# Agenda

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Executive Summary

• Environmental and climate protection are a top priority in Germany. The Klimaschutzgesetz (Climate Change Act) sets a clear goal: achieving greenhouse gas neutrality by 2045. Ambitious climate targets are set for all sectors.

• Since 1990, greenhouse gas (GHG) emissions have been reduced by 40% (2022). The 2030 objective is to reduce GHG emissions by at least 65%, the 2045 objective is a neutral GHG emission balance.

• Green Federal securities are part of Germany’s sustainability strategy. They strengthen green financial markets and increase the transparency for selected green budget items.

• Indicative amount of eligible green expenditures for 2022 budget: € 18.5 bn, selected from five sectors: (1) transport; (2) international cooperation; (3) research, innovation and awareness raising; (4) energy and industry; (5) agriculture, forestry, natural landscapes and biodiversity.

• Germany will continue to establish a green yield curve in 2023 with a new 10-year Green Bund and another longer maturity. The aggregate annual issuance volume is to be further expanded to € 15-17 bn in 2023 (after € 14.5 bn in 2022, € 12.5 bn in 2021 and € 11.5 bn in 2020).

• The innovative twin bond concept makes the ‘greenium’ transparent and has created a new benchmark in the green bond market.
Green Bonds Issuance Plan 2023

<table>
<thead>
<tr>
<th></th>
<th>0% Bobl/g</th>
<th>1.3% Bobl/g</th>
<th>0% Bund/g</th>
<th>0% Bund/g</th>
<th>0% Bund/g</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Issuance</strong></td>
<td>04.11.2020</td>
<td>31.08.2022</td>
<td>02.09.2020</td>
<td>08.09.2021</td>
<td>11.05.2021</td>
</tr>
<tr>
<td><strong>Maturity</strong></td>
<td>10.10.2025</td>
<td>15.10.2027</td>
<td>15.08.2030</td>
<td>15.08.2031</td>
<td>15.08.2050</td>
</tr>
<tr>
<td><strong>Outstanding</strong></td>
<td>€ 6.5 bn</td>
<td>€ 6.5 bn</td>
<td>€ 9.5 bn</td>
<td>€ 9 bn</td>
<td>€ 10 bn</td>
</tr>
</tbody>
</table>

- Planned issuance volume of € 15-17 bn
  - thereof € 3.0 bn already issued in two auctions (January und March 2023)
  - 3 more auction dates for re-openings of existing bonds
- Multi-ISIN auctions possible
- 2 syndicates for new issues of a 10Y Green Bund and one further long maturity
1 Germany’s Green Footprint
Following a Stringent Green Path – Germany`s Contribution to the 1.5 Degree Celsius Target

With the United Nations' 2030 Agenda for Sustainable Development and the Paris Climate Agreement, the German Government is pursuing the clear goal of setting the course for a sustainable social and economic system. Climate protection is a core priority, thus, Germany was one of the first countries to submit the long-term low GHG emission development strategy to the UNFCCC as required under the Paris Agreement. Germany contributes to reaching the goals set out in the Paris Agreement through the EU Nationally Determined Contributions (NDCs).

With the Climate Action Programme 2030, a new level of commitment is set in German climate policy, even regulated by law: For the first time, national climate targets are given legal status with the Klimaschutzgesetz (Climate Change Act) which – and the climate targets anchored therein – was significantly tightened in 2021 as a result of a judgement by the highest German court. Sector targets are checked upon in an annual monitoring procedure.

Furthermore, the Climate Action Programme paved the way for the Inaugural Green Federal securities. With the innovative twin bond approach, Germany makes a substantial contribution to the growth of the sustainable bond market.
Intergenerational Contract for the Climate

With the amendment to the Climate Change Act in June 2021, the German Government has defined a more ambitious GHG mitigation pathway and has enshrined in law the goal of achieving GHG neutrality by 2045.

- **Greenhouse gas emissions**
  - By 2030: 65% less CO2
  - By 2040: 88% less CO2
  - 2045: Climate neutrality

- **Permissible annual CO2 emissions** for individual sectors such as energy, industry, transport and buildings to be reduced.

Germany’s Path to Decarbonisation

GHG Emissions Development in Germany per Sector (in MtCO₂e)

Sources: Federal Climate Change Act; Umweltbundesamt (15.03.2023); *net zero anthropogenic GHG emissions from all sectors covering all GHG emissions, which means emissions from carbon dioxide as well as other GHG like methane
**Focus on Energy Area**

<table>
<thead>
<tr>
<th>Share of GHG emissions</th>
<th>34% of all GHG emissions in Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022 achievement</td>
<td>256 MtCO₂e (–46% vs 1990 level)</td>
</tr>
<tr>
<td>2030 target</td>
<td>108 MtCO₂e (–77% vs 1990 level)</td>
</tr>
</tbody>
</table>

**Overview**

- Through ambitious targets and regulatory measures, such as the Renewable Energy Sources Act (EEG), GHG emissions in the energy sector have been halved since 1990.
- Full decarbonisation by 2045 through transformation of energy supply towards more renewable energies and energy efficiency.

**Germany’s path to the energy system of the future**

- No more power from coal at the latest by 2038 (ideally by 2030)
- No nuclear power station in operation since 15 April 2023
- Renewables to generate 80% of Germany’s power by 2030
Focus on Energy Area - Primary Energy Consumption in Germany

Source: Arbeitsgemeinschaft Energiebilanzen (04/2023); rounding issues may occur
Focus on Energy Area

Development of Primary Energy Consumption in Germany since 1990

In 2022, the consumption of primary energy recorded a reduction of 5.4% compared to the previous year and fell to the lowest level since 1990.

Source: Arbeitsgemeinschaft Energiebilanzen (04/2023); *1kg Steinkohleeinheit (SKE) = 0,7 Öleinheiten (OE) / Oil equivalent
Focus on Industry Area

Overview

- The decarbonisation of the industrial sector is to be achieved through a comprehensive modernization strategy.
- Industry will become more climate-friendly with increased efficiency, more renewable energies and new production processes (e.g. “green” hydrogen).

<table>
<thead>
<tr>
<th>Share of GHG emissions</th>
<th>22% of all GHG emissions in Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022 achievement</td>
<td>164 MtCO₂e (−41% vs 1990 level)</td>
</tr>
<tr>
<td>2030 target</td>
<td>119 MtCO₂e (−57% vs 1990 level)</td>
</tr>
</tbody>
</table>

Transforming the industry sector

- National decarbonisation programme, i.a. introducing Carbon Contracts for Difference
- Establishing lead markets for green products
- Incentivising energy and resource efficiency

Final energy consumption by energy source in industry (2021)

- 35.4% Gas
- 29.6% Electricity
- 14.3% Hard coal
- 6.6% District heating
- 5.4% Others
- 4.5% Renewables
- 2.8% Lignite
- 1.3% Heating oil

Source: Arbeitsgemeinschaft Energiebilanzen (March 2022)
Focus on Buildings Area

<table>
<thead>
<tr>
<th>Share of GHG emissions</th>
<th>15% of all GHG emissions in Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022 achievement</td>
<td>112 MtCO₂e (−47% vs 1990 level)</td>
</tr>
<tr>
<td>2030 target</td>
<td>66 MtCO₂e (−69% vs 1990 level)</td>
</tr>
</tbody>
</table>

Overview

- The basis for making building and living more climate-friendly is a mix of funding, information and advice, CO₂ pricing and regulatory law.
- Funding is focused on refurbishment and the use of renewable energy for heating, but KfW loans are also available for highly sustainable new buildings. Building codes set standards predominantly for new buildings, amendment under way to foster use of renewables in existing buildings.

Sustainable green housing

- Upgrading heating systems and energy efficiency
- Tax incentives for energy upgrades
- Developing energy standards
- Supporting modular upgrades
Focus on Transport Area (1/2)

<table>
<thead>
<tr>
<th>Share of GHG emissions</th>
<th>20% of all GHG emissions in Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022 achievement</td>
<td>148 MtCO$_2$e (–9% vs 1990 level)</td>
</tr>
<tr>
<td>2030 target</td>
<td>84 MtCO$_2$e (–49% vs 1990 level)</td>
</tr>
</tbody>
</table>

Overview
• With record-high investments into clean and sustainable transportation such as rail, public and non-motorised transport, as well as electro-mobility and alternative fuels (especially hydrogen), transport-related emissions should be cut significantly by 2030.
• Investments in the railway system are both a key area of action in the Climate Action Programme 2030 and a key part of Green Bunds.

New pathways for transportation
• Fundamental and massive overhaul of transport sector
• Increasing the share of passenger and freight rail transport in the modal split
• Increasing the share of the mileage in heavy road haulage of vehicles powered by electricity or electricity-based fuels.
• Expanding the charging infrastructure for electric mobility
• Expanding cycle routes
• Digitalisation of mobility
Investment in the railways

Strengthening rail freight transport

Making rail travel more attractive by modernising the rail network

Freight GHG emissions (CO$_2$e) in gram per ton and km in Germany

<table>
<thead>
<tr>
<th>Freight-Train</th>
<th>Inland waterways</th>
<th>Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 CO$_2$e</td>
<td>33 CO$_2$e</td>
<td>118</td>
</tr>
</tbody>
</table>

Passengers (long-distance) GHG emissions (CO$_2$e) in gram per person and km in Germany

<table>
<thead>
<tr>
<th>DB Long-distance traffic</th>
<th>Coach</th>
<th>Car</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 CO$_2$e</td>
<td>37</td>
<td>162</td>
</tr>
<tr>
<td>271 CO$_2$e</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Deutsche Bahn AG, March 2023
Focus on Agriculture

<table>
<thead>
<tr>
<th></th>
<th>Share of GHG emissions</th>
<th>2022 achievement</th>
<th>2030 target</th>
</tr>
</thead>
<tbody>
<tr>
<td>8% of all GHG emissions in Germany</td>
<td>62 MtCO$_2$e (−25% vs 1990 level)</td>
<td>57 MtCO$_2$e (−26% vs 1990 level)</td>
<td></td>
</tr>
</tbody>
</table>

**Sustainable agriculture - a mix of measures to make the sector more climate-friendly**

- Sustainable farming
- Conservation and sustainable management of forests and timber use
- Avoiding food waste

Focus on Waste Management and others

<table>
<thead>
<tr>
<th></th>
<th>Share of GHG emissions</th>
<th>2022 achievement</th>
<th>2030 target</th>
</tr>
</thead>
<tbody>
<tr>
<td>1% of all GHG emissions in Germany</td>
<td>4 MtCO$_2$e (−90% vs 1990 level)</td>
<td>5 MtCO$_2$e (−89% vs 1990 level)</td>
<td></td>
</tr>
</tbody>
</table>

Waste management is at a very high level in Germany already. Waste is collected, separated, reused, recycled or used for energy.
Environmental and Climate Policy within the German Federal Budget

- German climate and environment policies are extensive.
- The federal budget contains a significant amount of green expenditures.
- The reporting for Green German Federal securities provides high transparency regarding the allocated green expenditures.

The federal budget contains many more green items than those selected for Green German Federal securities:

- Eligible green expenditures earmarked for the NGEU funding program
- Green expenditures associated with funds raised by the Carbon Pricing Scheme, channeled through the Climate and Transition Fund (KTF)
- Grants to increase energy efficiency in buildings associated with KfW Green Bonds
- Further green expenditures, which are neither earmarked for a green bond program nor part of the KTF
Green Bond Framework Overview
Overview of the Green Bond Framework

- Germany’s Green Bond Framework follows the ICMA’s Green Bond Principles (“GBP”)
- A Second Party Opinion as well as a Third Party Verification of the Allocation Report are provided
Eligible green expenditures:
- Green Eligible Expenditures can include any type of Federal expenditure contributing to a transition towards a low-carbon, resource efficient and sustainable economy.

Excluded expenditures:
- State expenditures which are already earmarked by other public Green Bond issuers (such as KfW or NGEU)
- Armaments, defence, tobacco, alcohol, gambling, fossil fuels and nuclear power

Germany’s Green Bond Framework provides for five Green Sectors for the use of proceeds:
1. transport
2. international cooperation
3. research, innovation and awareness raising
4. energy and industry
5. agriculture, forestry, natural landscapes and biodiversity

Eligible Green Expenditures contribute to the six environmental objectives of the EU Taxonomy Regulation and at least 12 out of the 17 UN Sustainable Development Goals.
Project Evaluation, Selection and Reporting

Expenditures

Year n-2
- Budget planning and passing of the federal budget of year n-1

Year n-1
- Expenditures are made by the respective German ministries

Year n
- Eligible Green Expenditures for year n-1 are selected and validated (amount and composition)

Following years

Issues

Year n+1

Reporting

Year n+1
- Allocation Reporting on the Final Eligible Green Expenditures

Year n
- Impact Reporting on the Final Eligible Green Expenditures
3  Green Federal Securities in Practice - Eligible Green Expenditures
Clear differentiation of green expenditures:

- Expenditures proposed by the federal government in the German Recovery and Resilience Plan (DARP) for the NGEU program are excluded from the allocation to Green Bunds.
- Only KTF expenditures in the amount financed by the federal budget (including reserves) are taken into account for Green Bunds.
- Federal budget expenditures associated with KfW Green Bonds are excluded from the allocation to Green Bunds.

Exclusion of double counting:
Expenditures allocated to Green German Federal securities are earmarked for this purpose only, and will not overlap with the use of any other green funding source.
Overview Use of Proceeds: Eligible Green Expenditures (€ mn)

<table>
<thead>
<tr>
<th>Green Sectors</th>
<th>2022 Indicative</th>
<th>2021</th>
<th>2020</th>
<th>2019</th>
<th>Sector Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>9,200.0</td>
<td>8,344.1</td>
<td>7,387.3</td>
<td>7,125.3</td>
<td>e.g. rail transport, alternative drive systems and fuels, waterways, cycling infrastructure</td>
</tr>
<tr>
<td>International cooperation</td>
<td>4,400.0</td>
<td>3,701.0</td>
<td>3,278.3</td>
<td>2,981.7</td>
<td>Assist EM and developing economies in their transition towards greater environ-mental sustainability; governance: page 25</td>
</tr>
<tr>
<td>Research, innovation and awareness raising</td>
<td>1,500.0</td>
<td>1,359.8</td>
<td>1,085.0</td>
<td>625.1</td>
<td>Support and facilitate knowledge and innovation about climate and environ- mental matters; eligible items: page 26</td>
</tr>
<tr>
<td>Energy and industry</td>
<td>2,700.0</td>
<td>2,665.5</td>
<td>1,093.2</td>
<td>1,198.5</td>
<td>e.g. energy research, renewable energy, energy efficiency</td>
</tr>
<tr>
<td>Agriculture, forestry, natural landscapes and biodiversity</td>
<td>700.0</td>
<td>767.0</td>
<td>564.0</td>
<td>381.5</td>
<td>e.g. sustainable agriculture and forestry, coastal and flood protection, protection of ecosystems</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>18,500.0</strong></td>
<td><strong>16,837.4</strong></td>
<td><strong>13,407.8</strong></td>
<td><strong>12,312.1</strong></td>
<td></td>
</tr>
</tbody>
</table>
Key Sector “International Cooperation”

Eligible programs and projects are targeted at mitigating and adapting to climate change, transitioning towards sustainable energy systems based primarily on renewable energy sources, improving energy efficiency, protecting habitats and biodiversity sustainable use of natural resources and energy, including developing renewable energy generation facilities and sustainable agriculture.

The selection and approval of specific projects is subject to compliance with German law, the Guidelines for bilateral Financial and Technical Cooperation and all relevant international agreements and treaties signed by Germany.

Governance safeguards and processes are in place for every type of expenditure to prevent corruption and money laundering in line with European and national legislation and standards.

Social safeguards and processes are in place for every type of expenditure to reduce the risk of forced labor and child labor and to promote and strengthen human rights in developing countries in accordance with European and national legislation and standards.

International support is reported in accordance with internationally agreed guidelines, criteria and reporting cycles, either as official development assistance (ODA) to the OECD Development Assistance Committee (DAC) and/or as climate finance to the EU and United Nations Framework Convention on Climate Change (UNFCCC).
Eligible budget items primarily include:

- Expenditure enabling the development of solutions for combating climate change, for the preservation of ecosystems and biodiversity and for compensating for fluctuations in power grids due to the increasing use of renewable energy sources to generate electricity
- Expenditure enabling research for all renewable energies and energy storage, energy efficiency, power grid and renewable energy integration, energy transition
- Expenditures enabling research related to climate change, biodiversity, nature protection and the environment
- Expenditures enabling research on coasts, oceans and polar areas

In a society making a transition towards a sustainable economy, strong government commitment is essential. Thus, the federal budget contains considerable green expenditures on research, innovation and awareness raising. The expenditures are found partly in this research sector (~8% of the eligible expenditures) and partly in the other four sectors (if there is a clear connection to the respective sector). Taken together, they account for approximately 14% of the total allocated expenditures.
Contributions of Eligible Green Expenditures: Breakdown by Green Sector

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

<table>
<thead>
<tr>
<th>Sector</th>
<th>2022</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>49.7%</td>
<td>49.6%</td>
</tr>
<tr>
<td>Energy</td>
<td>14.6%</td>
<td>15.8%</td>
</tr>
<tr>
<td>Research</td>
<td>8.1%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Internat. cooperation</td>
<td>23.8%</td>
<td>22.0%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>3.8%</td>
<td>4.6%</td>
</tr>
</tbody>
</table>

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Contributions of Eligible Green Expenditures: Breakdown by EU Environmental Objective

Symbols are taken from „Financing Sustainable Growth“, European Union, 2019.
4 Green Federal Securities Execution - Strategy and the Twin Bond Concept
Twin Bond Concept

Conventional German Federal security “Conventional twin”

- Investors
  - Bond Purchase
  - Agreement on interest & principal repayment

- German Federal Government

Green German Federal security “Green twin”

- Investors
  - Bond Purchase
  - Agreement on interest & principal repayment
  - Declaration on allocation and impact reporting

- German Federal Government
  - Reporting on allocation and impact of green expenditures

Main terms (Green) Bobl Oct 2027 as an example:

<table>
<thead>
<tr>
<th></th>
<th>Conventional twin</th>
<th>Green twin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maturity segment</td>
<td>5y</td>
<td>5y</td>
</tr>
<tr>
<td>Coupon</td>
<td>1.3%</td>
<td>1.3%</td>
</tr>
<tr>
<td>Interest dates</td>
<td>Annually</td>
<td></td>
</tr>
<tr>
<td>Maturity</td>
<td>15 October 2027</td>
<td>Deliverable</td>
</tr>
<tr>
<td>Future-Contracts</td>
<td>€ 28.5 bn</td>
<td>€ 6.5 bn</td>
</tr>
<tr>
<td>Outstanding size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Issuance date</td>
<td>28 June 2022</td>
<td>31 August 2022</td>
</tr>
<tr>
<td>ISIN</td>
<td>DE0001141869</td>
<td>DE0001030740</td>
</tr>
</tbody>
</table>

Identical to both twins:
- Bond Purchase
- Agreement on interest & principal repayment

Different for each twin:
- Outstanding size
- Issuance date
- ISIN
Secondary Market Activity by Finanzagentur Ensures Liquidity

1. Outright ("one-way") sales and purchases

Outright purchase

Finance Agency

Outright sale

Green Bund

Finance Agency

Green Bund

2. Repurchase agreements and securities lending, using the Federal Government’s own stock of Green Bunds

Finance Agency

Repos and lending

Green Bund

Finance Agency

Green Bund

3. Combined and debt-neutral sale-and-purchase (switch) transactions: Most powerful tool

Green Bund

Finance Agency

Conventional twin

- Always sufficient conventional twins: tapped into own accounts simultaneously with green twins
- Budget neutral
- Risk neutral
- Debt neutral
- Cash neutral

Bundesrepublik Deutschland
Finanzagentur GmbH

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The Twins` Performance: Making the 'Greenium' Transparent

Greenium (yield spread vs. conventional twin, bps)

Greenium = yield spread between green and conventional bond

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The Twin Bond Concept Creates a Liquid Curve and Offers a Diversified Maturity Spectrum for Different Investor Types

- Germany will be a permanent issuer of green bonds.
- Liquid green yield curve acts as a reference for the euro area.
- This curve serves different investor type needs, e.g.:
  - Duration considerations
  - Liquidity considerations
Developing Sustainable Finance Markets by Applying the Twin Bond Concept

The twin bond concept ...

1. ... transfers the Bund’s established market approach to the green segment
2. ... creates a liquid curve and offers a diversified maturity spectrum for different investor types
3. ... provides full price transparency and allows for outperformance of the green twins

- will therefore accelerate the development of sustainable finance markets
- will serve as a catalyst to channel more investments towards a more environmentally friendly economy
- will attract new investors to the Green Bond market
Selected Case Studies of Eligible Green Expenditures (2022 budget year)
Case Study 1: Climate-Friendly Commercial Vehicles and Infrastructure

Objective

- Funding programme is part of the overall approach to climate-friendly commercial vehicles of the German Federal Ministry for Digital and Transport
- Intended to stimulate the market ramp-up of climate-friendly commercial vehicles
- Goal: one third of heavy road freight transport in Germany must be electric by 2030

Output and measures

- Funding of
  - Commercial & special vehicles with battery or fuel cell electric drive (EC vehicle category N1, N2 and N3) and externally rechargeable hybrid-electric vehicles (N3 only)
  - Refuelling and charging infrastructure necessary for the operation of the requested commercial vehicles on private sites (in particular depots)
  - Feasibility studies

Achievements

- Requested funds in the first two funding calls: approx. € 1.7 bn
- Until today € 272 mn approved (about 1,350 small and medium sized trucks and about 1,000 heavy duty trucks + charging infrastructure)
- Majority of commercial vehicles approved in first call: heavy commercial vehicles (N3)

Project partner

cooperation:
NOW GmbH
granting authority:
Federal Logistics and Mobility Office
Case Study 2: Tramway Infrastructure in Central Karlsruhe

Objective

• To reduce travel times and improve timetable reliability of the light rail service in Karlsruhe, an underground bypass was built under the pedestrian area in the city centre.

Output and measures

• Through the separation of tram/light rail traffic and pedestrians in the city centre, the traffic safety and timetable stability can be increased.
• In addition, travel time can be saved for passengers crossing the tunnel.
• By eliminating the disturbance by dense tram traffic, the livability of the pedestrian area can be improved.
• Furthermore, by the launch of a street-level tram service on a green track in an adjacent thoroughfare, the streetscape there could be redesigned and the quality of life improved.

Achievements

• A tramway tunnel with a southern branch was built under Kaiserstrasse, the main shopping street in the city.
• The new infrastructure comprises a 3.5 km long tunnel with seven stops, and a new street-level tram line in an adjacent thoroughfare.
• The new service was launched in December 2021.
Case Study 3: Second Core S-Bahn Route in Munich

Objective

To reduce pressure on the existing core S-Bahn route through central Munich, a second core route is being built from Laim station in the west to Leuchtenbergring station in the east.

Output and measures

• To improve journey times and reliability, the S-Bahn lines will be split into the two core routes through the city centre.
• On many S-Bahn lines, trains will run every 15 minutes throughout the day. In addition, express S-Bahn trains will offer fast and convenient service between the surrounding area and Munich city centre every 30 minutes. Also regional S-Bahn lines will be launched as a direct connection from the city to the wider metropolitan region (e.g. Buchloe and Landshut).

Achievements

• The heart of the route will be a 7-km-long tunnel connecting Munich Main Station and Munich East.
• The tunnel will serve three new subterranean stations at Munich Main Station, Marienhof and Munich East.
• Serving just three stations, the new core route will significantly reduce journey times. A new express S-Bahn system will offer attractive journey times between Munich's suburbs and its city centre.
Case Study 4: Promotion of the Purchase of Buses with Alternative Drives

Objective

• Convert local public transport bus fleets to battery electric drive systems, reducing greenhouse gas emissions from public transport as around two-thirds of all CO₂ emissions from local public transport come from diesel buses
• Support the market ramp-up of electric buses in order to reduce the acquisition costs in the medium-term through learning processes, economies of scale and the resulting increased competition
• Contribute to the development of a self-sustaining market

Output and measures

• € 522 mn of total funding
• Transportation agencies receive up to 80% of the additional investment costs for a battery electric bus compared to a diesel bus and up to 40% of the full investment cost of non-public charging infrastructure

Achievements

• 50 projects in over 60 cities and regions are supported
• The project supports the purchase of around 1,500 battery electric buses
• This is more than 15 times the number of buses in service before the purchase program began
• The market dynamics induced by the support program lead to an increasing differentiation of the product range on the part of the manufacturers, for example with regard to designs and battery sizes
Objective

- The AIMFREE research project aims at the parallelization of workstations and the implementation of versatility and flexibility in the final assembly of automobiles.

Output and measures

- A key aspect of the project is the holistic consideration of all necessary aspects of an agile assembly system. This includes the initial system design as well as planning and control.
- Self-driving robots and a self-driving car for the end-of-line use case is implemented in the system.
- The aim is a comparisons of the requirements and available technologies for different kinds of self-driving vehicles.
- Funding amount: € 3.6 bn; project term: 01.01.2020 – 31.03.2023

Achievements

- Physical demonstrator located at RWTH Aachen
- Digital demonstrator that visualizes all project outcomes
- The consortium published the results on relevant conferences, journals and produced a video of the agile assembly system.

Project partner

- RWTH Aachen; Bär Automation GmbH; ELABO GmbH; Pilz GmbH; Porsche AG; Siemens AG; ipolog GmbH; Fraunhofer IPT

source: http://aimfree.wzl.rwth-aachen.de
Case Study 6: Energy Systems of the Future in Brazil

Objective

- Planning Authority (EPE): Improvement of strategies for integrating variable renewable energy into long-term energy planning based on energy system modelling.
- Regulatory Agency (ANEEL): Implementation of research-based regulatory solutions to promote a higher integration of variable renewable energies into the Brazilian energy system.

Output and measures

- Identification of regulatory improvements for ANEEL’s Energy Efficiency Program, which has contributed to reducing energy demand on average by 335,894.77 MWh per year in 172 projects since 2008.
- Information compilation of over 200 public, private and civil society entities active in energy efficiency throughout Brazil.
- Energy Efficiency Network, which, during the 12 months of its duration, helped participating industries reduce their collective energy consumption by 38.12 GWh and increase their use of renewable energy sources by 31.14 GWh.

Achievements

- Installed capacity of solar power plants in Brazil exceeded the mark of 26 GW in 2023. Distributed solar power generation grew nearly 90% in 2022 in comparison to 2021 exceeding the mark of 16 GW.
- In 2022 solar power represented 4.3% of Brazil’s electricity matrix compared to 2.5% in 2021. Wind power represented 11.6% in 2022 compared to 10.6% in 2021.

Project partner

- Implemented by giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Case Study 7: Soil Protection and Rehabilitation for Food Security

**Objective**

Agroecological and climate-smart approaches for sustainable soil protection and rehabilitation have been implemented at scale in selected partner countries.

- The programme aims to support partner countries with the broad-scale implementation of field-tested approaches for soil conservation and rehabilitation.
- It helps protect or rehabilitate degraded soil and increase yields of key crops.
- At the same time, the programme strengthens strategies and incentives for sustainable land use.
- And improves the climate effect of soil protection and rehabilitation measures in selected agroecological zones.

**Output and measures**

- Increased yields of key crops by more than 37% on protected land.
- 515,192 trained smallholder farmers in measures suitable for climate change adaptation
- 39% women are adopters of promoted measures

**Achievements**

- On 565,881 ha soil conservation and rehabilitation practices with a mitigation co-benefit are applied (i.a. increase of soil organic carbon and biomass)
- Based on the programme’s climate monitoring system the annual mitigation contribution of the programme is 400,000 t CO₂e in 2022 on this area (0.7 t/ha)

**Project partner**

- Implemented by giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Case Study 8: Program for the Protection and Use of Natural Resources (PAGE II)

Objective

• The project contributes directly to reducing deforestation and improving the socio-economic situation of the population in the periphery of protected areas.

Output and measures

• Strengthening the technical capacities of value chain actors.
• Improvement of the administrative and technical framework.
• Strengthening the capacity of government technical services in natural resource management and selected value chains.

Achievements

• More than 6,000 households (34% women) are involved in the professionalization of 6 value chains (honey, cashew nuts, moringa, honey, energy wood, construction and service wood).
• 89,000 ha of locally managed natural forests and forest plantations are sustainably exploited by actors in the wood-energy and timber sectors.
• 41 other development projects have introduced at least one approach, method or instrument for the sustainable management of the value chains supported by PAGE II, taking into account a total of 17 different approaches, methods and instruments.

Project partner

• Implemented by giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
## Case Study 9: PtX Development Fund II

### Objective
- The PtX Development fund promotes the development of PtX (Power to X) value chains in developing countries (production of green hydrogen and its derivatives).

### Output and measures
- Award of financing and investment cost grants to help the development of individual components of the value chain, including new technologies.
- All components of value chain are eligible for funding, from the generation of electricity based on renewable sources to the production of green hydrogen and its derivatives and their transport and use in different industries and sectors.
- Expected total investment (target fund volume): € 1.35 bn
- Federal Funds (Grant): € 249.98 mn (FZ-Regionen)
- Project will be implemented until 2027

### Achievements
- Expected total GHG savings: 432,000 t CO₂e p.a.
- Expected total newly installed renewable energy capacity: 405 MW
- Expected total newly hydrogen production capacity: 1,177 t/day

### Project partner
- The project is implemented by KfW

Source pictures: [www.kfw-entwicklungsbank.de/Unsere-Themen/PtX/index.html](http://www.kfw-entwicklungsbank.de/Unsere-Themen/PtX/index.html)
Objective

- The project supports the Peruvian government in its efforts to ensure that 100% of the waste collected in Peru is disposed of and recycled in an environmentally sound manner
- Reduction of GHG emissions and climate protection

Output and measures

- Construction of landfills, sorting facilities, composting facilities, transfer stations, the procurement of containers and waste collection vehicles in selected regional urban centers in Peru
- Construction of a mechanical-biological waste treatment plant in one urban center.
- A complementary measure also supports TA measures for the provincial administrations and the Peruvian Ministry of Environment.
- Expected total investment: € 65 mn
- KfW development loan: € 52.3 mn (subsidized interest rate)
- Project will be implemented until 2027

Achievements

- Expected total GHG savings: 602,000 t CO₂e p.a.
- The project reaches around 1.4 million people in several cities in Peru.

Project partner

- The project is implemented by KfW
Case Study 11: Amazon Fund

Objective

- Protection and sustainable use of the Amazon Rainforest

Output and measures

- The Amazon Fund remunerates proven results in reducing GHG emissions from deforestation in the Brazilian Amazon.
- raises and manages donations for non-reimbursable investments in actions to prevent, monitor and combat deforestation, and to promote the conservation and sustainable use of the Amazon biome.
- also supports the development of systems for monitoring and controlling deforestation in other Brazilian biomes and other tropical countries.

Achievements

- More than $1.2 bn raised and $700 mn disbursed
- More than 100 supported projects
- 207,000 beneficiaries in the scope of sustainable productive activities
- 101 indigenous territories supported

Project partner

- The project is implemented by KfW
Case Study 12: Central African Forest Initiative (CAFI)
the biggest forest and climate multi donor trust fund for the Congo Basin

Objective

According to the 2015 CAFI Joint Declaration, signed between the donors and the six partner countries of the region, the objective of this initiative is to recognize and preserve the value of the forests and peatlands of the region to mitigate climate change, reduce poverty, and contribute to its sustainable development.

Output and measures

The objective shall be attained through the implementation of country-led, holistic low emissions development investment frameworks that include national policy reforms and measures addressing drivers of deforestation and forest degradation over several sectors. Based on so called Letters of Intent, signed between CAFI and the respective partner country, projects and programs are implemented.

Achievements

- 33 projects approved and under implementation in 4 partner countries. Currently, the donors’ contributions to the fund accumulate to $835 mn.
- The sectors of intervention are: forest sector, agriculture, energy, demographic pressure, gender, mining and hydrocarbons, governance, infrastructure, land-use planning and land tenure
- The fund’s field-level projects are expected to have reduced 75 million t of CO₂ and to have enhanced the livelihoods of up to 10 million people.
- Germany contributed with €245 mn so far (2022: €45 mn).

Project partner

9 donors: GER, UK, NOR, EU, FRA, BEL, SWE, KOR, NEL; 6 partner countries: DRC, CMR, RoC, GNQ, GAB, CAR. UN MPTF as administrator with several implementation organizations from UN, AFD, WB, GIZ, ENABLE, etc.

Source: Home / Central African Forest Initiative (CAFI)
Case Study 13: Solar Energy Use for Storage, Fuels and Industry (Projects PEGASUS, BaSiS)

**Objective**
- Novel power cycle combining a CSP plant with a sulphur storage system for 24 hours baseload operation
- Demonstrate a thermo-chemical sulphur storage cycle to permanently and efficiently store solar energy in chemical form as elemental sulphur at a 30 times higher energy density than today's molten salt systems
- Long-term storage solutions to replace fossil power plants 24/7
- Processing sulphur as one of the most important raw materials for chemical industry by means of solar energy (PEGASUS)

**Output and measures**
- On-demand solar power generation using sulphur storage technology (BaSiS)
- Direct combustion of sulphur in gas turbines for highly efficient renewable energy recovery
- Product SO₂ can be used for sulphuric acid production and for hydrogen production

**Project partner**
- DLR, in cooperation with KIT, BrightSource (and others)

Source: DLR Solar Towers in Jülich © DLR
Case Study 14: CoBra - High Temperature Heat Pumps based on the Brayton Process; located in Cottbus

Objective

- Roughly 60% of the industrial energy demand in Germany is used for process heat
- There is significant need in CO$_2$-neutral process heat in the range of 150-500°C. Market cannot provide heat pumps with adequate performance.
- Objective is the development, upscaling and integration of CO$_2$-neutral high temperature heat pumps in energy intensive processes of several industries (chemistry, petrochemistry, iron, steel, paper, food, cement, aluminium)

Output and measures

- Demonstrator high temperature heat pump (HTHP) operational at DLR Cottbus by the end of 2022
- Development of necessary turbo components
- Accompanying research will identify options for operating scenarios
- Virtual model of the HTHP and its embedding in the industrial processes
- Electrification of the industrial process heat demand up to 500 °C could result in CO$_2$ savings equal to the current Switzerland's CO$_2$ emissions

Source: DLR, CAD scheme of the first test facility for a HTHP
Case Study 15: Institute of Maritime Energy Systems

Objective

• Development & Demonstration of sustainable CO₂ neutral maritime energy systems

Output and measures

• Sustainable maritime energy systems for ships of various sizes
• Prevention of air pollution by pollutants from the use of fossil fuels, especially CO₂.
• Introduction of CO₂-neutral fuels like H₂, NH₃, and LOHC
• Optimization of energy demand and supply on-board for power, heat and cooling
• Conception of needed infrastructure in ports
• Offering test facilities on shore and research vessel for tests and qualifications of components

Project partner

Source: www.dlr.de/ms

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Case Study 16: TTP Leichtbau - Verbundvorhaben CC-Mesh

Objective

• Joint project for lightweight construction
• Transfer of design and reinforcement concepts from lightweight construction to concrete construction.

Output and measures

• Funding amount: € 1.8 mn, project term: 01.11.2020 - 31.10.2023
• Development and optimization of innovative, large-format and durable carbon reinforcements for concrete construction.
• The three-dimensional reinforcement structures adapt optimally to the force flow, GHG savings potential of up to 86% compared to reinforced concrete

Project partner

CarboCon GmbH, HA-CO Carbon GmbH, Technische Universität Dresden - Institut für Massivbau, Hochschule für Technik, Wirtschaft und Kultur Leipzig

Source: CARBOCON GMBH
## Case Study 17: Project 328H2-FC

### Objective
- Product-relevant design and realization of a hybrid-electric regional aircraft with a hydrogen fuel cell system as energy supplier

### Output and measures
- Development of an airworthy fuel cell system with a performance of 1.5 MW
- Optimization of the hybrid drive architecture
- Development of a liquid hydrogen tank incl. integration into a Do328 regional aircraft
- Development of a suitable thermal management solution
- Development and integration of high-performance electronics
- Analysis of the climate impact of hydrogen-based propulsion systems

### Achievements
- Top level aircraft requirements (TLAR) definition completed
- System Requirement Review #1 (SRR#1) completed, SRR#2 in preparation
- Conceptual design review (CoDR) in preparation

### Project partner
- German Aerospace Center (DLR), Deutsche Aircraft, H2FLY, DIEHL Aerospace, DIEHL Aviation (DAL & DAG), HS Elektronik Systeme (HSG), Bauhaus Luftfahrt, IABG, Airbus Aerostructures, GE Aviation

**Source:** DLR, Deutsche Aircraft GmbH
Case Study 18: HydroPoLEn
Hydrogen Powered Large Marine Engines

Objective

• Internal combustion engines (ICE) will continue to play a significant role in future deep sea shipping applications.
• Therefore, great efforts are currently being made to decarbonize this proven technology.
• The objective of this joint R&D project is the development of large medium speed engines with high power density for 100% hydrogen operation.
• The power density shall correspond to the characteristics of modern diesel engines.

Output and measures

• Demonstration of hydrogen combustion processes for dual-fuel (95% H₂) and mono-fuel (100% H₂) medium speed engines. H₂-Mono-fuel engines allow a 100% reduction of GHG emissions.
• Derivation of concepts to avoid pre-ignition phenomena, which significantly limit the power density of H₂-ICE.
• Development of customized components for hydrogen injection, ignition and the tribological system.
• Funded by the Federal Ministry for Economic Affairs and Climate Action in the Maritime Research Programme.
• Funding amount: € 8.9 mn, project term: 01.09.2022 – 31.08.2025.

Project partner

MAN Energy Solutions SE / TU München / WTZ Roßlau gGmbH / Federal Mogul Burscheid GmbH

Source: MAN Energy Solutions SE
Case Study 19: Project ReCircE (Digital Lifecycle Record for the Circular Economy)

Objective

- Information/data about a product and its lifecycle is stored in a passport
- This information/data can be shared with involving stakeholders e.g. manufacturers, consumers or waste management companies
- They can use the information e.g. to improve the efficiency of the recycling process

Output and measures

- Creation of the Digital Lifecycle Passport and the cloud storage infrastructure
- Implementing a use case on an AI-enhanced sorting machine to demonstrate that the Digital Lifecycle Passport can improve the waste sorting process
- Project duration: 01.10.2020 till 30.09.2023
- Federal funding: € 1.8 mn

Project partner

- Green Delta GmbH
- German Research Center for Artificial Intelligence
- Technical University of Darmstadt
- Fraunhofer Research Institution for Materials Recycling and Resource Strategies IWKS

Sources:

- https://www.recirce.de/
- https://www.z-u-g.org/foerderung/ki-leuchttuerme-fuer-umwelt-klima-natur-und-ressourcen/projekt/recirce/
Case Study 20: Market Incentive Programme for Renewable Energies in Heating Sector (MAP)

Objective
- The building sector is responsible for about 35% of Germany’s total final energy consumption
- The MAP funding scheme aimed at incentivizing homeowners, businesses, municipal entities, and charitable organizations to invest in the energetic refurbishment of existing buildings, for example by installing heating systems such as heat pumps or heating networks.

Output and measures
- By switching from fossil to renewable energy sources for heating, substantial energy savings can be achieved and GHG emissions can be reduced correspondingly.

Achievements
- From 2000 to 2022, MAP funding was granted for more than 2.3 million heating systems with federal spending of almost € 8 bn (programme ran out at the end of 2020 and was merged into the new federal funding programme for energy efficient buildings, BEG).

Source: © Adobe Stock/Gerhard Seybert
Case Study 21: Federal Funding for Energy and Resource Efficiency in the Economy (EEW)

<table>
<thead>
<tr>
<th>Objective</th>
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<tbody>
<tr>
<td>• The industry sector is responsible for about 29% of Germany’s total final energy consumption</td>
</tr>
<tr>
<td>• The aim of EEW funding is to create incentives for industry and commerce to invest in energy- and resource-efficient technologies, renewable process heat and reduction of energy and resource consumption</td>
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<table>
<thead>
<tr>
<th>Output and measures</th>
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<tbody>
<tr>
<td>• Funding of investments up to 60% by grants</td>
</tr>
<tr>
<td>• the EEW includes the following modules:</td>
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<tr>
<td>➢ Module 1: cross-sectional technologies</td>
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<td>➢ Module 2: renewable process heat</td>
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<tr>
<td>➢ Module 3: measurement, control and regulation technology</td>
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<tr>
<td>➢ Module 4: Energy and resource-related optimization of systems and processes</td>
</tr>
<tr>
<td>➢ Module 5: Transformation Concepts: to support companies in planning their decarbonization strategy</td>
</tr>
<tr>
<td>➢ grant competition: similar to Module 4</td>
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<thead>
<tr>
<th>Achievements</th>
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<tbody>
<tr>
<td>From the beginning of the programme in 2019 to 2022: funding of approx. 54,000 projects with a grant volume of € 1.7 bn</td>
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<tr>
<th>Project partner</th>
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<tbody>
<tr>
<td>Federal Office for Economic Affairs and Export Control</td>
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<tr>
<td>KfW</td>
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<td>VDI/VDE/IT</td>
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*Image source: @ stock.adobe.com/Blue Planet Studio, Projektträger VDI/VDE-IT*
Case Study 22: Oshivela - Green Iron from Namibia

**Objective**
- Oshivela uses hydrogen technologies made in Germany to produce green iron in Namibia, thus contributing to the decarbonisation of the energy-intensive steel production.
- BMWK funds the project with € 13.8 mn within the funding directive for international hydrogen projects. The directive is intended to promote the establishment of trade relations with potential exporters of green hydrogen/its derivatives and the application of German hydrogen technologies abroad.

**Output and measures**
- The project contributes to the industrial transformation towards a carbon-free steel industry by using innovative technologies for iron reduction and green hydrogen production.
- Within 24 months, the pilot production plant aims to produce 15,000 tons of green iron with “Net Zero” emissions using the innovative HyIron process.
- A 12 MW electrolysis plant will be set up to produce hydrogen for the HyIron process. The necessary power will be provided by a 20 MW photovoltaic power plant.
- The manufacturing process is also the basis for the development of adjacent industries (e.g., foundries, steel mills or 3D metal printing).
- Due to the enormous wind and solar resources as well as iron ore deposits in Namibia, there is great potential for the country to establish itself as an important future supplier of CO₂ neutral iron for the German steel industry. BMWK supports this transformational process by funding the Oshivela pilot project.

**Project partner**
- CO2GRAB GmbH
- TS ELINO GmbH
- LSF Ltd.

**Diagram**
- The hydrogen (H₂) draws the Oxygen (O) from the Iron Ore (Fe₃O₄). As a result, there is water (H₂O) and iron (Fe).
- The water is split into Hydrogen (H₂) and Oxygen (O) in the Electrolysis.
- Renewable energies from PV farm.
- Iron reduction with Carbon (traditional).
- Iron reduction with Hydrogen (H₂) (HyIron).
- Water Tank.
- Carbon Monoxide (CO).
- CO₂ – Carbon Dioxide.
- Hydrogen (H₂).
- Iron (Fe).
- Iron Ore (Fe₃O₄) or (FeO).
- CO₂ – Carbon Dioxide.
- Renewable energies from PV farm.
Case Study 23: Project NutriNet – Competence and Practice Research Network for the Further Development of NutriNet Management in Organic Agriculture

Objective

- More efficient nutrient management in organic farming through practical solutions
- Further development of methods of on-farm research / encourage farmers to engage in on-farm research
- Development of a data management tool

Output and measures

- Ten stakeholders in (organic) agricultural research are involved in the NutriNet project:
  - Identification of strategies to optimize nutrient management, testing them in practice and refining them (in 6 regional networks, each consisting of 10 farms)

Achievements

- Establishment of a nationwide (on-farm) research network for nutrient management in organic farming

Project partner

Bioland Beratung GmbH, Hochschule für nachhaltige Entwicklung Eberswalde, Universität Kassel; Landwirtschaftskammer Nordrhein-Westfalen, and 6 other project partners
Appendix:
Contact Persons and Further Information
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## Examples of Impact Reporting Approaches

<table>
<thead>
<tr>
<th>Sector</th>
<th>Indicative impact report indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>• Greenhouse gas emissions avoided (when possible)</td>
</tr>
<tr>
<td></td>
<td>• Length of electrified railway-km</td>
</tr>
<tr>
<td></td>
<td>• Length of newly built railway-km</td>
</tr>
<tr>
<td></td>
<td>• Length of newly built bicycle lanes</td>
</tr>
<tr>
<td></td>
<td>• Final reports about and descriptions of projects</td>
</tr>
<tr>
<td>International cooperation</td>
<td>• Greenhouse gas emissions avoided (when possible)</td>
</tr>
<tr>
<td></td>
<td>• Specific reports about the environmental efficiency of the German international cooperation and the mobilisation of private capital</td>
</tr>
<tr>
<td></td>
<td>• Listing of main initiatives and projects and presentation of key examples, and / or a description of mandates of financed multilateral institutions as well as international organisations and funds</td>
</tr>
<tr>
<td>Research, innovation and awareness raising</td>
<td>• Standard research indicators</td>
</tr>
<tr>
<td></td>
<td>• Total funding or number of funded projects</td>
</tr>
<tr>
<td></td>
<td>• Lists of main initiatives or presentation of key examples</td>
</tr>
<tr>
<td>Energy and industry</td>
<td>• Greenhouse gas emissions avoided (when possible)</td>
</tr>
<tr>
<td></td>
<td>• Reduction of energy consumption, share of renewable energies</td>
</tr>
<tr>
<td></td>
<td>• Specific reports about the climate and environmental efficiency of the subsidies</td>
</tr>
<tr>
<td>Agriculture, forestry, natural landscapes and biodiversity</td>
<td>• Specific reports about the climate and environmental efficiency of the GAK-policy (Gemeinschaftsaufgabe Agrarstruktur &amp; Küstenschutz: joint task of agricultural structure and coastal protection)</td>
</tr>
</tbody>
</table>
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