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EDITORIAL



Dear Reader,

The complexity of the expected future energy systems requires us to increase the sophistication of our tools and capabilities. The proliferation of distributed generation and of consumers who can also be producers ("prosumers"), the increasingly ubiquitous existence of power electronics in the networks, the deployment of multiple storage technologies, the emergence of electric vehicles and their corresponding mobile storage, the presence of HVDC links, among other developments, claim the need for testing, simulation and analysis of complex and real-time behavior of devices and networks, in order to maintain the risks, security of supply and sustainability of the energy system in acceptable levels.

It is in this context that we bring you in the Highlights section of this edition one of the R&D Nester efforts in that direction.

Indeed, within R&D Nester we are developing a laboratory with real-time simulation capabilities that allows us to deal with the above mentioned challenges with more confidence.

In the Technical Information, we offer you updated information on ongoing European efforts to add flexibility to the energy market, through an initiative called Universal Smart Energy Framework.

Additionally, some material on the ongoing discussion on the evolution of industry, in particular in what concerns transmission operators is also presented.

You will find more on this and other topics in the notes below. Enjoy the reading!

Sincerely,

Nuno de Souza e Silva
General Manager



HIGHLIGHTS



R&D Nester develops laboratory with real-time simulation capabilities

Within the context of one of its ongoing R&D and Innovation projects, R&D Nester is developing a laboratory with real-time simulation capabilities. This laboratory has the capabilities and benefits mentioned below.

One of the existing equipments installed in the laboratory was manufactured by OPAL-RT, a Canadian company which is one of the world leaders in the development of real time simulation devices and Hardware-in-the-Loop (HIL) testing equipment. The simulator at R&D Nester laboratory has the following main characteristics:

- A 32-core UNIX based computer (OPAL OP5030) which is the main equipment responsible for running real time simulations;
- Two expansion chassis, each one providing a set of digital and analog inputs/outputs, which enables the execution of HIL tests. The total number of ports per chassis is: 16 Analog Outputs, 64 Digital Inputs and 64 Digital Outputs;
- Three different families of softwares: Hypersim, eMEGAsim and ePHASORsim, which have the capability to simulate large power networks (up to 2000 buses in EMT simulation using Hypersim or 10000 buses in electromechanical transient stability using ePHASORsim). eMEGAsim offers the user the possibility to simulate complex and fast transient responses such as power electronics converters and control systems. It allows a minimum time step of 10 μ s, whereas Hypersim has a typical time step of 50 μ s and ePHASORsim has a time step of 10 ms.

Another simulation equipment is the ADPSS, which stands for Advanced Digital Power System Simulator and is the first simulator worldwide which can perform real time simulation of large scale complex AC/DC power systems with up to 3000 generators and 30000 buses. The hardware solution existing at R&D NESTER facilities has the following main characteristics:

- Three high performance computing clusters, with 20 cores each, performing a total of 60 cores for real time simulation purposes. These three real time servers also run in a UNIX platform specified for real time applications and are connected through a high speed InfiniBand network.
- A physical interface box, which provides the user a total of 48 Analog Outputs, 160 Digital Inputs and 160 Digital Outputs, for HIL testing;
- A digital interface box, specially designed for IEC 61850 applications, providing four interface cards, two for Sample values and two for Goose messages. Each card has a total of 6 optical outputs allowing a direct connection to Intelligent Electronic Devices (IED's).
- Two different softwares: PSASP for electromechanical transient stability simulations and ETSDAC which allows EMT simulations. PSASP provide different power systems simulation modules to the user, allowing the simulation of: Load flow; Transient stability; Short-circuit; Optimal load flow and reactive power optimization; Static security analysis; Network loss analysis; Static and dynamic equivalence calculation; User-defined model and program interface; Direct stability calculation; Small signal stability analysis; Voltage stability analysis; Relay protection setting calculation; Linear/non-linear parameter optimization; Harmonic analysis; Distributed off-line computing platform; Power system risk evaluation system; Transient stability limit automatic solution; Load current anti-icing and de-icing measures. ETSDAC can be used for: Analysis of power system fault; Analysis of transient overvoltage and overcurrent; Dynamic characteristic simulation of high-voltage direct current transmission system; Analysis of sub-synchronous oscillation phenomenon; Design of PSS or other control parameters; Design of high-voltage direct current transmission (HVDC) system and flexible alternating current transmission system (FACTS). Hybrid simulation of electromechanical and electromagnetic transient (ST-EMT Hybrid) is an important feature of ADPSS. Co-simulation of fast and slow timescale with different time steps can then be performed by applying ST-EMT Hybrid parallel simulation interface.

The above mentioned equipment is complemented by different other classes of equipment/software which allow a large range of different possible applications. These equipment /software solutions include, amongst other:

- Time synchronization server: which allows the time synchronization of the two simulators and other connected devices for HIL testing solutions;
- Riverbed OPNET, which provides a suite of protocols and technologies to design, model, and analyze communication networks;
- IXIA software, which consists in a communication network analysis tool;
- KEMA IEC61850 protocols testing software;
- Helinks IEC61850 Specification and Configuration Tool.
- Other complimentary equipment.

The existing of the facility developed allows a very large spectrum set of applications regarding power systems and communication networks. These include, amongst other:

- Model verification (e.g. Linear elements models - constant parameters transmission lines, pi-circuits; non-linear models - Surge arrester, etc) using field data and event records
- Simulation of large power networks in real time mode with prototypes or actual electronic controllers connected in-the-loop with the simulation (e.g. study the behavior of IED's in substations)
- Power systems transient studies
- Testing and simulation of integration of renewable energy sources
- Study, testing and simulation of Smart Grid developments, such as performance of smart substation specification
- Testing communication network performances (network traffic and devices)
- Perform risk analysis of network operations
- Support to network planning, scenario analysis and system operation.

R&D Nester also expects to use the laboratory and simulation capabilities to extend the cooperation with other national and international entities, in order to further contribute to the development of a sustainable energy system to the benefit of the energy industry players, the consumers and all the population.

R&D Nester presents papers in international events

R&D Nester published two papers in the 10th Jubilee International Conference on Deregulated Electricity Market Issues in South Eastern Europe (DEMSEE'15), held in Budapest on 24th and 25th of September.

This annual conference addresses the future of the deregulated electricity sector, particularly in the areas of electricity markets and energy regulation, integration of renewables and storage in the electrical system, and IT solutions in power systems operation and control.

The titles "Wind power forecast uncertainty using dynamic combination of predictions" and "TSOs and DSOs Collaboration: The Need for Data Exchange" presented the work that is being held in the scope of two of the R&D Nester projects.

The paper "Wind power forecast uncertainty using dynamic combination of predictions" presented improvements in the wind power forecast arising from considering self-adaptive combinations of an ensemble of wind power predictions. This paper was selected by the conference technical and scientific committee to be published in a special issue of the Periodica Polytechnica Electrical Engineering and Computer Science.

The paper "TSOs and DSOs Collaboration: The Need for Data Exchange" presented the common challenges facing Transmission System Operators (TSOs) and Distribution System Operators (DSOs), highlighting the need for a stronger cooperation. In line with the future European regulation, the study demonstrates the benefits of a more structured data exchange between TSOs and DSOs in several planning and operational power systems' areas.

[Link to the Conference: http://www.demsee2015.org/](http://www.demsee2015.org/)

R&D Nester presents at the APE event “Evening Debates”

“Dispatching of Renewable Energy: optimization of the integration of renewable energy into the electric network” was the theme of the most recent session of the “Debates ao fim de tarde (Evening Debates)” conferences, an initiative of the Portuguese Energy Association (APE).

Nuno Souza e Silva and Rui Pestana, respectively General Manager and Project Leader of R&D Nester, were the speakers in this debate that, according to Nuno Souza e Silva, “reinforces R&D Nester’s position as an important player in the national energy field”.

The theme under debate at this session is according to R&D Nester recurrent and continues to attract many specialists. The fact that Portugal is a singular case where the need to curtail wind production did not occur until now, despite the fact it is in the 2nd place of the European and the world rankings in terms of wind production penetration was highlighted. As for solar energy, the industry has also been paying strong attention to this type of generation due to the growth of expectations fueled by the lower costs of unit investment. The concerns are related to the current challenges of varying renewable energies to contribute to the system services. R&D Nester presented its developments regarding solar forecast and integration of this data in the system operations.

On this matter, Nuno Souza e Silva informed that “R&D Nester has developed work dedicated to the dispatch of renewable energies which in 2016 will address wind and solar generation capabilities in what electric network parameters controlling is concerned, such as frequency and voltage”, adding that R&D Nester’s will carry on “contributing to the safe and sustainable development of the national energy system for the benefit of consumers”.

R&D NESTER WINS PRIZE AT THE II PORTUGAL-CHINA GALA

R&D Nester is amongst the Portugal-China Gala Business Merit Prize winners in 2015. The Center for Research and Development for Energy REN and State Grid won its prize in the foreign trade category. Nuno Souza e Silva, General Manager of R&D Nester, was present at the ceremony and states that “for R&D Nester and its team it’s satisfying to see the recognition of two and a half years work”, and also that he believes this prize to “reflect the excellent cooperation and friendship that has been a characteristic of this period, and it is also gratifying to see the recognition of this private effort and investment that we make every day on behalf of a public good and for the benefit of the energy system.”



This was the second edition of the ceremony that is organized by the Portuguese Chinese Chamber of Commerce and Industry and it took place on the 29th of October with the purpose of celebrating the friendship of the two countries and recognizing the entities that strengthen this collaboration.



TECHNICAL INFORMATION



Universal Smart Energy Framework - USEF

Founded by seven key players, active across the smart energy chain, USEF partners are working together aiming at delivering the foundations of one integrated system which benefits all players in the energy value chain - new and traditional energy companies and consumers.

USEF, a non-commercial partnership, was founded in 2013 to design a scalable solution that recognizes the different stakeholders and their role in a coherent and commercially viable smart energy system and to accelerate its development.

In this way, USEF aims at being an extended market model revolving around localized flexible energy use, and fits on top of most market models, enabling the active market participation of all players, new and traditional.

For this purpose, USEF is a framework, with roles, responsibilities and arrangements, with very clear processes for effective implementation.

The seven founding partners are: ABB, DNV-GL (a global independent energy expert), IBM, Alliander (operator of electricity and gas distribution in The Netherlands), essent (the largest producer of energy in The Netherlands and also supplier of electricity, gas and heat, is part of RWE Group), ICT (a software integrator) and Stedin (responsible for the transport of electricity and gas).

The USEF Foundation develops, maintains and audits the framework.

By delivering a common standard on which to build smart energy implementations, USEF connects people, technologies, projects and energy markets. It is the basis for an integrated smart energy future that is both efficient and cost-effective. The framework defines each stakeholder role in the energy market, how they interact and how they can benefit by doing so. With existing detailed specifications and real-life pilots in the market, USEF claims to be the most comprehensive, advanced initiative of its kind.

In particular for TSOs, USEF claims the following benefits: “Responsible for operating the energy system on a larger and often national scale, the main focus for the TSO is maintaining overall balance within the system. While system balance management mechanisms are strictly regulated, to achieve it, they rely on BRPs (Balancing Responsible Parties). TSOs indirectly benefit from

USEF because, by unlocking flexibility and enabling it to be commoditized and traded, the framework helps optimize BRPs portfolios, allowing them to keep their own balance easier plus offer improved balancing capacity to the TSO. This makes system operation easier and therefore cheaper.

The TSO also at times faces congestion issues related to the transmission of electricity, for example over interconnection points with other countries, or where there are capacity issues as a result of maintenance etc. USEF eases these system pressures significantly by unlocking the availability of localized capacity for re-dispatch.”

Several real-life pilots already exist in the market and can be found in <http://www.usef.info/Home.aspx>

On the evolution of electricity transmission

Last September 29th the Florence School of Regulation published a research report on the future role of electricity TSOs, entitled “A conceptual framework for the evolution of the operation and regulation of electricity transmission systems towards a decarbonized and increasingly integrated electricity system in the EU”.

According to the report, the electricity industry is undergoing major changes mainly dictated by the need to simultaneously accomplish integration of European energy markets and build a low-carbon economy. This process was facilitated if not initiated by a wave of technological innovation. In order to ensure a timely, orderly and efficient transition towards the new low-carbon landscape the present legal and regulatory frameworks, devised long ago, must be reviewed and adapted in order to provide adequate rules and suitable incentives.

In order to better grasp some structural novelties of the new world we are entering in and to identify major critical issues, the report introduces three basic conceptual scenarios:

- Lower decarbonization within a pan-European system
- Higher decarbonization within existing Member State systems
- Higher decarbonization within decentralized systems

The Report then analyses the evolution of the TSO functions under each of the scenarios.

The report concludes that assuming that, in the short-term, implementation of 3rd Package legislation and associated Network Codes will continue and no fundamentally new legislation will be issued, serious governance issues must be somehow addressed. In this respect, not only national/EU interfaces require continuous attention; local/national interfaces become increasingly critical for transparency and reliability.

Among the many governance challenges to be addressed the following ones are considered particularly important:

- discussion of grid planning, system and market operation, leading to better coordination or mutualisation of hardware and software TSOs functions, as well as of the NRAs actions.
- Member States policies regarding security of supply and generation adequacy.
- Articulation between Member States “2030 NAPs”, network investments, systems and markets.
- Articulation of local and national grids, systems and pocket markets, implying new forms of multilayer coordination between DSOs, TSOs, NRAs and Member States.

<http://fsr.eu.europa.eu/Home.aspx>

<http://fsr.eu.europa.eu/Documents/ResearchReport/Energy/2015/FSR-Report-Electricity-TSOs-Future.pdf>



EVENTS



17-25 NOV 2015

PARIS, FRANCE

[EWEA 2015 ANNUAL EVENT](#)

24 NOV 2015

GRONINGEN, NETHERLANDS

[ENERGY CONVENTION 2015](#)

25-26 Nov 2015

LITHUANIA

[7TH BALTIC ENERGY FORUM 2015](#)

25-26 NOV 2015

LILLE, FRANCE

[GRID+STORAGE PROJECT WORKSHOP](#)

25-26 Nov 2015

BARCELONA, SPAIN

[EMART ENERGY 2015](#)

4th International Conference on Renewable Energy Research and Applications (ICRERA) 2015

22 to 25 November, Palermo, Italy

CONFERÊNCIA APE 2015 - O SISTEMA ENERGÉTICO: A MUDANÇA NO HORIZONTE 2030

25 November, Lisbon, Portugal

see +

The European Power Generation Strategy Summit

25 to 27 November, Prague

see +

Conferência APREN 2015 - O FUTURO DA ENERGIA

3 December, Estoril, Portugal

see +

COP 21 The Sustainable Innovation Forum (SIF15)

30 November to 11 December, Paris, France

see +



LINKS



- [American Energy Innovation Council \(AEIC\)](#)
- [Associação de Energias Renováveis \(APREN\)](#)
- [China Electric Power Research Institute \(CEPRI\)](#)
- [Electric power research institute \(EPRI\)](#)
- [Energy Research Center of the Netherlands \(ECN\)](#)
- [European Energy Research Alliance \(EERA\)](#)
- [European Network of Transmission System Operators for Electricity \(ENTSO-E\)](#)
- [The European Wind Energy Association \(EWEA\)](#)
- [Horizon 2020](#)
- [Laboratório Nacional de Energia e Geologia \(LNEG\)](#)
- [Nordic Energy Research](#)
- [Polo de Competitividade e Tecnologia da Energia \(EnergyIn\)](#)
- [Redes Energéticas Nacionais \(REN\)](#)
- [State Grid Corporation of China \(SGCC\)](#)
- [World Wind Energy Association \(WWEA\)](#)



QUIZ



1) THE NOMINAL POWER OF THE BIGGEST WIND TURBINE COMMERCIALY AVAILABLE IS:

- ☐ A) 8 MW
- ☐ B) 10 MW
- ☐ C) 15 MW
- ☐ D) 11 MW

3) THE SURFACE AREA OF THE WINGS OF THE BIGGEST COMMERCIAL AIRPLANE, AIRBUS A380-800 IS APPROXIMATELY:

- ☐ A) 550 m²
- ☐ B) 845 m²
- ☐ C) 675 m²
- ☐ D) 785 m²

2) IN 2012, THE AVERAGE VOLUME OF FOSSIL FUELS CO2 EMISSIONS PER CAPITA IN PORTUGAL IN TONES/INHABITANT WAS:

- ☐ A) 4.9
- ☐ B) 5.6
- ☐ C) 3.1
- ☐ D) 6.2

4) THE KINETIC ENERGY (WIND ENERGY) GENERATED INSIDE A MATURE HURRICANE, WITH SUSTAINED WINDS OF 40 M/S AND 60KM RADIUS IS APPROXIMATELY:

- ☐ A) 5 TWh/day
- ☐ B) 12 TWh/day
- ☐ C) 36 TWh/day
- ☐ D) 25 TWh/day

Answers of the 4th edition Quiz

1) Which of these is not an electro-chemical battery energy storage technology?

Answer: C) Flywheel is an electro-mechanical energy storage technology.

3) From the following list which one was invented by Nikola Tesla?

Answer: D) After the development of the rotating magnetic field (1882) Nikola Tesla developed the AC motor (1883), the tesla coil (1890) and a remote control boat (US Patent N. 613809) in 1898, among many other inventions (http://pt.wikipedia.org/wiki/Nikola_Tesla).

5) During the solar eclipse of last March 20th, which was the maximum reduction of PV generation that was experienced in the continental European power system compared with clear sky conditions?

Answer: B) At 9:41(UTC) or 10:41(CET) there was a reduction of 34,5 GW relatively to the expected value with clear sky.

2) Which is the biggest project using electro-chemical battery energy storage fully operational in the world in terms of installed power?

Answer: B) According to the DOE website (<http://www.energystorageexchange.org>) the biggest project in terms of installed power is Duke Energy Notrees Wind Storage Demonstration Project, USA, with 36MW of installed power.

4) Which is the biggest project using electro-chemical battery energy storage fully operational in the world in terms of stored energy?

Answer: D) According to the DOE website (<http://www.energystorageexchange.org>) the biggest project in terms of installed power is Rokkasho Village Wind Farm, in JAPAN, with 238MWh (34MW/ 7 hour) of available stored energy.

6) By the end of 2014, the total amount of wind power generation installed in Europe (EU-28) was approximately:

Answer: B) According to the EWEA website (<http://www.ewea.org>) the total amount of wind power installed in EU-28 was 128.751MW (~129GW).

Answers of the 5th edition Quiz

1) Solar resource is now a major source of energy for producing over 1 % of electricity at a global level. By the end of 2014, what was the total worldwide installed capacity of PV?

Answer: B) - 177 GW

3) Which of the following is not a photovoltaic cell technology of thin-film type?

Answer: D) Polycrystalline Silicon (poly-Si)

5) Inverters play a key role in the solar energy conversion chain, being used for different purposes. Which of the following is not a major capability of commercially available PV inverters?

Answer: C) Active power generation

2) Which of the following countries has the highest worldwide PV installed capacity?

Answer: B) China

4) Temperature and irradiance are two major variables influencing the output power of a PV power plant. In which condition photovoltaic cells produce more energy?

Answer: B) Low temperature and high irradiance

6) Over the past years technology advances have allowed a significant overall reduction of energy losses in PV systems. Best PV research-cell efficiency is now around 46 %, what about PV inverters' efficiency levels?

Answer: A) PV inverters' efficiency is approximately 95 % to 99 %.



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