

Innovation Report 2020 – 2022



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Chairman's letter

Ignacio S. Galán

It is during times of uncertainty such as these that the resilience and adaptability of organisations is tested. But, faced with the temptation to focus on short-term solutions, it is now more than ever necessary to reaffirm our determination to seek new paths that will make us stronger and better prepared to move forward. The ability to innovate is therefore an asset of enormous value in shaping this new future and anticipating new, as yet unknown challenges.

The complexity and globalisation of business activity means that companies are particularly conditioned by this reality. For this reason, strengthening an internal culture based on innovation has become an unavoidable duty for companies in all sectors, and especially for those most exposed to technological change.

Iberdrola's evolution over the last two decades demonstrates this. We have become drivers of the transition towards a sustainable, competitive and safe energy model based on electrification through the incorporation of new clean and efficient technological solutions.

This Innovation Report includes the most important actions and projects carried out by the group in the R&D&I field in the 2019-2022 period, in which we have invested more than €1,200 million in new renewable energies, smart grids, storage and green hydrogen. This has consolidated our position as the private utility company that allocates the most funds to R&D worldwide, according to the European Commission's classification.

As a result of this effort, we are leading the development of solutions for decarbonisation such as smart grids, with initiatives such as our Global Smart Grids Innovation Hub. Located in Bilbao, the centre has become an international benchmark from which we are promoting more than 120 projects in collaboration with dozens of companies and institutions around the world. In the field of grids, we also continue to incorporate digitalisation and artificial intelligence systems in transport and distribution infrastructures with the aim of continuing to increase the security and quality of supply.



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In renewable energy, of particular note is the boost given in recent years to offshore wind energy, of which we already have assets in operation and under advanced construction in the United States, United Kingdom, France and Germany, and we have others under development, both fixed and floating, in these same countries as well as in Sweden, Poland, Norway and Japan.

At the same time, we are committed to pumped hydroelectric storage, a technology in which we have recently inaugurated the Támega gigabattery, one of the principal European projects in the last 25 years; or to green hydrogen, a new energy vector in which Iberdrola already has the largest plant for industrial use on our continent.

And, of course, we have continued to launch new competitive, smart products and services for our customers, integrating technologies such as blockchain and big data.

All these initiatives are also the result of our commitment to the creation of entrepreneurial ecosystems, particularly with start-ups. Thus, in 2022 we promoted the first large technology fund to promote sustainability and the transformation of the electricity sector in Spain, Andrómeda, an ideal complement to our Perseo programme, through which we have already invested €100 million in innovative and cutting-edge companies such as Wallbox.

One of the main aims of our training programmes is also to generate a culture based on creativity. Our Research and Training Campus, inaugurated by Their Majesties the King and Queen of Spain, is enabling us to catapult new ideas in collaboration with prestigious institutions around the world. With them we have formed the Iberdrola UUniversity Programme, a network made up of tens of thousands of students, researchers and professors from such prestigious centres as Yale University and the Massachusetts Institute of Technology (MIT) in the United States; Strathclyde University in the United Kingdom; Comillas University in Spain; the Tecnológico de Monterrey in Mexico; the Federal University of Rio de Janeiro in Brazil; and Hamad Bin Khalifa University in Qatar.

With this report, we aim to showcase everything our group has achieved in recent years, but also to reaffirm a commitment that is strategic for Iberdrola. R&D&I is synonymous with the future, sustainability, productivity and quality, and will therefore continue to be an essential variable in our activity. This is because thinking ahead is the best guarantee of success, and also the best way to maximise our contribution to society; the ultimate goal of any business project.

R&D&I is synonymous with the future, sustainability, productivity and quality, and will therefore continue to be an essential variable in our activity.

01 Key figures

03 — Innovative ecosystem

04 — Iconic projects

01. Key figures

337,5 M€ Investment in R&D&I 2021

> > 2.000 M€ Investment in R&D&I in the last decade







02 Innovation strategy

04 — Iconic projects

02. Innovation, a strategic pillar for Iberdrola

We are the world's leading private energy company in terms of R&D&I investment, according to the European Commission.

In addition, Iberdrola is among the companies that most support start-ups in Europe. The Iberdrola Group views innovation as a strategic variable to guarantee the sustainability, efficiency and competitiveness of the company.

2.1. Vision and Strategy R&D&I

Our vision in terms of R&D&I is to promote the development of **innovative and sustainable technologies**, aligned with the key drivers of the transformation of the energy sector: the **decarbonisation of generation**, through the massive integration of renewable energies, boosting smart grids and **demand-side electrification**, mainly in transport (through electric vehicles), building (through electric heat pumps) and industry. We are also committed to promoting new uses of electricity, such as the production of **green hydrogen**, which is essential to reduce emissions from high-temperature industrial processes and sectors that are difficult to decarbonise, such as heavy transport, shipping and aviation. This will improve our processes, operating conditions and the safety of our facilities, while reducing our environmental impact.



Our R&D&I efforts are organised along five main lines:



New products and services which respond to customer needs with more personalisation of content and offerings.



Disruptive technologies which are becoming increasingly efficient, sustainable and respectful to the environment, optimising the functioning of facilities and processes, and of products and services that are more innovative and competitive.



Digitisation and automation in all businesses and processes to create value in the asset management lifecycle, the optimisation and aggregation of the grid, and the design of integrated services for the new digital customer profile. The digital transformation will be based on new technologies, such as blockchain, Big Data, IoT, Virtual Reality, Artificial Intelligence, etc., at all levels of the Group.



Innovation with start-ups, entrepreneurs and suppliers. We are pioneers in promoting innovation with start-ups, entrepreneurs and suppliers with the aim of developing new disruptive business models, promoting the exchange of knowledge and acting as a driving force among our partners.



A culture of innovation and talent by transferring knowledge, attracting talent and promoting an entrepreneurial spirit.



During 2021, we invested €337.5 million in R&D&I, which represents an accumulated investment of more than €2 billion in the last decade, having increased resources in this area by 15% compared to the previous year. These resources have been allocated primarily to projects related to renewable energy, smart grids, digital transformation, green hydrogen and the development of customised solutions for our customers. In doing so, we accelerate the energy transition by successfully addressing not only the climate crisis, but also by improving energy security, competitiveness and sustainable creation of jobs along the entire value chain.

In the coming years, in line with the company's current investment plan, we plan to invest €2 billion in innovative initiatives by 2025 and €4 billion by 2030, doubling our R&D&I efforts by the end of the decade.

We will continue to consolidate our business model based on more **renewable energy**, **more grids**, **more storage and more smart solutions for our customers**.





2.2. R&D&I Management

For the execution of our innovative activity we rely on a decentralised and open innovation model:

Decentralised, because the process is carried out independently in each business unit, with support and coordination from the Innovation Division. **Open**, as we consider ourselves to be a technology-driven company, and as such, it is our vocation to involve the Group's technology suppliers, such as universities, technology centres and equipment manufacturers, which form part of its day-to-day operations, in our innovation process.



In addition, in order to ensure that the R&D&I activities of all the Group's businesses are coordinated and structured, **in mid-2007 we implemented an R&D&I Management System, in accordance with the current UNE 166002:2021 Standard and certified by AENOR**, which allows us to systematise and standardise criteria in R&D&I activities in a global, efficient manner.

This R&D&I Management System has allowed us to value innovation as a basic activity of an organisation that is managed in a consistent, efficient way, articulated according to a group of well-defined and documented processes, with people in charge of the different activities and assigning resources appropriately.

03 Innovative Ecosystem



04 — Iconic projects

03. Innovative Ecosystem

We promote training and research in innovative and sustainable projects by collaborating with external entities.

3.1. Partnerships

Global Smart Grids Innovation Hub



The Global Smart Grids Innovation Hub is a global innovation and knowledge centre that aims to be a worldwide reference in **smart grids** and will make it possible to respond to the challenges of **energy transition**.

The centre acts as a driving force for innovation, combining the company's technological capacity with that of more than 80 collaborating entities and companies: suppliers, universities, technology centres and start-ups. It also serves to attract strategic suppliers and international talent, thus strengthening the business ecosystem. The hub focuses its activities on countries in Europe, America and the Middle East.

In the first months of the hub, we have registered on-going R&D&I projects for a total investment of €32 million in Iberdrola Networks Spain. Furthermore, we have identified more than 120 projects for their future development with an associated investment of more than €130 million per year.

The innovation hub occupies more than 1,000 m2 at the headquarters of Iberdrola's Networks business, located at Larraskitu (Vizcaya).

It has the collaboration of the Provincial Council of Vizcaya, which will facilitate interaction with a totally dynamic, innovative and entrepreneurial ecosystem.

The centre enables us to bring together the innovative potential of more than **200 professionals** in the development of R&D&I projects related to the challenges of the **electricity grids of the future**, among them, greater **digitalisation**, the processing of the **data** which these infrastructures generate and the response, in terms of **robustness and flexibility**, of the electricity grid to new models of consumption, such as **electric mobility and self-consumption**.



Four key pillars

The innovation centre is dedicated to the coordination and training of projects targeting strategic lines, as well as serving as a direct link with the Networks subsidiary (i-DE) to seek opportunities.



A global centre with international partners where new solutions are developed.



BASED ON PARTNERSHIPS

A public-private alliance, with funding from the Bizkaia Provincial Council and other collaborations.



MARKET-ORIENTED

Industrial products that can be installed in electrical distribution networks worldwide.



ATTRACTING TALENT Aiming to accelerate

collaboration and innovation to attract talent.



INTERNATIONAL PARTNERS



The centre has **4 laboratories**:

Smart City Laboratory

The digitisation of the low-voltage grid is the basis for building the **Smart City of the future** and efficiently achieve the goals of **descarbonisation** related to the electrification of energy end-uses, such as urban mobility.

This laboratory is working to develop the new generation of **smart meters and the low voltage network automation** to enhance customer service. Here, we collaborate with electrical manufacturers and electronics development companies to meet our functional requirements, allowing us to stay ahead in order to improve service to customers.

Among the projects undertaken, E-LVIS stands out, which includes the functionalities of the usual Control Centre systems for security analysis of the grid and remote control, applied to urban grids, in order to make the most of the grid's capacity and to be able to connect the new consumptions of electrification and self-consumption at a low cost.





Smart Substation Laboratory

In the Smart Substation laboratory we have developed the new **smart substation**, which consists of the development of an integral substation control system, applying and developing the international standard with manufacturers, which guarantees safety and efficiency in the complete cycle, from design and construction to operation and maintenance.

The new substation is sustainable both in terms of reducing materials, as well as due to its design, which takes into account the ecological footprint, and developments with manufacturers to reduce greenhouse gases that are commonly used for insulation in equipment.

Digital Factory Laboratory

Smart grids complement the digitisation of the grid with the future **Smart Worker**, who will perform field work more safely and efficiently, connected, and with robotised tools. Real-time risk information will be received and robots will be used as ground and aerial substitutes (drones) to carry out operations remotely, avoiding travel and performing the highest-risk jobs.





Cybersecurity Laboratory

Among the projects associated with this laboratory is the **TrueValSec**, a project carried out in a strategic consortium in the field of Cybersecurity with the following aim: to have a thorough understanding of the security mechanisms used at the different levels of communication in the electrical metering infrastructure of the Smart City; to identify the security barriers and weak points to which the power grid communication infrastructure is exposed; to study the techniques and tools to develop prevention and defence mechanisms; and to design and develop SW applications to increase security in the management of energy assets.

Iberdrola Innovation Middle East



Iberdrola Innovation Middle East is a world-leading technological innovation centre - located in the Qatar Science and Technology Park. We launched it in January 2016 to address practical technology challenges related to innovation and digitisation of the energy system. In line with our Group's strategic pillars, it develops innovative digital solutions for Iberdrola's three key business lines (networks, renewable energies and customers). Emerging from its solution development core, the company offers three types of innovation monetisation services: **new business incubation, advanced training and technology advisory services**.

Iberdrola Innovation Middle East maintains strong cooperation programmes with **Qatar's innovation ecosystem**, having signed co-development agreements with the Qatar National Research Fund (QNRF), Qatar University, Hamad Bin Khalifa University, the Texas A&M University of Qatar and the local electricity company (Kahramaa), among other actors in the innovation and energy industry. In addition, these agreements include training and education programmes and the sponsorship of graduate and PhD students.

We signed an agreement with IPA Qatar (Investment Promotion Agency of Qatar) in May 2022 to strengthen our strategic partnership in innovation and advance the digitalisation of the global power sector. The agreement, signed in Madrid during the visit to Spain of His Highness Sheikh Tamim bin Hamad Al Thani, Emir of Qatar, will allow us to expand our activities in the centre, with the aim of boosting the digitalisation of the electricity system in Qatar.



Sheikh Ali Alwaleed Al Thani, CEO of IPA Qatar and Santiago Bañales López, Executive Director of Iberdrola Innovation Middle East signing the agreement in the presence of the Minister of Commerce and Industry and Chairman of IPA Qatar H E Sheikh Mohammed bin Hamad bin Qassim Al Abdullah Al Thani, José Ignacio S Galán, Chairman and CEO of Iberdrola and María Reves Maroto Illera, Minister of Industry of Spain, May 2022

Development of Innovative Solutions Programme

Iberdrola Innovation Middle East's core business is to identify and solve key challenges related to the digitisation of the energy system. The programme is built around four main themes, covering our three business lines and different digital technology disciplines:

- 1. Design and control of electrical systems: ensuring effective and efficient integration of renewable energies into transmission and distribution grids. Development projects include: optimal sizing of hybrid assets (renewable energies plus storage), design of converters, advanced control for ancillary services, stability analysis of transmission grids under high penetration of renewable energy generation, etc.
- 2. Smart distribution grids: make the distribution grids the key element integrating the electricity system to achieve the zero net emissions targets. Product and service developments include battery-free multivariable smart sensors, performance improvement of last mile telecommunications (in particular power line communications), hardware virtualisation of transformer substations, etc.
- 3. Energy asset data analysis: collection, processing, analysis and visualisation of large time series of operational data from renewable generation units, network assets and customers for continuous improvement of planning, operations and maintenance processes. Product and service development includes fault prediction for wind turbines, discrepancy assessment in the generation of renewable energy, telecommunication fault prediction system, device detection (i.e. electric vehicles, heat pumps, etc.). from smart meter data, etc.
- 4. Energy Management at the edge: enabling the participation of the new energy customer in the energy market. Product and service development includes automation of energy efficiency in the built environment, adaptive perimeter computing applied to energy management, cloud computing and home management systems driven by machine learning. renovável, etc.

Services

At the centre we offer innovative services to energy producers and customers, helping them to improve network efficiency and reliability. The aim is to achieve cleaner and smarter energy consumption worldwide.

Energy services: We offer innovative solutions to our customers to minimise their consumption and contribute to the decarbonisation and diversification of the economy. We carry out audits and implement energy management systems and efficiency measures and savings certification, using Big Data to learn about consumption habits and avoid wasting energy. In addition, we design and implement complete renewable energy systems at microgrid level, both stand-alone and connected to the grid.

Training services: We provide training services to promote a better understanding of digital energy and facilitate the transition to a digitised grid. The courses we offer are aimed at professionals and engineers working in the energy or ICT sector who are looking to update and expand their practical skills to respond to the latest market demands. We customise training to meet the requirements and the knowledge level of each company.

Consultancy services

- Advanced metering infrastructure: at the centre we draw on our extensive experience, with more than 13 million installations worldwide, to provide technical advice to Middle Eastern energy companies at all stages of the smart grid implementation process.
- **Microgrids design:** we provide technical advice to both distribution system operators and large energy customers who want to invest in or configure microgrids based on clean energy.
- Energy system modelling: we provide planning services to energy companies by analysing the perspectives of the technology and developing advanced energy system models. The aim is to assess the potential impact of technology trends in the short, medium and long term.

Business model: its employees, its laboratory and its partners

Iberdrola Innovation Middle East is built on three pillars: its employees, its laboratory and its partners. Moreover, being part of the Iberdrola group gives them access to the latest technological and industrial advances and know-how at all times.



The employees

The centre's employees are a multicultural group of people with extensive experience in industrial deployment and applied R&D. Its diverse group of engineers, researchers and professionals covers the key areas of knowledge needed to digitise the electricity system: electrical engineering, computer science, artificial intelligence and data analysis techniques.

The Facilities

Iberdrola Innovation Middle East's laboratory enables us to turn research and development into innovation and market deployment. The integration of our hybrid hardware power electronics system emulator into the cycle, smart meter testing, energy efficiency prototyping and high-performance computer cluster, allows us to test new products and services prior to actual implementation in business operations and at the customer.



Partners

Iberdrola Innovation Middle East partners with universities, technology institutes, start-ups and local and international industrial companies that complement our knowledge and technological resources to tackle larger and more challenging projects. The list of partners is continuously growing:



Iberdrola Training and Innovation Campus



A global centre for knowledge,innovation and employability inaugurated by Their Majesties King Felipe and Queen Letizia in 2021.

Our Innovation and Training Campus comprises a 180,000 m2 complex with state-of-the-art facilities in San Agustín del Guadalix (Madrid), made up of a set of functional, sustainable and independent buildings that are interrelated by means of an upper covering that skims over the buildings.

This covering or canopy generates an interior bioclimate that allows **the production of hot and cold water for cooling and heating of buildings to be reduced** by minimising the thermal load generated on the façades. This also means a significant reduction in CO2 emissions into the atmosphere.

The Campus also has measures in place to **reduce water consumption.** A system has been established to collect rainwater, which will be used for watering and hosing the complex, as well as a system that **collects and treats the grey water from the hall of residence for its sanitary use.** It also has a **100 kW photovoltaic panel** installation for self-consumption and a solar thermal system for the production of domestic hot water with a surface area of 400 m2, as well as **60 charging points for electric vehicles**.

We have implemented other sustainability and energy efficiency measures in the buildings, such as the careful selection of plant species, **high-efficiency lighting systems** that enable a 20% reduction in consumption and sanitary appliances that reduce drinking water consumption by around 50% compared to conventional devices.

These innovations in sustainability have earned the Campus LEED Gold 2009 certification from the U.S. Green Building Council. The Leadership in Energy and Environmental Design (LEED) certification is the **world's most widely used green building rating system** and recognises buildings with high levels of health, efficiency and cost savings.

The Campus facilities include classrooms and workshops to contribute to the professional development of young people in the electricity sector. Nearly 13,000 people receive development training in its classrooms annually. One of the initiatives carried out at the complex is the Youth Plan - Professionals of the Future in the Electricity Sector, aimed at students and graduates of vocational training in Spain.

Specifically, the Iberdrola Campus has the following training workshops:

Hydro energy

- Hydropower plant workshop: recreation of a control room including the most important and critical elements of the power plants (hydraulic unit, distributor, controls, protections).
- Lifting and assembly workshop: Movement of loads using cranes located in the workshop itself. Assembly, disassembly and service of the different elements of the power plant.

Wind and solar energy

• Renewable energy workshop: wind turbine maintenance simulators and a solar energy plant with energy storage in batteries.

Substation workshop

- Fully functional 66kV outdoor substation interconnected to a control room for all types of training activities.
- Circuit diagrams workshop: control and protection elements of the substations and their elements.

Electricity grids

- Transformer stations workshop.
- Air transport workshop: simulators for training in work at height on electricity pylons, as well as a recreation of the components of an overhead power line for assembly, operation and maintenance work.



Technological training area

- Measurement workshop: training on various devices for measuring customer wiring. Fraud detection, electrical measurement, etc.
- STAR workshop: Transformer station simulators so that attendees can work on STAR technology (smart grids).

Other training areas

- Risk prevention workshop: training in confined spaces, safety in work at heights and driving simulators for both 4x4 vehicles and utility vehicles.
- Customer workshop: recreation of a home to showcase and test customer-focused smart solutions.

Centre of excellence in AI



We are currently in the process of creating an AI Centre of Excellence at the Iberdrola Campus in Madrid as part of the IA4TES project (Artificial Intelligence for Sustainable Energy Transition), whose main goal will be to train and attract talent, generate alliances and carry out proofs of concept of highly disruptive technologies in the area of AI in energy.



Smart Mobility Lab



Bilbao is home to our electric mobility laboratory, equipped with the latest electric vehicle charging technologies. The laboratory has around 30 charging points (CP) of different powers, serving as a test centre for the CP manufacturers and as support for the after-sales service, as it investigates the incidents found in operational equipment, replicating them and providing solutions remotely.



Vizcaya Supplier Innovation Programme



In July 2017, we launched the Vizcaya Supplier Innovation Programme, the purpose of which is to finance the development of projects by suppliers in Vizcaya (products and services of interest to Iberdrola) and to reinforce the image of a company that is a driving force in the industrial fabric.

The tax incentive in Vizcaya known as "Article 64bis" of the provincial income tax law, encourages private investment in innovative projects, allowing a third party acting as an investor in an R&D project to obtain tax deductions for its investment. In this way, we provide non-refundable funds to research companies, obtaining tax benefits in return.

So far we have financed 12 projects with different companies: Afesa, Ingeteam (2), Ormazabal (5), Arteche (2), ZIV and ATTEN2.



3.2. Universities Programme

Iberdrola U, the Iberdrola Universities Programme, aims to support the transfer of knowledge, talent and social contribution.



It strengthens the link between universities and companies with the goal of teaching young talents the skills to develop **innovative solutions to the energy sector's challenges.**

Through various global agreements and other collaborations with universities, Iberdrola U currently connects 500,000 members: students, scholarship holders, entrepreneurs, professors, researchers and Iberdrola employees form a network that promotes training, entrepreneurship and research.





Massachusetts Institute of Technology (MIT)

Iberdrola and Avangrid have signed a Chair in the area of "Power Systems engineering" to promote research and training in electrical systems. Within the framework of the Chair, we have carried out 12 R&D projects with 8 Iberdrola businesses in 5 countries (Spain, UK, USA, Brazil and Qatar). Of particular note is the R&D project on predictive maintenance using machine learning technology. The results of this project make it possible to optimise decision-making on the maintenance of renewable assets through short- and medium-term forecasts using a centralised platform and also have a direct impact on reducing operating costs.

We are members of the MIT Future Energy Systems Center, an industry research consortium providing insights on how best to navigate the energy transition based on multisectoral analyses of emerging technologies, changing policies, and evolving economics. We are also part of the Center of Energy and Environmental Policy Research (CEEPR) which studies of a wide range of policy issues related to energy supply, energy demand, and the environment.

Yale University



Iberdrola together with Avangrid and Yale University have signed an agreement focused on research and education for the future of energy.

We have jointly carried out different R&D projects, including a study on the benefits of grid electricity compared to off-grid electrification alternatives, as well as pilot tests for Blockchain, solar energy and storage.

In addition, students from Yale University have participated in Avangrid's Innovation Forum with the aim of developing solutions to the toughest challenges in the energy sector.

Columbia University

Columbia University



In the framework of COP 26, Iberdrola and Columbia University join forces to address the steps companies have taken to integrate the goals of the Paris Agreement into their corporate purpose. We have participated in the global and virtual conference "Business alignment with the Paris Agreement: from ambition to action" at Columbia University prior to COP26, as well as in the COP26 held in Glasgow (UK).

The University of New Mexico (UNM)



King Felipe VI Chair in Information and Related Technologies. The aim of this chair created in 2000 by the then Prince and Princess of Asturias at the University of New Mexico (UNM) is to advance knowledge in specific areas of science, information technology and energy, preferably in smart grids, alternative and renewable energies.



COMILLAS UNIVERSIDAD PONTIFICIA

Comillas Pontifical University

We have signed the Energy and Innovation Chair with the Comillas Pontifical University, whose objective is to carry out research, innovation and training activities in those fields of knowledge that are of strategic interest to our company.

Within this framework, research projects have been carried out, such as the assessment of electricity grid needs for the energy transition and on the expansion and operation of the system in the 2030-2050 horizon, as well as R&D projects. The aim of one of these is to identify how, based on the flexibility capacities of generation, demand and the distribution grid, we can achieve a 100% renewable energy system and a highly electrified society.

We also promote innovative entrepreneurship initiatives with the students of the Comillas Pontifical University through its sponsorship of the "ISC Racing Team" electric racing team, a project that we have supported since its inception and which each year brings together more than 80 young people who compete internationally with two electric prototypes; we also collaborate closely with the university to promote entrepreneurship among young people with actions such as the "Comillas Emprende" competition, awarding the prize for the best innovative initiative in the energy sector.

University of Salamanca



The main lines of research of the Chair are climate change and the decarbonisation of homes and cities.

Regarding R&D projects, it is worth highlighting the technical study we are carrying out with the USAL on the analysis of the feasibility of the electrification of the urban bus fleet, as well as projects related to the protection of biodiversity, the aim of which is to prevent the loss of birds of prey in wind farms. One of the projects has been carried out in Cadiz with the imperial eagle and the second in Albacete with vultures and other birds of prey.

In the area of entrepreneurship, Iberdrola has sponsored the European Contest for Young Scientists, a competition that encourages young Europeans to get involved in science and embark on a career in research, and several editions of Start-up Olé, a large entrepreneurial event that connects start-ups and technologicaldigital talent with companies, investors, accelerators, universities, public administrations, and the media.

Polytechnic University of Madrid



Iberdrola-UPM Chair for Sustainable Development Goals. We have joined forces with the Polytechnic University of Madrid to address the challenges of the international sustainability agenda.

Of particular note is the project on models and scenarios for the mass deployment of electric cookers to promote access to sustainable energy in low- and middle-income countries, thus complying with the Sustainable Development Goals.

In addition, we have participated in numerous training and dissemination events such as "Connecting Women" and the seminar on "Research: key to accelerating the energy transformation".

University of the Basque Country (UPV)



We have participated in the international MORE Master's degree -Master in Offshore Renewable Energy of the UPV, the conference "Decarbonisation of heavy transport: an opportunity for industry in the Basque Country" organised by the School of Engineers of Bilbao-UPV and we have sponsored the Science Week of the University of the Basque Country.

In addition, the UPV is a member of Iberdrola's smart grid centre of excellence located in Bilbao, where the challenges of the energy transition will be addressed.

MEXICO

Instituto Tecnológico de Monterrey



We have signed a Chair with the TEC that includes specialised training activities, entrepreneurship from the training action itself, and the development of R&D&I projects.

As an R&D project, we can highlight the study, development and implementation of a digital tool to improve response time in the search for electrical faults.

In addition, we have carried out a collaboration between Iberdrola, TEC and the Guggenheim Museum to participate in the Norman Foster Foundation's Art of Motion exhibition.

BRAZIL

- We have signed a collaboration agreement with the Federal University of Rio de Janeiro to carry out the R&D project for the deployment of smart grids in Brazilian cities.
- In addition, we have carried out numerous entrepreneurship initiatives through the Hackathon modality with the Federal University of Pernambuco, the Federal University of Rio Grande do Norte and the University of Sao Paulo.

K UK

University of Strachclyde



We have entered into a series of agreements and collaborations with Strathclyde University **to address certain challenges in the energy sector and to develop R&D projects:**

- ScottishPower Chair in Smart Grid Technology.
- Technology Innovation Centre (TIC).
- Power Networks Demonstration Centre (PNDC).

Collaborative and funded innovation projects:

- AGILE Aggregators as digital intermediaries in local electricity markets; modelling the cost sharing of grid improvements with electric vehicles and the value of interconnection in the evolving EU electricity system.
- NEUPA Grid space, engineering improvements and public acceptance.

QATAR

Hamad Bin Khalifa University



In collaboration with the university, we have developed numerous R&D projects related to the security and reliability of smart grids: Electric Grid Failures, DER Hosting Capacity Analysis for Distribution Networks...

Qatar University



We have an agreement with Qatar University to undertake joint scientific, academic and research initiatives, including the training and co-funding of postgraduate and PhD research students.

3.3. PERSEO International Start-ups Programme

More than 15 years committed to start-ups and business innovation as a brand value.



With Iberdrola's start-ups programme - PERSEO - we aim to facilitate the Group's access to the technologies of the future while promoting the development of a global ecosystem of start-ups in the electricity sector with a focus on sustainability. for this, we have invested €125 million through our portfolio of investments in start-ups, our PERSEO Venture Builder unit, pilot projects and the launch of the Iberdrola Start-up Challenge.

- +€125 million investment in start-ups: 10 companies in the portfolio.
- Challenges Open Innovation Tool: 10 challenges launched per year | +500 proposals received each year.
- +7,500 start-ups in our ecosystem: increasing by 300 per year.
- Pilot projects: Access to technology in real cases | +25 real pilot projects per year.
- Andormeda Sustainable Tech Fund: First large technology fund for energy transition |€300 million to invest in scale-ups.

Objectives of the PERSEO Start-Ups Programme



- a. Early identification of key trends for the future of the company.
- b. Encouraging an innovative, entrepreneurial culture.
- c. Access to disruptive technologies and business models.
- d. Supporting industrial sectors with high growth potential and boosting economic and social revitalisation.

Strategic Sectors



SMART SOLUTIONS FOR DOMESTIC, COMMERCIAL AND INDUSTRIAL CUSTOMERS

TECHNOLOGIES FOR THE INTEGRATION

- Devices for smart buildings/homes.
- Energy management platforms.

OF RENEWABLE ENERGIES

- Tools for customer loyalty.
- Electric heat, etc.



SOLUTIONS FOR THE ELECTRICITY **GRID OF THE FUTURE**

- Micro-grids.
- HVDC.
- Smart Grid Technologies.
- Advanced automation.
- Technologies for network resilience.
- Reliability and efficiency, etc.



Flexibility platforms.



DISTRIBUTED ENERGY RESOURCE MANAGEMENT (DERMS)

- Technologies for battery control.
- Solar.
- Electric heat.



ELECTRIC MOBILITY SOLUTIONS

- Charging infrastructure.
- Mobility Platform.



ADVANCED TECHNOLOGIES FOR **OPERATION AND MAINTENANCE**

- Data-based platforms.
- Drones.
- Sensors.
- Robots.
- Diagnosis.
- Online monitoring.
- Augmented Reality, etc.

04 — Iconic projects

Investment portfolio

PERSEO's technology investment portfolio is composed of start-up companies that develop innovative technologies and business models with a high social impact in the field of energy.





A global commitment Q Q +€125 million invested





€200 million to invest 10 start-ups in the portfolio

More than 15 years of work in search of the 'unicorns' that will revolutionise tomorrow's sector have enabled our project to consolidate its position as the benchmark corporate start-ups programme in the energy sector. Milestones such as the IPO in 2021 of the start-ups invested by PERSEO: Wallbox.







Energy efficiency for more sustainable homes



Digital solutions to improve energy efficiency

CO2 REVOLUTION



An operating system to connect and protect and protect industrial equipment



A comprehensive reforestation model supported by the latest technology



Data analysis using AI to optimise and optimise and improve customer service



Technology to improve the efficiency and durability of photovoltaic solutions



Advanced and intelligent management for electric vehicle charging



Charging solutions for vehicles

During 2022, together with the ICO Next TECH fund and Nortia Capital, we have partnered with Seaya to launch **Andromeda**, the first large technology fund to accelerate energy transition and sustainability.

The fund, which has a size of €300 million, will invest in European scale*upsrelated*) to sustainability, energy transition, electrification of the economy, and other areas such as sustainable agriculture and the circular economy.

It is the first major technology venture capital fund to have specific sustainability goals in line with Article 9 of the EU Regulation, with clear and measurable environmental, sustainability and governance criteria.

Public participation in Andromeda is articulated through the Next Tech Fund, with an investment of up to €100 million. This new operation is part of the drive for public-private collaboration in innovative digital projects in high-impact technologies and the development of scale-ups that generate quality employment, as envisaged in the Government's Recovery, Transformation and Resilience Plan.

2020/2022

PFRSFO Venture Builder

The PERSEO Venture Builder

unit was launched to create new business models that contribute to electrification in sectors that are difficult to decarbonise.



MAIN INITIATIVES IN THE FRAMEWORK OF PERSEO VENTURE BUILDER

The PERSEO Venture Builder unit was launched to create new business models that contribute to electrification in sectors that are difficult to decarbonise, with a budget of €40 million.

ENERGYLCOP

Together with FCC Ámbito, a subsidiary of FCC Servicios Medio Ambiente, we launched EnergyLOOP to lead the recycling of components from renewable facilities. The initial goal is to recover the components of wind turbine blades, which are mostly glass and carbon fibres and resins for reuse in sectors such as the energy, aerospace, automotive, textile, chemical and construction industries.



We participate in the Net-Zero MAR Alliance, which pursues the decarbonisation and electrification of the Spanish maritime sector with the aim of becoming a leader in Europe. It is a collaborative, non-profit platform focused on the electrification and decarbonisation of maritime infrastructures. The electrification of port infrastructures and the use of alternative fuels are two of the main pillars that will support the future decarbonisation of the maritime industry.



We are part of the consortium of investors of the Basque technology company Basquevolt, whose aim is the sustainable development of the best materials and cells for batteries, which will make possible the massive implementation of electric transport, stationary energy storage -including hybridisation with hydrogen-gas systems- and advanced portable devices. This project has an investment of more than €700 million and the prospect of generating more than 800 direct jobs.

Start Up Challenges

PERSEO launches an average of ten challenges per year, aimed at emerging technology companies from around the world, with the aim of receiving proposals with **innovative solutions** to improve the company's operations, increasing our competitiveness and positioning us in new markets, while minimising our environmental impact.



The latest start-up challenges launched have been based on the search for innovative solutions to electrify the countryside and promote renewable energies in rural areas, as well as on the search for new materials, designs and methodologies for electrical substations and very high voltage lines.

For example, the 'Start-up Challenge': Planning electric vehicle fleets, in which Iberdrola selected the Spanish company SwitchFleet and the US subsidiary of Hitachi Energy as winners. Both start-ups have presented two solutions to **develop a tool that can help fleet operators assess the feasibility, costs and benefits of using electric solutions** in their fleets, and which is available to customers on the company's website.

LIGHT TRANSPORT

The Spanish company SwitchFleet has developed a tool that will enable our Smart Mobility team to advise our customers on the transition to passenger car and light van fleets, as well as the sizing the corresponding charging infrastructure, both depending on the type of vehicle use by the customer.

HEAVY TRANSPORT

Hitachi Energy will develop a tool to enable the sizing of road transport fleets (mainly buses and trucks) focused on the replacement of the existing fleet and the analysis of the necessary charging infrastructure in collaboration with Avangrid.

Pilot projects

In addition to the challenges, and sometimes as part of the award to the winning start-ups, at PERSEO we carry out 25 pilot projects per year to test the new technologies and business models offered by emerging companies for the optimisation of processes and activities developed by Iberdrola businesses. At the close of 2021, PERSEO had carried out more than 70 pilot projects in real environments as a key preliminary step in the search for companies with which to establish business relationships.



We have contributed to making a reality one of the solutions awarded in the Start-up Challenge 'Automation of the construction of electrical transport facilities', together with the Finnish company Hyperion Robotics. An innovative technique for the sustainable construction of concrete structures: with 75 % less materials, up to 20 % less direct costs and the same levels of quality, efficiency and safety. This pilot project marks a milestone in the company's aim to minimise the carbon footprint in the construction of its transport network.

04 Iconic projects

04. Iconic projects

We are committed to disruptive technologies that enable us to meet the challenges of the new energy system.



4.1. Decarbonisation of generation

We are moving towards a decarbonised model in which greenhouse gas emissions caused by energy consumption must be phased out so that citizens can meet their energy needs in a sustainable manner, at a competitive price and with security of supply.

The first challenge in order to achieve an efficient energy transition is to decarbonise the electricity sector as much as possible, which is best placed to make this transition immediately and competitively, thanks to its ability **to integrate renewable energies**, while drastically improving the overall efficiency of the energy system.

Wind

Nearly 20 years ago, we were pioneers in onshore wind power generation and, in the same way, we have decided to lead the development of one of the most promising renewable energy sources: offshore wind on fixed foundations. We will do this through a portfolio of projects distributed around three areas: the North Sea, the Baltic Sea and the United States. We currently have 1.3 GW installed, which we will triple with the construction of 2.6 GW. The notable expansion of the portfolio comprising this technology, based on new growth platforms with great potential, such as Japan, Poland, Sweden and Ireland, will allow us to reach 12 GW in operation by 2030.



In addition, at Iberdrola we are committed to the floating offshore wind energy sector, which opens the door to sites further from the coast by allowing the deployment of wind turbines in larger and deeper marine areas with greater wind potential. After 8 years participating in various R&D projects, we have decided to go a step further and launch demonstration projects for this new technology. In particular, we are working on the development of a 10 MW floating offshore wind turbine and a semi-submersible concrete floating structure, at the Met Center in Norway. Both elements will be designed to operate in North Sea conditions and will pave the way for future 500 MW floating wind farms. The project is also an opportunity

to test the feasibility of installing them in other locations in the Mediterranean, the Atlantic and the Pacific, and to study the cost and logistical viability of using concrete technology instead of steel.



Solar



FLOATING PHOTOVOLTAIC PLANTS

Solar photovoltaic energy is one of the world's leading and most established renewable energy sources and a main pillar of our growth. In 2020, we installed 874 MW of new solar capacity, contributing to reach nearly 35 GW of installed renewable energy capacity worldwide. We also have the largest operational photovoltaic plant in Europe - Núñez de Balboa (Badajoz), with 500 MWp - and we are planning another even larger one Francisco Pizarro, which will be located in the province of Cáceres, which will have a capacity of 590 MWp.

Historically, photovoltaic installations have been placed in places where the weather was conducive to a good number of hours of sunshine per year and always on the ground or roofs. However, in this way, other very important resources were being discarded: marshes and reservoirs and, lastly, the sea. Thus, the floating photovoltaic system was created, which uses the surface of these important bodies of water to install **floating photovoltaic panels**.

Along these lines, different feasibility studies are being carried out, including those carried out in various ponds and reservoirs both in Spain and in other countries (France, Brazil, Mexico) with the aim of analysing the technical and economic feasibility of this type of installation. This installation will save large areas of land, will help to reduce the evaporation of water from the reservoir and will have a higher panel efficiency due to a lower ambient temperature.

04 — Iconic projects



AGROVOLTAISM

At Iberdrola -through the PERSEO International Start-up Programme- we are validating the application of four technological **solutions to make photovoltaic solar generation compatible with activities related to agriculture, horticulture, livestock, fish farming and beekeeping**, so as to improve the efficiency and competitiveness of the installations, the use of the land as well as to protect biodiversity. This is known as **agrovoltaic energy**.

Harnessing solar energy in agricultural areas also encourages photovoltaic selfconsumption, since the farms' energy needs can easily be met with the electricity generated.

- Irrigation: The Spanish company EcoEnergías del Guadiana has presented a pilot project to combine the cultivation of tomatoes under fixed or retractable structures that support solar panels, mitigating plant stress due to heat and hail, saving water and improving harvest results.
- Viticulture: The Winesolar project a collaboration between three Spanish companies: Techedge (advanced technological solutions), PVH (manufacturer of trackers and structures for solar panels) and Gonzalez Byass wineries aim to protect vineyards by generating shade thanks to a smart tracker. An artificial intelligence algorithm will control these trackers to adapt them to the physiological needs of the vineyards, and optimise photovoltaic production and collect data to measure humidity, temperature, etc. The panels, carefully integrated into the landscape, will create shade and an ideal microclimate against both thermal and hydric stress.

- Fruit trees: France's Ombrea also uses artificial intelligence to create shade. It presents a solution with solar panels that extend or retract to modulate light and shade, depending on the weather data collected on the ground through sensors. The aim is to protect plants from heat waves, drought, hail or frost.
- Animal welfare: The FarmLife analysis platform and monitoring system for cattle behaviour, from the French company itk, aims to save time and increase productivity by providing data for decision-making based on four pillars: reproduction, nutrition, comfort and health.



Storage systems are key to addressing the challenge of the energy transition and are set to become an essential element in the electricity system of the future, ensuring the stability and reliability of the grid and integrating and harnessing the energy generated by renewable sources.

In this regard, we have a large portfolio of innovative battery projects, either under construction or secured, with a capacity of 200 MW (some of them already installed), which will reach 300 MW in 2025, mainly in the UK and Australian markets. In total, **the planned capacity of battery storage systems amounts to 900 MW.**

In Spain, several projects have already been implemented. We have installed the first battery in a photovoltaic plant, Arañuelo III (40 MW), in Cáceres, with 3 MW of power and 9 MWh of storage capacity. In the Basque Country, at the Abadiño transformer substation, where the 6MW Oiz wind farm is evacuated, we have installed a battery with a guaranteed storage capacity of 3.5MWh. This project joins the one executed at the Elgea-Urkilla wind farm (32 MW), which has



an installed capacity of 5 MW and 5 MWh of storage capacity. In the Canary Islands, we will install batteries at the Ifara and El Vallito wind farms, which will incorporate a storage capacity of 12 MW.

In relation to the hybridisation of photovoltaic or wind installations with batteries, we have designed **a modular tool to estimate and optimise the storage requirements of each plant**, taking into account how the system interacts with the grid or with the corresponding generation technology. We have also carried out an analysis of how InMS energy management systems enable optimisation in the operation of hybrid storage systems (HESS) operating in conjunction with renewable energy sources.

Pumping

Pumped hydroelectric technology is currently the most efficient and mature system for **large-scale energy storage.** At Iberdrola, we are leaders in energy storage with 4.5 GW of power installed using this technology. By 2022, we expect to reach 90 GWh of storage capacity, which represents an increase of almost 30% compared to 2018: 20 GWh more, equivalent to 400,000 electric car batteries or 1.4 million batteries for residential use.

Along these lines, we are immersed in the **development of new technological approaches in the pumping systems of the Torrejón and Valdecañas reservoirs**, increasing their flexibility, storage capacity and efficiency, without modifying the structural conditions of both hydroelectric plants.

Specifically, two pioneering lines of research are being carried out. On the one hand, at the Torrejón reservoir, **a variable speed turbine and new electronic power units** are being designed, which represents a substantial technological leap, as most

turbines have a fixed speed. Thanks to this, a greater operating range is achieved, implementing rapid changes in active power and allowing maximum use to be made of the water jump of the hydraulic power station. On the other hand, **the electromechanics of the new Valdecañas turbine will be optimised** in order to hybridise it with a parallel battery system, acting mainly on the drivers, which are a key element for flexible operation. This will be accompanied



by a **new control algorithm** that will allow rapid variations in the power injected into the power plant grid and the implementation of a power regulation mode in pump mode and operation over a wide range of heights.

In Portugal, we have also started up the Támega gigabattery, one of the largest hydroelectric projects to be carried out in Europe in the last 25 years. It consists of three dams and three power plants (Gouvães, Daivões and Alto Tâmega) with a combined capacity of 1,158 MW.

Thanks to its pumping capacity, it can store energy to be used when it is most needed. It already provides almost 900 MW of pumping capacity to the Portuguese electricity system, which will mean an increase of more than 30 % over the country's current pumping megawatts. The complex will be capable of producing 1,766 GWh per year and storing 40 million kWh, equivalent to the energy consumed by 11 million people during 24 hours in their homes, making it one of the largest energy storage systems in Europe. Linked to the gigabattery, two wind farms will be built to convert the complex into a hybrid generation plant, whose final power is estimated to reach 300 MW, making it one of the largest wind projects in Portugal.



4.2. Integration of the system: Smart Grids and Digitalisation

In the new energy model, **electricity grids will play a fundamental role as an integrating element** between generation and demand, interconnecting sectors such as electricity and transport that until now have operated largely independently and including new players, such as households, which enter the scene as energy producers.

Their **digitalisation** will be essential for this, which will not only make it possible to offer a wide range of new products and services to customers, but also to improve the quality of supply and facilitate the integration of renewable energies and distributed generation resources (storage systems, electric vehicles and heat pumps, and increasingly active customers).

Technologies such as Big Data, artificial intelligence, machine learning,, cloud computing, IoT, Blockchain are already a reality in all of Iberdrola's businesses, with significant applications and impact in terms of efficiency, economics, and the environment.

In addition, it is essential **to seek solutions that help provide greater flexibility to the electricity system**, as a key element and support for this transformation, facilitating coordination between all actors involved in the provision of services to the distributor, with a special focus on the consumer.

Smart Grids



The massive integration of renewable generation envisaged to achieve the targets set by the European Union for 2050 poses major challenges for the **electricity distribution grid**, which was designed according to the requirements of conventional energy sources. In order to support this new **decarbonised**, **efficient and**, **flexible electricity system**, the aforementioned **smart grids** appear, combining equipment, electronic meters and IT and telecommunications systems.

In this sense, **new technologies and simulation models** are being researched to enable a 100% renewable and decarbonised energy mix, efficiently integrated into the electricity system of the future. To this end, the new functions of Distribution System Operators (DSOs) are being defined, researching the new technological **developments needed to increase efficiency by taking advantage of the flexibility** provided by both own and third-party resources, while maintaining the **overall security and stability of the system**.

In order to get the most out of distributed generation resources, in recent years we have been developing new control and protection systems to ensure the stable island operation of medium-voltage distribution grid feeders. This will improve the quality and continuity of the electricity service in the event of electrical disturbances, taking advantage of distributed generation sources as an alternative source of supply, creating a system that is sustainable over time.



Furthermore, during the transition of the electricity grid from a fully centralised to a highly **decentralised** system, grid operators have to change their operational activity to adapt to faster reactions and adaptive exploitation of flexibility. For this purpose, at Iberdrola we are involved in creating the necessary **conditions for a new generation of grid services** to take advantage of **demand** response, **storage** and **distributed generation**, within a framework of fair, transparent and open conditions for the consumer. As a result, while creating a European grid, it aims to build a customer-centric approach to grid operation. This ambitious vision is achieved by proposing new markets, products and services, creating a unique IT architecture.

Along these lines, together with various actors in the European electricity value chain, we are participating in a coordination project to **adapt**, **define and promote future standardised grid services and related market platforms** to enable a seamless pan-European electricity market with non-discriminatory access for all market participants.

GEM (Global Energy Management)

The main challenge of energy management lies in the agile adaptation to the change towards a decarbonised, renewable and distributed electricity system model. The focus is on finding solutions that help provide greater flexibility to the electricity system, as a key element of this transformation.



We are researching new technologies and simulation models that enable a 100% renewable and decarbonised energy mix, effectively integrated into the electricity system of the future. Thanks to the technological change already underway in the field of renewable generation, storage, grids and flexible demand management, it is possible to research new capacities, electrical models, algorithms, concepts and specific technology in areas such as power electronics, interoperability and connectivity of equipment and weather forecasting systems, which facilitate their integration and operational management.

Another pioneering initiative being carried out seeks to connect customers' flexible distributed resources in a VPP that enables their monitoring and distributed control for market management, also generating valuable services for the customer, such as: risk buffering in demand peaks, the possibility of new revenues and greater control over their consumption and processes. It also makes it possible to extract the value of the flexibility of these aggregate resources for their participation in the System Balancing Services, managed by REE. Along the same lines, with the aim of facilitating the integration of renewable generation and distributed generation resources (DERs), ensuring the quality of supply, we are committed to Virtual Power Plants (VPP) or Virtual Power Plants, aggregators of different distributed energy sources or resources, both generation and consumption, which can be managed from a single control system. The VPP allows energy resources to be redistributed internally in an optimal way in the event of weather and system variations, in order to provide flexibility and reliable energy production, while also providing services to the grid. This will provide transmission system operators (TSOs) and distribution system operators (DSOs) with knowledge, models and tools for the synthesis of VPP controls for both local (production) and grid (ancillary services) objectives.



In another line of action, we are also working on the development of new services for the system, as well as testing emerging markets with the different network operators. One of the most significant problems facing the operation of transmission grids is the problem of voltage control and the associated cost overruns

suffered by the system. We are therefore involved in a project to develop new strategies for

decentralised and centralised voltage control. We are developing a system of joint participation at the point of service provision (PPS) for installations with different technologies and different connection requirements. Within the framework of the project, new developments in the field of active power management will also be analysed, consisting of systems for limiting production in real time in order to improve the capacity to respond to incidents occurring in the transmission grid. All of this will enable significant contributions to be made to achieving the objectives set in relation to the decarbonisation of the electricity system, facilitating the penetration of renewable energies, increasing the system's electricity storage capacity, and increasing the security of the electricity supply.

Along the same lines, we also participate in various projects focused on defining and testing new local flexibility markets through demonstrators, to manage congestion or other problems in the distribution grid.

Through these projects, we want to advance in the design of an ecosystem that facilitates the interaction and coordination of all the actors involved (grid operators, TSOs and DSOs, flexibility providers, aggregators, etc.), define the architecture and platforms necessary for the introduction of these new services and markets, which together allow the flexibility of the energy system to be increased.

Digitalisation

At Iberdrola, we are at the forefront in the use of **digital technologies** and we are preparing to face a new era in which disruptive tools will be key in all areas. Thus, we maximise the use of technology in those business areas that add value, either by improving processes and the productivity of its assets or by achieving greater efficiency in its activities. We already digitally **manage our power generation assets and have transformed grids into smart grids** with digital tools and Artificial Intelligence.

04 — Iconic projects



PROOF OF CONCEPT

In a changing world, we are committed to **disruptive proofs of concept**, **using emerging and differentiating technologies** to enhance the immersion in the digital transformation in which the Group finds itself.

PoC1 - Energy management with AutoML

Using *Machine Learning* and Artificial Intelligence, an automatic prediction system of customer demand and market price has been developed. AutoML compares different models to select the one that improves on current prediction methods.

PoC2 - Wind turbine monitoring via IoT

We have developed the low-cost, IoT-based LoRA solution, which provides additional monitoring capabilities on existing wind turbines at our onshore wind farms at **ScottishPower**. This solution demonstrates that it is possible to add additional sensors to an existing wind turbine without the need for modification by the manufacturer.

PoC3 - New EV platform for battery banks

With this initiative, we are committed to a new line of business, battery banks for e-scooters. For this purpose, a new **SW mobility platform** has been developed in the cloud, through which the live data created by the new type of charging stations is monitored.

In addition, we have designed a **mobile application** to control the new drop&go charging station that will be integrated into the Iberdrola charging point management IT environment.

• PoC4 - Deep Learning for the identification of faults in network assets

This proof of concept aims to automate grid maintenance programmes using *Deep Learning techniques.*

Images taken by **Avangrid's** maintenance technicians on the Edge will be used to automate **image recognition** of faults and vegetation surrounding **power lines**. *Deep Learning* techniques will identify the most common faults in the distribution network, and vegetation segmentation will be used to schedule the necessary work to maintain the good condition of the network and anticipate future problems.

• PoC5 - Voting with Blockchain for the Shareholders' Meeting

With this PoC we intend to implement *Blockchain* as a mechanism to guarantee the security of the shareholders' vote during their annual meeting.



The shareholders' meeting is one of the most important events of the year for Iberdrola due to the importance of the results, as it can impact investment strategies, or growth plans.

Voting is carried out through the **Participation Portal** web application and then encrypted and recorded in an Alastria *Blockchain* block (based on Hyperledger Besu) along with an equally encrypted version of the shareholder's ID. The results can be verified and validated by any shareholder to ensure that what resides in the voting system matches the Blockchain results to ensure that the results **are immutable**.

PoC6 - Electricity substation 3D model

With this initiative we have implemented an **interactive 3D model of an Electricity Substation in Virtual Reality with dynamic operation at Neoenergia.** This model can be used by the operation and maintenance teams to optimise the planning of the necessary interventions, both to expand the system and as training and validation of the procedures to be adopted.

R&D PRO JECTS

We are carrying out **a modernisation of functionalities in our mainframe**, resulting in a new, more efficient system, which provides more performance and security in our transactions. Among the different lines of work, the following stand out:

- The use of productivity tools, leading to a significant reduction in operating costs in multiple areas of the company's work.
- The conversion of obsolete data storage systems to relational databases, which allows access to data through SQL queries, facilitating the conversion process.
- The transformation of our internal system distribution to advance our technology transition strategy, maintaining our position as a leader in energy trading and ancillary services.
- A re-engineering of the services required to review and process information. This new way of working leads us to rethink innovation in processes, improving them through the new emerging technologies.

In addition, we are leading a tractor project in Artificial Intelligence, IA4TES (Inteligencia Artificial para la Transición Energética Sostenible), which has been awarded the Next Generation Funds of the European Union. Its aim is to research the solutions that different Artificial Intelligence technologies can provide to the energy sector, with the new paradigm of the electricity system in mind. This research is focused on AI enabling technologies, both in new advanced intelligence algorithms and in new paradigms of data governance and distributed data intelligence. The 3 main vectors of the sector's value chain will be covered through cases of use:

- Generation: Smart Sustainable Production.
- Distribution: Smart Grid.
- Smart Consumption.



PARTNERS





aiadna

Sstemy

stituto de ingeniería

Ϊſ









vicontech

In the framework of the project we will create an **AI Centre of Excellence in the energy sector** that will extend its activity beyond the end of the project, with 4 main missions:

- **1. Diffusion**, **dissemination**, **generation and attraction** of talent hand in hand with academic institutions.
- 2. Alliances, collaboration agreements and other types of agreements with other similar centres.
- **3.** Additional foresight through small proof-of-concepts of highly disruptive technologies in the area of AI in Energy.
- 4. Advice for the partners on the protection possibilities of the new technologies generated in the project.



FORECASTING

The availability and accuracy of renewable resource predictions is key to ensuring electricity supply, developing demand forecasting plans, making projections for different time horizons and planning plant operation and maintenance tasks.

Along these lines, we have designed and developed **a new energy resource prediction** model that increases the degree of accuracy in the prediction of the renewable resource and the power of renewable energy generation facilities. This is an integrated system based on the most modern weather forecasting techniques, as well as *Machine Learning*, Artificial Intelligence and *Big Data*. technologies. It provides forecasts for all types of renewable installations, including onshore and offshore wind farms, photovoltaic plants and, more recently, hydroelectric installations.

All these advances have been developed inhouse, by our own team, made up of experts in different fields, who are responsible for the maintenance, monitoring and development of the system.

04 — Iconic projects

4.3. Demand-Side electrification

The transition to a carbon-neutral economy by 2050 will require significant efforts across all sectors, as well as the use of all available technologies that are either emission-free or carbon-neutral. Through **the electric vehicle and heat pump**, emissions from end-uses such as transport, heating and cooling can be eliminated. In addition, **clean hydrogen** (green hydrogen or green H2) can be produced from renewable electricity and thus carbon-neutral fuels in the form of gas (clean synthetic methane) or liquid (paraffin, gasoline or synthetic diesel).

This changing market also requires energy suppliers to continuously adapt to add new value to customer experiences. New product and service offers for the consumer will need to meet their new role as prosumers through selfconsumption **solutions and energy management of household electrical loads**, allowing the customer to minimise cost and environmental impact while optimising comfort, increasing awareness and maintaining control over their energy options and choices.

Transport electrification

We continue to push our stance on transport electrification as part of a strategy for a decarbonised economy, as a key factor in reducing emissions and pollution, as well as for a green recovery in the post-Covid world. Our commitment to the decarbonisation of transport covers all areas of action, including collective transport and micromobility. In this regard, electrification in micro-mobility and light vehicles is already a reality worldwide, and we are working on the technological developments necessary for the same to happen with heavy transport. At Iberdrola, we have already completed more than 60 infrastructure deployment agreements with administrations, institutions, companies, service stations, dealers and electric vehicle manufacturers, carrying out different initiatives.



SMART MOBILITY

We have a **sustainable mobility plan**, which will intensify the deployment of charging points for electric vehicles in the coming years. The initiative envisages the installation of around **150,000 high-efficiency charging points by 2025**, both on urban roads, in cities and on the first motorways, and in homes and businesses. With a global **investment of €150 million**, Iberdrola's comprehensive sustainable mobility plan has already enabled the installation of 20,000 charging points in Spain.

The commitment to deploying high-efficiency charging points will include the company installing ultra-fast (350 kW) charging points every 200 kilometres, super-fast points (150 kW) every 100 kilometres, and fast (50 kW) points every 50 kilometres.

We already have more than 2,500 public recharging points, of which around 40% are fast or ultra-fast recharging points, and we maintain an expansion rate of more than a hundred new chargers of this type per month. We also have a **unique public charging App** that allows you to check the public charging infrastructure available in Spain, with more than 5,000 chargers for electric vehicles, both our own and those of third parties.



In addition, our mobility electrification plan has the backing of the European Commission, through a €13 million grant awarded by the Innovation and Networks Executive Agency (INEA) under the CEF Transport Blending Facilities call. This grant will help finance the **installation of 2,339 fast, super-fast and ultra-fast recharging points in Spain and Portugal**, at points close to the trans-European transport networks (TEN-T), until 2023.

We have also entered into partnerships with various manufacturers. In this regard, in 2022 we inaugurated in in the Valencian Community **the largest ultrafast charging hub for electric vehicles that currently exists in southern Europe.** The infrastructure, carried out in collaboration with Porsche, has a total of four 400 kW chargers and another 12 200 kW chargers, with the **possibility of charging up to 16 vehicles simultaneously and with the capacity to recharge the battery of an electric car in less than five minutes.**

04 — Iconic projects

HEAVY TRANSPORT



We have reached various public-private agreements regarding the electrification of heavy transport.

With regard to **urban transport**, we collaborate with **Madrid's Municipal Transport Company (EMT)** in the electrification of the city's bus network, in the analysis of alternatives for electricity supply to EMT facilities, as well as in the planning of the present and future charging infrastructure network for electric transport. In fact, both companies have already identified optimal locations in the first EMT garages to be electrified, such as those in Fuencarral and Carabanchel.

We are also working with the Town Councils of Ávila and Badajoz and the urban transport concessionaires in both cities to carry out pilot projects with urban electric buses. We have collaborated with more than 20 town councils in the engineering study for the electrification of their fleets.

In addition, we are working together with Irizar to add actions aimed at technological innovation in this field. The alliance starts with our **renewable supply with Guarantees of Origin (GdOs) in Irizar's factories**, in order to contribute to the **decarbonisation of the life cycle of its buses** We will also advise Irizar in all areas that contribute to the group's sustainability, including energy efficiency projects, self-consumption, etc.

With regard to the decarbonisation of **heavy goods transport**, this is one of the great challenges facing the industry due to its high levels of polluting emissions. In this regard, we are going to lead a project to develop the first **Mediterranean Corridor for 100% electric heavy road transport.** For this, we

will work together with the transport and logistics company Disfrimur and the company specialising in power electronics, Ingeteam. The initiative includes three areas of action: the **acquisition of 100% electric heavy trucks of up to 40 tons; the development of public charging infrastructure**, such as the **deployment of a smart grid to serve these chargers**, ensuring maximum efficiency. The **project would complete the first Mediterranean Corridor for 100 % electric heavy transport**, which would run through the Region of Murcia and the Valencian Community, although the developers intend to extend it to all the other national freight corridors in the coming years.

MICROMOBILITY



The electrification of transport in urban areas also involves the promotion of **Personal Mobility Vehicles (PMVs)** such as bicycles, scooters and electric motorbikes. Mobility using this type of vehicle is not only more efficient and environmentally friendly, but also greatly helps to relieve congestion in cities at times of heavy traffic, thus helping to improve air quality.

For this reason, we are collaborating with Cooltra and Inetum in the implementation of **smart charging stations**, each capable of holding 20 chargers and multi-brand motorbike batteries. These smart charging stations will be automated for aroundthe-clock service seven days a week, ensuring continuous improvement of the service by harnessing the possibilities of Big Data and artificial intelligence. The first charging stations will be operated entirely by Cooltra, but their design allows them to be used by several operators and electric motorbike users.

In addition, we have launched - through the PERSEO International Start-ups Programme - a challenge **to find parking, custody and recharging solutions for micro-mobility that favour the electrification of urban transport.** The winning company was the Andalusian technology company Solum, which has developed its proposal for a **parking system for electric vehicles capable of accommodating bicycles and scooters.** The system is installed in synergy with an innovative solar hardstanding, which guarantees that the energy used in the storage and charging stations for the personal mobility vehicles (PMV) is from a renewable source. The company has already put into operation the first charger for electric scooters in Madrid supplied with 100% renewable energy.

PORTS

In addition to the aforementioned 'Net-Zero MAR Alliance', we offer **port decarbonisation solutions** including on-site renewable generation and deployment of OPS (onshore power supply) technology, among others.

Heat electrification

ELECTRIFICATION OF INDUSTRY

At Iberdrola we are committed to supporting industries in their energy transition through ad hoc solutions so that their production centres improve their energy efficiency and reduce CO2 emissions in a sustainable, cheap manner. Therefore, in 2021 we launched an Emission-free Industrial Heat Challenge to find innovative solutions to promote the decarbonisation of industrial processes through design automation and the integration of clean technologies and energy efficiency measures. The Challenge winner, Norway's Olvondo Technology, is collaborating with us to validate the scalability and



competitiveness in industrial processes of its high-temperature heat pump, called HighLift, which is unique in **converting waste heat into up to 200 degree steam.** This reduces industry's fossil fuel consumption, with associated reductions in both CO2 emissions and energy costs.

In addition, we are part of the Basque Net Zero Industrial Super Cluster initiative promoted by the World Economic Forum which aims to highlight the achievements of industrial clusters in the transition to net zero emissions and thus motivate and offer experiences and good practices to other clusters to adopt commitments in this transition. The initiative is based on inter-cluster collaboration to advance the transition to net zero emissions by boosting the decarbonisation of energy consumption in industrial activity. The first phase focuses on the sectors with the highest CO2 emissions in the Basque Country (refining, cement, iron and steel, foundry and paper) and will be articulated through the Clusters. Together with Petronor, we will play an important role as a driving force, seeking business opportunities based on new technologies and innovative services that will accelerate the transition.

ENERGY EFFICIENCY IN BUILDINGS

We are committed to the **refurbishment and energy efficiency of buildings**, providing solutions for energy saving and decarbonisation of dwellings, both single-family homes and buildings. The proposal consists of a final turnkey product that brings together different solutions: efficient electric air conditioning with heat pumps, actions on the thermal insulation of the home (façades, roofs, windows), energy supply and optimal maintenance of equipment. In this way, this guarantees simplicity, quality and cost containment to the customer.

04 — Iconic projects

With these actions we are committed to the most efficient electric air conditioning technologies (aerothermal/ geothermal), to the detriment of fossil fuels, reducing dependence on gas and promoting the consumption of a renewable energy mix. It also improves the carbon footprint of our customers, in line with our SDG commitments.



HEAT NETWORKS

We also promote the **creation of heat networks** to supply waste heat energy from renewable energy installations to buildings and homes. For this purpose, we have created IR Redes de Calor y Frío S.L. together with the company REBI Recursos de la Biomasa S. L. Through the heat network, an exchange of thermal energy between producers and demanders can be achieved, bringing the energy efficiency values to the maximum.

Among the initiatives planned is **the implementation of a 28-kilometre heat distribution network to supply heating and hot water** throughout the urban area of Puertollano. The heat will come from our green hydrogen production plant at the site. The heat generated by the electrolyser will be used entirely to heat a stream of water up to 40 and 50 degrees that will be distributed to various areas of the city. This electrolyser is powered by Puertollano's PHV and Renewable electricity from our portfolio, so the heat from the heat network will be 100% green.



Self-consumption



With the knowledge and experience of the Smart Solar unit, in addition to the standard self-consumption solutions for residential and business, the PPA On-site products for companies and Solar Communities have been launched.

Through the **On-site PPA**, the customer is provided with 100% renewable energy at a fixed price, producing savings, predictability and long-term stability. We have launched our **Smart Solar self-consumption solution for**

neighbourhood communities, in which the investment can be made by the customer or by Iberdrola, allowing communities **to generate their own 100% renewable energy and save on their bills.**

The energy generated is distributed among the neighbours and the community according to their participation. The customer who joins the plant is a solar self-consumer with all the advantages of self-consumption of energy: savings on their bill, payment for the surplus energy produced that is injected into the grid, and monitoring of the energy produced by the panels from their telephone, as well as enjoying advantageous solar tariffs on their bill during the hours when there is no electricity.

We also offer the possibility of setting up **Solar Communities**, these are communities that prefer to give up their roof for the installation of photovoltaic panels in exchange for clean energy. In this way, self-consumption of energy is treated as a service without the need for installation or investment and the savings can be monitored through the Smart Solar App.

Energy management

Smart grids represent a technological leap forward in responding to the electricity demand needs of today's citizens, enabling them to become prosumers and integrate a greater number of renewable installations. With this vision, Iberdrola seeks to provide a comprehensive response to the technological and social challenges posed by the needs



of citizens by committing to **Smart Cities.** These combine actions in electric mobility with solar self-consumption and climate electrification, and also add the layer of **local energy management and optimisation**, an essential requirement for connecting the solutions and being able to extract their maximum energy potential in an efficient manner.

In addition, at Iberdrola we have developed the **Advanced Smart Assistant**, a comprehensive energy management system which, based on AI, is capable of autonomously managing all the Smart Solutions present in our customers' homes. In this way, it generates additional value on each of the solutions, and a saving on the customer's bill, both through the optimisation



carried out by the assistant itself, and through the personalised messages and recommendations that the user will receive. With this, the customer will be able to forget about programming their electric vehicle or switching on the air conditioning, avoid consumption overlaps, decide when to charge their electric car according to the most economical hourly rate, etc. In addition, the user will have access to a breakdown of the electricity consumption of each of the household appliances in their home to improve their efficiency and save on the bill and will be able to consult the consumption history and make a forecast for the current month.

The Smart Assistant is now also available for companies (SMEs). In this case, the service is offered with a monthly report, which the customer can consult in their Customer Area or via email, and which includes a summary of all the functionalities available, which are similar to those for households. Our aim is to export this service to other countries, such as France or Italy, in order to continue contributing to energy savings, in line with the current European regulatory framework.

Green Hydrogen



As part of our commitment to leading the energy transition, we are spearheading the development of **green hydrogen obtained by electrolysis from clean energy sources**, with more than 60 projects in 8 countries (Spain, United Kingdom, Brazil, United States, among others) to meet the **decarbonisation needs of sectors that are difficult to electrify.** This portfolio of projects will require investments of \notin 9 billion by 2030, with the aim of producing 400,000 tons/year of green hydrogen. This would save the 830 million tons of CO2 per year that are generated when this gas is produced using fossil fuels.

And we have already initiated several projects that will enable **the decarbonisation of industry and heavy transport**, as well as the deployment of its value chain.

We have recently inaugurated the largest green hydrogen plant for industrial use in Europe, located in Puertollano (Ciudad Real), with an electrolyser capable of **producing 3,000 tons of renewable H2** per year, thus avoiding the emission of **up to 48,000 tons of CO2/year** into the atmosphere. This pioneering plant will **generate 100% green hydrogen with zero CO2 emissions** thanks to the use of renewable sources.

The electricity needed to produce the hydrogen comes from an innovative **100 MW solar photovoltaic plant** directly connected to the electrolyser. It is our first installation in Spain with bifacial panels and a lithium-ion battery storage system with a capacity of 20 MWh. The green hydrogen produced in our plant will be used in the ammonia factory that the Fertiberia Group has in Puertollano, which, thanks to this technology, will be able to reduce the plant's natural gas needs by up to 10%. In addition, this project is **circular**, as, in the future, the waste heat produced as a result of the electrolysis process could be used to provide hot water and residential heating to the town of Puertollano through a heat network that we are promoting in the town. Furthermore, in less than a year we have put into service a green hydrogen plant in the Free Zone of Barcelona to supply TMB (Transports Metropolitans de Barcelona) buses with this clean energy, with a capacity of 2.5MW. The installation will enable fuel to be supplied to other fleets of heavy vehicles in the industrial estate that adopt this vector as an energy solution. It also aims to generate a tractor effect around this technology and promote the creation of a green hydrogen hub in one of the country's main industrial areas. As of today, the number of hydrogen plants in the world is still scarce, several hundred spread around the world, especially in Japan, Germany, Norway and the United States, while in Spain the number does not reach ten. With this project, we will contribute to achieving the goal of reaching more than 100 hydrogenerators set by our country by 2030.



We are also involved in several European research projects. Specifically, in a project focused on improving the storage of this fuel. The **storage of green hydrogen is essential to guarantee the stability of supply** required by industry and to make efficient use of renewable energy production.

The project addresses two different perspectives:

- 1. Short-term storage: new low-cost, high surface area nanoporous MOFs (Metal Organic Framewoks) will be developed following an original forming process (3D printing). A container will also be developed that can accommodate stacks of MOF bodies in an adapted form.
- 2. Long-term storage: advanced materials (both catalysts and membranes) and their combination in a 3D printed intensified periodic open cell structured reactor will be developed to enable the storage of hydrogen in the form of ammonia in a more technically and economically efficient process than today with lower temperatures and pressures than conventional systems

Green hydrogen will also be part of the **energy communities** of the future. We are therefore participating in the development of a **technical and commercial ecosystem** to demonstrate the potential for coupling the energy sector by integrating local energy systems across the **federation of communities:** generating economic benefits, improving grid stability and reliability, contributing to the decarbonisation of the energy system and reducing the carbon footprint. In the framework of this project, we will develop both the optimisation models for the operation of the hydrogen plant and the optimal model for supplying electricity to the plant, considering renewable energy, batteries, grid and customer needs. The end result will be a scalable and adaptable cloud-based platform consisting of analysis, modelling and **optimisation services for planning, monitoring and control of integrated local energy systems** (electricity, gas, heating and cooling, industry, electric and hydrogen mobility).

Finally, we are developing and validating **a new innovative liquefier prototype for the cryogenic region**, based on magnetic refrigeration. We will work on increasing energy efficiency for small liquefaction volumes, reducing CAPEX and OPEX and integraton into conventional liquefaction plants **to increase their overall energy efficiency**.

Green hydrogen will be part of the energy communities of the future.



