

Research, development and innovation

Research and development: Goals, guidelines and processes

The goal of our research and development is to identify technological trends at an early stage, assess their economic potential and build up expertise in the business units. For this purpose, we carry out pilot and demonstration projects together with partners or customers directly at the site of their subsequent application. This ensures that successful research projects deliver innovations for our company.

Research, development and innovation also lead in many cases to inventions and patents. The portfolio of patents shrank slightly by 20 patents (previous year: +36) in 2020; the EnBW Group thus held 224 patents (previous year: 244) at the end of the year. The patents held by EnBW focus mainly on the areas of generation and electromobility.

Research and development: Selected activities

Wind energy: Offshore wind power plants with fixed foundations are limited to shallow waters with water depths of up to around 50 meters. Floating platforms could be used to install wind turbines in deeper waters. In cooperation with partners, we are investigating several different concepts for floating offshore wind farm projects that would be suitable for opening up new international offshore wind energy regions. In cooperation with the engineering company aerodyn from northern Germany, we tested a 1:10 scale model of a new design for floating wind turbines called Nezy² in 2020. Tests carried out on a gravel pit lake in northern Germany and in the Baltic Sea demonstrated that the platform concept worked even in stormy winds. Scaled up to the later true size of the system, the wave and wind conditions were equivalent to a category 4 to 5 hurricane with waves reaching heights of up to 30 meters. Nezy² will now be tested under real conditions at sea. The test using a 1:1 scale model is due to be carried out in China at the end of 2021 or beginning of 2022. We also concluded a cooperation agreement with other European companies at the end of 2020 to construct a pilot plant in the Irish Sea. We want to use the two demonstration projects to identify which type of floating platform is the best solution.

Photovoltaics: The University of Stuttgart has developed a laser process that enables the inexpensive production of non-toxic silicon solar cells with a high level of efficiency. We have been participating in this research project funded by the federal government since August 2017 and founded our subsidiary EnPV in December 2017 to prepare for the commercialization of the results. The EnPV team was strengthened in 2020 to help clarify

important issues relating to individual steps of the patented process and create the conditions for a pilot production process on an industrial scale.

Geothermal energy: In addition to the production of electricity, geothermal energy has the potential to reduce the use of fossil fuels in heating networks. We support our business partners, such as local authorities, in decarbonizing their heating networks using geothermal energy. A project in Bruchsal has now come to fruition: By the end of the 2019/2020 heating season, the Bruchsal geothermal power plant had supplied more heating to the nearby police station than planned. In August 2020, EnBW and MVV had their bid to carry out further explorations to the south of Mannheim accepted. We gained our experience in the provision of heating from geothermal energy through partnerships, in which we and our partners planned and constructed the geothermal power plants in Bruchsal (since 2012) and Soultz, France, (since 2016) and still operate them today.

Hydrogen from renewable energies: We also want to provide our customers with carbon neutral gaseous energy sources in the long term. The experience gained from various pilot and demonstration projects will help us achieve this. This also includes the alkaline hydrogen electrolysis plant with an electrical output of 1 MW in Wyhlen, which was built in 2018 by our subsidiary Energiedienst (ED) with funding from the State of Baden-Württemberg and is operated using electricity generated from hydropower. In 2019, ED had its bid to expand the plant by 5 MW accepted as part of the "Reallabore" tender process from the German Federal Ministry for Economic Affairs and Energy (BMWi), with the aim of supplying a district, as well as industry and customers in the mobility sector, with hydrogen produced from green electricity. The concept for the project was fundamentally revised in 2020 so that it will be possible to continue operating the plant economically after the project has finished. After receiving funding approval in December 2020, the project started in January 2021 with the largest power-to-gas plant in southern Germany at the time. We are thus acquiring the skills required to construct and operate other hydrogen generation plants in the future.

Hydrogen in the gas grid: The EnBW subsidiary Netze BW started a pilot project called the "Hydrogen Island Öhringen" in 2020 in the City of Öhringen in the Hohenlohe district that is unique across Germany. A section of the existing natural gas grid will be disconnected and supplied independently. A natural gas mix with a hydrogen content of up to 30% will be used in the island grid. The hydrogen will be produced with the aid of an electrolyzer on the premises of Netze BW that uses electricity generated from renewable energy sources. This multi-year project aims to demonstrate that the existing natural gas infrastructure can already deliver a climate-friendly energy supply today and is an important component of the Energiewende.

Internal carbon pricing: Internal CO₂ pricing is an emerging method for reducing a company's own emissions. A corresponding model for EnBW has been under development since 2018 as part of a dissertation at the Sustainability Center Freiburg. Case studies from suitable areas of the company are being used to develop internal options for improving the carbon footprint that go above and beyond a consideration of just direct emissions. The leverage effect of various measures for buildings, travel and other areas specifically tailored for EnBW will then be assessed.

Augmented reality in renewable energy planning: Augmented reality can support the planning processes for wind and PV power plants on-site and improve acceptance for new projects. A team at EnBW has developed an app with the support of an international IT company that can create a photographically realistic representation on a mobile end device. The app can create both predefined views of the power plants for the approval process also images from any freely selected perspective. It can thus be used to show how a power plant will be perceived within a private or public environment. A beta version was developed and tested in summer 2020 that can detect the horizon even in hilly regions. The process for handing over the software to the planning teams in the branch offices began in February 2021.

E-mobility charging infrastructure for apartment buildings:

As a result of the reform of the German Apartment Building Modernization Act (WEMoG) at the end of 2020, it is now much easier for residents in apartment buildings to install charging infrastructure in shared underground garages. This and other statutory measures should contribute to the ramping up of electromobility, especially in apartment buildings. Netze BW is investigating what sort of grid connection will be required in a residential complex when in future 58 e-cars are being charged in a shared underground garage and what impact this will have on the electricity grid in the "E-Mobility-Carré" project in Tamm near Ludwigsburg. The project is being carried out in a modern residential complex under real grid operating conditions.

E-mobility charging infrastructure in a rural setting: More and more people in rural regions will also start using electric cars in the future. This represents a major challenge for the electricity grid because the individual electricity circuits in these regions are significantly longer than in urban areas. The longer the power line, the more the voltage can vary. If a lot of electric cars are being charged on these electricity circuits in the future, it will exacerbate the problem. In order to find out what impact electromobility will have on rural electricity grids in the next few years, Netze BW is carrying out a test under real conditions in Kusterdingen (Tübingen District) in the "E-Mobility-Chaussee" project.

Smart charging at home: The power required by electric vehicles, especially if they are being charged simultaneously, which happens above all in the evening, will place a high demand on the electricity grid. Using a load management system for the grid, it is possible to smooth out peak loads and thus reduce the burden on the electricity grid. Using the smart metering system in combination with a control box offers great potential for developing a uniform solution for managing charging facilities.

This prospective management system is being developed in consecutive stages by Netze BW and tested in various locations under real conditions.

Inductive charging: An electric bus operated by EnBW will connect the EnBW site at the Port of Karlsruhe to the public transport system during the course of 2021. The special feature of this electric bus is that the batteries will be charged inductively during the journey. This charging technology involves inductive coils being embedded in the road surface. As soon as the vehicle drives over them, the receiver coils fitted on the underbody are activated. Electrical energy is generated in the coils via a magnetic field and is stored in the vehicle's battery. This enables the vehicle to cover long distances without the need to stop to recharge. The EnBW research project is thus testing inductive charging of the electric bus during everyday use. The Israeli start-up ElectReon is supplying the technology for the test route.

Sustainable extraction of lithium: In cooperation with the Karlsruhe Institute of Technology (KIT) and other firms and institutes from the world of science, we are investigating a process to sustainably extract lithium from thermal water as part of a research project. In December 2020, we received funding approval for the four-year project. At existing geothermal plants – such as in Bruchsal – special adsorbents will be used to specifically extract lithium from the rest of the thermal water. After successfully testing the process in the laboratory, the next challenge is to transfer the process to an operating geothermal plant.

Innovation management: Goals, guidelines and processes

EnBW Innovation has been a fixed component of EnBW since the middle of 2014 and is one of the leading corporate innovation labs in Germany. Together with employees, entrepreneurs, external partners and start-ups, we develop new business models in the strategic areas of connected home, digital utility, urban infrastructure and connected mobility. The **innovation strategy** focuses on two main approaches: the generation and scaling up of new business models and investments in external start-ups by EnBW New Ventures.

Alongside the development of new business models and supporting early-stage teams during the incubation phase, EnBW Innovation also accompanies more mature projects with the **Company Builder**. In the reporting year, the focus was placed on professionalizing processes and scaling up existing projects. In order to efficiently support the teams and their growth, the Company Builder provides start-ups with additional skills in the form of controlling, sales and marketing experts. For our expertise in the scaling up of start-ups, we were presented with the Digital Lab Award for the third year in a row by the specialist jury from the business magazine Capital and the management consultancy firm Infront in 2020. In addition, we have been supporting external teams on the journey from an innovation project through to a stable, value-generating company with start-up grants since 2020.

EnBW New Ventures invests in start-ups that develop digital solutions for infrastructures. The aim is to use the total available investment volume of €100 million to secure minority shareholdings of between 10% and 30% in up to 20 start-ups, with an investment period of four to eight years in each case. EnBW New Ventures plays the role of an active investor, supports the start-ups as a business coach or kind of “sparring partner” and is represented on their boards. The start-ups receive access to professional investor expertise via EnBW New Ventures. In addition, commercial cooperation with the operating units at EnBW is also possible.

Innovation: Selected activities

In 2020, the spin-off **WTT CampusONE** that was founded in 2017 was the first EnBW start-up to generate positive earnings. The company based in Ludwigsburg provides learning platforms and tools for digital workplace training. The training covers themes such as energy, administration and legal requirements such as occupational safety and data protection. Standard e-learning courses can be acquired individually via a license or as a flat-rate service. Customized e-training courses are also offered. As its second pillar, WTT CampusONE also offers solutions for digital human resources development. The tools and modules can be assembled according to the customer’s needs and are primarily used in the human resources sector. The combination of learning content and complementary tools offered by WTT CampusONE is unique on the market. The team of around 40 employees is considered one of the leading specialist providers of digital training in Germany.

LIV-T was founded in October 2017 by EnBW Innovation and the company builder **mantro** that is based in Munich. The company aims to optimize the ordering processes and supply chains for energy sources such as heating oil and pellets. Industrial and end customers have had to keep a close eye on their tank fill levels themselves up to now. The LIV-T software enables repeat orders to be initiated based on data. The software updates stock levels in real time and can interact with tank users and provide recommendations for action. As a result, the 30-person team has become the European market leader in the area of tank fill level management within three years. LIV-T is currently distributing its smart eco-system via 100 partner companies in seven

countries and is upgrading its software with other AI-based applications. We anticipate that the company will triple its sales in the next three years with this business model. LIV-T is the first EnBW start-up that has also been successful internationally.

Ben Fleet Services was founded in January 2019 by EnBW Innovation and the company builder **Bridgemaker** based in Berlin. It acquired another investor in the latest round of financing in the form of the globally active insurance group **Baloise**. It is thus the first EnBW start-up with an external investor. EnBW still holds a majority stake in **Ben Fleet Services**. The company offers fleet managers and fleet operators a comprehensive range of flexibly bookable services for their fleets. The special feature is that the range of services can be directly integrated into the customer’s existing system via a digital interface to improve the operational readiness and availability of their vehicles. The range of services includes on-site cleaning, refueling and charging, maintenance, repair and the relocation of vehicles – for individual vehicles or entire vehicle groups, for e-cars, transport vehicles, buses and trains, bicycles and scooters. This start-up based in Berlin now has around 100 employees at eight sites across Germany and its customers include traditional corporate fleets as well as leading providers of new mobility services. **Ben Fleet Services** plans to expand further in 2021 – also outside of Germany. The company will use the new capital to establish new sites in Germany and further develop the technology behind its service platform. It aims to secure its first customers in other European countries in 2021.

Expenditure and personnel

We spent €70.6 million (previous year: €54.4 million) on research, development and innovation in the 2020 financial year. The increase was primarily due to higher expenditure for the grids and the growth in innovation management. Sales in the area of innovation management increased to €13.4 million (previous year: €11.1 million). We received government research grants of €1.0 million (previous year: €0.9 million). There were 93 employees (previous year: 81) in the areas of research, development and innovation in 2020. 185 employees (previous year: 236 employees) were involved in research and development projects as part of their operational work. A further 248 employees (previous year: 130) were involved in innovation projects.

Expenditure on research, development and innovation in € million

