CONVERSATORIO :

Junio 10

Sistemas HVDC

SESIÓN 2 :
Operación e impacto de Sistemas HVDC en redes existentes

# Future Challenges in Power Electronics to existing Networks

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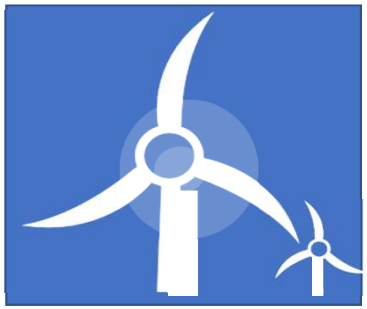
**General Electric**

Un evento:

# Trends Disrupting the Traditional Power Sector



## DECARBONIZATION

**BY 2040, RENEWABLES will represent 30% OF GLOBAL NET ELECTRICITY**

**IMPACT**

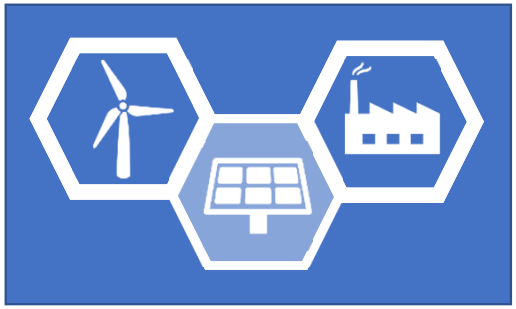
- Generation is becoming difficult to forecast & variable
- Grid stability and increasing need for system services and flexibility

## DIGITIZATION

**GROWING THE NUMBER** of **connected devices** & **smart sensors, management and new software capability**

**IMPACT**

- Reliable cybersecurity
- Orchestration of generation, grid and flexibility with grid software
- Data management and analytics



## DECENTRALIZATION

**GROWING PENETRATION** of **distributed resources** (renewables, storage)

**IMPACT**

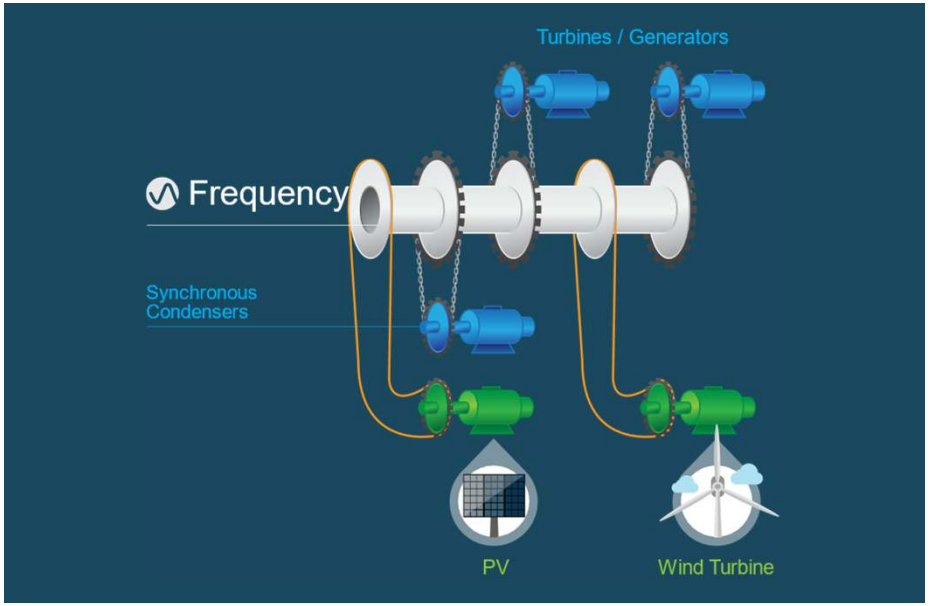
- End user becomes an active actor of the power system ('pro-sumer')
- Growing complexity of distribution grids
- Hedge devices management

# Displacement of Conventional Generation Plant can Lead to Stability Problems

With 60% renewables in the continental European system lower inertia reduces system robustness following to generation outages:

- a risk of load shedding (f< 49 Hz) – 0.8 % of the time
- a violation of ENTSO-E security limit (f < 49.2 Hz) - 25% of the time

**Curtailment to avoid stability problems during critical periods can only be limited if new technologies are available to provide fast frequency response**



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# The grid of the future requires a range of new solutions to address growing technical and organizational shortfalls

| SYSTEM SHORTFALL | ASSOCIATED ISSUES |
|---|---|
| Frequency control | System inertia<br>Reserves and Ramping capability |
| Voltage control | Short circuit strength<br>Steady state and dynamic voltage control |
| Rotor angle stability | Small signal stability<br>Transient stability |
| Network Congestion | Network hosting capacity<br>RES curtailment<br>Interconnection capacity allocation |
| System restoration | Black-start capability and load restoration<br>Network reconfiguration |
| System adequacy | Uncertainty of RES generation<br>System interdependencies |


**TECHNOLOGY**
RES and HVDC controls, DLR, storage, FACTS

**DIGITAL**
EMS, WAMS, ADMS, DERMS, MMS, TSO/DSO interface tools


**ORGANIZATION**
TSO/DSO cooperation
TSO-TSO coordination
Grid codes

Source: H2020 EU-SysFlex

# System Operational Challenges

- Frequency & Voltage Support
- Modifying the way we operate the Power System
- New Behaviour of our developing Networks

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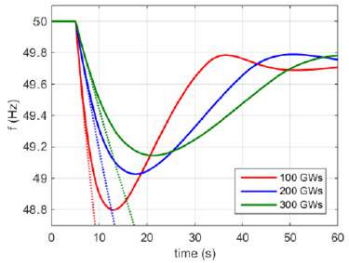
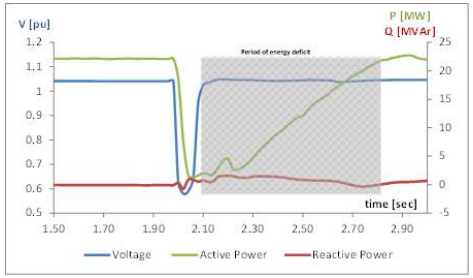
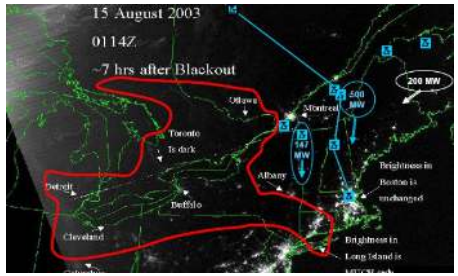
# System Operational Challenges: Frequency & Voltage Support

- Changes in Frequency due to reduction in Inertia
- Reactive Power : Static & Dynamic
- Restoring Power Systems



# System Operational Challenges

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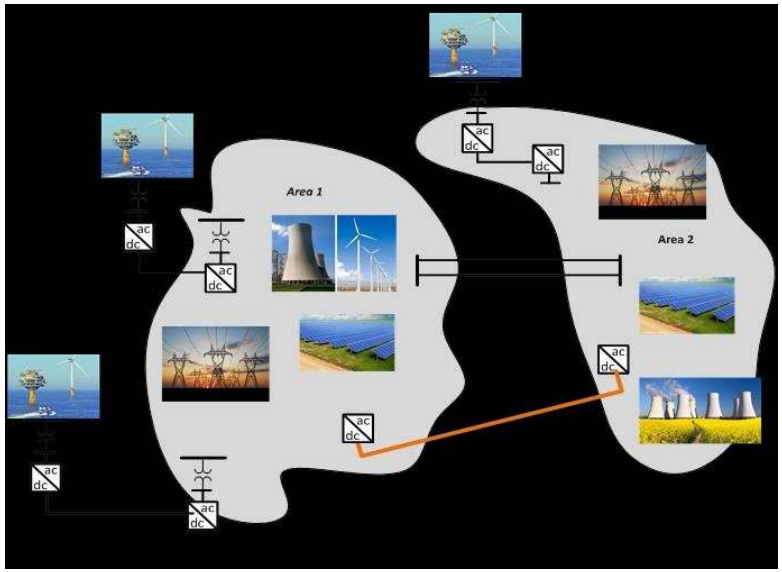
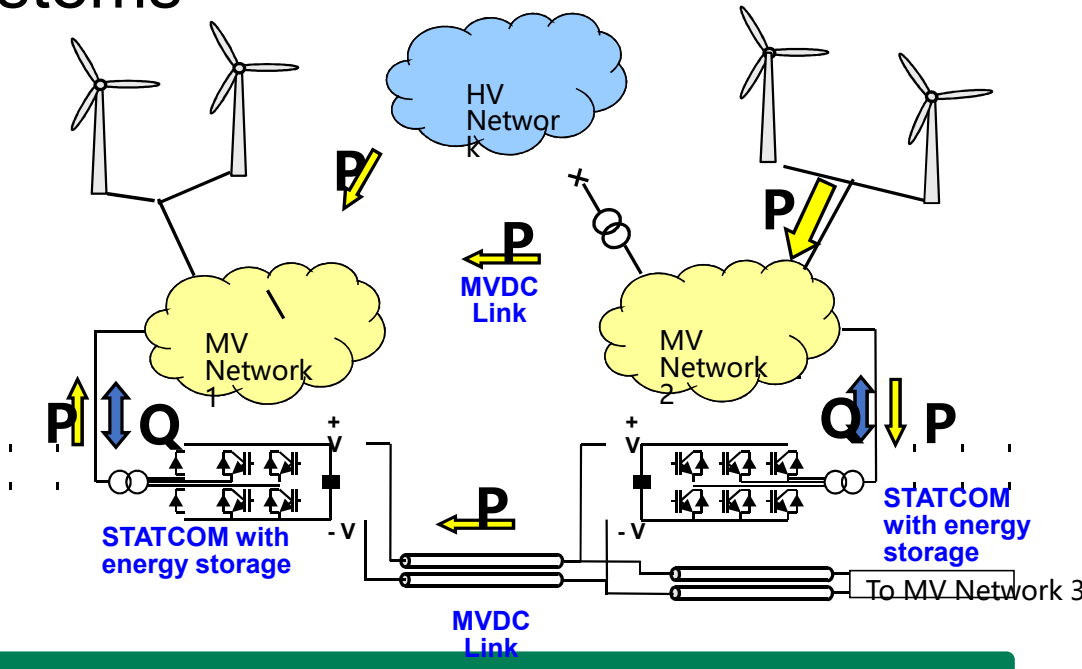
# System Operational Challenges: Modifying the way we operate the Power System

- Interaction between Transmission Systems & Distribution Systems
- Hybrid AC & HVDC Systems



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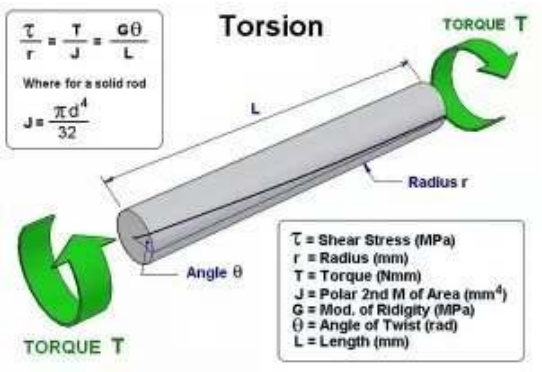
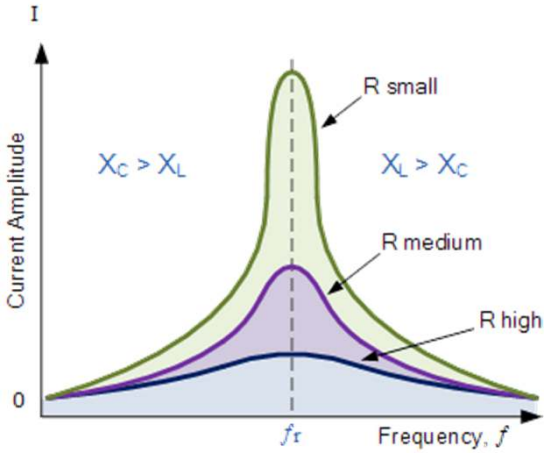
# System Operational Challenges : New Behaviour of our developing Networks

- Sub Synchronous Resonance
- More Cable, more Power Electronics = Higher Risk of Resonances



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# Grid of the Future requires that we solve complex grid challenges

| | | Power flow control | Voltage control (dynamic) | Voltage control (steady state) | Power oscillation damping | Transient Stability | Supply of passive grids | Flicker compensation (volatile loads) | Fault current limitation | Phase Balancing (Dynamic) | Phase Balancing (steady state) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RPC | MSC | ● | | ● | | | | | | | ● | $ |
| | MSR | ● | | ● | | | | | | | ● | $ |
| FACTS | STATCOM | ● | ● | ● | ● | ● | | ● | | ● | ● | $$$ |
| | SVC | ● | ● | ● | ● | ● | | ● | | ● | ● | $$ |
| | TCSC | ● | ● | ● | ● | ● | | | | | | $$$ |
| | FSC | ● | | ● | ● | ● | | | | | | $$ |
| | Sync Cond | ● | ● | ● | ● | ● | ● | ● | | | | $$$ |
| HVDC | LCC | ● | ● | ● | ● | ● | ● | | ● | | | $$$$ |
| | VSC | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | $$$$$ |

# Gracias


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