



R&D in Vattenfall

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2 R&D portfolio

3 Smart Grids

Vattenfall in brief

Net sales 2011:

181 billion SEK (20 billion €)

7.8 million electricity customers

5.8 million grid customers

2.1 million gas customers

38,000 employees

Sweden, Germany and Benelux as core markets

De-regulated markets with significant unbundling

Owned by the Swedish state

Electricity Generation:

166,7 TWh

Heat Generation

41,6 TWh

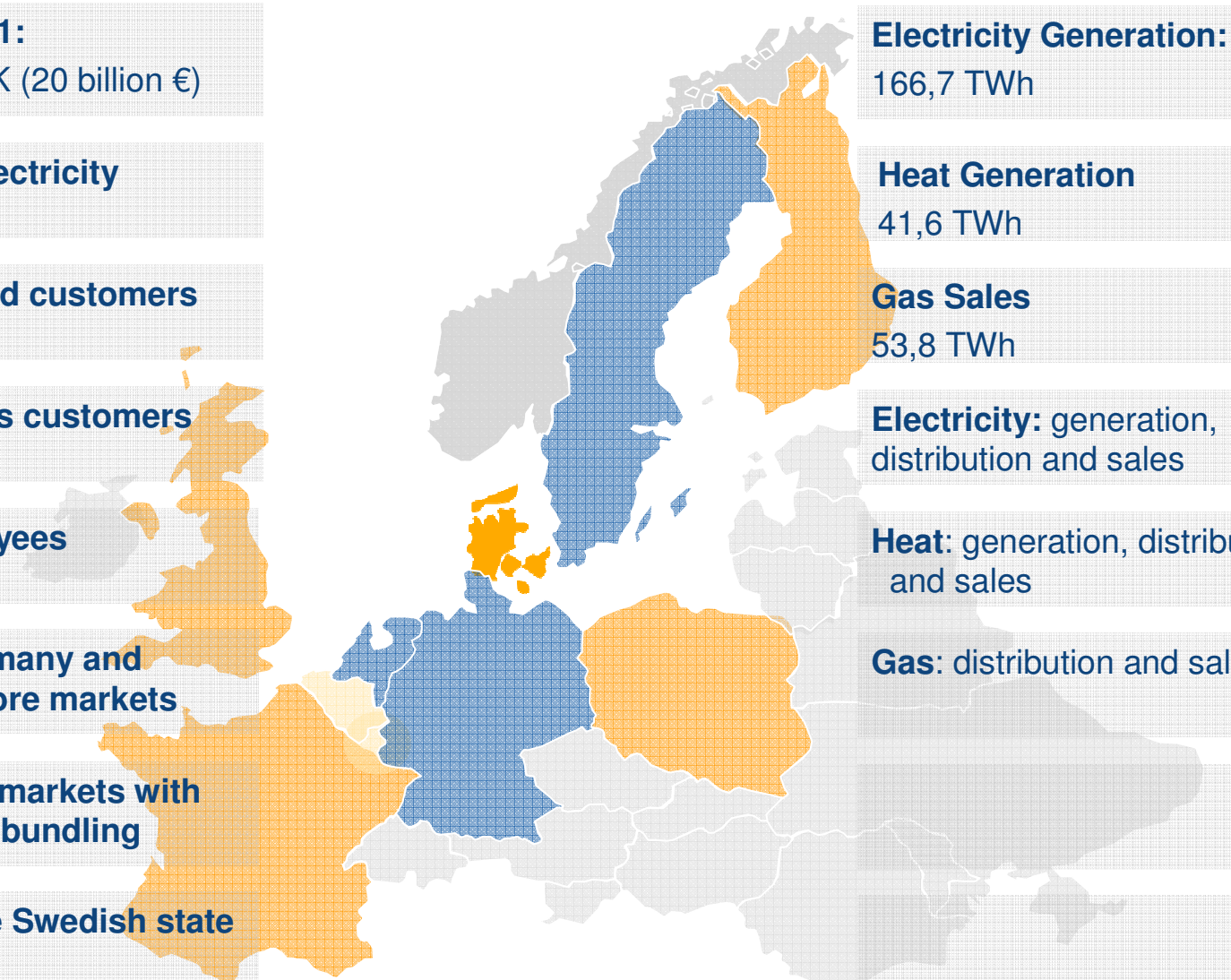
Gas Sales

53,8 TWh

Electricity: generation, distribution and sales

Heat: generation, distribution and sales

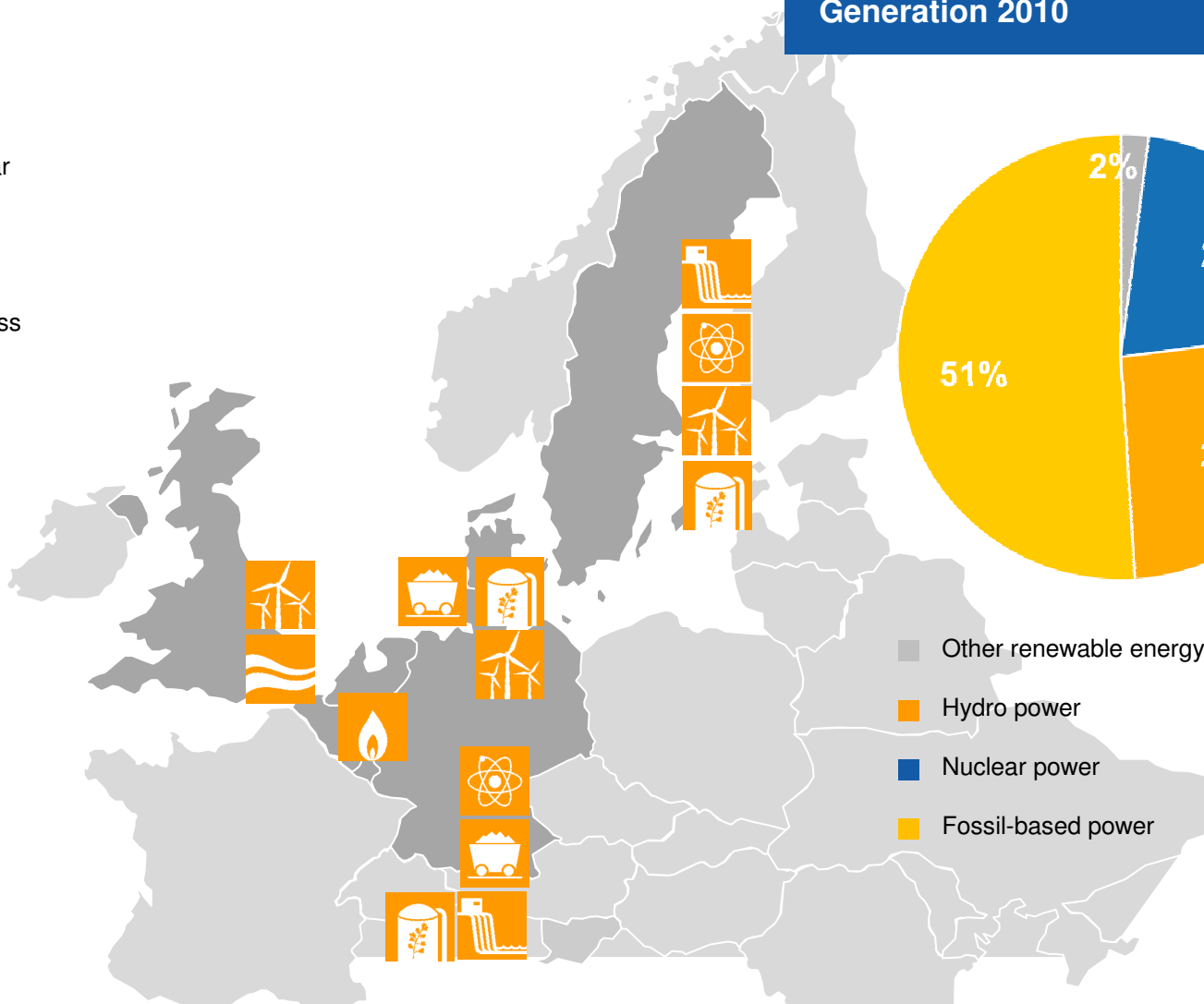
Gas: distribution and sales



Different markets - different challenges

Generation 2010

- Wind
- Nuclear
- Gas
- Biomass
- Coal
- Ocean
- Hydro



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Smart Grids

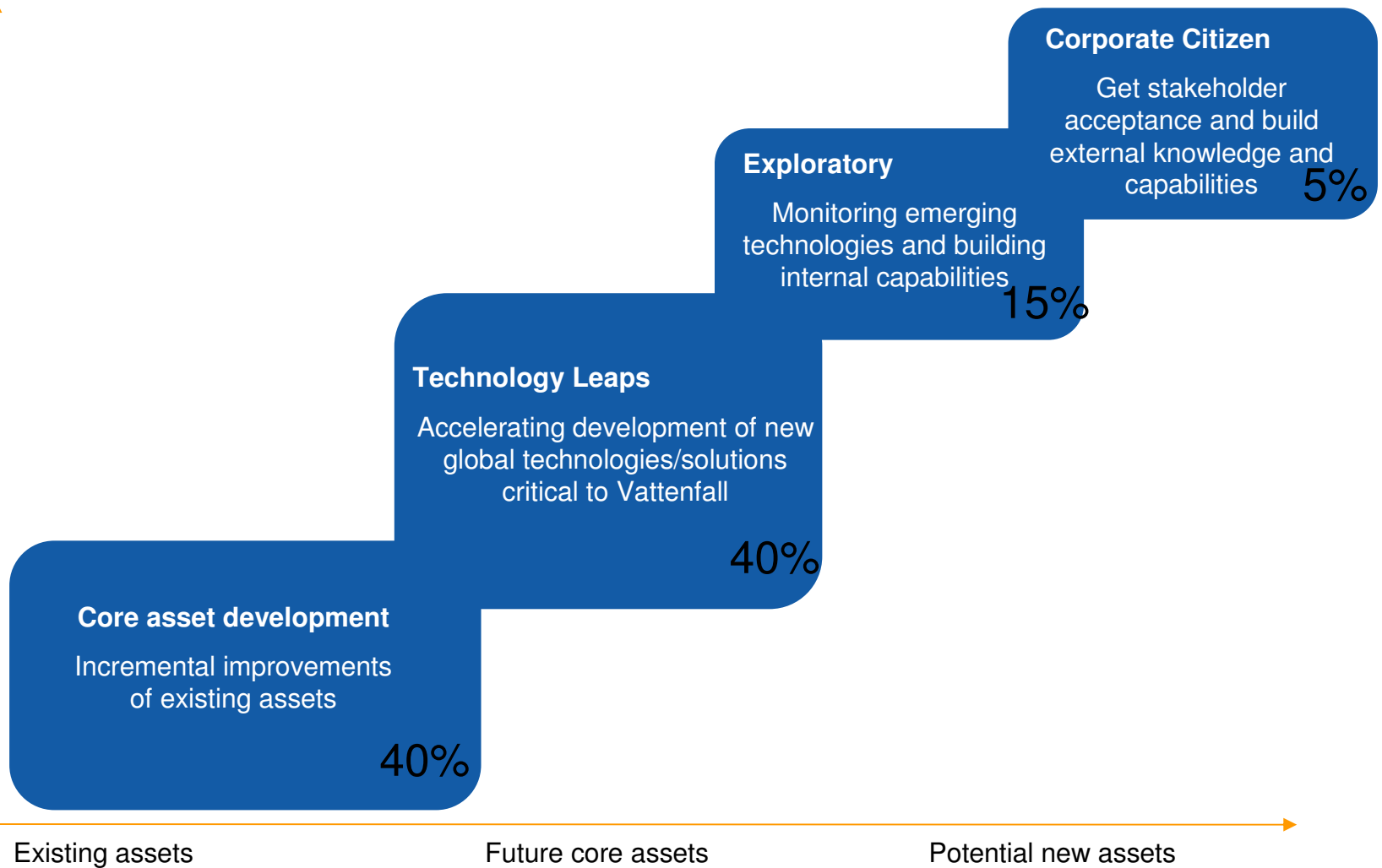
R&D Portfolio

Technology maturity

Emerging, not yet close to commercial

Technology at turning point, close to commercial deployment

Adjustments to existing technologies

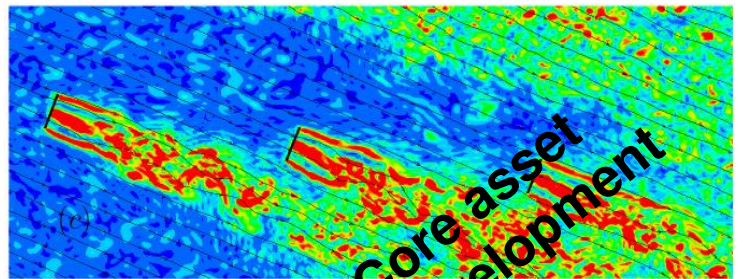
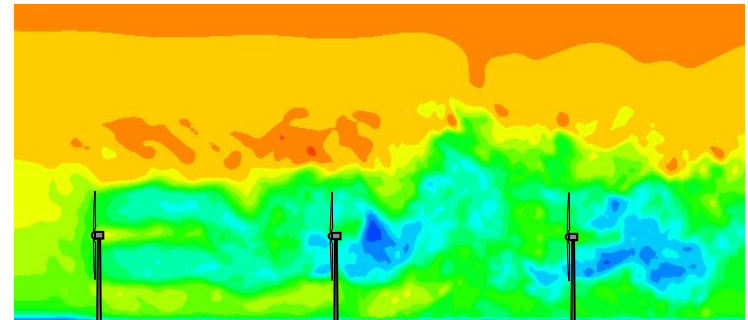


Six Focus Areas of R&D

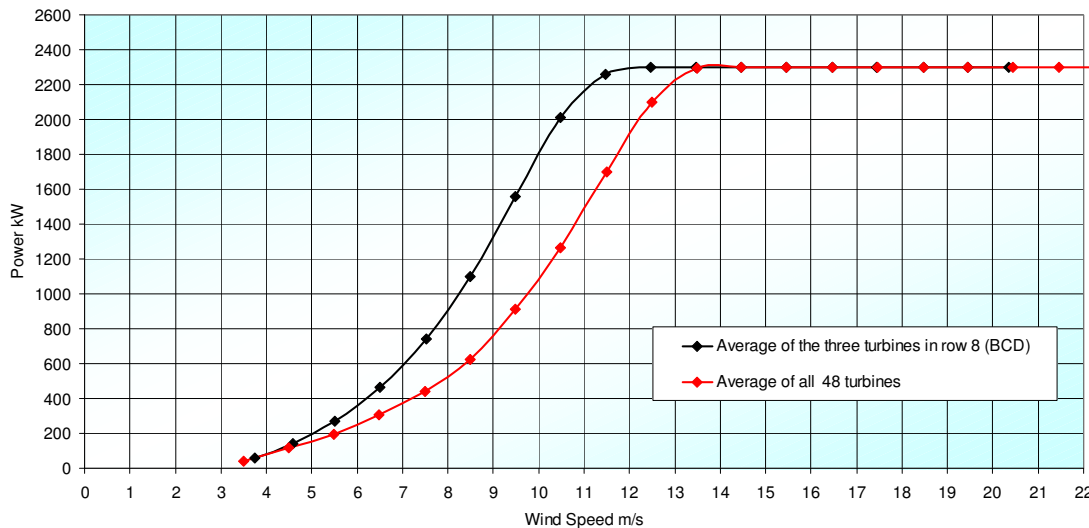
CCS	The focus of CCS is on supporting the demonstration projects in their efforts to take the technology from the pilot scale, where the technical abilities have been proven, to the demonstration scale.
Thermal and Biomass Technologies	Thermal and Biomass Technologies (TBT) is core business development to create cost saving potential in existing operation and dispatch, as well as development of future concepts for lignite based plants. TBT should also support strategic decisions, i.e. use of CO ₂ -lean fuels (co-combustion), and identify and analyse associated technical and/or economical constraints.
eMobility	Our vision is to facilitate a transition towards sustainable road transport, and its integration in the energy system, as well as to take action on future business opportunities by developing user-friendly driving and charging features.
Smart Grids	In 2030, Smart Grids will be the technical arena where Vattenfall meets EU's climate commitments by optimal use of sustainable energy sources in electricity generation, secure electricity supply, and involve the consumers when becoming producers.
Low Emitting Generation	Our mission is to identify and perform R&D projects which optimize and enhance Vattenfall's generation within ocean energy, nuclear, wind and hydro and maintain our safe, reliable, competitive and environmentally liable generation.
Strategic Innovation	Strategic Innovation scouts technologies that are not current core R&D activities as executed in the other departments, as well as develops capabilities to enable extracting maximum value out of R&D activities.

R&D-example: Spatial effects on wind farms

- The turbines in a wind farm affects each other
- Both "wind shadows" as well as turbulence will lower the out put
- Existing rule of thumb not sufficient, simulations necessary
- 1% improvement in average wind results in 3% increased generation.

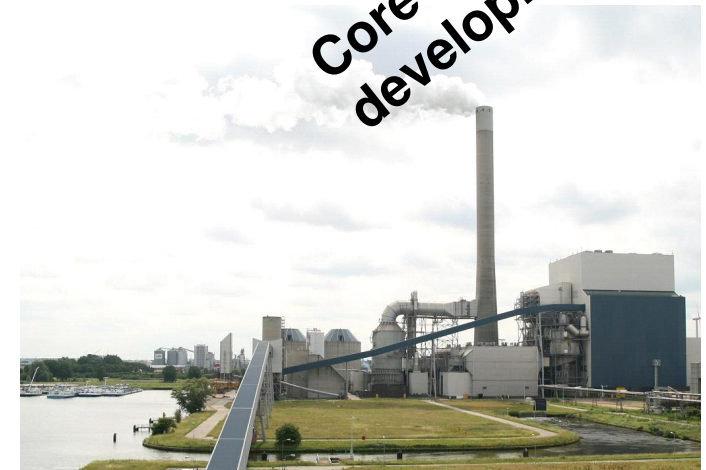


**Core asset
development**



R&D example: Refinement of biomass

- Vattenfalls target is to decrease the emission of CO₂ from 90 till 65 million ton until 2020
- However biomass is a complex fuel in respect to corrosion, handling, fire protection ...
- Refinement of pellets by torrefication or steam explosion simplifies handling and co firing with coal
- The cost for climate investments are reduced
- Vattenfall is developing business opportunities as well as looking at technology options.

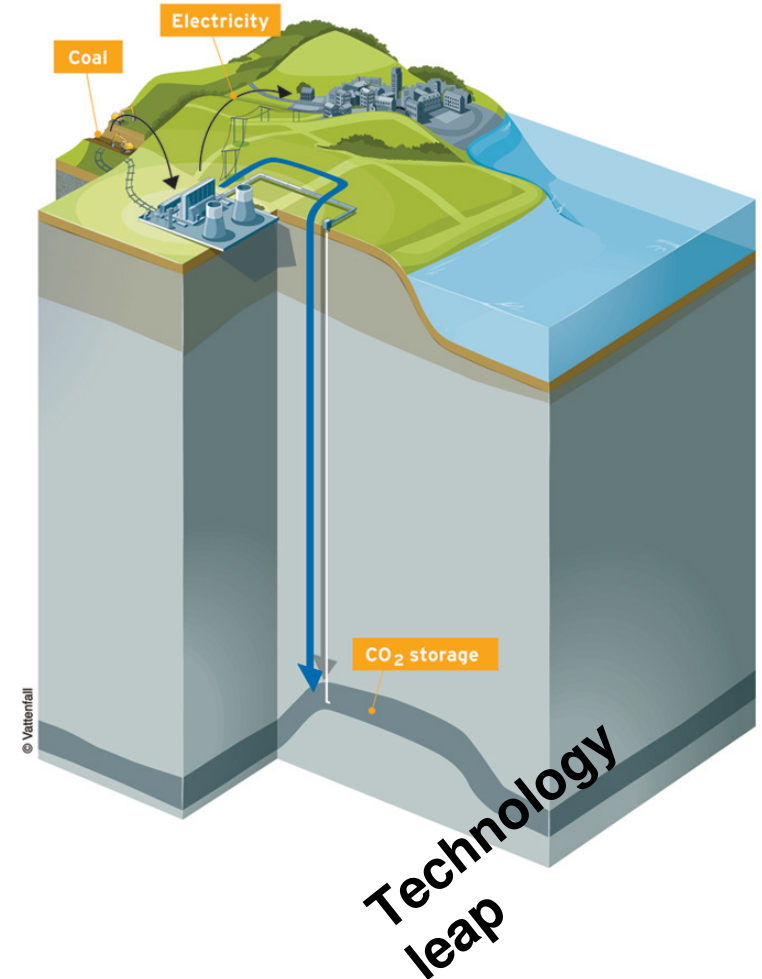


Storage tests

*Vattenfall is operating 40 heat and power-plants entirely or partly fired by bio mass. Vattenfalls is currently using approximately 3 million tonnes.

R&D example– CCS a bridge into the future

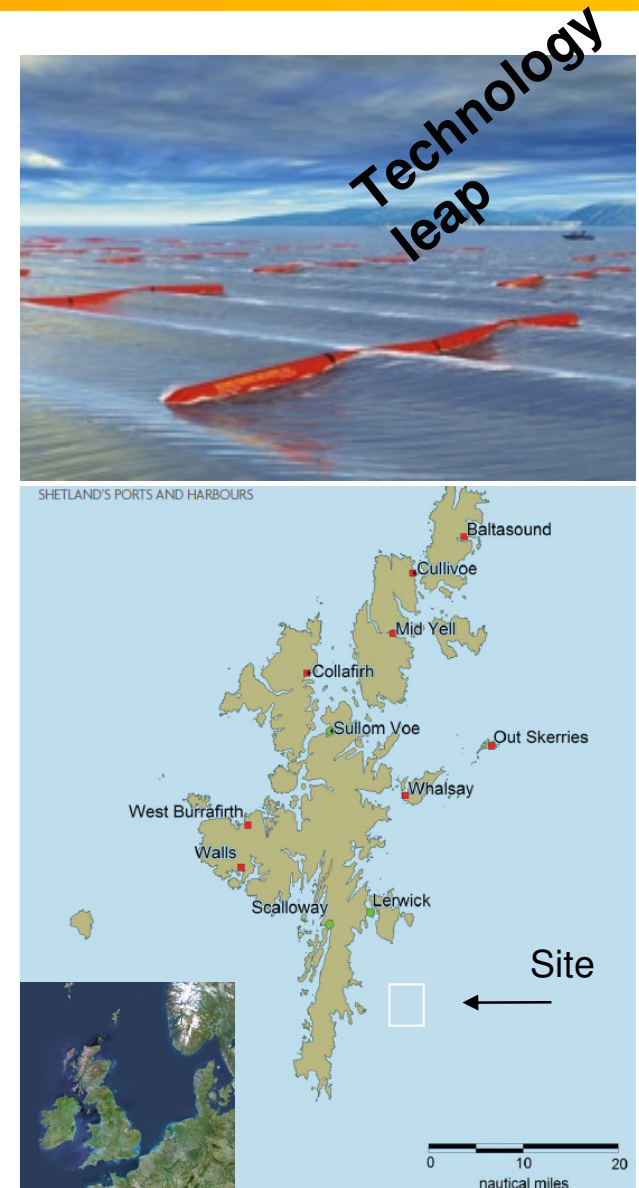
- Most of the generation capacity is based on coal. It is also the generation that increases fastest
 - Sustainable development requires coal generation with substantial decreased environmental impact.
- In CCS CO₂ is captured, compressed and stored in the rock bed.
- The capture ratio is well above 95%
- The world's first pilot plant for oxyfuel capture was started 2008 by Vattenfall
- The challenge is today political not technical



R&D Example: Wave power on the coast of the Shetland islands

- AEGIR Wave Power (Joint Venture between Vattenfall, 66% and Pelamis, 33%) is planning a pilot project in the form of a 10 MW wave power park from 2015, east of the Shetland islands
- Vattenfall and the Shetland Council agreed on developing ocean power
- Vattenfall is evaluating generation technologies.

No of Pelamis units	10
Rated power per unit	1 MW
Expected annual production (10 MW)	35 GWh
Dimensions of device (l x d)	220 m x 5,5 m
Weight (each)	~ 1000 tons



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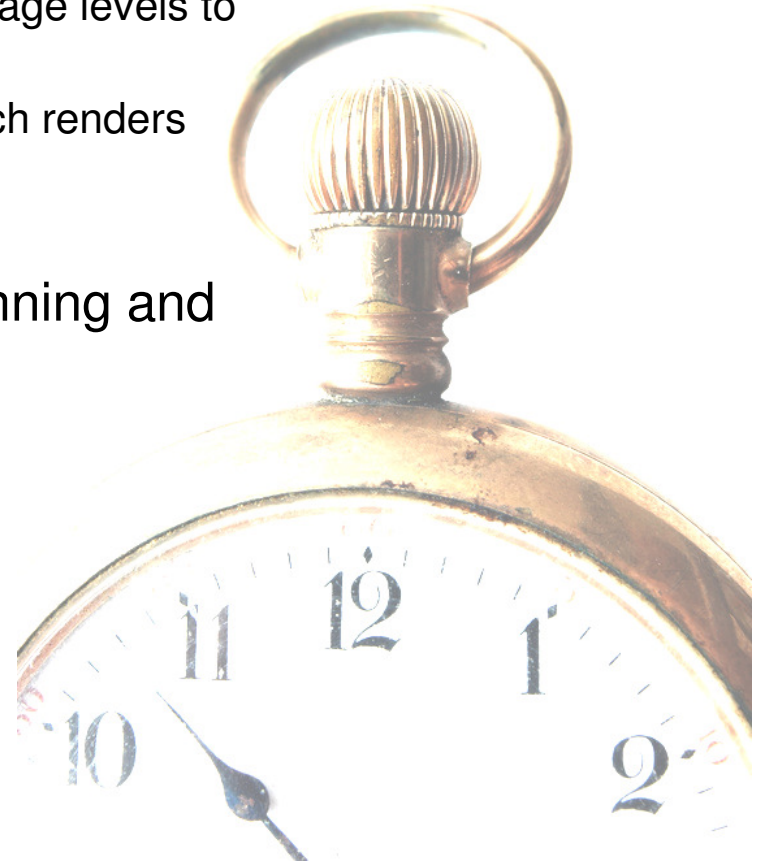
R&D portfolio

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Smart Grids

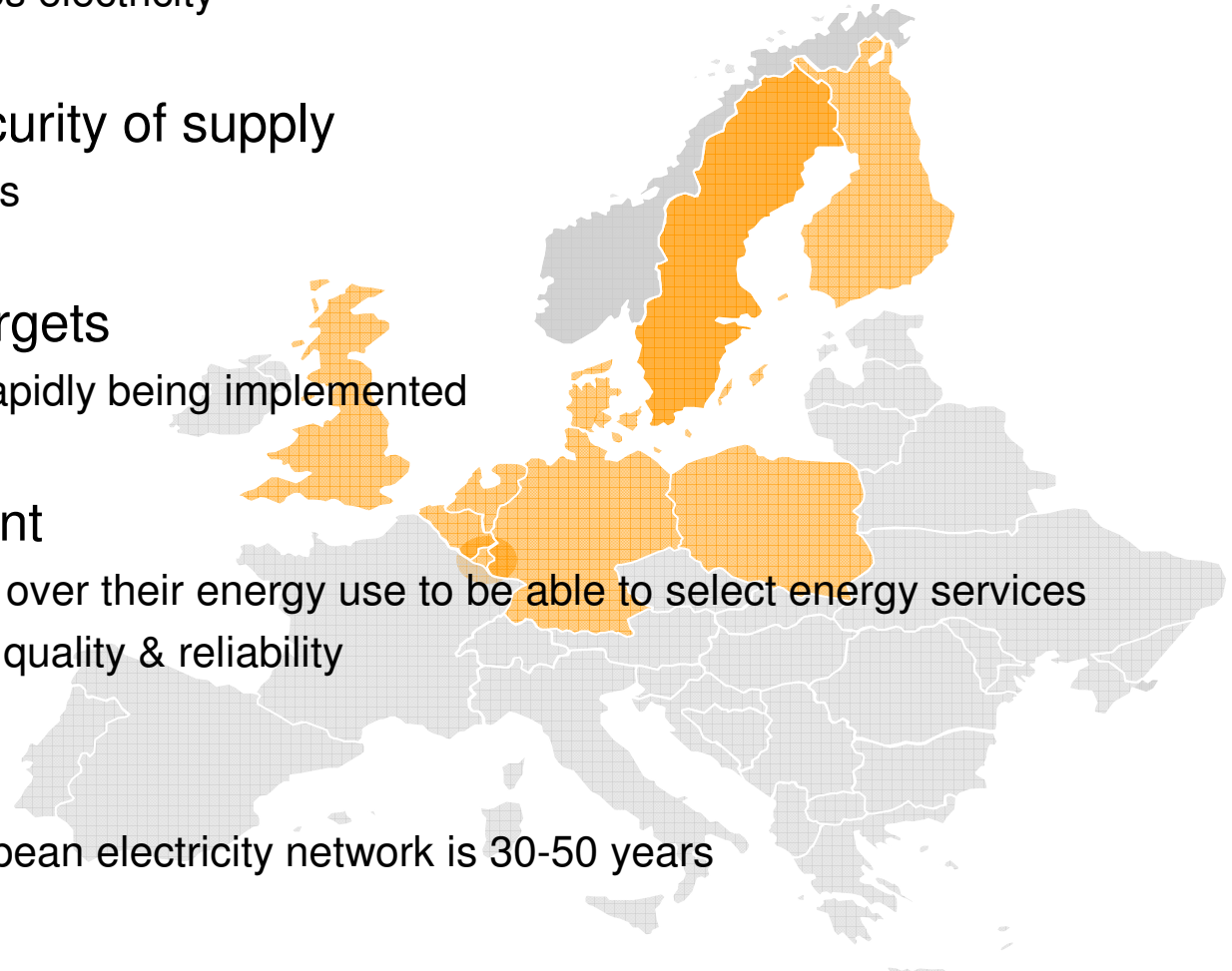
Today's European Electricity Network

- Designed during the 20th century
 - Large-scale, centralized generation
 - Generation follows load, every second
 - Electricity flow in one direction – from higher voltage levels to the customer
 - The network is designed for maximum load, which renders low asset utilization
- Country/region specific power system planning and expansion
 - Weak interconnections between regions
 - National and regional market regulations



Drivers for change

- Continued economical growth means increased demand for energy
 - This especially includes electricity
- European goals for security of supply
 - European primary fuels
- European 20/20/20* targets
 - Various maturity but rapidly being implemented
- Customer empowerment
 - Incentives and control over their energy use to be able to select energy services
 - Continued increase in quality & reliability
- Aging network
 - A majority of the European electricity network is 30-50 years



* 20% reduced CO2 emissions, 20% increased energy efficiency, 20% more renewable generation

Vattenfall and SmartGrids

In 2030 the Smart Grid is the technical arena where our goals are realised

To meet EU's climate commitments by optimal use of sustainable energy sources in electricity generation

Environmentally and economically rational use of electricity in society

Electricity as the reliable and available energy carrier

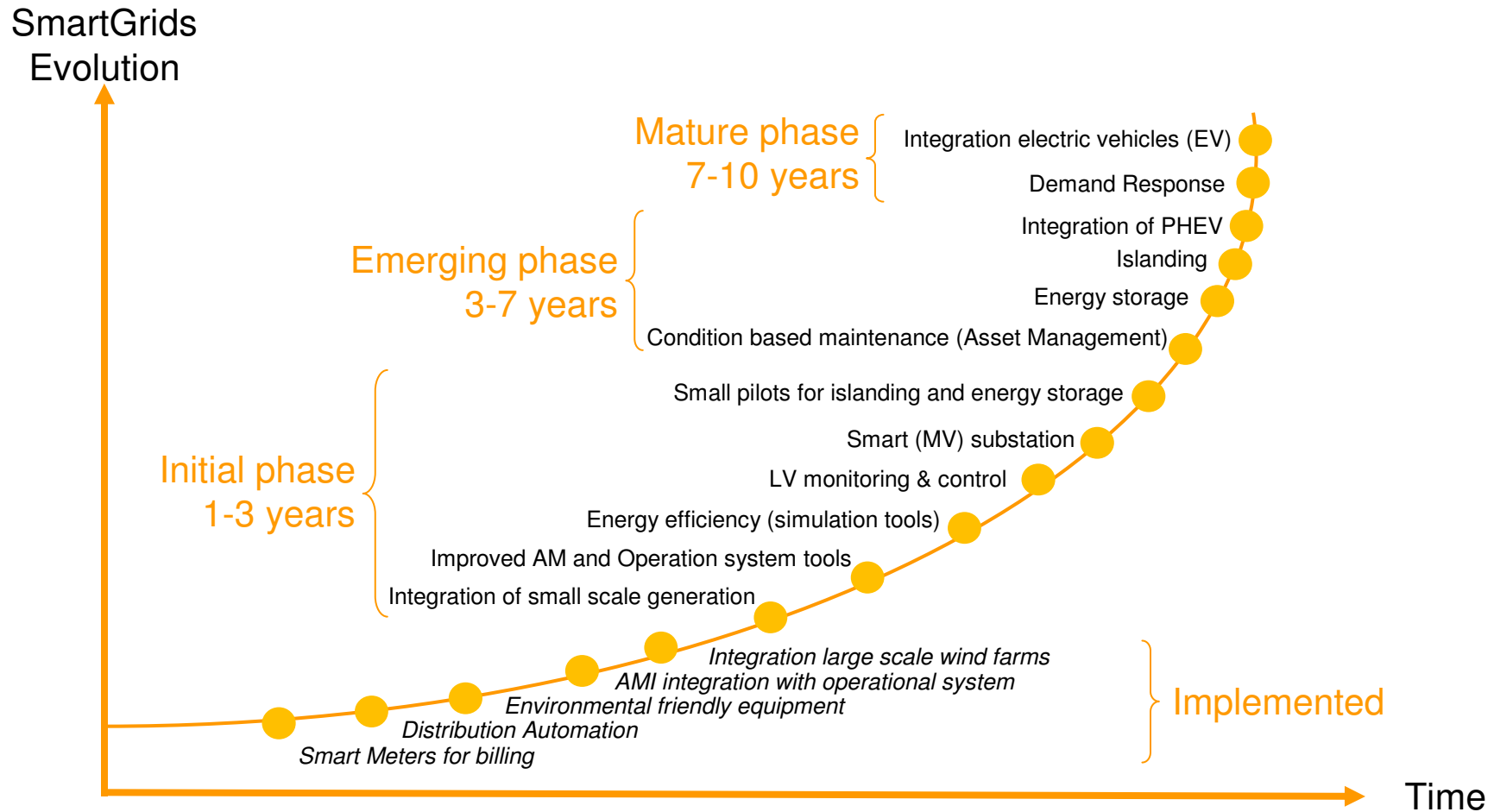
A transition towards sustainable road transport

To take action on future business opportunities



© Vattenfall

Smart Grid Evolution on the Nordic market



What has been done (Nordic View)



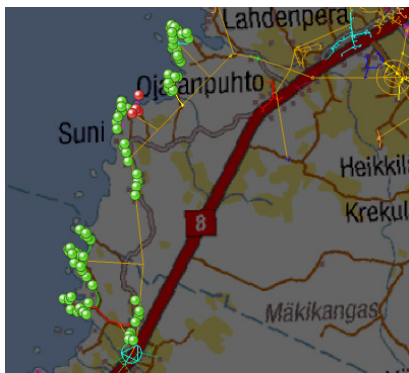
Smart Meter roll-out:

- 100% Smart Meter roll-out in Sweden and Finland
- Regulatory demand
- Business case based on grid company process improvements



Weather proofing the network:

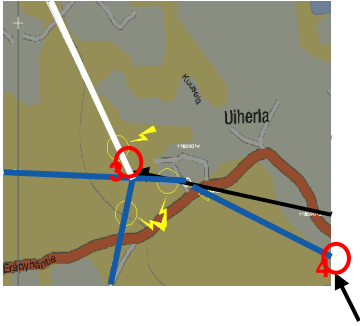
- Automation and isolation (incl. cables) of network
- Redundancy
- Targets improved reliability and availability (SAIDI)



Low voltage monitoring & control:

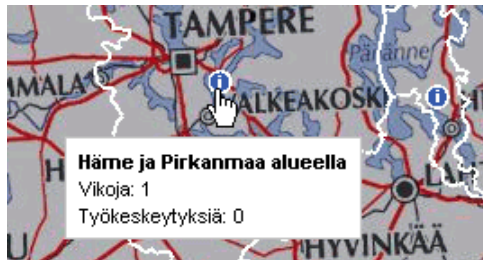
- Instant knowledge of customer supply status
- Improved and optimized outage management
- Improved reliability and availability (SAIDI)

What has been done (Nordic View)



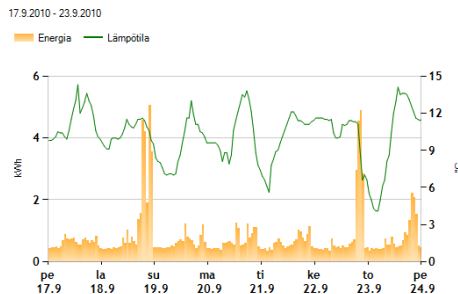
Fault isolation and restoration:

- Automatically isolates faults using network automation
- Restore supply to customers through assisted switching
- Fully automated process a matter of trust...



Customer outage information:

- Real time outage information through web or SMS
- Integrated with control centre & single source for info
- Estimated time for restoration



Web consumption reports:

- Hourly or daily values depending on availability
- Necessary tool for energy efficiency
- Part of network service

What has been achieved – Customer centric view

Energy Visualization in Hamburg



Values-to-web in Sweden



Customer promises



Examples of R&D projects in Smart Grids

Smart Grids Gotland



Maximize Value of Smart Meter Investment

VATTENFALL PER Larmpanel

Från datum: 2010-04-25 00:00:00 Till datum: Uppdatera Visa ett Visa alla
 Antal larm: 10 Autoscrol Håll Larmstämning i dag 1 h 3m
 Håll Stämning

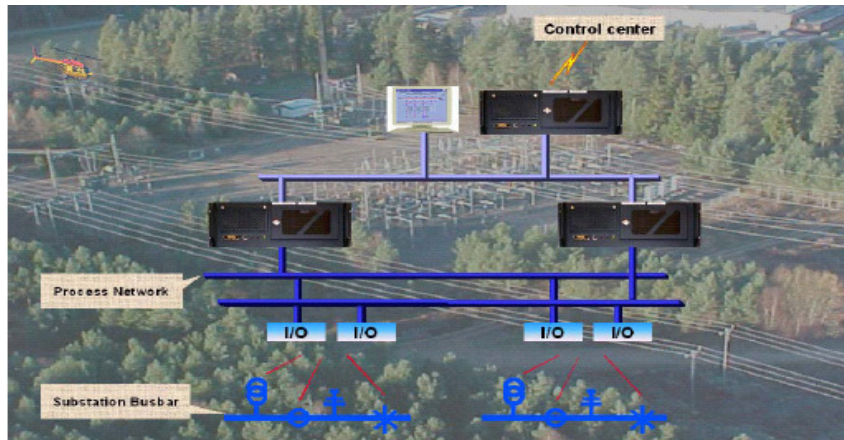
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Larmlogg, senaste händelser

Larmdatum	Status	Larmnamn	Objekt	Värde	Trend	Värdehögtid
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Larmstatus, aktiva larm

Smart Substation



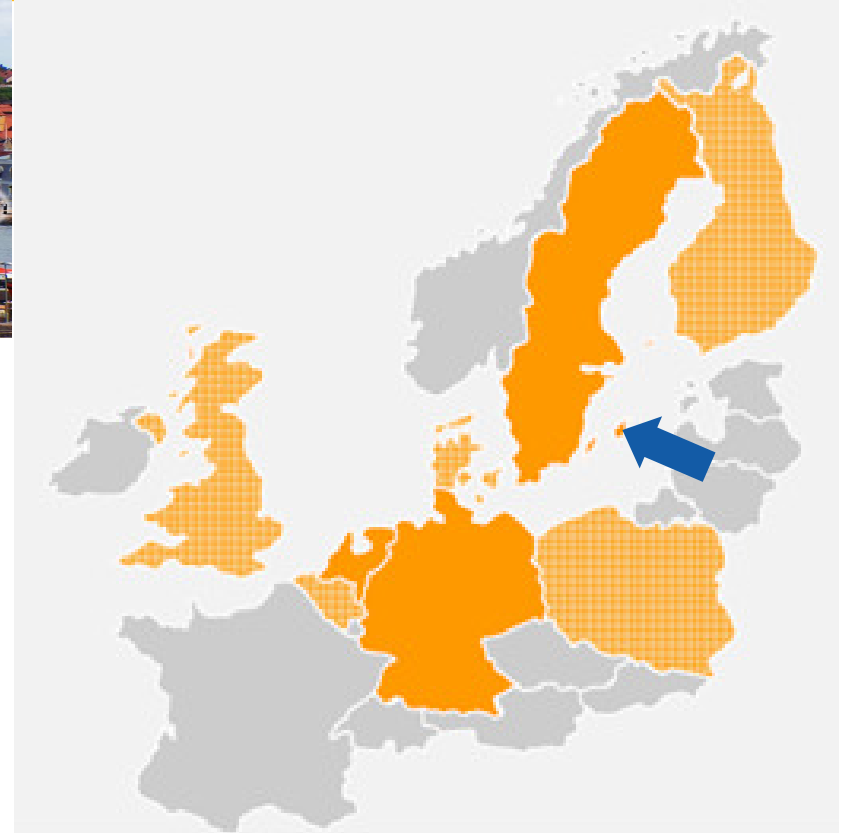
Grid4EU – Low Voltage Monitoring & Control



Smart Grid Gotland – Upgrade of an existing grid



- Unique full scale integrated demonstration and R&D project for a future distribution system
- Model for how to upgrade an existing distribution network to meet customer and society demands
- Real customers, producers, grid owners and other actors interact under real conditions to gain knowledge of the future electricity market



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Vattenfall AB
ABB
SVK

