

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 grew by 36 patents (previous year: 25) in 2019; the EnBW Group held 244 patents (previous year: 208) at the end of the year. The patents held by EnBW focus mainly on the areas of smart solutions 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 m. Floating platforms could be used to exploit the wind power potential 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. We signed a technology partnership agreement with the engineering company aerodyn based in northern Germany at the end of 2019. Together, the partners will realise a novel design for floating wind turbines that offers the potential for cost savings because of the way it is constructed. The small-scale test that began in 2020 in Germany has immediately led to a test under real conditions, which will be carried out by the Chinese renewable technologies company Ming Yang from Shanghai. We want to develop another floating platform concept in cooperation with European partners and construct a pilot plant in Europe. The two demonstration projects will help us to identify which type of floating platform is especially suited for future projects.

In addition, we are a member of a consortium that is designing a prototype for an offshore power plant with an output of more than 10 MW and aims to construct it as a pilot plant with funding from the EU. Following the insolvency of Senvion, General Electric has joined the consortium and the project is being continued.

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 commercialisation of the results. EnPV investigated the industrial feasibility of the process in cooperation with factory outfitters in 2019. It is expected that it will then be possible to produce non-toxic PV modules at a cost that is commercially viable in comparison to current market prices. Some outstanding issues relating to individual steps of the patented process will be evaluated in 2020 so that it can be demonstrated in a pilot factory on industrial machines.

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 partners, such as local authorities, in decarbonising their heating networks using geothermal energy. A project in Bruchsal has now come to fruition: The heating supply for a police station from the nearby geothermal power plant was inaugurated on 4 December 2019. 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.

Green gases and hydrogen: 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. Since the beginning of 2020, our subsidiary ZEAG has been generating green hydrogen with the aid of state funding. It is using a 1 MW PEM electrolyser (PEM = proton exchange membrane) that directly converts electricity from the “Harthäuser Wald” wind farm into green hydrogen. Our subsidiary Energiedienst Holding (ED) already opened an alkaline hydrogen electrolysis plant with an electrical output of 1 MW in Wyhlen in November 2018 – operated with green hydropower. In 2019, ED had its bid to expand the plant to up to 5 MW accepted as part of the “Reallabore” tender process of the German Federal Ministry for Economic Affairs and Energy (BMWi), with the aim of supplying districts, industrial premises and customers with hydrogen produced from electricity for their mobility needs. The project is due to start in 2020.

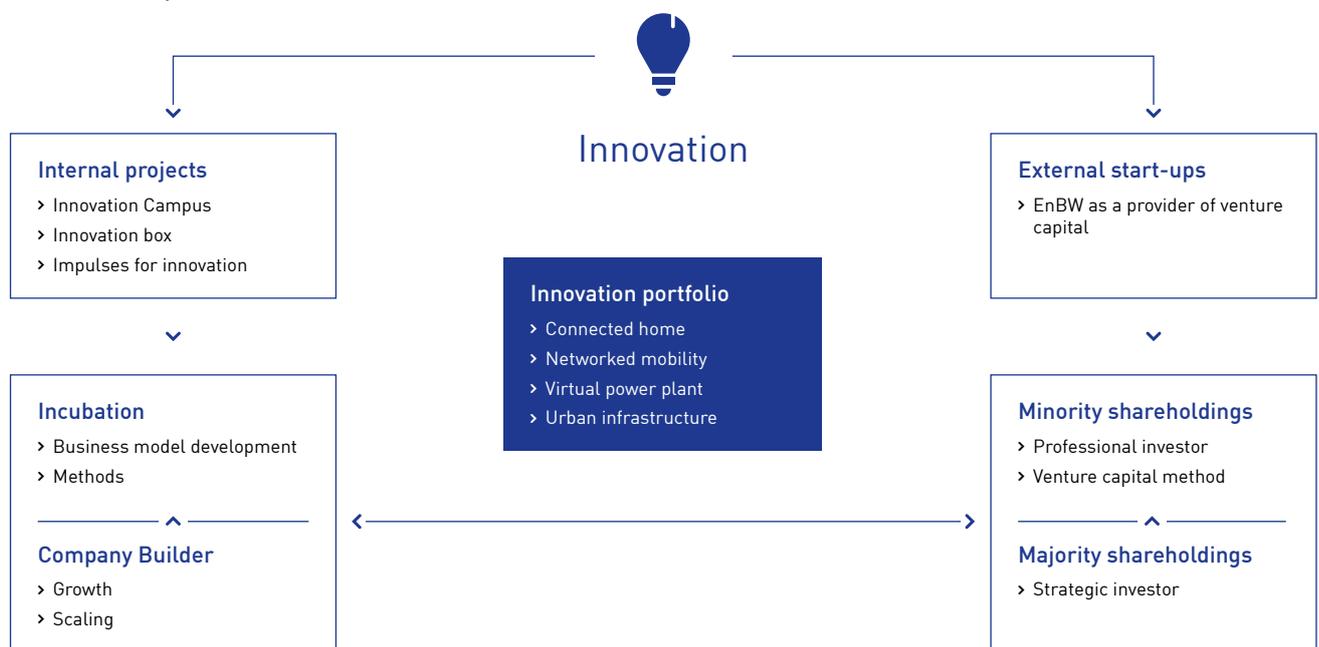
New technologies for the charging infrastructure (Glossary, from p. 139): Following preliminary studies, we will demonstrate a new method for contactless charging during journeys and test its suitability for everyday use in 2020. To this end, we entered into partnership in December 2019 with the young company ElectReon from Israel, which has developed an induction system for roads. It will be used for the first time on a test track in Baden-Württemberg. We are investigating how to speed up conventional charging without damaging the batteries using a special vehicle and a charging station with a capacity of up to 320 kW.

Load management for electromobility: The “E-Mobility Avenue” project carried out by Netze BW in Ostfildern near Stuttgart ended in October 2019. The aim was to test the impact of the broad use of electromobility on the electricity grid. For this purpose, ten households on one street were provided with e-cars and the required charging infrastructure (Glossary, from p. 139). Netze BW believes that the results demonstrate that the challenges faced by the distribution grid operators as a result of

the ramping up of electromobility can be overcome. In particular, the project showed that there is great potential for both smart load management to avoid bottlenecks and the temporary use of different types of battery storage systems to reduce the load on the grid. In addition, it was possible to gain valuable insights into the charging and user behaviour of drivers of electric cars. Follow-up projects in Tamm (“E-Mobility-Carré”, p. 58) and a test field in a rural setting (“E-Mobility-Chaussee”) have been launched.

Innovation management: Goals, guidelines and processes

The innovation process at EnBW



We develop new business models outside of our core business using the central innovation management department in order to quickly identify new sources of revenue and bring them to the market. The **innovation strategy** focuses on two main approaches: the generation and scaling up of new business models within the company in internal and external projects and investments in external start-ups by EnBW New Ventures.

Alongside the development of new business models and supporting start-up projects during the incubation phase, innovation management also accompanies mature projects during their growth phase with the **Company Builder**. In the reporting year, the focus was primarily placed on professionalising processes and scaling up existing projects. Following the successful development of new business models, the start-up teams then face further challenges in the growth and scaling-up phase. 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.

EnBW New Ventures invests in start-ups that develop digital solutions for infrastructures. It focuses on companies who realise value added through scalable business models and new technologies. 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.

In future, EnBW will also secure majority shareholdings in quickly growing mature companies with the aim of achieving substantial growth.

Innovation: Selected activities

A successful early start-up from our idea factory is **ChargeHere**, which offers inexpensive charging infrastructure solutions for car parks and large parking facilities to promote the further expansion of electromobility. Instead of equipping every parking space with its own wallbox, the solution from ChargeHere only requires a central switching cabinet from which the charging cables are laid to the individual parking spaces. The concept also enables optimised, dynamic load management and controlled charging of the vehicles. ChargeHere is now in the growth phase and has twelve employees. We are also using ChargeHere to expand the charging infrastructure (Glossary, from p. 139) at our own sites; a total of 264 charging points were installed at six large sites in 2019. ChargeHere is also participating in the iLIME project (smart charging infrastructure management for e-mobility), which is being supported by the Ministry for the Environment, Climate Protection and the Energy Industry, Baden-Württemberg. In cooperation with its partners, ChargeHere is developing a concept in the project for a multi-level smart load management system for e-mobility. The ChargeHere charging solution with dynamic load management has also been used since autumn 2019 at a housing estate with apartment buildings and shared underground parking facilities in Tamm. Around two thirds of the parking spaces in this “NETZlabor E-Mobility-Carré” were equipped with ChargeHere charging points for a practical test to examine the best way to integrate electromobility into an existing grid infrastructure.

SMIGHT was one of our first start-ups and was able to continue its positive growth in 2019. Originally founded as a supplier of smart, multifunctional street lights, SMIGHT has since changed its business model significantly. As well as recording traffic flows in medium-sized German cities using sensors installed on existing street lights, it is increasingly focusing on the target group of distribution grid operators. A smart electricity sensor has been developed for these customers that supplies real time data about the actual grid load and thus supports the needs-based expansion of the grid. The first major customer was Netze BW,

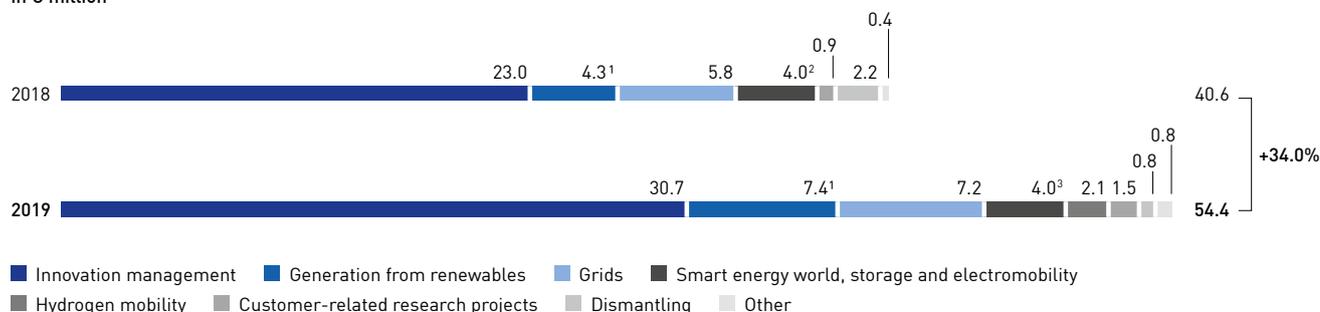
which has equipped 550 local transformer stations with the SMIGHT Grid electricity sensor. This has created 18,000 measurement points. Alongside traffic solutions, the grid sensor business remains a lucrative second pillar for SMIGHT.

The **Virtual Power Plant** (Glossary, from p. 139) is another mature start-up from the Company Builder. It collects and bundles together the renewable energy from smaller decentralised power plants such as wind turbines, photovoltaic plants or biomass power plants via its digital platform. The volumes of electricity that are collected are then sold on the electricity market. At the same time, the Virtual Power Plant also supplies consumers such as commercial customers or our quick-charging stations. It is growing constantly with the addition of new plant operators and cooperation partners. Electricity producers benefit from the fact that they have a competent partner to handle the sale and remuneration of the green energy. The Virtual Power Plant was founded in 2016 and has since developed into an established supplier on the market with around 30 employees and more than 1,000 customers. In 2019, we upgraded the Virtual Power Plant from an innovation project to a Micro Business Unit – a company within the company. Micro Business Units are mature projects that have already generated their first sales with a marketable business model.

Expenditure and personnel

We spent €54.4 million (previous year: €40.6 million) on research, development and innovation in the 2019 financial year. The increase was primarily due to the growth in innovation management; the corresponding sales increased to €11.1 million (previous year: €6.4 million). We received government research grants of €0.9 million (previous year: €2.3 million). There were 81 employees (previous year: 63) in the areas of research, development and innovation in 2019. 236 employees (previous year: 169 employees) were involved in research and development projects as part of their operational work. A further 130 employees (previous year: 110) were involved in innovation projects.

Expenditure on research, development and innovation in € million



1 Also includes green gases.
 2 Includes hydrogen mobility.
 3 Excluding hydrogen mobility.