Patrick Panciatici
Scientific Advisor
R&D dept. – RTE

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Electric Power Systems: the biggest industrial systems created by humankind
EUROPEAN POWER SYSTEM

34 interconnected countries
- Security of the European power system
- Economical optimization

4 synchronous areas
- Installed capacity ~ 880 GW
- Annual consumption ~ 3 200 TWh
- Annual exchanges ~ 380 TWh
- 300 000 km of lines
- ~ 530 millions inhabitants

41 Transmission System Operators

Fast and continuous increases of cross-border exchanges and interconnection capacities
Political decisions: a (re)evolution of power systems?

2020
-20 % of CO2 emissions compared to 1990

=20 % of final energy consumption coming from renewable energy sources

+20 % of energy efficiency compared to 1990

2030
-40 % of CO2 emissions compared to 1990

=27 % of final energy consumption coming from renewable energy sources
• Fast changes in generation patterns due to the success of “energy transition” policies
  - wind, solar, biomass…
  - phase-out or capping of nuclear (Germany, Switzerland,..), France (50% in 2025?)
Money Transition pushes to integrate more and more wind, solar power plants in electrical grids
► Smaller generating units interfaced through power electronics to electrical grids

Thousands of large synchronous generators—each ~1000 MW

Millions of power electronics interfaced generators—each less than 100 MW

System dynamics imposed by
Physical laws and hardware ➔ Controllers and software
Power Systems: Active distribution grids (smartgrids?)

✓ Energy Transition promotes small dispersed generating units (PV rooftop) and demand responses

► Passive distribution grids become active

1889 — 2020?

Continuous trend since 1889: more and more interconnections to ensure a secure and efficient operation of electrical grids

⇒ Now: Local Balancing?
ICT more and more at the core of this complex system....

✅ Energy Transition pushes towards more dispersed generation and distributed controls
  • To ensure a secure and efficient operation of large power systems ➔ observability/controllability of large population of devices/agents.
✓ «Cyber» dimension in all the decision making processes from system design to system operation

ο Yesterday: then

⇒ Co-design of «hardware/software» is mandatory to ensure a secure and efficient operation

✓ Avenue for new projects: advanced ICT for complex, critical infrastructures ⇒ CPSoSs
THANK YOU FOR YOUR ATTENTION

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