CIGRE STRATEGY AND FUTURE GRID

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For power system expertise

WHAT IS CIGRE

- CIGRE is the global expert community for electric power systems.
- Purpose - To foster **engagement** and **knowledge sharing** among power system professionals **globally** to **enable** sustainable provision for electricity for all.
- Mission – Contribute to the betterment of power systems by **enhancing the expertise** of the people within it
- Vision – to be universally recognized as the leading **global** organization for **all aspects** of electric power systems.

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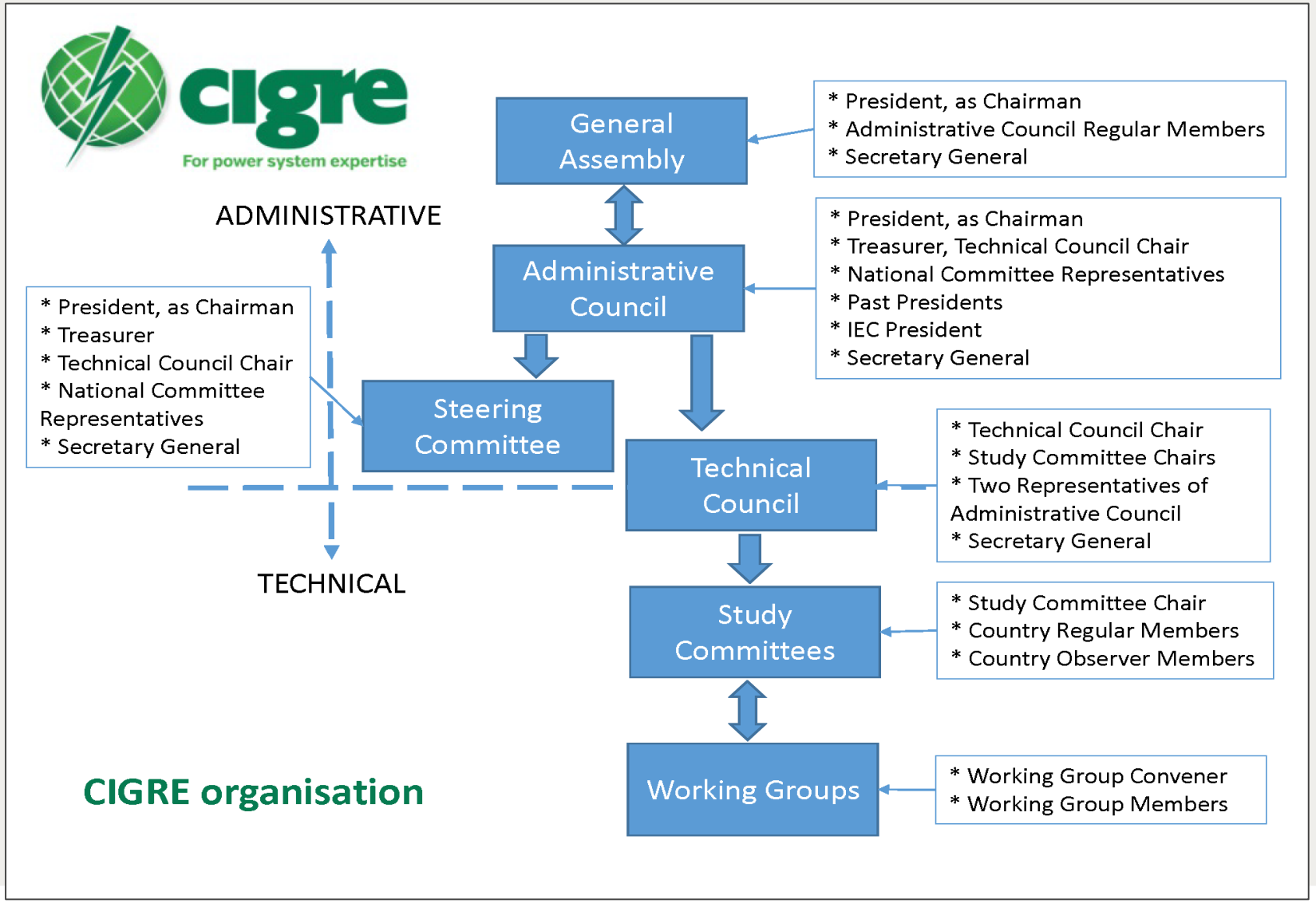
MEMBERSHIP

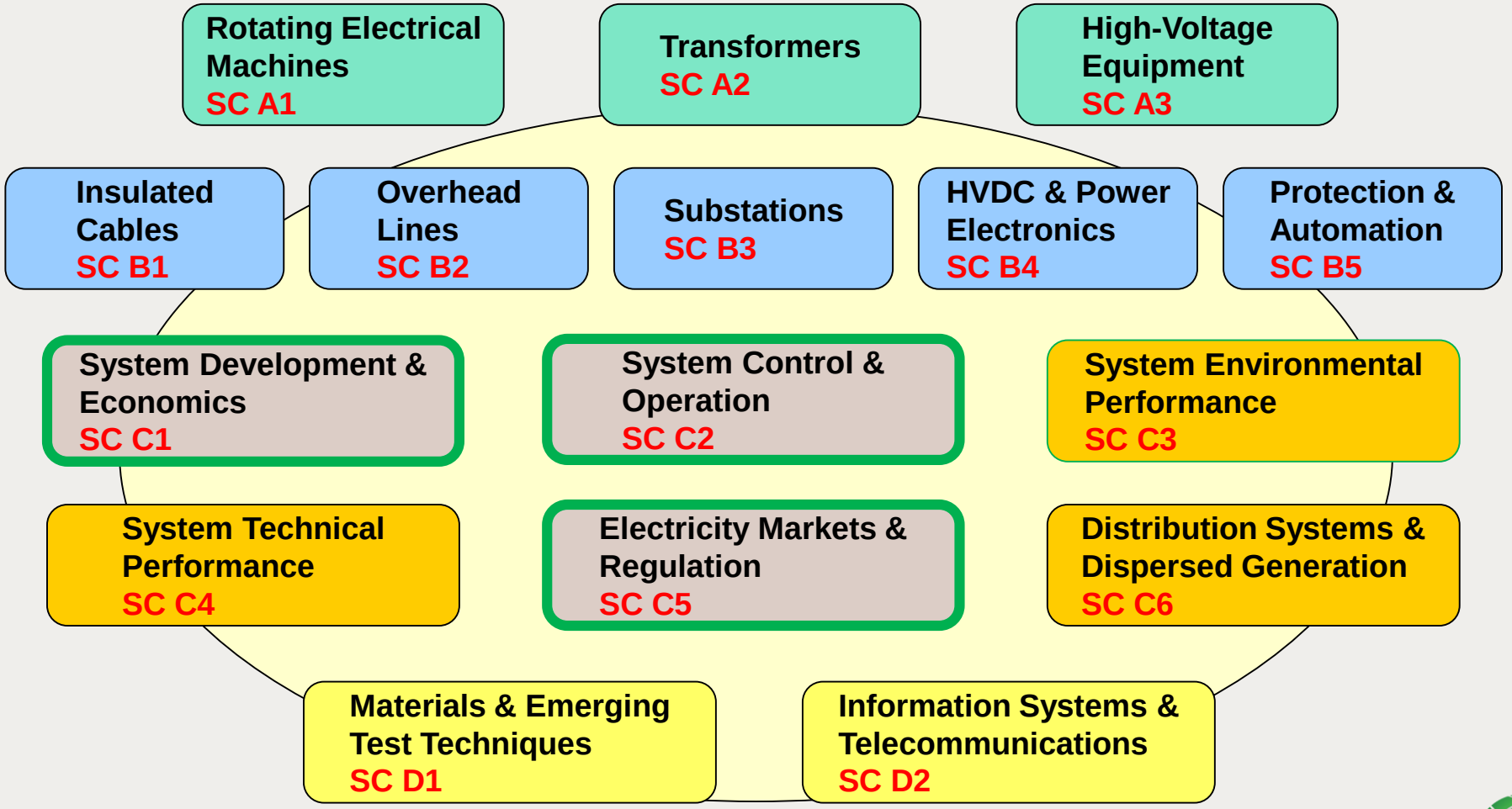
10150 individual; 1245 collective 90 countries

59 National Committees

CIGRE ORGANIZATION



CIGRE STUDY COMMITTEES



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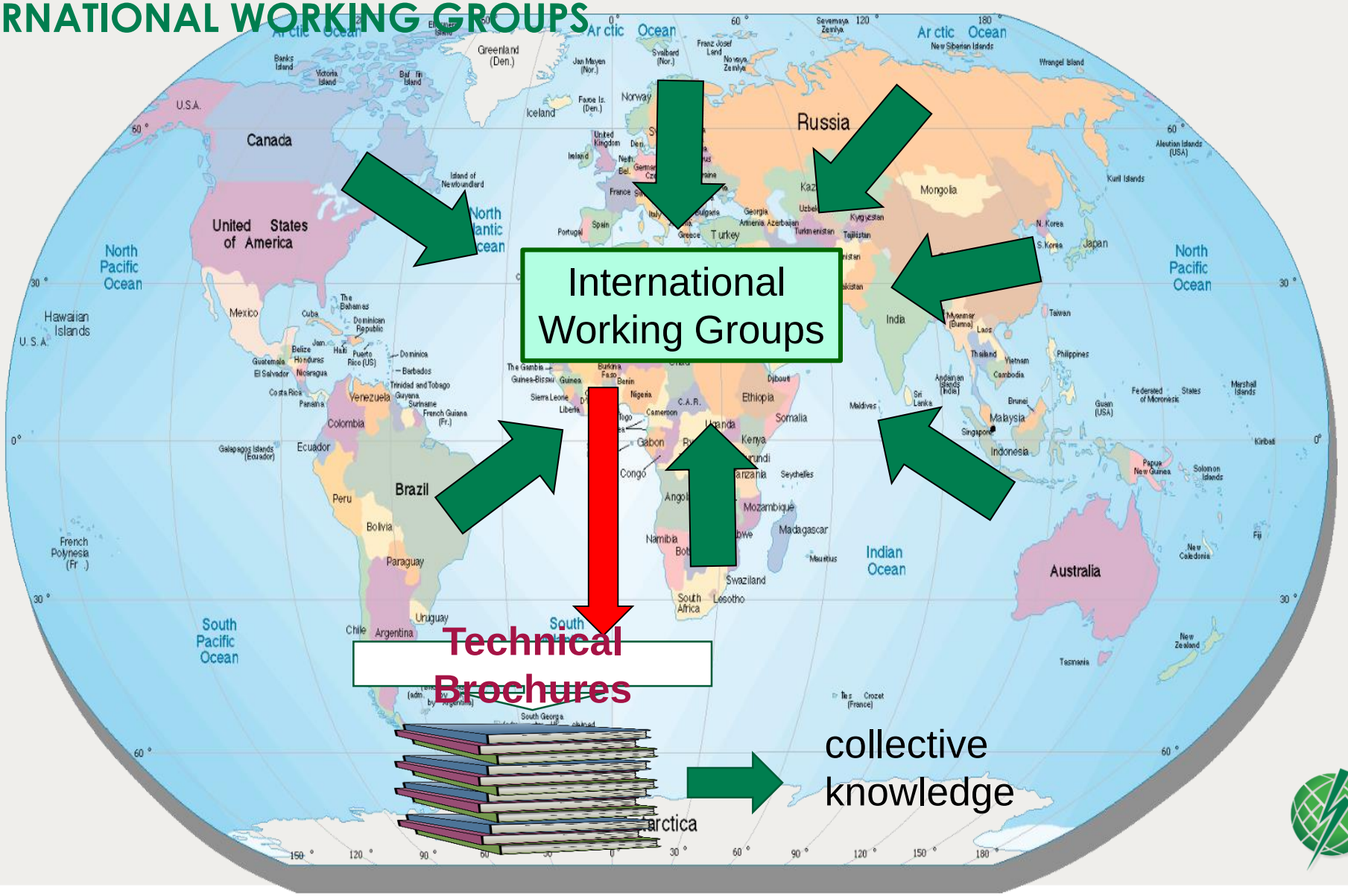
HOW CIGRE WORKS

- **Conferences, Colloquia, Symposia, Tutorials all over the world**
  Flagship: bi-annual Paris Session
  (3800 participants in 2018, 9000 visitors)

- **International work bodies**, dedicated to topics of common global and/or regional interest

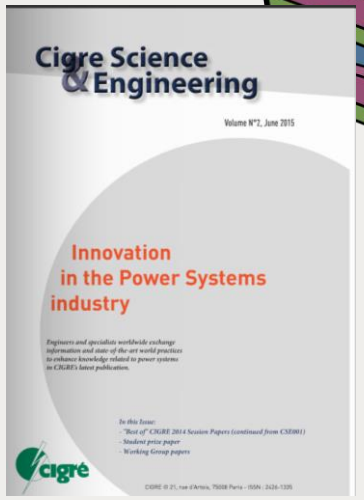
- Publications

230 INTERNATIONAL WORKING GROUPS



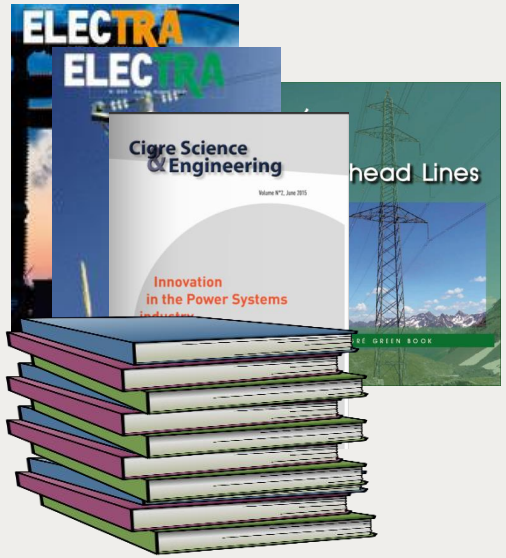
CIGRE'S PUBLICATION PORTFOLIO

Technical Brochures
(around 1500 since 1921)



Green Books

USING INFORMATION



IEC Work Body

direct publication

used for dialog between manufacturers and users as a «sort of standard»

information for the electric power sector: e.g. utilities, manufacturers, institutions, laboratories, universities, consultants

textbooks for education

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STRATEGIC THEMES

- Influence and Contribute – providing key information to executives and engineers for influence and awareness.
- Vibrant and inclusive – Excellent CO services
- Power system of the future – Understand and influence the development of new technology and practices for all voltages and systems
- People and skills of the future – increase participation and skills for our growing membership and improve the diversity (WIE, NGN) of our membership to enhance our relevance in addressing the electric power system of the future across the globe

ACTIONS TAKEN TO DATE

- Strategic plan completed – standardized direction
  - Purpose
  - Mission
  - Value
  - Focus areas
- Marketing activity to provide assistance to NC's
  - Standardised templates – presentations, documents, information
  - Website standardized pages to assist NC's create own identity at low cost
  - CIGRE information available on all devices – Logo altered slightly to accommodate this.
  - Information on CIGRE activities – excellent response to videos and pictures showing CIGRE at work.

OTHER INITIATIVES

- Move to lower voltage with end to end approach
  - 6 members for SC dealing in lower voltage technology to be appointed.
  - These members to initiate projects, contribute experts in lower voltage technology.
- Paris session – CEO event – to indicate the benefit of CIGRE to the industry leaders
- Revision of ELECTRA – move to digital platform – increase value via a number of valuable documents
  - WG papers
  - TB summaries
  - Reference papers
  - News from CIGRE

FUTURE GRID - TEN AREAS OF FOCUS

1. ACTIVE DISTRIBUTION NETWORKS
2. MASSIVE EXCHANGE OF INFORMATION
3. INTEGRATION OF HVDC/POWER ELECTRONICS
4. SIGNIFICANT INSTALLATION OF STORAGE
5. NEW SYSTEMS OPERATIONS /CONTROLS
6. NEW CONCEPTS FOR PROTECTION
7. NEW CONCEPTS IN PLANNING
8. NEW TOOLS FOR TECHNICAL PERFORMANCE
9. INCREASED USE OF EXISTING INFRASTRUCTURE AND NEW T&D DEVELOPMENTS
10. STAKEHOLDER AWARENESS

PAST SYSTEM

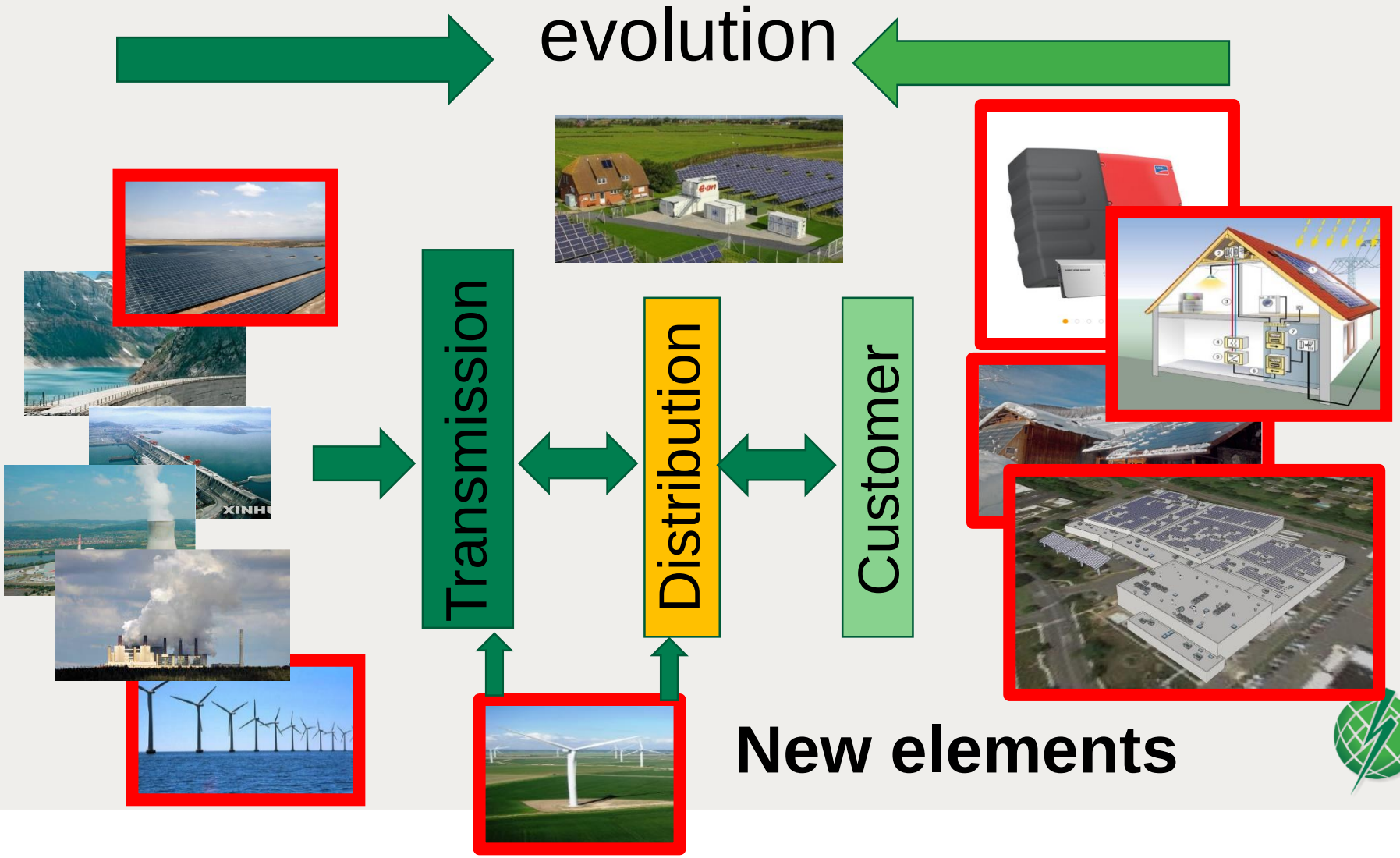
Transmission

Distribution

Customer

Uni-directional load flow from source to load

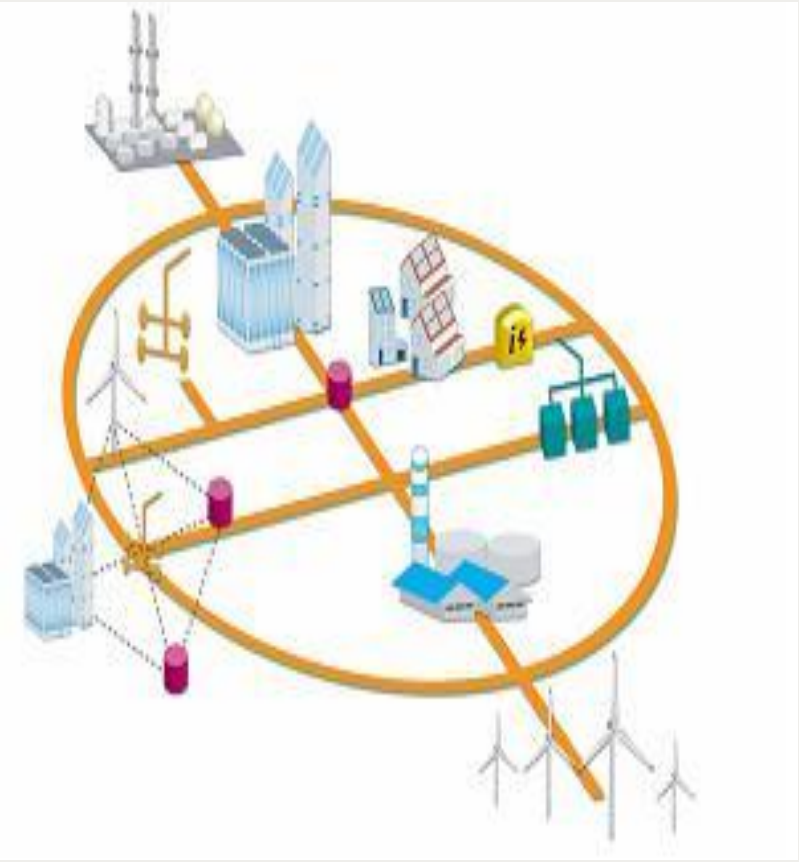
EVOLUTION OF GRID USE



NEW KEY ELEMENTS

- Continental and intercontinental interconnections
- Deployment of variable sources
- Electric energy storage on all voltage levels
- Massive number of residential- and business generation
- Grid control and energy management by digitalization - also on the low voltage side
- Massive increase of new consumers (e-mobility and heat pumps)

1 ACTIVE DISTRIBUTION NETWORKS



Key Challenges

- Distribution level needs **more "smartness"**
- Massive penetration of **distributed generation** units imposes the need for their control and coordination
- **Smart metering** implementation and active demand participation
- Evolution of **markets** and regulation

2 MASSIVE EXCHANGE OF INFORMATION

Key Challenges

- **New architectures** of information, communication technologies and algorithms for system operation, protection, maintenance, etc.
- **Large amount of data exchange** between an increasing number of stakeholders from distribution networks, dispersed generation and consumption.
- **Cyber security** and access control

3 INTEGRATION OF HVDC / POWER ELECTRONICS (PE)

Key Challenges

- **Integration** of multi-infeed HVDC networks in the AC network
- **Effects of PE penetration at all voltage levels**

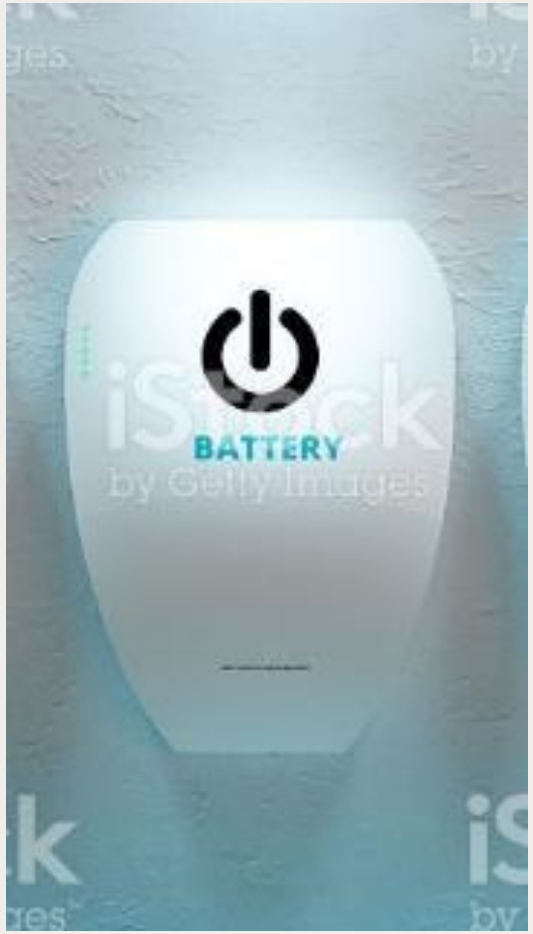
INVERTER BASED RESOURCES-GROWING

Fastest growing electricity source: by 2030 expected to be a major source of electricity (IEA)

e.g. China: in 2015 wind 128 GW ; PV 43 GW

by 2020 wind 250 GW, PV 150 GW ;

4 SIGNIFICANT INSTALLATION OF STORAGE

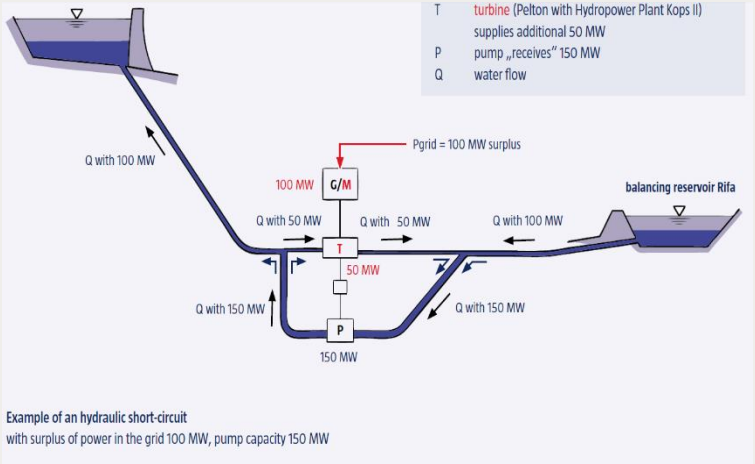


Key Challenges

- **Modeling** for steady state and dynamic simulations.
- **Management** of storage for peak shaving, ancillary services, RES balancing and energy arbitrage

STORAGE CAPACITIES

Global
145 GW (98%)



Example of an hydraulic short-circuit
with surplus of power in the grid 100 MW, pump capacity 150 MW

PV combined with storage
Global : around 2200 MW
In 2025 expected > 21 GW

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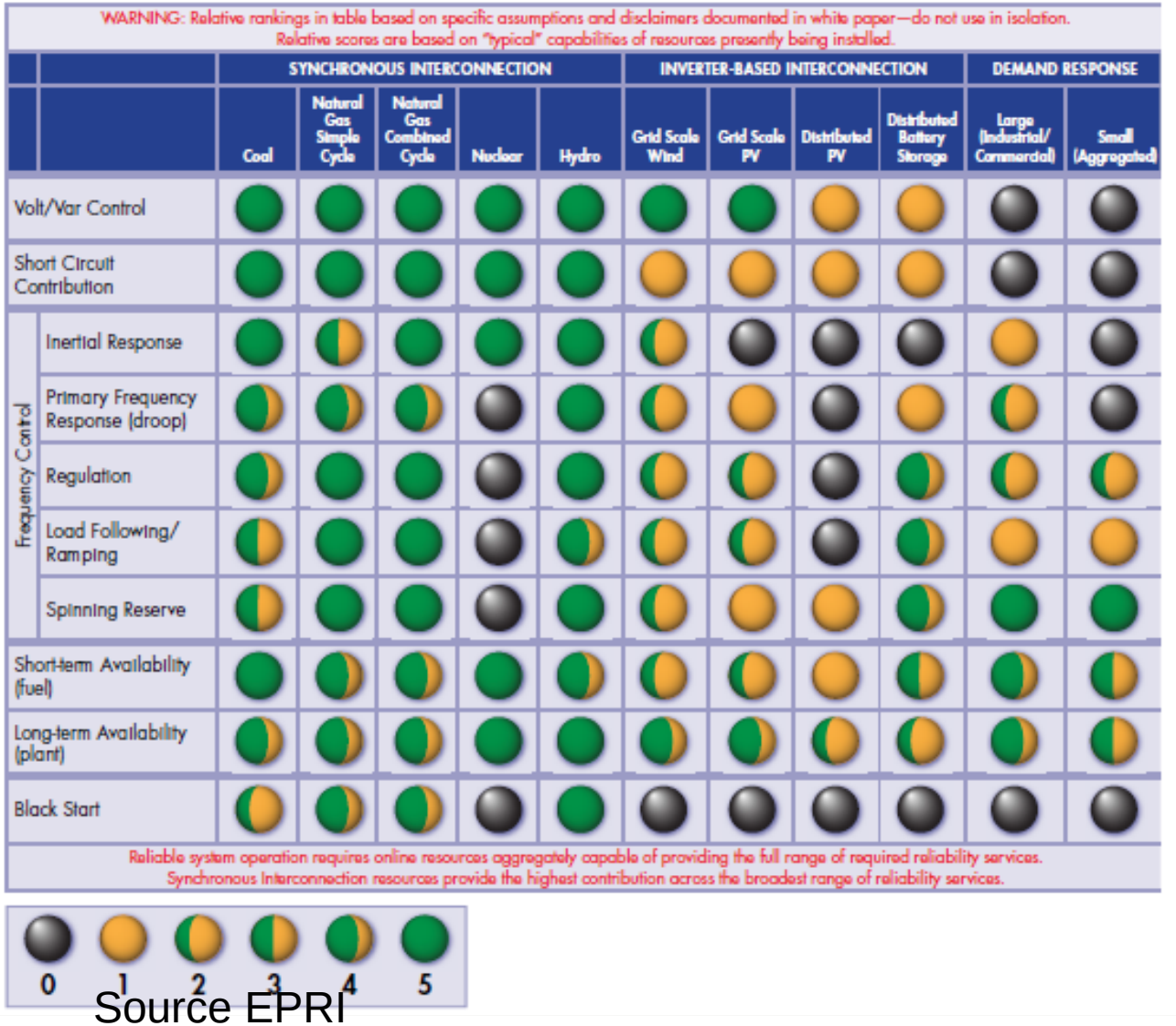
5 NEW SYSTEMS OPERATIONS / CONTROLS

Key Challenges

Operational challenges by stochastic generation, flexible loads and energy storage:

- Power balancing
- Congestion management
- Active and reactive reserve
- Risk management and probabilistic approaches

WHAT GENERATION PROVIDES WHAT SERVICE



WARNING: Relative rankings in table based on specific assumptions and disclaimers documented in white paper—do not use in isolation.
Relative scores are based on "typical" capabilities of resources presently being installed.

		SYNCHRONOUS INTERCONNECTION					INVERTER-BASED INTERCONNECTION				DEMAND RESPONSE	
		Coal	Natural Gas Simple Cycle	Natural Gas Combined Cycle	Nuclear	Hydro	Grid Scale Wind	Grid Scale PV	Distributed PV	Distributed Battery Storage	Large (Industrial/ Commercial)	Small (Aggregated)
Volt/Var Control		5	5	5	5	5	5	5	1	1	0	0
Short Circuit Contribution		5	5	5	5	5	1	1	1	1	0	0
Frequency Control	Inertial Response	5	2.5	5	5	5	2.5	0	0	0	1	0
	Primary Frequency Response (droop)	2.5	2.5	2.5	0	5	2.5	1	0	1	2.5	0
	Regulation	2.5	5	5	0	5	2.5	2.5	0	2.5	2.5	2.5
	Load Following/ Ramping	2.5	5	5	0	2.5	2.5	2.5	0	2.5	1	1
	Spinning Reserve	2.5	5	5	0	5	2.5	1	1	2.5	5	5
Short-term Availability (fuel)		5	2.5	2.5	5	2.5	2.5	2.5	1	2.5	2.5	2.5
Long-term Availability (plant)		2.5	2.5	2.5	5	5	2.5	2.5	2.5	2.5	2.5	2.5
Black Start		2.5	2.5	2.5	0	5	0	0	0	0	0	0

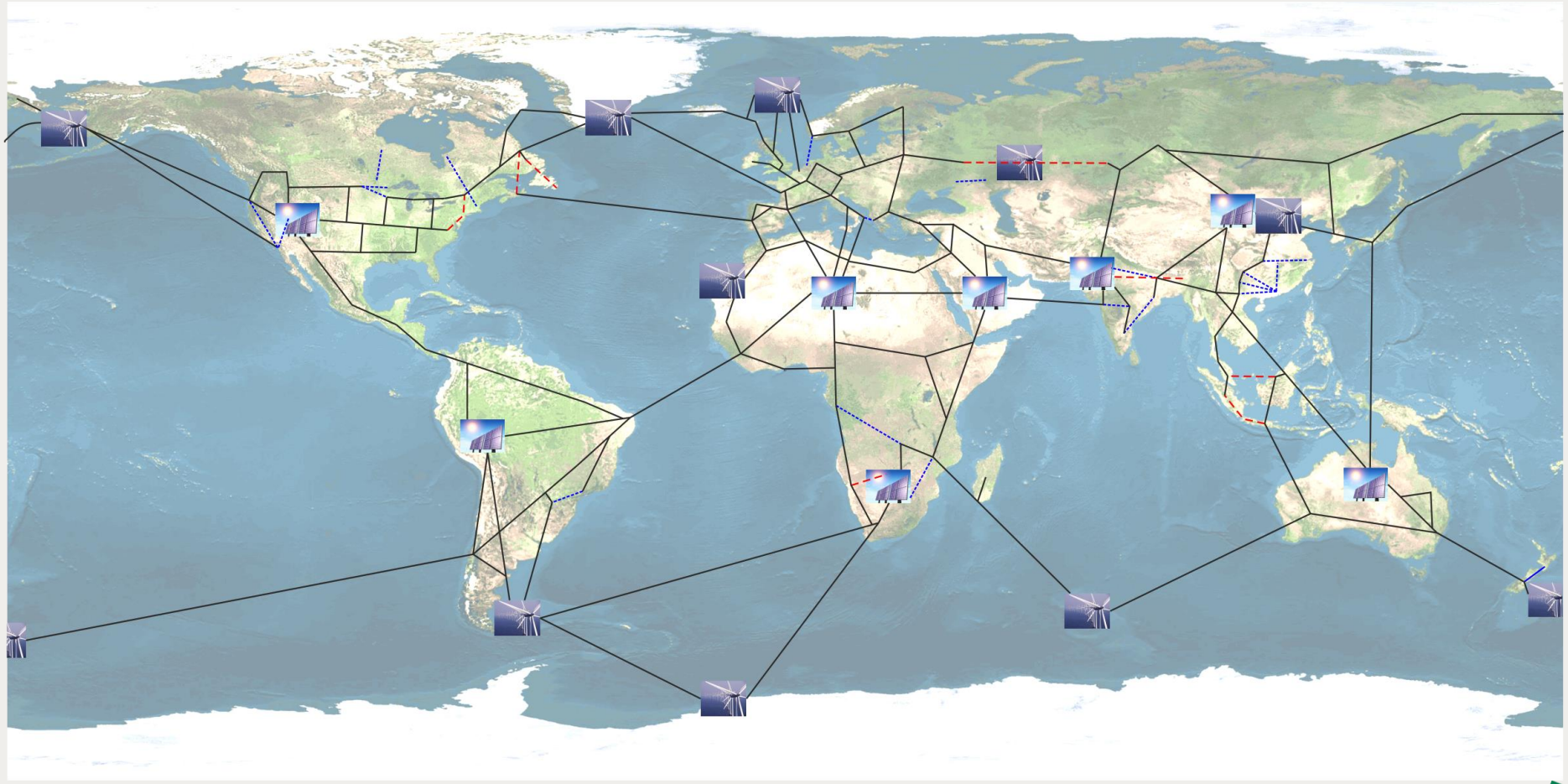
Reliable system operation requires online resources aggregately capable of providing the full range of required reliability services.
Synchronous Interconnection resources provide the highest contribution across the broadest range of reliability services.

0 1 2 3 4 5

Source EPRI

NEED SCORE OF AT LEAST 5 CONSTANTLY AVAILABLE

GLOBAL GRID – PV AND WIND BALANCE



S. Chatzivasileiadis, D. Ernst, G. Andersson - The Global Grid

Swiss Federal Institute of Technology, Zurich

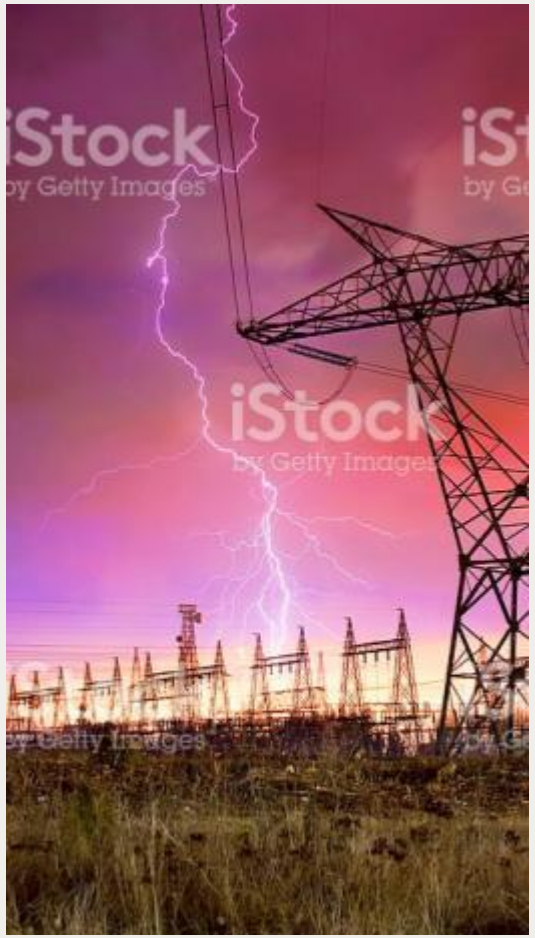
AVAILABLE TECHNOLOGY FOR TRANSMISSION

- UHV up to 1200 kV AC and +/- 800 DC (1100 kV DC feasible)
- Submarine cables to a depth of 3000 m
- Digital substations
- Compact GIS substations allow cost reduction and off shore transmission
- Hybrid lines (AC and DC on one tower)

ELECTRICITY FOR ALL

Low density, high cost, low demand, no address, pre paid meters.

6 NEW CONCEPTS FOR PROTECTION



Key Challenges

- **Limitations of special protection** schemes in terms of reliability, flexibility and maintenance cost
- **Impact of PE interfaced generation** technologies with decreased short circuit currents
- **UFLS** systems

7 NEW CONCEPTS IN PLANNING

Key Challenges

- **Very high uncertainties** including higher community awareness: impacts ability to plan to minimize asset stranding, while maintaining reliability and quality
- **Changes in technology:** need to understand cost, capabilities and lead times of each solution to enable comparison between options

8 NEW TOOLS FOR TECHNICAL PERFORMANCE

Key Challenges

- **Advanced numerical methods** for the solution of dynamic problems in integrated timeframes and for multiphase power-flow problems.
- Advanced tools and techniques for power balancing and reserve requirement evaluation
- Operational tools allowing a **probabilistic and risk-based planning**

9 INCREASED USE OF ASSETS T&D DEVELOPMENTS

Key Challenges

- **Uprating of existing lines**, such as replacing old conductors by **high temperature conductors**, re-tension of existing conductors, upgrading voltage level, use real time thermal monitoring, etc.
- **Conversion of AC to DC lines**, considering hybrid lines (DC & AC), compact lines and aesthetic supports.
- **Compact design of converter stations** for off-shore and urban applications

10 NEED FOR STAKEHOLDER AWARENESS

Key Challenges

In the planning phase:

- Demonstrate the **usefulness and the benefits** that will result from the project
- Guarantee that **Sustainable Development** principles and issues are being incorporated at this stage
- Take into account public views and needs already in the design steps, e.g. choice of alternatives

CONCLUSION

- Inverter based resource penetration will continue to accelerate
- Loads/generators will be interchangeable, mobile, and variable.
- Flow of power will be uncertain.
- Markets will further distort the power and revenue/expense flow
- GREAT OPPORTUNITY
  - Further studies in business models, revenue retention, product development.
  - Future studies in almost all aspects of grid planning, design, operation, protection and maintenance.
- ENJOY THE FUTURE

Acknowledgements

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