Håkan Johansson – ABB Smart Grid Initiative – CPS Week 2010

Smart Grid, an evolution challenging the entire power system

Smart Grid main driver!

Increased utilization of electricity can save energy and reduce emissions!*

* E.g. none fossil generation

ABB's view on Smart Grid
- more than IT and smart meters!

A SmartGrid is an electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies.

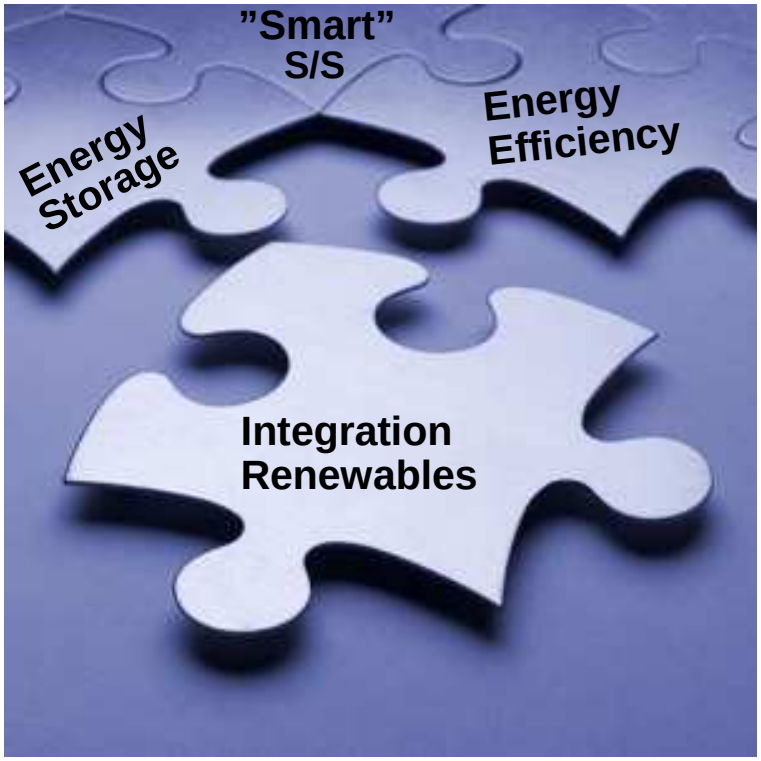
Source: European Technology Platform SmartGrids

A Smart Grid is self-healing, enables active participation of consumers, operate resiliently against attack and natural disasters, accommodate all generation and storage options, enable introduction of new products, services and markets, optimize asset utilization and operate efficiently, provide power quality for the digital economy.

Source: US Department of Energy

- **Smart Grid is the future evolution of the entire power network.**
- **Smart Grid includes both transmission and distribution, focuses on the integration of renewable generation, reliability and efficiency of the grid.**
- **Smart Grid includes the demand response and the potential of new technologies such as large scale integration of electric vehicles.**
- **Smart Grid includes both automation/IT and controllable power devices in the whole value chain from production to consumption.**

Smart Grid
A puzzle of business opportunities



- New business opportunities in many areas, but…
- In other areas a market for commercial solutions must be developed
  - Not only new technical solutions
  - New regulatory rules and business models
- Demonstration sites are needed
  - Place to meet for politicians, authorities, utilities, suppliers and users
  - Innovation centers for research, development and demonstration
- Power utilities goes ”Smart Grid certified”

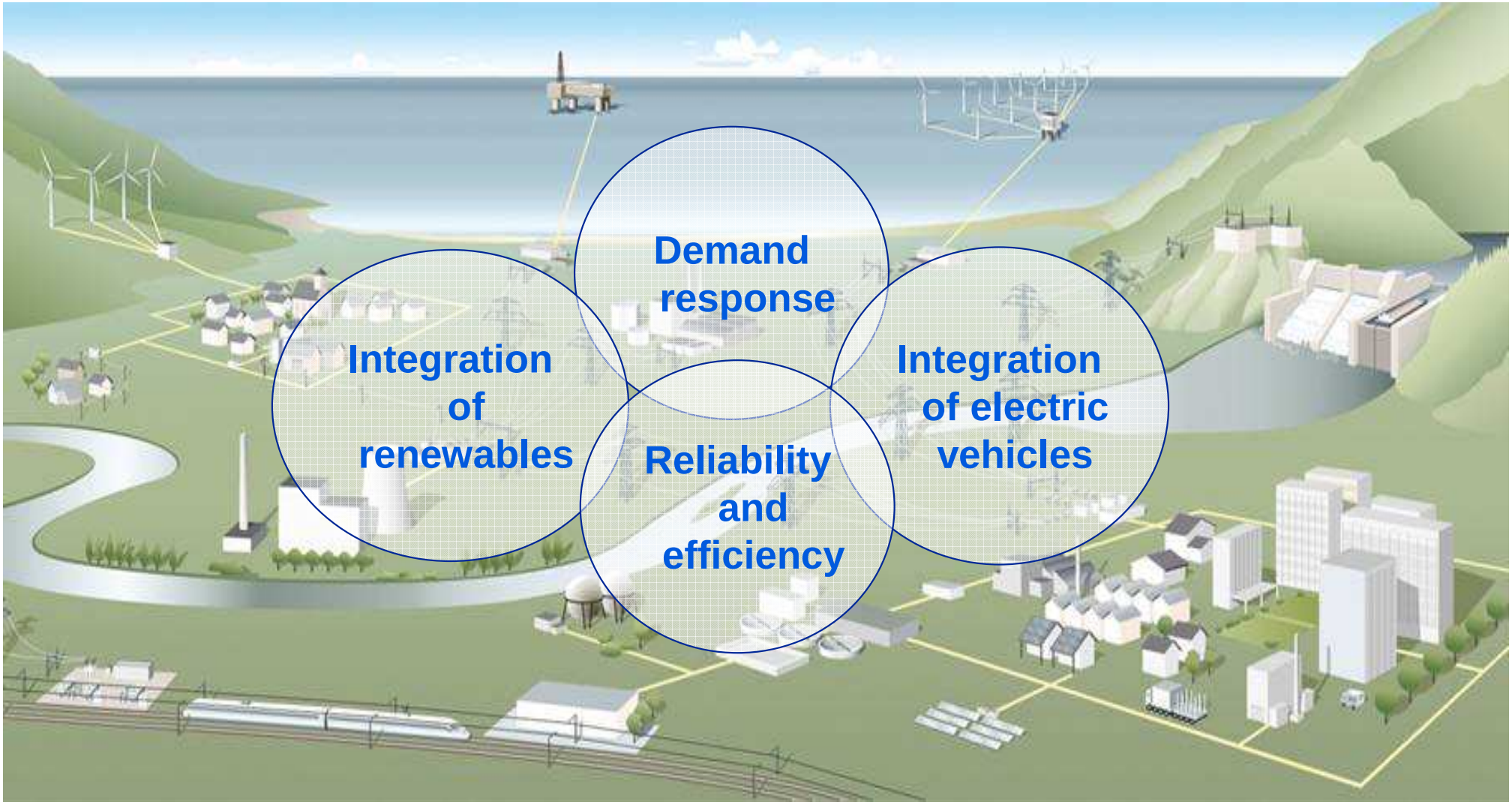
The future electrical system requires new business models and standards

Challenges, as of today and tomorrow
What is new?

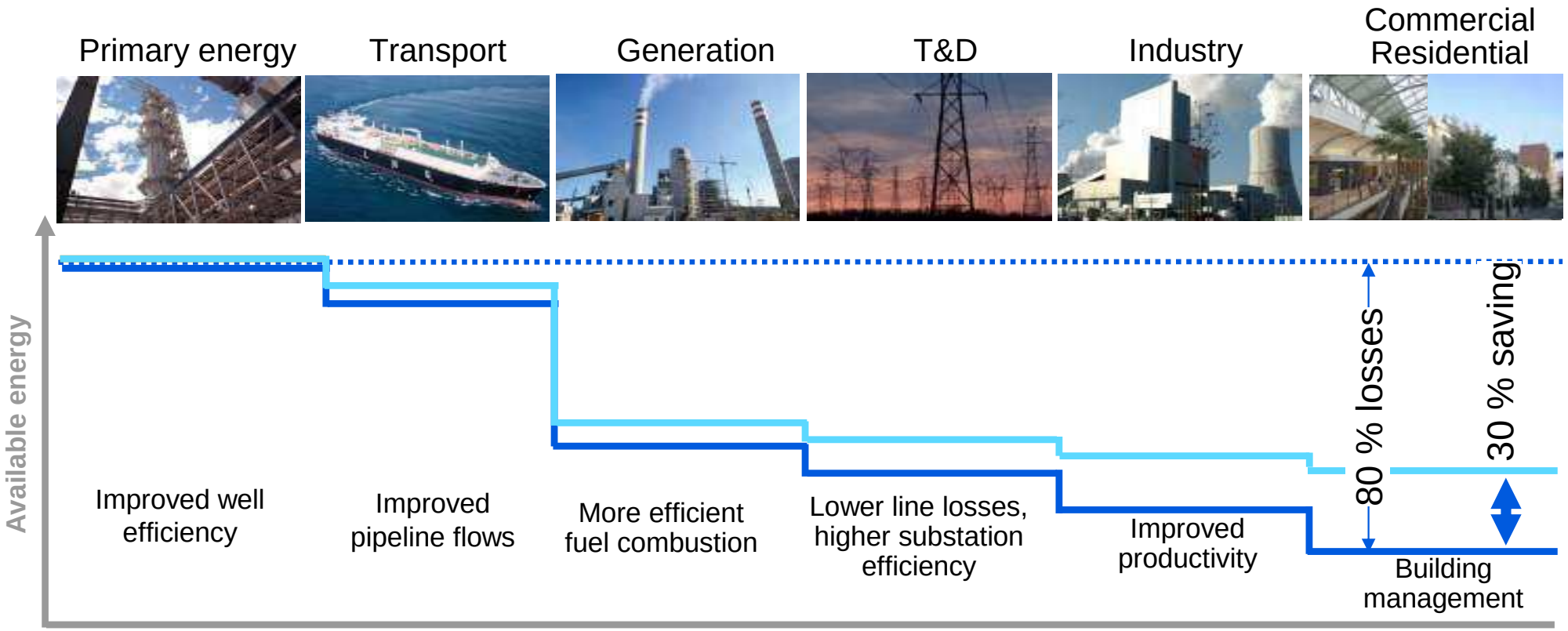
- **Reliability and efficiency**
  - **Increased network capacity. At the same time, improved security and power quality**
- **Integration of renewables**
  - **Hydro, wind, large-scale wind, bio energy, large-scale solar, *osmotic*, wave power etc***
  - **Energy storage, balancing power etc**
- **Integration of electric vehicles**
  - **Charging infrastructure etc**
- **Customer interaction, demand/response**
  - **Home automation, active houses etc**
- **Business models**
- **Standards**

*Statkraft, Tofte Oslo, Norway

Smart Grid challenges
Improve efficiency along the whole process



Efficient generation, transport and better utilization of electricity



- Up to 80 percent losses along the energy value chain
- Some losses inherent to the generation of electricity
- Network losses in EU are an estimated 50 TWh, the annual consumption of 13 million households*

Energy efficiency along the value chain can reduce losses by 30 percent

* Source: European Commission

Super Grid vision becomes Smart Grid vision

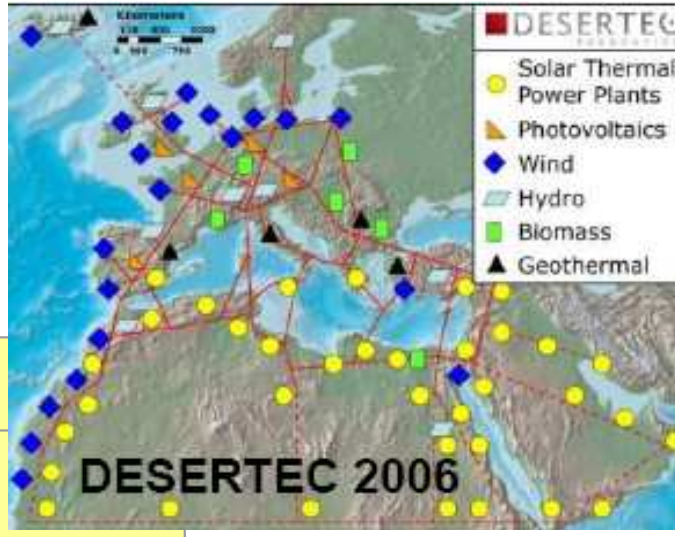
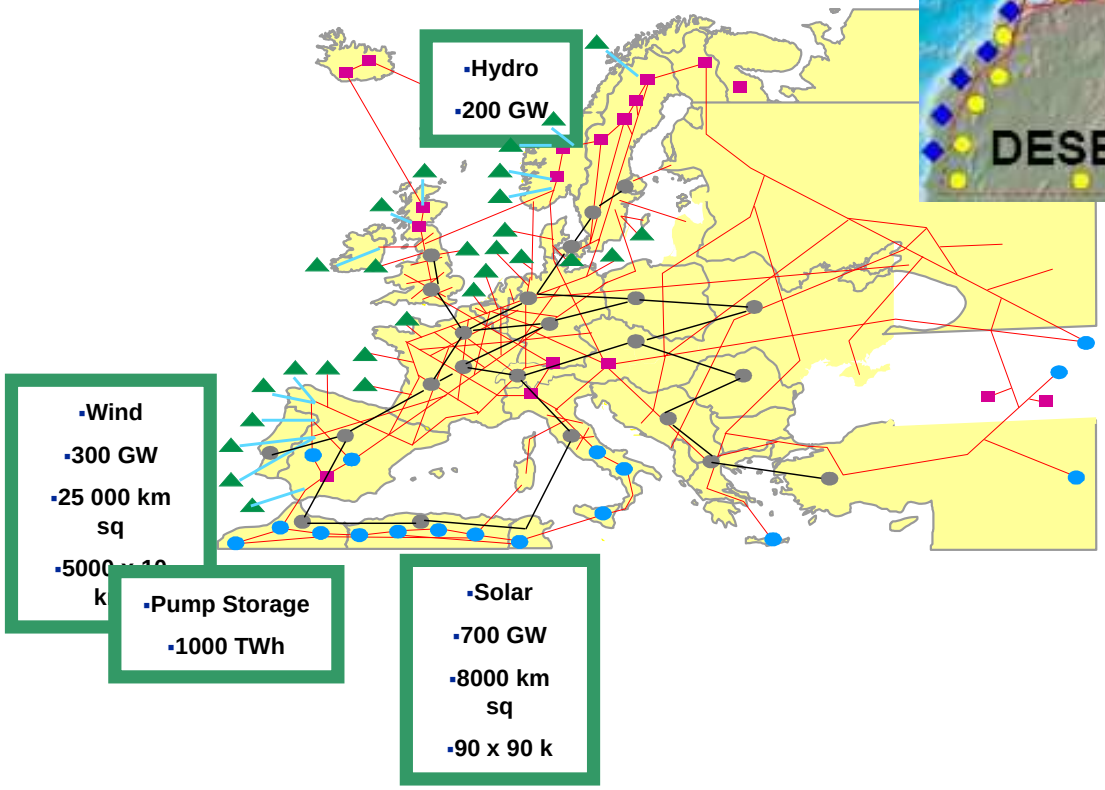
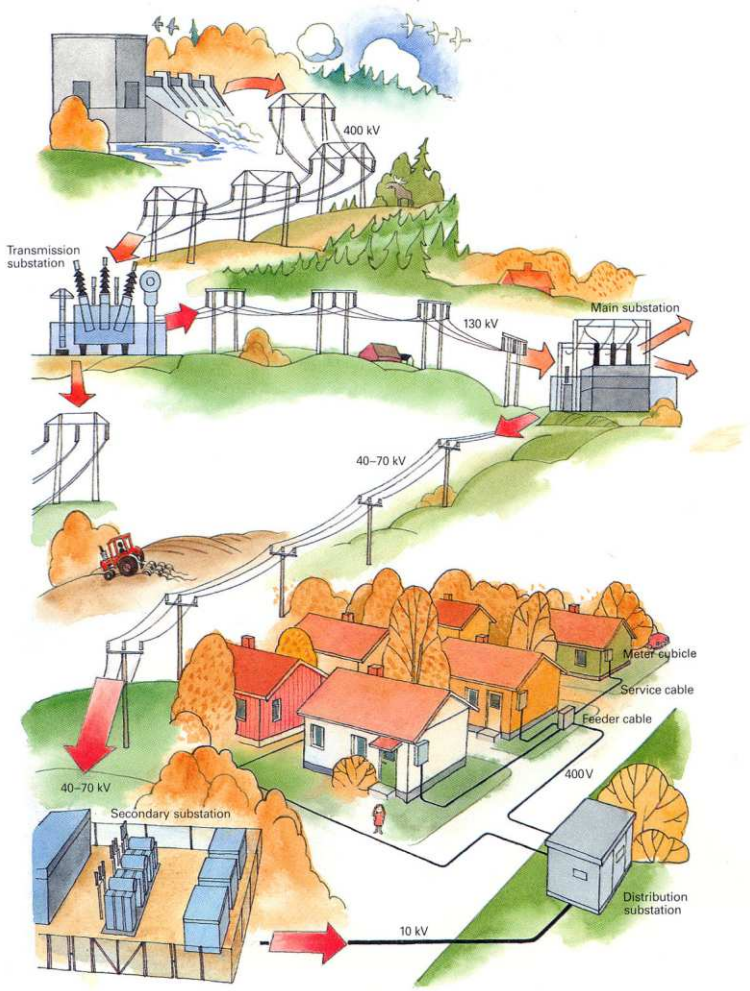


ABB vision 1992



- **Transmission capacity**
  - Large renewable power generations
  - Emission free balancing power
- **Load flow control to compensate**
  - Day / Night
  - Time zones

Smart Grid enables balance by interconnected networks and integrated active consumers



Balance control from the production and/or consumption side

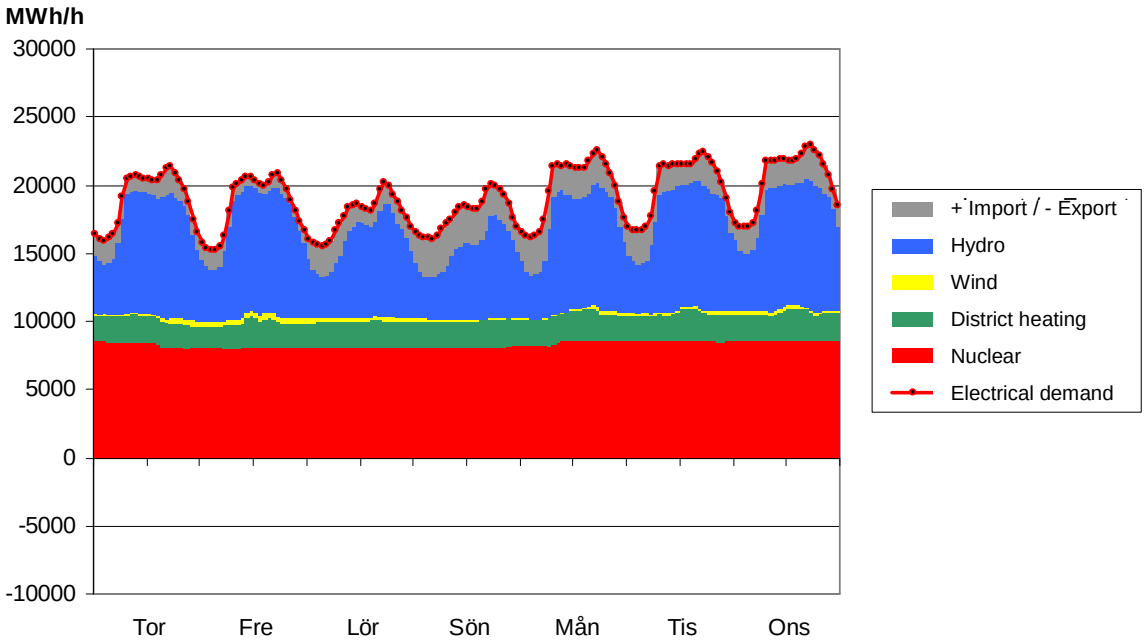
Planning targets for Sweden

Wind	30 TWh, 12 000 MW

Compare with

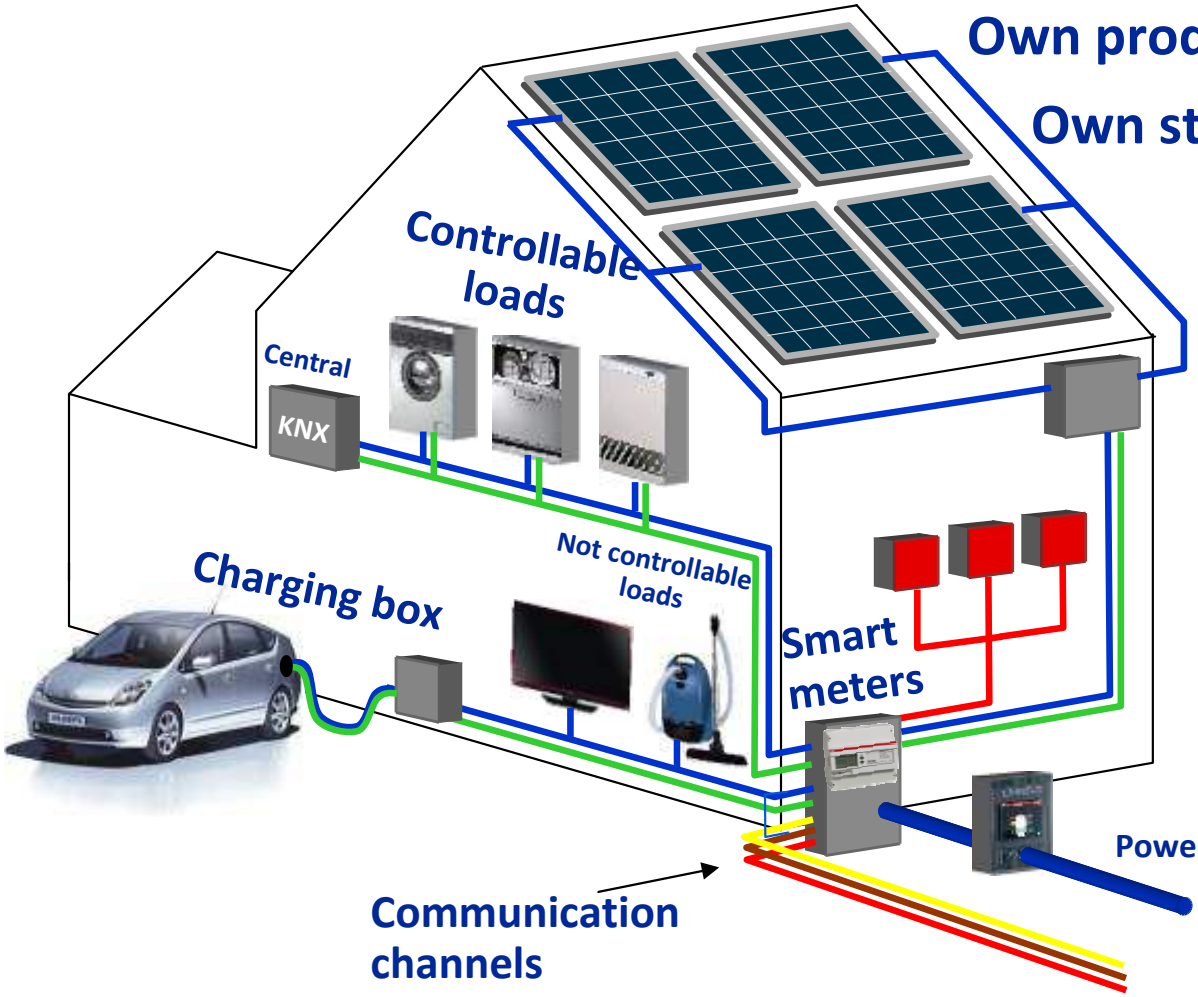
Hydro	16 000 MW
Nuclear	9 000 MW

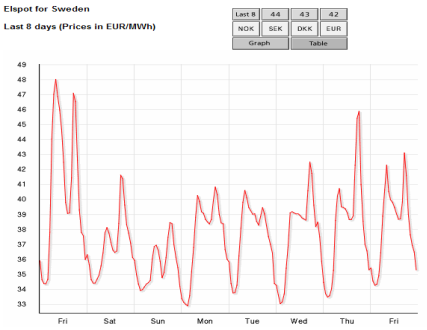
How to balance intermittent 12 000 MW wind?



Source: SvK Sweden

Smart Grid components:
Integrated Active House and Electric Vehicle





Benefits

- Active ‘procumer’ benefits from most favorable spot price
- Peak load shaving by local production, storage and time shift of consumption
- Overall reduction of energy consumption by increased consumer awareness

Communication options

To and
from utilities

Multi utility
communication
controller MUC

To and
from houses
and in the house

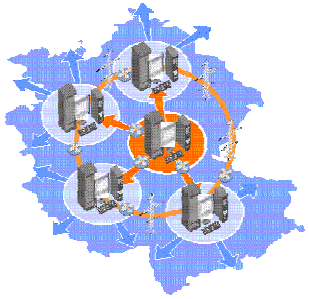
- Full two-way communication via different channels [1]
- Remote energy shutdowns possible e.g. QLD, AU
- Energy import and export measurements
- Electronic meters for monitoring serve all customer needs
- Multi-tariff options, load profiles, real time or monthly reading
- Visualization, control and configuration e.g. Google Power Meter, Google Wave, but also others

[1] Communication via GSM (GPRS); Internet (WAN, LAN, DSL, ISDN); PLC; M Bus over TP, Ethernet or GSM/GPRS, LonWorks PLC or EIB/KNX

Customized solutions for information exchange and demand response

Smart Grid components:
Charging infrastructure Electric Vehicles

Billing system

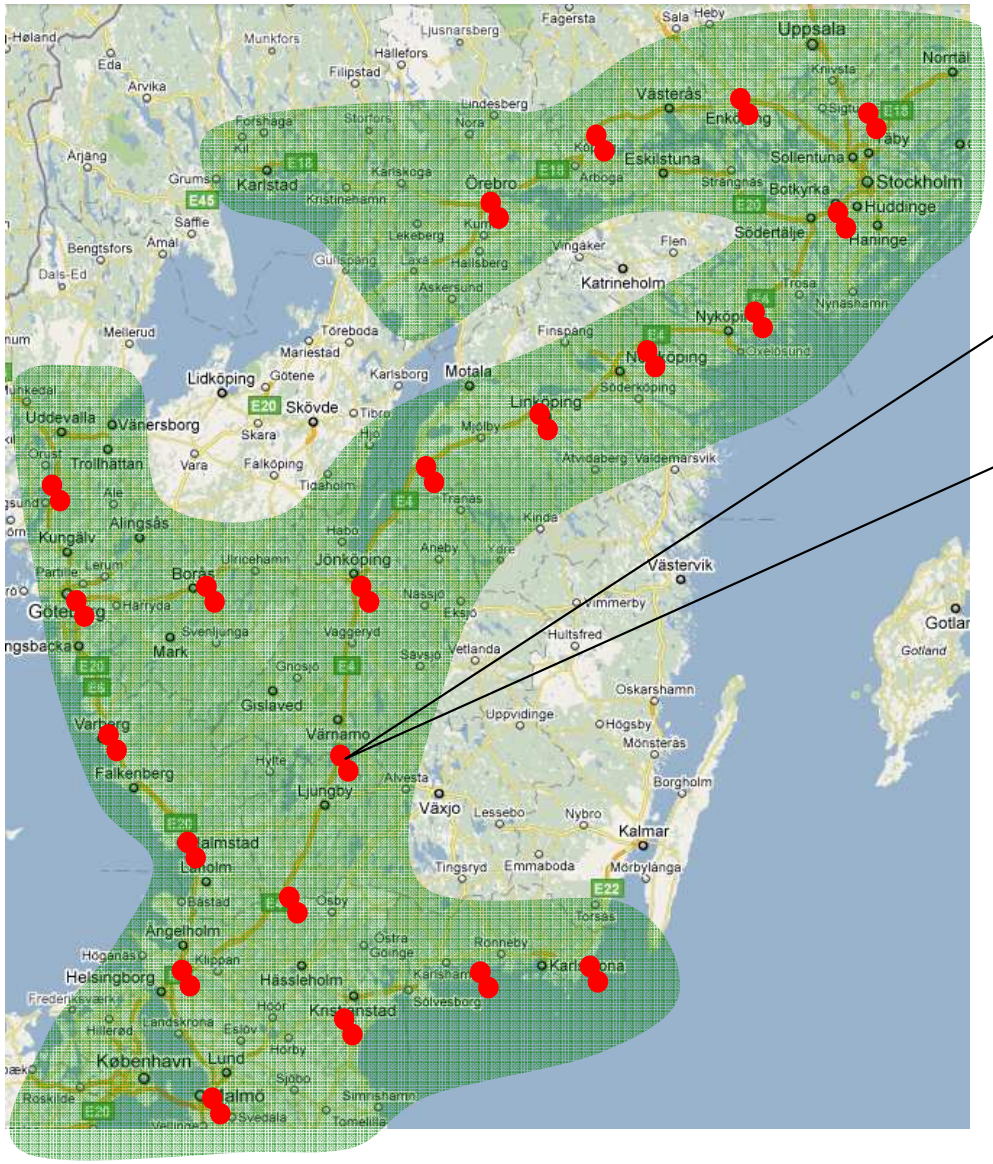


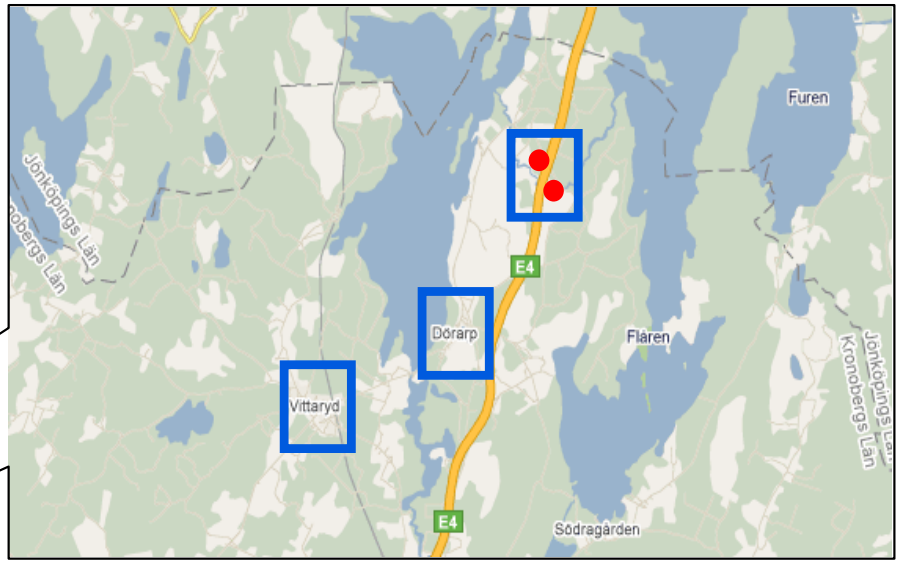
Benefits

- CO2 reduction
- Allows for the possibility to dispose energy when excess production is available.
- Peak load shaving

Charging method	Description	Installation
Slow charging	▪ Individual poles at home or parking lots ▪ Charging time ~6 hours	▪ ~2kW, , AC converters
Fast charging	▪ Special charging stations or with equipment at home ▪ Charging time ~1 hour	▪ ~20kW, AC converters
Ultra-fast charging	▪ Concept for special charging stations ▪ Charging time ~6 min	▪ >300kW, DC converters

Impact on the grid
Voltage drops in rural areas due to ultra-fast charging

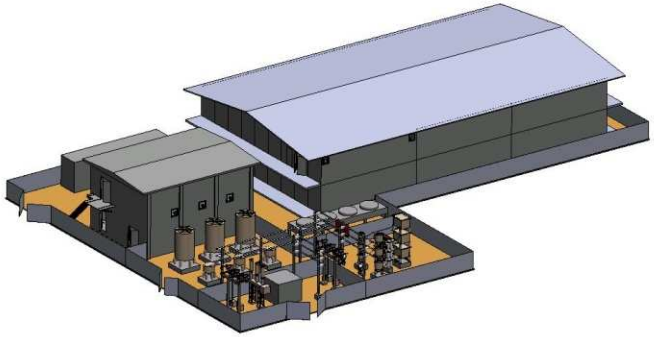




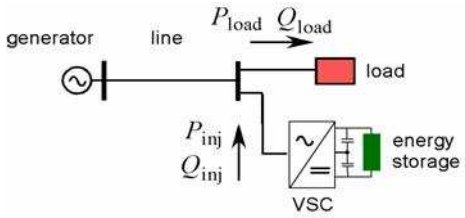
Countryside in Småland:

- Ultra-fast charging station at E4 highway
- Next primary substation is >30km away
- Neighboring villages at same medium-voltage connection

ABB SVC Light with energy storage



- Handles intermittent energy production issues such as voltage control, grid stability during and after faults, as well as frequency regulation.
- Used during peak load situations and as emergency reserve during power outages.
- Energy Storage as alternative to investment in increased grid distribution capacity
- Current Project
  Two wind farms connected to 11 kV distribution system. Rated 200 kW/1 h , 600 kW/15 min



Smart Grid
Smart Meters

- **The European market for meters will be 244 million meters by year 2015, let us assume at least 50% will be smart meters**
- **By 2015 at least the same amount of smart meters will be installed in NAM**
- **By 2015 China is well on its way**
- **The WW amount of meters year 2015 is estimated to 500 million**
- **Assume one meter will be able to control 1000 W, corresponding to 500 000 MW.**

Demand response, an issue also for transmission systems

Stockholm Royal Seaport
A Smart Grid R&D Pilot Project

Driver: Stockholm, a sustainable city.
Reducing energy consumption to half

2009-2025:

- 10 000 apartments
- Customer interaction demand response
- 30 000 new office places
- Electrical vehicles and ship to shore connection
- Micro generation and energy storage

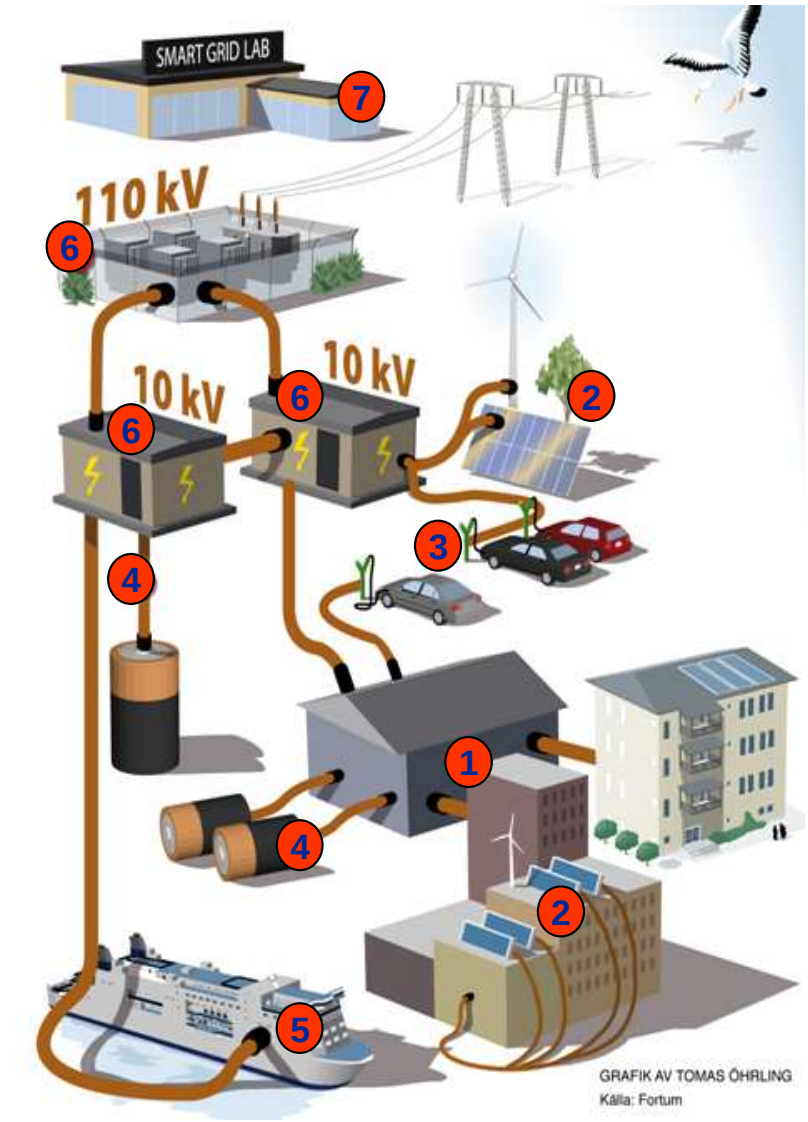
2020:

- CO2-reduction from 4,5 down to 1,5 ton per person

2030:

- Fossil free city

Example of a large-scale Smart Grid (Stockholm Royal Seaport)



*DES, Distributed Energy Systems

1. **Active houses/buildings and Demand Response**
   - Reduced peak load and increased energy efficiency by demand side participation and home/building automation
2. **Distributed Energy Systems**
   - Integration of production for local generation PV and Wind in Home/Building Automation Solution
3. **Integration and Use of electric vehicles**
   - Integration of PHEV Charging Infrastructure
4. **Energy Storage for Network Support and DES***
   - Increased stability and power quality
5. **Harbor Control Solution**
   - Reduced CO2 emission based High voltage shore connection
6. **Smart Primary Substations**
   - Increased efficiency and reliability with higher automation level
7. **Smart Grid Laboratory (part of Innovation Center)**
   - Research, development, simulation and implementation of smart grid application

Smart Grid Roadmap

- **Step 1: Smart Grids Initial phase (1-3 years)**
  - Integration large scale wind/solar farms
  - Smart Meters for billing
  - Pilots for energy storage, active houses, electric vehicles, demand response, distribution automation, AMI integration
- **Step 2: Emerging Smart Grids (3-7 years)**
  - AMI integration with operational system
  - Distribution Automation
  - Energy storage
- **Step 3: Mature Smart Grids (7-15 years)**
  - Active houses
  - Demand Response
  - Integration electric vehicles

Conclutions

- Smart Grid will be an important arena where politicians, authorities, utilities, suppliers etc. will meet to discuss how to reach the goals related to sustainable energy systems with increased energy efficiency and reliability.
- Everyone has to reconsider the individual energy consumption behavior
- Smart Grid means an evaluation from today's system, that is not by definition "none smart"
- Most of the products and systems needed to create a Smart Grid is here today:
  - Power -systems, -products, Automation -systems, -products
- New functions like e.g. integration of large-scale renewables, electric vehicles etc will be tested by pilots and demo and research sites
- Energy storage
- Demand response
- Standards must be developed
- Smart Grid creates new jobs and attracts new skills

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