Transition of the Energy System and Electric Mobility

Iceland, INE Conference, Oct 4th, 2012

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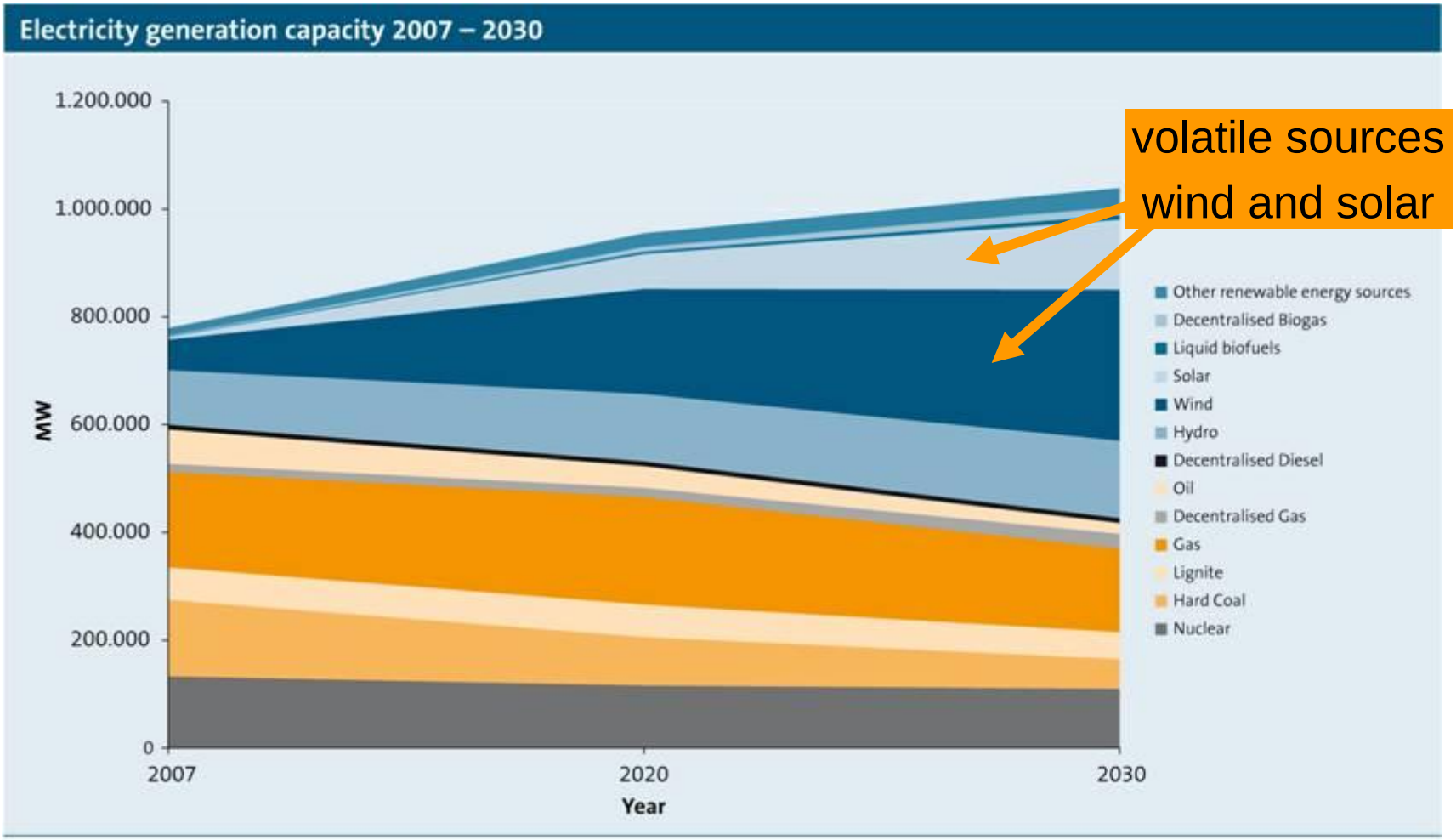
Transition of the Energy System

Development of Generation Capacity in Europe



Source: VDMA

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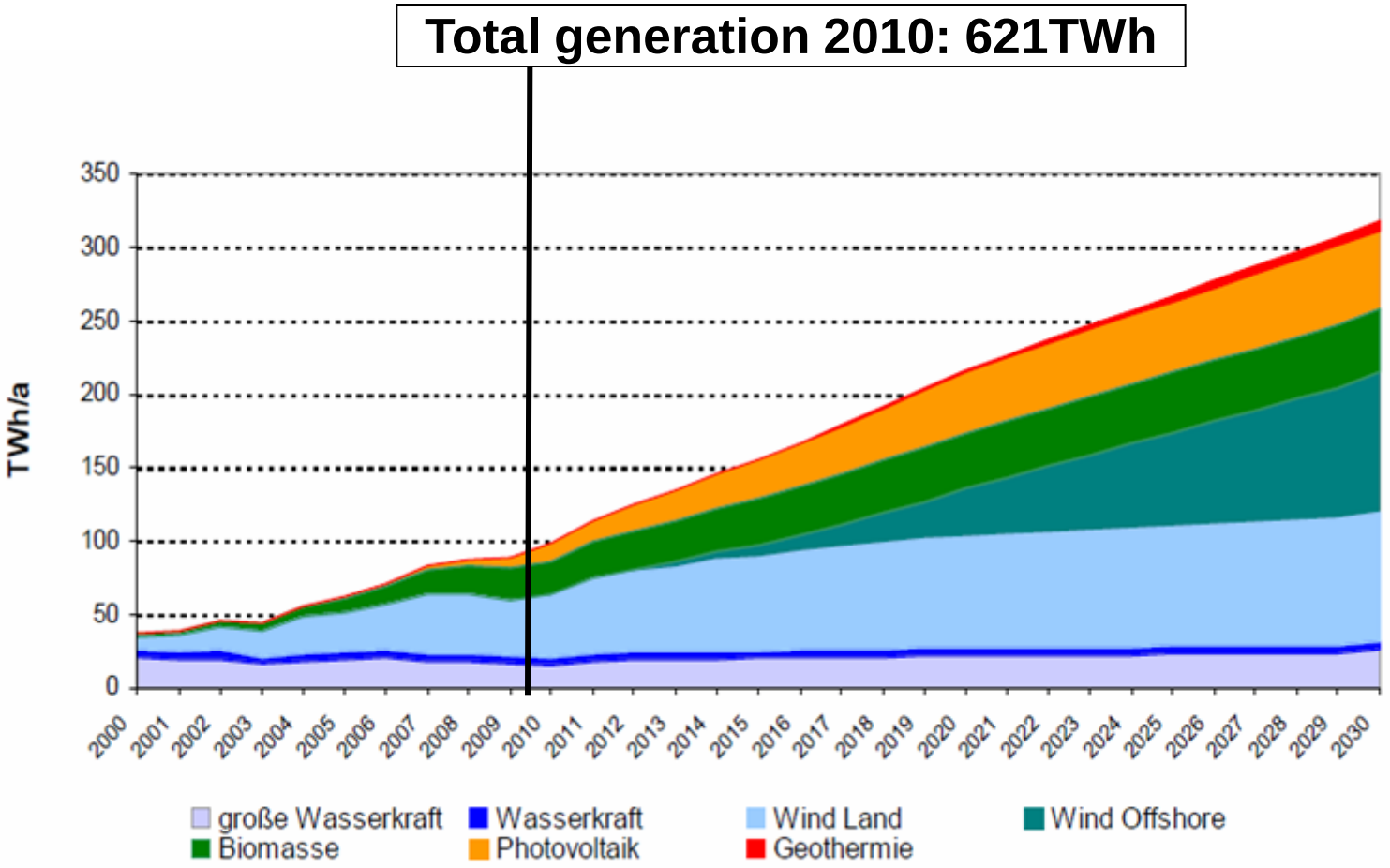
Renewable Power Generation Development in Germany



Source: BMU

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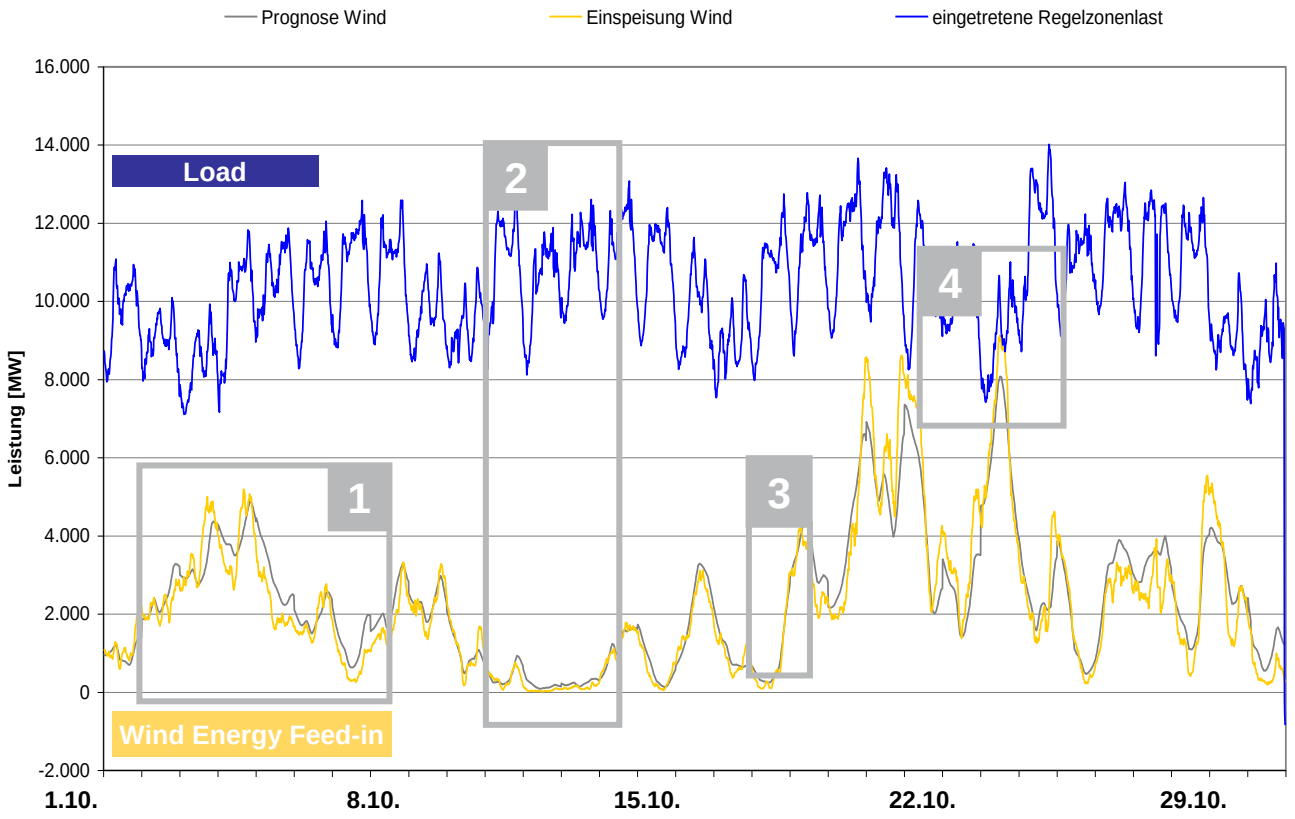
Volatile wind integration is a new challenge for transmission grids in terms of system stability

Load, Wind Energy Forecast and Wind Energy Feed-in in East Germany (01-31.10.2010)



1 **Deviation from forecast**

2 **Calm**

3 **Gradient**

4 **Production > Load**

Data source: 50Hertz Transmission

Not utilized wind power in 2010: some 150 Mio. kWh (ca. 40000 households)

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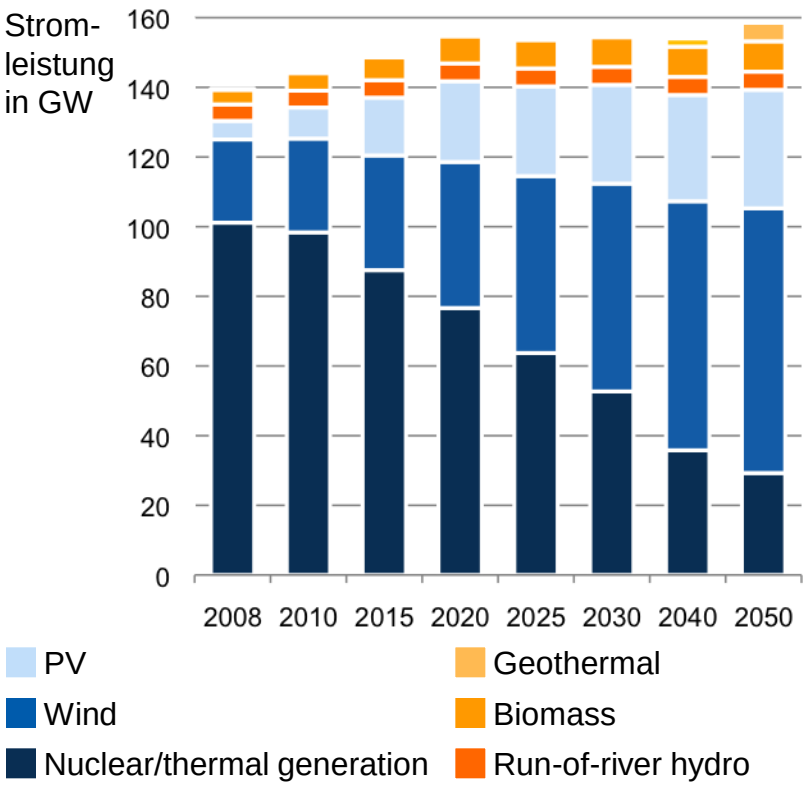
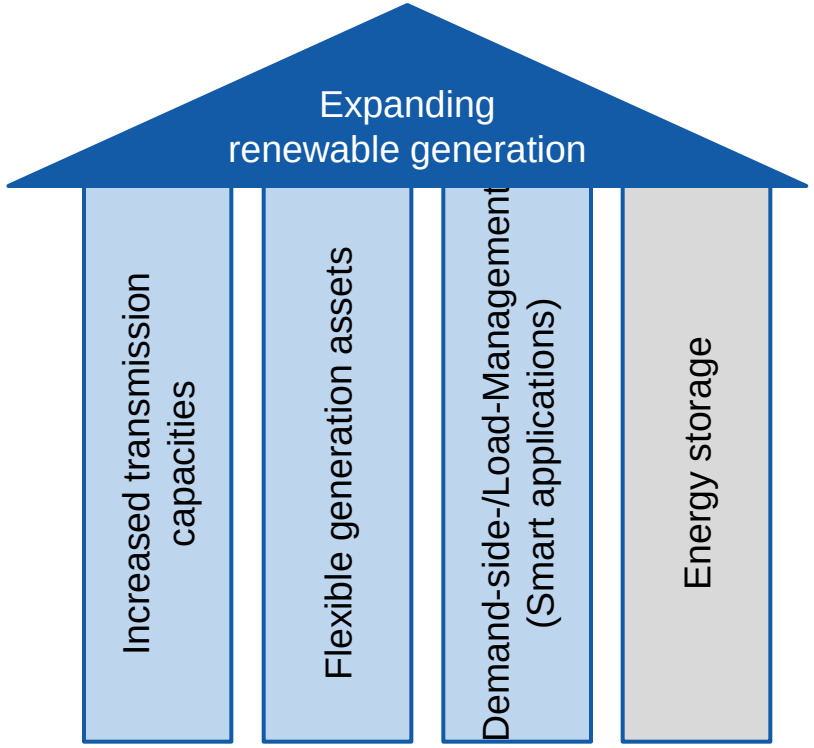
Market projections show strong renewable growth requiring various countermeasures in the energy system

Projection of installed capacity[1)] in Germany according to BMU 2009 Scenario[2)]



Countermeasures for energy system transition



1) Without pumped-storage

2) BMU: Bundsministerium für Umwelt, Naturschutz und Reaktorsicherheit

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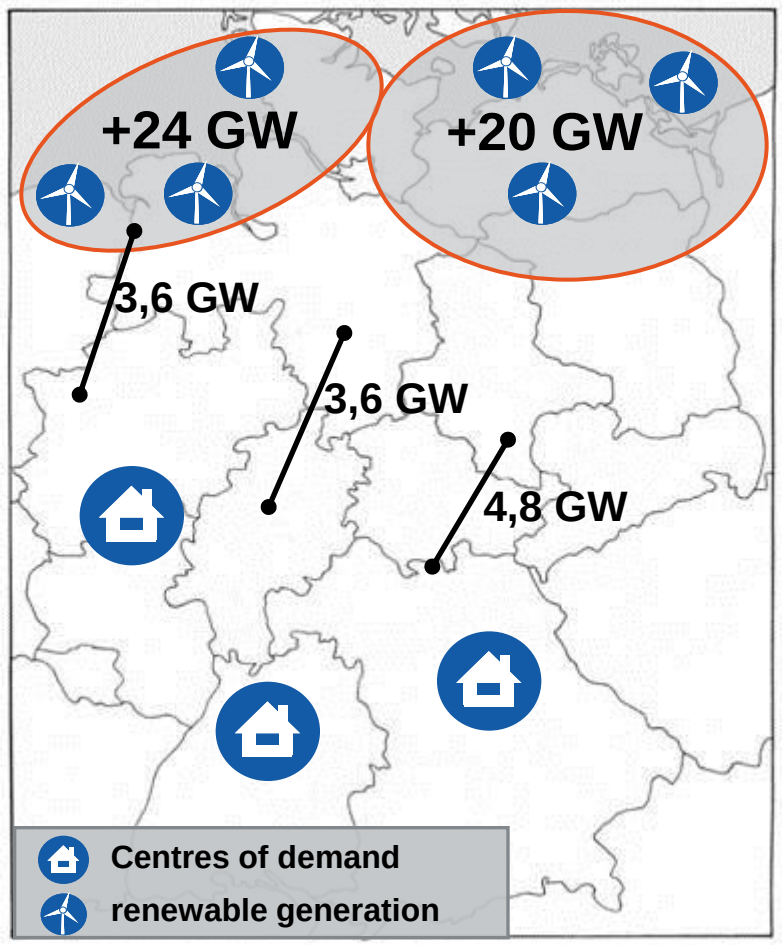
Bottleneck in Transport Capacity North-South



Already today the north-south lines are heavily loaded during high wind feed in

44 GW new generation until 2020
vs.
12 GW new transport capacity

Fast increase of grid capacities is required

Source: 50Hertz Transmission & TenneT GmbH Prognosen für 2020
***Kapazitäten der Leitungen siehe Bundestag Drucksache 16/10491, Begründung zum EnLAG**

Source: 50hertz

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Transmission Grid Development Plan (Netzentwicklungsplan)

situation today

lead szenario B 2022

szenario B 2032

Investment needed until 2022: 1.5-2b€ p.a.

Source: NEP 2012, Stand: Mai 2012, www.netzentwicklungsplan.de

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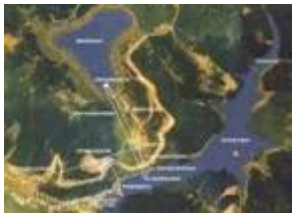
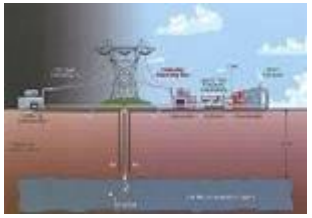
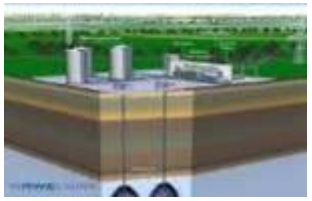
Energy storage options to integrate renewables

Pumped Hydro	Heat	Hydrogen	Batteries	Compressed Air
				
				

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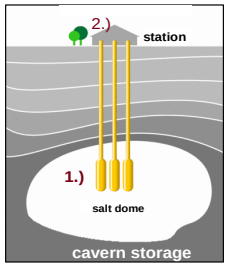
Pumped hydro storage

- Profen technology
- High efficiency
- Relatively low specific storage capacity
- Main limitation: New sites hardly possible to develop

Wind-Hydrogen

renewable electricity → electrolysis → storage (optional) → utilization



cavern

- Feed into natural gas grid
- Fuel for transportation
- Industrial feedstock
- Power Generation

Advantages:

- Option to store large amounts of energy – high storage capacity
- Different value chains for hydrogen
- Almost no site restrictions

Disadvantages:

- Core component electrolysis needs to be further developed
- For power generation the overall efficiency is weak
- Business cases are uncertain

Source: LBST

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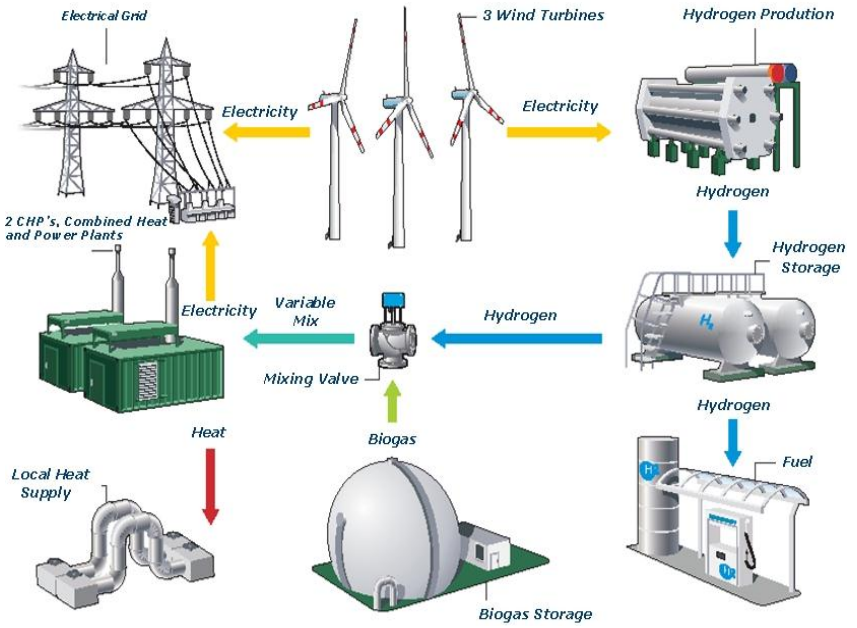
Hydrogen Storage – Hybrid Power Plant

- Enertrag, Vattenfall, Total and Deutsche Bahn are opearting a wind-hydrogen hybrid power plant
- Wind farm with direct coupling to electrolyzer
- Hydrogen storage
- Utilization of hydrogen in small scale CHP and for external use
- In operation since Nov 2011



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Batteries stationary

2 x 0.5MW/3.6MWh NaS Batterie (Younicos)

Options

- Local applications
- Avoiding of grid congestions
- Peak load shaving
- Avoiding of investments
- Offering of grid service (voltage stabilisation etc.)

Applications in the area of grid optimisation and smart grids

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Electric Mobility
- Hydrogen / Fuel Cells and Battery EVs

Refueling infrastructure: Vattenfall builds largest European hydrogen station in Hamburg HafenCity

Hydrogen

- Lighthouse project of the Clean Energy Partnership consortium - broad initiative of the industry to develop the market entry of hydrogen / fuel cell, supported by the German government
- Production and delivery of hydrogen to busses and vehicles
- Start of operation February 2012
- On site production of hydrogen with electrolysis (50%) 520 kg hydrogen per day
- From 2012
  - Hamburger Hochbahn will extend the Daimler fuel cell bus fleet (7 busses until 2013 with ramp up after 2013)
  - Daimler will deliver up to 500 fuel cell vehicles until 2015

"H_2 Mobility" Initiative – Overcoming the Chicken and Egg Dilemma

- Memorandum of Understanding for "H_2-Mobility" signed Sept. 10th 2009 in Berlin
- Ten key stakeholders from industries (OEM, oil, utility & industrial gas) and NOW as public-private-partnership
- Intention to build up hydrogen fueling infrastructure and establishing Germany as lead market

DAIMLER EnBW THE LINDE GROUP AIR LIQUIDE NOW Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie OMV AIR PRODUCTS TOTAL eni VATTENFALL

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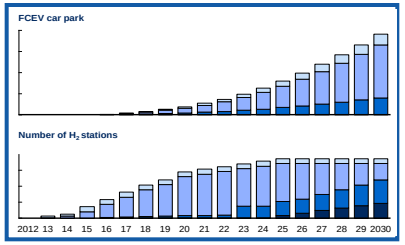
Main achievements and selected end products for pilot market Germany

Hydrogen

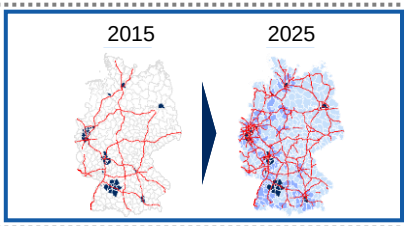
Roll-out scenarios for H_2 station network and FCEVs

- Development of **FCEV roll-out** scenarios with car OEMs via "clean team" based on assumptions (e.g., incentives, market environment)
- Assessment of **H_2 station rollout** and network requirements (e.g., density, sizes)



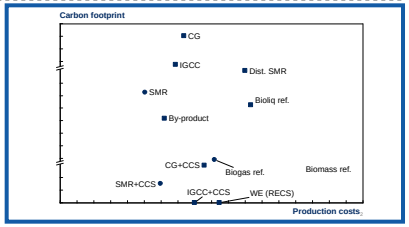
Roll out regions and timing

- Analyses of German **regions** on traffic density, income per capita, car registrations, etc.
- Definition of **"focus regions"** and connecting highways



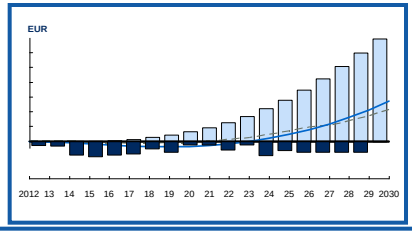
H_2 production and supply road map

- Assessment of **H_2 production technologies** on cost and CO_2 emissions (water electrolysis, steam methane reforming, etc.)
- Definition of H_2 **production and supply mixes** focusing on CO_2 abatement, sustainability, and economic efficiency



Holistic roll-out cases

- Description of consistent **rollout case** for Germany
- **Financial assessment** of roll-out cases including NPV, investment, payback time
- Evaluation of **risks** and **sensitivities**



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Vattenfall's E-Mobility expertise from various projects

Battery

Joint Venture
Vattenfall/ Volvo

JV with Volvo

National Procurement Initiative

National Procurement Initiative Sweden

Set up Public Charging Infrastructure

Amsterdam Tender

Proof of day2day usability of E-Mobility

Optimization of Charging Concept and Infrastructure

MINI E Berlin V. 1.0
powered by Vattenfall

MINI E Berlin V. 2.0
powered by Vattenfall

Managed Charging 2.0

Delivery Vehicle[EMKEP]

Integration of E-Mobility in Public Transportation Concepts**

Pilot Region Berlin

BeMobility

Pilot Region Hamburg

hh=more
hamburg modell region elektromobilität

*) Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)

**) Federal Ministry of Transport, Building and Urban Development (BMVBS)

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Current offerings: www.vattenfall.de/emobility

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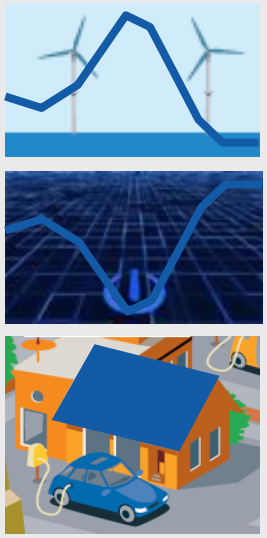
Vattenfall offers integrated solutions for E-Mobility

Charging Infrastructure

Green electricity

Managed Charging



Business Services

Customers

B2C:

- Private customers with and without dedicated parking slots

B2B:

- Automakers
- Companies with large fleets and car park operators

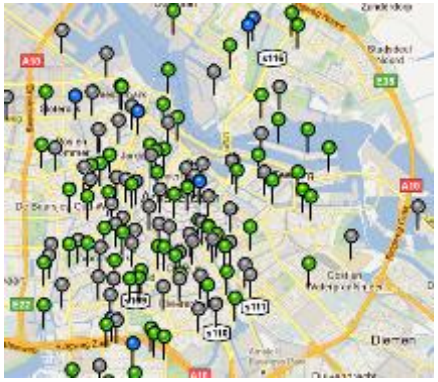
B2G:

- Public charging infrastructure
- Governmental fleets

A charging infrastructure is implemented in three urban core markets of Vattenfall

infrastructure implemented

- Amsterdam
- Berlin
- Hamburg



> 250 charging points in Amsterdam > 80 charging points in Berlin > 60 charging points in Hamburg

Service package:

- Personal RFID-charging card
- Access to the Vattenfall/Nuon charging infrastructure
- Access to the charging infrastructure of further suppliers

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Conclusions

- Strongly increasing share of renewables in most European countries
- wind and solar power will play a major role -> volatile power feed in
- The present electricity supply system was not built to cope with large amounts of volatile renewables
- Different countermeasures are possible, but there is no silver bullet
- Additional power lines storage will be required to integrate more renewables in our system
- The transition is possible from a technical point of view, but electricity prices will increase

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- Electric vehicles (H2/FC and BEV) will enter the market in the coming years
- Adequate charging infrastructure build up is crucial for the success of EV market introduction
- For BEVs business models for private infrastructure (B2C, B2B) viable, but difficult for public solutions,
- business case for hydrogen refueling infrastructure exists, but not very favorable in the beginning
- Electric vehicles can supply moderate storage capacities to the grid

Thank you

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