R&D NESTER

15 NL jun 2019

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EDITORIAL | HIGHLIGHTS | TECHNICAL INFORMATION | LITERATURE REVIEW | EVENTS | LINKS | QUIZ - This specific Quiz deals with concepts related to substations. The definitions have been taken from www.electropedia.org



EDITORIAL

- GIFT "Geographical Islands Flexibility", where R&D Nester is helping to develop innovative multi-service multi-vector energy storage solutions to decarbonize the energy system
- OSMOSE "Optimal System-Mix of Flexibility Solutions for European Electricity", where R&D Nester is contributing to the definition of flexibility services and the demonstration of the technologies that will enable to provide these services, including the consideration of issues such as interoperability and TSO-DSO coordination
- BigDataOcean, where R&D Nester is co-creating a platform and a database, that is currently one of the largest related to maritime applications (150+TBytes), with a particular focus on energy related services, namely aiming at reducing the currently required time to perform wave energy studies, thus contributing to the development of associated technology

We are also proud to announce that our Laboratory is once more listed in the European Commission's JRC "Smart Grids Laboratories Inventory" worldwide. We selected some highlights of the report for your information.

Our Technical Information section addresses two hot topics: "Clouds and Solar Power" and "Virtual Power Plants". Let us you know your feedback on those if you are active in that space.

We also bring to your attention some great industry literature material that was recently published in case you missed it. Topics are "Internet of Thing in Electricity", "TSO-DSO Integrated approach to active system management", "Innovation in Power Systems" by CIGRE and an official publication on R&D investment in Portugal where R&D Nester is listed.

As you can see, the industry is extremely active and counting with innovative solutions to address the challenges it is facing. We at R&D Nester continue engaged in Creating a Smart Energy Future and sharing it with our community. We hope that you find the minutes spent with us both relevant and rewarding. Enjoy your reading and please continue to share with us your feedback!

Sincerely,

Nuno de Souza e Silva
Managing Director

HIGHLIGHTS

R&D Nester in the kick-off of project GIFT - “Geographical Islands Flexibility”



The Kick-off meeting of the project GIFT - "Geographical Islands Flexibility" occurred on January 31 and February 1, 2019.

R&D Nester participates as leader of the Work Package on electricity, heating/cooling and transportation networks' synergies through multi-service multi-vector energy storage solutions.

The GIFT project is an Innovation Action awarded for funding by the European Union under the Horizon 2020 programme.

GIFT aims at decarbonise the energy mix of European islands through multiple innovative solutions, such as a virtual power system, energy management systems for harbours, factories and homes, better prediction of supply and demand and visualisation through a GIS platform, as well as innovative storage systems, allowing synergy between electrical, heating and transportation networks.

During 4 years, the partners will develop and demonstrate the solutions in two lighthouse islands, in Hinnøya, Norway's largest island and the small island of Procida in Italy. The project will also study the replicability of the solutions, at least, in Evia (Greece) and in Favignana (Italy). The GIFT project has started to build a Replication Board with associations that already gather 1640 European islands able to study the replication of the solutions into their territories.

The consortium gathers 17 partners from 7 countries, including 1 industrial partner, 9 SMEs, two municipalities, 3 research centres and 2 universities with the aim to provide sustainable solutions with a strong market uptake and plans to widely disseminate their solutions and replicate it on EU islands and beyond.

The project provides the possibility to apply and further develop the knowledge in flexibility management in the electric system, in the operation and management of storage system, in the usage of Demand Side Management and the integration of all these aspects in an electric system.

More information here

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824410

R&D NESTER CONTINUES TO CONTRIBUTE TO THE DEVELOPMENT OF SOLUTIONS RELATED TO WAVE ENERGY THROUGH BIGDATAOCEAN PROJECT



R&D Nester participated in one of the last consortium meetings of the European project BigDataOcean, which is funded by Horizon 2020. With the project ending in June 2019, this meeting had as main purposes the final definition of the project exploitation strategy and the final definition of the services to be offered by the platform developed in the project, which aims at being one of the world largest maritime data repository. Currently hosting around 150 TBytes of data, the platform already allows the execution of multiple big data related algorithms to extract value from the hosted datasets, such as data filtering, processing and clustering, and multiple data visualization tools.

Currently the project team is preparing to launch a pre-final version of the multiple services associated to the four pilots included in the project. One of these pilots is related to the assessment of weave energy potential, work leaded by R&D Nester. This release will happen during March, when all platform services will have available beta versions, to be tested by platform users.

In a work that since the beginning of BigDataOcean has been developed with the cooperation of ENONDAS, R&D Nester will allow platform users to verify the potential of waves as energy resource in multiple locations in Europe, and to verify the suitability of different wave energy converters to the selected locations. This service aims to reduce the currently required time to perform these studies, thus contributing to the development of this technology, which despite the fact that it is still in a premature stage of development, has the potential to become one of the most important energy sources in a medium term scenario.

All details of BigDataOcean can be accessed at www.bigdataocean.eu/site/ and more details about the platform, available data and services, and requests to have access can be obtained by emailing nuno.amaro@rdnester.com.

R&D NESTER ONCE MORE IN THE EUROPEAN COMMISSION'S JRC SMART GRID LABORATORIES INVENTORY



The Joint Research Centre of the European Commission published the third release of the inventory of Smart Grid Laboratories worldwide. The report containing aggregated technical information about the smart grid activities carried out by smart grid laboratories in Europe and has been published in the beginning of 2019.

R&D NESTER has been identified again as a European laboratory relevant in the field of Smart Grids.

Includes technical data about 89 smart grid laboratories. The majority of the participant laboratories are located in Europe (69), covering a large number of countries. The major part of labs is in Italy and Spain (11 and 14, respectively) with Portugal following (7 Laboratories).

Some general conclusions achieved were:

- The main focus of the labs activities are Generation and Distributed Energy Resources (DER) (85.2%), Demand Response (75%), Grid Management (75%) and Storage (70.5%).
- There is an increased interest in Generation and DER, ICT and Electromobility.
- The sector to which most of the work is addressed, is Utilities (70.5% of labs conduct research for it), with Industry and Academia following with 66% and 65% respectively.
- Technology development, R&D of equipment, Standards development and Prototype testing are fields on which more than 70% of the labs work on.
- 90% of the labs have their research activities on the distribution grid, whereas the islanded grid and the transmission grid are the ones to follow with 60% and 57% respectively.
- Almost 1/3 of the labs have spent between EUR 100,000 and EUR 500,000 as initial lab investments.
- Almost 1 out of 10 labs (11%) has dedicated investments of up to EUR 4 - EUR 5 million for the lab setup.
- The period in which these investments are spanned varies; however, almost 4 out 10 labs (38.5%) have performed the investments throughout 2-3 years.

The report 'Smart Grid Laboratories Inventory 2018' is available to download https://ses.jrc.ec.europa.eu/smart-grid-laboratories-inventory.

For additional information, please visit Joint Research Centre publications webpage.

REN AND R&D NESTER INVITED TO PRESENT THEIR VISION ON THE SUBSTATION OF THE FUTURE



It took place on March 29th, in Lisbon, organized by EFACEC, a session to present the DSGrid and ADMS4LV projects, in which EFACEC was one of the partners. Both are applied research projects subsidised by the Portugal 2020 funds.

The first, DSGrid (Digital Systems Technology for Next Generation Grid), had the goal to develop equipment and applications for the protection, automation and control (PAC) systems of substations of the transmission and distribution networks.

Since the 'Substation of the Future' project and its continuation 'Smart Substation testing and Implementation' project, under development at R&D Nester, involving REN and CEPRI, are also an initiative in the area of PAC systems, EFACEC, a partner in these projects, invited the development team to make a presentation on the theme 'The vision of the substation of the future'.

It was up to Ricardo Cartaxo, an R&D Nester researcher, to make this presentation, describing the various options taken in the project, in order to meet the vision for the substation of the future, achieved by the team in the first year of development, through the survey to several stakeholders.

For example, one of the options taken was the merging of control and automation system with the protection system, into a unique PAC system, with all functions having redundancy, which previously only happened in the protection system.

Ricardo also highlighted the new way the interlocking function is implemented, using rules instead of Boolean equations. This new approach avoids the need to develop new equations for a new substation or bay topology, which reduces the probability of error in the implementation of this function.

This researcher concluded his presentation by referring some possible future developments in PAC systems, not considered in this project: drones in substations, cloud computing (for protection algorithms), interchangeability (possibility to change one device by a different one, without loss of functionalities) and primary devices (circuit breakers, disconnectors, transformers) with communication interface to the PAC system.

For more information about the DSGrid project: http://www.dsgrid-project.efacec.com

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R&D Nester – BigDataOcean Workshop, June 5th

R&D Nester hosted on the 5th of June, at its headquarters in Sacavém, a Workshop to demonstrate the results obtained in the European project BigDataOcean.

This project, integrated in the European Programme for research, development and innovation "Horizon 2020" (H2020), has been developed since January 2017, through a multidisciplinary European consortium and with the contribution of ENONDAS. The consortium has partners from Greece, United Kingdom, Germany, Italy and Portugal, in addition to R&D Nester.

In this workshop, the big data platform developed in the project was presented. The platform was developed mainly by three of the

consortium partners: National Technical University of Athens, Ubitech (software house), University of Bonn. Currently, the platform has stored around 150 Tb of data related with different maritime domains including: oceanographic / weather-related data (e.g. wave, wind, biology), IAS data (georeferenced and vessel navigation data), vessel operational data, and other georeferenced data (e.g. protected areas, location and characteristics of ports, among other). It is expected that the quantity and variety of data continues to raise now that the platform is publicly available to all users.

Additionally, together with the services currently existing in the platform, future possible developments in multiple sectors related to the maritime domain and offshore renewable energies were also presented.

The presentation was also focused in the wave power assessment pilot, which has been the main activity developed by R&D Nester in the project, with the collaboration of ENONDAS. This service has two main goals: the evaluation of wave energy potential, in locations or areas selected by the user and the evaluation of the potential for conversion into electric power considering wave energy converters. The services are created by correlating data with wave characteristics from multiple sources (numerical models, buoys, satellite) and allow platform users a significate time reduction while performing these studies, assuring the quality of obtained results.

The workshop showcased the platform, where existing datasets and its potential will be shortly described, and the four aforementioned services, with a higher detail in the service related to the assessment of wave energy potential.

R&D NESTER HOSTS MEETING OF THE EUROPEAN PROJECT OSMOSE ("Optimal System-Mix of Flexibility Solutions for European Electricity")



R&D NESTER hosted again a meeting of the team participating in the Task 7.1 'Interoperability' of the European project H2020 OSMOSE ('Optimal System-Mix of Flexibility Solutions for European Electricity'), which took place on 2th and 3rd of April, at its facilities in Sacavém, as the demonstrator developed under this task will be implemented in the R&D Nester laboratory. Interoperability between devices is extremely important as it allows components of the same system to be purchased from different vendors, with the inherent technical and economic advantages.

This demonstrator aims to prove the proper functioning of a Protection, Automation and Control (PAC) system supported by the IEC 61850 communication standard. One of the aspects under study is the engineering process, that is, the sequence of steps for the configuration of a PAC system.

In addition to allowing 'real-time' interoperability between devices from different manufacturers, the IEC 61850 standard defines the SCL (Substation Configuration Language) that allows the global configuration of PAC systems, even if involving configuration tools from multiple manufacturers, that is, there is also interoperability between configuration tools.

The engineering process defined by this standard is generic, allowing several approaches, so one of the initial objectives of the project team responsible for this task was the creation of an engineering process that would make it possible to take full advantage of all the potential of the IEC 61850.

An example of a new aspect considered is the creation of a new type of SCL file that will allow the specification of IEDs (intelligent electronic devices, such as protection relays and bay units) and which utilities will be able to use in the procurement phase of PAC systems.

Another of the topics developed in this task of OSMOSE is the survey of the signals used by the TSOs that are members of ENTSO-E, work that is being done jointly with the working group IEC 61850 of that organization, and which objective is to analyse the gaps in IEC 61850, in terms of data model.

This collection is being done using a tool developed for this purpose, which also allows the exporting of the information into the SCL format, being this the first step of the referred engineering process.

R&D Nester (Ricardo Cartaxo and João Saragoça) and REN (Isabel Brito) are involved in this task. It also must be mentioned the collaboration of Nuno Costa Martins (REN), under the scope of work of collecting signals, for the help he provided regarding the signals of the protection system, his area of expertise.

The OSMOSE project is important for REN as it addresses a topic that is extremely relevant to the future of energy systems: flexibility services and the demonstration of the technologies that will enable to provide these services (e.g., energy storage or DSR); these technologies will be tested in the scope of the project, through several demonstrators. On the other hand, it also addresses the development of a holistic methodology for network planning, considering flexibility resources.

The project also aims to identify ways of scaling and replicating the results, addressing several areas of REN's interest (e.g., interoperability and

coordination TSO-DSO), which will enable it to integrate these results in the future.

OSMOSE

OPTIMAL SYSTEM-MIX OF FLEXIBILITY SOLUTIONS FOR EUROPEAN ELECTRICITY

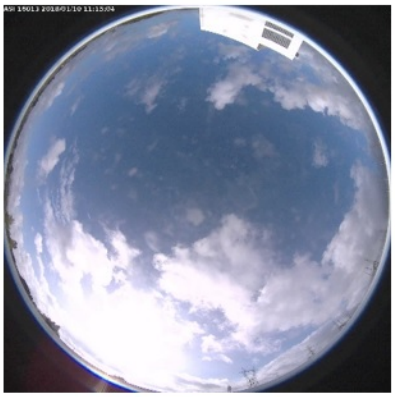
For more information: https://www.osmose-h2020.eu/

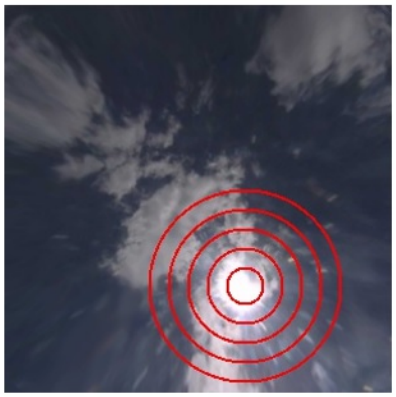
TECHNICAL INFORMATION

CLOUDS AND SOLAR POWER

Several meteorological variables influence the way the solar radiation is converted to power in the photovoltaic cells in a solar power plant. None of them is more volatile and more impacting that the clouds in the sky. In a forecast updated every 6 hours, for instance, variables such as solar radiation and ambient temperature can have an estimation with a low error due to the fact that it will not change drastically in that period.

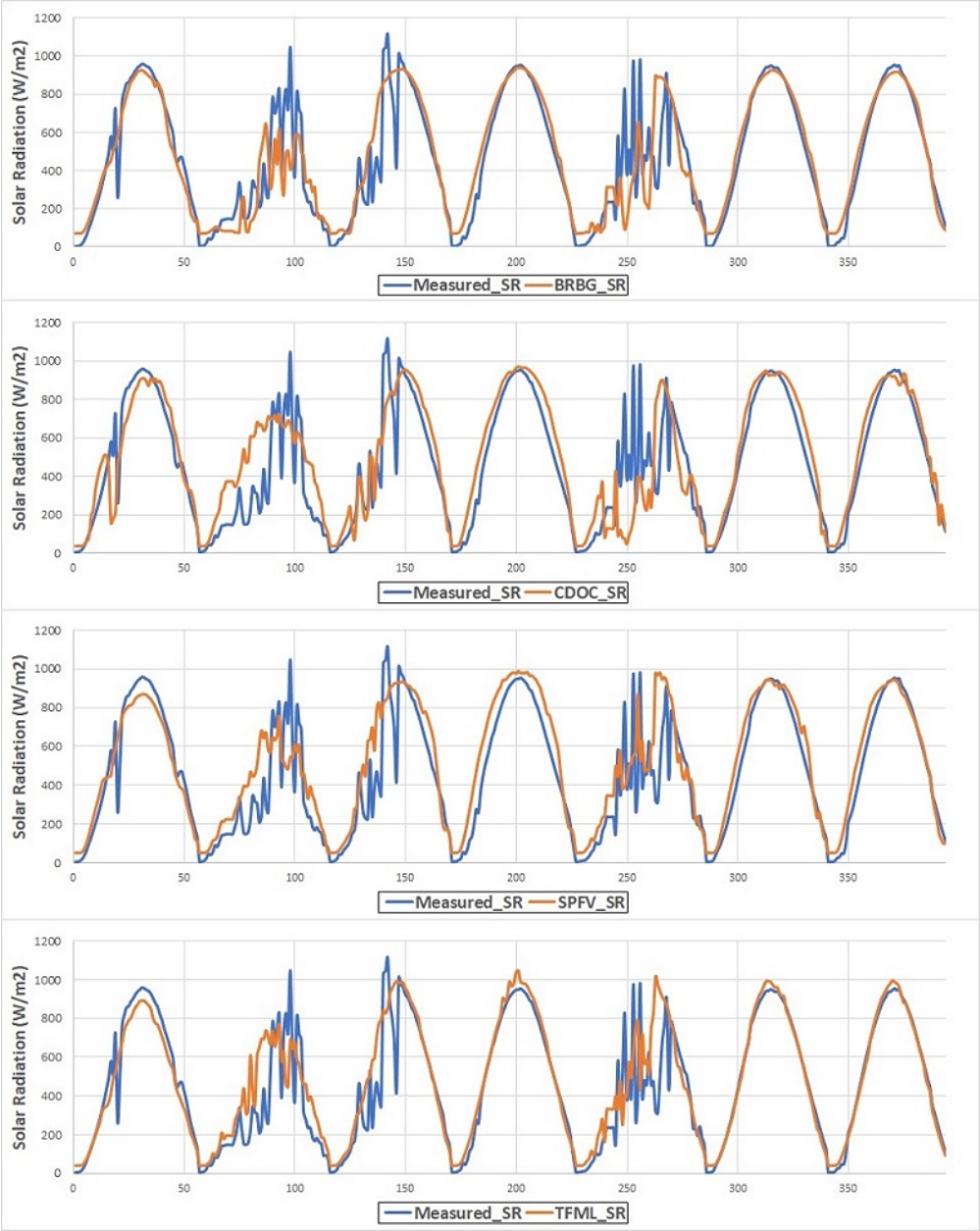
The clouds, in contrast, in 6 hours (or any time horizon in which a forecast is updated) can change drastically in a matter of minutes. This fact highly impacts the solar power plants production and must be included in the forecast algorithms. R&D NESTER, since 2014, have a sky camera installed in the Alentejo Region (close to a PV site) which takes pictures from the sky every 5 minutes.





Cloud index (CI) algorithms have been developed in order to estimate the amount of clouds in the sky in order to incorporate this feature in the solar forecast algorithm, that R&D NESTER is running in continuously operation for the Portuguese TSO. From these efforts, two new state of the art CI algorithms were developed, denominated as TFML and CDOC. These CI were compared with other two know algorithms (BRBG and CDOC) in order to assess their performance.

To test the performance of the cloud indexes, 7 days were selected with different solar radiation profile (from clear sky to heavy cloudy sky). The cloud indexes were applied to the theoretical solar radiation to estimate it behavior. The in-house developed TFML CI obtained the best results and the study can be seen in the figure below.



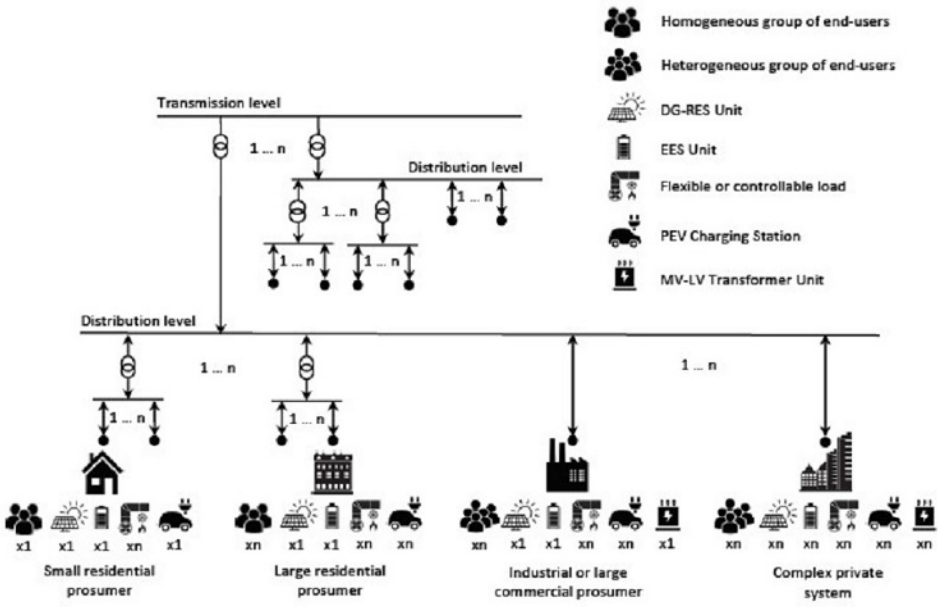
The studies are going to continue and more results regarding this topic are going to be share. The next step is to apply the CI directly to the solar power forecast.

VIRTUAL POWER PLANTS

Virtual Power Plant (VPP) consists in the aggregation of multiple energy sources concentrated in one area (distributed wind and solar units, energy storage batteries, controllable loads, etc.) creating a virtual entity that can be coordinated, controlled and monitored by a remote software system. This allows the formation of clusters at distribution level with different generation characteristics and flexible loads, which can provide substantial benefits for the electricity system regarding production, markets and flexibility purposes.

With the new challenges posed by the decentralization of the generation and the growing of the Renewable Energy Sources (RES), mainly the distributed ones, the VPPs are seen as an unavoidable solution to fulfill the requirements of the actual grids. Nowadays, this concept of energy management system (EMS) is technologically well supported, however, in the majority of the cases, their implementation and architectures are still rooted in the centralized control paradigm [1].

Figure 1 presents the schematization of the different level of assets aggregation that can be considered for a sustainable management and integration of the prosumers in the energy system via VPPs.



In terms of high level architecture, a VPP should has Smart Grid domain where are included the operators of the system (TSOs, DSOs) and others entities that manage the grid (market operators, aggregators, regulators, etc.). Additionally, a prosumer domain where are enclosed all the assets owned by them and the administrator of the VPP systems that is responsible for the adequate and optimal management of the system. The third domain is composed by users and third-party agents that are the entities that are not included in neither of the above-mentioned domains, like end-users that are not supervised by a VPP or services providers for the prosumers.

To gather all the information that comes from the different domains provided by the diverse agents involved, the existence of an adequate data exchange infrastructure is key. Data related with the system, user's data, logs, requests from the end-users, information from IEDs, controllers or gateways are some examples of the heterogeneity of data that needs to be exchanged between stakeholders. For the EMS behind the VPP concept work properly, it is needed a dedicated and robust ICT infrastructure, with diverse layers, that is responsible to aggregate data, virtualize the DERs and assure that all the information required can flow throw all the agents involved . This EMS ICT infrastructure is responsible for the coordination of the bidirectional communication between the VPPs and each of assets in order to control power flows, status and manage assets in an efficient way.

The VPP can be advantageous for demand side management purposes, since it enables the possibility to act directly in the power profiles of costumers like prosumers, in order to get a more sustainable management of the electricity system. Furthermore, VPPs allow utilities and aggregators to pool production from diverse DERs and by this way participate in the electricity market.

Therefore, the operation of VPPs can bring huge benefits to the energy system, as for example:

- Allow to produce energy at a lower cost;
- It provides customers with in hands flexibility, what can increase the global efficiency of the electrical system by capturing flexibility of DERs units;
- Reduction of CO2 emissions;
- Energy losses decrease because the consumption points are closer to those where the energy is generated, reducing the loss of energy during the transportation;
- Increased visibility of DER units for consideration in network operation;
- Improve the communication between TSO-DSO-prosumers.

References

[1]https://www.researchgate.net/publication/323738170_A_Virtual_Power_Plant_Architecture_for_the_Demand-Side_Management_of_Smart_Prosumers



"Internet of Things (IoT) applications, offers a range of possibilities for how electric utilities can move forward. IoT can improve the efficiency and performance of the power grid in three phases: first, by gathering data from sensors to improve the resilience of the grid; then through enablement, where utilities use that data to actively manage resources; and finally, optimization, where all stakeholders are able to make informed decisions about power usage and generation. Through these three phases, IoT offers some indications of how utilities can not only survive, but thrive, in this new competitive environment." - Deloitte Insights

Please find here the view of SGCC (State Grid Corporation of China) on IoT for Electricity, recently presented in Milan.

R&D NESTER IN THE LIST OF THE 100 COMPANIES IN PORTUGAL THAT INVESTED MOST IN R&D ACTIVITIES

DGEEC

DIREÇÃO-GERAL DE ESTATÍSTICAS DA EDUCAÇÃO E CIÊNCIA

AS EMPRESAS COM MAIS DESPESA EM ATIVIDADES DE I&D EM 2017 – PORTUGAL

[LISTAS DEFINITIVAS]



IPCTN 2017 - R&D NESTER in the list of the 100 companies in Portugal that invested most in R&D activities (category equivalent to SMEs)

Last February, the National General Directorate of Statistics of Education and Science (DGEEC) published the results of IPCTN survey for 2017, regarding R&D expenditure in Portugal by companies.

According to this publication, the investment in 2017 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.

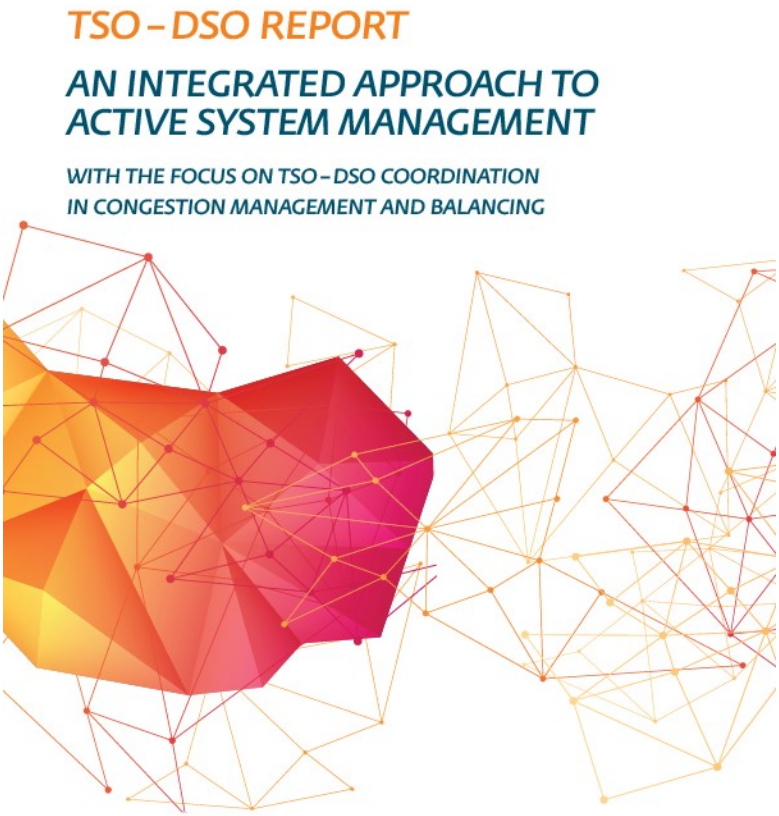
Currently, R&D NESTER is working in several R&D Projects, covering topics such as Renewable Integration, Flexibility, Cooperation-TSO DSO, Big Data, among others. The complete portfolio of finished and under development projects can be found here.

In what concerns to national global results, in the year under review, Portugal total expenditure in R&D reached 2.585 MEuros, representing an increase around 8% compared to 2016. When it comes to the impact on GDP, the amount spent on R&D represented 1.33%, of which 0.67% correspond to the business sector - about 50% of the total expenditure.

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.

TSO – DSO REPORT AN INTEGRATED APPROACH TO ACTIVE SYSTEM MANAGEMENT

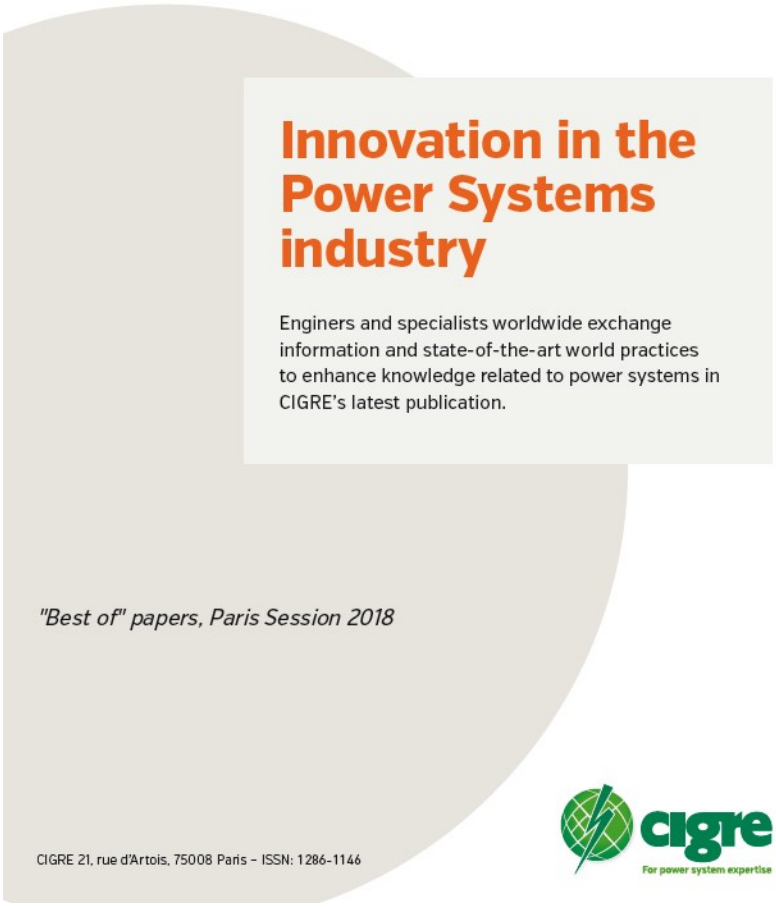
publication available here



CIGRE SCIENCE & ENGINEERING – VOLUME Nº.13, FEB 2019 “INNOVATION IN THE POWER SYSTEMS”

publication available here

CIGRE SCIENCE &ENGINEERING
Volume No.13, February 2019



EVENTS

26 -30 Aug 2019

BUDAPEST, HUNGARY

ISH2019 CONFERENCE - INTERNATIONAL SYMPOSIUM ON HIGH VOLTAGE ENGINEERING

9 -11 Sep 2019

OPORTO, PORTUGAL

SEST 2019 2ND INTERNATIONAL CONFERENCE ON SMART ENERGY SYSTEMS AND TECHNOLOGIES

17 -19 Sep 2019

BERLIN, GERMANY

SMART GRID BIG DATA 2019

24 -26 Sep 2019

BERLIN, GERMANY

GIS4SMARTGRID 2019

14 -18 Oct 2019

LONDON, UK

WORKSHOP FUNDAMENTALS OF IEC 61850 2019

31 -4 Oct /Nov 2019

SINGAPORE

30TH ASSEMBLY OF ADVANCED MATERIALS CONGRESS "ENERGY STORAGE TECHNOLOGIES"

LINKS

Some useful links:

ON RESEARCH, DEVELOPMENT AND INNOVATION

Portugal:

- Portugal 2020
- Programa Operacional Competitividade e Internacionalização (COMPETE 2020)
- Agência Nacional de Inovação
- COTEC Portugal

Europe:

- Energy Research Center of the Netherlands (ECN)
- European Energy Research Alliance (EERA)
- Horizon 2020
- Nordic Energy Research
- JRC Publications - Joint Research Centre - Smart Electricity and Interoperability
- ETIP SNET - European Technology and Innovation Platform Smart Networks for Energy Transition
- European Space Agency

Rest of the World:

- American Energy Innovation Council (AEIC)
- China Electric Power Research Institute (CEPRI)
- Electric Power Research Institute (EPRI)

OTHER ENTITIES

Portugal:

- Laboratório Nacional de Energia e Geologia (LNEG)
- Polo de Competitividade e Tecnologia da Energia (EnergyIn)
- Associação de Energias Renováveis (APREN)

Europe:

- European Network of Transmission System Operators for Electricity (ENTSO-E)
- The European Wind Energy Association (EWEA)
- World Wind Energy Association (WWEA)

Rest of the World:

- CIGRE - International Council on Large Electric Systems

QUIZ - This specific Quiz deals with concepts related to substations. The definitions have been taken from www.electropedia.org

1) HOW MANY SUBSTATIONS EXIST IN THE PORTUGUESE TRANSMISSION GRID?

- a) Around 50
- b) Around 60
- c) Around 70
- d) Around 80

2) WHICH DEVICE EXISTS IN A SUBSTATION, BUT DOES NOT EXIST IN A SWITCHING STATION?

- a) Circuit breakers
- b) Isolators
- c) Transformers
- d) Earthing switches

3) WHICH OF THE FOLLOWING IS A RELAY IN THE SUBSTATION TRANSFORMER?

- a) Faraday
- b) Alzheimer
- c) Maxwell
- d) Buchholz

4) WHICH OF THE FOLLOWING IS NOT A TYPICAL SUBSTATION TOPOLOGY (BUSBAR ARRANGEMENT) IN THE PORTUGUESE TRANSMISSION GRID?

- a) Ring
- b) Double busbar
- c) Double busbar with transfer bus
- d) Breaker and half

5) IN A SUBSTATION, WHICH SYSTEM SUPPLIES POWER TO THE SUBSTATION?

- a) Protection system
- b) Auxiliary services
- c) Control system
- d) None of the above

6) THE FIRST TRANSMISSION SUBSTATIONS IN PORTUGAL HAVE BEEN PLACED INTO SERVICE IN...

- a) 1941
- b) 1951
- c) 1961
- d) 1971

7) PORTUGUESE TRANSMISSION SUBSTATIONS ARE USUALLY OPERATED:

- a) Locally
- b) Remotely, from other substations
- c) Remotely, from a control center
- d) Remotely, from the operators' home

8) WHICH OF THE FOLLOWING IS NOT A SUBSTATION BAY (SECTION):

- a) Resistor bank
- b) Transmission line
- c) Transformer
- d) Capacitor bank

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) Around 70
2. Answer: c) Transformers
3. Answer: d) Buchholz
4. Answer: a) Ring
5. Answer: b) Auxiliary services
6. Answer: b) 1951
7. Answer: c) Remotely, from a control center
8. Answer: a) Resistor bank



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