

European Regional Development Fund

NEWSLETTER N°2

EVOLUTION OF THE IMPROVEMENT PROJECT

IMPROVEMENT-Integration of Combined Cooling, Heating and Power Microgrids in Zero-Energy Public Buildings under High Power Quality and Continuity of Service Requirements

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Newsletter N°2



KICK-OFF MEETING OF THE IMPROVEMENT PROJECT IN CORDOBA

Due to the COVID-19 situation most of the IMPROVEMENT project meetings were held online. We summarise below the meetings held so far between the partners of this consortium:

24-25/02/2021. ONLINE / CONSORTIUM MEETING N° 3 TOGETHER WITH A TECHNICAL AND STEERING COMMITTEE MEETING.

The main project progress focused on the scientific articles in IEEE Trans on Power Systems (Q1) related to the Energy Management System of the CNH2 pilot plant, such as <u>"Cooperative Optimization of Networked Microgrids for Supporting Grid Flexibility Services using Model Predictive Control"</u> or <u>"Optimal schedule for networked microgrids under deregulated power market environment using model predictive control"</u>.

In order to advance in the business model, the Global Architecture of the pilots was defined. Moreover,

the Andalusian Regional Government started the regulatory framework for implementation. Due to the COVID-19 situation, laboratory tasks were delayed so the power control system was advanced through simulations and tests. The thermal system was defined in both pilot plants as established in the planning.

15-16/07/2021. ONLINE / CONSORTIUM MEETING N° 4 TOGETHER WITH A TECHNICAL AND STEERING COMMITTEE MEETING.

The IMPROVEMENT consortium shared the status of the different tasks and work packages being developed:

- The Andalusian Regional Government showed their progress regarding business models and the study of applicability building.
- The University of Cordoba presented an innovative method with which to receive a real-time measure of power quality for the different loads connected to the pilot plants.
- The University of Castilla La Mancha showed their progress as regards to the development of a fourwire power inverter with active neutral control.
- ENSMA has produced a machine learning algorithm with which to predict the load





consumption in the Hospital of Axarquia of Velez Malaga, while the University of Lisbon is working on forecast algorithms for the energy generated in microgrids and the prediction of day-ahead energy prices.

- The University of Perpignan and the National Hydrogen Center have developed advanced energy management systems for microgrids under minimum degradation criteria for combined cooling, heating and power microgrids with a hybrid energy storage system.
- The National Laboratory of Energy and Geology (LNEG) explained innovative techniques for the reconversion of public buildings into Zero Near Energy Buildings.
- Finally, the integration of two pilot plants was presented by CNH2 and LNEG.

17-18/11/2021. ONLINE / CONSORTIUM MEETING N° 5 TOGETHER WITH A TECHNICAL AND STEERING COMMITTEE MEETING.

A two days project partners meeting was held where the lead partners of each work package presented the different advances achieved by the IMPROVEMENT project.

Specifically, it was discussed during the meeting how progress has been made in the development of the architecture of the two pilot plants through the installation of equipment and the use of new techniques such as phase change materials, as well



as the advancement and development of thermal and energy management systems that will provide intelligence pilot plants. Progress has also been made in the different advances in the facilities and works of the LNEG (Lisbon, Portugal) and CNH2 (Puertollano, Spain) pilot plants. Moreover, the analysis and implementation of business models have been carried out by the consortium.

Partners were informed that the IMPROVEMENT website and communication material (roll-ups) are available, and, in terms of supply quality, progress has been made as planned in the development of the inverter and intelligent sensorization (IoT) with the collaboration between the University of Córdoba and the University of Castilla-La Mancha.

In regard to the Energy Management System, other advances have been carried out using different price and time prediction algorithms, which will be implemented in the final pilot plants.





25/11/2021. ONLINE / INTERMEDIATE MEETING WITH SUDOE SECRETARIAT.

The project consortium was represented by the main beneficiary and coordinator, the National Hydrogen Centre and the coordinator of project communication, the Andalusian Energy Agency. In addition, the Euro-Funding company supporting the internal coordination of the project to CNH2 also participated in the meeting, as well as the SUDOE Secretariat, Ms. Patricia Herrán who is in charge of the communication of the Secretariat and Ms. Marién Delgado, as manager of the IMPROVEMENT project for the SUDOE Secretariat.

During the meeting, the main progress was shared, together with an analysis of the results and their consequent effects of the development and implementation of the project during this period. The importance of transnational collaboration as a means to achieve the objectives of the project and the main steps taken to implement a future capitalization plan after the project was highlighted.



24/03/2022 & 08/04/2022. ONLINE / CONSORTIUM MEETING N° 6 TOGETHER WITH A TECHNICAL AND STEERING COMMITTEE MEETING.

A two days project partners meeting was held in order to share among partners the project status, after an adaptation to the COVID-19 situation. The consortium is entering in the year 2022 of the works that have been prorogated until 31 of March 2023.

Partners explained the advance of the work. From Andalusia, the Andalusian Regional Agency showed their progress regarding business models and the study of applicability building. The University of Cordoba presented an innovative method with which to receive a real-time measure of power quality for the different loads connected to the pilot plants. The University of Castilla La Mancha showed their progress as regards the development of a four-wire power inverter with active neutral control. ENSMA has produced a machine learning algorithm with which to predict the load consumption in the Hospital of Axarquia of Velez, Malaga, while the University of Lisbon is working on forecast algorithms for the energy generated in microgrids and the prediction of day-ahead energy prices. The University of Perpignan and the National Hydrogen Centre have developed advanced energy management systems for microgrids under minimum degradation criteria for combined cooling, heating and power microgrids with a hybrid energy storage system.

We would like to highlight the roll of the Pilot Plants within the Improvement Project, as National Hydrogen Centre explained the advanced at the project pilot. The National Laboratory of Energy and Geology also explained the innovation at the pilot project.



18-19/07/2022 & 21/07/2022. PERPIGNAN (FRANCIA) / CONSORTIUM MEETING N° 7 TOGETHER WITH A TECHNICAL AND STEERING COMMITTEE MEETING.

After the COVID-19 restrictions, the time has finally come for the IMPROVEMENT partners to meet again in person, this time in France. During this meeting, the progress of each working group was reviewed in detail and technical visits were made, among which the Solar Furnace in Odeillo stands out.



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CONFERENCES AND PRESENTATIONS OF IMPROVEMENT

The evolution of the project was presented in the following events:

01/07/2021. ONLINE / XVIII ANNUAL SEMINAR ON AUTOMATICS, INDUSTRIAL ELECTRONICS AND INSTRUMENTATION, SAAEI 2021

Presentation of the IMPROVEMENT publication "Integration of microgrids for combined heat, cold and electricity generation in public buildings with zero consumption under criteria of high quality and continuity of supply" by the National Hydrogen Center.

11-17/07/2021. ONLINE/ 21 CONGRESO MUNDIAL DE LA FEDERACIÓN INTERNACIONAL DE CONTROL AUTOMÁTICO, IFAC 2021

Presentation "Power Quality Management of Interconnected Microgrids Using Model Predictive Control" as a result of the IMPROVEMENT by the National Hydrogen Center.

15-17/09/2021. IN PERSON / MÁLAGA (SPAIN) / 22ND NATIONAL CONGRESS OF HOSPITAL AND SANITARY MANAGEMENT.

The University of Córdoba presented the results of the IMPROVEMENT project in a plenary twodays conference called "IMPROVEMENT Project - Integration of Microgrids of Combined Heat, Cold and Electricity Generation in environments with High Quality Requirements and Service".

This event has become an important appointment for the **Spanish Society of Health Directors** (SEDISA) and the **National Association of Nursing Directors** (ANDE), as organising entities, with health management in general and specifically with the professionalisation of health managers.





05/04/2022. ONLINE / IMPROVEMENT AWARENESS EVENT N° 1 IN FRANCE.

Presentation of the IMPROVEMENT project through a brief overview and summary about the project, its main objectives, what steps have been followed so far and what achievements and milestones have been met since the project was officially launched in January 2020.



18-20/05/2022. IN PERSON / MADRID (SPAIN) / EUROPEAN HYDROGEN ENERGY CONFERENCE 2022, EHEC 2022.

This Europe's conference is a reference in the field of hydrogen energy and it was identified in the Spanish Hydrogen Roadmap in 2020 as one of the measures to position Spain as a benchmark for these technologies in Europe.

The National Hydrogen Centre presented the first results of the IMPROVEMENT project with the presentation "Integration of Combined Cooling, Heating and Power Microgrids in Zero Energy Public Buildings with High Power Quality and Continuity Requirements".



14-16/06/2022. IN PERSON / MADRID (SPAIN) / INTERNATIONAL ENERGY AND ENVIRONMENT FAIR, GENERA FORUM 2022.

The GENERA Forum is one of the largest commercial platform for this industry, with the support of the Institute for Energy Diversification and Saving, IDAE (Ministry for Ecological Transition and Demographic Challenge) as well as with the renewed support of the main agents of this important economic sector.

The National Hydrogen Center, Andalusian Energy Agency and the University of Córdoba presented the results of the IMPROVEMENT project. The main lines of research, the objectives pursued, as well as some of the main milestones and achievements to date with this project were explained.



20-22/06/2022. IN PERSON / PALMA DE MALLORCA (SPAIN) / XVII IBERIAN CONGRESS AND THE XIV IBERO-AMERICAN CONGRESS ON SOLAR ENERGY, CIES 2022.

The National Laboratory of Energy and Geology presented the pilot plant in process in Lisbon (Portugal) in the framework of the IMPROVEMENT project.

The audience joined the researchers and experts from the Ibero-American community, as well as Spanish and Portuguese speakers, from the numerous fields of solar energy applications.





30/06/2022. ONLINE / SUDOE CONFERENCE.

The National Hydrogen Center presented the most recent advances of the IMPROVEMENT project, together with 3 projects of the Interreg SUDOE programme.



06/07/2022. IN PERSON / LLEIDA (SPAIN) / XXIX ANNUAL SEMINAR ON AUTOMATICS, INDUSTRIAL ELECTRONICS AND INSTRUMENTATION, SAAEI 2022

Presentation of the publications' IMPROVEMENT "Discrete Control with Nested Regulators for the Current Injected into the Grid with a Single-Phase Inverter and an LCL Filter" and ""Detection and



Compensation of Current Harmonics in a Microgrid using an Active Power Filter with an IoT Sensor Network" by the University of Castilla La Mancha.

19/08/2022. ONLINE / 2ND ELECTRONICS AND ELECTRICAL ENGINEERING VIRTUAL.

The University of Córdoba presented the results of the IMPROVEMENT project with the presentation "Combined cooling, heating, and power (CCHP) microgrids in nearly Zero-Energy Building with critical loads under high Power Quality and Reliability requirements, a position paper ".

29/09/2022. IN PERSON / PUERTOLLANO (SPAIN) / INTERNATIONAL CONGRESS ON HYDROGEN - H2 REVOLUTION

The National Hydrogen Center presented the results of the IMPROVEMENT project in this congress which is a perfect international showcase for any company and project related to green hydrogen and its countless applications.







PILOT PLANT AT LNEG FOR RENEWABLE GENERATION SYSTEMS

The **LNEG pilot plan** is implemented under the leadership of the National Laboratory of Energy and Geology, with the support of the Instituto Superior Técnico de Lisboa (IST), which will integrate renewable heat/cold generation systems in a microgrid for the conversion of an existing public building into a zero energy balance building. For this purpose, LNEG will make available the Laboratory for renewable energy integration installations at its Lisbon Campus.





The pilot plant is powered by a 4 kWp photovoltaic system and 2.5 kW wind turbine and 30 kWh battery storage system, all integrated on a solar trigeneration system that provides electricity to power a micro grid. The thermal comfort energy is provided by a Solar Hot Water (SHW) installation of 4m² Vacuum Tubes solar collectors and a 300 l

water storage tank coupled with a 16kW power air/water heat pump associated to 1000 I water inertial tank to heat and cool individually the pilot plant meeting rooms through 4 fan coils. A Solar Domestic Hot Water (DHW) system with 4,2m² PVT solar collectors and a 300 I solar tank completes the thermal installation.



INTERVIEW THREE QUESTIONS TO PARTNERS

Ana Estanqueiro. Scientific Responsible by Renewable Energy System Integration R&D

Ana Estanqueiro was born in Coimbra, Portugal in 1963. She has a PhD and MSc in Mechanical Engineering (Energy) and holds a 5 year degree in Electrical Engineering (Energy) from Instituto Superior Técnico - Technical University of Lisbon.

She is a senior researcher at LNEG, where she is the Scientist Responsible for the Area of Renewable Energy Systems Integration. Her scientific interests within renewable energies are vast, and LNEG benefits from both her electrical and mechanical background, being mainly focused on planning of power systems with large participation of variable renewable energy sources (vRES) including dynamic modelling and aggregation, grid integration and vRES participating into electricity markets and their contribution to system's services, as well as virtual power plants, microgrids and local energy communities.

She is an invited Associate Professor at the Masters of Engineering of Energy and Environment (MIEEA) at Faculdade de Ciências of University of Lisbon (FCUL) where she coordinates the Energy Networks and Wind Energy courses.

She is the Portuguese Delegate to International Energy Agency Wind Technology Collaboration Programme (IEA TCP Wind) and European Energy Research Alliance (EERA), Joint Programme on Energy System Integration and Wind Energy, as well as the representative of Portugal representing in the standardization technical commissions – IEC Technical Group 88-WG10 and CEN/CENELEC Wind Energy as well as President of CTE 88 – Wind Turbines (IEP/IPQ/IEC)¹.

She was Chair (2006-08) of the International Energy Agency (IEA - Implementing Agreement on Wind Energy and Vice-Chair (2004-06). She was a project expert and evaluator for the European Commission, the Danish Energy Agency, the Academy of Finland and the Nordic Energy Research among others.

Recent projects she is/was involved are H2020 TradeRES (as coordinator), POSEUR OffshorePlan, ERAnet+ NEWA, FP7 IRP.Wind, ESFRI Windscanner. eu, FP7 DEMOFLOAT, FP7 NORSEWIND, IEEE 2020 SEANERGY, FCT Fluct.Wind, FCT ROADMAP, FAI REIVE, DEMTEC T.URBan, among others.

She is reviewer of several scientific journals: IEEE Transactions on Power Systems, IEEE Transactions on Sustainable Energy; Renewable Energy, Wind Energy and IET Renewable Power Generation where she also is co-editor. She is the author and co-author of more than 190 papers in scientific journals and conferences.

WHAT WERE THE REASONS WHY THE NATIONAL LABORATORY OF ENERGY AND GEOLOGY (LNEG) DECIDED TO PARTICIPATE IN THE IMPROVEMENT PROJECT?

LNEG's participation in the IMPROVEMENT project is the recognition of our expertise and vast experience in the nZEB area, as well as in the variable renewable energy areas (vRES). CNH2 invited LNEG's researchers to join what enabled a fruitful collaboration in the preparation of the projects proposal, benefiting from both entities complementary experiences and expertise, with the valuable contribution from IST team, involved by LNEG in the project. LNEG's motivation lies on the alignment of this project workplan with LNEG's mission, in several main areas of activity, namely energy efficiency in buildings, solar energy, wind energy and (renewable) energy systems' integration, that enabled to build a pilot in which LNEG's (and IST's) teams are able to join efforts from different sectors and learn together how to improve the performance of existing public buildings, with minimal investment and optimization the outcomes, focusing on the dissemination of methods, materials and techniques applied In the SUDOE climates and other countries with similar climate and construction problems.

WHAT WILL THIS PROJECT BRING TO PORTUGAL AND TO LNEG?

The IMPROVEMENT project will enable LNEG to test new solutions to improve the energy efficient of existing buildings and tentatively bring them to a nZEB era. The focus of the Portuguese pilot is on the use of low-cost and minimal invasive techniques, that may be applied in public buildings with small (and short) construction works, using endogenous resources and renewable generation (solar thermal, solar PV and wind) thus optimizing the investment in converting these constructions into, possibly not fully nZEB, but much more energy efficient buildings, public and other.

Another very important side effect of the IMPROVEMENT project is to allow the dissemination of the developed methods, techniques and applied

Newsletter N°2



materials to other regions of similar climate, both within SUDOE regions and other countries.

For the reasons above, it is possible to conclude that the IMPROVEMENT project is fully in line with the current process of Energy Transition, and contributes to several measures of the Portuguese National Plan for Energy and Climate 2021-30.

WHAT IS THE CURRENT STATUS WITH NZEB AND HYDROGEN IN PORTUGAL AT THE MOMENT?

Portugal has a wide range of measures to support the energy efficiency and decarbonization of buildings, including quality standard, codes, certifications and financial support mechanisms for the renovation of old buildings. From January 2019, all new buildings owned or occupied by a public entity need to satisfy nearly zero-energy buildings (NZEB) requirements. Also starting in January 2021, all newly constructed or majorly renovated private buildings with an area larger than 1,000 m² need to satisfy those requirements. Under the National Buildings Energy Performance Certification System (SCE), all residential, service sector and public buildings must go through an audit to receive an energy certificate when they are constructed or deeply renovated, each time the building changes ownership or is leased and under other conditions for service sector or public buildings (IEA 2021²).

Portugal sees a key role for hydrogen produced from renewable energy in hard-to-decarbonize sectors and for achieving carbon neutrality. The National Hydrogen Strategy (EN-H2) sets a goal for hydrogen produced from renewable energy to cover 1.5-2% of Portugal's energy demand by 2030, foreseeing its use in industry, domestic maritime shipping, road transport and the incorporation into the natural gas network. The EN-H2 indicates that achieving those goals requires deployment of 2.0-2.5 GW of electrolysis capacity along with enabling legislation, regulations and standards (IEA 2021).

Portugal's National Energy and Climate Plan (NECP) sets 2030 targets for a 17% reduction of non-ETS GHG emissions and a 45-55% reduction in total GHG emissions with 47% renewable fraction at gross final consumption of energy, 80% renewable fraction at gross final consumption of electricity, 20% renewable fraction at transportation and 1% per year rise of the renewable share at heating and cooling processes, as well as the carbon neutrality national objective in 2050, which translates in a reduction of at least 95% of GHG emissions of the energy sector by 2050 (relative to 2005) (DGEG 2020³)

The introduction of hydrogen generation will favor the integration of vRES (variable renewable energy systems) as wind and solar photovoltaic systems, by promoting the flexibility of the power system, both in what concerns demand side management to consume vRES generation peaks (in excess of consumption) and the storage of that exceeding energy at large time scales.

On April 18th, Decree-Law 30-A/2022 was published, which "approves exceptional measures aimed at ensuring the simplification of energy production procedures from renewable sources" in line with the communication from the European Commission to the European Parliament, the European Council, the European Economic and Social Committee and the Committee of the Regions "REPowerEU: joint European action for safer and more sustainable energy at more affordable prices" (EU 2022⁴), which sets out greater ambition and a set of actions to accelerate the production of green energy, diversify supply and reduce demand.

At LNEG research groups are working to accelerate the sustainable energy transition by mapping Portugal's renewable resources (wind, bioenergy and green H2) and to ensuring all challenges regarding the integration of this variable renewable energy generation are overcome. LNEG mission is to collaborate with Portuguese society and entities outside Portugal developing new energy efficient, renewable energy-based, circular economy and decarbonized solutions (LNEG 2022⁵).



TECHNICAL PUBLICATIONS FROM PARTNERS

We would like to share with the IMPROVEMENT community some publications done so far:

- 14/12/2020. CNH2. Cooperative Optimization of Networked Microgrids for Supporting Grid Flexibility Services using Model Predictive Control
- 2. 16/12/2020. CNH2. Cooperative microgrids with advanced functionalities: Flexibility and resilience.
- 3. 01/01/2021. UCO. Electricity demand during pandemic times: the case of the COVID-19 in Spain.
- 4. 01/02/2021. CNH2. Microgrids power quality enhancement using model predictive control.
- 5. 26/02/2022. CNH2. Model Predictive Control for Microgrid Functionalities: Review and Future Challenges.
- 6. 27/02/2021. UCLM. Multiterminal HVDC System with Power Quality Enhancement.
- 7. 08/04/2021. CNH2. Stochastic Optimization of Microgrids with Hybrid Energy Storage Systems for Grid Flexibility Services Considering Energy Forecast Uncertainties.

- 8. 01/09/2021. UCO. Interactive visualization of IoT power quality data on mobile devices.
- 9. 02/09/2021. UCO. Energy Management Expert Assistant, a New Concept.
- 10.15/01/2022. CNH2. Resilience-oriented schedule of microgrids with hybrid energy storage system using model predictive control.
- 11. 17/03/2022. UCO. IoT Cloud-Based Power Quality Extended Functionality for Grid-Interactive Appliance Controllers.
- 12.06/07/2022. UCLM. Detection and compensation of current harmonics in a microgrid using an active power filter with an IoT sensor network.
- 13.06/07/2022. UCLM. Discrete control with nested regulators for the current injected into the grid with a single-phase inverter and an LCL filter.

Follow our section of publications on the project website <u>here</u>



For further information on the IMPROVEMENT PROJECT please, consult our web page:

https://www.improvement-sudoe.es/

IMPROVEMENT - Integration of Combined Cooling, Heating and Power Microgrids in Zero-Energy Public Buildings under High Power Quality and Continuity of Service Requirements is a project Co-Funded by the Interreg SUDOE programme of the European Union Grant Number SOE3/P3/E901



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