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Storage reinvented: a green energy revolution

2024: A global strategic vision



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Storing the future

There is an urgent need to restore balance to the planet's limited resources and develop sustainable energy solutions to strengthen energy security. That is why, at EDP, we are committed to continuous innovation, constantly testing new technologies and integrating them into renewable energy projects.

One of the successes featured in this edition is flexible energy storage. This technology is already affording us more flexibility to store and manage the wind and solar power that is delivered and consumed, which would otherwise be lost. We also talk about green hydrogen, a technology that is vital for the decarbonization of the industry, transportation, and heating.

As this is the first issue of the year, we also feature the Executive Board of Directors' business strategy vision for 2024, the challenges that lie ahead, and the main projects that will guide our company's sustainable growth.

Finally, we are proud to showcase the EDP project in Pulau Ubin, Singapore, where we decarbonized the island's microgrid using renewable energy.

Happy reading!



by Miguel Stilwell d'Andrade
CEO, EDP Group

“At EDP, we are committed to continuous innovation, constantly testing new technologies and integrating them into renewable energy projects.”



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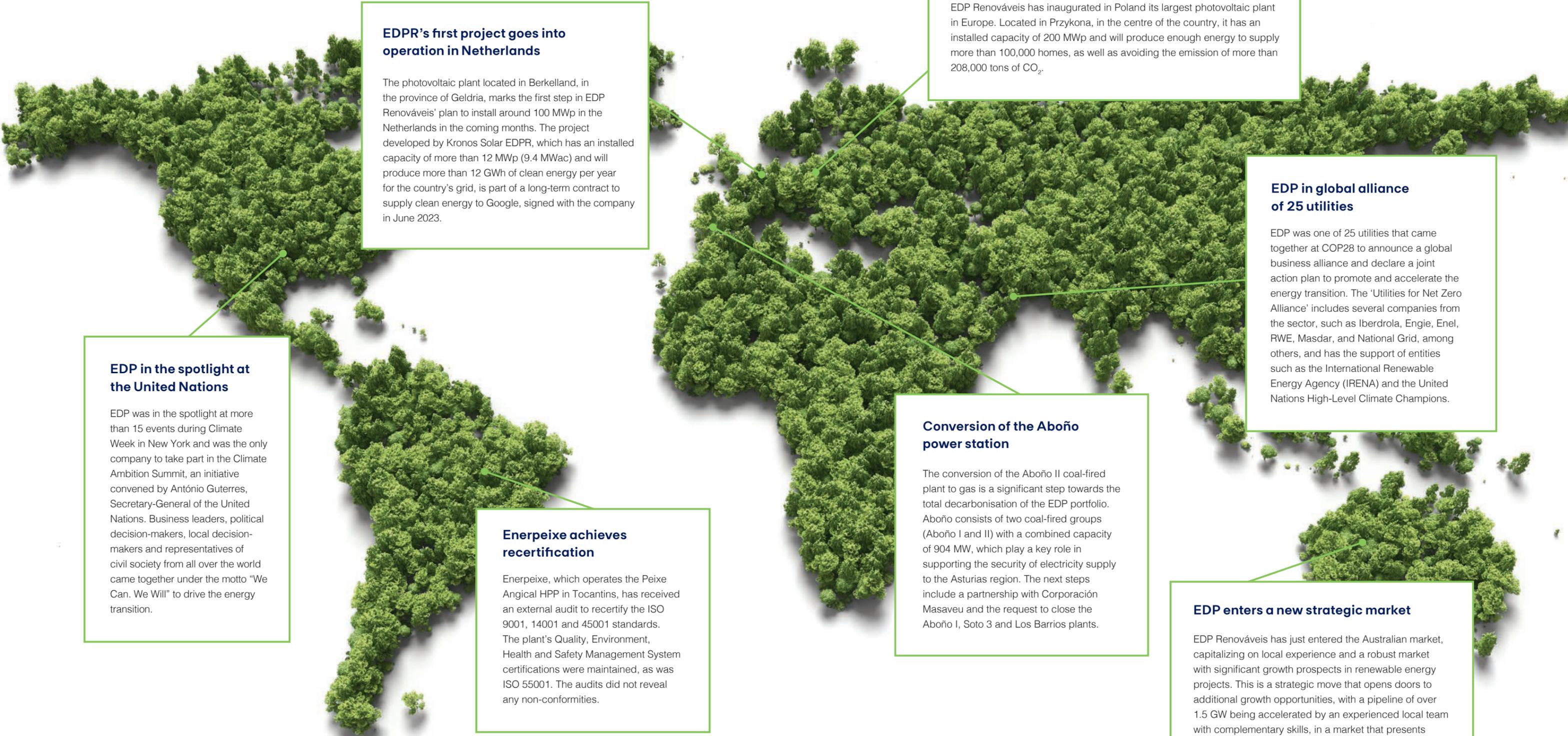
Interview with Sunita Satyapal

DOE Hydrogen Programa Coordinator of U.S. Department of Energy talks about the environmental and economic impacts of this technology.

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know.



EDPR's first project goes into operation in Netherlands

The photovoltaic plant located in Berkelland, in the province of Geldria, marks the first step in EDP Renováveis' plan to install around 100 MWp in the Netherlands in the coming months. The project developed by Kronos Solar EDPR, which has an installed capacity of more than 12 MWp (9.4 MWac) and will produce more than 12 GWh of clean energy per year for the country's grid, is part of a long-term contract to supply clean energy to Google, signed with the company in June 2023.

EDPR's largest park in Poland

EDP Renováveis has inaugurated in Poland its largest photovoltaic plant in Europe. Located in Przykona, in the centre of the country, it has an installed capacity of 200 MWp and will produce enough energy to supply more than 100,000 homes, as well as avoiding the emission of more than 208,000 tons of CO₂.

EDP in global alliance of 25 utilities

EDP was one of 25 utilities that came together at COP28 to announce a global business alliance and declare a joint action plan to promote and accelerate the energy transition. The 'Utilities for Net Zero Alliance' includes several companies from the sector, such as Iberdrola, Engie, Enel, RWE, Masdar, and National Grid, among others, and has the support of entities such as the International Renewable Energy Agency (IRENA) and the United Nations High-Level Climate Champions.

EDP in the spotlight at the United Nations

EDP was in the spotlight at more than 15 events during Climate Week in New York and was the only company to take part in the Climate Ambition Summit, an initiative convened by António Guterres, Secretary-General of the United Nations. Business leaders, political decision-makers, local decision-makers and representatives of civil society from all over the world came together under the motto "We Can. We Will" to drive the energy transition.

Enerpeixe achieves recertification

Enerpeixe, which operates the Peixe Angical HPP in Tocantins, has received an external audit to recertify the ISO 9001, 14001 and 45001 standards. The plant's Quality, Environment, Health and Safety Management System certifications were maintained, as was ISO 55001. The audits did not reveal any non-conformities.

Conversion of the Aboño power station

The conversion of the Aboño II coal-fired plant to gas is a significant step towards the total decarbonisation of the EDP portfolio. Aboño consists of two coal-fired groups (Aboño I and II) with a combined capacity of 904 MW, which play a key role in supporting the security of electricity supply to the Asturias region. The next steps include a partnership with Corporación Masaveu and the request to close the Aboño I, Soto 3 and Los Barrios plants.

EDP enters a new strategic market

EDP Renováveis has just entered the Australian market, capitalizing on local experience and a robust market with significant growth prospects in renewable energy projects. This is a strategic move that opens doors to additional growth opportunities, with a pipeline of over 1.5 GW being accelerated by an experienced local team with complementary skills, in a market that presents ambitious plans for the exit from coal and very abundant renewable resources.



.01 A2E selects ten projects

The use of decentralised solar production and energy storage technologies are common points in the ten projects selected for the 5th edition of the A2E (Access to Energy) fund. Out of a total of 192 applications, initiatives were selected from organisations in five African countries - Nigeria, Kenya, Rwanda, Malawi and Mozambique - which will now benefit from a total funding of one million euros to develop their projects. These initiatives include, for example, electrification systems for small clinics, lighting for primary schools, energy supply for agricultural production or solar mini-grids that will electrify small communities. In total, it is estimated that these projects could have a positive impact on the lives of around half a million people. Created in 2018 to support projects that promote access to renewable energy

in remote and vulnerable communities, the A2E Fund has already invested 2.5 million euros to support 28 projects in seven countries in Africa, benefiting more than 1.5 million people - a universe that will now reach almost two million. Financing renewable energy projects in emerging countries - and especially in Africa - was also one of the topics on the agenda at COP28, the world's main climate conference, which took place in late December in Dubai and in which EDP once again played an active role. To find out more about these projects and the activity of the A2E fund, visit EDP's website.

.02

ED&I Volunteer Week
In an effort to promote

EDPR NA's commitment to equity, diversity, and inclusion (ED&I) and allow employees to give back to local communities, the company's ED&I Committee organised a successful inaugural Volunteer Week in September of last year. Coordination between all offices across the continent was by no means easy. Nevertheless, the initiative gathered support from members who helped out in the planning stage, some of whom even stepped up to be volunteer leads to coordinate the efforts with local charities and organizations - Just Roots in Chicago, West Houston Assistance Ministries (WHAM) in Houston, Cultivate KC in Kansas City, PACO IAP in Mexico City, West Side Campaign Against Hunger (WCAH) in New York City, and Transition Projects in Portland.

.03

Recognition at the ESG Investing Awards
EDP was once again recognised for its good sustainability practices at the ESG Investing Awards 2023, which evaluate and reward the best listed companies worldwide in the ESG (Environment, Social and Governance) investment areas. In the 2023 edition, EDP won, among the major companies, in the category of 'Best Climate Report'

Additionally, donation collections were carried out in the Indianapolis and Toronto offices. Employees could also donate to Easterseals if they were remote or could not attend the mentioned volunteer activities in person.



and came second as 'Best Company in Social Responsibility'. In addition to these distinctions, EDP was included in the short list of finalists in two more categories: 'Diversity, Equality and Inclusion' and 'Sustainability Report'. Published for the first time in 2022, EDP's Climate Transition Plan brings together the group's strategic goals for decarbonisation and carbon neutrality, supported by the 2023-2026 Business Plan and which highlights, among several objectives, the ambition to achieve the Net Zero target by 2040. This recognition from the ESG Investing Awards 2023 marks a significant step forward for EDP compared to the previous year, when it was classified as "runner-up" in a category: "Best Sustainability Report".

.04

EDPR NA and 4-H join forces
EDPR NA announced a new partnership with 4-H, the largest youth development organisation in the United States. This collaboration brings together two organisations dedicated to sustainability, education, and community empowerment. The collaboration will focus on STEM education through the distribution of 4-H STEM Challenge kits and educational curriculum on CLOVER by 4-H, a dynamic, e-learning platform. The 2023 4-H STEM Challenge kit, Power Protectors, is a collection of three activities that teach kids how to address real-world issues and explore



careers in energy. CLOVER meets Gen Z and Gen Alpha digital natives where they are with online content that sparks curiosity for learning and future career paths.

.05

The Four? Seasons: 300 Years Later
What would The Four Seasons sound like if Vivaldi wrote them today? On the occasion of the International Day against Climate Change, EDP put this question to a meteorologist, a composer and a conductor. The two worked together to create a new score in which the composer translated the climatic changes reflected

in the scientist's report into music. The result, the unpublished work The Four? Seasons: 300 years later, premiered at the EDP Gran Vía Theater on late October, performed by a chamber orchestra and with great media coverage: more than 60 media appearances in fifteen countries that brought the action to more than 141,000 people. This is how one spectator defined it: "An original show, full of suggestions, emotion and that makes us think about the immediate future that awaits us if we are not more ambitious and careful". The score is in the public domain, so any orchestra can play it and, as EDP has already done, raise awareness among its audience, through music, of the importance of protecting the planet. //

The Road Ahead: EDP Group's Vision and Outlook for 2024

EDP's leadership team share their vision and anticipate the main challenges for 2024. Over the next few pages, find out what the near future holds for us, in what is a crucial phase for achieving the key objectives for an energy transition.

Miguel Stilwell
d'Andrade



“EDP is ready for the great challenge of the energy transition”

In a context of macroeconomic instability, the company's main focus is to continue diversifying its renewable portfolio worldwide. This year, we expect to reach 4 GW of renewable capacity. It will also be a time to continue investing heavily in electricity grids, a key segment for the energy transition. What role will EDP play in the global energy transition, and what are the initiatives that will contribute positively to the change the world needs?

The energy transition is key to effectively tackling climate change and to meeting the challenges of energy security and access to clean energy. Our goals are clear: phase out coal, keep gas as a short-term backup, and continue to invest heavily in renewables, grids, and energy efficiency while supporting our clients.

“We will continue to work on our organizational model to ensure that we have a structure that reflects our global dimension effectively, increasingly fostering collaboration, efficiency, and agility in our decision-making.”

At the same time, we must keep pace with changes in the world and the energy sector, increasing the use of digital tools, technological innovation, and investment in skills and talent.

The offshore Windfloat project and floating solar project in the Alqueva are prime examples of this.

The main message is that we need to accelerate the expansion of renewables and ensure more investment and innovation to reduce overall costs. EDP is ready for it, but we need regulatory stability. And the macroeconomic context is not helping, nor is the worsening of climate change.

The energy transition requires a serious commitment from everyone: governments, companies, and civil society. EDP already has a global presence based on four key regions (Europe, North America, South America and Asia-Pacific) and has made a clear commitment to renewables over the last two decades, from almost 80% thermal generation then to more than 85% renewable generation today.

And we have been doing it so governed by the principle of just transition, working together with governments and local authorities in the regions impacted by the decommissioning of thermal assets, like in Sines, and with plans to have “green energy hubs” in those locations, with renewable energy, green hydrogen, storage, and flexibility.

Today, our global emissions are 48% lower than in 2015 and we intend to reduce absolute emissions by 90% in all areas by 2040. We are investing €25 million between 2023 and 2026, with around 85% (€21 million) in the renewable segment: wind, solar, green hydrogen, and energy storage. All of it combined with greater investment in our grids and an increasingly sustainable customer offering.

What are the priorities for 2024? What areas will be more critical to invest in and what concerns should we be more aware of?

Our focus for 2024 remains growing our renewable energy portfolio globally, particularly in Europe and the United States. Last year saw some delays in the installation of new renewable capacity, so there is a greater challenge in 2024. The goal is to install around 18 GW of renewable capacity between 2023 and 2026, as we announced on Capital Markets Day back in March 2023. I am confident that all our teams are working toward this goal. At the same time, we will continue to invest in electricity grids, which is a key segment for the energy transition.



What are the company’s investment strategies to continue the modernization of the power grids in the long term? What specific advances are shaping the sector today?

The transmission and distribution grids are an essential pillar of the energy transition. A lot of investment is needed to cope with increased distributed production, the electrification of the economy, electric mobility, and growing self-consumption. This trend is present in the most developed countries, leading to grids needing to become increasingly decentralized, digitalized, and more flexible.

In line with this, the group’s investment strategy in the grids segment involves a strong commitment to modernization to enable that transition. EDP is investing €3.2 billion until 2026 to strengthen the digitalization, intelligence, resilience, and efficiency of our infrastructures in the three countries where we operate grids: Portugal, Spain, and Brazil. Digitalization also plays a central role in all of this. This investment cycle will reinforce the digital transformation of grids to ensure quality, efficiency, and physical and cyber-physical security. The focus on automation, monitoring, remote control, and sensorization of the grid will continue, leveraging our investments in grid intelligence, managing real data about energy demand behavior, and using the information gathered to address quality-of-supply issues.

In terms of people, their development and cohesion, and attracting talent, what will be the challenges for EDP in the coming year?

We have more than 13,000 employees worldwide, and I hope that EDP will continue to evolve as a global organization, supported by a common purpose (“Our energy and heart drive a better tomorrow”) that has a positive influence on our people’s work experience and sense of belonging. This has become very clear over the past year.

We are mindful of the path we are on as an organization and will continue to work on our organizational model to ensure that we have a structure that reflects our global dimension effectively, increasingly fostering collaboration, efficiency, and agility in our decision-making. Our track record of strong organizational climate results, along with EDP’s recurring international recognition as a top employer, demonstrates the company’s commitment to providing a positive and attractive work experience.

We are also committed to an increasingly global, swift, and inclusive recruitment experience and will continue to offer an attractive and competitive compensation and benefits model. We also want to consolidate a culture of feedback and transparency that promotes meritocracy.

In terms of development, we are going to continue to accelerate the development of our leaders, empowering them for an increasingly global role and enabling them to develop their own teams. Nevertheless, we need to develop business skills that will enable us to respond to the new challenges of the energy transition—not only through training that is increasingly tailored to the needs of each individual, but also through our global marketplace of internal mobility opportunities, one of the finest attributes of our organization.

Rui Teixeira



In the last two years we have faced a global energy crisis and a challenging macroeconomic scenario. But even so, the company managed to revise its guidance upwards, with an optimistic outlook for 2024. For these results, EDP's CFO highlights the role of investors and guarantees investment in renewable energy projects that create value.

“Our investors play a fundamental role as allies for the energy transition”

Considering the current scenario and economic projections, after an upward revision of the guidance for 2023, what are the expectations for the company's financial performance in 2024?

After a challenging year in 2023, we successfully achieved the set goals, which makes us optimistic about EDP's performance in 2024. We believe we are on the right track to fulfil the objectives communicated in March last year during EDP's Capital Markets Day, forecasting a net profit of between €1.2 and €1.3 billion for 2024. This result reflects the strength of our diversified and resilient portfolio. We anticipate a strong performance in our integrated Iberian business, driven by hydro reservoirs above historical maximum levels, a trend that began in 2023 and will continue this year. We also highlight the importance of electricity distribution networks, bolstered by two positive regulatory reviews in 2023: the recent review of regulated electricity distribution tariffs in Portugal, with a 4 per cent increase compared to the previous year, and the impact of the regulatory review of distribution in Brazil. In addition, the active management of financial costs in 2023 should have a positive impact, due to the rebalancing of the weight of US dollars in our debt and a reduction in the weight of Brazilian reais in the total debt. The acquisition of 100 per cent of EDP Brasil's share capital will also have a positive impact on the group's net profit for 2024.

China's real estate crisis, inflationary expectations, climate and geopolitical shocks, and high public debt... How are investors responding to these uncertainties and what are the prospects for energy investments, considering the various risk factors?

There is no doubt that in the last two years, the macroeconomic and geopolitical context has presented some challenges for the development of renewable energies. In particular, the year 2022 served as a wake-up call not only for the energy sector, but for each and every one of us: we had to face a global energy crisis, due to the war, along with the worst drought in 90 years in Iberia. This context, and the increasingly tight deadline we have to decarbonize our planet, reinforce the urgent need to boost the energy transition, accelerating the growth of renewable energies and the electrification of consumption. EDP's commitment to the energy transition is embodied in our goals of investing €25 billion over the years 2023 to 2026 and adding around 18 GW of renewable capacity.

To this end, our investors play a key role, as allies in the energy transition. Our commitment to investors is to always ensure investment in projects that create value, always evaluating projects in relation to their risk and return and meeting our return targets at >2% IRR/wacc (internal rate of return/weighted average cost of capital), which we are currently achieving, even in this context of high interest rates and inflation.

“Governments are already intervening and need to continue to do so through concrete measures, guaranteeing a stable and reliable regulatory framework for investors.”



What will it take for the renewables sector to regain market confidence?

Companies in the sector must continue to map out their strategies, focusing their investment on renewables, and it is essential to maintain the current long-term strategy of the European Union and the USA, and consequent regulatory stability. We have seen the launch of relevant policy measures in the EU, which now aims to have at least 40% renewable energy sources in its energy mix by 2030. The EU guidelines are essential and a very important first step, but now successful implementation and the path to the energy transition are at the level of the Member States, which must ensure speedy permitting and grid connection of renewable projects. In the US, an important step was taken with the Inflation Reduction Act, which provided visibility of investment incentives for more than ten years in different technologies. This was the most consequential change in federal energy policy in US history, an extremely important measure to increase investor confidence in this market. Governments are already intervening and need to continue to do so through concrete measures, guaranteeing a stable and reliable regulatory framework for investors, otherwise we could jeopardize the energy transition. At EDP we will continue to do our part by continuing to invest in “traditional” renewable technologies, but also in innovative solutions and, necessarily, in electricity networks.

Vera Pinto Pereira



We are on the cusp of an energy revolution that will dramatically improve our daily lives, says Vera Pinto Pereira, member of the Executive Board of Directors, responsible, among others, for the areas of Client Solutions and social impact programs at EDP. The most important thing is to leave no one behind in this paradigm shift toward a more electric world.

“We want to increase investment in just energy transition projects”

As customer expectations and technological trends in the energy sector continue to shift, what initiatives do you have in the pipeline to improve customer experience in 2024?

Meeting the decarbonization targets that the world has agreed to requires structural change in the way we produce, consume, and manage electricity. Today, customers are at the heart of the energy transition, and that means we need to change the way we engage with them.

In the past, clients simply consumed energy. Now, they are the ones with the power to electrify the economy—with their electric vehicles and heat pumps—and we need them to make sure that every rooftop, parking lot canopy, and patch of farmland has solar panels producing renewable energy.

This paradigm shift implies transitioning from simple energy products to a complex ecosystem, with frequent and shared daily decisions instead of limited interaction between customer and supplier. It means moving from a portfolio of generic offerings to a seamless and integrated experience that is tailored to each customer’s specific needs. Today, electricity retailers are—and increasingly want to be—sustainability partners, facilitating the customers’ relationship with their energy and helping them manage it efficiently. EDP is no exception. To achieve this vision, our

focus has been on digitalizing and automating our customer interactions, strengthening the delivery capacity and quality of our operations, and making sure our communication is even clearer and more transparent. To that end, we are implementing a plan involving more than 60 initiatives that began in 2023 and will continue into 2024. They include, for example, reviewing all our customer communications, implementing a process for digitally signing contracts, and creating a specialized remote technical support team.

“Today, electricity retailers are—and increasingly want to be—sustainability partners, facilitating the customers’ relationship with their energy and helping them manage it efficiently.”

What initiatives or programs does EDP plan to implement to address social challenges in 2024? What role will the social impact strategy play in tackling them?

As we ramp up the energy transition, our responsibility is to ensure that it is done fairly and equitably, leaving no one behind. For us, that is more than an ambition. It is a very clear and tangible goal. That clarity of purpose means that the entire EDP Group is working together with a solid strategy, implemented consistently on a global scale.

In Portugal, the Social Impact Coordination Office (SICO) and EDP Foundation are stepping up projects that help the most vulnerable communities. These include “Solar Solidarity,” which installs solar PV systems in charities; “Energy Inclusion,” which provides energy efficiency solutions to low-income families and individuals throughout the Iberian Peninsula; and the revamped “EDP Energy Solidarity,” which will invest more than €2 million to support innovative social projects that promote a just energy transition in Portugal.

In 2024, these three projects are going to go global—with the help of the EDP Foundation in Spain and the EDP Institute in Brazil—enabling a successful model to be replicated in other countries.

There are other very important projects being implemented by other EDP entities. EDP Renewables, for example, is helping boost employability in rural areas where it operates by training students to work on renewable energy projects. This “Keep It Local” program is being carried out in Colombia, Brazil, Italy, Poland, and throughout North America.

In 2024, we also want to increase investment in just energy transition projects on a global scale. Our aim will be to implement successful programs in even more countries, focusing on issues such as energy inclusion, self-consumption, access to energy, and the democratization of electric mobility.

With a turbulent international environment and soaring inflation, 2023 was another challenging year. What is your assessment of the past year and how do you see those challenges unfolding in 2024?

We live in turbulent times. After three years of pandemic, international conflicts are having a huge impact on the price of raw materials. In the energy sector, they have shown the importance of energy security and independence, as well as the critical need to switch to clean energy.

All of it against the backdrop of an increasingly clear sense of global urgency to protect our planet.

Despite our concerns, 2023 has left us hopeful. It was an unprecedented year in terms of how many families and companies decided to take an

active role in the energy transition and have more control over the type of energy they consume. Today we see

every rooftop, building facade, and parking lot as an opportunity to step up this transition, whether through

solar power generation or electric mobility. We are also excited to take on this opportunity because we know

we are not alone. Through collective effort and true partnerships, we are increasingly convinced that we will be

able to achieve the ambitious goals of transforming our country.

We are confident that we will continue to deliver projects in 2024 that

accelerate the energy transition in Portugal and in the other 30 countries where we operate. We are confident

that we will bring more families and companies into the energy transition and that we will continue to attract and

retain the most qualified professionals to help us on this journey.

We live in turbulent and uncertain times, in a decade that is fraught with challenges—but also hope. We are on the cusp of an energy revolution

that will dramatically improve our daily lives.

Ana Paula Marques



“We will continue to anticipate future business trends”

Innovation and digitalization as cornerstones of EDP’s strategy for the coming years, the role that conventional generation will play in creating value, and how regulatory changes can impact the business. These were the topics we discussed with Ana Paula Marques, member of the Executive Board of Directors responsible for those areas.

How is the EDP Group planning to continue to lead the way in innovation and digitalization to drive growth in 2024?

Innovation and digitalization are cornerstones of EDP’s strategy for the coming years. In terms of innovation, we want to continue to lead and drive the growth of the EDP Group in 2024 by delivering value to the business and by strengthening the company’s foresight capacity. We want to promote a more innovative culture in the organization, always in conjunction with the business and on an increasingly global scale. After a year of consolidating and improving the innovation model, in 2024 we want to continue to develop internally and deliver high-potential innovation projects that address the current and future needs of the different businesses, including their scaling up. We will also leverage different ecosystems to identify and test solutions that can bring competitive advantages to the group through open innovation, as well as identifying and investing in startups with high strategic and financial potential. Finally, we will also continue to anticipate future business trends, consistently develop know-how, and increasingly promote innovation within the EDP Group through the various channels available—including

through our intrapreneurship program, The Spiral. The first edition was very well received and a great success. When it comes to digitalization, our main objective for 2024 is to deepen current lines of action. Among them are working increasingly close with the business units, streamlining the operations of the DGU itself, actively promoting EDP’s digital ambitions, and focusing heavily on efficiency and value creation. To break down the line of action of promoting digitalization across the group in more concrete terms, we are looking to focus on three complementary vectors in 2024: accelerating the creation of value that digitalization brings to the business, progressively consolidating a digital culture and new ways of working at EDP, and renewing our digitalization ambitions through data and AI. It is also worth noting the key role that DGU NOW will be playing. This transformation program—launched in 2023 and currently being rolled out—will be a catalyst for these major lines of action for 2024.

What about conventional generation? What role will it play in EDP Group’s strategy and what are the main challenges you foresee?

The role of conventional generation in delivering the Group’s strategic objectives is based on four pillars: a strong cash-flow contribution, creating value in the hydro portfolio, transitioning the thermal power portfolio and preparing the company for the future. In the hydro portfolio, we want to leverage the existing structure through investments in optimization, pumping, hybridization and storage projects. With regard to the transition of the thermal portfolio, we want to continue to ensure that we take the necessary steps to fulfil the group’s commitments to coal-free generation by 2025. On the one hand, we will work on optimising the portfolio through partnerships for natural gas conversion and hybridisation projects that will require greater flexibility in adapting the assets, their operation and their performance. On the other hand, we will remain committed to the elimination of coal by 2025, which already began in 2023 with important steps taken in the closure of coal-fired power stations in Spain and the start of the conversion to gas in Aboño. It will be essential to guarantee the delivery of these commitments, preparing the decommissioning of assets and accelerating the projects necessary for their fair transition.

“Another important challenge is the transition of the thermal portfolio, which is essential to fulfil the group’s objectives of coal-free generation by 2025.”

The regulatory framework keeps changing. How will that impact the group’s operations and strategy in 2024?

The energy sector is known for its large investments, especially in generation assets and grids. They typically have very long service lives and long payback periods. Therefore, it is crucial to have a predictable and stable legal and regulatory framework. Regulatory uncertainty adds risk to the business and may jeopardize project execution and viability. At European level, the new electricity market design has just been approved. It introduces clarity into the regulatory framework, particularly regarding investment in renewable energies and networks, which is very positive. In the United States, the Inflation Reduction Act (IRA) is also already in place to promote the energy transition with clear timeframes and funding earmarked. In one way or another, all other countries where we operate are also moving in this direction. Overall, this is a positive scenario for EDP Group’s strategy in 2024 and beyond. However, the regulatory dynamic never stops and there are still several challenges to overcome, such as licensing and permitting in various geographies. It should be noted that uncontrollable and unforeseen events may once again cast uncertainty on operations, but the group has already demonstrated its resilience in the past and I am sure that, should new situations arise, we will be ready to face them.

Pedro
Vasconcelos



“GEM will increasingly be an important competitive instrument”

GEM will increasingly be an important competitive platform for the ambitious growth plan of EDP as energy offtaker, manager/placer of energy in markets and in identifying investment opportunities that bring flexibility and broaden our integrated position. GEM's performance was already decisive for the good results that EDP group will present at the end of 2023. The expectation for 2024 is no less ambitious, but our goals and priorities are clear: to further integrate our positions with generation and expand geographical scope to manage deviations worldwide, while becoming significantly more digital.

“APAC region has very strong fundamentals, but it is still at an early stage of maturity”

Since EDP arrived in APAC (Asia-Pacific region), we have more than doubled our installed capacity and surpassed the 1 GW milestone only 18-months post-closing; while building up a robust pipeline to sustain commitment to deliver 1.5 GW additions within the business plan period and long-term growth ambition to tenfold capacity within this critical decade to 5-7 GW by 2030.

Asia in general, and Southeast Asia in particular, have tremendous potential for decarbonization but are also lagging behind in terms of their intrinsic ability to develop renewables and thus facilitate the energy transition. ASEAN countries have very limited grid interconnectivity, which hinders the maximization of the usage of the renewable resources available. The Singapore government is leading the region with the aim of importing up to 4 GW of renewable energy into the country, which could act as a catalyst for the connectivity of the region, potentially adding a population of up to around 2 billion inhabitants, with Singapore at its centre.

Looking ahead, and from a strategic standpoint, the APAC region has very strong fundamentals but short-term is demonstrating to be dynamic between markets. Thus, forcing to re-focus business development efforts while maintaining growth options and being efficient in managing them, which we can achieve with a handful of active markets. Under the principle of going deeper instead of wider, and following a dual track technology strategy that combines DG short-term actionability in a couple of markets like Singapore, China and others such as Taiwan and Vietnam, with centralized PV and wind onshore in the medium to long-term in Japan, Australia, South Korea, potentially Vietnam and Philippines, as well as from Cross Border projects promoting ASEAN interconnection. Namely importing 400MWac of clean energy from Riau Islands, Indonesia into Singapore as per the conditional award we received from Singapore's Energy Market Authority.

With an increasingly consolidated and leading positioning in the region, the expectations for 2024 are even greater: we will continue to deliver accelerated scalable DG growth while stepping up utility-scale generation capabilities, combining the group's global expertise and the local know-how of the markets to develop greenfield projects.

In an increasingly complex and volatile geopolitical and regulatory context, the new Global Energy Management (GEM) platform is becoming increasingly important for the EDP group. Pedro Vasconcelos also talks about the dynamics and expansion plans for the Asia-Pacific region.

What strategic positioning and emerging technologies should EDP focus on and what is the role of GEM?

EDP must promote the value maximisation of its global portfolio and the potential of its integrated position, actively managing energy from generation to supply. This is a critical factor in a macroeconomic context of greater volatility, and one that adds value, given the growing regulatory and geopolitical complexity, as well as a differentiating factor in the face of a highly competitive landscape and increasingly sophisticated customers.

The advancement of automation and digitalization plays a crucial role in facilitating advanced analytics and automated trades through big data analysis. Emerging technologies such as storage are pivotal tools for optimizing flexibility, particularly in aggregating and managing risks, especially where merchant exposure is concerned.

“GEM's performance was already decisive for the good result that EDP group will present at the end of 2023. The expectation for 2024 is no less ambitious.”





Sandhya Ganapathy
North America



Duarte Bello
Europe / LATAM



João Marques da Cruz
EDP Brasil

“2024 is set to be a record year for EDPR North America in terms of MW additions”

EDPR NA, headquartered in Houston and with 8 offices across North America, employs more than 1,000 people. It has traditionally been one of the growth engines of the EDP Group, with an asset base of around 10 GW, putting it among the top 5 renewable players in the region.

The business plan 2023-26 contemplates additional growth in North America, with investment representing 45% of the Group’s investment plan. This growth plan is fueled by the Inflation Reduction Act (“IRA”) which extends powerful tax incentives for wind and solar as well as the introduction of new credits for stand-alone storage and green H2.

The US renewable sector is expected to add between 500-600 GWs of additional capacity through the end of this decade. EDPR is well positioned to capitalize on this fundamentally stable and booming market with our deep pipeline, origination capabilities and operational track record. Despite the challenges experienced in the past couple of years predominantly around solar supply chain, 2024 is set to be a record year for EDPR NA in terms of MW additions, with expectations to bring online more than c 2.0 GWs.

As of today, more than 50% of our target additions for 2023-26 are fully secured in terms of offtake. EDPR NA also has a growing presence in the US distributed generation market.

A third of our assets are fully operated end to end through our self-perform business model which is unique to EDPR NA.

We are looking forward to 2024 and beyond with renewed vigor, a lot of excitement and optimism in terms of what lays ahead.

“The year will be marked by the delivery of many projects that we have in the pipeline”

I think that 2024 will be clearly marked by the delivery of many projects that we have in the pipeline and which, last year, with the challenges that the whole sector went through, ended up being delayed. In the case of the European and Latin American regions, we are talking about installing around 2 GW of renewable capacity over the course of the year, which is a new record for these regions.

Secondly, I would say that in 2024 we will continue to see the reinforcement of EDP’s installed capacity in Solar and decisive advances in Storage, with the entry into operation of a very significant portfolio in this technology all over the world and with a relevant contribution from projects that we will set in motion in Brazil, Italy and Spain, to highlight a few, and the markets where Kronos Solar EDPR operates, a company that we acquired in 2022 and through which we are exploring opportunities in the German market, the Netherlands, France and the United Kingdom. At the beginning of this year, we already reached a very important milestone, which was the commissioning of Spain’s first wind and solar hybrid (after having been the first to implement hybrids in Portugal and Poland). These hybridisation solutions will continue to be important, particularly in Europe. But also, in Storage - a key technology for accelerating the energy transition - we are going to start building the first “standalone” project in the UK. The first of many that we hope to accelerate in the rest of Europe.

Throughout the year, in the different regions where we operate, we will continue to face an uncertain environment due to the geo-political and macroeconomic situation, but we are confident that we have the right people. With the agility, resilience, and ability to deliver needed to continue developing our projects and achieving our goals.

“Brazil will be the center of EDP’s South America Hub”

EDP has been in Brazil for more than 25 years, and it is a strategic country for the group with significant growth potential. In 2023, EDP made a major investment to delist EDP Brasil, and it is now important to continue to develop a single, united EDP in Brazil, covering the various businesses developed in that country, from renewable and hydrogeneration, to networks and customers.

In distribution, the main challenge is to achieve a concession extension, while keeping the focus on improving our operating ratios and customer services, which are often affected by severe weather events. In solar, our goal is to grow in decentralised generation, guaranteeing a robust increase in sales in our target markets, always considering potential strategic acquisitions. As EDP’s only market with a transmission business, it is crucial for the company to win new lots in the 2024 auctions to maintain the ongoing asset rotation strategy.

In energy sales, we need to strengthen our important position as a player in the free energy market for wholesalers and retailers, in preparation for the full liberalisation of the Brazilian market, scheduled for four or five years from now. On the other hand, the generation portfolio must be more balanced, considering its different sources, resulting in the disposal of some of our hydroelectric power assets.

Our aim is to execute all these strategies in a way that creates value for the group and this only can be done being efficient. EDP is a benchmark in Brazil in terms of innovation, ESG and energy transition and this know how will be critical for EDP to be more relevant and strategic in its participation in COP30, which will take place in Brazil in 2025. We must have “a road to Belém”. //



The world's most sustainable electric utility

With a final rating of 88 points, above average in the energy sector, EDP stands out as one of the world's sustainability champions. EDP is the only Portuguese company to be included in this global benchmark index for 16 consecutive years and is also a member of the DJSI Europe.

EDP once again stands out as the most sustainable electricity company in the world by securing leadership of the S&P Dow Jones Sustainability Indices (DJSI) World. With a final rating of 88 points (out of 100) and above the average for the energy sector, EDP is the best among eight electricity companies, evaluated within a total group of 3,500 companies eligible for inclusion in the Dow Jones sustainability indices. EDP is thus part of the group of 321 companies from different industries that have been selected to be included in the Dow Jones Sustainability World Index, which includes 15 utilities.

global leadership in good ESG (Environment, Social and Governance) practices. This performance is also worth EDP's leadership in the DJSI Europe, where the company is also the most sustainable of six electricity companies in a group of nine utilities and out of a total of 150 companies selected to be part of the European index.

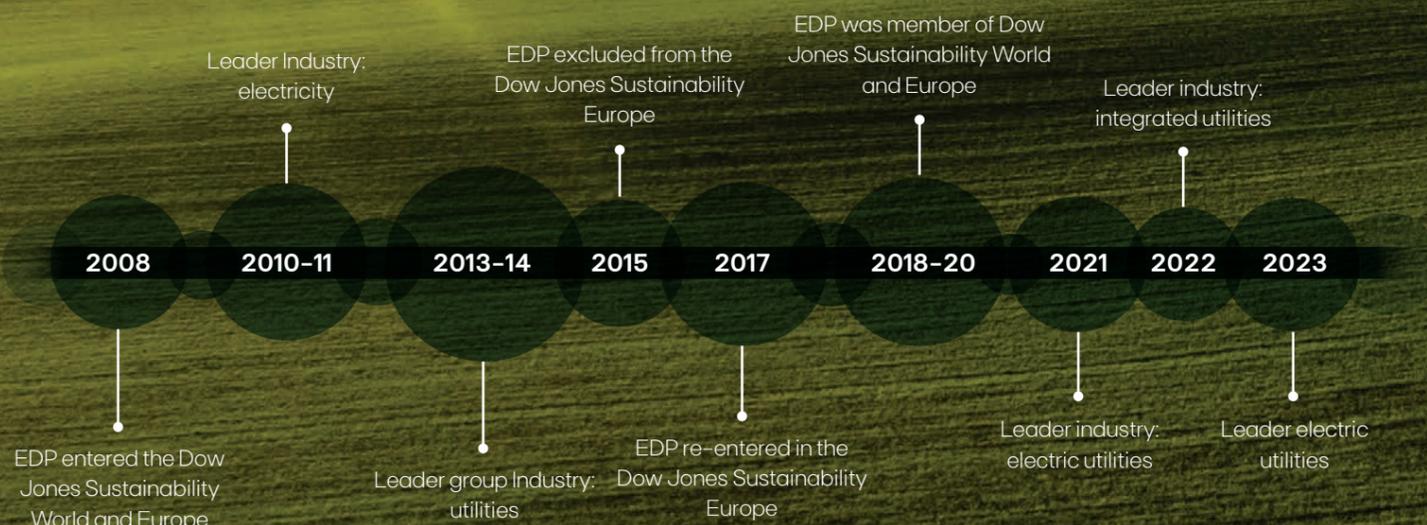
Recognition in this global index thus reinforces the results of the S&P Global ESG Score evaluation released in November, which had already anticipated its inclusion due to EDP's

EDP has been a member of the Dow Jones Sustainability Index since 2008, making it the Portuguese company with the most consecutive appearances on this reference list. The company has also been a member of the Dow Jones European Index for 14 years. Since then, EDP has moved significantly away from the top ranking of 75 points and, over the last 16 years, has almost always been in the top two places in its segment. //



EDP's Journey

World (16 years) and Europe (14 years)



According to the assessment of 26 criteria, the company obtained the maximum score ('Best in Class') in four of them:

1. Climate strategy

EDP was distinguished for its net zero plan, supported by consistent reporting in line with the core elements of the recommended climate-related financial disclosures (TCFD). In addition, at the beginning of 2023, EDP increased its decarbonisation ambition and announced its commitment to achieve carbon neutrality by 2040. An ambitious strategy included in the company's Climate Transition Plan presented at the last annual shareholders' meeting and which received 99% approval.

2. Business Ethics

The EDP group has shown good results in the field of business ethics due to the strategy initiated by joining the United Nations Global Compact, the publication of the Code of Ethics, the existence of an ethics process management system and the transparent reporting of infractions.

3. Innovation Management

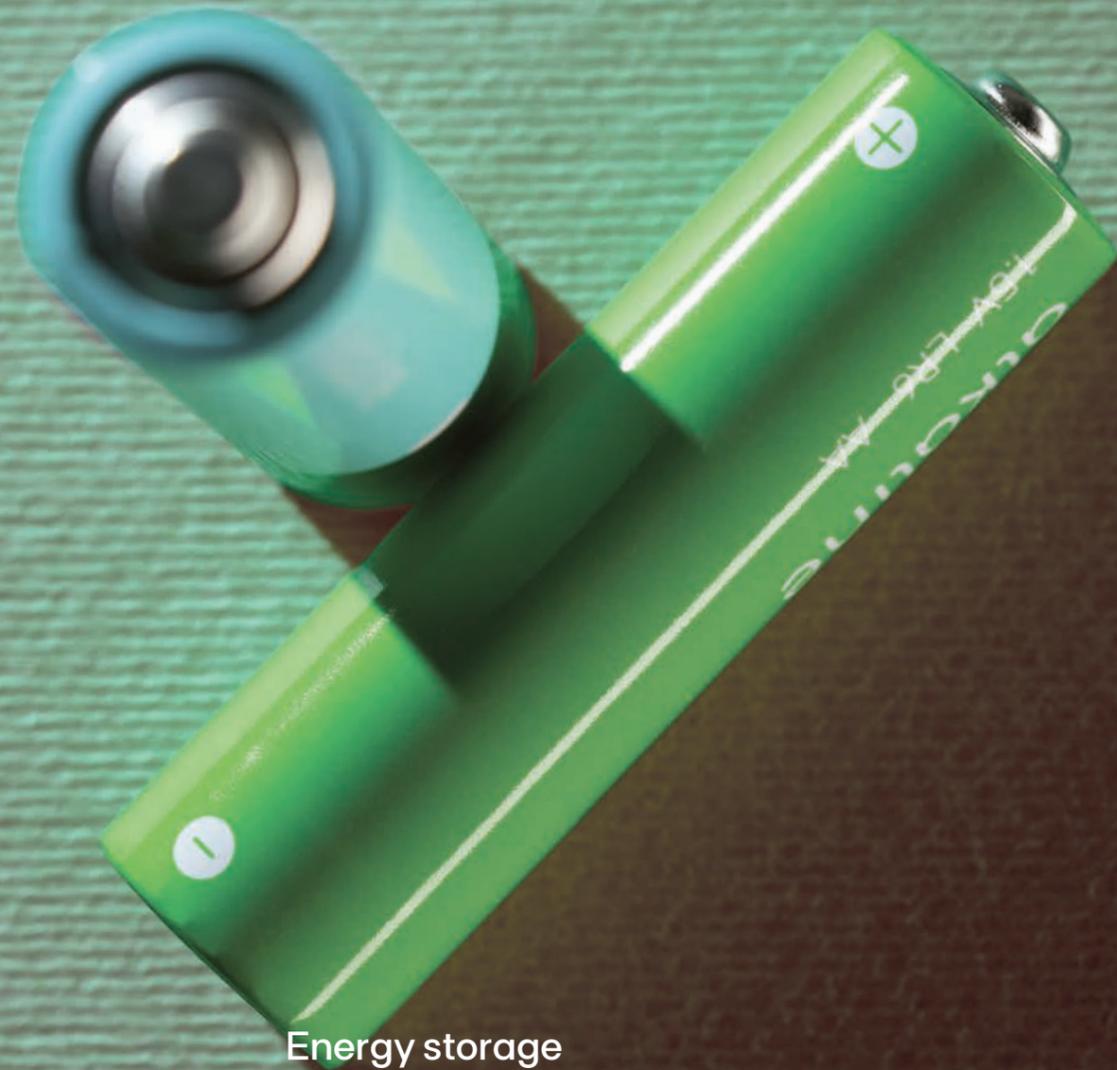
EDP connected its first hybrid wind and solar project in the Iberian Peninsula to the grid in 2023 (an innovative model that it had already materialised in Alqueva in 2022, with a floating solar park, hydropower, and storage), which implies an additional contribution to decarbonisation and the increase of renewable energies in the electricity grid.

4. New Business Opportunities

Anticipating the new energy paradigm, in which generation, distribution and consumption will be increasingly decentralised, EDP offers a range of energy solutions tailored to the specific needs of different customer segments. Its products and services are competitively priced and contribute to electrification and improving the efficiency of energy consumption. In solar DG, EDP is a leader in Europe, helping customers to decarbonise - since 2019 it has increased its capacity 25x. Sustainable mobility is also of particular importance to society and one of EDP's top priorities.



act.



Energy storage

The key to energy sustainability

What if the electricity produced by solar or wind power plants could be stored to be used later as needed? That is not as far-fetched as you might think. According to the study “European Market Monitor on Energy Storage,” around 4.5 GW of new energy storage facilities were completed in 2022. The outlook for 2023 is even more encouraging, with estimates of more than 6 GW of new capacity. While the United Kingdom and Germany currently lead the market, growing interest across Europe is transforming the energy system into a driving force for a cleaner, more sustainable future.



In a world marred by geopolitical challenges such as limited access to energy resources, war, economic tension, and climate change, the need to adopt sustainable solutions and achieve energy security has never been more urgent.

The road to carbon neutrality by 2050 is more than an aspiration; it is a global commitment. If the target is to be met, however, energy storage must be bolstered, ensuring that an electricity grid based on intermittent renewable sources remains stable.

According to “European Market Monitor on Energy Storage,” a study carried out by the European Association for Storage of Energy (EASE), the demand for energy storage solutions in Europe is growing to unprecedented levels.

The ability to store energy for later use is not a recent concept, but it is becoming ever more important in an increasingly electrified world. This transition is a vital step, especially in a world where electricity generation is increasingly driven by intermittent renewable sources, such as solar and wind power. The majority of electricity is generated when the wind blows or the sun shines, which poses challenges for the management of transmission and distribution grids.

EDP has been leading the way in this regard for several years, innovating and adapting to meet the challenges of the transition to a more sustainable energy matrix.

“The integration of storage systems will play a critical role in future renewable energy mixes, because it will help address the issue of intermittency. By mitigating the impact of external factors that can affect availability, these systems are key to overcoming one of the main limitations of renewable energy, all without producing harmful emissions,” says Miguel Stilwell d’Andrade, CEO of EDP and EDP Renewables.

Renewable Energy

With renewable energy becoming increasingly important, storing it brings back the extra flexibility to maintain the stability of the electricity system by increasing the weight of Renewable Energy Sources (RES). And in that regard, EDPR's commitment to the technology is clear.

Storing Energy to Decarbonise the Planet

EDPR is committed to increasing the potential of renewable energy assets on a global scale. In its updated business plan for 2023-26, the company aims to achieve a storage capacity of more than 500 MW, mainly through batteries installed at wind or solar farms, with a smaller component made up of stand-alone assets, such as the recently acquired project in the United Kingdom. It currently has 190 MW of contracted storage capacity in North America and more than 4 MW/6.5 MWh under construction in the Asia-Pacific region.

Its most recent venture is in Arizona, in the United States. There, EDPR is revolutionising the energy landscape in the desert with an innovative solar power and energy storage project.

With 23 MWp of installed capacity and a 15 MW/60 MWh battery, this project can store up to four hours of surplus solar power for later use. The project was awarded to Mohave Electric Cooperative (MEC), a nonprofit distribution co-op in Fort Mohave, in the Arizona desert, and will enable its 36,700 members to partially replace the use of gas with cleaner energy.

With more than 54,000 solar panels, the Mohave ground-mounted system will offset more than 36,000 metric tons of CO₂ annually—equivalent to the carbon sequestered by 43,000 hectares of U.S. forests. This is the largest distributed solar generation and storage project developed to date by the EDP Group, demonstrating the company's ability to provide solutions tailored to the different needs of its customers. The Mohave project uses ATI trackers, an innovative solution in decentralised solar systems that allows the panels to follow the path of the sun throughout the day. Unlike fixed solar panel installations, this tracking system maximises energy absorption by ensuring that the panels are always positioned to capture sunlight, significantly contributing to Mohave Electric's renewable energy portfolio. The energy storage will feature AI-driven solar forecasting and advanced modeling for solar , providing added value to MEC and its members.

As construction progresses, a dedicated team must overcome the challenges of geography and extreme weather, with temperatures reaching up to 48 °C (118 °F).

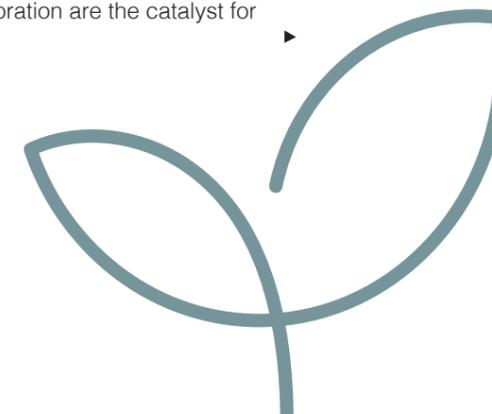
This is a significant step toward a more sustainable future, where innovation and collaboration are the catalyst for positive change.



Energy storage: The Key to the Energy Transition

The European Association for Storage of Energy (EASE) identifies six benefits of energy storage:

1. Energy storage helps meet the decarbonisation targets for 2030 and 2050 by facilitating the integration of a higher percentage of renewable energy into the grid.
2. Investment in research, demonstration, and roll-out of energy storage solutions allows the European Union to be a global leader in clean technologies.
3. Energy storage helps infrastructures, regions, and islands that are heavily dependent on fossil fuels to transition away from coal and intensive energy use.
4. Private energy storage solutions enhance energy efficiency and optimisation, and boost citizen involvement.
5. Energy storage supports the decarbonisation of transportation and mobility, helping the European Union achieve its carbon neutrality ambitions.
6. Energy storage increases flexibility over even longer periods, with direct impact on the decarbonisation of the European economy.





Some 1,200 kilometres (750 miles) further west, in California, EDPR has invested in the Sonrisa Solar Park, with a PPA for 200 MWac and 40 MWac of storage. In addition to these more robust and ambitious new projects, “there is a [Biden] administration that is more favourable to the environment and to renewable energy, and we are expecting more incentives for energy storage,” says Pablo Berruecos, head of energy storage analytics at EDP Renewables in North America. “In the Texas energy market, the so-called Electric Reliability Council of Texas (ERCOT), there was 1 GW of energy storage installed in 2020 alone, and 8 GW in the following three years.”

In Europe, the company's latest project, signed this year in the U.K., represents a strategic step toward optimising resources and improving energy efficiency. It is the first stand-alone energy storage project in Europe.



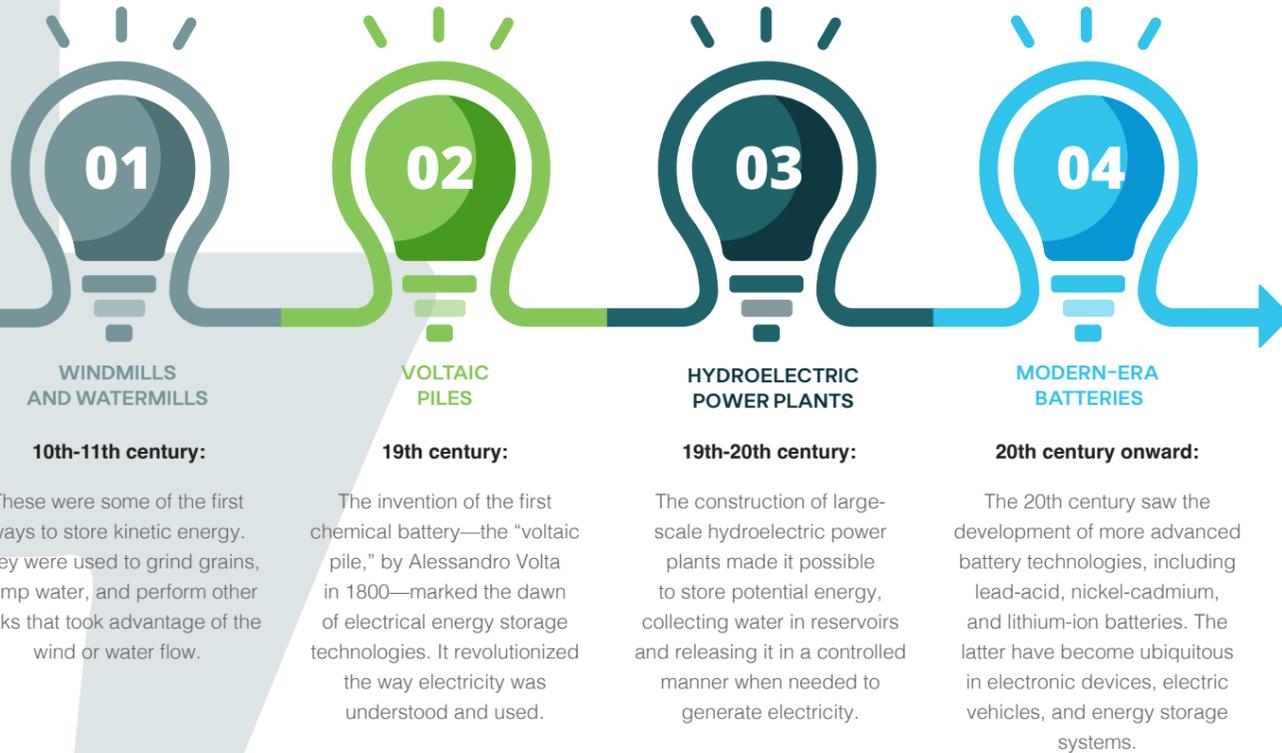
Mohave is the largest distributed solar project in the U.S., with 23 MWp of capacity and a 15 MW/60 MWh battery.

The project will contribute approximately 50 MW of capacity to the electricity grid and guarantee two hours of storage capacity. It will also play a crucial role in grid management, offering flexibility and shoring up the British government's strategy for renewable energy. This first energy storage system developed by EDPR will be located in Kent, England. It was bought from Tupa Energy, a British company that specialises in utility-scale battery storage, solar generation, and other technologies. The project is expected to be operational by the end of 2024.

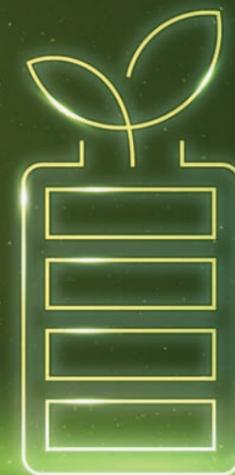
Energy storage is a high priority in EDPR's long-term strategy. The company expects significant growth in this technology, particularly in the U.K. Thanks to a favourable regulatory framework, the British market stands out as the most advanced in Europe in the development of battery-based storage assets. At present, the U.K. already boasts 3.3 GW of grid-connected battery projects, with a further 2 GW under construction. ▶

The History of Energy Storage

The need for energy storage has a rich and diverse history that goes back many centuries. Here are some significant milestones:



Challenges for the Future



Despite significant progress, energy storage continues to come up against challenges, such as the need for cheaper and more sustainable technologies, as well as large-scale storage systems to meet growing demand. However, research and development continue, with technological innovations pointing to a more efficient future.

The frenzy of ideas around and technologies related to batteries is evident in the number of patents that have been issued in recent years. According to the International Energy Agency (IEA), more than 65,000 patents relating specifically to energy storage have been filed worldwide since 2000, with Japan, South Korea, the European Union, the United States, and China leading the way. Between 2005 and 2018, the number of patents rose by 14% annually, a rate that is four times higher than in the technology sector as a whole. Nevertheless, according to “Energy

Storage Targets 2030 and 2050,” a review study published by the EASE, “storage deployment in Europe must increase to at least 14 GW/year to meet a target of 200 GW by 2030. By 2050, at least 600 GW of storage will be needed in the energy system, more than two-thirds of which will be provided by power-to-X-to-power technologies.”

The study concludes that “Energy storage must become a political priority alongside renewable energy. Without a complementary storage strategy and the expansion of market-ready energy storage technologies, the EU will not be able to achieve a net-zero emissions energy system and risks continuing to be exposed to the volatility of fossil energy markets.” The fact is that energy storage is a cornerstone in the construction of a more sustainable energy future. And EDP is playing a key role in the 24 markets where it operates.



Generation

Pumped storage represents 90% of the planet's electrical energy storage

EDP Generation has two different storage technologies at its disposal: pumped storage, operating on a larger scale and more mature technologically; and battery-based storage, included in hybridisation projects.

In addition to producing renewable energy, hydroelectric power plants contribute to the flexibility and security of the electricity system, promoting more efficient management of the power grid during peak demand or periods when other non-dispatchable sources—such as solar and wind—are not available.

In addition to other features, dam reservoirs have the capacity to store energy—whether long term, between seasons, or for shorter periods, in some cases in the form of pumped storage.

Pumped storage is done in hydroelectric power plants equipped with reversible turbines, making it possible to use surplus energy—which is not being fed to the grid and used by consumers—to pump water in the opposite direction to production and thereby refill the upstream reservoir. That water is stored until consumption justifies putting the turbine back in generation mode.

EDP Generation in Portugal, Spain, and Brazil operates 68 hydroelectric power plants, with a combined installed capacity of around 7,000 MW. In the Iberian Peninsula, 10 are equipped with reversible turbines. Dams are true drivers of the energy transition and one of the key focuses for EDP on its path to becoming a 100% green energy company by 2030.

Furthermore, hydroelectric power can be considered a sustainable and with low emissions source of electricity, especially if it follows certain fundamental principles of planning, design, construction, and operation.

EDP Generation is currently exploring opportunities at the Iberian level to boost the use of this technology, studying the optimisation of existing pumped-storage systems, power increases, and conversions.

This work is being carried out by the Engineering Department and Hydropower Asset Optimisation and Management Department teams. It includes surveying operations throughout the Iberian Peninsula, evaluating conventional and/or more sophisticated solutions, as well as the detailed study and execution of the resulting projects.

There are two projects currently underway: the conversion of Alto Lindoso, which involves replacing a conventional turbine group with a reversible one; and the optimisation of the Torrão reversible turbine, which involves the replacement of the drive wheel to increasing efficiency in both turbine generator and electric pump mode.

Pumped storage accounts for almost all of the planet's energy storage: 100% water, 100% natural.

Battery Storage and the Alqueva Floating Solar Power Plant

We now know that battery storage systems are a vital component of any flexible energy generation system.

The incorporation of a battery storage system in the Alqueva's Floating Photovoltaic project was decided with the understanding that the market design would have to evolve to incorporate these and other new renewable generation assets. The main objective was to test its compatibility with the 5 MWp FPV platform and with the hydroelectric power generation and pumped storage system.

The various components of the Alqueva storage system were developed in partnership between EDP Generation, Hitachi Energy, Chinese battery manufacturer CATL, and renowned U.S.-based EPC.

Alqueva's multi-functional batteries could cover up to 10% of the floating facility's daily production, in daily loading and unloading cycles.

At the moment, the electricity generated by the floating platform feeds Alqueva's ancillary systems and is sold on the market. The installation of the batteries in this solar-hydroelectric system will provide the opportunity to test a wide range of functionalities. The results will become a learning experience and a benchmark for future projects.

Once this system has been assembled and put into operation, the entire plan made in 2019 will finally be realised: a solar power plant and a battery-based storage system in the natural environment of a hydroelectric power plant, sharing the same grid connection point.

The Floating Solar Power Plant project in Alqueva involved a lengthy studying and licensing phase and prompted new legislation. It was the first Portuguese project to be officially recognised as a hybridisation and opened the door for many more to come. ▶

Algorithm-Driven Batteries

In addition to delivering energy to the grid, the batteries will be able to work in various operating modes. A decision-making algorithm will be used to choose the most economically rational mode at each moment:

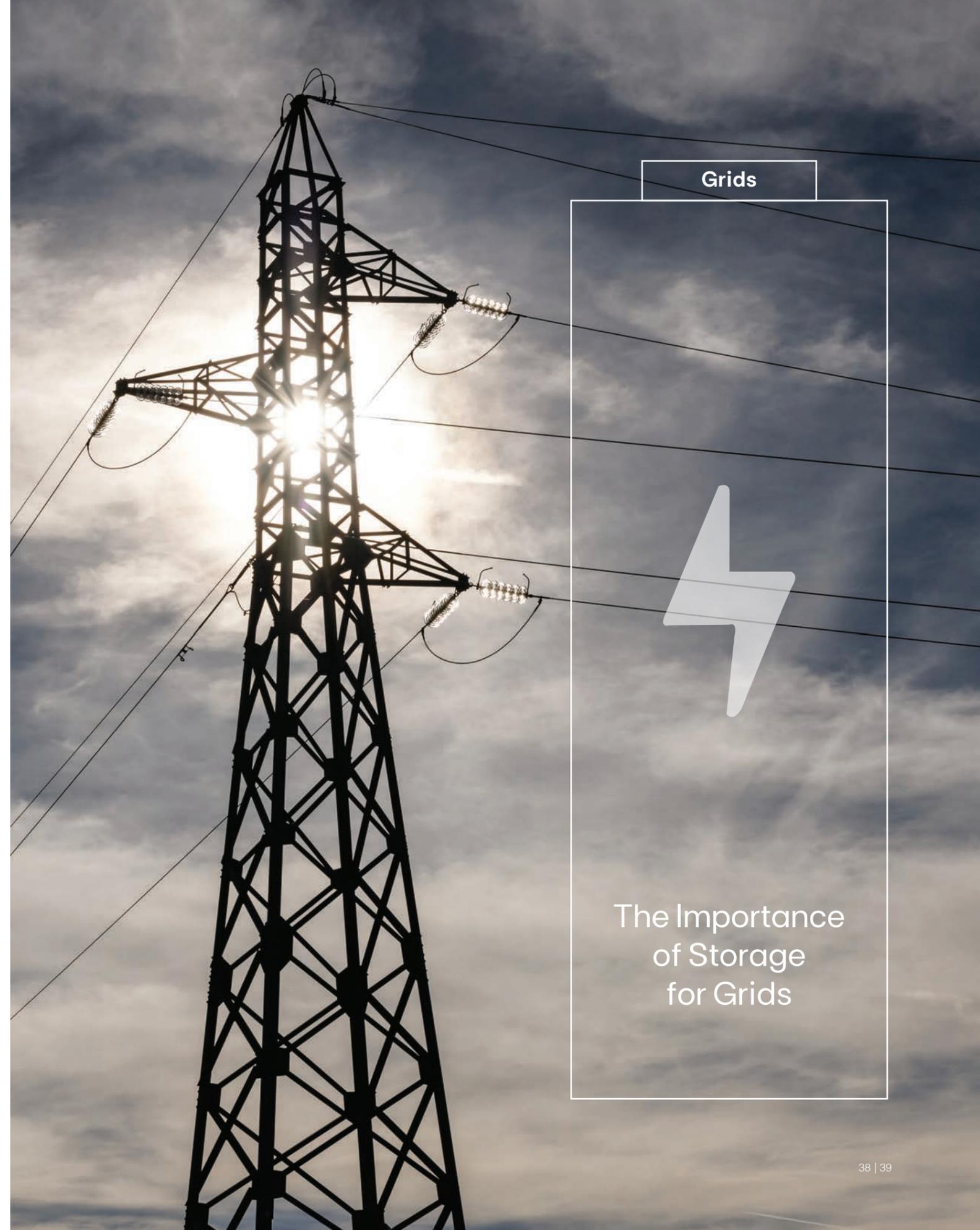
- **Price arbitrage:** Buying and selling energy to the grid to take advantage of the price difference, as happens with pumped hydroelectric energy storage facilities.
- **Solar plant load shifting:** Similar to the previous mode, it allows energy that would otherwise be sold at very low prices to be stored and fed into the grid when prices are higher (during peak demand).
- **Market deviation minimisation:** In this mode, the short-term storage battery can be used to smooth out the production curve of the floating solar plant, ensuring that short-term production variances—due to weather conditions, for example—are compensated for.

In addition, the battery can also be programmed to meet the power plant's ancillary consumption.



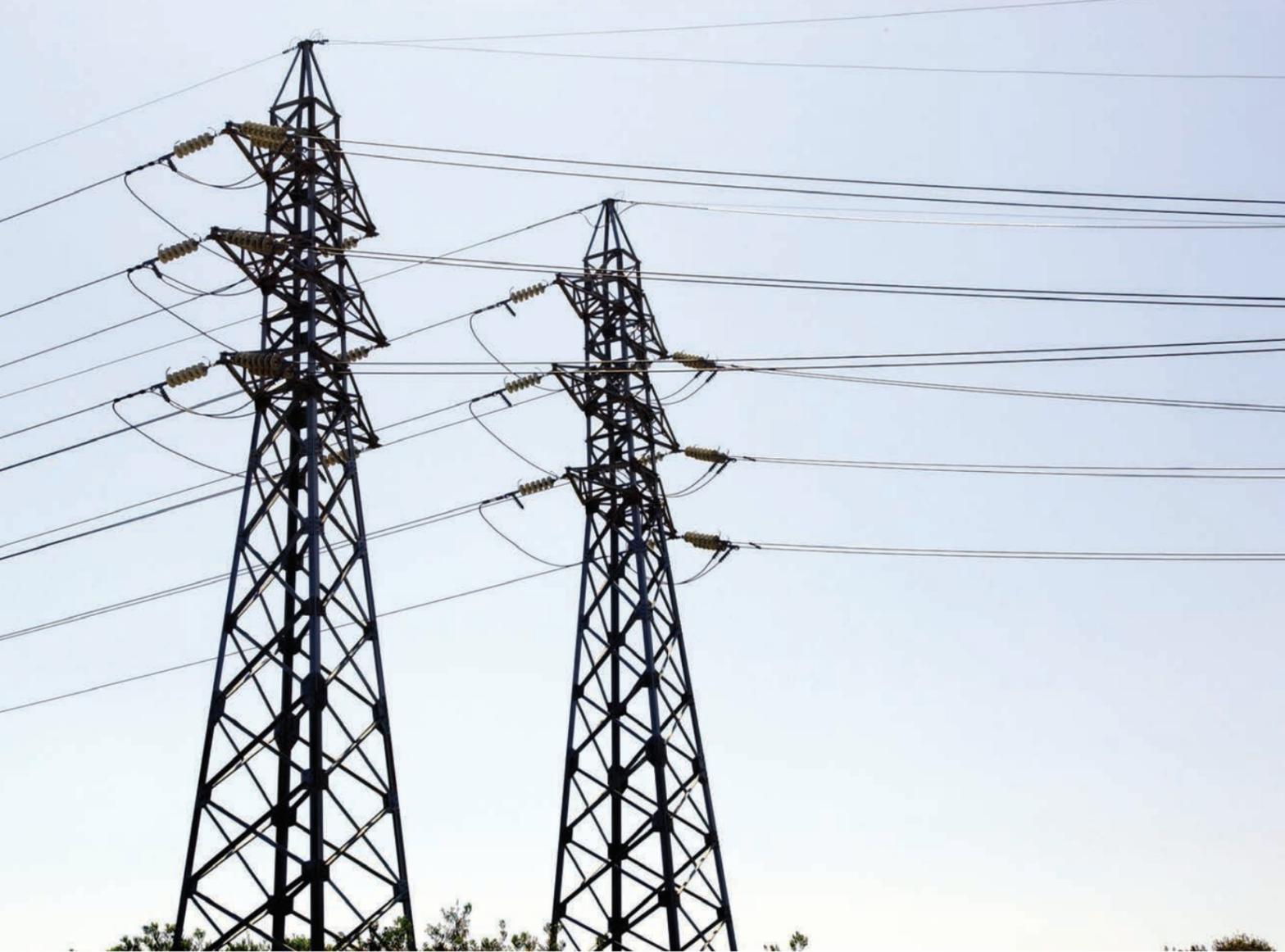
Battery characteristics

Storage capacity	Battery Racks
2,6 MWh	7
1 MW of rated power	2 inverters



Grids

The Importance of Storage for Grids



“The grid has to be very flexible and it has to have tools that allow it to be flexible. Batteries enable it to be just that.”

new ways of producing lower amounts of power, in the context of cogeneration or generation from renewable sources, have emerged.

But if these technologies require less space, the connection of these various distributed generators ends up having to be located where the grid is closest. And that was not something that was considered from the beginning, because the Portuguese and Spanish ultra high voltage transmission grid operators (REN and REE, respectively), had no way of knowing how things would evolve when they set up the system.

To use an analogy, the transmission grid works like a kind of electricity highway, which is connected to all kinds of roads and even dirt tracks. E-REDES is the company that manages the flow of the distribution grid through all those back roads, and the challenge now is to have the capacity to accommodate all the electricity coming from the new sites using systems that, in most cases, are not ready for it.

Pedro Godinho Matos, head of business development at E-REDES, says that “if we have a lot of generation coming from a place where the grid has limited capacity, there are going to be constraints.” To use the traffic metaphor again, those back roads do not have the same capacity to carry electricity and there is no easy way of controlling how many vehicles are traveling on those dirt tracks.

“There are two ways to solve grid congestion: build more grid; or be more flexible, find ways to ensure that those who want to travel along the road can do so at a time that is more useful from the point of view of the grid managers,” he explains. “If everyone wants to go from Lisbon to the Algarve at the same time, we know that the road is going to get jammed. The solution is either to build a new road just for those occasions, which isn’t very efficient because most of the time it will be empty; or you can hire flexibility and, in that case, the example is to pay someone to stop for a coffee, or to stay at home and not go until the next day.”

In the case of electricity, the solution could be to give incentives to those who want to use the grid in order to adapt their behavior and make sure the grid is able to respond as effectively as possible to the incentive. In other words, it is not about not using or cutting back on energy consumption, but rather consuming it at times when the grid infrastructure—which is paid for by everyone—can handle everything

that is needed, avoiding those peaks in demand.

“The aim of E-REDES is not to stop anyone, but for the traffic to flow,” says Pedro Godinho Matos. “All requests are accepted. We just need to hire someone to help organize that ‘electricity traffic’.”

In the specific case of solar power, at peak sun, there are a number of power plants generating a substantial amount of electricity. The substations, however, do not have the capacity to absorb all that energy. So, either you build twice as many substations (which is unthinkable, given the cost) or you find a way to store energy at peak times, so that it can flow through the existing infrastructure later on.

“It’s much more efficient to maximise the use of what we already have, because the infrastructure is already in place, with no additional costs,” he explains. “The grid has to be very flexible and it has to have tools that allow it to be flexible. Batteries enable it to be just that. The issue is that, for now, storage is still expensive.

Who wants to spend millions to store only a few euros worth of energy?”

The reality is that, following a decade during which generation from renewable energy sources has not increased by more than around 10% a year, the figures in the revised Portuguese National Energy and Climate Plan for 2030 suggest that the amount of energy flowing through the grid could potentially double. It is a tremendous growth that represents a major challenge for everyone involved. All of this electricity must be absorbed. And that means more grids and more flexibility to reach every corner with no New Year’s Eve blackouts.



Everyone knows that on Dec. 31 at 11:59 p.m., the telecommunications networks essentially grind to a halt. There are too many calls wishing a Happy New Year, so people have become used to calling five minutes before or five minutes after midnight. But suppose the same thing happened to the power grid. Would anyone just agree to being left in the dark? When it comes to electricity, the system must remain in operation no matter how high the demand.

In a world with ever growing consumption needs, electricity is increasingly in demand. And regardless of how it is produced, one thing is for sure: it needs a grid to get to us. Power transmission and distribution systems have undergone little or no change in the past, but with the large-scale integration of renewable energy into the grid and more decentralised generation, that paradigm is about to be turned on its head.

Power grids were born out of the need to bring together those who generate and those who consume electricity. Historically, it was generated in large power plants, which were usually located in isolated areas, spewed out a lot of smoke, and gave off an unpleasant smell. Then, this mass-produced electricity had to be delivered, especially to cities, where demand was most concentrated.

The energy transition is changing this paradigm. Today, there are almost no thermal power plants left. Electricity is generated in a fully distributed way, wherever there is space to set up wind turbines and solar panels. The number of producers has grown significantly, and

Clients Solutions



Residential and Corporate Solutions

The world is witnessing a transformation in the way we consume, produce, and store electricity. In anticipation of this revolution, EDP offers its clients a comprehensive package that goes beyond purchasing a solar power solution. With monitoring systems, maintenance, batteries, and integrated solutions to respond to flexibility opportunities, the company is providing a more holistic view of electricity generation, distribution, and consumption.

In a scenario where, by 2030, 25% of energy storage solutions worldwide are expected to be installed in homes and businesses, EDP is well positioned in this sector. The €6 million investment in **GridBeyond**, a company specialising in consumption optimisation (see box), demonstrates the EDP Group's commitment to developing innovative solutions to meet the challenges of the energy transition. ▶

By 2030, 25% of energy storage solutions worldwide are expected to be installed in homes and businesses.

GridBeyond: from startup to global player

Founded in 2007, GridBeyond is a pioneer in the use of demand-side response and battery technology to manage flexibility for industrial and business clients. In just over ten years, it has grown from an Irish start-up into an award-winning, globally recognised company that promotes the energy transition in the sector. It provides services to more than 400 commercial and industrial sites, including some of the world's most recognised brands. It already operates in Ireland, United Kingdom, United States, and Australia—and it is now expanding into the Japanese market.

In 2020, EDP Commercial invested €6 million in GridBeyond. This investment represents the EDP Group's commitment to the most dynamic energy market in Europe, with an innovative service that promotes the stability of the power grid by optimising clients' consumption and energy efficiency. The decision to invest in GridBeyond—a finalist of the Free Electrons program—is in line with EDP's strategy to lead the energy transition by investing in a growing area that is key to the future of the sector: demand-side flexibility management services.

GridBeyond develops solutions that enable the delivery of smart ancillary services by acting remotely on flexible loads that are available in end-user industrial plants or facilities. Examples of flexible loads include large furnaces, refrigeration systems, and even HVAC systems that can be regulated remotely and marginally, without impact on the final production. In return, clients are compensated for their participation in the local wholesale energy and ancillary service market, benefiting from reductions in their energy bills.

In terms of B2C, EDP has already installed more than 3,500 batteries in the Iberian Peninsula, with 36% in Portugal and 64% in Spain, for a total installed capacity of more than 20 MWh in 2023. Although sales of battery-based solutions account for only 5% of total solar sales at the moment, their impact is remarkable.

Clients who have adopted EDP's solar + battery solution in the Iberian Peninsula have obtained an average reduction of 63% in their grid consumption, representing an average annual saving of €1,000. This success highlights not only the efficiency of the technology, but also the tangible saving potential it offers clients.

Driving Innovation in Business

In the corporate segment, Italy is a good example of how energy storage solutions are gaining traction. In 2023, the average number of solar + battery installations for EDP Energia Italia's business clients is already three times what it had been in 2022. This includes success stories like those of Pan Chemicals S.p.A., with 909 kWp of solar capacity and 186 kWh of daily storage, and Borghi Assali, with 350 kWp and the same storage capacity.

Businesses that opt for these solutions are not only fostering their energy independence from the grid, but also seeing significant savings and reducing CO₂ emissions. Pan Chemicals S.p.A. is expected to save €19,000 a year from energy storage alone and reduce CO₂ emissions by 422 metric tons, while Borghi Assali projects savings of more than €25,000 and a reduction of 112 metric tons of CO₂ annually.

More than 3,500 batteries have already been installed in the Iberian Peninsula, with a combined installed capacity in excess of 20 MWh by the end of 2023.

Strategic Partnerships

EDP is not alone on this path to cleaner, more efficient energy. Its partnership with Huawei in Spain represents a significant step toward boosting the residential battery market. Incorporating 5 kWh batteries into an average solar installation allows energy independence of 90% to be achieved, resulting in annual savings of more than 1,400 euros and a 90% reduction in energy consumption.

With the aim of equipping one in every four solar installations in Spain with batteries by 2024, EDP is leading an energy revolution in the residential market. The incentives under the Spanish Recovery, Transformation, and Resilience Plan for residential batteries, with subsidies that can save up to 70% on the cost of installation, provide a way to make a quick return on the investment.

The truth is that EDP is not just delivering electricity. The company is leading the transformation toward more sustainable, efficient, and independent energy. Every client who adopts an EDP energy solution is helping build a greener, more resilient future.

Residential Clients

Partnerships That Transform the Future of Electricity

EDP and Huawei join forces for sustainable transformation

At the heart of the energy revolution, EDP and Huawei—a leader in technological solutions—have forged a partnership that marks the next step in the evolution of solar self-consumption. This deal, signed in November 2023, aims to boost the smart battery market in Spain, transforming not only the way we consume energy, but also how we store and use it.

Adding batteries to solar self-consumption installations is not only an environmentally conscious choice, but also a smart financial move. In addition to the autonomy provided by these innovative batteries, the savings can also be substantial, amounting to more than €1,400 per year.

In a typical solar power installation, unused energy generated during the day simply dissipates into the grid. But by integrating a Huawei Luna battery, this excess energy can be stored for use during the night. The result is unparalleled energy efficiency, with the potential to reduce dependence on the power grid by up to 90%.

A typical 4.1 kWp solar power installation by EDP generates around 5,600 kWh/year. With 50% going to self-consumption and the rest fed into the grid, the addition of a 5 kWh battery turns the whole scenario on its head. Imagine reaching 90% energy independence, with annual savings of more than €1,400, a 90% reduction in power consumption and a 90% reduction in your total bill.



Corporate Clients

Solar as a Service (AAS): A Sustainable Revolution for Businesses

Solar AAS accelerates the adoption of distributed solar generation by EDP. This flexible model ensures a smooth transition to solar power, with no upfront investment required from clients. EDP takes on the cost of installation and provides end-to-end services across Europe, including 24/7 maintenance, monitoring, and control of the photovoltaic systems throughout the contract. After a 15-year period, clients can opt to take ownership of the installation and continue to benefit from it for the remainder of its expected 35-year lifespan.

The addition of energy storage batteries to self-consumption installations significantly amplifies the advantages. Instead of being directly injected into the grid, surplus solar energy is stored for future use, optimising the efficiency of solar generation. This integrated solution reduces dependence on the grid, increases energy savings for clients, and reduces carbon emissions. Once the battery reaches maximum capacity, the surplus can be injected directly into the grid, providing clean energy to other homes and businesses.

EDP has recently teamed up with Exide Technologies, a leading provider of electrical energy storage solutions for industries in more than 80 countries, to install two solar PV power plants with integrated storage solutions at its facilities in Portugal. The partnership also resulted in a new installation in Spain.

That photovoltaic installation has a capacity of almost 1 MWp and is made up of 2,000 solar panels. It generates approximately 1,500 MWh of electricity annually—equivalent to the average consumption of more than 360 families. To ensure optimum performance, the power plant is equipped with an advanced energy monitoring system that provides real-time tracking and analysis of the electricity generated.

In Portugal, the Azambuja-Castanheira do Ribatejo installation has a combined capacity of 4.5 MWp and is supported by Exide's advanced energy storage system, which provides 500 kWh of storage.

With more than 11,000 PV panels and 70 inverters, this is one of the largest decentralised solar facilities for self-consumption backed by an energy storage system in Europe—and the largest solar + storage installation created by EDP in Portugal. The combined output of these two installations generates enough electricity to supply more than 1,500 families and reduces carbon emissions by more than 20%, the equivalent of more than 2,600 metric tons of CO₂ per year.

The units were contracted under an AAS model, with EDP overseeing the operation, maintenance, and real-time monitoring of the installation for a 15-year period, cementing the commitment to long-lasting relationships that benefit all parties. //



Ground-mounted solar PV installation at Exide Technologies, Lda, Portugal

What is the impact of the AAS model on the business?

- **Sustainability:** Solar energy is clean and practically inexhaustible, which significantly reduces the carbon footprint and meets the regulatory requirements for decarbonisation.
- **Energy independence:** Businesses can significantly reduce their dependence on the power grid, minimising exposure to price fluctuations.
- **Cost savings:** The return-on-investment period ranges from 4 to 6 years. Under the AAS model, clients can switch to solar power with no upfront investment, benefiting from significant reductions in their electricity bills.
- **Product durability:** Solar panels have a lifespan of around 35 years and are versatile and easy to maintain, suitable for large and small-scale installations.

SOLAR POWER PLANT WITH ENERGY STORAGE

How does a solar + storage installation work?

- 1 The solar power plant generates electricity
- 2 The client installation consumes electricity generated by the solar power plant
- 3 If generation exceeds consumptions, the surplus is stored in the battery
- 4 When the battery is fully charged, the surplus is injected into the grid
- 5 When consumption exceeds generation, the battery discharges the electricity stored to be used by the installation



The solar power plant will produce electricity to be used on site, stored, or injected into the grid, depending on consumption needs.



explore.

“Each person’s well-being
journey is unique”

Andi Campbell

President of WellSpark Health



For the fourth year in a row, EDP has launched a new edition of the global Mind your Mind campaign, in which the focus has been on promoting psychological safety in teams, demystifying prejudices and publicising internal support mechanisms. We spoke to Andi Campbell, a specialist in mental health at work, who shared some best practices.

What steps can organisations take to foster a culture prioritising mental health and well-being among employees?

The decisions we make as leaders have a great impact on our employees' well-being and mental health. Prioritise honest, open communication. Communicate early and often, especially about change, to ensure people have time to ask for help when they need it.

Can you share some personal experiences or insights that led you to become passionate about promoting work-life balance in the workplace?

I once worked with an employee who couldn't afford her medication for depression as a result of a change we (the employer) made to the company's health benefits. This was heartbreaking and have since that time stayed steadfastly committed to helping employers prioritize wellbeing at work.

In a post-pandemic world, in your opinion, what are some common challenges employees face in maintaining their mental health and overall well-being in the workplace?

I think employees often struggle with setting and keeping boundaries, especially if they are working remotely (from home). Creating and keeping fixed work hours can be difficult (and that can lead to stress and burnout). Research is telling us that there's a demonstrated link between social support at work and lower rates of burnout, greater work satisfaction, and absolute productivity. People crave connection. Connection is the energy that's created between people when they feel seen, heard, and valued.

What strategies or practices have you found effective in managing mental health while maintaining productivity and engagement at work?

Set and keep boundaries, and make time for things that bring you joy. Stop for a few minutes for deep breaths, take a walk around the building (or neighborhood) at lunch, or even have a "walk and talk" meeting (using phone vs computer/video). I think we've been faced, societally, with this definition of balancing things, work, and life. What does that mean to you? I think that your work, your career, and your ambitions must fall into the same kind of equilibrium as other things in your life. Cooking, relaxing, leisure, spirituality, ►

exercise, hobbies, parenting, whatever it is for you, work is a part of your life. And I like to call this living whole. I don't really want someone at the end of my life to stand up at my funeral and say, gosh, she gave all these extra hours, or she missed dinner with her stepson so that she could finish that PowerPoint deck. That's certainly not what I want in my life, and I don't imagine that's what you want, either.

How can managers be better equipped to recognise and address mental health issues within their teams, and what training or resources can help them?

Know what benefits EDP has available to employees and how to point people to them. Managers don't have to have the answers, but knowing where people can get help is essential.

What role do open communication and destigmatising mental health play in creating a healthy workplace culture?

I think people sharing their honest experiences brings more "human" to the workplace. The more people can hold space for other people's experiences, the more likely people are to feel comfortable/safe asking for help.

Lastly, what advice would you offer to individuals and organisations looking to initiate positive changes in work-life balance, mental health support, and overall workplace culture?

Be honest about your experience and try not to compare. Each person's wellbeing journey is unique and what's right for some may not be right for others. Get informed about what resources/benefits are available to you (and use them). Cultivating a culture of wellbeing starts at the top – respecting people's time and creating space for people to ask for help are some ways organisations can make positive change. //

“The fact that people share their experiences in an honest way makes the workplace more ‘human’.”

Taking an extra moment to watch your child when you drop him/her off at daycare/school.

Asking your spouse/partner/colleague how his/her/their day was and actually listening to the answer.

mindyourmind

Wellbeing could look like...

Take a quick break for a short walk during a busy day.

Eating lunch mindfully without reading email at the same time.

Take an extra ten minutes in the morning to make breakfast for yourself.

Saying thank you.

Paying attention to how someone reacts to what you say.

Stopping to take a deep breath before calling a difficult employee.

Setting your phone down during meals.

Take a walk for your next meeting instead of sitting in an office.

“Silence erodes
human and
company capital”

Wendy Addison

Founder of SpeakOut SpeakUp consulting firm

Wendy Addison was working as a treasurer in an international group when she publicly denounced some transactions that seemed suspicious to her. Threatened by the executive management, Wendy not only quit her job automatically, but also set up a company that trains organisations on how to speak up and listen courageously, as well as business projects to support whistleblowers. She is a fierce promoter of speak-up and has made it her mission to encourage people and equip them with the skills to voice their concerns in the workplace. ▶



Can you share what motivated you to become an advocate for promoting speak-up cultures and psychological safety?

I wish the organisation that took my breath away but also took my voice away, had cultivated a climate of psychological safety which allowed everyone to contribute, to be heard, to be invited to integrate their knowledge. Without this, I was driven to blow the whistle externally when blind spots and slippery slopes catalysed into corruption.

What, in your opinion, defines a strong “speak-up culture” within an organisation, and why is it so crucial in today’s workplace?

A ‘speak-up culture’ is mission critical in today’s knowledge-based economy running through many regulatory and social frameworks. The wellbeing of our societies, our institutions and of all stakeholders is going to require the kind of world where we broaden our hearts and, minds and abilities to become capable of transferring, translating, and transforming knowledge across syntactic, semantic, or pragmatic boundaries.

A ‘speak up culture’ is one where there’s an open exploration of ideas and possibilities and involves people with varying levels of experience and authority. Such a culture nurtures wise power and cultivates intellectual courage and humility in order to grab hold of the new. A ‘speak-up culture employs diversity across many variables. Being able to disagree better across different opinions and generative dialogues is one of the clear signs of diversity outside of race, gender, orientation etc Harmony is the pleasing arrangement of different tones, voices, or instruments, not the combination of identical sounds. Creative tension makes beautiful music. Demonstrate, make visible and become more public about the speak-up behaviours you want to see.

What strategies or best practices are crucial for organisations to adopt to create an environment where employees feel safe to raise ethical concerns and advocate for a strong speak-up culture?

The alignment of the formal and informal systems is one of the most important aspects of organisational culture. For example, a Code of Conduct is a formal element of a company’s culture, often seen as an expression of the values by which the company and its employees shall work and live. How the employees abide by those values and comply with the Code is the informal system at play. Change the conditions in the organisation so that employees don’t think it requires courage just to do many of the basic workplace tasks. That is possible through the Triple S framework.

“People in psychologically safe teams have a greater sense of inclusion and contribution to the organisation, which increases employee retention and engagement.”



The Triple S framework:

S = SELF

Model the behaviour you would like to see in others – do you speak-up about yourself, do you admit to making a mistake, apologising, taking responsibility?

S = SITUATION

Intentionally cultivate psychological safety. How you handle your most annoying co-worker might be a sign of how much psychological safety there is.

S = SYSTEM

Ensure there’s active alignment on leaders being clear on following the rules and using strategies on how to show up.

Actively cultivate courage by making friends with what you don’t know. We can’t vow to become courageous and resilient through mere words. Courage develops from the rope of experience that is thrown to us through pop-up opportunities that come our way every day – grab that rope.

Can you provide examples of how psychological safety and ethical behaviour go hand in hand and how they mutually reinforce each other within the workplace?

The failure of an employee to speak up in a crucial moment cannot be seen. Because NOT sharing a concern is an invisible act, it’s hard to engage in real-time course correction. The case with the catastrophic failure of the heat-shielding systems on the space shuttle Columbia in 2003, which cost the lives of all seven astronauts aboard when the vehicle

exploded, is a tragic example of a lack of psychological safety. Taken together, the cognitive, organisational and interpersonal context in which the NASA team was working reinforced a natural tendency to downplay the potential danger of an ambiguous threat—something that might or might not cause serious harm, as opposed to an obvious, immediate risk. Facing an ambiguous threat is a “leadership moment of truth. It’s crucial at these junctures to gather input from as many perspectives as possible. This means that leadership needs to create opportunities for all parties who have diverse points of view to speak up – especially when that might mean potentially bad news.

Could you provide insights into the potential consequences when organizations lack a culture that promotes speaking up, both for employees and the organization itself?

When employees are not empowered or encouraged to speak up and listen up the risks and costs of silence can be higher than any other costs. That’s because silence erodes human and company capital.

Bad news doesn’t get better with age. Without the ability and support around speaking up, and listening up, certain attitudes, conversations and behaviours not only allow problems to perpetuate, but the silence also

normalises certain attitudes and allows to them to prevail and escalate.. Businesses in the receipt of sugar-coated information may begin looking for the ‘next home run’, new acquisitions, new products and neglect the real issues that have not been spoken about. When people know they are part of a collusive environment where speaking up is unwelcome, they hide parts of themselves out of view. This is significantly corrosive and impacts a person’s well-being, self-development and growth, possibly for the rest of their lives. The next time you see your colleague turn a conversation about a problem into the “person” raising the problem, you can gently nudge with a question: is it their problem or ours to solve? Be brave enough to suck when something is new. A leader who can correct when people bring them issues is a leader who helps the company and its employees succeed. //

“A leader who can correct when people bring them issues is a leader who helps the company and its employees succeed.”



A Journey to the World of Energy

Photos by: Francisco Nogueira

There's a new tour to take at MAAT Central, as the century-old Central Tejo power plant has been renamed. A dynamic and interactive exhibition space that invites you to discover the history of energy, from the past to our collective future, with a focus on the challenges of energy transition and sustainability.

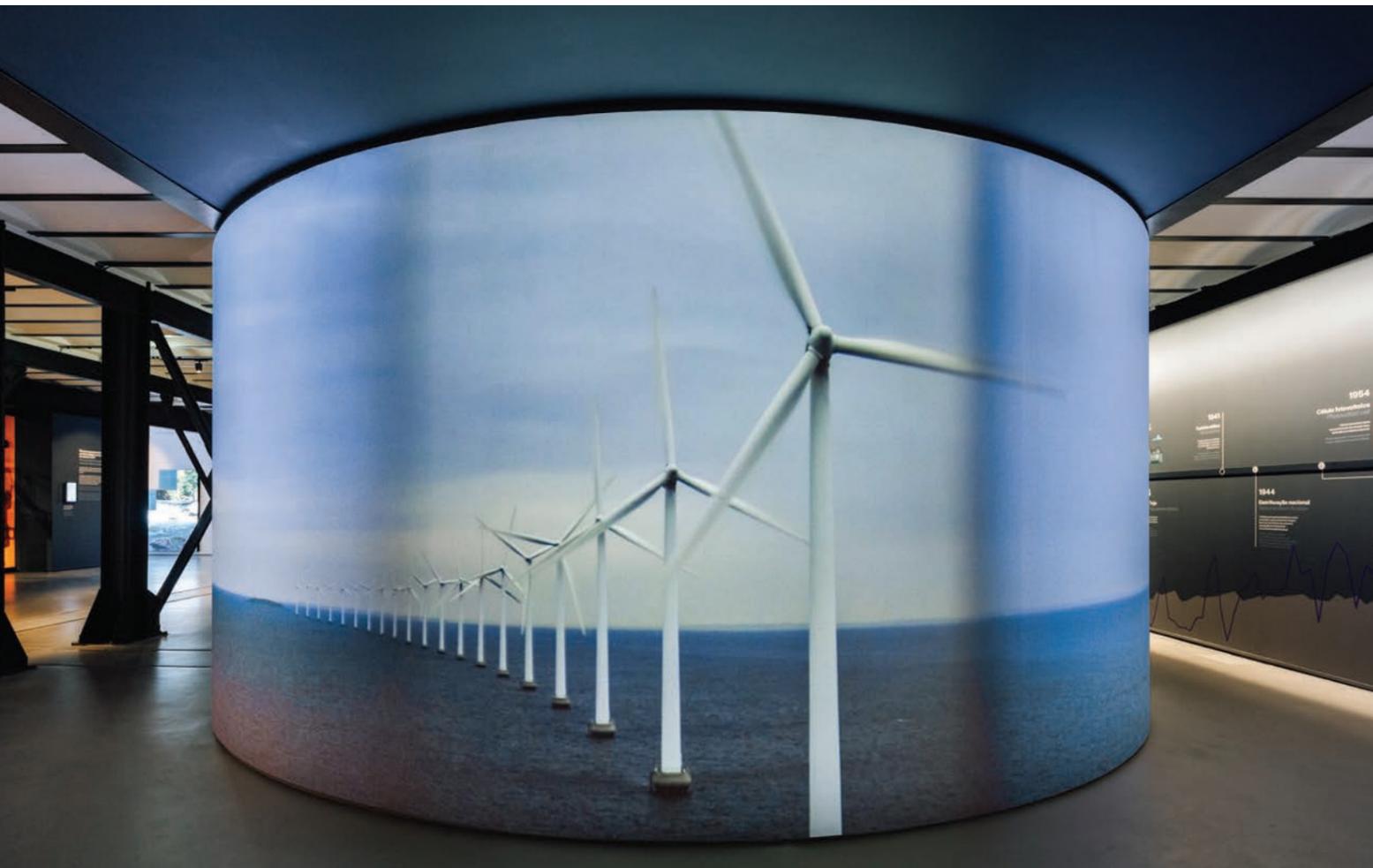


MAAT Central, in Lisbon's waterfront, takes visitors on a journey from the development of the steam engine to the challenge of decarbonisation and the role of renewable energies. The tour begins around 100,000 BCE, when we learned to control and use fire, and goes all the way to 2050, the timeframe of the Paris Agreement to keep the rise in mean global temperature to below 2 °C above pre-industrial levels - and preferably limit the increase to 1.5 °C. It's a narrative told through a variety of content, including audiovisual media, quizzes, fun facts, and hands-on experiences.

Visitors are then confronted with a clear message: in order to combat climate change, we must urgently move away from fossil fuels and towards renewable energies. That is why they are also invited to explore the origin, shape, and scale of each of those sources: hydroelectric, tidal, biomass, geothermal, solar, and wind power.



Once at the heart of the energy revolution, the question then becomes, how can we change our energy consumption habits and eliminate our dependence on fossil fuels? In this part of the exhibition, you can ride an electric bike, learn about electric charging systems, see the Enfield 8000—the first electric vehicle to come to Portugal in 1975—and use a console that lets you measure your daily carbon footprint.





The final stage showcases the world of the future that is being built today: one that is more renewable, more efficient and more sustainable, with new green fuels, all-electric railroads, smart grids, self-driving electric vehicles, and buildings with efficient energy management. A number of organisations are already working to develop solutions, and EDP is one of them. Everyone is, therefore, invited to learn about the social projects being developed by EDP in various countries, always with the aim of promoting a fair and inclusive energy transition.

Visão de Futuro *Future Vision*



“The goal of this new space is to present an immersive history of energy, with a clear focus on EDP’s vision and ambition for a more sustainable and inclusive future. We want to invite everyone who visits MAAT Central, regardless of age, to join in this exploration of our collective future and discover how each of us can contribute to a better tomorrow for future generations,” says Vera Pinto Pereira, president of the EDP Foundation.

The new space also features a free exploration area for children who, through simple and fun experiments, can gain some scientific knowledge about, for example, energy generators and motors, magnetic fields, electricity conductors, and renewable energies. //



inspire.

Pulau Ubin

is greener than ever

Pulau Ubin, an island to the north of Singapore, had no connection to the mainland grid and relied on its 10-year-old micro-grid, powered heavily by diesel. But that's all in the past now. EDP has electrified the area with clean energy for its inhabitants and activities.



EDP Renewables in APAC has recently greened Pulau Ubin's Micro-grid with renewable sources. Situated to the north of Singapore, Pulau Ubin is an island with no connection to the mainland's power grid and was previously relying heavily on diesel.

Supported by Singapore's Energy Market Authority (EMA), EDPR was appointed to enhance Pulau Ubin's existing micro-grid with renewables technology. The enhanced micro-grid includes a 328 kilowatt-peak (kWp) solar photovoltaic system together with a 1 Megawatt-hour (MWh) Energy Storage System (ESS). The enhanced system will benefit more than 30 households and businesses, reducing the island's reliance on diesel by nearly 100,000 litres per annum, avoiding 268,000 kgs of CO₂ emissions.

An aerial view of the Solar Green Roof and Vanadium Redox Flow Energy Storage System

Impact of Pulau Ubin Green Micro-grid



Before

Diesel

Consumes 100,000 liters of diesel annually

Produces massive amounts of air contaminants, including nitrogen oxide and particulate matter

Noise pollution from diesel generators



After

Solar

Solar & battery to combat intermittency

90% of Pulau Ubin's electricity needs in Main Village is met by solar through the micro-grid

Clean, affordable and renewable energy in the long run

Aligns with Singapore's sustainability agenda to solarize the nation



Pulau Ubin Green Micro-grid

Accelerating Decarbonisation for the Local Community Through Innovation



Reduce CO₂ emissions by 268,000 kilograms per annum



Reduction of diesel consumption by 100,000 liters per annum



Benefits more than 30 households and businesses

Nuno Marinho, Head of Innovation at EDP Renewables APAC, who oversaw the development of the project

Aside from the positive environmental impact, the enhanced system also improves the quality of life for the island residents.

Two main innovative green solutions can be highlighted: First, a Solar Green Roof which consists of different types of greenery planted below the solar panels with the goal to regulate ambient temperatures and therefore optimise system efficiency by up to 4%.

Second, a 1 MWh Vanadium Redox Flow Battery (VRB) ESS is deployed to increase the reliability of the electricity sourced from the Solar Green Roof. The ESS helps to mitigate solar variability and ensures the consistent operation of the grid by actively managing mismatches in supply and demand. Notably, when compared to lithium-ion batteries, vanadium-based batteries offer a longer lifespan of up to 25 years. There is also a significant reduction in fire risks as vanadium is not flammable.

Aside from the positive environmental impact, the enhanced system also improves the quality of life for the island residents.

A resident who benefits from the enhanced micro-grid is 73-year-old Madam Ng Ngak Heng, a provision shopkeeper who inherited the business from her father-in-law. As she sells refrigerated items such as ice-cream, drinks and other chilled products, power outages would greatly affect her business. With the ESS in place mitigating the variability of the clean energy generated, she no longer has to worry about inconsistent power supply.

Sharing her thoughts on diesel generators, Madam Ng commented, "Last time, we used the generator and we had to constantly pour the diesel in ourselves. My husband did it; it was a very laborious task because the canisters were heavy."

Madam Ng also expressed, "Last time when we had generators, you can hear them all the time, but now with solar, it's much quieter."



Madam Ng with the diesel generators in her store, which she finds herself using only as backup now during power outages

Inauguration ceremony

To mark the commissioning of the enhanced system, an inauguration ceremony was held on the island in early November 2023. In attendance was Singapore Minister at Prime Minister's Office and Second Minister for Education and Foreign Affairs Dr Maliki who was the Guest-of-Honour. Industry partners and Pulau Ubin residents were also invited.



Minister Dr Maliki giving an opening address at the Pulau Ubin inauguration ceremony.

At the inauguration ceremony of Pulau Ubin's Green Micro-grid
[4th from left onwards] Singapore Minister Dr Maliki, Pedro Vasconcelos, Energy Market Authority Assistant Chief Executive (Markets & Systems) Low Xin Wei, and Filipa Ricciardi.

Green Micro-grid Innovative Solutions

Compared to lithium-ion batteries, vanadium-based batteries have a longer lifespan. Additionally, the core metal used in VRB construction can be reused and repurposed at the end of its lifespan, leading to a further reduction in waste generation.

The new **328kWp Solar PV System** produces clean, renewable energy and relies on the plants and foliage of the **green roof** to regulate ambient temperatures, optimizing panel efficiency.

Vanadium Redox Flow batteries, the size of 40ft containers, help to mitigate solar intermittency and ensure the consistent operation of the grid by actively managing any mismatches in supply and demand.



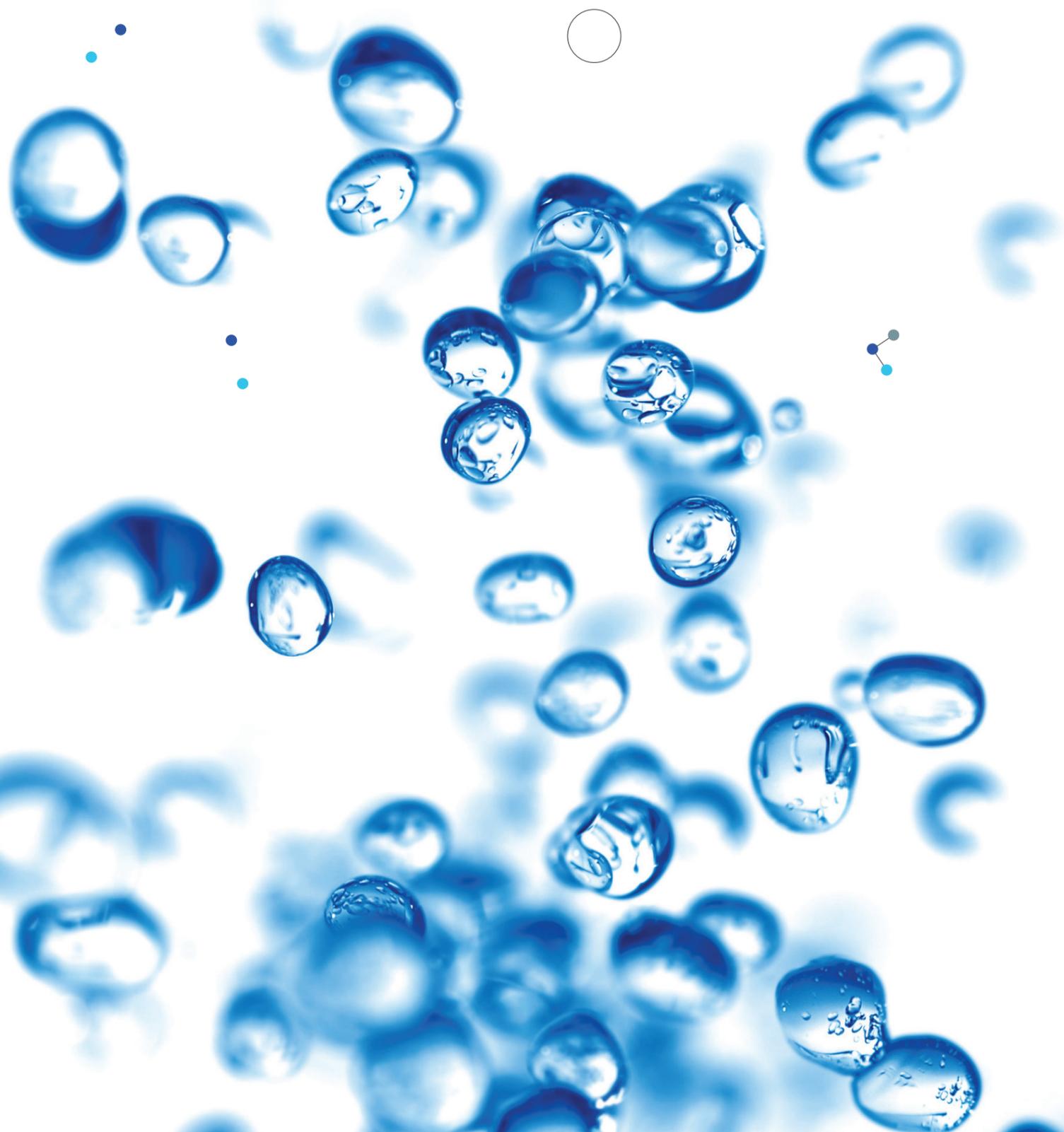
With the enhancements of the micro-grid, Madam Ng and her husband no longer have to refuel their diesel generators themselves. The usage of diesel generators also produces noise pollution, which causes disruption, especially at night.

Through this project, EDPR is also working with Singapore Institute of Technology (SIT) to research the different types of renewable energy integration and storage for future applications. Research areas include the experimental design of the Solar Green Roof, data analysis of the solar power efficiency, and micro-grid energy management system design.

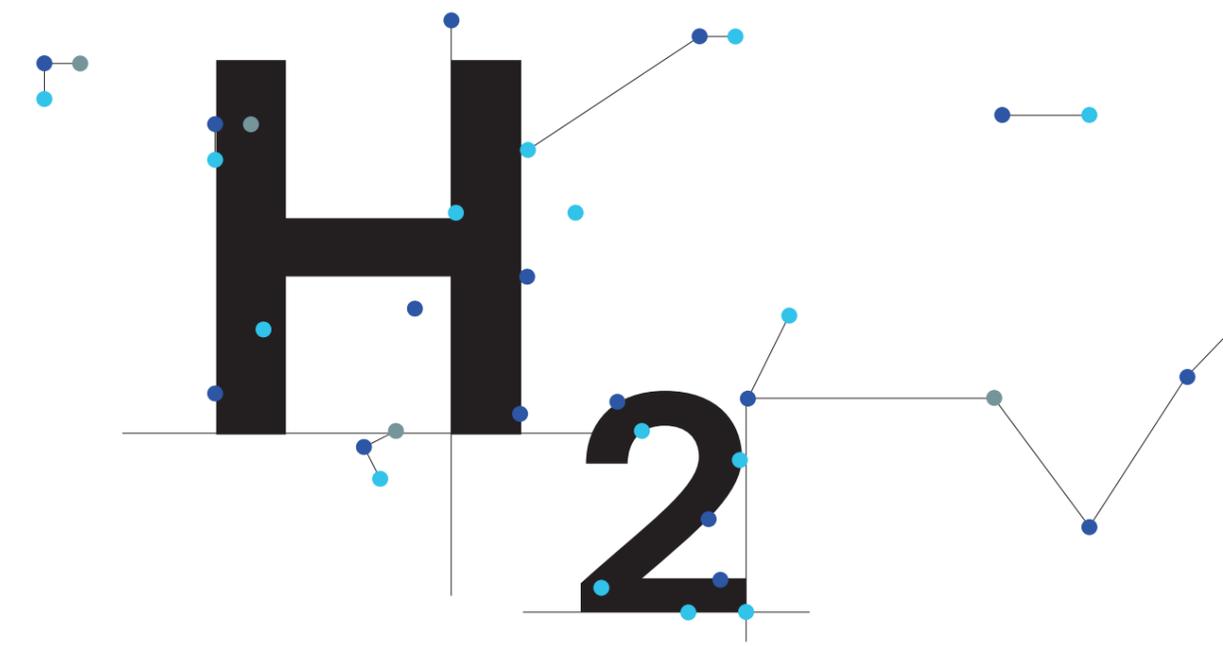
These solutions will be further researched throughout the first year of operation at Pulau Ubin, to understand their impact on this project and the replication potential on other projects in Singapore or the APAC region.

The implementation of these green innovations marks a step towards Singapore's sustainability agenda, contributing to the broader national goal of environmental stewardship and energy security.

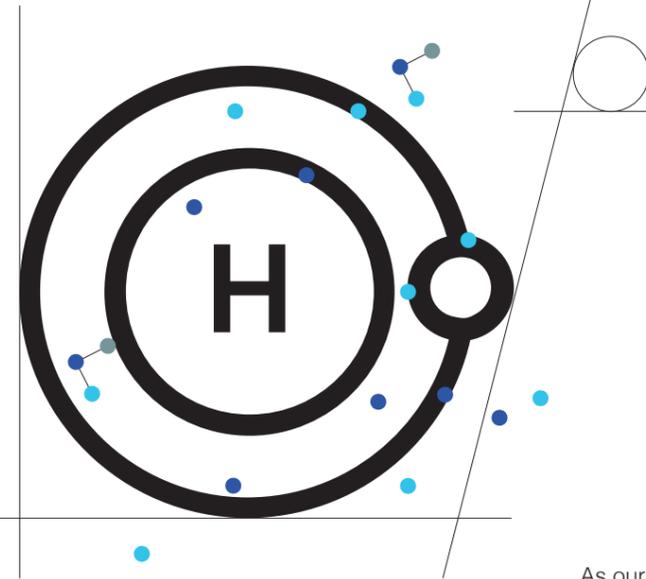
The Pulau Ubin Green Micro-grid is a replicable project for similar off-grid islands heavily reliant on diesel. The hope is for this project to stand as a sturdy reference that paves the way for the decarbonisation of other hard-to-electrify areas across the APAC region. //



Green Hydrogen: the fuel of the sustainable future



The urgency to reach full decarbonisation has forced Governments, the scientific community, companies and many other stakeholders to look beyond the low-hanging fruit enabled by direct electrification and search for solutions to decarbonise hard-to-decarbonise activities. With this in mind, several studies have estimated that hydrogen and its derivatives may represent up to 25% of the final energy use by 2050. In this article we talk about what is renewable hydrogen, the opportunities behind its deployment, and the challenges it confronts. We'll also address how EDP is positioning itself to seize this opportunity for the future.



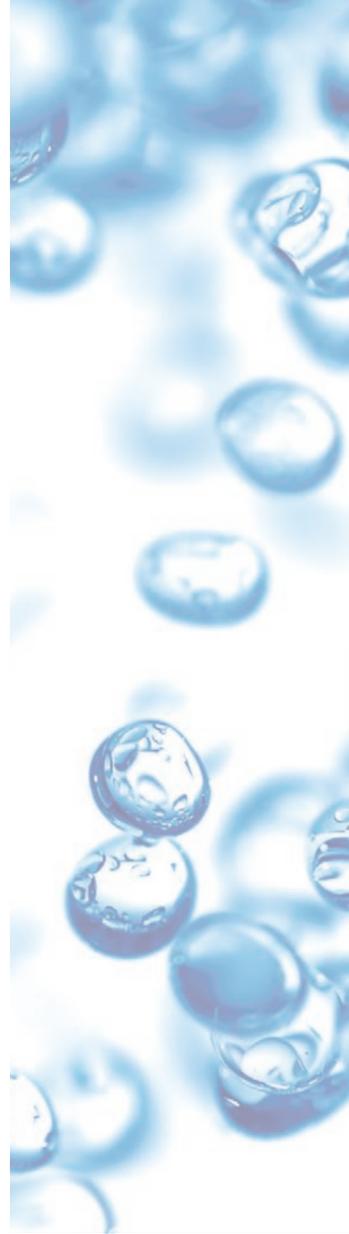
What is renewable H₂?

Currently, the existing hydrogen global market is estimated to be ~120-180 b\$. For comparison, renewable energy market has an estimated value of ~800-100 b\$. In 2022, the H₂ industry produced almost 95 Mt of hydrogen, most of which in dedicated local production sites for refining and ammonia processes. With ~83% of this hydrogen being produced from fossil fuels without carbon capture, the hydrogen industry was responsible for almost 2% of total global carbon emissions. However, with the need to decarbonise and the growing potential to use hydrogen in other applications, this scenario is likely to change.

Hydrogen has the capacity to support the decarbonisation of various sectors, including transportation, industry, and power generation, as its combustion or use in fuel cells does not result in the emission of carbon dioxide (CO₂). Even if some energy uses are technically challenging for direct hydrogen use, the production of hydrogen derivative products such as ammonia, methanol or sustainable aviation fuel may be an option.

As our world grapples with the urgent need to address climate change and transition to a more sustainable energy landscape, the race to be able to produce hydrogen at scale and with limited carbon footprint is on. While several technologies exist to produce hydrogen, relying on a variety of energy vectors, renewable hydrogen has been gaining traction as the best option, promising to revolutionise our energy systems, decarbonise industries, support economic development and mitigate the environmental challenges we face.

But what is in fact renewable hydrogen? At its core, it is hydrogen gas produced through a process called electrolysis, which uses renewable electricity, such as wind or solar power, to split water molecules into hydrogen and oxygen. Unlike traditional hydrogen production methods, which primarily rely on fossil fuels like natural gas, renewable hydrogen is generated with minimal carbon emissions. Even compared to the so-called blue hydrogen, produced from natural gas with carbon capture and storage (CSS), renewable hydrogen is expected to have lower environmental impacts. This makes it a clean and sustainable energy carrier with enormous potential to drive the transition to a carbon-neutral world.



What are the opportunities?

The primary driver behind the implementation of renewable hydrogen is the urgent need to combat climate change. With rising global temperatures and increasing concerns about the environmental impact of fossil fuels, the transition to low-carbon energy sources has become imperative. Renewable hydrogen offers a pathway to significantly reduce carbon emissions across multiple sectors, aligning with international climate goals outlined in agreements like the Paris Agreement.

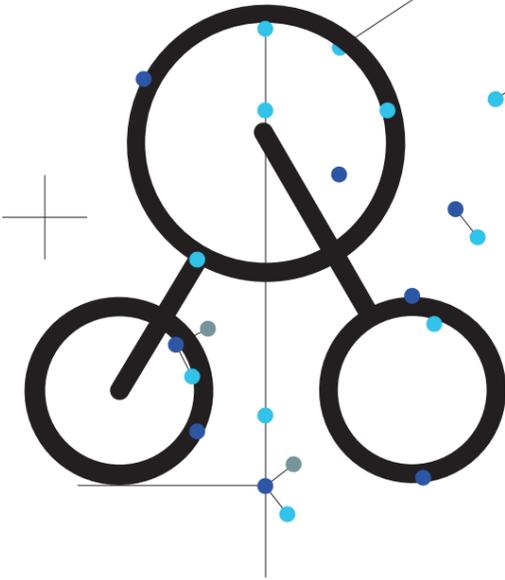
“Renewable hydrogen offers a pathway to significantly reduce carbon emissions across multiple sectors.”

But the adoption of renewable hydrogen brings about several benefits that justify the attention being given to it. One of the compelling reasons to adopt renewable hydrogen is the enhancement of energy independence and security. Renewable energy resources are better distributed than fossil fuels, enabling any country to produce some of their hydrogen needs and therefore reducing external dependency from fossil fuels. Additionally, by diversifying the countries they import from, nations can strengthen their energy resilience and mitigate geopolitical risks associated with energy supply disruptions, in cases such as the war in Ukraine, which has shown us this so well.

The renewable hydrogen economy also represents a significant economic opportunity. It has the potential to create millions of jobs across the value chain, many of which in the countries where it is consumed, from renewable energy generation and hydrogen production to infrastructure development and research and development activities. Moreover, countries that position themselves as leaders in renewable hydrogen can benefit from export opportunities and economic growth.

With this in mind, over 52 countries have launched H₂ strategies, and more are being prepared. The strategies aim to support the development of this new industry, establishing ambitious targets, proposing required regulation, implementing support mechanisms and detailing concrete steps across the value chain to enable its deployment (from the production of renewable electricity, manufacturing of equipment, deployment of projects, H₂ transportation and storage and use). As expected, the strategies are based on the natural conditions that each country possesses and the current and future needs it may have.





Also, the inexistence of a robust infrastructure for hydrogen storage, transportation, and distribution inhibits the development of large hydrogen production centres in areas with access to abundant renewable electricity but low hydrogen demand.

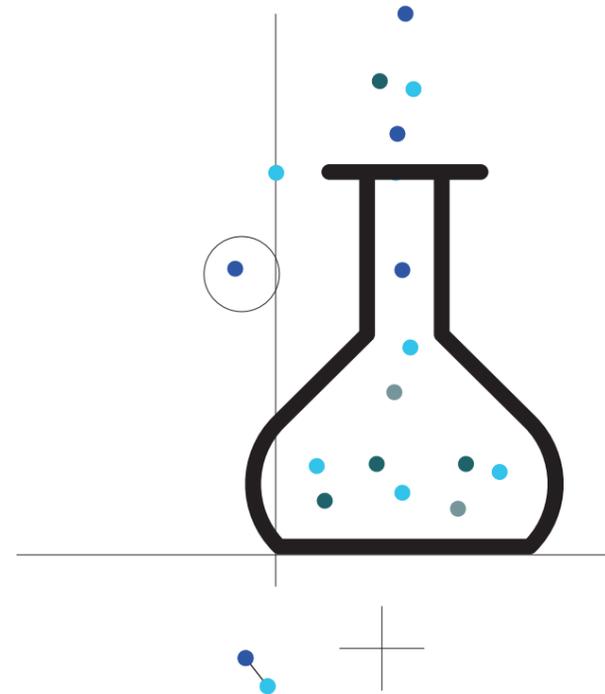
Finally, while significant progress is being made on establishing a complete regulatory framework and support mechanisms for the establishment of a hydrogen market, there are still several uncertainties on the application of many regulatory pieces.

Ultimately, all these challenges result in a much higher production cost for renewable hydrogen when compared to fossil fuels or hydrogen generated from fossil fuels. Reducing the cost through technological advancements (e.g. reduction of critical materials and efficiency improvements), economies of scale and significant increases in renewable energy capacity, by addressing land use concerns and grid integration issues, is essential for its competitiveness. In addition, there is a need to establish just regulatory and fiscal frameworks based on the polluter-pays principle to ensure a level playing field between renewable hydrogen and fossil fuel-based alternatives.

Facing big challenges

But while the potential benefits of renewable hydrogen are vast, its widespread adoption is not without challenges. The first one being the lack of technological track record. Despite being a process with more than a century of history, electrolysis, the process used to produce renewable hydrogen, there is very little experience in developing large scale electrolysis production capacity. This is particularly true for most electrolyser manufacturers, which have not yet had the opportunity to produce their technologies at scale and for long periods of time. The implications of this are numerous, including lack of production capacity, low efficiency of the electrolysers and uncertainty in their operation over time (lifetime, degradation, operational conditions).

Another challenge is the energy intensity aspect of renewable hydrogen production. With the current high prices of renewable electricity, and its lower competitiveness compared to the direct use of fossil fuels, this ends up being one of the key cost components for the production of renewable hydrogen.



The path forward

The importance of renewable hydrogen in shaping a sustainable and carbon-neutral future cannot be overstated. It represents a powerful tool for addressing climate change, enhancing energy security, and fostering economic growth. While significant challenges exist, the concerted efforts of governments, industries, and the research community are driving innovation and progress.

As we move forward, it is crucial to prioritise investments in renewable hydrogen technology, as opposed to solutions based on fossil fuels, support policy frameworks that incentivise its adoption, and foster international collaboration to create a global renewable hydrogen economy. With determination and collective action, we can harness the potential of renewable hydrogen to build a cleaner, more resilient, and sustainable world for generations to come.

Key Challenges ● ● ●

Electrolyser manufacturing capacity

Most electrolyser manufacturers have a limited track record, hindering the capability to deliver equipment at scale and on time, which brings uncertainty to the market in terms of costs, performance and dates for delivery.

Technology immaturity

Most technologies have only been proven at a small scale and lack the track record to allow equipment manufacturers to provide warranties

on the performance of the equipment during its operations (lifetime, efficiency degradation, operation conditions, among others).

Delays and unclear regulation

Despite positive advances in multiple regions on the regulatory framework concerning renewable hydrogen, several questions remain on their applicability, including the conditions under which hydrogen production may be eligible for certain supports or

the concrete application of hydrogen consumption mandates.

High inflation and electricity prices

The recent energy and economic context has resulted in increased costs for equipment and the development of additional renewable electricity capacity, as well as higher power prices overall, which puts significant pressure on the cost of renewable hydrogen compared to the costs of fossil fuel-based alternatives.

Global targets and initiatives

The H₂ strategies currently launched would require more than 200 GW of electrolyzers to reach 2030 targets, with different regions following different approaches based on their natural conditions and expected needs for hydrogen.

Europe

The European Union has set ambitious targets for renewable hydrogen, aiming to become a global leader in this field. Projects like the European Clean Hydrogen Alliance and the Hydrogen Valleys Partnership are driving innovation and investment. At an EU level, there is a target to consume 20 Mt of renewable hydrogen by 2030, of which 10 Mt would be produced domestically and the rest imported from other regions. To foster this adoption, mandates for the uptake of renewable hydrogen and its derivatives have been set for the industrial and transport sectors.

At a country level, Germany has launched the H2Global program (initial budget of 900 M€), aimed at importing ammonia, methanol and synthetic fuels. The Netherlands have earmarked 7.5 bn€ of funding for H₂, of which 5.1 bn€ for onshore projects and 1.8 bn€ for offshore projects. The UK has several support mechanisms for H₂, such as the £240m Net Zero Hydrogen Fund and the Hydrogen Production Business Model.

North America

In the United States, the Department of Energy has launched the Hydrogen Energy Earthshot initiative, with the goal of reducing clean hydrogen production costs to \$1 per kilogram within a decade. To support the uptake of clean hydrogen in the country, it has set a target to consume 10 Mt of clean hydrogen by 2030, it will support clean production by up to \$3/kg through the US IRA (Inflation Reduction Act) and will distribute up to \$7 billion to establish Regional Clean Hydrogen Hubs. Replying to the US IRA, Canada has announced it will enable a Hydrogen ITC (Investment Tax Credit) of 15 to 40% on H₂ production equipment; expecting to allocate a budget of 5.6 bCAD in the next 5 years and 12.1 bCAD between 2028-2035; as well as establishing other decarbonisation measures that also support H₂ (RES ITC, CO₂ price, clean fuel regulations).

Other regions

The abundant renewable energy resources in the Middle East, Australia and South America have led to plans for large-scale renewable hydrogen production projects, with the intent to export hydrogen to international markets. In the case of the Middle East and Australia, this is a way of retaining their energy exports industries, while for South America it is viewed as a way of promoting economic development.

Asia

Countries like Japan and South Korea are investing heavily in green hydrogen infrastructure, with a focus on importing hydrogen as a clean energy source. Japan's Fukushima Hydrogen Energy Research Field is one such example.

Japan has one of the oldest H₂ strategies and recently reviewed it, increasing H₂ supply from 2 Mt to 3 Mt by 2030 (expected review to 12 Mt by 2040), as well as establishing international partnerships to ensure imports of H₂ and ammonia (Australia, Middle East and other countries in Asia).



EDP's efforts on renewable hydrogen

The renewable hydrogen market represents one of the growth axes for EDP, aiming to capture the growth of the sector due to the decarbonisation objectives being set, supported by the expected increasing competitiveness over the course of this decade. With the creation of the H2 Business Unit (H2BU), EDP aims to strengthen its ability to respond to the growing needs for this market, whether it is renewable electricity or renewable hydrogen itself, in a strategic and cross-cutting way that promotes investment in renewable energy.

The focus of H2BU is on developing opportunities for the uptake of renewable hydrogen in promising sectors such as the industries of steel, chemistry, refineries, and cements, as well as long-haul heavy transports. Aligned with EDP's group footprint and the development of the market, the priority geographies are the United States and Europe, leveraging the existing renewable capabilities, active pipeline and market knowledge.

1.5 GW

Target capacity by 2030

>500 MW

Projects in advanced stage of development

~200 M€

Public funding secured

3 IPCEI

Important Projects of Common European Interest

2 Innovation Funds

Projects selected in Spain and Portugal

6 RRP

Projects supported through the Recovery and Resilience Plans



Since the establishment of the H2BU in 2021, EDP has pursued three goals that enable building a track record on renewable hydrogen while planning for future growth: build operational experience; demonstrate EDP's competitiveness; and create growth opportunities. Following this approach, EDP has currently one project in operation in Brazil and a project under construction in Portugal, which are supporting the development of skills to build H₂ projects from a technical (e.g. electrolysis, BOP (balance of plant), storage), regulatory (e.g. licensing, permitting), and market (e.g. electricity sourcing) perspectives.

“The projects being developed by EDP range from 5 to 150 MW, with several of them having the potential to grow to over 500 MW”

EDP's projects

EDP has been developing different types of projects, leveraging on its distinctive capabilities and aiming to create knowledge about different project configurations and business models.

R&D Projects

R&D projects are an excellent approach to create knowledge in developing and operating hydrogen projects as well as testing innovative technologies. Currently, EDP has one R&D project built in Pecém, Brazil, which is a 1.25 MW PEM electrolyser supplied by a 3 MW PV plant. The hydrogen produced from this facility has recently been the first in South America to be certified as renewable. Similarly, a project of 1.25 MW is currently being built in Carregado, Portugal, which will enable the testing of hydrogen co-combustion with natural gas for power production in a combined cycle.

Renewable hydrogen hubs

The development of renewable hydrogen hubs on the sites of EDP's coal power plants is an opportunity being explored to ensure a just transition for those regions. Leveraging on existing infrastructure and skilled human resources, EDP aims to supply renewable hydrogen to local industries, heavy transport and explore export opportunities. Examples of the hubs being developed by EDP are the 100 MW GreenH2Atlantic project in Sines, Portugal, the 130 MW Green H₂ Los Barrios project in Algeciras, Spain, and the 150 MW Asturias H₂ Valley in Aboño, Spain.

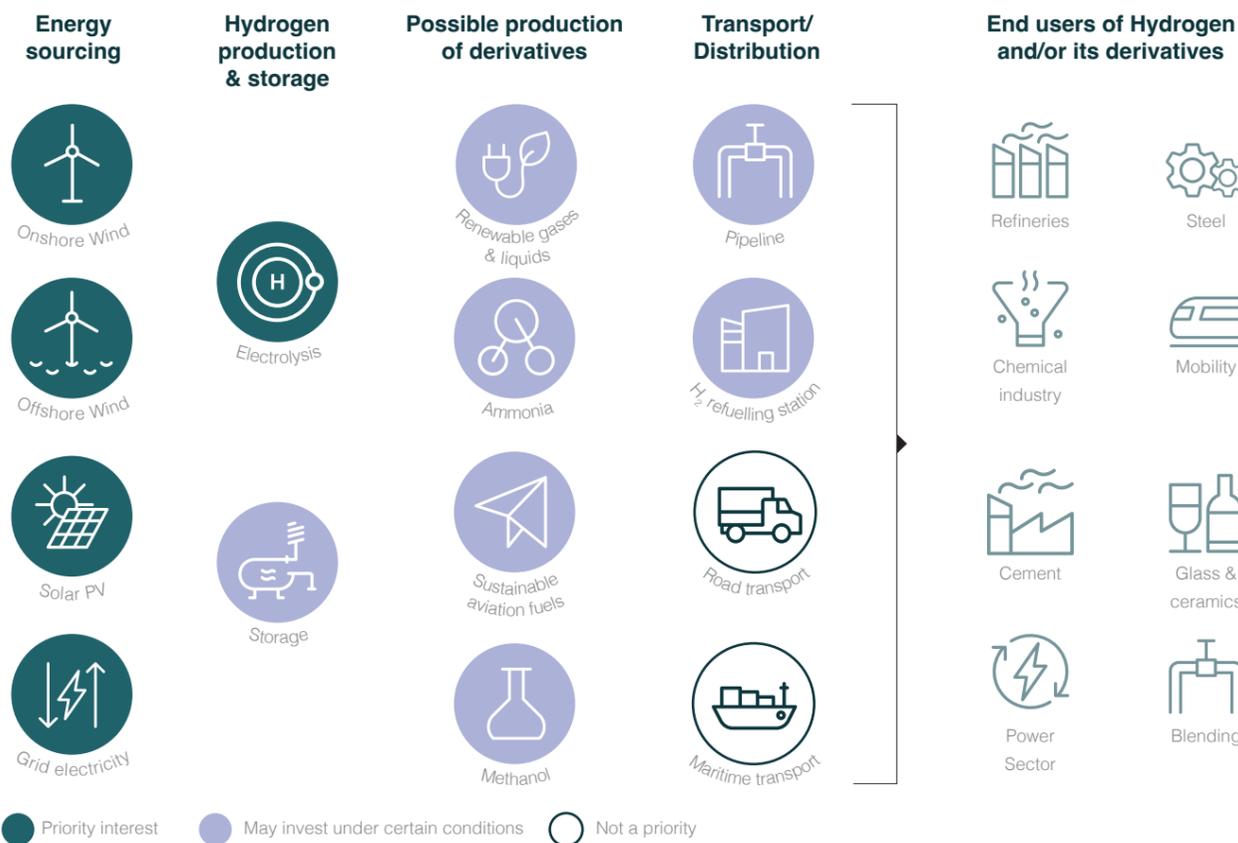
Co-location of renewables and hydrogen production

The direct connection between renewable electricity capacity and electrolysers opens the opportunity to develop optimised systems that may lead to cost reductions, avoid grid fees and open a new avenue to create value for renewable assets. However, several challenges remain in valuing the benefits that may be achieved and potential operation challenges that may appear. Currently, EDP is exploring how the co-location of electrolysers with renewable assets may support the business case of existing renewable assets and offer a new route to market for the development of new renewables that are not dependent on the development of electricity networks.

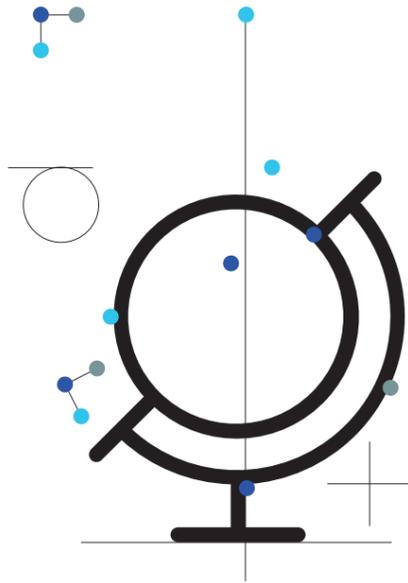
Dedicated hydrogen production

While hydrogen is already being used globally, it is mainly focused on two applications: refineries and ammonia production. To achieve decarbonisation, hydrogen will have to be an alternative for several energy uses, from industry to transport, which need to create the knowledge on how to adapt their technological systems but also understand the implications for human resources training, safety procedures and operational conditions. EDP is currently exploring projects with industrial off-takers to enable the creation of this knowledge in a controlled and incremental manner.

EDP's key interests are to develop renewable electricity and Hydrogen, with the possibility to participate on broader P2X applications



(*) Converting electrical energy into another form of storable energy.



The development of the proof of concept for the coupler burner is in the final stage of laboratory tests and the expectation is to carry out the first practical tests by February

Pecém H2V Project A Pioneering Journey in Green Hydrogen

The Pecém H2V project in Brazil continues to make significant progress, positioning itself as one of the pioneers in the search for sustainable solutions. Currently, the project's operation and maintenance phase not only reinforces the expertise of the teams involved, but also provides essential knowledge to this new business paradigm.

The pilot project, which is constantly improving its processes, has reached significant milestones, achieving contractual performance. This achievement made it possible to transition from blue to green hydrogen by cooling the alternators at the Pecém thermoelectric power station, raising the average purity from 92% to 99.9%, ensuring greater efficiency in thermal exchange and equipment performance.

Green Origin Certification: Strategic Partnership with CCEE
The Electricity Trading Chamber (CCEE) plays a crucial role in the Brazilian electricity sector, acting as a trading environment and ensuring the viability and transparency of transactions in the energy market. In the context of green hydrogen, certification becomes a cornerstone for validating the renewable origin of the raw materials used in its production.

The partnership between EDP and CCEE for the certification of green hydrogen represents a significant milestone in the commitment to sustainability and the transition to cleaner energy sources. This process certifies that hydrogen production comes from renewable energy sources, such as solar and wind, guaranteeing its low carbon footprint and its positive contribution to the environment.

The green origin certification, issued by the CCEE, is a seal of quality that grants reliability to consumers and investors, ensuring that the hydrogen produced meets strict sustainability criteria. This strengthens not only the credibility of the product, but also boosts the confidence of markets and investors in EDP Brasil's viability and commitment to clean and renewable energy sources.

Developing Proofs of Concept: Towards Innovation
In addition to certification, EDP is focused on developing innovative proofs of concept. Of particular note are the advances in the area of coupled burning (co-firing), a method that combines conventional fuels with hydrogen. These tests aim to optimise the use of hydrogen in industrial processes, reducing carbon emissions and promoting a cleaner transition for national industry.

At the moment, the development of the proof of concept of the coupler burner is in the final stage of laboratory tests, using a Gas to Liquid Ratio (GLR) of 0.5% (the tests will include the following GLR ratios: 0.5%; 1%; 1.5% and 2%). Currently, 40% of the infrastructure needed to receive the burner at the Pecém plant is ready, and the expectation is to carry out the first combustion tests of the diesel and hydrogen mixture in the boiler by February 2024.

“Certification strengthens the credibility of the product and boosts the confidence of markets and investors.”

Development of the Scenario Simulation Platform
Another significant milestone is the creation of a business modelling platform. This resource will be essential for analysing different hydrogen application scenarios, taking into account technical, regulatory and economic variables. This platform will be a crucial tool in formulating effective strategies for expanding the use of green hydrogen.

Among the main advances is the finalisation of the 100 MW scenario (1, 10 and 50 MW had already been completed), along with the discussion of the roadmap's assumptions, including opportunities, obstacles, sector policies, business models and financing, among others. In addition, estimates of CAPEX, OPEX and contributions for all the alternatives are underway, as well as analyses of reference cases, showing the scope and depth of the studies underway. //



François Paquet

Impact Director at the Renewable Hydrogen Coalition

How does the European hydrogen strategy align with its climate and energy goals, particularly in the context of the European Green Deal?

The European Hydrogen Strategy is a cornerstone of the European Union (EU)'s efforts to achieving its climate and energy goals and renewable hydrogen comes at the centre of the European Green Deal.

Renewable hydrogen currently accounts for a mere 2% of the European energy mix. Most of the hydrogen consumed in Europe today - a staggering 95% - is sourced from fossil natural gas. The production of this so-called "grey hydrogen" releases about 70-100 million tons of CO₂ annually, equivalent to the yearly emissions of the Czech Republic. The European hydrogen strategy and the European Green Deal aim to replace part of this highly polluting hydrogen with much cleaner renewable hydrogen.

Renewable hydrogen is a game changer in the energy transition, bringing renewables where they could not go before to decarbonise sectors that cannot be electrified such as heavy industry, aviation and shipping. It complements electrification efforts.

What's more is that it brings an opportunity for economic growth and job creation in Europe by seizing first mover advantage on the markets of the future, such as green steel or zero emission fertilisers.

The invasion of Ukraine by Russia has exposed Europe's overreliance on an insecure and volatile fossil fuel supply. Renewable hydrogen offers a unique opportunity to build a more energy secure and resilient Europe thanks to home-grown renewables.

Europe has set ambitious targets for hydrogen production. What progress has been made, and what challenges remain in achieving these targets?

Europe is leading on the regulatory front, where unparalleled progress was made over the past two years. Nowhere in the world, investors have such a legal certainty on both supply and demand for renewable hydrogen. The EU has established clear production rules and ambitious targets for its uptake in hard-to-electrify industry and transport (aviation and shipping). Notably, by 2030 at least 42% of the hydrogen industry consumes will have to be renewable based, increasing to 60% by 2035. This is a formidable new downstream market for renewable energy producers.

But regulation alone will not be sufficient to move from hype to reality. Today, according to the European Commission's Clean Hydrogen Alliance initiative, only 14% of announced renewable hydrogen production projects have reached final investment decision (FID) and only 4% have started construction. Seeing more FIDs from off-takers is crucial. For this, several challenges must be addressed urgently. First,

the cost of renewable hydrogen is still too high compared to incumbent alternatives. Covering the green premium with proper public funding will be crucial to unlock investments. Second, at least 100 GW of solar and wind projects are stuck today, awaiting grid connections or permits. Accelerating permitting and grid connections will be paramount to deploy the renewables needed for electrification and hydrogen production. Third, the hydrogen infrastructure to transport and deliver the volumes end-users need is lacking today. Ensuring the speedy roll-out of fit-for-purpose, properly sized, hydrogen infrastructure will be key to scale up renewable hydrogen in Europe and meet the EU targets.

The Renewable Hydrogen Coalition is the voice of the industry that is dedicated in making Europe the global leader in renewable hydrogen solution. What are the main concerns of the coalition's supporters?

Transitioning a substantial proportion of today's 95% grey hydrogen to renewable hydrogen is the core ambition of the Renewable Hydrogen Coalition (RHC). Uniting the entire value chain, we shape the policies that are needed to unlock and accelerate investments in renewable hydrogen and that recognise its multiple

benefits, for only renewable hydrogen is truly clean hydrogen. The stake is to secure a preferential treatment across legislation over other forms of hydrogen, so-called "low carbon" hydrogen, which deepens Europe's dependency on imported fossil fuels and if poorly regulated can lead to increase emissions.

The race to seize leadership in renewable hydrogen is now global. Despite its comprehensive strategies and targets on paper, progress in Europe has been too slow and other regions are catching up very fast. European producers face potentially strong competition from imports outside Europe. If Europe wants to maintain its leading edge, it needs a true European industrial policy that also ensures a true playing field. A key concern is the lack of fit-for-purpose public financing in Europe, which is crucial in this early phase, especially given the challenges posed by inflationary pressures and increasing interest rates that cast a shadow over the business case of capital-intensive projects. As EDP and other RHC supporters stressed in a recent joint letter to European Ministers of Finance, the European Hydrogen Bank is a highly promising tool and step in the right direction, but there is an urgent need to bolster its budget and provide a clear calendar for auctions up to 2030. National authorities should embrace this tool and use its "Auction-as-a-Service" to ensure simplicity and speed, avoiding creating a patchwork of different support schemes across Europe. Europe has everything it needs to lead the renewable hydrogen revolution. RHC is proud to be able to count on committed companies like EDP to make sure this opportunity is not missed.

A unique opportunity to build a more energy secure and resilient Europe

- A game changer in the energy transition, that brings renewables where they could not go before to decarbonise sectors that could not be electrified. For François Paquet, renewable hydrogen is part of the future and Europe has everything it needs to lead this revolution.



Sunita Satyapal

DOE Hydrogen Program Coordinator
U.S. Department of Energy

Historic investments in clean hydrogen in the U.S.

Hydrogen is an essential part of the mix of solutions for achieving a sustainable future. This is the conviction of Sunita Satyapal, head of the US Department of Energy’s green hydrogen strategy. In this interview, she talks about the environmental and economic impacts of this technology.

What are the main drivers behind the adoption of hydrogen as a clean energy vector in the USA? And how do they align with the country’s environmental and energy goals?

Given its potential to help address the climate crisis, enhance energy security and resilience, and create economic value, interest in producing and using clean hydrogen is intensifying both in the United States and abroad. Clean hydrogen, produced with low

overall greenhouse gas emissions, can be produced from renewable power, nuclear energy, or fossil energy when carbon emissions are captured. Clean hydrogen is a key part of a comprehensive portfolio of solutions to achieve a sustainable and equitable clean energy future. It has a particularly important role to play in cleaning up some of the hardest-to-decarbonise sectors of our economy—including industrial processes that are essential for our modern quality of life, such as

steelmaking and chemical production (including fertilisers) as well as heavy transportation, such as long-haul trucking and offroad applications. The United States is stepping up to accelerate progress through historic investments in clean hydrogen production, midstream infrastructure, and in targeted research, development, demonstration, and deployment (RDD&D) in this critical technology, aligned with meeting the Biden Administration’s 2050 net zero climate goals.

“Green hydrogen has a particularly important role to play in cleaning up some of the hardest-to-decarbonise sectors of our economy.”

Could you provide insights into the key H₂ initiatives, projects and R&D efforts in the USA, especially those supported by the Department of Energy?

Key hydrogen activities by the U.S. federal government are guided by the U.S. National Clean Hydrogen Strategy and Roadmap – a comprehensive national framework for facilitating large-scale production, processing, delivery, storage, and use of clean hydrogen to help meet bold decarbonisation goals across sectors of the economy.

The U.S. Department of Energy (DOE), the lead U.S. federal agency for research, development, demonstration, and deployment (RDD&D) of energy technologies, has been working for decades through its Hydrogen Program on clean hydrogen, fuel cells, and related technologies to unlock hydrogen’s potential to decarbonise multiple sectors in our economy and support national goals. For example, through DOE’s Hydrogen and Fuel Cell Technologies Office funding, more than 1,300 U.S. patents have been issued to recipients of DOE funding and more than 30 technologies have been commercialised.



The U.S. Department of Energy has recently unveiled the 7 hydrogen hubs selected to receive 7b\$ of public funding as a part of the IIJA bill. Can you tell us what the DOE learned about hydrogen’s role in our energy future and how these investments might shape the way we power our industries and transportation means in the long run?

The regional clean hydrogen hubs are a key part of the national strategy for clean hydrogen (as laid out in the U.S. National Clean Hydrogen Strategy and Roadmap). Investing in and scaling these regional hubs will enable large-scale clean hydrogen production close to high-priority hydrogen users, allowing the sharing of a critical mass of infrastructure. Also, these investments will drive scale in production, distribution, and storage to facilitate market liftoff. Properly implemented, these regional networks will create place-based opportunities for equity, inclusion, and sustainability. Priorities will include reducing environmental impacts, creating jobs – including good-paying union jobs – securing long-term offtake contracts and jumpstarting domestic manufacturing and

“Properly implemented, these regional networks will create place-based opportunities for equity, inclusion, and sustainability.”

private sector investment. The hubs include various production methods from diverse resources (renewables, nuclear, and fossil with carbon capture and storage) and multiple end uses from heavy-duty transportation to industrial and chemical applications as well as infrastructure including pipelines and large scale storage. As they unfold, they will inform and catalyse further developments.

In terms of job creation and economic growth, how is the hydrogen sector expected to benefit the U.S. economy, and what are the projections for the growth of this industry in terms of jobs and economic impact?

Clean hydrogen, catalysed in the U.S. by the Bipartisan Infrastructure Law and the Inflation Reduction Act, will both enable decarbonisation of hard-to-abate sectors and create and preserve good-paying jobs, provide environmental and energy justice benefits, and create energy independence and export opportunities. As laid out in the National Strategy, pathways for clean hydrogen to decarbonise a wide range of applications are informed by demand scenarios for 2030, 2040, and 2050 with strategic opportunities for 10 million metric tonnes (MMT) of clean hydrogen annually by 2030, 20 MMT annually by 2040, and 50 MMT annually

by 2050. These values are based not only on the opportunity for clean hydrogen production in the United States, but on demand for clean hydrogen use across various sectors, informed by achieving market competitiveness in specific applications. Using clean hydrogen can reduce U.S. emissions approximately 10 percent by 2050 relative to 2005, consistent with the U.S. Long-Term Climate Strategy. Independent analysis estimates that by 2030, the hydrogen economy could result in 100,000 net new direct and indirect jobs due to the build-out of new capital projects and clean hydrogen infrastructure. These jobs include both direct jobs like those in engineering and construction, and indirect jobs like those in manufacturing and raw material supply chains. //

¹ <https://www.whitehouse.gov/wpcontent/uploads/2021/10/US-Long-Term-Strategy.pdf>

