R&D NESTER

20 NL mar 2021

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EDITORIAL

Dear Reader,

At R&D Nester, our motto is "Creating a Smart Energy Future"!

This issue of our Newsletter is a good example of walking the talk. Indeed we are bringing to you six recent direct contributions from our side, in the form of papers and scientific contributions, on very different energy system aspects.

One of them, in the field of **network planning**, is the recent publication in the ENERGIES journal entitled *"The Innovative FlexPlan Grid-Planning Methodology: How Storage and Flexible Resources Could Help in De-Bottlenecking the European System"*.

Still in the **planning** field, but applied to **offshore wind energy**, there is the paper entitled *"Grid capacity for floating offshore wind integration - The Portuguese Case"* published in the International Conference on Renewable Energies Offshore, RENEW 2020.

Another one addresses **energy forecasting** that was the subject of the paper presented in the IEEE PES Innovative Smart Grid Technologies (ISGT) Europe Conference entitled *"Energy forecasting using an ensemble of machine learning methods trained only with electricity data"*. Still in this event we presented a poster on "Impact of the dynamic line rating analysis in regions with high levels of wind and solar PV generation". These addressed both forecasting of generation and forecasting of consumption/load.

Moving away from planning and forecasting, we highlight our contributions as speakers to the **flexibility** topic with the webinar on the International Smart Grid Action Network ISGAN entitled *"Flexibility needs at system level"*. There is also an expansion on this topic in the section below on Technical Information.

Finally, two additional contributions are in the field of **digitalization and substations**: one is our paper at the CIGRE Regional South-East European Conference RSEEC 2020 entitled *"Digital substation testing with HIL Implementation of process bus and Line protection over MPLS"* and another one is the publication in the PAC World Magazine *"From Specification to the Substation - The OSMOSE Project Contribution to improve the IEC 61850 Engineering Process"*.

Additionally to these contributions we continue to work towards new contributions. Examples of this are the recent kickoffs of two additional projects: *"MarCo - Research on Key Technologies of the European electricity market coupling"* and *"OneNET - TSO - DSO - Consumer: Large-scale demonstration of innovative grid services through DR, storage and small-scale (RES) generation"*. Read more about these below.

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 Souza e Silva

Managing Director

HIGHLIGHTS

R&D Nester represented in RENEW 2020, with paper

on Grid Capacity for future offshore Renewable Energy Sources



R&D Nester was represented in this 2020's edition of the International Conference on Renewable Energies Offshore, RENEW 2020.



This Conference aims to contribute to the exchange of information about the developments and experience obtained in concept development, design and operation of renewable energies offshore.

The scope of RENEW Conference is broad, covering all aspects of the renewable energies offshore activities.

This Conference is coordinated by IST - Instituto Superior Técnico and CENTEC - Centre for Marine Technology and Ocean Engineering. The Centre for Marine Technology and Ocean Engineering (CENTEC), is a research centre of IST, recognized and funded by the Portuguese Government through the Foundation for Science and Technology of the Portuguese Ministry of Science and Technology.

TÉCNICO LISBOA
UNIVERSIDADE DE LISBOA
CENTEC
CENTRE FOR MARINE TECHNOLOGY AND OCEAN ENGINEERING

In this online edition R&D Nester was the author in one paper that was presented.

This paper is entitled "Grid capacity for floating offshore wind integration - The Portuguese Case". Its content was produced in the scope of R&D Nester project ARCWIND. This project ARCWIND (Adaptation and implementation of floating wind energy conversion technology for the Atlantic region) aims to contribute to the transition from fixed to floating wind platform systems for use in deep water and more exposed sites in the Atlantic Area by: the assessment of wind energy potential with a regional atmospheric model and remote sensed data; the study of different types of floating high power wind turbines numerically and experimentally; case studies of farms will be considered for cost assessment, logistics and maintenance planning as well as risk assessment.

For more information: ARCWIND Project

For more information regarding this event: Conference website

R&D Nester present at RSEEC 2020, with paper on Digital Substations

R&D Nester was represented in the **CIGRE Regional South-East European Conference**.



At its fifth edition, RSEEC is a major biennial event in power systems which provides an exceptional venue to CIGRE members and interested parties for presenting: Innovation for efficient and effective management, solutions for power systems of the future.



The conference brought together power systems engineers, decision makers, economists, academics, students and others with interest in the domain.

This Conference was organized by The CIGRE's Romanian National Committee, with the cooperation of CNTEE Transelectrica (the Romanian TSO) and University "Politechnica" of Bucharest - The Faculty of Power Engineering.

In this online edition R&D Nester was the author in one paper that was presented.

This paper is entitled "Digital substation testing with HIL Implementation of process bus and Line protection over MPLS". Its content was produced in the scope of R&D Nester project 'Smart Substation Testing and Implementation'. Inspired by the results derived from the previous R&D Nester project entitled 'Substation of the Future', where a specification for a new generation of PAC systems was developed and tested, this project aims to further develop the functionalities and extend the testing portfolio for PAC systems.

This Paper is also the result of the work developed by R&D Nester in cooperation with REN, in the **IPMLS project**. This project was undertaken by REN and R&D Nester, gathering both company's expertise in both protection, automation and control (PAC) systems and communication networks, aiming to validate a solution for an IP/MPLS network providing communication services for line protection systems.

For more information: SMART SUBSTATION TESTING AND IMPLEMENTATION Project

For more information regarding this event: Conference website

R&D Nester participated in ISGT Europe 2020, with two communications on Energy Forecasting and Wind/Solar Photovoltaic Generation

R&D Nester participated in 2020's edition of the **IEEE PES Innovative Smart Grid Technologies Europe Conference**.



ISGT-Europe was organized by IEEE Power & Energy Society (PES) and Delft University of Technology, Delft, The Netherlands. This conference is one of the two IEEE PES flagship conference organized in Europe and has established a strong reputation of the last years. It focuses on industrial and manufacturing theory and applications for the wide use of information and communication technologies and integrated renewable and distributed energy resources on the electric grid.



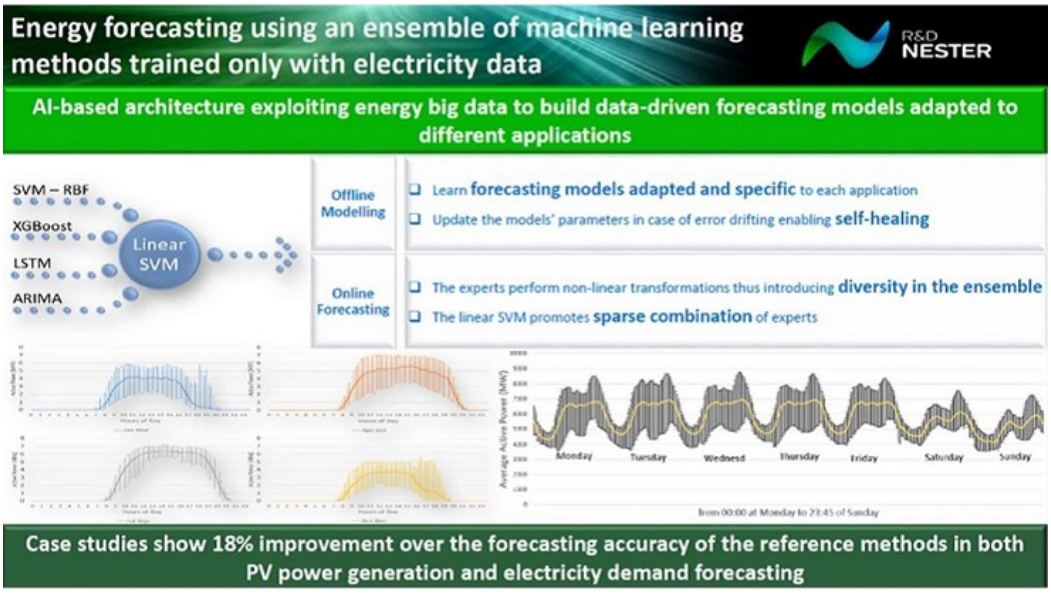
This year, it was a virtual event, under the theme "Smart Grids: key enablers of a green power system".

ISGT Europe 2020 featured keynotes, plenary sessions, panels, industry exhibits, paper and poster presentations by worldwide experts on smart grid and related technologies. Researchers, practitioners and students worldwide presented papers at this conference and discussed the latest trends and emerging and innovative technologies for grid modernization.

In this online edition, R&D Nester was the author in one paper and co-author in a poster that was presented:

The article is entitled "Energy forecasting using an ensemble of machine learning methods trained only with electricity data". Its content was produced in the scope of R&D Nester participation in the project **"GIFT"** funded by the EU H2020 Research and Innovation program. The GIFT project is an innovation action aiming at decarbonize the energy mix of European islands.

At ISGT 2020, R&D Nester presented its AI-based architecture for electricity forecasting, an innovative approach to build forecasting models adapted to different applications. In particular, the work presents applications to PV power generation and electricity consumption prediction, showing improved performance over the state-of-the-art.



The poster, in which R&D Nester is co-author, is entitled "Impact of the dynamic line rating analysis in regions

with high levels of wind and solar PV generation". Its content was produced in the scope of R&D Nester participation in "OptiGRID" project, which is funded by national funds through the budget of the Foundation for Science and Technology (FCT).

This project main objectives are the development of an operational tool and a methodology using Dynamic Line Rating increasing the transmission capacity to facilitate an increase of RES integration in the power system and to reduce the number of separation hours of markets, affecting its prices.

Conference website

GIFT Project

OptiGRID Project

R&D Nester as speaker in Webinar on Flexibility Solutions

R&D Nester participated as speaker in the 25th webinar of the **ISGAN Academy**.



This event was organized by **INTERPRETER**, in partnership with **FlexPlan** and CoordiNet projects, all funded by the EU H2020 Research and Innovation program.

The objective of the ISGAN Academy is to offer the ISGAN community of high-level engineers, decision makers, students and public in general a means of rational and efficient continuous technical skills complement and updates in the field of smart grids. The Academy presents updated information about new emerging topics and challenges, recent developments, best practices, novel methodologies, smart grids theory, applications, deployments and events of ISGAN activities.

This R&D Nester presentation was produced in the scope of its participation in INTERPRETER Project, whose main objective is the implementation of a modular grid management solution consisting of a set of 10 software applications for an optimal design, planning, operation and maintenance of the electricity grid - with a special focus on the distribution network - that will be offered to grid operators through an open-source interoperable platform.

This webinar presentation was entitled **"Interpreter - Flexibility needs at system level and how RD&I projects are leveraging these solutions"** and provided an introduction to flexibility solutions, which can be used to increase efficiency in power systems. These solutions were demonstrated using the examples of the INTERPRETER project and were followed by another presentation of "FlexPlan" and "CoordiNet" projects. R&D Nester is also involved in the FlexPlan project.

Link for event
Interpreter Project
FlexPlan Project

R&D Nester's new Project on the European Electricity Market Coupling

R&D Nester started the project **MarCo - Research on Key Technologies of the European Electricity Market Coupling** in November 2020.



The European electricity market coupling is the process of building the internal European market for electricity. The realization of the internal European market for electricity increases the security of electricity supply in Europe, promotes Europe's energy independence and has the potential to lower greenhouse gas emissions and the price of electricity, allowing widespread consumption of renewable generation, even in regions without significant renewable resources.

This project has a duration of 21 months and studies the development of the internal European market for electricity, its operation and the coordination and negotiation mechanisms supporting the SDAC (Single Day-Ahead Coupling) and the SDIC (Single Intraday Coupling).

MarCo performs an analysis of the existing mechanisms and the trends of future developments, including those aspects related to the allocation of capacity between bidding zones and the congestion management. To this end, the project will develop a market model with security constraints and chronological stochastic simulations to support the quantitative assessment of the efficiency of the processes in the SDAC and the SDIC, in order to identify opportunities for improvement in the construction of the European internal electricity market.

For more information: MarCo Project

R&D Nester in the kick-off meeting of the Project OneNet

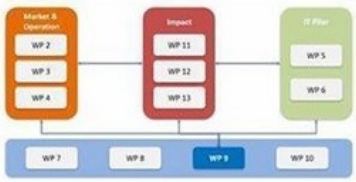
The European Commission H2020 project **OneNet - TSO-DSO - Consumer: Large-Scale Demonstration of Innovative Grid Services through DR, Storage and Small-Scale (RES) Generation** is a 3-year project that started on October 2020 and will last until September 2023.

This project aims to achieve the following objectives as stated in the call:

- "...creating the conditions for a new generation of grid services able to fully exploit demand response, storage and distributed generation while creating fair, transparent and open conditions for the consumer;
- build a customer centric approach to grid operation by proposing new markets, products and services and by creating a unique IT architecture..."

The concept proposed by OneNet will be tested and implemented in 4 geographical cluster demos.

On 29/10/2020 a kick-off webmeeting on OneNet was held in which the dedicated Work Packages were briefly presented. The work packages are clustered in three pillars (Markets & Operation, Impact and IT) as shown in the figure:

Markets and Operation WP2 **Products and Services definition** in support of OneNet WP3 **Integrated and coordinated markets** for OneNet WP4 **Integrated System Operation** for OneNet **IT Pillar** WP5 **Open IT Architecture** for OneNet WP6 **Reference IT Implementation** for OneNet **Geographical cluster demos** WP7 North Cluster Demo WP8 South Cluster Demo **WP9 West Cluster Demo (Portuguese, French and Spanish demos)** WP10 East Cluster Demo **Impact** WP11 **CBA, SRA and Business Models** for OneNet	

OneNet counts with the participation of 72 partners, where, amid many others, R&D NESTER, REN and EDP Distribuição are going to participate and contribute in developing the West Cluster demo in Portugal. The Work Package concerning the West Cluster Demo is where R&D NESTER will be more involved together with other WP highlighted in bold in the figure.

A new logo was adopted during the kick-off meeting:

ONENET
one network for Europe

More information can be found on:

https://cordis.europa.eu/project/id/957739

OneNET Project

TECHNICAL INFORMATION

Flexibility providers: identification and cost evolution

The current fast changing context of power systems presents multiple challenges for grid planning studies. The need for flexibility in the system needs to be addressed through flexibility solutions. Although there is no unified and agreed definition for the term 'flexibility' in power systems, one common definition by IEA is [1]: "the ability of a power system to reliably and cost effectively manage the variability and uncertainty of demand and supply across all relevant timescales, from ensuring instantaneous stability of the power system to supporting long-term security of supply".

Flexibility resources can be used to provide the required flexibility services for a reliable and secure operation of the power system. In the last edition of our newsletter, we dedicated a section to the identification of energy storage systems (ESS) which are examples of flexibility resources. Herein we further identify additional flexibility resources and provide a tentative characterization of those, focusing on the envisaged application and providing some tentative cost characterization.

In grid planning studies, one needs to take into consideration the power and energy capacities. From a grid planning perspective, power capacity relates to the ability of meeting peak demand with the net generation, allowing not to oversize the network to answer to peak demands and support the fluctuations in RES generation and demand variation. On the other hand, energy capacity is related to the duration in which the resource can

provide a flexibility service at the desired power rate. Table 1 includes a description of different flexibility resources and an expected range of power and energy capacities. Flexibility solutions for fast transient phenomena, with a large power capacity but low energy capacity (less than one hour) are not considered.

Flexibility resource		Power capacity range	Energy capacity range
Battery energy storage system (BESS)[2]		kW - MW	kWh - MWh
Demand Response [3]	Domestic	kW	kWh - MWh
	Industrial	kW- MW	kWh - MWh
Electric vehicles [3]		kW-MW	kWh - MWh
Hydrogen [4]	Alkaline	kW - MW	MWh
	PEM	kW - MW	MWh
	SOEC	kW - MW	MWh
Pumped storage hydro		GW	TWh
Thermal loads [5]	Space heating /cooling	kW-MW	kWh - MWh
	Cold storage	MW	MWh
Combined heat and power [6]		kW-MW	kWh - MWh
Compressed air storage [2]		kW-MW	MWh
Liquid-Air Electricity Storage systems [7]		kW-MW	MWh

The deployment of these solutions is related to their economic viability assessment as they all present valid technical solutions, depending on the grid size and foreseen application. To give a general overview of the cost structure for these technologies, Table 2 contains the CAPEX and OPEX costs for the different technologies considering two time horizons: 2021, and 2050. Values are calculated assuming a discount rate of 6% per year [8].

Flexibility resource		CAPEX (€/kW(h))		OPEX (€/kW(h))	
		2021	2050	2021	2050
BESS [2]		278 - 1475	67 - 226	low	low
Demand Response [3]	Domestic	54/year	15/year*	32/year	9/year
	Industrial	54/year	15/year*	32/year	9/year
Electric vehicles [3]		54/year	15/year*	32/year	9/year
Hydrogen [4]	Alkaline	500 - 1500	200 - 600	2% CAPEX	2% CAPEX
	PEM	1200 - 1800	200 - 800	2% CAPEX	2% CAPEX
	SOEC	2500 - 5000	500 - 900	2% CAPEX	2% CAPEX
Pumped hydro		40 - 150	16 - 43.5*	low	low
Thermal loads [5]	Space heating /cooling	54/year	15/year*	32/year	9/year
	Cold storage	54/year	15/year*	32/year	9/year
Combined heat and power [6]		880 - 2240	880 - 2068	0.01 -0.04	0.017 -0.11
Compressed air storage [2]		40 - 80	40 - 80	0.15 – 0.30	0.15 – 0.30
Liquid-Air Electricity Storage systems [7]		60 - 600	17.4-174*	Small	Small

* fuel costs

As can be seen, significant price reductions are expected over the next years, indicating the need for new flexibility resources, enabling new flexibility services, and bringing technologies that are currently not economic viable to the market. Depending on the grid characteristics and operation conditions (e.g. share of renewables), a different set of these flexibility resources can be combined to achieve the best technical solution. Grid planning studies should also consider these resources as part of the grid expansion process, depending on the needs. A thorough analysis is performed in the scope of FlexPlan project, available in [9].

References:

[1] 21CPP and IEA, "Status of Power System Transformation 2019: Power system flexibility," IEA, 29 May, 2019.

[2] "Electricity Storage and Renewables: Costs and Markets to 2030," International Renewable Energy Agency (IRENA), Abu Dhabi, 2017.

[3] COWI, "Impact assessment study on downstream flexibility, price flexibility, demand response & smart metering - Final report," EUROPEAN COMMISSION DG ENERGY, Brussels, 2016.

[4] IEA, "The future of Hydrogen - Seizing today's opportunities," 2019.

[5] R. Baetens, "FutureFlow Deliverable 1.1 Requirements for DR & DG participation in aFRR Markets," 2016.

[6] M. Bhandari, E. Chartan, E. Hale, B. Hedman, R. Heffner, B. A. Hamilton, P. Lemar, S. Nimbalkar, M. Ruth, B. Stoll, J. Storey, R. Tidball and C.

Wagstaff, "Modeling the Impact of Flexible CHP on California's Future Electric Grid," US Department of Energy, 2018.

[7] "Highview Power," Highview Power, [Online]. Available: https://www.highviewpower.com/technology/

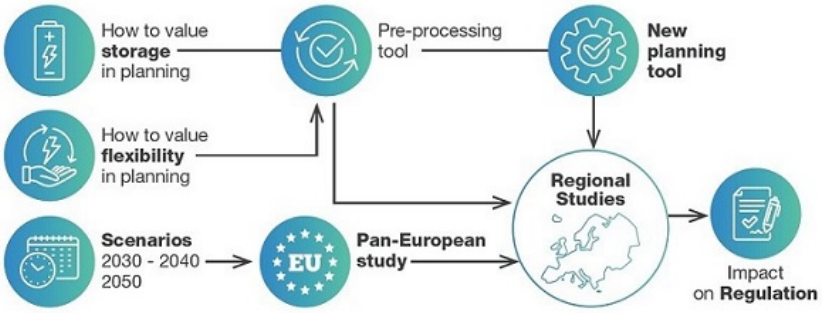
[8] "The social discount rate," Government.no, 2012. [Online]. Available: https://www.regjeringen.no/en/dokumenter/nou-2012-16/id700821/sec6

[9] "FlexPlan Project - D2.2", FlexPlan. [Online]. Available: https://flexplan-project.eu/wp-content/uploads/2020/06/D2.2_20200622_V1.0.pdf

LITERATURE REVIEW

R&D Nester publishes scientific paper in Energies Journal related to work performed in FLEXPLAN Project about Grid-Planning Methodology

R&D NESTER is one of the partners involved in the publication of a new scientific paper in **ENERGIES journal**. The paper, entitled "**The Innovative FlexPlan Grid-Planning Methodology: How Storage and Flexible Resources Could Help in De-Bottlenecking the European System**" has as the objective of giving a general overview of the methodologies used in the project, as well as presenting the study cases considered.



FlexPlan aims to create an innovative grid-planning tool that allows including flexibility sources as alternatives to traditional grid reinforcement measures, applicable to transmission and distribution grids. The expansion candidates are evaluated in a multi-period timeframe (2030, 2040 and 2050) and selected through a multi-objective cost benefit analysis. The tool also considers the utilization of stochastic contingency analysis methods and considers as well the variability of renewable sources through a multi scenario analysis, including Monte Carlo variants. Simulated network models correspond to six regional cases covering a large part of Europe, allowing to demonstrate the tool capabilities in real cases of relevant size and complexity.

R&D NESTER contributed to the creation and publication of the paper by performing a summary description of the methodology used to create the network models and energy scenarios to be simulated in the regional use cases, as well as identifying all necessary data to the execution of these simulations. This work is developed by R&D NESTER as leader of Work Package 5, which is dedicated to the simulation of the project regional cases.

FlexPlan project is financed by H2020 and is developed in a consortium composed of 13 partners, including three TSOs and one DSO. R&D NESTER and REN are active members of this consortium.

All FlexPlan details can be accessed in https://flexplan-project.eu/.

Link for Publication

R&D Nester on the JPP ERA-NET Smart Energy Systems Laboratories Inventory



The European **Joint Programming Platform ERA-Net Smart Energy Systems** aims to accelerate the development of innovation ecosystems through a transnational network composed of several *Living labs* and *Testbeds* focused on Smart Energy Systems (SES) that will allow companies and researchers to test and validate their technological solutions in environments with close to real conditions.

It is in this context that R&D NESTER promotes its Real-time Power System Simulation Laboratory (RTPSS Lab). The RTPSS Lab is now on the first list of partners selected to be part of this international testing and validation platform. These partners can thus participate in new consortia that can apply for funds from the JPP ERA-net SES program.

This list presents 52 partners at European level who provide their infrastructure or offer their services to projects.

The list of partners can be found at https://www.eranet-smartenergysystems.eu/Partners/Living_Labs.

The RTPPS Lab from R&D NESTER is referenced once again as a European laboratory relevant in the field of Smart Grids.

For additional information, visit the JPP ERA-net SES website.

PAC World Magazine “From Specification to the Substation” The OSMOSE Project Contribution to improve the IEC 61850 Engineering Process

The European project **OSMOSE (Optimal System-Mix of Flexibility Solutions for European Electricity)**, of which R&D Nester is partner, in a consortium of thirty-two organizations, is featured in the last December issue of **PAC WORLD Magazine**, a magazine dedicated to PAC (protection, automation and control) systems.

The article published in this journal gives international visibility, not only to the project, but also to the R&D Nester laboratory, where tests related to the 'Interoperability' task are being carried out.

This article was contributed by R&D NESTER researchers and describes the work developed in this task including the comparison between the standard engineering process and that proposed by Osmose, describing the test procedures of interoperability between devices, which it will allows to validate that the proposed changes to the engineering process provide interoperability and efficiency improvements.

OSMOSE is a project selected for funding by the European Union under Horizon 2020. Its main objectives are the demonstration of different technological solutions of energy flexibility, increasing their technical and

economic viability and their scalability, the prediction of the optimal economic mix of flexibility for the future European electric system and the proposal of new market designs and regulation that facilitate the integration of flexibility and maximize social well-being.



For more information about the OSMOSE project:

[OSMOSE Project website]

[OSMOSE on R&D Nester website]

World Energy Trilemma Index 2020 Report - Oct/2020

The World Energy Council's definition of energy sustainability is based on three core dimensions: Energy Security, Energy Equity, and Environmental Sustainability of Energy Systems.

Balancing these three goals constitutes a 'Trilemma' and balanced systems enable prosperity and competitiveness of individual countries.

The **World Energy Trilemma Index** has been prepared annually since 2010 by the World Energy Council in

partnership with global consultancy Oliver Wyman, along with Marsh & McLennan Advantage of its parent Marsh & McLennan Companies. It presents a comparative ranking of 128 countries' energy systems. It provides an assessment of a country's energy system performance, reflecting balance and robustness in the three Trilemma dimensions.

Since 2010, the Report has provided an independent and objective rating of a country's energy policy and performance using verified global and country-specific data to assess management of three core dimensions: Energy Security, Energy Equity and Environmental Sustainability.

The World Energy Trilemma Index enables countries to keep track of their own progress and to learn with and from each other about what's working and what's not.

The annual assessment is designed as a tool to be used, not a report to be read and placed on a shelf. In this report we also suggest 'how to' use the World Energy Trilemma Index as an energy policy pathfinding tool.



Link for publication

EVENTS

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 Jun /Jul 2021

MADRID, SPAIN

POWERTECH 2021 - "POWER FOR THE SUSTAINABLE DEVELOPMENT GOALS"

20 -25 Aug 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

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"

LINKS

- A European Green Deal | European Commission
- ON RESEARCH, DEVELOPMENT AND INNOVATION
- Portal de Ciência e Tecnologia | Fundação para a Ciência e a Tecnologia (FCT)
- Horizon Europe
- European Energy Research Alliance (EERA)
- BRIDGE (H2020)
- Associação de Energias Renováveis (APREN)
- European Distributed Energy Resources Laboratories (DERlab)
- Portugal Energia
- DGGE - Direção-Geral de Energia e Geologia

Others Entities Europe

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

Others Entities World

- World Intellectual Property Organization (WIPO)
- International Energy Agency (IEA)
- International Electrotechnical Commission (IEC)
- EUASP - The European Union Agency for the Space Programme
- CTCN - Climate Technology Centre and Network

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

1) DEPENDABILITY (OF AN ITEM) IS:

(a) ability to perform as required
(b) ability to perform as and when required
(d) none of the above
(c) ability to perform when required

2) REDUNDANCY IS:

(a) existence of more than one means for performing a required function in an item
(b) existence of a duplicated item in which a function performs an action
(c) ability to execute a function a second time in case of failure

4) WHAT IS AN UNMANNED SUBSTATION?

(a) a substation which is operated by personnel who are not stationed at the substation
(b) a substation operated by machines
(c) a substation where the commands are issued by automatic functions
(d) a substation where the personnel do not stay at night

5) WHAT IS A SWITCHING SUBSTATION?

(a) a substation which includes switchgear and usually busbars, but no circuit breakers
(b) a substation which includes switches only
(c) a substation which includes switchgear, but no busbars

(d) ability to execute a function a second time if case of doubt

3) SECURITY (OF A PROTECTION) IS

(a) the probability for a protection of eliminating a fault in the specified time interval

(b) the probability for a protection of not causing damage to other devices or personal

(c) the probability for a protection of avoiding being hacked

(d) the probability for a protection of not having an unwanted operation under given conditions for a given time interval

and power transformers

(d) a substation which includes switchgear and usually busbars, but no power transformers

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

1. Answer: (b) ability to perform as and when required

2. Answer: (a) existence of more than one means for performing a required function in an item

3. Answer: (d) the probability for a protection of not having an unwanted operation under given conditions for a given time interval

4. Answer: (a) a substation which is operated by personnel who are not stationed at the substation

5. Answer: (d) a substation which includes switchgear and usually busbars, but no power transformers

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