R&D NESTER

21 NL mai 2021

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EDITORIAL

Dear Reader,

The ongoing Energy Transition is requiring the Energy System agents to adopt new tools for their activities, being them planning, operation or others.

These new tools must cope with the new reality of demand side participation in the energy system, the management of flexibility sources by system operators, the continuous focus on efficiency and reliability of the system, among others. The H2020 European Project INTERPRETER ("*Interoperable tools for an efficient management and effective planning of the electricity grid*"), where R&D Nester is participating, is precisely looking into some of those aspects, as you can read below.

Furthermore, analytics and data management are increasingly becoming key aspects to take into consideration in the Energy System, namely for system operation and for network maintenance purposes. The new European projects BD4NRG ("*Big Data for Next Generation Energy*") and I-NERGY ("*Artificial Intelligence for Next Generation Energy*"), in which R&D Nester partakes, explore the application of big data, AI, IoT and analytics to improve decision making. We bring you additional information on this initiatives below.

As the Energy Transition progresses, namely with the introduction of diverse flexibility sources, it is important to ensure that the stability, efficiency and security of supply of the system is kept. OSMOSE project ("*Optimal System-Mix of Flexibility Solutions for European Electricity*") is looking into those aspects, with the participation of R&D Nester, and you can read about the application to Southern Western Europe below.

In a more exploratory note, on "*High-Temperature Super Conductivity for Accelerating the Energy Transition"*, you can read below how R&D Nester is contributing to COST Action CA19108 on that topic. We also bring you some information unveiling what we are doing on the solar energy forecast front and on the standard developments related to communications for smart-grids/smart-meters, namely Broadband communications. As you see, diverse and rich material to learn from! Also, we updated our Links related section, as new entities and organizations are emerging which can be of interest to you in this exiting, evolving and increasingly interconnected field.

Finally, if you are up to a challenge, you can see how you score on electricity protections trivia in our popular Quiz section at the end of this Newsletter.

Enjoy your reading!

Sincerely,

Nuno de Souza e Silva

Managing Director

HIGHLIGHTS

INTERPRETER Project promoted workshop on Flexibility Markets with R&D Nester's participation



INTERPRETER is a project financed in the scope of the European R&D H2020 Program entitled "Interoperable tools for an efficient management and effective planning of the electricity grid".

This project includes an ambitious validation phase, in which the solutions will be tested in 3 pilots in Belgium, Denmark and Spain, thus ensuring a high replicability across Europe.

The coordination of this 3 years project organized an online Workshop "Distributed Flexibility Markets in H2020 Projects" that was held on March 16th, with speakers from Horizon 2020 projects PARITY and INTERPRETER together with invited guests.



Grid integration and implementation of distributed flexibility market concepts were some of the topics discussed, in the context of the solutions under development in the projects.

Among other aspects, both projects had set to deal with grid management solutions to address the significant challenges on grid balance caused by known issues such as the inelasticity of demand or the continuously increasing presence of distributed intermittent energy sources.

Demand flexibility concepts strive to become part of the solution and, as such, generate new opportunities for planning, operation and control of the network.

For more information:

Link for Event

INTERPRETER website

INTERPRETER (R&D Nester website)

R&D Nester starts new European H2020 Project “BD4NRG” – Big Data for Next Generation Energy



The project **BD4NRG - "Big Data for Next Generation Energy"** is a 3-year project that started on January 2021 and will last until December 2023.

The need of increasing levels of information to operate the power systems is unveiling an enormous opportunity for energy stakeholders to leverage on Big Data and AI technologies to improve decision making.

In that respect the project BD4NRG that involves **35 partners from 12 countries** will in short:

- Deliver a **reference architecture to enable B2B multi-party data exchange**, while providing full interoperability of leading-edge big data technologies with smart grid standards and operational frameworks;

- Deliver an open **modular big data analytic toolbox** (data, computing resources, models, algorithms);

- Deliver predictive and prescriptive edge AI-based big data analytics on **13 large scale pilots**, deployed by different energy stakeholders (e.g. TSOs and DSOs, aggregators, local energy communities, ESCOs, etc), covering the energy value chain.

BD4NRG two days kick-off web-meeting counted with the participation of its 35 partners, from 12 countries, where, amid many others, R&D NESTER, REN, UNINOVA and ENERCOUTIM are from Portugal.

R&D Nester together with REN (Portuguese TSO) will develop proof-of-concept solutions to support two assets that are critical for the performance of the power systems:

- Condition-based maintenance of circuit breakers taking into account different operational conditions

- Generate a semi-automatic maintenance plan for overhead lines from inspection data.

The project is financed in scope of the H2020 program.

For more information:

https://cordis.europa.eu/project/id/872613

BD4NRG Project (R&D Nester website)

R&D Nester starts new European Horizon 2020 Project “I-NERGY” - Artificial Intelligence for Next Generation Energy



The project **I-NERGY - Artificial Intelligence for Next Generation Energy** is a 3-year project that started on January 2021 and will last until December 2023.

AI spreading in the energy sector is expected to dramatically reshape energy value chain in the next years, by improving business processes performance, while increasing environmental sustainability, strengthening social relationships and propagating high social value among citizens.

I-NERGY aims at evolving, scaling up and demonstrating innovative AI-as-a-Service (AIaaS) Energy Analytics Applications and digital twins services that will be validated along **9 pilots**, which range from optimised management of grid and non-grid RES assets, improved efficiency and reliability of electricity networks operation, optimising local and virtual energy communities involvement in flexibility and green energy marketplaces.

I-NERGY involves **17 partners from 10 countries** and will deliver in short:

- New AI-based energy services, fully aligned with AI4EU service requirements;

- An open modular framework for supporting AI-on-Demand in the energy sector by capitalising on state-of-the-art AI, IoT, semantics, analytics tools, which leverage on edge-level AI-based cross-sector multi-stakeholder sovereignty and regulatory preserving interoperable data handling.

R&D Nester is participating developing two use cases addressing the following topics:

- **Asset management** and predictive maintenance with specific focus on circuit breakers;

- Network loads and **demand forecasting** for operational planning **timeframe**.

For more information:

https://cordis.europa.eu/project/id/101016508

I-NERGY Project (R&D Nester website)

Task lead by R&D Nester in OSMOSE Project delivers results on Stability, Flexibility and Reserve Exchange for the European Power System



As the Energy Transition progresses, namely with the introduction of diverse flexibility sources, it is

important to ensure that the stability, efficiency and security of supply of the system is kept. OSMOSE project ("*Optimal System-Mix of Flexibility Solutions for European Electricity*") is looking into those aspects.

In the context of the activities from task **T1.4 - Innovative Flexibility Options in the Context of Planning, Operation and Stability**, led by R&D NESTER, the partners REN (PT) and ENSiEL (IT) successfully delivered the internal deliverables associated with their sub-tasks at the beginning of the current month of April.



These reports addresses two relevant topics from WP1 (Work Package), which tackles the long-term flexibility needs of the European power system, namely through the assessment of the impact of flexibility resources in multiple dimensions:

> **Sub-task 1.4.2 - "Cross-border reserve exchange for improved flexibility and efficiency"**, led by REN (Portuguese TSO), evaluates the long-term scenarios developed within WP1, with special focus on the Continental South West region (including Portugal, Spain and France), from the operational reserve needs perspective for this interconnected system. In this work, REN resorted to own tools.
>
> **Sub-task 1.4.3 - "Stability aspects"**, led by ENSiEL (Italian consortium of public universities), analysed the impact of high levels of renewable energy sources (RES) in the dynamic stability of South Italy power system. Additionally, assessed the contribution of these flexible resources, characterized by a power-electronics' based interface and/or low inertia (e.g. wind, solar, battery energy storage), to the dynamic stability of the system.

The two reports provide key takeaways from the analysis on the OSMOSE scenarios for 2030 and 2050 time horizons.

From the sensitivity analysis performed in T1.4.2 for the Continental South-West region (PT, ES, FR), none of the scenarios lead to any type of security of supply constraint. Nevertheless, in the scenario Current Goals 2050 the operation conditions were more demanding leading in some circumstances to reliability indexes (e.g. LOLE or EENS) greater than zero.

On the other side, in the stability analysis performed in T1.4.3 on part of the Italian power system, the simulation results support that the Sicilian power system operates within the normal frequency range when interconnection with continental Italy is maintained. In the case this interconnection is lost, the Sicilian system becomes less stable, requiring, in some scenarios, the contribution from wind farms, BESS and DSR (e.g. synthetic inertia) in order to be able to maintain the system's stability.

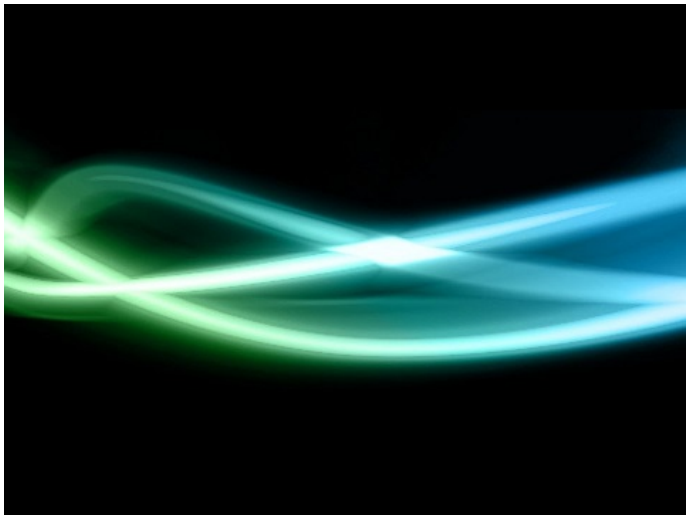
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°773406.

For more information:

OSMOSE website

Osmose Project (R&D Nester website)

R&D Nester participates in Workshop on Applications for High Temperature Superconducting Technologies in the Electrical Energy Chain



R&D NESTER participated in an online workshop organized by COST Action CA19108 - *High-Temperature SuperConductivity for Accelerating the Energy Transition.*

This workshop aimed to present high temperature superconducting technologies as well as possible applications in power systems, aiming at contributing to the energy transition.

R&D NESTER performed a presentation related to the context that power systems will face in the next few years, focusing on the technical and technological challenges that the sector is facing, particularly those related to the growing penetration of renewable energy sources and associated challenges.

R&D NESTER is one of the partners involved in this COST Action, which aims to contribute to the development of high temperature superconducting technologies and includes multiple partners from industry and academia at European level.

R&D NESTER contributed to this COST Action by sharing knowledge related to the current and future context of power systems and associated challenges.

All details can be accessed at: http://www.ieee-pemc2020.org/workshop.php

All details about this COST Action can be checked at: https://www.cost.eu/actions/CA19108/

R&D Nester welcomes 4 students to contribute in Research and Development



R&D Nester hosts this year 4 students who will contribute in research, studies and projects. Two of them are from **ISEL - Instituto Superior de Engenharia de Lisboa** and another 2 are from **ISEC - Instituto Superior de Engenharia de Coimbra**.

These selected students are from **Electrical Engineering** and **Mathematics Applied to Technology and Enterprise** courses.

This type of initiative allows these students to learn about the reality of the energy sector dealing with real projects and customers.

In these period of collaboration with R&D Nester, these students end up acquiring more in-depth knowledge of the many concepts of the electricity and energy sector in general that until then mostly knew in theory.

This experience seeks to reconcile the academic knowledge these students acquired in their courses, bridging the experienced in R&D Nester and the decisions that are associated to energy sector in general.

The context of R&D Nester is particularly suitable for this type of initiatives, as it provides them with work in Research, Development and Innovation areas, often close to the student's study areas and already with a connection to applications in business life.

The collaboration with these students will last between 4 to 7 months. Facing the current pandemic context by COVID-19, R&D Nester has adapted its organizational structure to the remote working mode, allowing to welcome these students remotely, managing to maintain the needed connection and information sharing.

This is intended to be an enriching and memorable experience and to boost the professional career of these 4 potential researchers and future professionals in the sector.

Trainees will work on themes such as **solar photovoltaic optimal park layout**, **voltage control with artificial intelligence methods** and **machine learning techniques for wind power forecasting**.

TECHNICAL INFORMATION

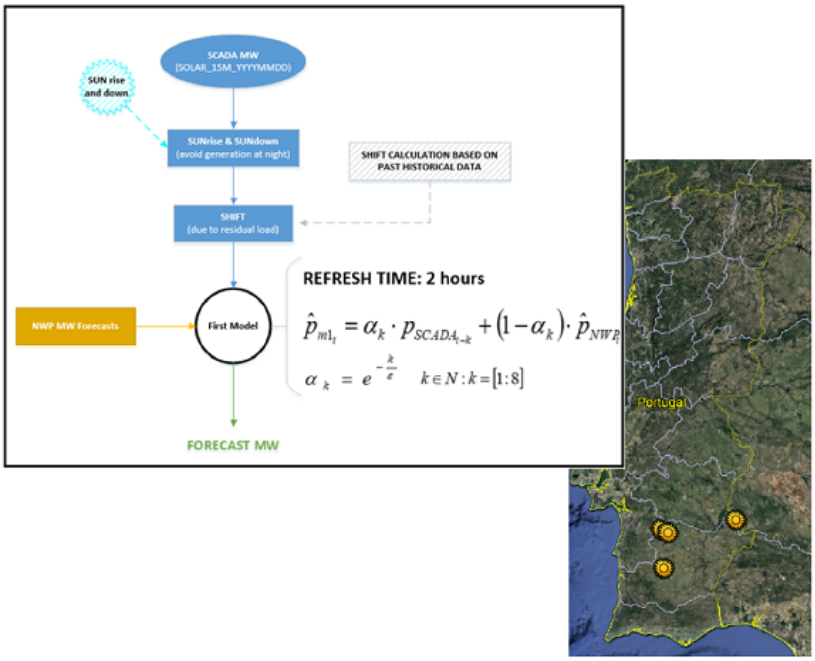
Results of applying persistence models to solar forecast

In the scope of solar energy forecast, R&D NESTER developed a case study to test the effect of **persistence algorithms** in the solar forecast. The persistence was applied using Supervisory Control and Data Acquisition (SCADA) power information and tested with four different photovoltaic (PV) power plants. Four different models were developed and tested:

- A persistence application using a **2 hours refresh rate**, which uses a SCADA power measure value to generate forecasts until 2 hours ahead.
- A persistence application using a **24 hours refresh rate**, which uses the SCADA power measurement of the previous day to generate the forecast.

- A persistence application that performs a **combination** of the previous models.
- A persistence application that utilizes the persistence error (using the output of the third model and the SCADA values) to improve the forecast using the persistence's error.

In the figure bellow, it is shown the location of the PV power plants used to build the case study, as well as the formulation of the first persistence model flowchart as an example. These PV power plants have different sun tracking technologies [1], which are taken into consideration in the developed models.



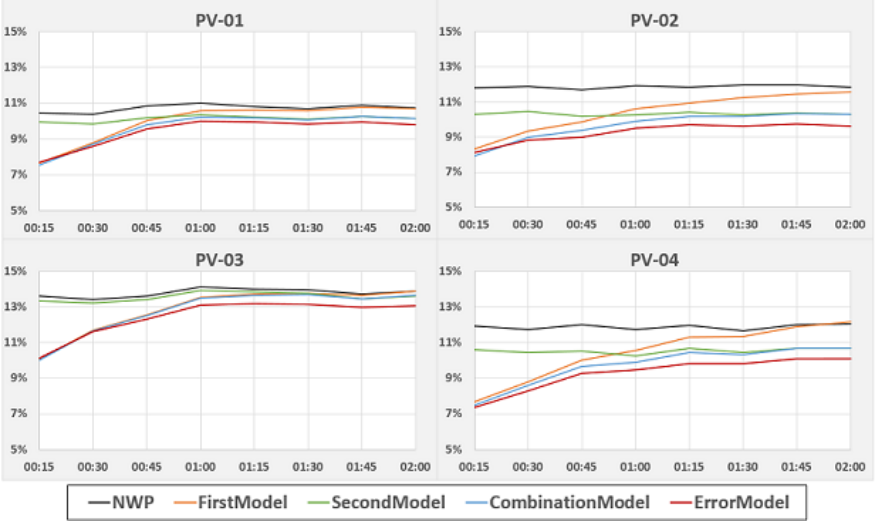
In addition to these developed models, a set of quality control methodologies were used in order to guarantee the quality of the SCADA values. On the one hand, the theoretical clear sky curve [2] was used to set the **sunrise** and **sundown**. This formulation takes into account the geographic location of the site under study. On the other hand, an **optimization model** was built to use past historical data to fit the SCADA to the real power production. Thus, aiming to mitigate the residual noise on the SCADA data.

Each one of the developed persistence models parameters were optimized using past historical data of real power production and SCADA data. In a first step, the total normalized root mean squared error (NRMSE) for the full year of 2019 was calculated. The error resulting from the numerical weather prediction (NWP) models are used as the baseline in which the persistence models are applied. These results are detailled in the Table below:

Site	NWP	*FirstModel*	*SecondModel*	*CombinationModel*	*ErrorModel*
PV-01	10.74%	10.03%	10.14%	9.66%	9.45%
PV-02	11.86%	10.48%	10.31%	9.68%	9.28%
PV-03	13.80%	12.93%	13.58%	12.83%	12.49%
PV-04	11.90%	10.57%	10.54%	9.78%	9.32%

The results show that using the persistence models with the NWP models can provide a benefit in terms of global error. Each one of the developed persistence models are able to reduce the NRMSE when compared to the NWP. Nevertheless, the latter two models are providing better results giving the fact that they are combining other models and, in the last one, using past error as refeed to self-correct the model.

The effect to each one of the developed persistence models can be easily seen when depicting the NRMSE values over a 2 hours time horizon. The contribution of each model can be clearly seen in the Figure bellow:



References:

[1] C. S. Solanki, "Solar Photovoltaics Fundamentals Technologies and Applications", New Delhi, PHI 2009.

[2] L.T. Wong, W.K. Chow, Solar radiation model, Applied Energy, Issue 3, July 2001, Volume 69, Pages 191-224.

IEEE 1901.1 – New Broadband Power Line Carrier standard



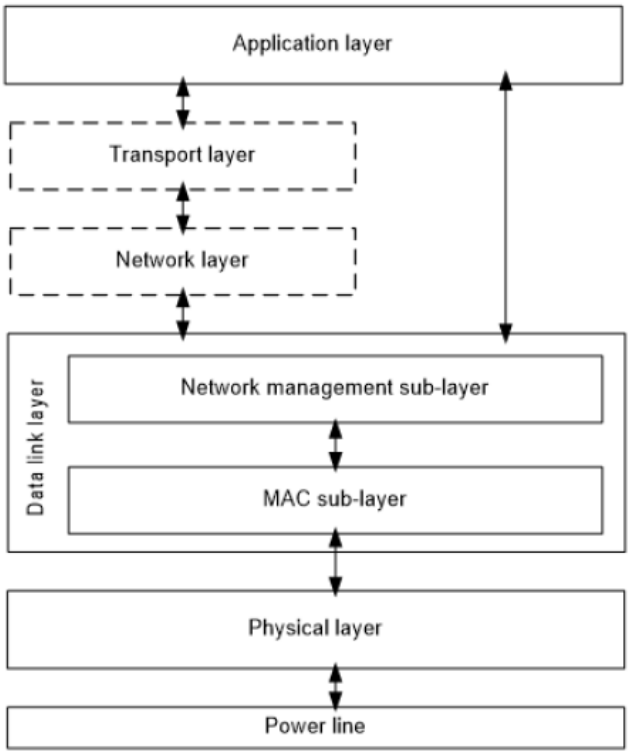
Power Line Communication (PLC) technologies have been developed over the last few years contributing to the implementation of smart grid services. PLC are used as part of AMI (Advanced Metering Infrastructure) solutions, enabling smart meters communication and paving the way for the creation of new innovative services in power systems, including smart billing or real time load/price information and control).

PLC technologies can be separated into two categories, depending on the used frequency: narrow-band PLC solutions (NB-PLC), operating at frequencies under 500 KHz and broadband PLC solutions, operating at frequencies higher than 1.8 MHz [1]. NB-PLC solutions are already commonly used [2]. PRIME [3] and G3-PLC [4] are two examples of well-known standards for communications using NB-PLC technologies. These are widely used accounting respectively for 20 million users in 15 countries and 50 million users in more than 30 countries. On the other hand, BB-PLCs have been substantially developed during the last decade but are not yet fully deployed in meter to concentrator communication levels. When compared to NB-PLC, these have increased bandwidths and bit-rates, allowing for the creation of more data-intensive services in the smart grids context.

In 2018, IEEE released the IEEE 1901.1 standard for Medium Frequency (less than 12 MHz) Power Line Communication for Smart Grid Applications standard [5]. This BB-PLC standard uses OFDM modulation and includes different physical layer specifications including innovative solutions as dual turbo coding, time-frequency interleaving, diversity copy and data link layer specifications including channel timing optimization, tree-topology network and multi-area network coordination. The standard

also defines an operation frequency band of 2 MHz to 12 MHz. Due to its novelty, IEEE 1901.1 is not largely deployed yet. Nonetheless, this standard presents a promising solution for PLC as it presents high bandwidth, high reliability and low delay as main operational characteristics.

As a reference model, the standard follows a general broadband carrier communication network protocol stack, illustrated in the next figure. It contains five layers: physical, data link, network, transport and application.



The network and transport layers reflect the same layers of the OSI model. The data link layer provides transmission services for the application layer and can interoperate with the TCP/IP model to provide IP communications. IEEE 1901.1 describes the physical and data link layers.

In summary, the data link layer, which is separated into the network management and the MAC sub-layers, and the physical layer have the following functions:

- Network management sub-layer: implements networking of a broadband carrier communication network, network maintenance, and route management; and aggregates and distributes application layer packets.

- MAC sub-layer: competes for physical channels based on the two channel access mechanisms, carrier sense multiple access with collision avoidance (CSMA/CA) and time division multiple access (TDMA), to provide reliable data transmission.

- Physical layer: encodes and modulates MAC sub-layer packets to broadband carrier signals and sends them to power lines or receives broadband carrier signals from power lines, demodulates them, and then sends them to the MAC sub-layer.

As multiple manufacturers are already working in devices which implement this PLC standard, IEEE is currently working on an additional standard, IEEE 1901.1.1 [6], which describes the conformance tests which should be performed in order to consider a device to be compliant with IEEE 1901.1. Additionally, IEEE 1901.1.1 also defines the necessary characteristics of compliance testing platforms, ensuring that these are made in similar conditions, ensuring common rules for all devices under test.

Within the next few years, it is expected that IEEE 1901.1 deployed solutions increase, providing a state of the art communication standard for power line communications. Its characteristics, namely the large bandwidth and high bit rate, will enable new smart grid related services.

References:

[1] S. Galli, A. Scaglione, and Z. Wang, "For the Grid and Through the Grid: The Role of Power Line Communications in the Smart Grid," Proc. IEEE, vol. 99, no. 6, pp. 998-1027, Jun. 2011.

[2] M. Hoch, "Comparison of PLC G3 and PRIME," in 2011 IEEE International Symposium on Power Line Communications and Its Applications, 2011, pp. 165-169.

[3] Prime Alliance, "Interoperable Standard for Advanced Meter Management & Smart Grid," 2021.

[4] G3-PLC Alliance, "G3-PLC," 2021. [Online]. Available: https://www.g3-plc.com/home/.

[5] IEEE 1901.1, "Standard for Medium Frequency (less than 12 MHz) Power Line Communications for Smart Grid Applications." 2018.

[6] IEEE 1901.1.1, "IEEE Approved Draft Standard Test Procedures for IEEE 1901.1 Standard for Medium Frequency (less than 15 MHz) Power Line Communications for Smart Grid Applications." 2019.

LITERATURE REVIEW

R&D Nester in Top 100 companies in Portugal that invested most in R&D activities

IPCTN 2019 - R&D Nesterin the list of the 100 companies in Portugal that invested most in R&D activities (category equivalent to SMEs).

Recently the National General Directorate of Statistics of Education and Science (DGEEC) published the Final results of IPCTN survey for 2019, regarding R&D expenditure in Portugal by companies.

DGEEC DIREÇÃO-GERAL DE ESTATÍSTICAS DA EDUCAÇÃO E CIÊNCIA

iPCTN 19 Inquérito ao Potencial Científico e Tecnológico Nacional 2019 EMPRESAS

According to this publication, the investment in 2019 placed R&D NESTER in the list of the 100 companies that invested most in R&D activities in Portugal, in the category equivalent to SMEs.

For R&D Nester, this achievement is a sign of commitment towards its shareholders and country, in developing new and innovative solutions in the energy sector.

Currently, R&D NESTER is working in several R&D Projects, covering topics such as Renewable Integration, Flexibility, Cooperation TSO-DSO, Big Data, among others. The complete portfolio of finished and under development projects can be found here.

Regarding national results, in the year under review, total R&D expenditure in Portugal reached 2,992 million euros (1.40% of GDP), which represents an increase of about 8% compared to 2018.

In the ranking of thematic areas with the highest growth in R&D investment in 2019, compared to the previous year, the highlights were "Transport, Mobility and Logistics", with a variation of 32.3%, and "Energy", with an increase of 18.8%.

However, it is in the areas of "Information and communications technologies" and "Health" that most was invested in R&D, 23% and 19% of total expenditure, respectively.

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1 The IPCTN is the official source of statistical information on R&D activities in Portugal. It is a survey of mandatory response, carried out in accordance with the criteria laid down at international level by Eurostat and OECD, with reference to the Frascati Manual.

News from FlexUnity Project "Power Flexible Communities Scaling-up project powered by Blockchain and AI"

R&D Nester partakes in the project FleXunity - "Power Flexible Communities Scaling-up project powered by Blockchain and AI", submitted to the European Commission's H2020 program and approved.

This project aims to develop commercially the concept of the energy community through the logical aggregation of consumers and distributed energy resources using AI and Blockchain.

FleXunity focuses on minimizing the cost of energy and optimizing the use of distributed renewables from the utility or community portfolio. Our energy community approach will promote active participation of end-users monetizing their flexibility and energy sharing, supported by secure transaction mechanisms with technologies such as blockchain. Below are some key figures associated with the project:



The key project outcomes will be achieved by testing and demonstrating the proposed services in two distinct pilots, in Iberia and in the UK, with very different market conditions:



On March 2021 was released the first issue of FleXunity's newsletter, where you can find the latest developments and details.

Also 2 brochures have also been published as part of this project. The last one was released recently in May.



FleXunity Website

FleXunity Project (R&D Nester website)

2021 World Energy Issues Monitor - Mar/2021 "Humanising Energy World Energy Council"

The World Energy Issues Monitor provides a snapshot of what keeps CEOs, Ministers and experts awake at night in over 100 countries. The Monitor helps to define the world energy agenda and its evolution over time. It provides a high-level perception of what constitute issues of critical uncertainty, in contrast to those that require immediate action or act as developing signals for the future.

This 12th iteration of the World Energy Issues Monitor is based on insights of more than 2,500 energy leaders in 108 countries to provide 60 national assessments across six world regions. This year's report also asks energy leaders to highlight the priority issues for 2021 and how prepared their country is to handle different risks.

This year's survey reveals diversity in regional perceptions of preparedness to pandemic crisis, adding to the list of new energy shocks - cyber threats, extreme weather events (flooding, drought, ice and forest fires). Successful recovery planning will require resilience to be built-in to avoid new energy shocks.



Link for publication

8 -11 Jun 2021

MUNICH, GERMANY

INTERSOLAR EUROPE 2021

20 -23 Jun 2021

KYOTO, JAPAN

ISIE 2021 - 30TH IEEE INTERNATIONAL SYMPOSIUM ON INDUSTRIAL ELECTRONICS

27 -2 May /Jun 2021

MADRID, SPAIN

POWERTECH 2021 - "POWER FOR THE SUSTAINABLE DEVELOPMENT GOALS"

20 -25 Jun 2021

PARIS, FRANCE

CIGRE CENTENNIAL SESSION

6 -8 Sep 2021

VAASA, FINLAND

4TH INTERNATIONAL CONFERENCE ON SMART ENERGY SYSTEMS AND TECHNOLOGIES (SEST'21)

17 -20 Oct 2021

PROVIDENCE, USA

THE GRID OF THE FUTURE SYMPOSIUM CIGRE US NATIONAL COMMITTEE (USNC) AND ELECTRIC POWER RESEARCH INSTITUTE (EPRI) TECHNOLOGY FOR THE 21ST CENTURY ELECTRIC UTILITY

6 -10 Sep 2021

(VIRTUAL)

38TH EU PVSEC - EUROPEAN PHOTOVOLTAIC SOLAR ENERGY CONFERENCE AND EXHIBITION

24 -27 Oct 2021

SAINT PETERSBURG, RUSSIA

25TH WORLD ENERGY CONGRESS 2022

29 -2 Nov /Dec 2021

VIENNA, AUSTRIA

3RD CIGRE SEERC CONFERENCE, "COOPERATION . SUSTAINABILITY . FUTURE"

QUIZ

1) ON WHAT PRINCIPLE DOES THE DISTANCE PROTECTION (I.E. FOR LINES) OPERATE?

- (a) Fault distance computation based on current measurements of both sides of the protected element;
- (b) Fault distance computation based on local (one side) current measurements of the protected element;
- (c) Fault impedance computation based on local (one side) voltage and current measurements;
- (d) Fault impedance computation based on measurements from both sides of the protected element.

2) ON WHAT PRINCIPLE DOES THE DIFFERENTIAL PROTECTION (I.E. FOR LINES/TRANSFORMERS) OPERATE?

- (a) Comparison of the current measurements of the three phases of the protected element;
- (b) Comparison of the voltage measurements of the three phases of the protected element;
- (c) Both a) and b);
- (d) Comparison (phase by phase) of the current measurements on each end of the protected element.

3) FOR WHICH PURPOSE IS THE AUTORECLOSE FUNCTION, WHICH PRODUCES AN AUTOMATIC CLOSE COMMAND TO A CIRCUIT BREAKER, USED?

- (a) To execute an automatic close command to the circuit breaker, at a programmed time of the day;
- (b) To execute an automatic close command to the circuit breaker, when the operator is not present;
- (c) To execute an automatic close command to the circuit breaker, after a trip of a protection due to a fault in the associated circuit;
- (d) To execute an automatic close command to the circuit breaker at one side of the line, when a line is energized from the other end.

4) POWER TRANSFORMERS COME EQUIPPED WITH A SET OF INTERNAL PROTECTIONS. WHICH OF THE FOLLOWING DOES NOT CORRESPOND TO A TRANSFORMER PROTECTION?

- (a) Buchholz protection;
- (b) Maxwell protection;
- (c) Pressure protection;
- (d) Winding Thermometer protection.

5) THE SYNCHROCHECK FUNCTION GIVES PERMISSION FOR A CLOSE COMMAND TO A CIRCUIT BREAKER BASED ON THE VOLTAGE AT BOTH SIDES OF THE EQUIPMENT. ON WHICH PRINCIPLE DOES IT WORK?

- (a) Checks that the frequency, at each side of the circuit breaker, is close to the nominal frequency (50 Hz) within certain limits;
- (b) Checks that the voltage magnitude, at each side of the circuit breaker, is within certain limits;
- (c) Checks that the difference of the voltage magnitude, frequency, and phase angle between each side of the circuit breaker are within certain limits;
- (d) Both b) and c).

Correct answers will be provided to you soon.
If you have problems answering this quiz, click here to answer this via browser.

1. Answer: (c) Fault impedance computation based on local (one side) voltage and current measurements;

2. Answer: (d) Comparison (phase by phase) of the current measurements on each end of the protected element.

3. Answer: (c) To execute an automatic close command to the circuit breaker, after a trip of a protection due to a fault in the associated circuit;

4. Answer: (b) Maxwell protection;

5. Answer: (d) Both b) and c).

LINKS

Some useful links:

ON RESEARCH, DEVELOPMENT AND INNOVATION

Portugal

- Portugal 2020
- Portal da Inovação
- Agência Nacional de Inovação (ANI)
- COTEC Portugal
- Portugal in Europe Research and Innovation Network (PERIN)
- Agência para o Desenvolvimento e Coesão (AdC)
- Direção-Geral de Estatísticas da Educação e Ciência (DGEEC)

Europe

- BRIDGE (H2020)
- European Energy Research Alliance (EERA)
- ETIP SNET - European Technology and Innovation Platform Smart Networks for Energy Transition
- Horizon 2020
- Horizon Europe
- BlueInvest
- EIT InnoEnergy
- Eurostat - Science, Technology and Innovation
- Funding, Tenders | European Commission
- Research and Innovation | European Commission
- Energy, Climate Change, Environment | European Commission
- European Distributed Energy Resources Laboratories (DERlab)

Rest of World

- China Electric Power Research Institute (CEPRI)
- EU-GCC Clean Energy Technology Network

OTHERS ENTITIES

- Laboratório Nacional de Energia e Geologia (LNEG)
- Associação de Energias Renováveis (APREN)
- Associação Portuguesa da Economia da Energia (APE)
- Portugal Energia
- Portal de Ciência e Tecnologia | Fundação para a Ciência e a Tecnologia (FCT)
- ERSE - Entidade Reguladora dos Serviços Energéticos
- DGGE - Direção-Geral de Energia e Geologia

- European Network of Transmission System Operators for Electricity (ENTSO-E)
- The European Wind Energy Association (EWEA)
- The Alliance for the Internet of Things Innovation (AIOTI)
- Joint Research Centre - Smart Electricity and Interoperability
- The European Commission's Priorities
- A European Green Deal | European Commission
- A Europe fit for the digital age | European Commission
- European Climate, Infrastructure and Environment Executive Agency (CINEA | ex-INEA)
- EUASP - The European Union Agency for the Space Programme
- ESA - The European Space Agency

- CIGRE - International Council on Large Electric Systems
- CTCN - Climate Technology Centre and Network
- GEIDCO - Global Energy Interconnection Development and Cooperation Organization
- Energy Web
- World Intellectual Property Organization (WIPO)

- International Energy Agency (IEA)
- International Electrotechnical Commission (IEC)

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