IEA Workshop Paris
Smart Grids – current status

Power and productivity
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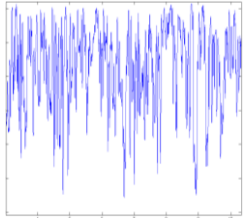
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Smart Grid deployment
Where are we?

- Global energy challenges

- Renewable energy – market situation and trends

- Challenges for the grid

- International cooperation – Grid4EU smart grid project

- Summary

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Global energy challenges

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Properties of renewable generation
Fundamentally new challenges for power systems

Variable and uncertain generation

Maximum output varies depending on wind and sunlight
No perfect forecast for wind and sunlight available

Inertial response capability

Non-synchronous generation technologies connect to grid via power electronics and have little or no inertial response capability

Location constrained

Areas with the best resources are often situated in remote locations. Tapping into these resources will require efficient ways to transport a large amount of power over long distances
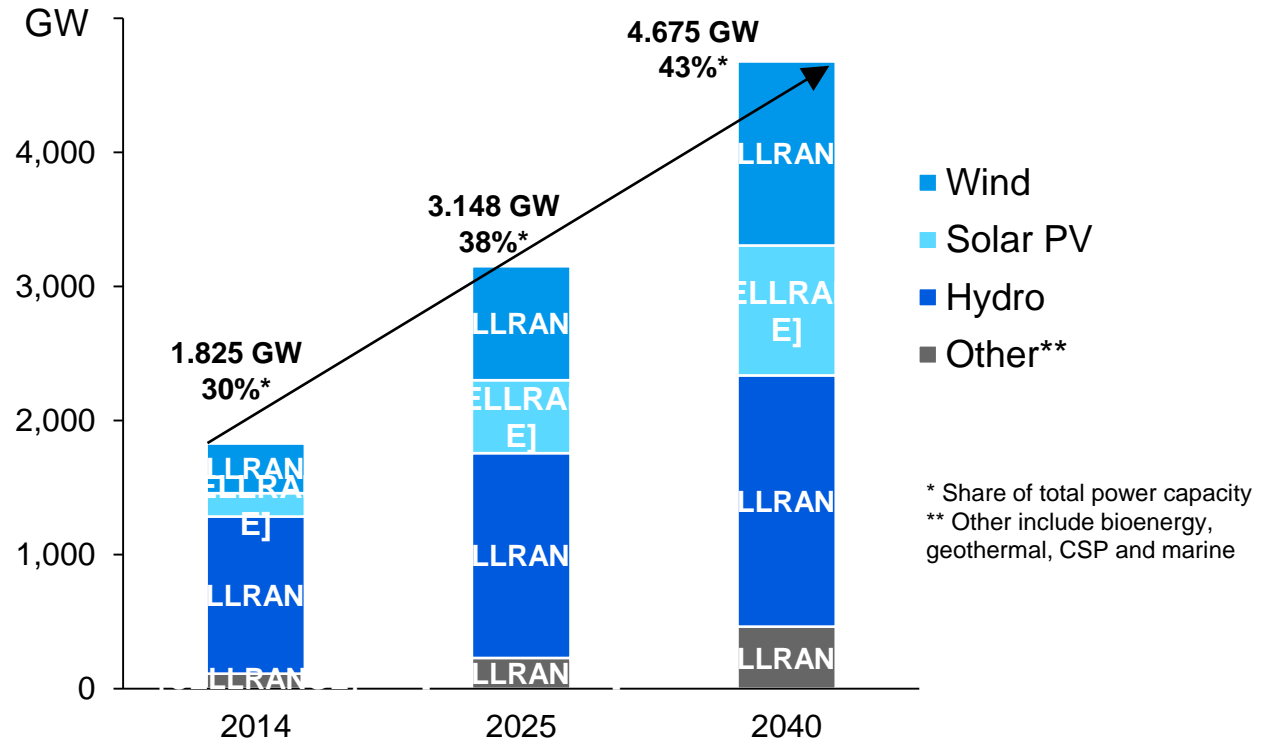
Modularity

Renewable power generation can be found as residential or commercial size. Increasing levels of distribution level generation will require new approaches to regulate and manage this energy.

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Market situation and trends

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Renewable energy
Global installed capacity more than double by 2040

GW

- 4.675 GW 43%*
- 3.148 GW 38%*
- 1.825 GW 30%*

Legend:
- ■ Wind
- ■ Solar PV
- ■ Hydro
- ■ Other**

* Share of total power capacity
** Other include bioenergy, geothermal, CSP and marine

Source: IRENA Statistics

Wind and solar amount to 50% of total renewables in 2040

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Renewable integration
Affecting all levels of power systems and markets

Integration level	Main issues
Local connection to the grid	▪ Voltage control ▪ Reactive power control ▪ Power quality ▪ Power flow and overload control ▪ System protection
System-wide integration	▪ Generation adequacy ▪ Network enforcement and extension ▪ Balance of load and generation, load-frequency-control ▪ Renewable curtailments and demand response
Market integration	▪ Area balancing ▪ Price volatility ▪ Generation forecasting ▪ Regulation and financing schemes

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Challenges for the grid

The evolving grid
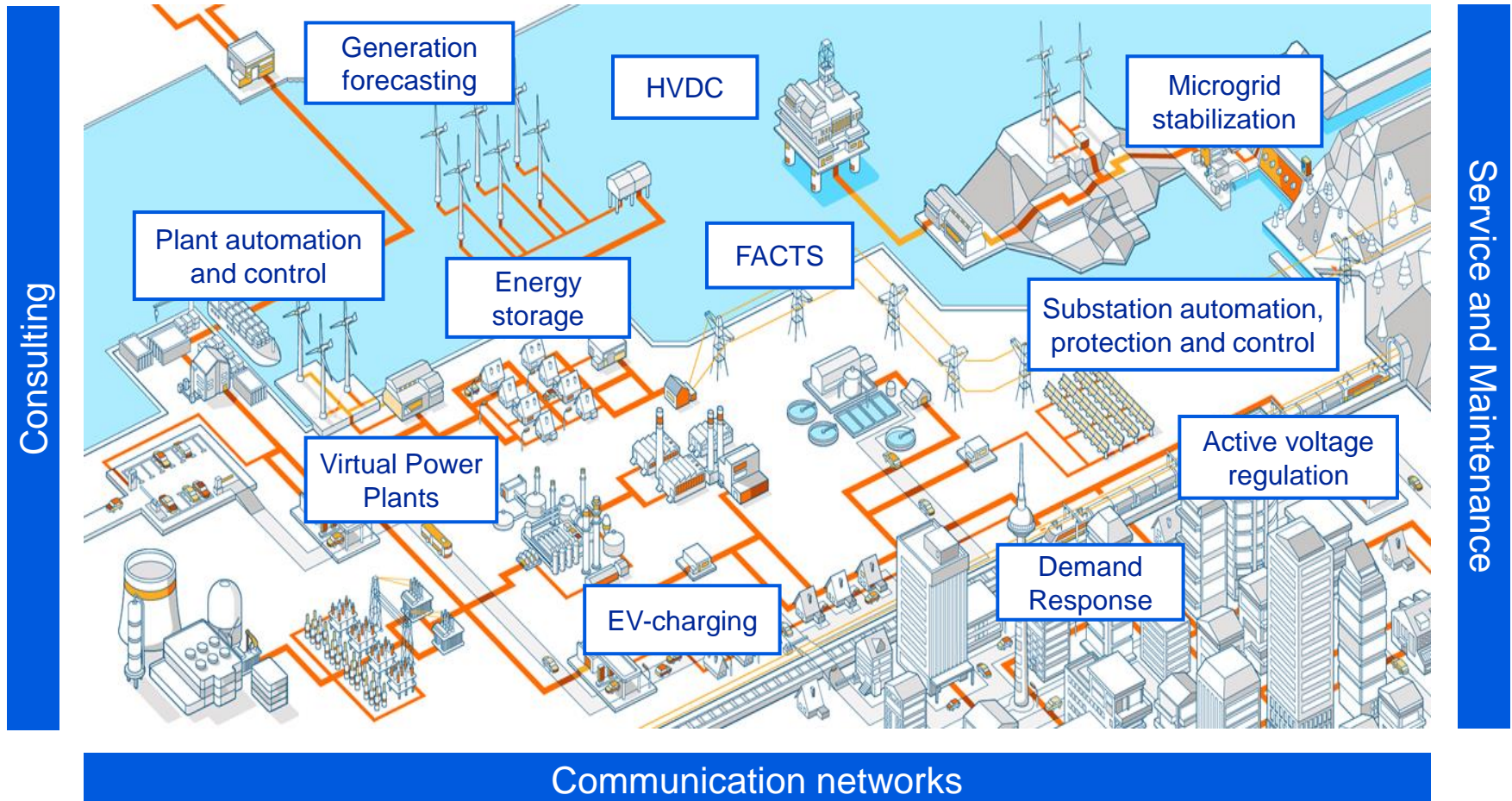## From traditional to smart grid
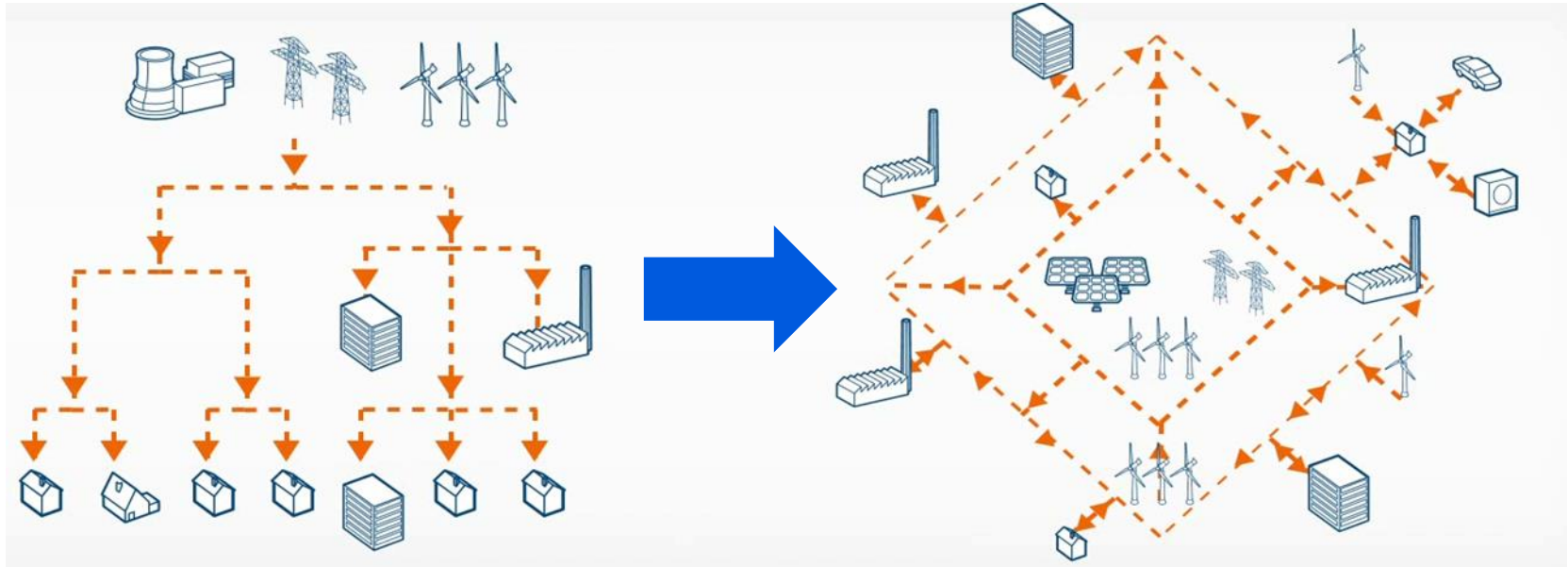
- Centralized power generation

- One-directional power flow

- Generation follows load

- Top-down operations planning

- Operation based on historical experience

- Centralized and distributed generation

- Multi-directional power flow

- Intermittent renewable generation

- Consumption integrated in system operation

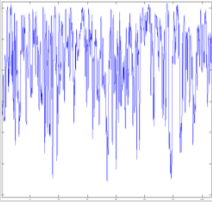- Operation based on real-time data

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The evolving grid
New intelligence

Consulting

Service and Maintenance

Generation forecasting

HVDC

Microgrid stabilization

Plant automation and control

FACTS

Energy storage

Substation automation, protection and control

Virtual Power Plants

Active voltage regulation

EV-charging

Demand Response

Communication networks

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Renewable integration
Technologies to increase system flexibility

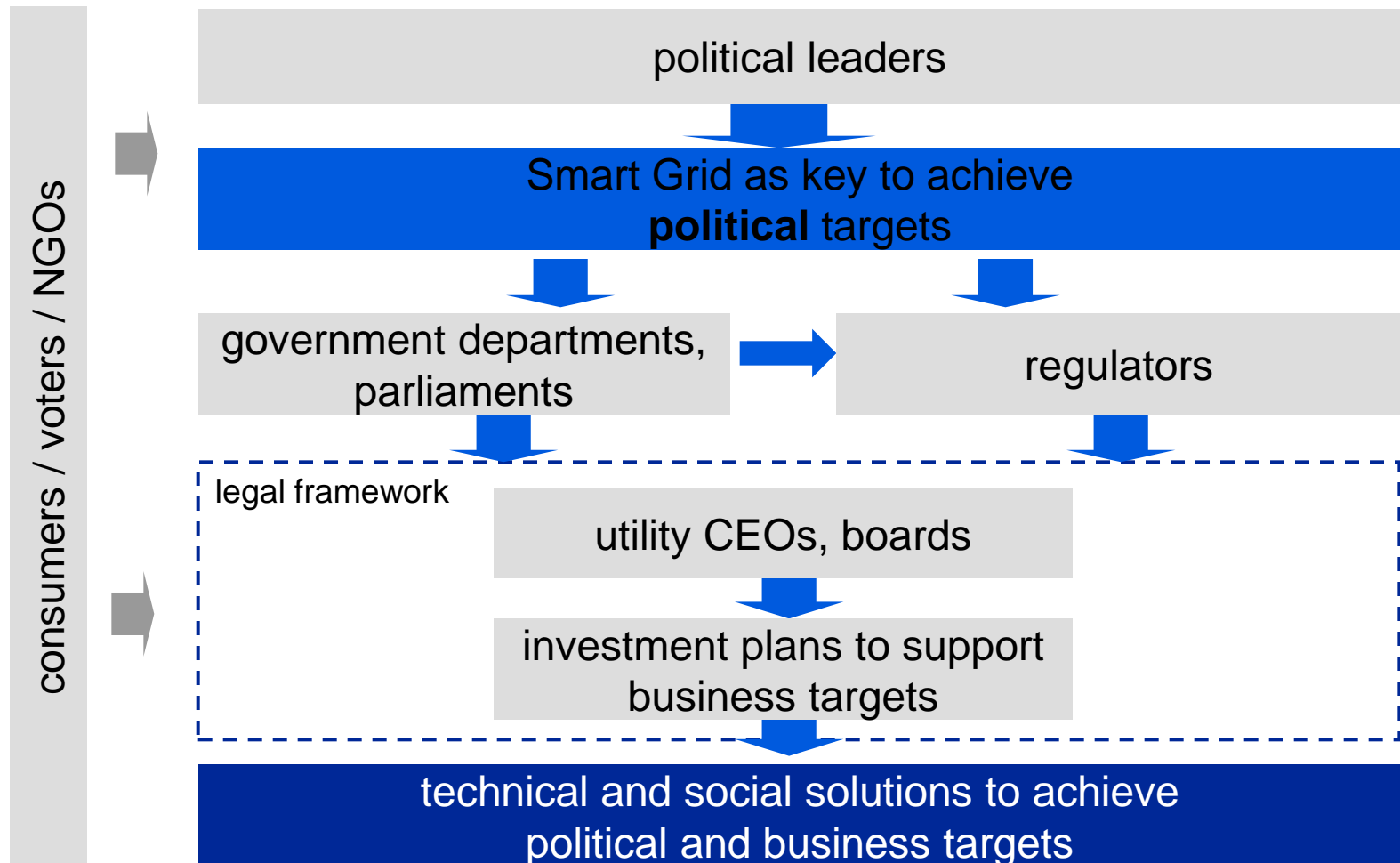| Driver		Conv. generation	Transmission	Distribution	System operation	Application
Variability and uncertainty		▪ High efficiency all over output range ▪ Flexibility	▪ Trans-regional leveling ▪ Overlay grid/ HVDC ▪ Bulk storage	▪ Distributed storage	▪ Demand response ▪ VPPs[2] ▪ PMU/WAMS[3]	▪ Storage (in applications) ▪ Demand response
Lack of inertial response capability		▪ Faster activation of FCR[4]	▪ Fast storage	▪ Flywheels ▪ Fast storage	▪ Faster response of FCR[4]	▪ Demand response (frequency response)
Locational constraints			▪ FACTS[1] ▪ Long dist. transmission ▪ Overlay grid/ HVDC		▪ Stabilization with FACTS[1]	
Modularity, distributed-ness				▪ Automation ▪ Voltage regulation (grid) ▪ Voltage support (gen.)	▪ Communication ▪ Control ▪ VPPs[2]	

[1] FACTS: Flexible AC Transmission Systems
[2] VPP: Virtual Power Plant
[3] PMU/WAMS: Phasor measurement units/wide area monitoring systems
[4] FCR: Frequency Containment Reserve

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Smart Grid is also a political issue
Many players need to be informed consistently

consumers / voters / NGOs

political leaders

Smart Grid as key to achieve **political** targets

government departments, parliaments → regulators

legal framework

utility CEOs, boards

investment plans to support business targets

technical and social solutions to achieve political and business targets

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Smart grid collaboration

ABB Smart Grids
R&D projects enable smart grids understanding
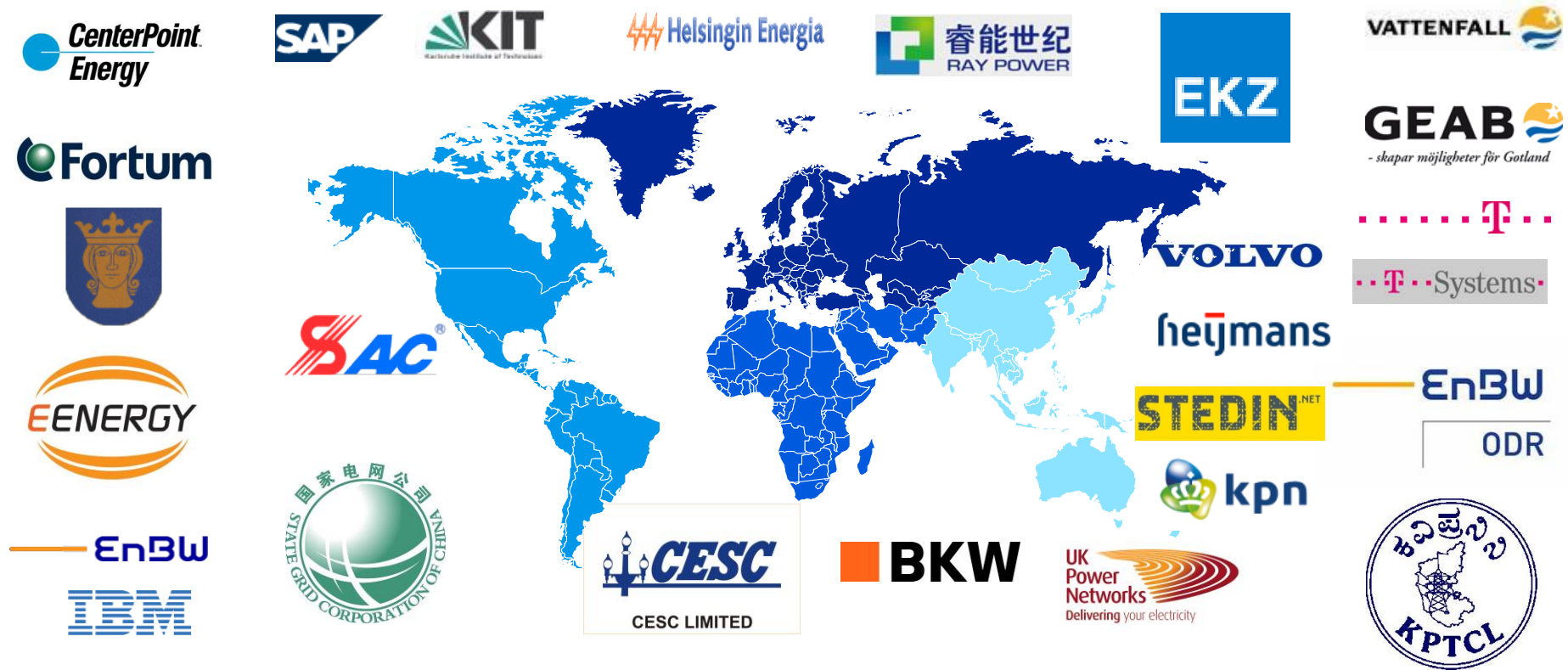
We have on-going developments in all relevant areas of smart grids in several regions across the world.

Grid4EU
Innovation for Energy Networks

Customers: Six main European DSOs
- RWE, Vattenfall, Iberdrola, ENEL, CZE, ERDF

Partners: More than 25 partners and institutions around Europe

Key objectives:

- Develop and test innovative technologies
- Define standards through the set up of demonstrators
- Guarantee the scalability of these new technologies
- Guarantee the replicability over Europe
- Analyze Smart Grid Cost-benefits (Business Case)

6 Main European DSOs cover more than 50% of electricity supply

ABB's contribution:
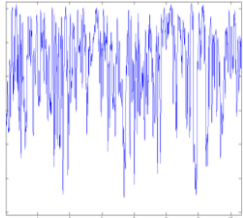
ABB contributed its technology and expertise to three of the six demos: Demo 1, 2 and 5.

Summary

Enabling clean power for a sustainable world
A holistic challenge – technology, markets, laws,…

- Large scale integration of renewable energy means
    - Long distance transmission
    - Integration of all types of highly distributed resources
    - Matching highly volatile supply with demand

- Technical challenges
    - HVDC overlay grids
    - Storage
    - Managing the complexity of millions of devices
    - Stabilizing the system with little or no inertia

- Non-technical challenges
    - Framework for defining and maintaining infrastructure
    - Market design and business models
    - Consumer behavior

**Many components are already available today,
but we have still a long way to go!**

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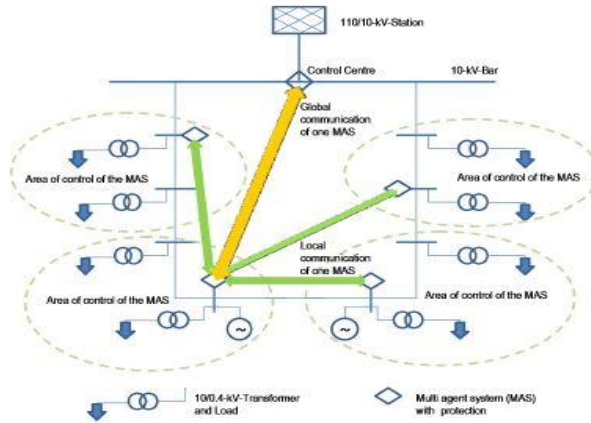Power and productivity
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Grid4EU - Germany
Advanced MV network operation

RWE is one of Europe's five leading electricity and gas companies

Partners: RWE, TU Dortmund, EU, seventh framework program

Key objectives:

- Flexible MV networks for integration of high amounts of DER
- Installation of observer and control capabilities for MV networks
- Increase of automation of the network (fault detection, self-healing structures)
- Higher reliability and shorter recovery times after grid failure

ABB's response – Smart grid scope

- Develop autonomous RTU500 agents to determine and optimize the current MV network status
- Direct communication between RTUs
- Automatic Fault Detection, Isolation and Restoration with RTU500

Grid4EU - Sweden
LV network monitoring and control

Partners: Vattenfall, Schneider Electric, KTH, EU, seventh framework program

Key objectives:

- Demonstrate the use of data collected by existing and future AMM technology
- Achieve monitoring and control of the LV Network enabling:
  - Connection of small scale DER
  - Increased AD
  - Extended use of power quality information
- Support network operations and customer information exchange

ABB's response – Smart grid scope

- Provide data to 112 Secondary Substations: ABB RTU560 with CVD-multimeters and GPRS modem
- RTU 560 cabinet design, implementation and deployment
- SCADA system architecture: MicroSCADA SW suite including DMS 600 and historical database (Historian SYS600)
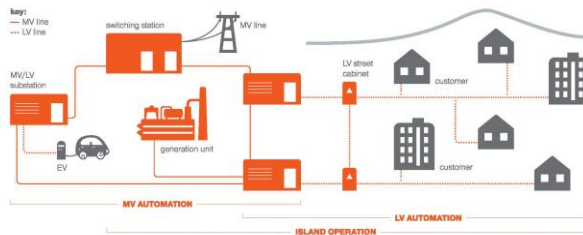
Vattenfall is a Swedish power company, wholly owned by the Swedish government

Uppsala

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Grid4EU – Czech Republic
LV and MV grid automation

Partners: CEZ, TU Dortmund, EU, seventh framework program

Key objectives:

- Management of island operation
- Medium voltage and low voltage grid automation and failure management

CEZ is the largest utility and biggest public company in Central and Eastern Europe

ABB's response – Smart grid scope

- Horizontal and vertical communication links according to protocol IEC61850 (mostly GOOSE) on MV level for protection system and fast load shedding purposing while island operation.
- Protection system set up and calculation for all network modes.
- RIS development - Fully automatized street LV cabinets with communicating small RTU device