



Trends and Grid consequences

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Renewables Grid Initiative, Berlin October 17-18, 2011

Experience
you can trust.

Challenges of large scale renewable generation

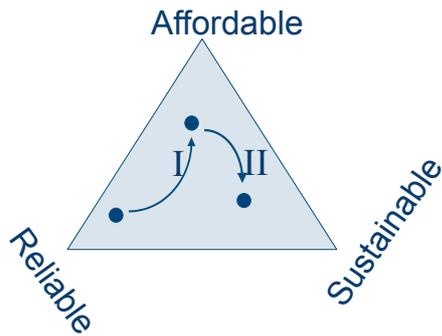
Impacts on system planning and operation

- Availability – Conventional generator dispatch
- Variability – Allocation of reserves
- Frequency Control – Short term (spinning) reserves
- Voltage / power control – Reactive reserves
- Transmission Capacity – Thermal constraints



How to keep the balance with so many end-users and different customer needs?

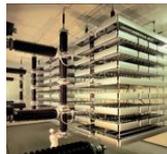
Reliable, Affordable and Sustainable



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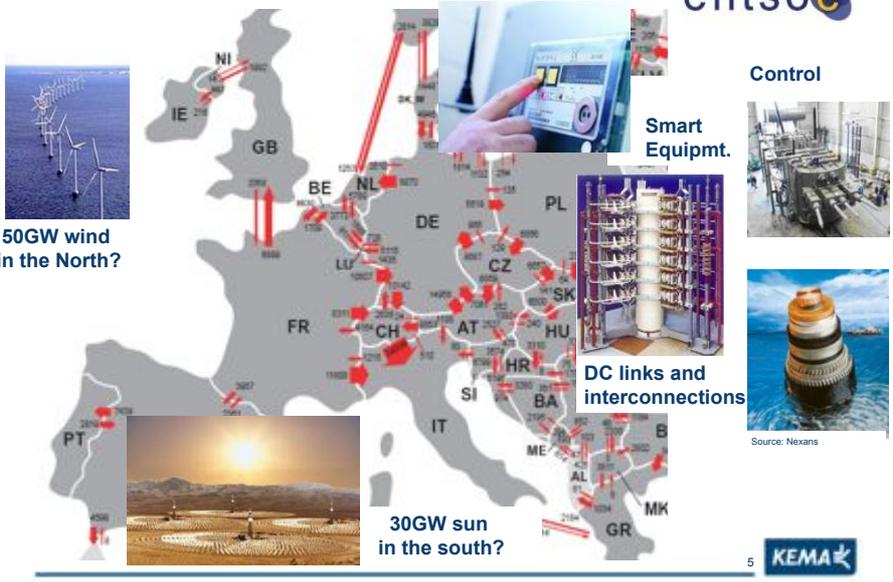
Wind at sea impact

- What about the sea-grid?
- AC and DC solutions
- Grid operation effects



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Increased bulk transmission



50GW wind in the North?

30GW sun in the south?

entsoe

Control

Smart Equipmt.

DC links and interconnections

Source: Nexans

KEMA

DC becomes part of the solution

- Technology is mature (HVDC-VSC 1000MW ±500kV)
- Controllability (e.g. reactive power)
- Less losses compared to AC
- Many applications use DC



250-1000 MW



5 W



1.2 kW

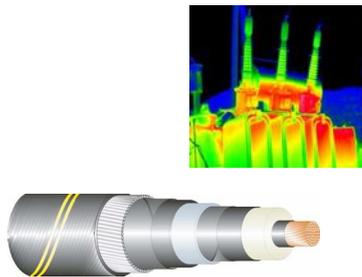


2x120 kW

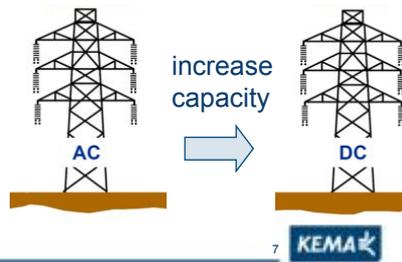
KEMA

Doing more with less

- Overhead → underground
- Public voice = CAVE
- Use existing right of way



wintrack



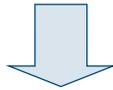
Distributed Solar Power up

- Exponential growth
- Prices drop fast
from 5€ to 2€ / Wp
in 2 year
- Grid parity: 2012-2015 ?
- Significant effect



Network owner/operator needs

- Measure, monitor and diagnose (real time)
- Model, simulate, predict and communicate
- Control, steer and manage power & information
- Integral energy (including information) solution approach



- Test, certificate and validate distributed power systems and control equipment

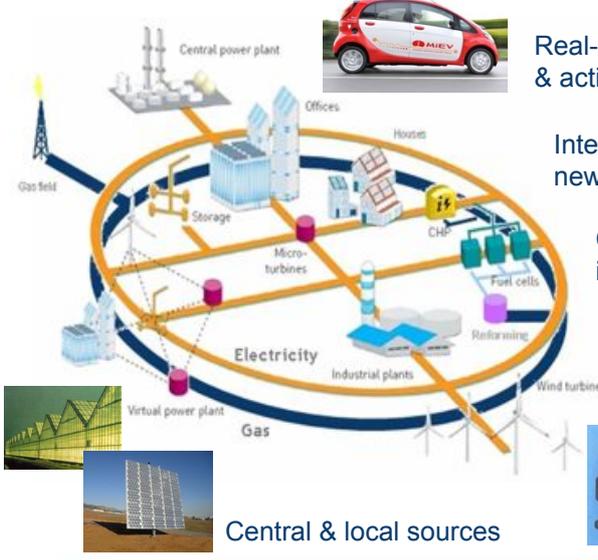
Testing and certification



The Flex Power Grid (FPG) Lab offers unique services for DG and RES grid integration, power conversion equipment and power monitoring & control devices by offering a predefined grid or load in the MW range.



An internet-like distribution grid



The diagram illustrates a circular distribution grid with various components:

- Central power plant**: A large industrial facility at the top.
- Gas field**: A facility on the left.
- Storage**: A central hub for energy storage.
- Micro-turbines**: Small power units within the grid.
- Industrial plants**: Various factory-like structures.
- Wind turbine**: A large turbine on the right.
- Gas**: A source at the bottom.
- Virtual power plant**: A facility on the left, associated with solar panels.
- Offices** and **Houses**: Residential and commercial buildings.
- CHP** (Combined Heat and Power) and **Fuel cells**: Energy conversion units.
- Renfarming**: A facility at the bottom right.

Real-time information & active participation: Accompanied by an image of a red MIEV car.

Integration of new applications: Accompanied by a smart meter (BD).

Central & local intelligence: Accompanied by smart control units.

Smart (power) electronics: Accompanied by a tablet displaying a control interface.

Central & local sources: Accompanied by images of solar panels and a power plant.

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E-mobility (storage) a growing force

- Means of decoupling generation & demand
- Controllability issue
- Slow take off (or not)
- Huge effect



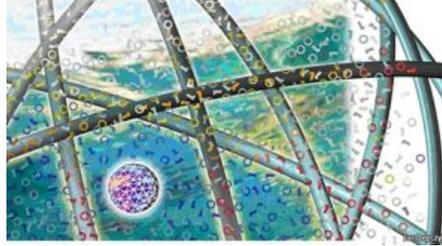

Opel Ampera



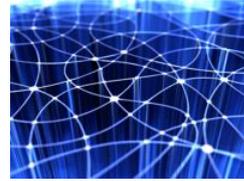
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The digital dilemma

- Data explosion
- Networking, adding → functionality
- New equipment and players
- Security risk



stuxnet-worm



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Changes under the hood



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Thank you for your attention

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Experience
you can trust.