220WK26A5; 2220WK26B5	0.2	1 April 2021 to 31 July 2024
FraxVir (4 subprojects)	Joint project: Detection, characterisation and analyses of the occurrence of viruses and ash dieback in special stands of Fraxinus excelsior – supplementary study to FraxForFuture 2220WK40A4; 2220WK40B4; 2220WK40C4; 2220WK40D4	0.2	1 October 2021 to 31 December 2024
	Total	**1.4**	

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5.3. Biodiversity and natural landscapes

5.3.1. Grants for funding environmentally friendly land management geared to market and local conditions, including contractual nature conservation and landscape management (including investment in nature conservation)

Budget chapters and items:	Annex 1 to 1003 (1095) 632 33 and 882 31
Eligible expenditures 2021:	€119.3 million
GHG emission reduction:	N/A
Other indicators:	155,091 funding cases
	3,753,737 ha of grant-aided area
	26,068 funded livestock units
	410,657 grant-aided trees
Funding share:	60% (federal government funding share)
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) b) f)

Assumptions and limitations: GAK reporting by the *Länder*, reporting period 2021.

Figures for the two indicators "funding cases" and "grant-aided area" are only available for the total expenditure of approximately €120.3 million for measures under the above budget chapters and items, funded through GAK funding area 4 (excluding measure groups F and J). According to the 2021 GAK reporting, funding was provided for a total of 156,232 funding cases and 3,781,341 ha of grant-aided area. To exclude alcohol, the 0.73% share of land under hopyards and vineyards based on data from the Federal Statistical Office was applied equally to the expenditures and indicators.

Links: https://www.bmel.de/DE/themen/laendliche-regionen/foerderung-des-laendlichen-raumes/gemeinschaftsaufgabe-agrarstruktur-kuestenschutz/gak.html

https://www.bmel-statistik.de/fileadmin/daten/0002000-2021.pdf

https://www.bmel-statistik.de/fileadmin/daten/4000100-2021.pdf

For general remarks on the Joint Task for the Improvement of Agricultural Structures and Coastal Protection (GAK), see Section 5.2.2 "Forestry measures".

In addition to the contribution to environment protection and climate change mitigation, these measures are primarily aimed at the conservation and promotion of biodiversity, the improvement of soil structure and the reduction of fertiliser and pesticide inputs. The federal government contributes 60% of the funding costs, and implementation is carried out by the *Länder*.

When carrying out agri-environment-climate measures (AECMs) or measures such as introducing and continuing organic farming, famers voluntarily commit, generally for a period of five years, to complying on their farms with the AECM farming requirements stipulated by the *Länder* in funding guidelines. The requirements stipulated in those funding guidelines must exceed the statutory minimum requirements.

With the help of the above-mentioned funds, measures in the following areas were financed in 2021:

- Cooperation in rural regions for environmentally friendly land management geared to market and local conditions, including contract-based nature conservation and landscape management (14 funding cases);

- Organic farming and other particularly sustainable whole-farm practices (40,219 funding cases; indicator: 1,809,382 ha of grant-aided area);
- Particularly sustainable practices in arable farming and annual specialised crops (45,319 funding cases; indicator: 1,280,006 ha of grant-aided area);
- Particularly sustainable practices on permanent grassland (49,814 funding cases, indicator: 627,743 ha of grant-aided area);
- Particularly sustainable practices for permanent crops (8,598 funding cases, indicators: 6,416 ha of grant-aided area and 410,657 grant-aided trees);
- Conservation of the diversity of genetic resources in agriculture (2,498 funding cases; indicator: 26,068 grant-aided livestock units);
- Non-productive investment in nature conservation (1,107 funding cases);
- Contract-based nature conservation (8,663 funding cases; indicator: 57,792 ha of grant-aided area).

Farmers who commit to applying these measures contribute to the preservation of natural capital and ecosystem capacity, on which the economy and society both equally depend.

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5.3.2. Federal share of financing for the special framework programme for insect protection measures (including investments)

Budget chapters and items:	Annex 1 to 1003 (1095) 632 97 and 882 97
Eligible expenditures 2021:	€57.7 million
GHG emission reduction:	N/A
Other indicators:	140,260 funding cases
	720,678 ha of grant-aided area
Funding share:	60% (federal government funding share)
EU environmental objectives under Article 9 of the Taxonomy Regulation:	a) f)

Assumptions and limitations: GAK reporting by the *Länder*, reporting period 2021.

Figures for the two indicators "funding cases" and "grant-aided area" are only available for the total expenditure of approximately €58.26 million for measures under the GAK framework plan on insect protection. According to the 2021 GAK reporting, funding was provided for a total of 141,292 funding cases and 725.978 ha of grant-aided area. To exclude alcohol, the 0.73% share of land under hopyards and vineyards based on data from the Federal Statistical Office was applied equally to the expenditures and indicators.

Links: https://www.bmel.de/DE/themen/laendliche-regionen/foerderung-des-laendlichen-raumes/gemeinschaftsaufgabe-agrarstruktur-kuestenschutz/gak.html

https://www.bmel-statistik.de/fileadmin/daten/0002000-2021.pdf

https://www.bmel-statistik.de/fileadmin/daten/7000300-2021.pdf

For general remarks on the Joint Task for the Improvement of Agricultural Structures and Coastal Protection (GAK), see Section 5.2.2 "Forestry measures".

Measures for environmentally friendly land management geared to market and local conditions have long been funded under the Joint Task for the Improvement of Agricultural Structures and Coastal Protection (GAK). In the 2016 revision of the GAK Act, this funding area was supplemented and explicitly extended to include measures for environmentally friendly land management including contractual nature conservation and landscape management. To reverse the trend in insect decline, the existing measures need to be reinforced and new measures implemented to benefit insects. The funding for environmentally friendly land management geared to market and local conditions including contractual nature conservation and landscape management under the regular GAK framework plan is therefore to be supplemented.

In order to meet the additional funding needs required for these priority measures, additional federal funding is made available to the *Länder* under this special framework plan. This also implements a key measure under the federal government's Action Programme for Insect Protection. The federal government contributes 60% of the funding costs and implementation is carried out by the *Länder*.

For example, farms that commit to agri-environment-climate measures (AECMs) and provide areas of flowering vegetation for bees and other insects can apply for funding in their respective *Länder*.

Measures supported with the above funding in 2021 include the following:

- Organic farming practices (6,000 funding cases; indicator: 279,089 ha of grant-aided area)

- Integration of natural structural features of farmland (19,945 funding cases, indicator: 52,565 ha of grant-aided area)
- Particularly sustainable practices on permanent grassland (7,537 funding cases, indicator: 86,444 ha of grant-aided area)
- Non-productive investment in nature conservation (2,568 funding cases)
- Contract-based nature conservation (105,242 funding cases; indicator: 307,880 ha of grant-aided area)

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5.3.3. Grants to fund measures within the federal programme for biodiversity

Budget chapters and items:	1604 685 01
Eligible expenditures 2021:	€39.7 million
GHG emission reduction:	Pursues other objectives
Other indicators:	99 projects
Funding share:	**See project list** The stated funding share includes multi-year federal funding and third-party funding that is included in the total cost.
EU environmental objectives under Article 9 of the Taxonomy Regulation:	f)

Assumptions and limitations: A detailed evaluation is only available for the entire period 2011-2022.

Links: https://biologischevielfalt.bfn.de/bundesprogramm/ueberblick/
https://www.bfn.de/bpbv-projektevaluation

Expenditures within the federal programme for biodiversity serve to fund measures under the Federal Biological Diversity Programme to implement the National Strategy on Biological Diversity. Programme funding priorities include:

- Securing ecosystem services
- German national responsibility species
- Biodiversity hotspots in Germany
- Additional measures of particular representative importance for the Strategy
- Urban nature (new from 2021)

The largest projects of 2021 are presented as examples in the following (by funds disbursed in 2021; corresponding to 22.4% of eligible expenditures in 2021).

Project name (click on the profile to visit the website)	Eligible expenditures (in € million)	Total expenditures (in € million)	Funding share (in %)	Duration
Luppe	3.39	14.86	22.8	2012-2023
	Revitalisation of the Elster-Luppe floodplain from Leipzig to Schkeuditz			
Urban nature	1.26	2.22	56.5	2019-2024
	A nationwide competition, “Stadtnatur – Kommunen für Insekten” (“Urban nature – local authorities helping insects”) aims to support local authorities in doing more for urban nature and hence to protect insects in urban areas and their immediate surroundings.			
Southern Harz gypsum karst	0.92	4.54	20.3	2018-2024
	The primary aim of the project is the sustainable conservation of the unique habitat and species diversity of the southern Harz region Zechstein belt.			
Brommi	0.66	6.14	10.7	2020-2025
	The Biosphere Reserves as Model Regions for Insect Protection (Brommi) project targets agriculturally dominated areas of five biosphere reserves,			

Project name (click on the profile to visit the website)	Eligible expenditures (in € million)	Total expenditures (in € million)	Funding share (in %)	Duration
	where it aims to select, possibly adjust and develop, establish and assess the effectiveness of measures benefiting insects.			
European flat oyster	0.60	4.66	12.9	2018-2024
	Reintroduction of the European flat oyster as a key species with a special ecological function in the ecosystem of the North Sea			
Nature watchers	0.58	2.16	26.7	2020-2024
	The NABU naturgucker-Akademie (“Nature and Biodiversity Conservation Union Nature Watchers Academy”) provides professional, competence-oriented training in order to bring about a substantial and lasting increase in the number of people interested in species at various knowledge levels and to enhance their knowledge about the subject-matter.			
Fruit growing	0.51	3.32	15.2	2016-2022
	Promotion of biodiversity and ecosystem services in commercial fruit growing.			
Garden dormouse	0.48	1.71	28.0	2018-2024
	The “Spurensuche Gartenschläfer” (“Tracking the Dormouse”) project aims to investigate the causes of the decline in the garden dormouse population. The findings will be used to develop an effective dormouse conservation strategy.			
Venturing urban wilderness	0.48	1.48	32.2	2016-2021
	Urban surroundings and wilderness are often seen as opposites that cannot coexist. By creating a new aesthetic vision of urban wilderness, the project aims to resolve this contradiction and improve the acceptance of extensively managed green and ecological succession spaces in cities.			

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5.3.4. Grants for the establishment and long-term protection of areas of nature and landscapes of national importance (chance.natur)

Budget chapters and items:	1604 882 01					
Eligible expenditures 2021:	€11.9 million					
GHG emission reduction:	Pursues other objectives					
Other indicators:	157,331 ha project area					
	19 projects					
Funding share:	**See project list** The stated funding share includes multi-year federal funding and third-party funding that is included in the total cost.					
EU environmental objectives under Article 9 of the Taxonomy Regulation:						f)

Assumptions and limitations: --

Links: Click the project name to view the project profile.

The "chance.natur" programme promotes the establishment and long-term protection of areas of nature and landscape of national importance. Through the programme, the federal government makes an important contribution to the protection of biological diversity and natural heritage in Germany.

The largest projects of 2021 are briefly described in the following (corresponding to 74% of eligible expenditures in 2021).

Project name (click on the profile to visit the website)	Eligible expenditures (in € million)	Total expenditures (in € million)	Funding share (in %)	Duration	Grant-aided area (ha)
Lower Havel Lowlands (Brandenburg/ Saxony-Anhalt)	2.51	67.98	3.7	2009-2025	9,000
	Large, near-natural floodplains (damp meadows and oxbows) either side of the River Havel, with prolonged flooding. The area, much of which is designated as wetlands of international importance (a Ramsar site) and a Natura 2000 site, is an important breeding habitat for numerous meadow and water birds (including the ruff, black-tailed godwit, corncrake, great bittern, red-necked grebe and black tern). It is also one of the most important resting places in Central Europe for cranes, geese, swans and ducks. Other federal Red List vertebrate species found in the area include beaver, otter, fire-bellied toad and nine species of bat. Major threats result from the modern-day, modified state of the Havel, impoundments, land improvement measures and nutrient inputs.				
chance7 II (North Rhine-Westphalia)/ Siebengebirge II (North Rhine-Westphalia)	1.15	15.15	7.6	2015-2025	9,752
	Due to its geology and climate, the Siebengebirge region has very rich biodiversity. In the Siebengebirge hill range alone, some 730 plant species are found in an area of 4,800 ha. The project region is distinguished by locally characteristic and nationally representative deciduous woodland of the Siebengebirge range and Leuscheid ridge (Luzulo-Fagetum beech forests, Asperulo-Fagetum beech forests, media-European limestone beech forests of the Cephalanthero-Fagion, Sub-Atlantic oak-hornbeam				

Project name (click on the profile to visit the website)	Eligible expenditures (in € million)	Total expenditures (in € million)	Funding share (in %)	Duration	Grant-aided area (ha)
	forests (Stellario-Carpinetum), Galio-Carpinetum oak-hornbeam forests, Tilio-Acerion forests of slopes, screes and ravines, and riparian, bog and swamp forests), of which the indicator species is the black stork; by sparse orchards as part of the historical cultural landscape of the Pleiser Hügelland hill range with breeding populations of little owl; and by the extensive rock and rocky slope habitats marking the northern range limit for nationally vulnerable species such as the common wall lizard. Near-natural rivers, streams and forest springs complete the outstanding natural endowment of the core areas, which since 2015 also extend across the Bonn city boundary.				
Hohe Schrecke II (Thuringia)	0.91	14.4	6.3	2013-2023	6,030
	Hohe Schrecke is an almost completely uninterrupted forest area. Over centuries of extensive cultivation and 50 years as a restricted military zone, the forest has developed and maintained a richly diverse structure with a significant proportion of old-growth timber. A substantial portion of the forest aligns with the potential natural vegetation characteristic of Central Europe – particularly acidophilous beech forest – and harbours an exceptional array of species characteristic of such habitats.				
Industrial Heritage North II (Saarland)	0.80	12.61	6.3	2013-2024	2,362
	The area encompasses a mosaic of the characteristic landscape features found in a post-mining region affected by coal mining and the accompanying mining industry. These features range from industrial wastelands to slag heaps, mud ponds and the corresponding water and land management structures. The four core zones represent distinct landscape and land-use types within the former industrial region, serving as representative examples of the diverse habitats found in this area. Together, they form a unique combination that is unparalleled in such a compact space.				
North Western Pomerania Forest Landscape II (Mecklenburg-Western Pomerania)	0.72	8.45	8.5	2020-2025	8,014
	The central nature conservation measure in the core area is the designation of "natural forest development areas" (areas that have not been used for forestry for at least 30 years or only to a limited extent) on at least 850 ha in order to improve the habitat conditions for the lesser spotted eagle. Of these, approx. 330 ha will be secured as unused forest stands (natural forest cells and old wood islands). In addition, approx. 550 ha of damaged swamp, marsh and riparian forests and marshy depressions and swales are to be rewetted and 650 ha of permanent grassland is to be secured and newly established as permanent feeding habitat for the lesser spotted eagle.				
Allgäu Moor Alliance II (Bavaria)	0.69	16.93	4.1	2012-2030	13,811
	The project's landscapes of peatlands and wetland meadows are among the richest and best endowed with peatlands in Germany. The area contains several nationally significant, in part unimpaired raised bog cores with largely original and complete zonation. The peatlands in Kempter Wald are the largest contiguous peatland area in the Allgäu and are also nationally significant due to the extensive mountain pine bogs. Such mountain pine bogs and former commons peatland pastures are specific to the region. The Allgäu peatlands are a nationwide concentration of glacial relics such as the endangered or critically endangered shrubby birch, dwarf birch, creeping sedge, Davall's sedge, slender cottongrass and swamp willow.				
Baar II (Baden-Württemberg)	0.65	7.95	8.1	2018-2028	4,289
	The large-scale nature conservation project will preserve and further enhance the close spatial integration between the peatlands, litter meadows, wetland meadows, other wetland habitats, forests, open countryside and nutrient-poor grasslands of the Baar plateau. Measures range include watercourse restoration, extensive grazing to keep nutrient-poor grassland open and the abandonment of forest cultivation.				

Project name (click on the profile to visit the website)	Eligible expenditures (in € million)	Total expenditures (in € million)	Funding share (in %)	Duration	Grant-aided area (ha)
	This will improve the region's passability and hence its role in the ecological network. Peatland rewetting measures and measures to stabilise the peatland hydrological regime make a sustainable contribution to reducing greenhouse gas emissions in the region and thus to climate change mitigation.				
Bienwald II (Rhineland-Palatinate)	0.51	10.29	5.0	2009-2021	17,768
	The project centres on the designation of a contiguous 1,680 ha area of natural forest that the State of Rhineland-Palatinate has donated to the project. On the remaining 10,000 hectares of production forest – above and beyond the nature-oriented silviculture practices already applied today – further nature conservation objectives are to be implemented in forest management. These include the development of forest ecological communities characteristic of the physiographic region and the implementation of an old-growth and habitat tree strategy.				
Green Belt Rodachtal II (Bavaria/Thuringia)	0.51	8.47	6.0	2016-2026	8,207
	The main objective is the long-term preservation of the habitat diversity and structural diversity of close-to-nature stretches of the Green Belt in the funded area and the targeted development of other areas in order to restore their nature conservation value. Other objectives comprise the lasting conservation, maintenance and development of valuable, rare or endangered forest ecological communities and cultural landscape habitats and the restoration of selected sections of rivers and streams.				
Middle Elbe-Schwarze Elster I (Saxony-Anhalt)	0.48	3.32	14.4	2020-2023	-
	The project involves environmental planning for a subsequent restoration. The envisaged project area for later in the project covers 4,937 ha.				

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5.3.5. Wilderness Fund

Budget chapters and items:	1604 893 02					
Eligible expenditures 2021:	€5.7 million					
GHG emission reduction:	Pursues other objectives					
Other indicators:	206.6 ha placed under protection					
Funding share:	100%					
EU environmental objectives under Article 9 of the Taxonomy Regulation:						f)
Assumptions and limitations: --						
Links: https://www.bmuv.de/programm/wildnisfonds https://www.z-u-g.org/aufgaben/wildnisfonds/						

The National Strategy on Biological Diversity aims to halt and reverse the decline of biodiversity. This also involves returning more large areas of Germany to wilderness. The strategy sets a specific goal in this regard, with at least 2% of Germany's land area to be left to develop undisturbed by 2020. This applies to areas such as forests, post-mining landscapes, former military training grounds, riparian and coastal land, peatlands and mountains. The federal government has set up the Wilderness Fund to support a range of measures to help achieve the 2% wilderness goal:

- Purchase of wilderness areas or significant portions thereof
- Purchase of land to complete or expand wilderness areas or suitable minimal intervention areas
- Purchase of leases, or financial compensation for permanently relinquishing the economic use of wildness areas or significant portions thereof
- Purchase of leases, or financial compensation for permanently relinquishing the economic use of land to complete or expand wilderness areas or suitable minimal intervention areas.

Project	Purchase/lease/grant-aided area
Completion of Jütebog wilderness area (Brandenburg), small claim application	Land purchase: 0.6 ha
Completion of Laubacher Wald/Stadtwald Hungen wilderness area (Hesse)	Lease purchase: 176 ha
Land purchase by the Institute for Federal Real Estate (BImA): Completion of Zeitzer Forst National Natural Heritage area (Saxony-Anhalt)	Land purchase: 30 ha
Total area in 2021	**206.6 ha**

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5.4. Coastal and flood protection

5.4.1. Grants to fund flood protection facilities, the renaturation of dykes, torrent control and the renaturation of water bodies

Budget chapters and items:	Annex 1 to 1003 (1095) 882 15
Eligible expenditures 2021:	€74.9 million
GHG emission reduction:	Pursues other objectives
Other indicators:	1,260 funding cases
	175,156 ha protected area from construction and reinforcement of flood defences and torrent regulation works
	15 ha retention area gained by relocation and removal of dykes
	5,355 km/2,991 ha funding scope for renaturation of water bodies
Funding share:	60% (federal government funding share)
EU environmental objectives under Article 9 of the Taxonomy Regulation:	b) c)
Assumptions and limitations: GAK reporting by the *Länder*, reporting period 2021	
Links: https://www.bmel.de/DE/themen/laendliche-regionen/foerderung-des-laendlichen-raumes/gemeinschaftsaufgabe-agrarstruktur-kuestenschutz/gak.html https://www.bmel-statistik.de/fileadmin/daten/0002000-2021.pdf https://www.bmel-statistik.de/fileadmin/daten/4500101-2021.pdf	

For general remarks on the Joint Task for the Improvement of Agricultural Structures and Coastal Protection (GAK), see Section 5.2.2 “Forestry measures”.

The above funding was used in 2021 to support both flood protection measures and the renaturation of water bodies implemented by the *Länder* (60:40 federal government/*Länder* funding split):

- Construction and reinforcement of flood defences and torrent regulation works (704 funding cases; indicator: 175,156 ha protected area)
- Relocation and removal of dykes (2 funding cases; indicator: 15 ha retention area gained)
- Measures for the renaturation of water bodies aim to help improve the ecological and chemical status of surface waters in rural areas. This includes the creation of riverine corridors and improving landscape water retention (554 funding cases; indicator: 5,355 km/2,991 ha funding scope).

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5.4.2. Grants to fund coastal protection measures

- Grants to fund coastal protection measures
- Grants to fund coastal protection measures to counter the effects of climate change

Budget chapters and items:	Annex 1 to 1003 (1095) 882 61 and 882 81
Eligible expenditures 2021:	€101.0 million
GHG emission reduction:	Pursues other objectives
Other indicators:	256 funding cases
	686,940 ha protected area
Funding share:	70% (federal government funding share)
EU environmental objectives under Article 9 of the Taxonomy Regulation:	b) c)

Assumptions and limitations: GAK reporting by the *Länder*, reporting period 2021

Links: https://www.bmel.de/DE/themen/laendliche-regionen/foerderung-des-laendlichen-raumes/gemeinschaftsaufgabe-agrarstruktur-kuestenschutz/gak.html
https://www.bmel-statistik.de/fileadmin/daten/0002000-2021.pdf
https://www.bmel-statistik.de/fileadmin/daten/6500100-2021.pdf
https://www.bmel-statistik.de/fileadmin/daten/4500301-2021.pdf

For general remarks on the Joint Task for the Improvement of Agricultural Structures and Coastal Protection (GAK), see Section 5.2.2 "Forestry measures".

A wide variety of precautions are taken in order to protect the coasts from excessive wind and wave erosion. They include dykes, breakwaters, groynes, barrages, sluices, pumping stations, seawalls, sand replenishment and dune vegetation planting. What measures are most effective in a particular case depends on local conditions, currents, surf and the coastal topography (low-lying or steep coast).

Planning, implementing and maintaining coastal defences is the responsibility of the *Länder*. The German coastal *Länder* each specify their coastal protection strategy in individual general coastal protection plans which are updated regularly.

Due to the major importance of coastal protection, the federal government has contributed 70% of the costs of coastal protection measures carried out since 1973.

The above funding was used in 2021 for various measures to increase safety on the coasts, on the islands and on the flowing surface waters in the tidal area against flooding and land loss due to storm surges and sea attack (70:30 federal government/*Länder* funding split). Implementation is carried out by the coastal *Länder*.

The following measures are supported, to which the above indicators relate:

- Construction and reinforcement of flood defences, including dyke defence tracks and debris clearing tracks (163 funding cases)
- Barrages and other structures in the flood protection line (15 funding cases)
- Groynes, breakwaters and other installations in the sea (5 funding cases)
- Foreshore works in front of seawalls up to a depth of 400 m (4 funding cases)
- Sand replenishment (5 funding cases)

Due to the changing climate, sea levels are rising more rapidly than previously predicted. This must be taken into account when dimensioning coastal protection structures. Planned or new coastal protection measures must be implemented more quickly. In order to meet the additional funding needs required for these priority measures, additional funding is made available through the **GAK special framework plan on Coastal Protection Measures in Response to Climate Change**.

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The above funding was used to fund the following coastal protection measures in 2021, to which the above indicators relate:

- Construction and reinforcement of flood defences, including dyke defence tracks and debris clearing tracks (55 funding cases)
- Sand replenishment (1 funding case)

5.4.3. Federal share of funding the special framework programme for preventative flood protection measures

Budget chapters and items:	Annex 1 to 1003 (1095) 882 82					
Eligible expenditures 2021:	€60.5 million					
GHG emission reduction:	Pursues other objectives					
Other indicators:	16,619 ha reclaimed floodplain area from the removal of dykes					
	324 million m^3 retention area gained from measures to gain retention areas					
Funding share:	60% (federal government funding share)					
EU environmental objectives under Article 9 of the Taxonomy Regulation:		b)				

Assumptions and limitations: GAK reporting by the *Länder*, reporting period 2021

Links: https://www.bmel.de/DE/themen/laendliche-regionen/foerderung-des-laendlichen-raumes/gemeinschaftsaufgabe-agrarstruktur-kuestenschutz/gak.html
https://www.bmel-statistik.de/fileadmin/daten/0002000-2021.pdf
https://www.bmel-statistik.de/fileadmin/daten/4500201-2021.pdf

For general remarks on the Joint Task for the Improvement of Agricultural Structures and Coastal Protection (GAK), see Section 5.2.2 “Forestry measures”.

In order to strengthen the support for urgent preventive flood protection measures, additional investment funds are made available to the *Länder* under the GAK special framework plan “Measures for Preventive Flood Protection”. Rivers regain more space as a result of dyke relocation. Other preventive flood protection measures include the construction of flood retention basins and flood retention polders.

The above funding was used to provide additional support for numerous urgent investment measures for preventive flood protection in 2021. These included the following measures, to which the above indicators relate:

- The removal of dykes to improve flood protection, in particular to reclaim floodplains
- Measures to gain retention areas, such as the creation of flood-retarding basins and polders.

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III. Methodology

Explanatory notes are provided in the following on the methodology for budget items with GHG estimates at budget item level. The methodology varies according to budget item, programme and project duration, ranging from ex-ante estimates and modelling to ex-post evaluation. For this reason, the figures are only aggregated (e.g. to provide an overview of significant contributions) to the extent that the estimation approaches allow.

Budget items	Eligible expenditures (in € million)	Methodology
1.1.1 Construction cost subsidies for investments in the expansion of the federal rail infrastructure	2,045.0	For projects under the Federal Transport Infrastructure Plan 2030, ex-ante estimates were made of the change in life cycle emissions, meaning greenhouse gas emissions from the operation of rolling stock and from the construction, maintenance and repair of infrastructure. The annual GHG emission reduction represents the annual GHG reduction share from route opening.
1.1.5 Reduction in track access charges in rail freight transport	344.0	Model calculations from the evaluation carried out in 2021 for the previous funding period (1 July 2018 to 31 December 2020). The 2021 impact was approximated from the ratio of the funding in 2021 to the funding over the funding period covered by the evaluation.
1.1.7 Subsidies to private companies for investments in combined transport	31.3	Report on the evaluation of the "Guidelines on the promotion of transhipment facilities for combined transport by non-federally owned companies". The relief effect of 40.95 tkm per euro of funding used, on which the calculation is based, is an average figure calculated from the relief effect due to the additional transhipment volume of all CT terminals funded in the period 1998-2019. Applied to 2021 funding volumes and transport performance converted to GHG reduction.
1.1.8 Investment subsidies to private companies to fund the construction, expansion, reactivation and replacement of sidings and other rail freight facilities	15.7	The calculation is based on a 2019 evaluation of the sidings funding guidelines over the evaluation period August 2004 (when the funding was introduced) to September 2019 (the assessment cut-off date) and an evaluation scope of 125 projects (funded sidings) with a funding volume of €91.7 million. In terms of rail transport performance, new and additional traffic totalling 38,900 million tkm was generated in the evaluation period. This means an average 424 million tkm transport performance was shifted to rail or additionally generated for each €1 million in funding. Likewise in 2019, on the basis of the TREMOD project, the Federal Environment Agency published a comparison of greenhouse gas emissions from the various modes of freight transport. This showed that rail freight can reduce greenhouse gas emissions by an average of 84 g/tkm compared to road freight. Based on the 424 million tkm transport performance generated in the above evaluation period, this corresponds to a total reduction in CO_2e emissions by 35,600 tonnes per €1 million in funding.
1.3.4 Local-authority public transport pilot projects from 2018 to 2021 to complement	18.8	Analysis of the average number of car trips saved by the measures and estimation of the reduction in km travelled and GHG emissions.

Budget items	Eligible expenditures (in € million)	Methodology
the “Immediate Action Programme for Clean Air”		
1.4.2 Replacement, extension and construction projects relating to federal waterways	131.1	For projects under the Federal Transport Infrastructure Plan 2030, ex-ante estimates were made of the change in life cycle emissions, meaning greenhouse gas emissions from the operation of vehicles and from the construction, structural maintenance and maintenance of infrastructure.
2.5.1 Development of foreign markets	16.3	The GHG emission reduction relates exclusively to the Renewable Energy Solutions (RES) programme with eligible expenditures of €2.682 million. The entire GHG reduction relates to reduction effects obtained during the project period (ex-post). It does not include projected savings generated by, for example, the ongoing use of renewable energy sources.
3.4.1 Technology transfer – lightweighting	13.9	It is only possible to estimate potential GHG reductions, which must be regarded with considerable caution given the R&D character of the projects and the related uncertainty concerning the implementation of market-relevant products. On a conservative estimate, it is assumed that only 10% of the projects will be commercialised. Data on potential GHG reductions from the projects is requested at various points in time in an accompanying monitoring programme. The stated potential reductions are based on data requested at an early stage of the projects. The projects report on potential reductions for products and materials in the production, use and end-of-life phases. To obtain comparable data, the figures are requested at a short-to-medium-term interval after completion of the R&D projects. A summary analysis is applied for this purpose over a period of seven years after project completion.
4.2.3 Improving framework conditions for shore-to-ship power supply in German ports	21.8	GHG reductions are reported for 2021 for two completed systems.
4.2.4 Funding to promote energy efficiency and renewable energy measures in buildings	1,334.7	The GHG reduction figure relates to the lifetime of the systems for which funding was paid out in 2021. The timing of implementation may vary from this. For a detailed description of the assumptions/methodology, please refer to the evaluation report. Please refer to the evaluations of the CO_2 building rehabilitation programme and the market incentive programme. The GHG reduction is determined by extrapolating from the funding efficiency of the MAP in 2020.
4.3.1 Energy efficiency in industry and businesses	352.6	It should be noted that the savings identified in the evaluation report relate to the approved funding volume. The savings are therefore converted on the basis of the funding efficiencies identified in the evaluation report for GHG savings or end-use energy savings for the applicable eligible expenditures. The stated annual GHG savings and end-use energy savings apply from 2021 for an eight-year lifetime.
4.3.2 Providing advice on energy efficiency	98.8	Evaluation of energy advice to private consumers, for residential buildings, non-residential buildings, installations and systems. The average reductions identified in the evaluations for each

Budget items	Eligible expenditures (in € million)	Methodology
		consulting format are multiplied by the annual case numbers in the various programmes.
4.4.1 National Climate Initiative	173.0	The GHG emission reduction for 2021 is estimated based on the eligible expenditures in the individual programmes of the National Climate Initiative and the net figures for the funding efficiency from the 2020/2021 evaluation report.
5.1.3 Subsidies to fund measures for improving energy efficiency in agriculture and horticulture (including investments)	25.3	The data on GHG reductions and number of beneficiaries refers to the projects for which funding was paid out in 2021, some of which began to be implemented in 2020. The sum total of GHG emission reductions is based on expert appraisals for each individual project and relates to the investment projects.

IV. Acknowledgements

This report was prepared in cooperation with the relevant ministries under the coordination of the Core Green Bond Team and validated by the Interministerial Working Group.

The Core Team would like to thank the many colleagues who contributed to the preparation of the report, including from the following ministries:

- Federal Ministry for Economic Affairs and Energy (BMWi)
- Federal Ministry of Food and Agriculture (BMEL)
- Federal Ministry of Transport and Digital Infrastructure (BMVI)
- Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
- Federal Ministry of Education and Research (BMBF)
- Federal Ministry for Economic Cooperation and Development (BMZ)

The names and responsibilities of the ministries correspond to the structure of the ministries in the 2021 fiscal year.[72]

Furthermore, thanks are due to the many project partners, authorities and funding agencies that implement the funding programmes and hence contribute significantly to impact reporting.

[72] Official order according to the announcement of the formation of the government on 14 March 2018 in the Federal Gazette of 16 March 2018: https://www.bundesanzeiger.de/pub/publication/OfWcxTATaMQbtpse55z?0

V. Glossary

ABS	*Ausbaustrecke* (rail upgrade)
AI	artificial intelligence
BAFA	Federal Office of Economics and Export Control
BLE	Federal Office for Agriculture and Food
bn	billion
CFCs	chlorofluorocarbons
CO_2	carbon dioxide
CO_2e	CO_2 equivalents for all greenhouse gases
CT	combined transport
DARP	German Recovery and Resilience Plan
DB AG	Deutsche Bahn AG
DLR	German Aerospace Center
EKF	Energy and Climate Fund (since 2022: Climate and Transformation Fund (KTF))
EIB	European Investment Bank
EU	European Union
FONA	Research for sustainability
FTIP	Federal Transport Infrastructure Plan
GAK	Joint Task for the Improvement of Agricultural Structures and Coastal Protection
GCF	Green Climate Fund
GHF	Green Hydrogen Fund
GHG	greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GWh	gigawatt-hour
H_2	hydrogen
ha	hectare
ICMA	International Capital Market Association
IZB	Infrastructure Condition and Development Report
km	kilometre
LPT	local public transport
LuFo	aeronautical research programme
LULUCF	land use, land-use change and forestry
MW	megawatt
MWh	megawatt-hour
N/A	not available
NBS	*Neubaustrecke* (new rail line)
NDC	nationally determined contributions to Paris climate targets
NIP	National Hydrogen and Fuel Cell Technology Innovation Programme
NO_x	nitrogen oxides
O2	oxygen
p.a.	per annum
PEM	proton exchange membrane
PM	particulate matter
PV	photovoltaic

R&D	research and development
SAFs	sustainable aviation fuels
SDGs	UN Sustainable Development Goals
SMEs	small and medium-sized enterprises
SO	sulphur oxide
t	tonne
TC	technical cooperation
tkm	tonne-kilometre
TTP LB	Technology Transfer Programme – Lightweighting
UBA	Federal Environment Agency
USD	US dollars
VIB	Transport Investment Report

Published by

Federal Ministry of Finance
Public Relations Division

Wilhelmstr. 97
10117 Berlin, Germany

October 2024

Edited by
Division VII C 2

More information is available online at
www.bundesfinanzministerium.de

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It is distributed free of charge and is not intended for sale.

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