Multi-Stage Stochastic Optimization for Clean Energy Transition (BIRS-CMO 19w5091)

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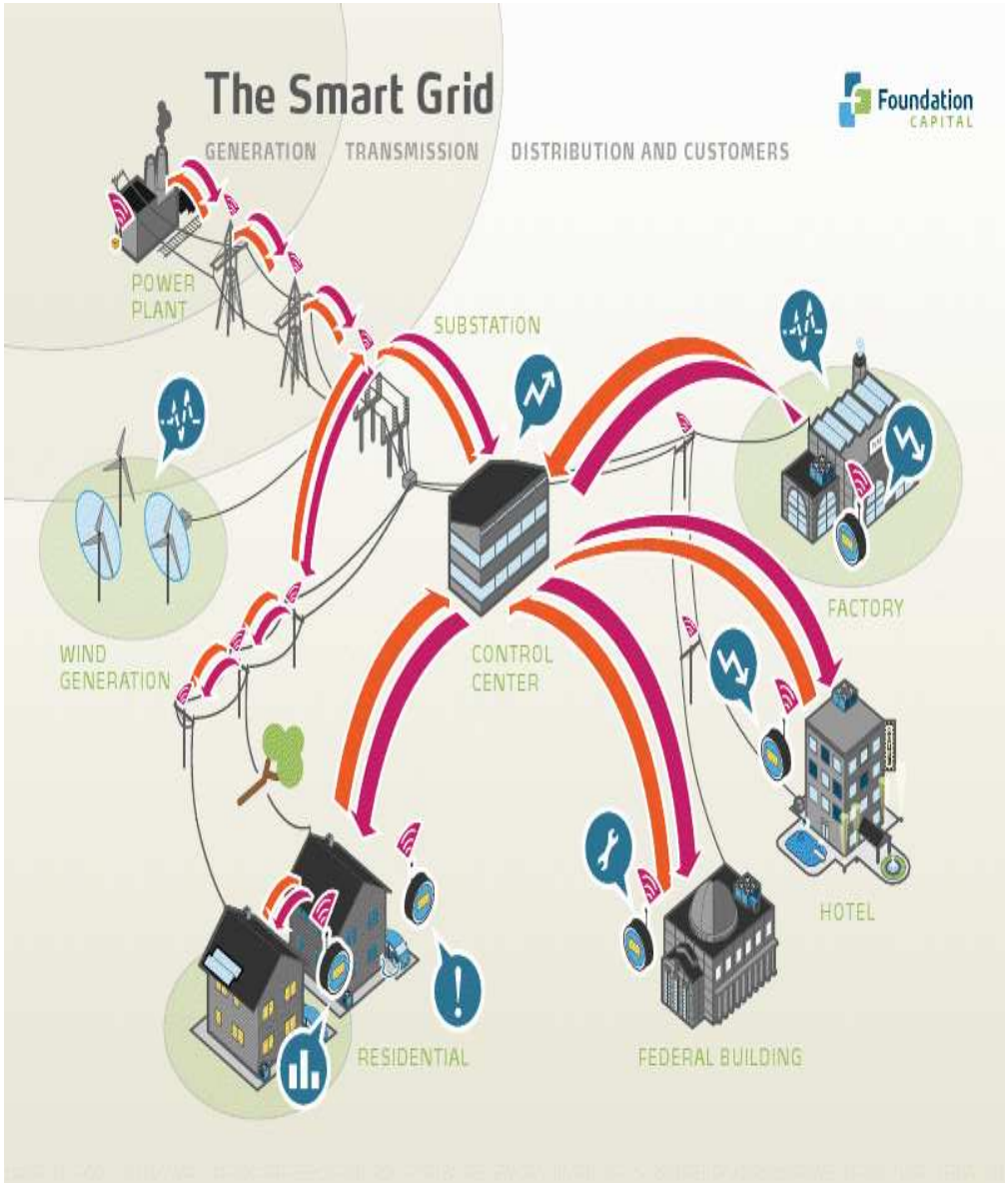
Challenges ahead for optimization in energy



Optimizing is obtaining the best compromise between needs and resources

Marcel Boiteux
(président d'honneur d'Électricité de France)

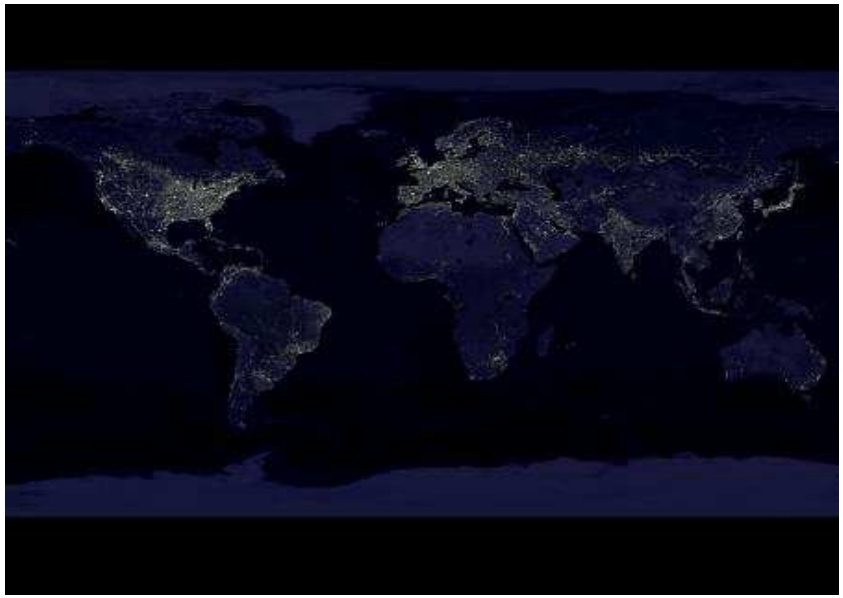
Outline of the presentation

What is happening to power systems?

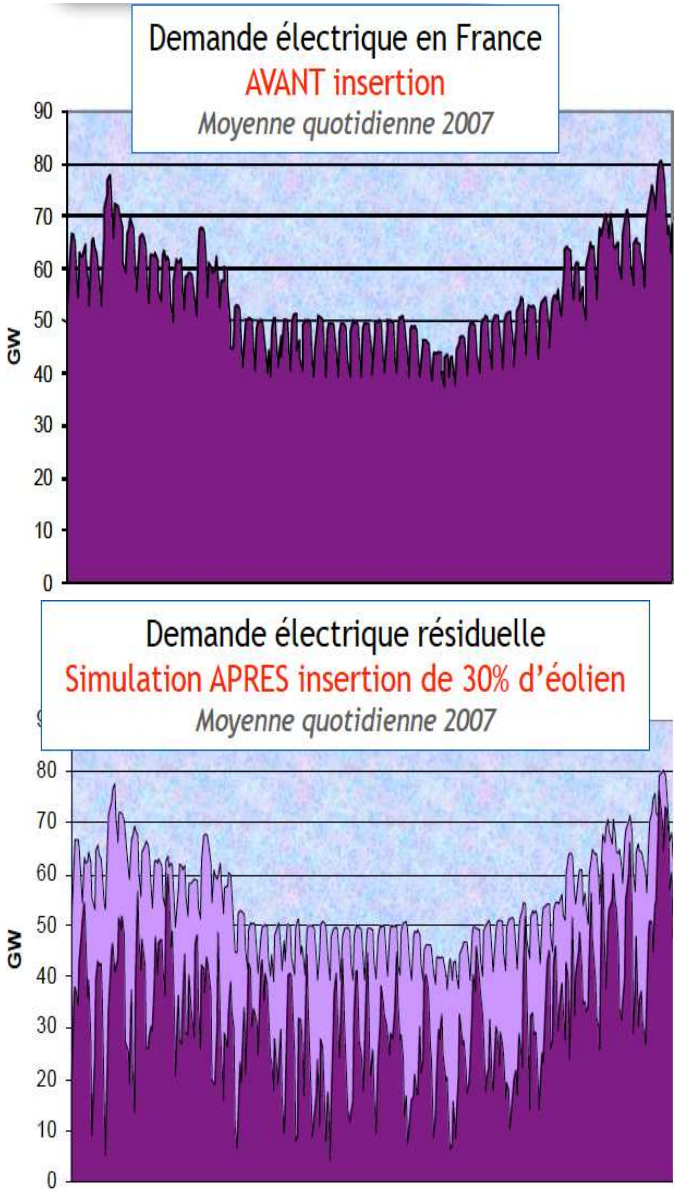
Perspectives

Three key drivers are remolding power systems

- Environment / Penetration of renewable energies
- Expansion of markets
- Penetration of Information Technology

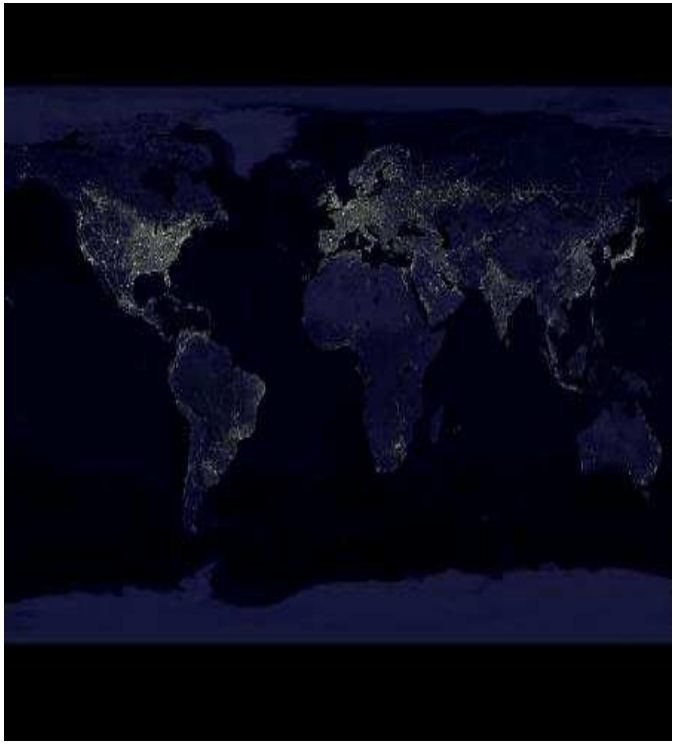


Key driver: environmental concern / penetration of renewable energies



- Costs of wind and sun energies have dropped down
- Successfully integrating renewable energy sources has become critical
- But wind and sun energies are unpredictable and highly variable
- This triggers the use of local storage

Key driver: economic deregulation



- A power system (generation/transmission/distribution)
  - less and less vertical (deregulation of energy markets)
  - hence with many players with their own goals
- with some new players
  - industry (electric vehicle)
  - regional authorities (autonomy, efficiency)
- with a network in horizontal expansion
- with more and more exchanges (trade of commodities)

$\Downarrow$

A change of paradigm for management
from centralized to more and more decentralized

Key driver: telecommunication technology

Linky

A power system
with more and more technology
due to evolutions in the fields of metering, computing and telecoms

- smart meters
- sensors
- controllers
- grid communication devices...

$\Downarrow$

A huge amount of data which, one day, will be
a new potential for optimized management

Outline of the presentation

The electricity grid is becoming more and more complex

- Multiple energy resources: photovoltaic, solar heating, heatpumps, wind, hydraulic power, combined heat and power
- Spatially distributed energy resources (onshore and offshore windpower, solarfarms), producers, consumers
- Strongly variable production: wind, solar
- Intermittent demand: electrical vehicles
- Two-ways flows in the electrical network
- Environmental and risk constraints (CO2, nuclear risk, land use)

Challenges induced by the electric grid transformation

- Tackling stochastic optimization problems of large scale: design algorithms that use spatial, temporal and random structures to decompose problems
- handling risk issues by proper mathematical formulations, and design adapted algorithms
- coping with team problems, with decentralized and private information
- deal with multiple actors with their own objectives: game theory, stochastic equilibrium, market design