More Clean Energy

White Paper

TECH4 Sustainability - More Clean Energy

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TECH4 Sustainability

the academy and the city with a ”more clean” energy

Following the success of the first topic on Circularity, this new conference will focus on **developing sustainable energy solutions with ”More Clean Energy.” Renewable energy** plays a **fundamental role in ensuring a healthier environmental future** by meeting **the energy needs of communities** and reducing **dependence on fossil fuels**.

The **city of Porto and its academic community have demonstrated a clear commitment to implementing energy solutions** that not only **reduce greenhouse gas emissions** but also **promote energy self-sufficiency and technological innovation**. At the forefront is the use of **solar, wind, biomass, and wave and tidal energy**, leveraging nature as an ally to achieve a healthier interaction between the environment and humanity. These technologies offer immense potential, **revolutionizing how the city**—and the broader metropolitan area—**produces and consumes energy**.

Offshore wind energy, for example, is being extensively studied to **optimize and maximize its efficiency in coastal maritime areas**.

The **Tech4Sustainability** initiative strengthens the **connection between academic research and practical projects in the city of Porto**, highlighting the contributions of the **Faculty of Engineering of the University of Porto to urban sustainability**. The initiative **aims to shed light on the often underrecognized direct impact of scientific research** on the city’s life, aligning with the **green and digital transition** and **reinforcing the commitment to achieving carbon neutrality by 2030.**

The **first edition** of this initiative focuses on three priority areas: **Greater Circularity, More Clean Energy, and Better Mobility**. These topics are crucial to **Porto’s commitments within the scope of the 100 Climate-Neutral and Smart Cities**, involving broad collaboration between public and private entities serving citizens.

Beyond wind energy, there is **significant investment in wave and tidal energy, offering sustainable solutions for ports and coastal areas by converting wave energy through its integration into port structures**. Given the extensive Atlantic coastline of the Porto Metropolitan Area, these solutions could prove highly valuable. **Other impactful research projects** in the decarbonization sector focus on **producing energy without greenhouse gas emissions, such as biogas derived from biological processes**.

Porto's strategic investment includes **photovoltaic solar energy, increasing production capacity through coverage across the urban area**. This challenge **aligns with national and European decarbonization goals**. Among the innovative projects aimed at expanding production capacity is the **creation of energy communities, including a pilot project in Bairro da Agra do Amial, as part of the Asprela + Sustainable initiative**. The **Porto Solar project, a mark of excellence, involves investments in installing solar panels on municipal buildings, enabling the city of Porto to produce 1.6 GWh of renewable energy**. These projects increase clean energy production, inspire the proliferation of such technological solutions by public and private entities and citizens, and help **reduce energy costs, promoting efficiency and savings for both citizens and institutions**.

This integrated strategy, involving collaboration between research teams, the public sector, and private entities, reflects **Porto's vision as a resilient, smart city committed to sustainability, grounded in innovative best practices**. Implementing renewable energy solutions is not just a response to current needs but also a long-term investment, creating an **urban development model that could be replicated in other cities and regions across Portugal and the world**.

Tech4Sustainability aims to establish itself as a platform for dialogue and showcasing existing capabilities, anticipating **future achievements based on technology and innovation and leveraging Porto's best practices**. The **partnership between academia and the city** will continue to be crucial for **driving innovative solutions to address complex environmental and urban challenges**.

Porto is emerging as a model of sustainability in Europe. Achieving these goals will require **active commitment across various sectors of society, fostering synergies that will transform the city into a benchmark of resilience, intelligence, and carbon neutrality**.

Portos

Francisco Taveira Pinto

Seaports require a significant electricity supply and are a source of air pollution, two environmental challenges that can be mitigated by using renewable energy. Considering the convergence of resources, infrastructures, and facilities in ports, **marine renewable energies offer a promising alternative.** The **PORTOS project (Ports Towards Energy Self-Sufficiency) aimed to evaluate, develop, and promote the integrated use of renewable energy resources in Atlantic Area ports and to enhance their energy efficiency, establishing a roadmap for a more competitive and sustainable sector.**

Launched in 2019, the PORTOS project focused on **promoting renewable energy and sustainability in ports**. To achieve this, **partnerships were established with 12 institutions from Portugal, Spain, France, the United Kingdom, and Ireland, including universities, R&D centers, companies, and ports**. The project was **co-funded by the INTERREG Atlantic Area program 2014-2020, with a total budget of around €3 million**. The integration of renewable energy in Atlantic Area ports was assessed, developed, and promoted through renewable energy exploration plans for the target ports. These plans served as a baseline for **developing new tools and decision-support systems to guide other ports—not only in the Atlantic Area but also globally—on their path toward energy self-sufficiency**.

The **PORTOS project advanced sustainability in the Atlantic Area through cutting-edge research into marine renewable energy for port supply**. This enabled research teams to test and analyze the performance of various renewable energy devices in the consortium's laboratories, including technologies from institutions such as the University of Porto in Portugal, IH Cantabria in Spain, the University of Plymouth in the United Kingdom, and UniOvi in Spain. **Each technology was tested for at least two weeks** in these laboratories between August 2020 and March 2021.

Throughout the project, the best areas for renewable energy exploitation were identified in five ports that served as case studies—Vigo (Spain), Leixões (Portugal), Shannon-Foynes (Ireland), Tenerife (Canary Islands), and Azores Ports (Portugal). **This work involved analyzing data related to aspects such as energy consumption, renewable energy resources (wind, wave, tidal, and solar), environmental constraints, and legal frameworks. High-resolution numerical models were applied to improve resource assessments and enable cost-effective site selection for renewable energy development**. Once the best areas for the **exploitation of various marine renewable energy resources** were identified, a **technical and economic assessment of different conversion devices to be integrated into the ports was conducted**.

Beyond achieving its research objectives, the **PORTOS project** successfully **raised societal awareness about the benefits of renewable energy and sustainability in ports through several dedicated events**, including **OpenPorts, OpenLabs, and Thematic Stakeholder Seminars**. During the **OpenLabs, consortium research institutions opened their doors to local communities**. Guest speakers from academia and industry shared their **perspectives on current developments in marine renewable energy and its application in ports**. Laboratory visits were also organized. Participants were informed about **current and future sustainable port practices being implemented in ports**. Additionally, **training courses were offered to improve social awareness about renewable energy in ports and enhance participants' knowledge of marine renewable energy**.

To **disseminate the progress achieved through the PORTOS project, several articles were published in scientific journals**, and the **project's results were presented at nine international conferences**.

Poseidon

Tiago Ferradosa

The **POSEIDON project** (funded by FCT) focuses on **optimizing innovative erosion protection solutions for complex foundations**, particularly in the **context of infrastructure associated with marine renewable energy. Offshore renewables, such as wind energy**, hold **great potential for the global energy transition** but **face several technical and economic challenges that POSEIDON aims to address**.

One of the main concerns in offshore installations relates to sediment erosion around foundations. This erosion can compromise the stability and durability of the infrastructure, leading to high maintenance costs or even structural failures. **POSEIDON specifically investigates erosion protection solutions for various types of offshore foundations, such as monopiles (used in wind turbines), jacket foundations (lattice structures), and gravity-based foundations**. These foundations are critical to **ensuring the stability of structures installed in challenging marine environments**, which are **subject to forces from currents and waves that can accelerate erosion processes**.

The **project integrates physical and numerical modeling to develop an advanced methodology for the application of dynamic erosion protection**. Dynamic protections have the potential to adapt to changing seabed conditions, reducing the need for constant interventions and repairs while lowering costs related to transportation, materials, and installation. **This concept focuses on optimizing traditional protective layers, which typically use large rock materials**. By refining sizing procedures and studying the hydrodynamic behavior of the rock layer that protects the seabed and structure, **POSEIDON aims to provide more cost-effective and efficient protection. The main advantage lies in the protection's ability to continuously adapt over time in response to changes in the marine environment**.

By combining physical modeling, through laboratory tests simulating real conditions, and numerical modeling, which enables the prediction of diverse scenarios and the adjustment of parameters, **POSEIDON seeks to create a robust methodological framework applicable to various contexts**. This integrated approach facilitates the **development of solutions for different types of foundations and environmental conditions, increasing operational efficiency and reducing the total lifecycle costs of offshore infrastructure**.

Another important aspect of POSEIDON is the potential **impact on lowering the levelized cost of electricity in the marine renewable energy sector**. By **optimizing erosion protection, offshore infrastructure can become more durable and less costly**, directly contributing to the competitiveness of renewable energy compared to other forms of energy production. **Reducing maintenance costs and improving the reliability of these structures are essential for offshore renewables to become a large-scale, economically viable alternative**.

Beyond its technological and economic implications, **the POSEIDON project aligns with the goals of the energy transition and environmental sustainability**. By supporting the development of more efficient infrastructure for clean energy production, the **project directly contributes to decarbonizing the energy sector and mitigating the effects of climate change**. The **use of renewable energy**, such as **offshore wind, is crucial for reducing dependence on fossil fuels and achieving global targets for greenhouse gas emission reductions**.

In terms of collaboration, **POSEIDON involves a multidisciplinary team of researchers and engineers specializing in areas such as hydrodynamics, geotechnics, coastal engineering, and computational modeling**. Additionally, the project **establishes strategic partnerships with companies in the maritime engineering sector and international institutions** to ensure that the results can be transferred to the industry and applied in real-world marine renewable energy projects.

With the success of POSEIDON, **it is expected that the developed solutions will be applied to future projects, contributing to the expansion of offshore renewables and the creation of a more sustainable future for the energy sector**. The project **not only enhances the technology and efficiency of infrastructure but also strengthens Portugal's role in innovation and leadership in marine renewable energy research**, particularly in offshore wind energy.

Se@Ports

Paulo Rosa Santos

Ports are essential infrastructures for the transport of goods and the competitiveness of Europe, accounting for approximately 75% of its external trade. However, these infrastructures have very high energy demands and often contribute to or exacerbate environmental problems, particularly air pollution, as recognized by the European Sea Ports Organisation in a study involving 91 ports from 20 EU member states. These environmental issues, however, can be mitigated through the use of renewable energy in port activities, which can be locally generated by converting marine renewable resources into electricity.

Port infrastructures and facilities are protected by breakwaters, designed to withstand wave action and dissipate its energy, creating sheltered conditions suitable for activities within the port. The exposure of breakwaters to wave action makes them particularly suitable for the integration of Wave Energy Conversion Technologies (WECs), allowing them to combine their traditional role of port shelter with electricity production from renewable resources. This contributes to environmental sustainability and improves the image of port infrastructures. Other advantages of these multifunctional structures include sharing construction and maintenance costs, proximity of WECs to land and the electrical grid, and the potential improvement of the hydraulic performance of breakwaters due to efficient wave energy absorption. The challenges associated with offshore installation of WECs are also avoided. However, the integration of WECs into port breakwaters must not compromise their functional performance, particularly reflection behavior, wave energy dissipation, and transmission, especially overtopping when there are downstream port terminals. Furthermore, no hydrodynamic instability issues can be introduced, and the structural integrity of the breakwater must not be negatively affected.

This context and rationale led to the SE@PORTS project – Sustainable Energy in Ports, which aimed to demonstrate that this combination is advantageous for both breakwaters and WECs. During the project, and after analyzing existing WECs, a new wave energy conversion technology, the Hybrid WEC, was conceived and developed. This innovative system combines two complementary conversion principles: the oscillating water column (tested, for example, in Pico Island, Portugal, and Mutriku, Spain, with TRL8) and a system based on overtopping (TRL4). The Hybrid WEC was studied using numerical and physical modeling, first to prove the concept and then to improve its overall performance. This includes not only electricity production for the site-specific marine conditions but also the impacts on the functionality of the breakwater, such as reflection behavior, overtopping, and stability.

After the SE@PORTS project ended, the study of the Hybrid WEC system continued under the WEC4Ports project – A Hybrid Wave Energy Converter for Ports, aiming to increase its technology readiness level and bring the concept closer to market implementation.

Photovoltaic Energy in Porto

Rui Pimenta

Agra do Amial: Porto's first renewable energy community

In the energy sector, the future lies in **increasing photovoltaic energy production in Porto and promoting its sharing, whenever possible, through the creation of renewable energy communities**.

The **renewable energy community of Bairro da Agra do Amial in Porto emerged from the "Asprela + Sustentável" project and is the first energy community in the city**, as well as the first of its kind in the country. It **encompasses over 180 families and involves collaboration between the residential sector and the Agra do Amial Primary School, managed by the Municipality of Porto.** This project included the **installation of photovoltaic solar systems on rooftops, enabling the neighborhood to generate its own energy and contribute to decarbonization.** In the first months of operation, it is estimated that more than 50% of the monthly energy consumed by participating families originated from this renewable source. Additionally, **surplus energy is stored in batteries for later use and sharing**.

This innovative project integrates sustainability across its three core pillars: environmental, by **reducing carbon emissions; economic, by lowering energy costs; and social, by engaging community members as both producers and consumers of clean energy**.

Bairro da Agra do Amial was selected as the pilot project site due to its proximity to Porto's hub of knowledge and research, which includes universities, polytechnics, and research centers. The collaboration between these entities and the municipality, within the scope of "Asprela + Sustentável," **facilitated measures in sustainable mobility, the creation of new technologies, clean energy consumption, the promotion of a circular economy, and the fight against energy poverty**.

Energy poverty is one of the country's most significant challenges, affecting an estimated 1.8 to 3 million Portuguese citizens. The public sector plays a **crucial role in addressing this issue by ensuring resources are directed to facilitate the transition and encourage more sustainable practices, thereby improving well-being and quality of life**.

While these pioneering projects and initiatives are driving substantial sustainable transformation, the city of Porto is setting even more ambitious goals. The city aims to **expand the creation of these energy communities to more than 50 municipal neighborhoods, serving nearly 30,000 people and generating an estimated 6 MW of renewable energy**.

By 2030, all municipal housing buildings are expected to produce energy, reinforcing Porto's commitment to sustainability. The direct investment for this initiative is **approximately 6 million euros, with the return being increased decarbonization and reduced energy poverty**.

Beyond municipal assets, where the Municipality of Porto can intervene directly, it is also **crucial to create conditions to encourage private sector participation in the city's decarbonization efforts.** Porto continues to l**ead by example and already offers incentives for energy production, including a reduction of 500 euros in Property Tax (IMI) for each kilowatt installed**.

The Future of Clean Energy

Watch the documentary

Luís Seca

Francisco Taveira Pinto

José Luís Alexandre

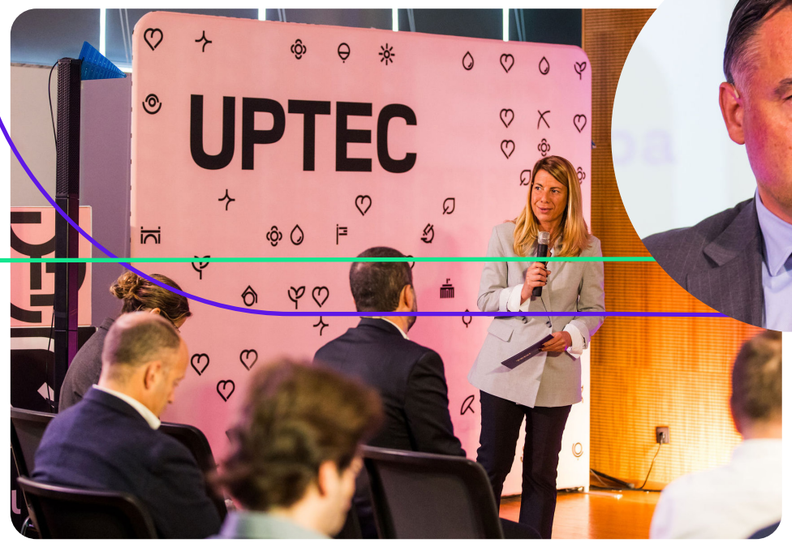
At the **“More Clean Energy” conference, the panel discussion on the ”Future of Clean Energy”** was **moderated by Luís Seca, a senior researcher at INESC TEC**, and featured two prominent scientific researchers: **Professor Francisco Taveira Pinto, a specialist in marine renewable energy—including wave, tidal, and offshore wind energy—and Professor José Luís Alexandre, an expert in cogeneration and clean energy technologies. Both are professors and researchers at the Faculty of Engineering of the University of Porto (FEUP)**.

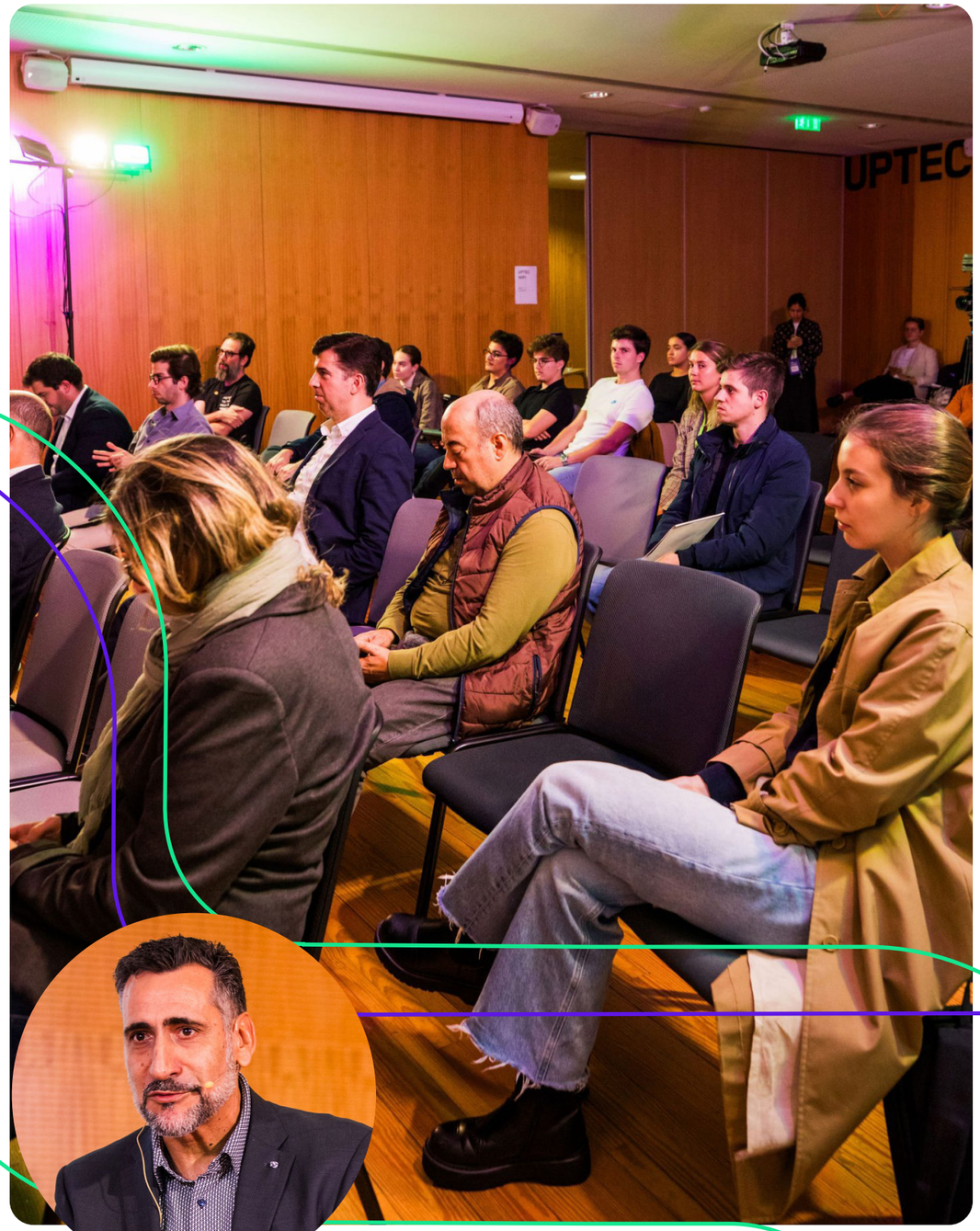
The discussion highlighted projects such as **”Portos” and its precursor ”SeaPorts,”** which focus on incorporating hybrid devices for harnessing wave energy in port infrastructure near the coastline.

Expanding on this topic, **Francisco Taveira Pinto emphasized that no energy source is entirely clean, as all types of energy consumption have some environmental impact**. The concept behind these projects is to **harness marine energy in port structures** instead of merely dissipating it, thereby **supporting the self-sufficiency of ports and utilizing excess electrical energy either for integration into the conventional grid or for hydrogen production**. The ocean represents a highly interesting energy resource: on average, the **energy available in the ocean in all its forms is approximately equal to the world’s annual energy consumption**. However, due to efficiency constraints, not all of this energy can be utilized, though **numerous opportunities exist within the realm of renewable energy**.

Professor José Luís Alexandre contributed insights into the potential of **high-impact projects focusing on renewable gas cogeneration technology, which combines electricity production with heat recovery for heating or cooling, thus promoting energy efficiency.**

This technology can be applied in **renewable energy communities, not only for sharing electricity** (the most common example) **but also for sharing thermal energy**. One implemented example involves the **gasification of biomass from organic waste in wastewater treatment plants (WWTPs), enabling the production of surplus biogas that can be used for cogeneration, providing low-cost hot water heating.** This underscores the potential for **energy communities to share both electricity and thermal energy**, depending on the available processes.





The discussion concluded with a call to reflect on the **use of diverse energy sources and the skepticism surrounding expectations for implementing renewable capacity**. Regarding future technologies and Porto's energy needs, the panel reached a unanimous conclusion: **diversifying energy sources—including natural gas, biogas, wind, marine, and photovoltaic energy—is a viable solution to overcome existing challenges**. Additionally, ensuring **energy efficiency and promoting responsible consumption**, highlighted through the concept of sufficiency, are crucial. These elements should form the foundation of a new energy usage culture in society, **guaranteeing the necessary sustainability to enhance energy rationality and independence in the region**.

Explore the project

112CO_2

Adélio Mendes

This project is characterized by the **development of a technology that enables the production of energy without emitting greenhouse gases or pollutants**. The objective of the responsible team is for this **low-cost, sustainable, and quickly implementable technology to be used in both stationary and mobile applications**.

In this context, **the technology transforms methane** (which can be biomethane or natural gas) **into carbon and hydrogen without producing other pollutants**. It is expected that, **in the case of natural gas use, this process will represent savings of approximately 50% compared to the method currently in use. If biogas is used, the estimated savings rise to 90%**.

In the context of stationary applications, and taking the chemical and petrochemical industries as examples, the **hydrogen produced could be used in fuel cells to generate electricity and to transform iron ore into metallic iron**. This change would allow for the supply of hydrogen to neighborhoods or districts.

Globally, the **ammonia industry consumes about 55% of the hydrogen produced, followed by refineries with approximately 25%, and methanol production with about 10%**. In 2022, according to the IEA, around **95 million tons of hydrogen were produced, representing a total of 1.2 Gton of CO2 emissions** (the IEA reports an average of 12-13 kg of CO2 emitted per kilogram of hydrogen produced).

Approximately 48% of this hydrogen is produced through Steam Methane Reforming (SMR), emitting around 9 kg of CO2 per kilogram of hydrogen. If all hydrogen production via SMR were **replaced by the CMS process, it would result in CO2 savings of 410 Mton and €62 billion** (€95 GkgH2 × 0.48 × (€2.74/kg H2 - €1.39/kgH2) = €62 billion or €62,000 million), assuming CO2 emissions must be paid for. **If the global production of hydrogen were replaced by CMS, the CO2 emission savings would amount to 1.2 Gton per year.**

In mobile applications, **the carbon or charcoal produced in particle form could be used in construction**, with examples including the production of composite blocks, roads, and/or the tire industry.

The energy «the planet needs»

The chemical reaction that transforms methane into hydrogen and carbon is known as methane cleavage or methane decomposition.

"The success of this project will very quickly allow for energy production based on natural gas without CO2 emissions, gaining the time the planet needs to **develop other technologies that exclusively use renewable energy sources**. In any case, **methane cleavage will remain one of the most efficient technologies for atmospheric CO2 removal when combined with the biogas industry,"** explains **Adélio Mendes, a researcher at the Laboratory for Process Engineering, Environment, Biotechnology, and Energy (LEPABE) at FEUP and leader of the project's research team**.

The "112CO2" project has secured European funding totaling €3.5 million and includes partners such as the Faculty of Arts of the University of Porto (FLUP), the Agencia Estatal Consejo Superior de Investigaciones Científicas (CSIC) in Spain, the Deutsches Zentrum für Luft- und Raumfahrt (DLR) in Germany, and the École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland. **Several European companies are also involved**, including Quantis (Switzerland), Paul Wurth (Luxembourg), and PixelVoltaic (Portugal).

Biogas at WWTP

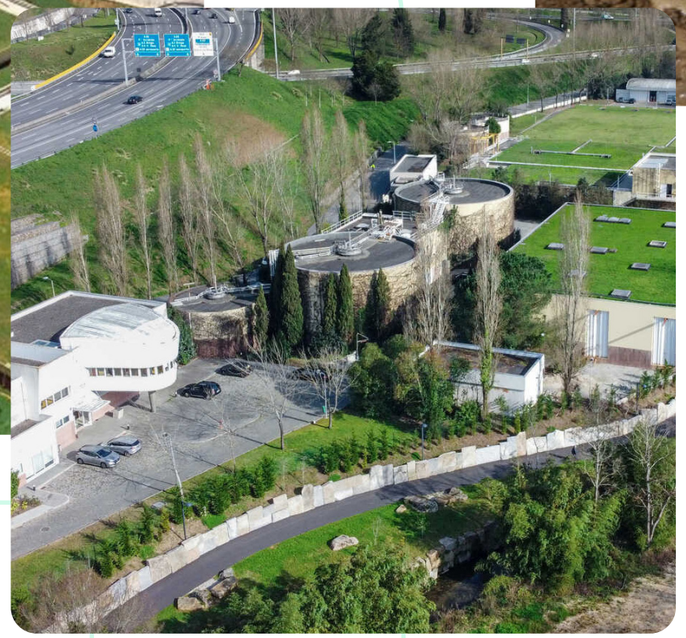
Cecília Santos

Explore the project

In the current context of energy transition and the fight against climate change, Wastewater Treatment Plants (WWTP) play a crucial role in promoting a more sustainable future. Águas e Energia do Porto (AEdP) is committed to transforming wastewater treatment by focusing on energy efficiency and the recovery of resources contained in wastewater.

On the path toward energy neutrality, various **projects are being implemented, aiming both to reduce energy consumption and to produce renewable energy.**

One of these projects involves **biogas production**. At the **Freixo WWTP, primary and biological sludge produced during wastewater treatment is stabilized through anaerobic digestion**. In this process, which takes place in the absence of oxygen under controlled conditions, **organic matter in the sludge is broken down and converted into biogas**, which is primarily composed of methane. **Biogas is a renewable energy source, and its recovery helps reduce reliance on fossil fuels, fostering a transition to more efficient and sustainable energy sources. The optimization of the anaerobic digestion process and the enhancement of biogas utilization will improve the use of this resource**.



Another important project focuses on photovoltaic energy production. The **Freixo WWTP already has a photovoltaic energy production unit for self-consumption**, which will be expanded to a total installed capacity of 570 kW. Similarly, at the **Sobreiras WWTP, 387 kW of solar panels are being installed**.

These projects will enhance **energy autonomy and significantly reduce carbon emissions**. The complete coverage of Porto's WWTP not only facilitates landscape integration but also provides extensive areas for the installation of such energy production units.

In parallel, equipment in **both WWTP is being replaced with more energy-efficient technologies** as part of a broader strategy to revamp and optimize processes.

In the field of research and development, **projects like SUPREMAS are underway. This international initiative, funded by the HORIZON Europe program, aims to develop and test technology for renewable energy production through the gasification of various types of waste.**

Águas e Energia do Porto will play a key role by testing and validating this technology on WWTP sludge, installing a modular mobile unit at the Freixo WWTP. The syngas obtained from the sludge will be purified and can be used in cogeneration systems or Solid Oxide Fuel Cells (SOFCs), enabling highly efficient generation of electrical and thermal energy without atmospheric emissions. The significant advantage of this process lies in the complete valorization of the sludge **produced at the WWTP, along with the production of byproducts such as BIOCHAR and CO2, both with high recovery potential.**

All these projects align with the municipality's strategy for energy transition and decarbonization, reinforcing its commitment to sustainability and the circular economy.

Photovoltaic Panels at FEUP

Ana Sofia Guimarães

Explore the project

The Faculty of Engineering at the University of Porto (FEUP) completed the installation of a new self-consumption photovoltaic production unit in 2021.

This project, executed over a six-month period, involved the **installation of 708 panels on the rooftops of several campus buildings**, covering an area of approximately 1,420 m² and with an installed capacity of 280 kW DC.

In addition to supporting the **implementation of sustainable energy policies, the installation of these panels also contributed to reducing electricity consumption costs.**

The installation is producing an average of 417 MWh annually, representing about 10% of FEUP's electricity consumption, and has **resulted in an average annual cost savings of approximately 100,000 euros**. In terms of **CO2 emissions**, calculations estimate a **reduction of 100 tons per year**.

The project, valued at 233,000 euros, was executed by DST Solar and fully funded by Santander Totta as part of an existing protocol with the University of Porto.

Porto Solar

Daniel Freitas

Porto Solar is one of the initiatives implemented by the Porto municipality as part of its ambitious climate strategy outlined in the Porto Climate Contract and earlier strategic frameworks. In partnership with the Porto Energy Agency (AdEPorto), Domus Social, and Águas e Energia do Porto, this initiative **aims to implement photovoltaic systems for energy production and consumption in municipal buildings**, enabling them to become **producers of clean energy and contributing to the city's decarbonization**.

In its first phase, **Porto Solar covered a total of 29 municipal buildings, including 25 primary schools, the Municipal Police headquarters, the facilities of Porto's Municipal Fire Brigade, the Municipal Nursery, and the Carvalhido municipal facilities, with the installation of 5,143 m² of solar panels**. The municipal investment of approximately €722,000 allows for a reduction of about 30% in electricity consumption from the grid, savings of over €150,000 annually on electricity bills, and a **reduction of approximately 412 tons of greenhouse gas (GHG) emissions per year. Additionally, the energy produced enables the charging of part of the municipal fleet's electric vehicles using 100% renewable energy**.

At the **facilities of Porto's Municipal Fire Brigade, renewable energy production now exceeds half of its consumption, with annual savings of over €23,000 projected by the municipality**. These investments are significant, as, on average, **30% of energy consumption in these buildings now comes from renewable sources**.

In addition to the environmental and economic benefits, **this project has an educational dimension, as students from the various schools involved can access real-time data on solar energy production and consumption**.

This allows them to compare results with other schools and understand the scale of energy consumption in their facilities. By engaging younger generations, the initiative aims to **raise awareness about efficient and responsible energy consumption habits**.

Looking ahead, the municipality intends to continue **investing in photovoltaic installations across its numerous buildings to further increase the production of clean energy and enhance Porto's energy resilience**. Porto Solar will undergo new phases of expansion and be developed alongside other photovoltaic

installation projects in municipal buildings. In doing so, **Porto reaffirms its commitment to combating climate change**, integrating projects like Porto Solar into its environmental strategy, which aligns with **political commitments to achieving the city's carbon neutrality**.

This clean energy production approach sets an example for fostering a city better prepared for future energy challenges while **encouraging the community to adopt a culture of conscious and sustainable consumption**.

Energy Communities | CoGeneration

José Luís Alexandre

Explore the project

The Faculty of Engineering of the University of Porto (FEUP) has been actively involved in developing technologies and solutions aimed at reducing carbon emissions, striving to meet national and international emission targets by 2050.

Highlighted initiatives include:

1. **"Auto-gasification" of biomass** for use in internal combustion engines, enabling the simultaneous production of electricity and heat (heating + cooling)

2. Production of **synthetic fuels (eFuels)**

3. **Conventional cogeneration units** powered by renewable gases

According to J**osé Luís Alexandre, a researcher from the Fluids and Energy Section of the Department of Mechanical Engineering at FEUP**, these represent **a new generation of cogeneration units capable of using natural gas mixed with hydrogen (H2NG) or other renewable gases**.

Initially, these blends can incorporate up to 25% hydrogen but could evolve to systems running entirely on hydrogen. Lower hydrogen percentages require minimal technical adaptations to existing engines. However, utilizing 100% hydrogen presents significant challenges due to the high combustion temperatures that result in NOx (a harmful pollutant).

In such cases, **cogeneration (or tri-generation) offers promising technological solutions, both in the initial phases with natural gas usage and later with blends of synthetic fuels** (e.g., synthesized methane).

A practical example is the **Hospital São João in Porto. It operates a modern cogeneration unit with over 12 years of service, producing 7.29 MW of electricity, 7 MW of heat, and 4 MW of cooling for the hospital's needs**. This is not an isolated case; Viseu Hospital is also installing a cutting-edge unit under the PRR program. This unit supports HyBlend with up to 25% hydrogen and potentially higher levels, producing 1.0 MW of electricity for self-consumption and hot water (mainly sanitary) and cooling when necessary. **These systems can also run on landfill biogas, biogas from urban wastewater digesters, or eFuels**.

Such self-consumption units powered by renewable gases can be integrated into renewable energy communities. However, **their operational and investment costs are higher than photovoltaic panels**, explaining the more widespread adoption of solar energy systems compared to cogeneration units.

Teresa Santos

Rui Pimenta

Explore the project

Renewable Energy Communities:

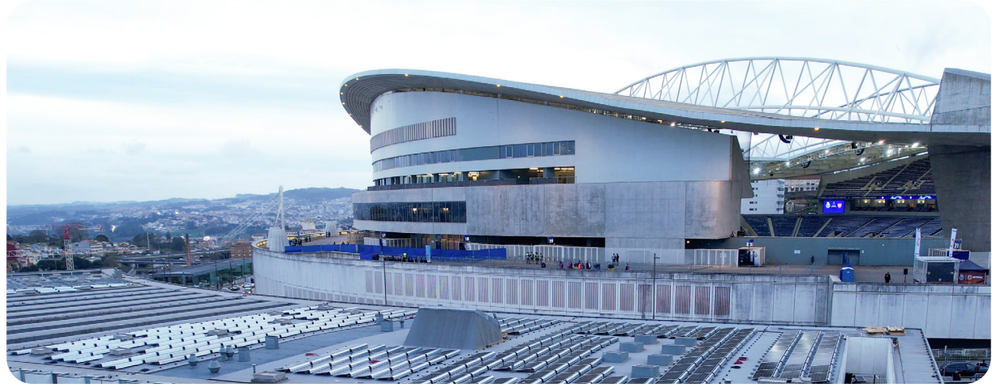
Futebol Clube Porto and Porto Wholesale Market

The **city of Porto** has made **substantial progress in energy transition through innovative actions focused on decarbonization and fostering renewable energy communities**. Two private entities stand out as leaders in this field

Futebol Clube do Porto

The Futebol Clube do Porto (FC Porto), in partnership with Greenvolt, has developed two renewable energy communities: one in the eastern part of Porto and another at the Olival Training Center. This initiative aims to **promote efficient energy management**, enabling local residents and neighboring institutions to contribute to and benefit from photovoltaic electricity production and consumption. The goal is to **attract more participants to these communities, providing access to sustainably produced electricity at reduced and competitive prices**.

Approximately **2,000 photovoltaic panels have been installed at the Dragão Arena and other facilities.** While this is not sufficient to meet all energy demands, **the project offers mutual benefits**. Local producers gain financial advantages by selling surplus energy, **while FC Porto reduces energy costs, decentralizes energy production, enhances environmental performance, and adopts cleaner energy practices**.



Porto Wholesale Market

The Porto Wholesale Market is a prime example of practical excellence in the city's decarbonization efforts. A 1.5 MW photovoltaic system for self-consumption has been installed, resulting in an annual reduction of 1.68 GWh in grid energy consumption and a decrease of 430 tons in greenhouse gas emissions. This project is both environmentally and financially attractive, generating significant benefits for all involved while supporting the city's ambitious climate goals. **The surplus energy produced at this facility can be shared with other local entities, maximizing the potential of renewable energy communities**.

In Campanhã parish, several investments are being implemented to create a renewable energy hub addressing diverse energy needs. This includes the Estádio do Dragão, Porto Wholesale Market, Porto's former slaughterhouse, and various municipal buildings for services and social housing. These initiatives are part of Porto's broader commitment to its **Climate Pact, which seeks to achieve carbon neutrality by 2030**.

Renewable energy communities, combined with other efficiency measures and renewable energy production solutions, **strengthen Porto's leadership in energy transition**. By balancing resource sharing and sustainable consumption, alongside the integration of clean technologies, **the city is building a future centered on the needs of new generations**.

TECH4 Sustainability: More Clean Energy

What happened at the conference

Joana Maia

Filipe Araújo

Adélio Mendes

Porto stands out in the urban sustainability landscape with innovative renewable energy projects that combine municipal efforts with academic expertise. During the **TECH4 Sustainability Conference, themed "More Clean Energy,"** Filipe Araújo, Vice-President of Porto City Council, and Adélio Mendes, professor and researcher at FEUP, discussed key initiatives such as **Energy Communities (CE), scientific research projects, and the role of academia in the energy transition. The panel was moderated by Joana Maia.**

Energy Communities are strategic in promoting renewable energy production, reducing carbon emissions, and encouraging civic participation. Filipe Araújo highlighted initiatives like **Porto Solar,** which directly engage citizens in green energy generation**.**

However, **Adélio Mendes questioned whether academia is effectively contributing to the energy transition and suggested that the University of Porto** establish a dedicated office to align research with public policies, maximizing the impact of applied solutions tailored to local needs.

The session addressed challenges such as **dependency on Chinese-made photovoltaic panels**, a critical factor for energy security. **Mendes advocated for the development of buildings that integrate functionality, aesthetics, and energy efficiency**, requiring collaboration between architects and engineers.

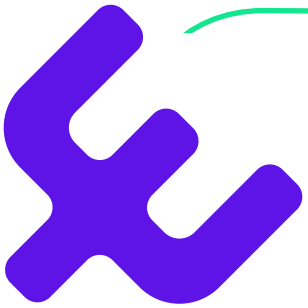
Additionally, **concerns were raised about the environmental impact of large-scale solar panel production**, with proposals for a mix of renewable energy sources to mitigate waste and reduce environmental impact.

The 112CO2 project, funded by the European Commission, was **highlighted as a model for clean energy production, capturing CO2 and transforming it into accessible and storable energy.** This initiative was presented as a **"win-win" solution with significant potential to integrate urban and industrial energy networks**, helping

By fostering collaborative practices and integrating complementary technologies, Porto strengthens its commitment to urban sustainability, positioning itself as a model of innovation in renewable energy and the circular economy.

Porto decarbonize its energy grid. Filipe Araújo also referenced the biogas project at the Freixo WWTP, which converts waste into energy at significantly lower costs than natural gas, promoting the circular economy and leveraging local resources.

The session underscored the value of cooperation between academia, the municipality, and companies, emphasizing the need for diversified and resilient energy solutions. Adélio Mendes highlighted the potential of international partnerships in developing best practices and advanced technologies that can be locally applied to optimize energy network efficiency.



More Clean Energy

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