R&D NESTER

17 NL fev 2020

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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

Dear Reader,

Advanced tools for the design and planning and operation of electricity grid infrastructure including distribution and transmission level are increasingly required to cope with the complexity of the Energy Systems of the Future (and of the Present, by the way). For that reason R&D Nester, together with several other European partners from 11 countries, proposed to the European Commission research and innovation activities aiming at the creation of a new tool for optimizing transmission and distribution grid planning, considering the placement of flexibility elements as an alternative to traditional grid planning, while taking into account environmental impact and carbon footprint. This will now materialize in the "**FlexPlan**" H2020 European Project recently approved from which you can learn more below.

Also the concept of Energy Communities is gaining traction in the field with significant legislation being passed at European level and also at local level in several geographies. The objective of having the Customer in the Centre of a Future Energy System is therefore gaining momentum. R&D Nester is involved in this process, always aiming at creating a Smart Energy Future, ensuring the creation of a Sustainable, Reliable and Efficient energy system. In the recently approved "FleXunity" H2020 European Project, we will be working on a "Power Flexible Communities Scaling-up project powered by Blockchain and AI". Read below and stay tuned.

Meanwhile, we continue contributing to the development of "Optimal System-Mix of Flexibility Solutions for European Electricity" with our participation in the European Commission H2020 Project "OSMOSE". Below you can read more on Innovative Flexibility for Grid Reinforcement and Operation and on Interoperability based on the IEC61850 standard.

Beyond the European borders, we are also attentive to Global Energy Interconnection initiatives. See below what is being discussed on this topic.

We also bring to your attention some great industry literature material that was recently published in case you missed it. Topics are "Regulation and market design barriers" from CIGRE, where R&D Nester is also active, "Storage", from the World Energy Council, and a book on "Flexitranstore" Project, where R&D Nester presents 3 papers related to flexibility in Power Systems.

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.

Don't forget to test your knowledge on energy trivia with our Quiz below and to follow us on our LinkedIn page (https://www.linkedin.com/company/r&d-nester), where these and other updates are often highlighted.

Enjoy your reading and please continue to share with us your feedback!

Sincerely,

Nuno de Souza e Silva
Managing Director

HIGHLIGHTS

R&D Nester and REN win new H2020 Project on “Advanced Methodologies and Tools"



R&D Nester and REN won an H2020 project, submitted to the Call ES-6 related to "Research on Advanced Tools and technological development", in particular to the topic "Advanced tools for the design and planning and operation of electricity grid infrastructure including distribution and transmission level (...)".

In this new project, R&D Nester and REN are part of a consortium with 11 other partners from multiple European countries including Italy, Serbia, Slovenia, Belgium, Norway, Spain and Germany. The project team includes several research and development institutes and grid operators (3 TSO and 1 DSO).

The project is entitled "**FlexPlan**" and aims at "creating a new tool for optimizing transmission and distribution grid planning, considering the placement of flexibility elements as an alternative to traditional grid planning", while "taking into account environmental impact and carbon footprint".

R&D Nester participates in all (8) Work Packages and will be responsible for one of them, namely WP5 - "Regional Cases and assessment of advantages", where the planning tool will be tested using six different regional cases in Europe.

Additionally, R&D Nester also has a strong contribution to WP4 - "Pan-European scenarios at target years", being the partner responsible for collecting and harmonizing data necessary to the creation of Pan-European and regional scenarios in three time horizons: 2030, 2040 and 2050. REN has a contribution to the identification of data sources and data collection, and a focus on the development of one of the six regional cases focused in the Iberian Peninsula, besides contributing partially to other work packages.

The project started in October 2019, extend until September 2022 (36 months), and is financed by H2020 under the Grant Agreement 863819.

For more information:
http://www.rdnester.com/en-GB/fields_and_projects/projects/project_25__flexplan/
https://www.linkedin.com/company/flexplan-project/about/

R&D Nester renewed the Certification on Research, Development and Innovation (RDI)

Recently, R&D NESTER hosted a meeting of the European project FLEXITRANSTORE.



In the aim of R&D NESTER Certification in Research, Development and Innovation (RDI), by the Portuguese Standard NP4457: 2007, an external audit was carried out by APCER on November 25th.

According to the final report, the auditing entity concluded that «the organization has demonstrated a Research, Development and Innovation Management System that enhances the improvement of its innovative performance, knowledge creation and the creation of economic and social value», so all the conditions were met in order to maintain this Certification.

R&D NESTER is certified by this RDI standard since 2015. This certification was renewed in 2018, initiating a new cycle of annual follow-up audits, with a view to verifying the maintenance of the conditions to grant the certification.

R&D NESTER will remain committed to keeping the RDI Management System certified, ensuring that the organization's practices remain in line with the requirements of this RDI Standard.

“Optimal System-Mix of Flexibility Solutions for European Electricity”

R&D Nester participated in Plenary Meeting of European Project OSMOSE



R&D NESTER participated in the plenary meeting from European project OSMOSE, organized by TERNA, which took place in Rome on December 2019.

The main objective of this meeting was the presentation of the work done in the various Work Packages (WPs) over the past year and the work plan for the next period.

This project, which has 33 partners from 9 different countries, aims to study the application of flexibility solutions in the optimal integration of renewable energy sources and the demonstration of innovative technology solutions and flexibility services in electrical energy systems such as energy storage systems.

From R&D NESTER's side, this meeting was attended by the researchers Ricardo Pastor (project manager) and Ricardo Cartaxo who presented the work developed under WP1 (Optimal mix of flexibilities) and WP7 (Scaling-up & replication). REN, which is also a partner on this project, was also present in the meeting.

In this project R&D NESTER leads task 1.4 "Innovative Flexibility for Grid Reinforcement and Operation" where the application of innovative flexibility solutions for the planning and operation of the electrical system will be analyzed and in which REN and ENSIEL also collaborates.

R&D NESTER also participates in 2 more tasks from WP7, task 7.1 related to the 'interoperability' topic based on the IEC 61850 standard and task 7.2 where it addresses TSO-DSO coordination for the use of flexibility assets, the latter in close collaboration with REN and

EFACEC.

This project is particularly important by allowing to anticipate solutions that might be implemented in the future and understand their potential implications in terms of planning, operation and system management, as well as their impact on the market and on the relationships between the different market agents.

Website: https://www.osmose-h2020.eu/

Optimisation of the IEC 61850 Protection, Automation and Control Systems (PACS) Engineering Process and Tools

R&D Nester hosts Meeting of CIGRE Working Group B5.68



CIGRE, the International Council for Large Electrical Systems, is an entity established in 1921, based in Paris, aiming to create a community to share information in this area of knowledge.

To fulfil this goal, this organisation is divided into 16 study committees, corresponding to the same number of areas of work. In each study committee, there are several working groups, which purpose is to respond to current and future challenges related to power systems, based on the experience of their members. There are about 250 working groups spread across the various study committees.

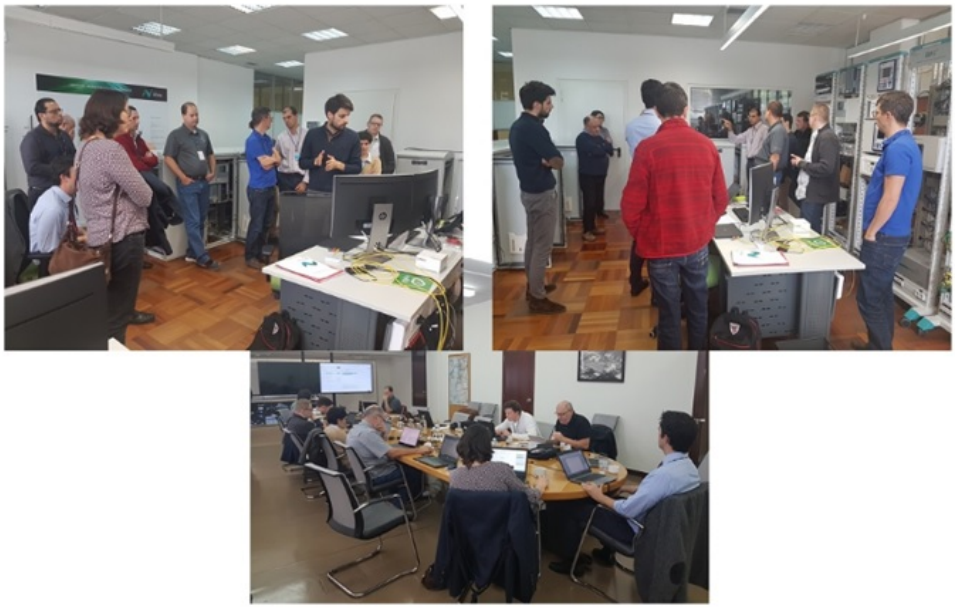
One of these working groups, the B5.68, which belongs to the study committee B5 (protection and automation), intends to study the optimization of the engineering process (device configuration) and respective tools for systems based on the IEC 61850 communication standard.

The convener of this group, Camille Bloch, also integrates the team of the OSMOSE European project, namely, in the 'interoperability' task, that gathered at R&D Nester last November, for another project meeting.

Leveraging the presence of the convener and other members of B5.68, R&D Nester hosted a meeting of this working group, taking into account that the scope of the B5.68 and the OSMOSE task are similar.

In addition to the meeting itself, members of this working group had the opportunity to visit the R&D Nester laboratory, learning about the projects being implemented in this infrastructure.
The IEC 61850 standard, published in 2004, is now widely used by electrical distribution and transmission companies to support communication in the protection, automation and control systems of their substations.

This standard is under permanent evolution (it is in its second edition), existing several working groups exploring and improving their capabilities and proposing new areas of application.



Scaling-up Power Flexible Communities Business Models empowered by Blockchain and AI

R&D Nester wins new H2020 Project "FleXunity"

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.

On the one hand, specific control tools for distributed resources will be developed and tariff structures and market designs that promote the participation of community members will be developed, both in a context of energy exchanges within a community and in a context of energy exchange with the outside. On the other hand, services, communications architectures and functions that promote a friendly integration of the energy community in the electricity grid will be studied, namely through the provision of ancillary services. The project includes two demonstrators, namely in the UK market and in the Iberian market.

The FleXunity consortium has 5 partners from Portugal, Spain, Finland and UK. R&D Nester is responsible for the work package "Balancing and ancillary services design", where the aggregators' business models will be validated technically and economically using the R&D Nester's RTPSS lab.

The project started in December 2019 and has a duration of 24 months.

For more information: http://www.rdnester.com/en-GB/fields_and_projects/projects/project_24__flexunity/

R&D Nester in the 2019 Global Energy Interconnection (GEI) Conference



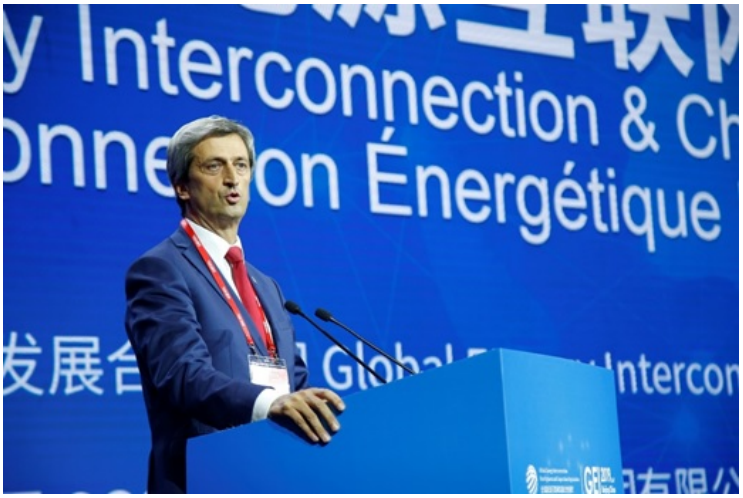
The 2019 GEI Conference was held in Beijing in the beginning of November, under the topic "A Path toward Green, Low-carbon and Sustainable Development", with more than 1000 guests from over 79 countries, and presence and messages from several international Ministers and high officials.

R&D Nester was also present, and Nuno Souza e Silva, Managing Director, moderated the panel discussion of the first session during the first day devoted to "Clean Energy and Green, Low-carbon Development".

In essence, the GEI can be considered as "Smart Grid + UHV Grid + Clean Energy", and aims at being a platform on which clean energy can be developed, transmitted and consumed at a massive scale worldwide.



In terms of implementation, the GEI concept defends "Two Replacements" (‘clean replacement' of generation sources; ‘electricity replacement' on consumption formats), "One Increase" (of electrification) and "One Restore" (of fossil fuels back to an industrial raw material).



During the event, two new studies on Africa interconnection were released, including the "Report on Developing African Energy Interconnection to promote Co-development of Electricity, Mining, Metallurgy, Manufacturing and Trade". The study addresses a 30 years development plan where interconnections plays a key role in the process.

For more information: https://en.geidco.org/

R&D Nester at COP25, Creating a Smart Energy Future!



O R&D Nester was present at the UN Climate Change Conference COP25. This year, the conference was held in Madrid under the Presidency of the Government of Chile and with logistical support from the Government of Spain.

The conference is designed to take the next crucial steps in the UN climate change process. Following agreement on the implementation guidelines of the Paris Agreement at COP 24 in Poland last year, a key objective for this year was to complete several matters with respect to the full operationalization of the Paris Climate Change Agreement.

At COP25, o R&D Nester also attended the GEIDCO (Global Energy Interconnection Development and Cooperation Organization), invited to the discussion table.

The theme of the event was "Jointly Promoting Global Energy Interconnection to Create New Momentum for Climate Mitigation".

In this GEIDCO event were released the following reports: "Global and Continental Energy Interconnection Research and Outlook", Global Energy Interconnection for Addressing Climate Change" and "Global Electricity-Carbon Market Research".





The event was hosted by Liu Zhenya, President of GEIDCO and counted with the presence of Liu Zhenmin, UnderSecretary-General of the United Nations for Economic and Social Affairs, Ovais Sarmad, Deputy Executive Secretary of the United Nations Framework Convention on Climate Change (UNFCCC), Petteri Taalas, Secretary-General of the World Meteorological Organization and Sun Zhen, Deputy Director General, Department of Climate Change, Ministry of the Ecology and Environment of the People's Republic of China, the Deputy Secretary General of Delegation to China to COP25.





TECHNICAL INFORMATION

Hydrogen-Bromine Flow Battery

The application of Battery Energy Storage System (BESS) in the Power System environment has shown remarkable results in the fields of ancillary services providing Spinning and Frequency Reserve services while improving Power Quality and managing peak shaving

operations. One case of success is the Hornsdale Power Reserve, the 100MW battery system installed in Mid North region of South Australia by Tesla, which in only six months after beginning of operations, was responsible for 55% of frequency control and ancillary services in South Australia and reduced the service costs by 90% [1].

With the ever-growing renewable energy sources and their consequent intermittency, the demand for high rated BESS will grow proportionally. The most commonly used technology for these systems is the Lithium-ion battery that depends heavily on minerals like Lithium, Cobalt, Nickel and other specific metals. These materials are not abundant resources, restricted to geographical availability and might be dominated by small groups of suppliers. Recent demand due to soaring production of electrical vehicles could cause the cost of a BESS to be unsustainable. Due to this possible limitation on the development of new BESS, the R&D community has been putting a lot of focus into developing alternatives to the Lithium-ion battery.

Such technologies being developed are on the field of Redox Flow Batteries. There is a large variety of active materials from which flow batteries can be built (redox couples). From a cost point of view, the ideal flow battery must show a high power density, a high energy density and must be designed around low cost active materials. The combination of these 3 factors is to a large extent decisive for the storage cost per kWh and therefore fundamental when creating a sustainable product affordable to be installed at large scale, although in the case of static batteries the Energy Density becomes the least important factor.

One such promising redox couple is the hydrogen and bromine. Hydrogen and bromine are abundantly available on a global scale. Figure 1 shows the electrochemical cell configuration of an HBr Flow battery.

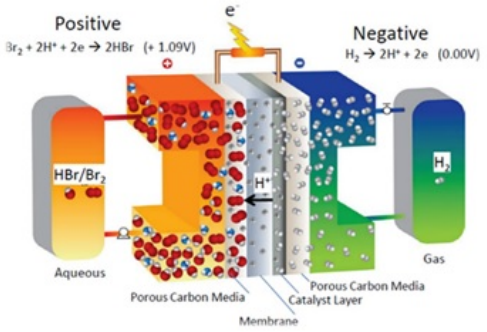


Figure 1 - electrochemical cell configuration of a HBr Flow battery [2]

The membrane in this cell is on one side in contact with the electrolyte circuit, an aqueous solution of HBr and Br2, and on the other side with a hydrogen (H2) gas circuit. Both active materials circulate in a closed loop along their own respective side of the cell. The electrolyte (HBr/Br2 solution) and hydrogen (H2) circuits can be separated by a proton-conductive membrane. A complete battery is comprised of several of this cells stacked together in series.

$$\text{Negative } (-): \mathrm{H_2} \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftarrows}} 2\mathrm{H^+} + 2\mathrm{e^-} \qquad \mathrm{E^o} = 0\,\mathrm{V}$$

$$\text{Positive } (+): \mathrm{Br_2} + 2\mathrm{e^-} \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftarrows}} 2\mathrm{Br^-} \qquad \mathrm{E^o} = 1.09\,\mathrm{V}$$

$$\text{Overall}: \mathrm{H_2} + \mathrm{Br_2} \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftarrows}} 2\,\mathrm{HBr} \qquad \mathrm{E^o} = 1.09\,\mathrm{V}$$

Figure 2 - Charging and discharging process for the HBr flow battery [3]

During the charging process, when an electrical current is established and breaks the HBr molecule into an H+ ion (= proton) and a Br- ion:

- The H+ ion crosses the membrane, absorbs an electron to form hydrogen (H2), stored at the right part of Figure 1.
- The Br- ion releases an electron to form Br2 and remains stored in the reservoir at the left side of Figure 1.

During the discharge process, when applying an electrical load, H2 and Br2 molecules are combined into hydrobromic acid (HBr):

- The H2 molecule releases 2 electrons and forms 2 H+ ions (protons).
- These protons cross the membrane and form HBr in the electrolyte circuit and remain stored in the reservoir until it is re-charged.

This makes process 100% reversible meaning no materials are consumed and therefore need no replenishment other than electric power. The system is however dependent of H2 and HBr reservoirs and their respective apparatus that make for a complex build of plant (BoP) when comparing to other types of batteries.

Notably, as membranes can account for 22% to 40% of the total cost there are some studies that apply membrane-less cells using the concept co-laminar streams of liquid flowing at low Reynolds numbers [3]. This could even further decrease the cost of the batteries while increasing their life cycle, as HBr environments are typically corrosive for physical membranes.

Although The HBr battery have lower energy density (less than that of lithium-ion batteries) and a complex BoP that actually prevent the use of H2-Br2 flow batteries in transportation applications, for BSSE applications, these drawbacks are dismissible.

Overall, there are some commercial applications of this technology where storage costs per unit of electricity are 95% lower than those of Lithium batteries [2], meaning it could be a viable solution for keeping future BESS projects affordable.

[1] - https://electrek.co/2018/05/11/tesla-giant-battery-australia-reduced-grid-service-cost/

[2] - https://www.elestor.nl/technology-the-elestor-solution/

[3] - G. Lin, P.Y. Chong, V. Yarlagadda, T.V. Nguyen, R. J. Wycisk, P. N. Pintauro, M. Bates, S. Mukerjee, M. C. Tucker, and A. Z. Weber - **Advanced Hydrogen-Bromine Flow Batteries with Improved Efficiency, Durability and Cost**
Journal of the Electrochemical Society 2015 163: A5049-A5056.

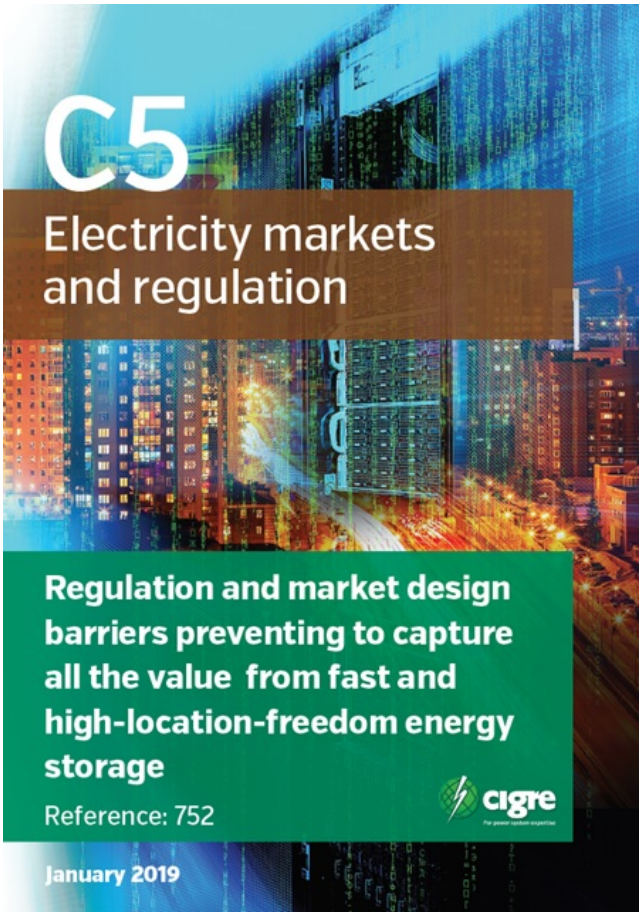
[4] - Braff, W., Bazant, M. & Buie, C. - Membrane-less hydrogen bromine flow battery. Nat Commun 4, 2346 (2013). https://rdcu.be/b0OMj

LITERATURE REVIEW

CIGRE Technical Brochure C5, WG C5.25 “Electricity Markets and Regulation”, N° 752, Jan/2019 “Regulation and market design barriers preventing to capture all the value from fast and high-location-freedom energy storage”

This report is the result of a collaborative work to identify regulation and market design barriers preventing to fully capture the value from "new" energy storage technologies, which are faster and have higher-location-freedom than conventional power generation assets. A theoretical analysis of potential value streams and barriers is presented together with a practical inventory for 14 countries. Article written with the contribution of the R&D Nester team.

Link to open publication



Five Steps to Energy Storage – Full Innovation Insights Brief World Energy Council

The topic of this briefing is energy storage. We interviewed energy leaders from 17 countries, exploring recent progress in terms of technology, business models and enabling policies. We showcase these in 10 case studies. While the brief addresses energy storage as a whole, most insights are focused on electrical storage. Our research highlighted that today's mainstream storage technologies are unlikely to be sufficient to meet future flexibility requirements resulting from further decentralisation and decarbonisation efforts. Furthermore, a restricted focus on lithium-ion batteries is putting the development of other cost-effective alternative technologies at risk.

Link to open publication

WORLD ENERGY COUNCIL

FIVE STEPS TO ENERGY STORAGE

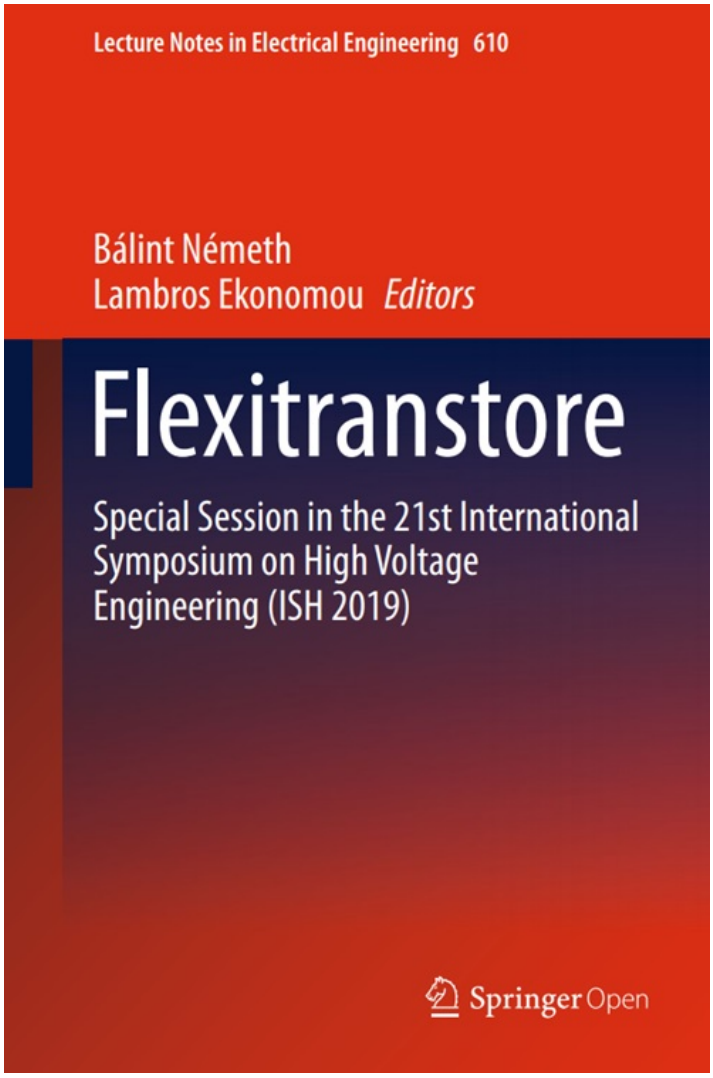


Flexitranstore Special Session in the 21st International Symposium on High Voltage Engineering (ISH 2019)

This open access book comprises 10 high-level papers on research and innovation within the Flexitranstore Project that were presented at the FLEXITRANSTORE special session organized as part of the 21st International Symposium on High Voltage Engineering, held in Budapest, Hungary, last year of 2019.

Three of these papers have R&D NESTER's team collaboration.

Link to open publication



EVENTS

12 -13 Mar 2020

BARRANQUILLA, COLOMBIA

4TO ENCUENTRO INTERNACIONAL DE ENERGÍAS RENOVABLES - WORLD ENERGY COUNCIL

31 -1 Mar /Apr 2020

LISBON, PORTUGAL

LARGE SCALE SOLAR EUROPE - "WINNING BUSINESS IN THE EU SOLAR RENAISSANCE"

13 -14 May 2020

LISBON, PORTUGAL

8º FORUM ENERGIA - JORNAL ÁGUA & AMBIENTE

23 -28 Aug 2020

PARIS, FRANCE

48TH CIGRE SESSION 2020

5 -10 Oct 2020

BEIRUT, LEBANON

WORLD ENERGY WEEK - WORLD ENERGY COUNCIL

24 -27 Oct 2020

SAINT PETERSBURG, RUSSIA

25TH WORLD ENERGY CONGRESS - WORLD ENERGY COUNCIL

LINKS

ON RESEARCH, DEVELOPMENT AND INNOVATION

- Associação de Energias Renováveis (APREN)
- Associação Portuguesa da Economia da Energia (APE)
- Portugal Energia
- DGGE - Direção-Geral de Energia e Geologia
- ERSE - Entidade Reguladora dos Serviços Energéticos
- Portal de Ciência e Tecnologia | Fundação para a Ciência e a Tecnologia (FCT)
- European Network of Transmission System Operators for Electricity (ENTSO-E)
- The Alliance for the Internet of Things Innovation (AIOTI)
- The European Wind Energy Association (EWEA)
- The European Commission's Priorities
- A Europe fit for the digital age | European Commission
- Joint Research Centre - Smart Electricity and Interoperability
- A European Green Deal | European Commission
- European Climate, Infrastructure and Environment Executive Agency (CINEA | ex-INEA)

OTHER ENTITIES

- EUASP - The European Union Agency for the Space Programme
- CIGRE - International Council on Large Electric Systems
- CTCN - Climate Technology Centre and Network
- ESA - The European Space Agency
- GEIDCO - Global Energy Interconnection Development and Cooperation Organization
- Energy Web
- World Intellectual Property Organization (WIPO)
- International Energy Agency (IEA)

QUIZ

1) WHAT PERCENTAGE OF THE TOTAL NUMBER OF ELECTRIC CARS WORLDWIDE IS LOCATED IN CHINA IN 2019?

- a) 45%
- b) 20%
- c) 31%
- d) 15%

2) WHAT IS THE INSTALLED CAPACITY OF THE LARGEST EUROPEAN PV PROJECT RECENTLY FINALISED DURING JANUARY 2020?

- a) 322 MW
- b) 500 MW
- c) 350 MW
- d) 550 MW

3) WHICH IS THE LONGEST TRANSMISSION LINE IN THE WORLD?

- a) Belo Monte-Rio de Janeiro transmission line, Brazil
- b) Rio Madeira transmission link
- c) Jinping-Sunan transmission line, China
- d) Xiangjiaba-Shanghai transmission line, China

4) WHAT WAS THE LOWEST BID IN THE RECORD-BREAKING SOLAR TENDER FROM LAST YEAR IN PORTUGAL?

- a) 16,81€/MWh
- b) 20,73€/MWh
- c) 14,76€/MWh
- d) 19,78€/MWh

5) ACCORDING TO THE MOST RECENT DECISION OF ACER, THE INTRADAY MARKET AUCTIONS SHOULD SUPPORT PRODUCTS COVERING THE FOLLOWING MARKET TIME UNITS:

- a) 60min, 30min, 15min
- b) 120min, 60min, 30min
- c) 90min, 45min, 15min
- d) 60min, 15min, 5min

6) WHAT WAS THE ADDITIONAL INSTALLED CAPACITY OF WIND POWER IN EUROPE DURING 2019:

- a) 4.2GW
- b) 3.6GW
- c) 2.3GW
- d) 5.1GW

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

1. Answer: a) 45%
2. Answer: b) 500 MW
4. Answer: c) 14,76€/MWh

3. Answer: a) Belo Monte-Rio de Janeiro transmission line, Brazil

5. Answer: a) 60min, 30min, 15min

6. Answer: b) 3.6GW

EDITORIAL

HIGHLIGHTS

TECHNICAL INFORMATION

LITERATURE REVIEW

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

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