Integration of Wind Power - A National and International Task – Danish Perspective

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Wind Integration Workshop

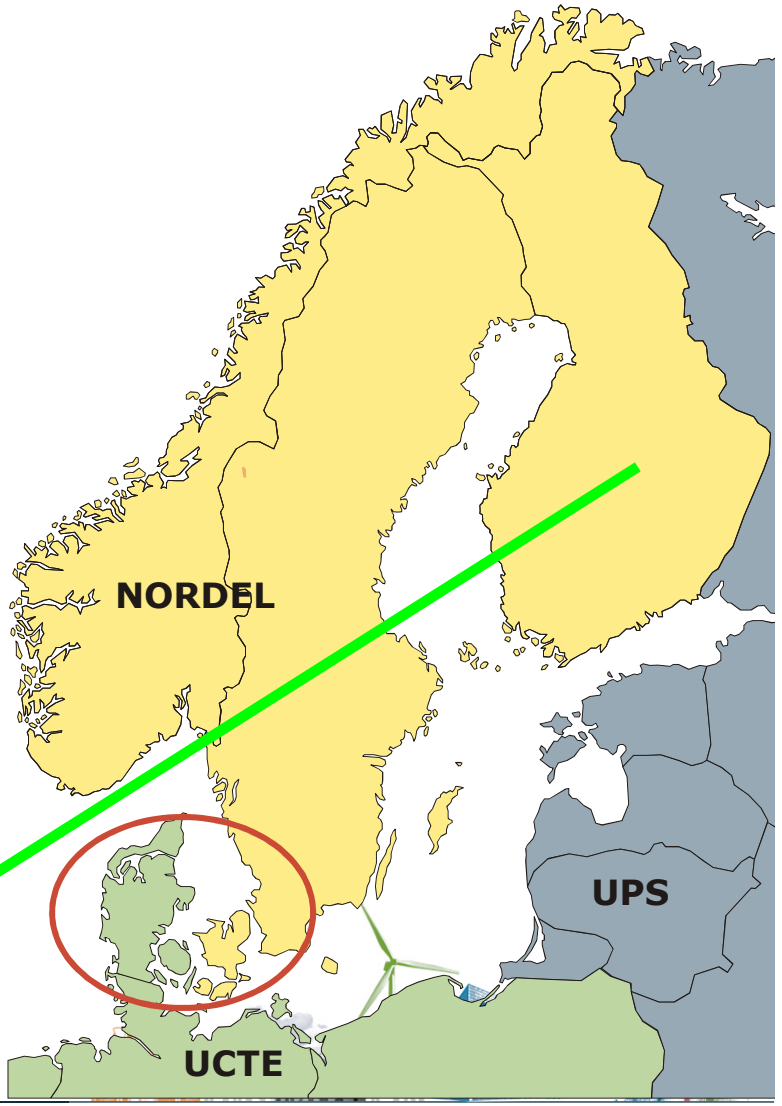
19th of October 2012, Tokyo, Japan

Agenda

1. The Danish Energy System 2012
2. <u>The National Plan:</u>
   The Danish Energy Agreement -
   Fossile-free Energy Supply 2050 & 50% Electricity from Wind 2020
3. <u>National Implementation:</u>
   Need for Grid- Adaptation and -Expansion / Linking Different Energy Sectors (Heat, Gas, Transport)
4. <u>The International Plan:</u>
   Integration of Offshore Wind Power as multinational Task
5. <u>International Implementation:</u>
   North Sea Grid – Status Quo and Outlook

Denmark – a small part of a large electricity market

- Denmark is located between a thermal- and a hydro-dominated power system. This makes Denmark a "transit-corridor".
- Energinet.dk operates Eastern – and Western Denmark independently in two different synchronous power systems (Nordic and Continental Europe).



DK: ~ 5 mio inhabitants

Power balance 2012

Two synchronous areas

West:

Consumption	1400 - 3700 MW
Primary power stations	3150 MW
Local CHP plants	2000 MW
Wind turbines	2950 MW

4950 MW

East:

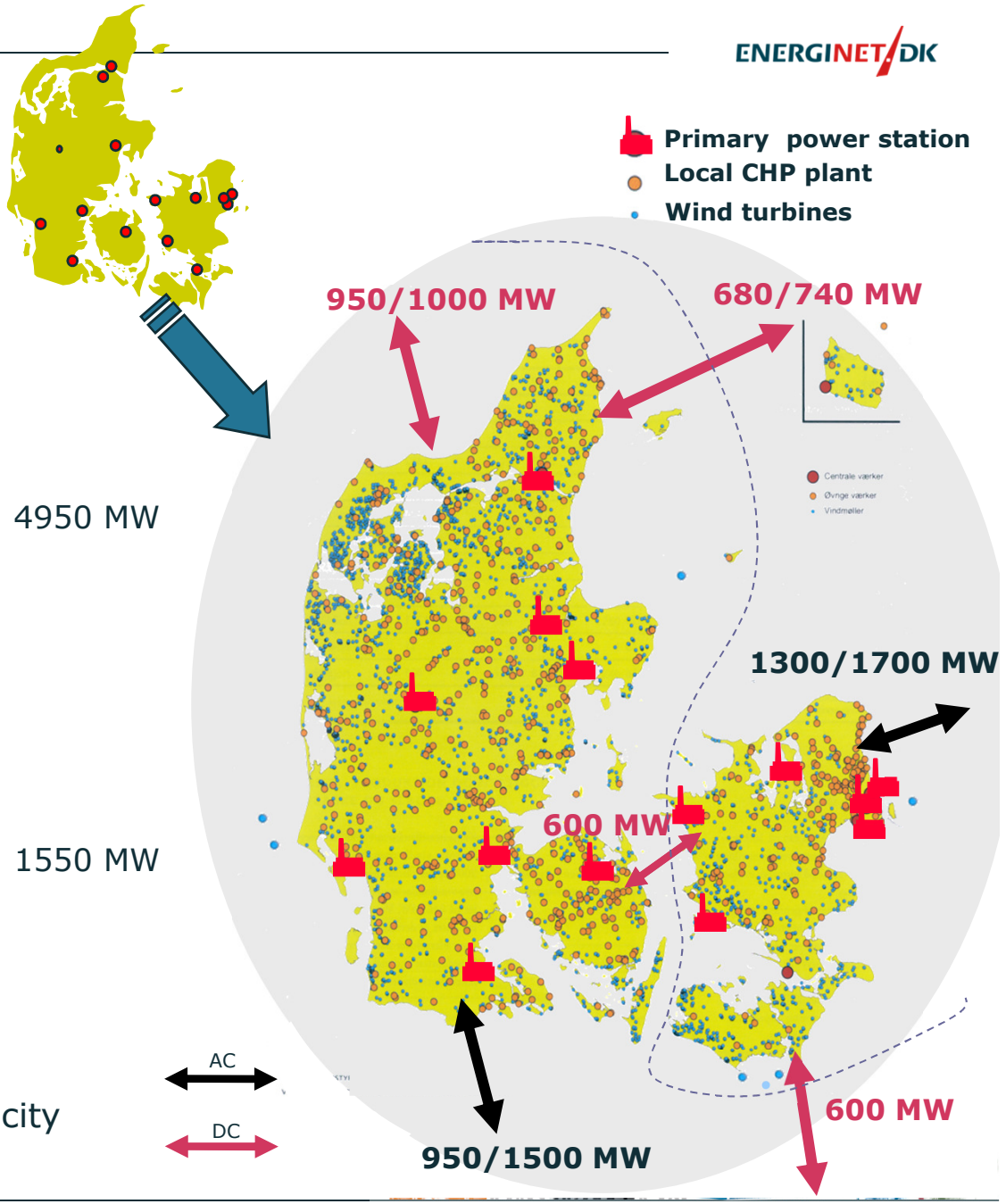
Consumption	900 - 2700 MW
Primary power stations	3100 MW
Local CHP plants	600 MW
Wind turbines	950 MW

1550 MW

Interconnections (W/E):

Import ~ 85/90 % of peak consumption

Export ~ 50/60 % of total installed capacity



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The national Plan:

The Danish Energy Agreement -
Fossile-free Energy Supply 2050 & 50% Electricity from Wind 2020

Political Targets: – More Wind Power in Denmark

2020

35 % Renewables in the energy system (el + heat)

50 % of conv. electricity consumption from wind energy

=> **+ 2000 MW** new Wind Power Capacity:

(offshore + 1000 MW; near shore + 500 MW; onshore + 500 MW

12 % Reduction of gross energy consumption (vs. 2006)

Shift from coal to Biomass in central power stations

2035

100 % renewables in electricity and heating systems

2050

100 % of energy supply covered by Renewables

= (electricity, heating, industry and transport)

March 2012: supported by 171/175 MPs

Wind Energy Coverage = 50%: => Wind Capacity ~ Danish Peak Load! ~ 2,5 x min Load

⇒ Increase from 28% (2011) within 9 years /

⇒ Increase RES share of consumption from 39% to 78%

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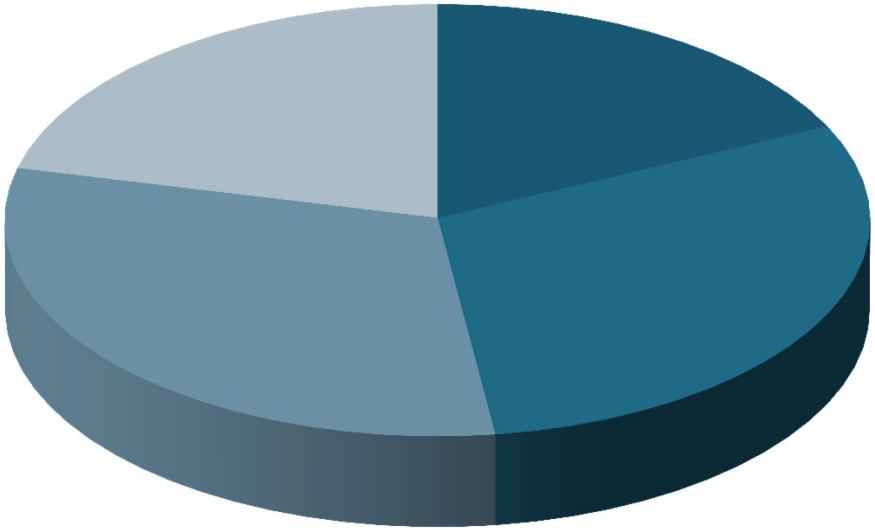
National Implementation:

Need for Grid- Adaptation and -Expansion / Linking Different Energy Sectors (Heat, Gas, Transport)

2010..2020 expected investments in new transmission assets ~3 b€



Excluding 0.8 b€ for the purchase of the regional transmission companies (132+150 kV)

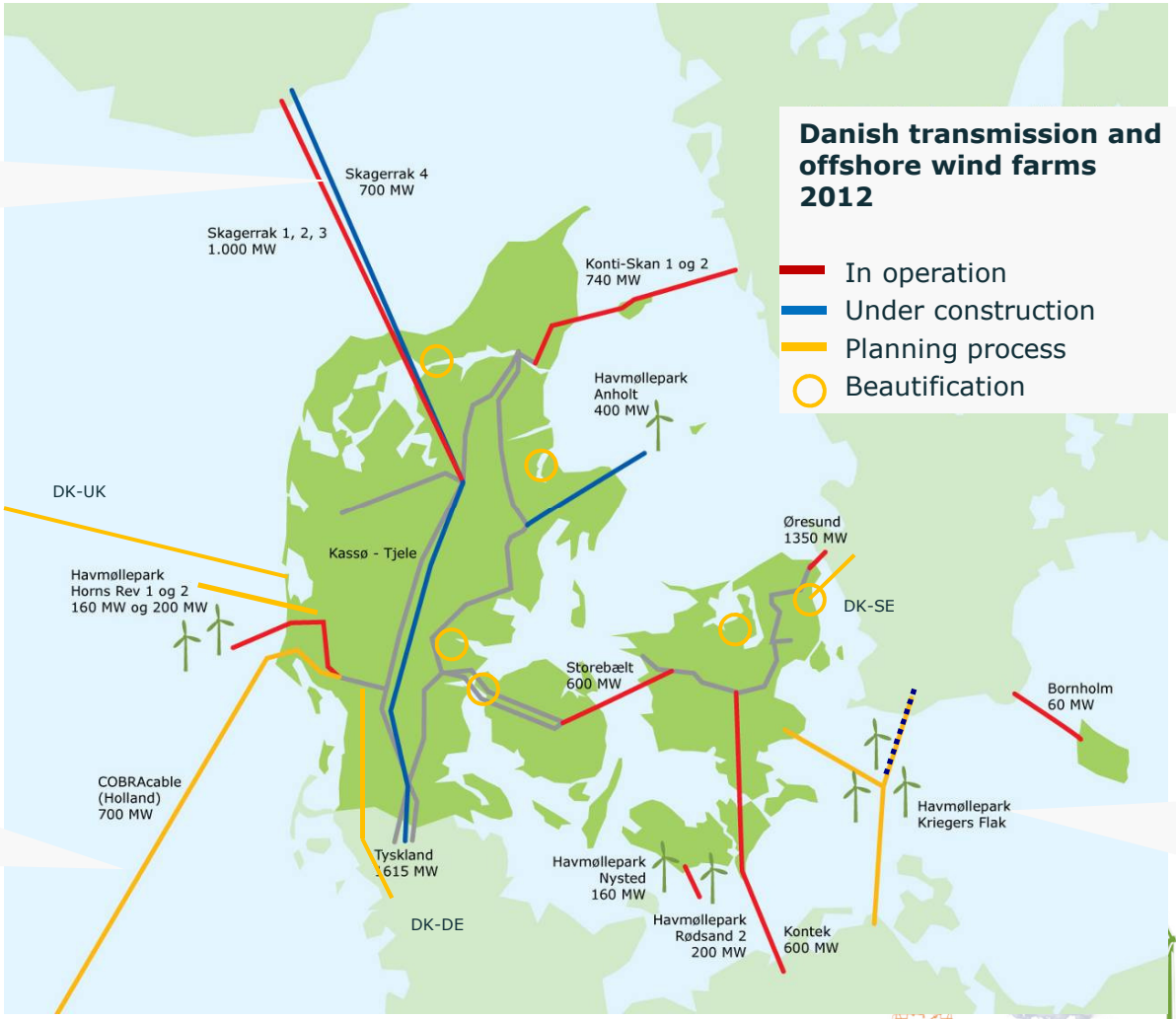
Interconnectors – planned and upcoming projects

Skagerrak 4

700 MW - HVDC

NO-DK1

HVDC - VSC



COBRA

700 MW - VSC

NL-DK1

EC co-funding

Kriegers Flak

600 MW Wind farm offshore

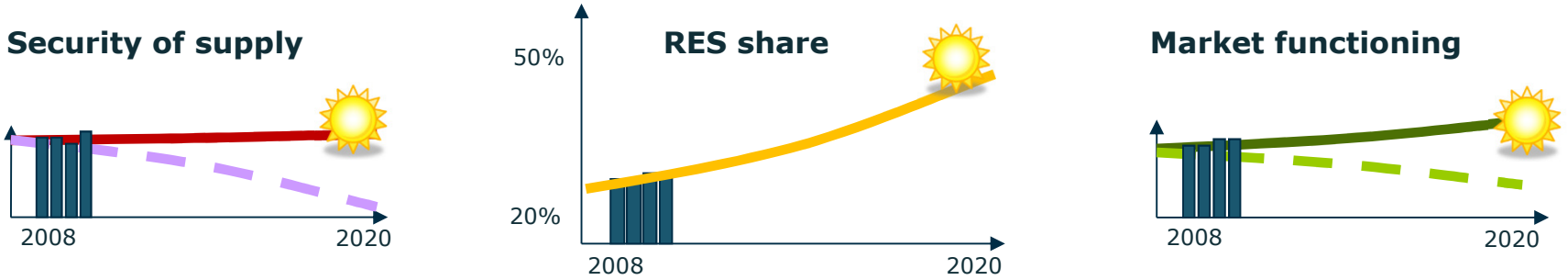
600 MW – HVDC

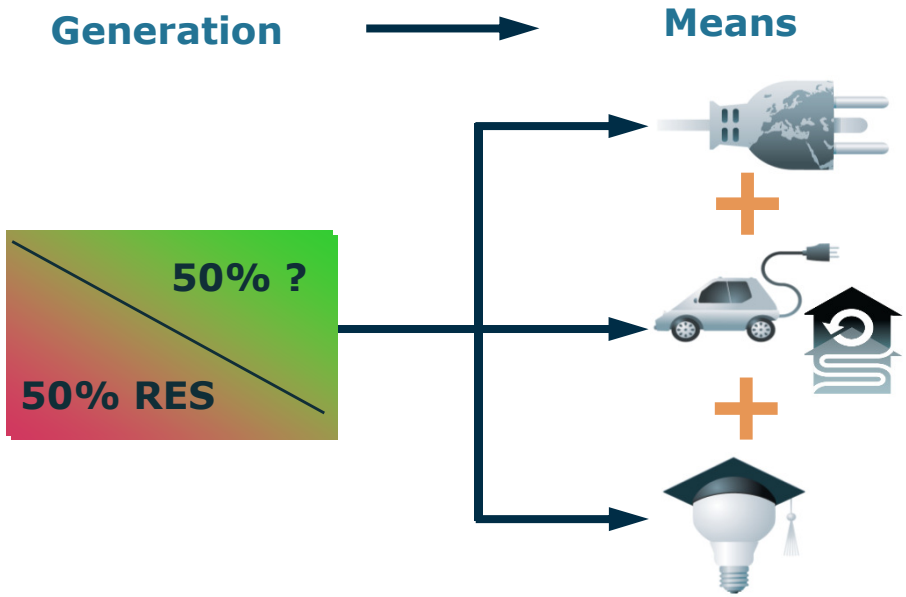
HVDC - VSC

DE-DK2

EC co-funding

Strategy for the development of the electricity system





Robust transmission grids,
Strong interconnections
International markets

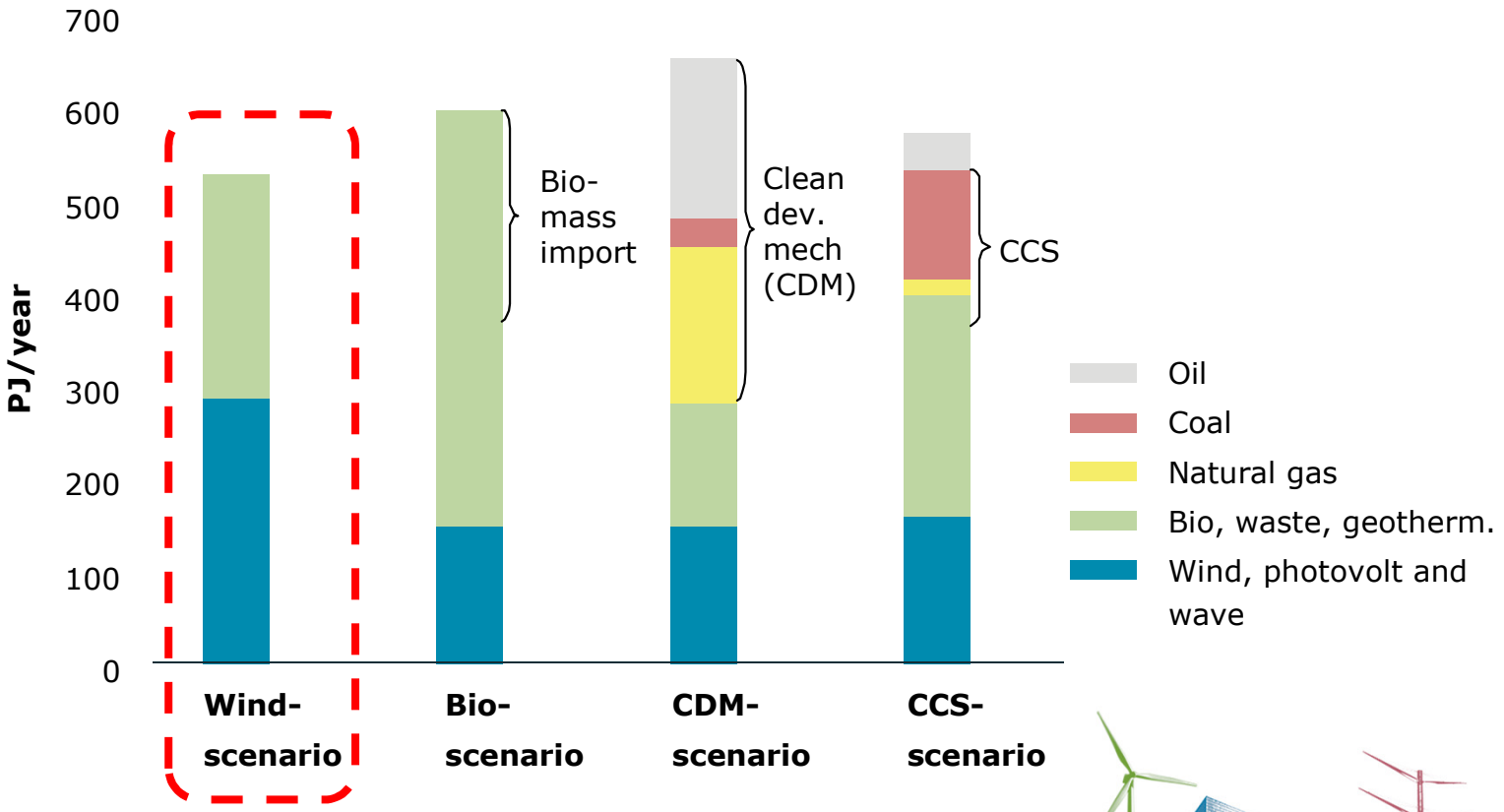
Flexibility in demand and generation – cooperation with heat/ cooling, transportation and gas sectors

Smart Grids for efficient, market based control of the system

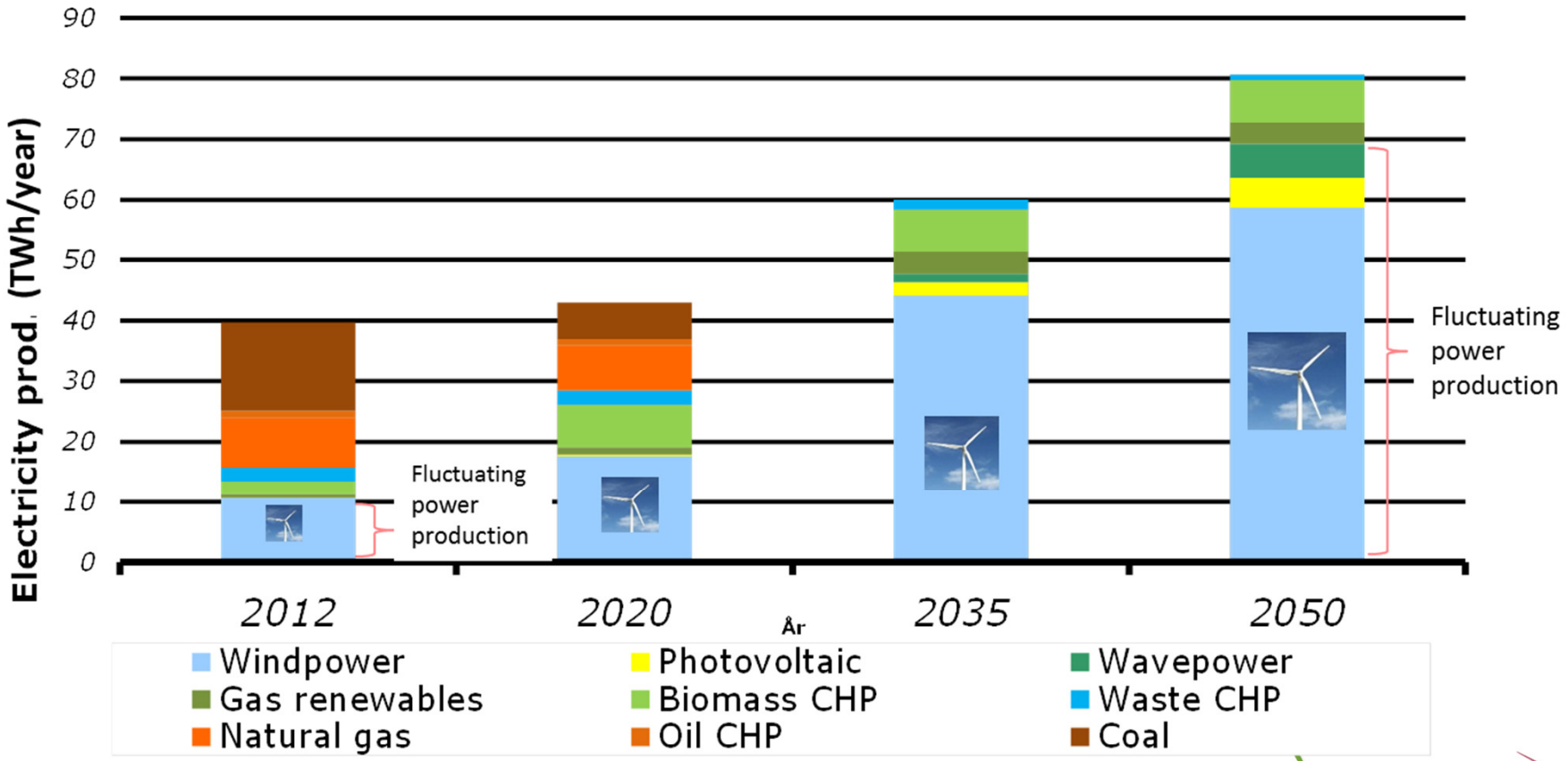
Analysed scenarios for energy system

2011
(% of consumption):

- Wind: 28%
- Biomass: 11%
- Conv: 56%
- Losses: 4%

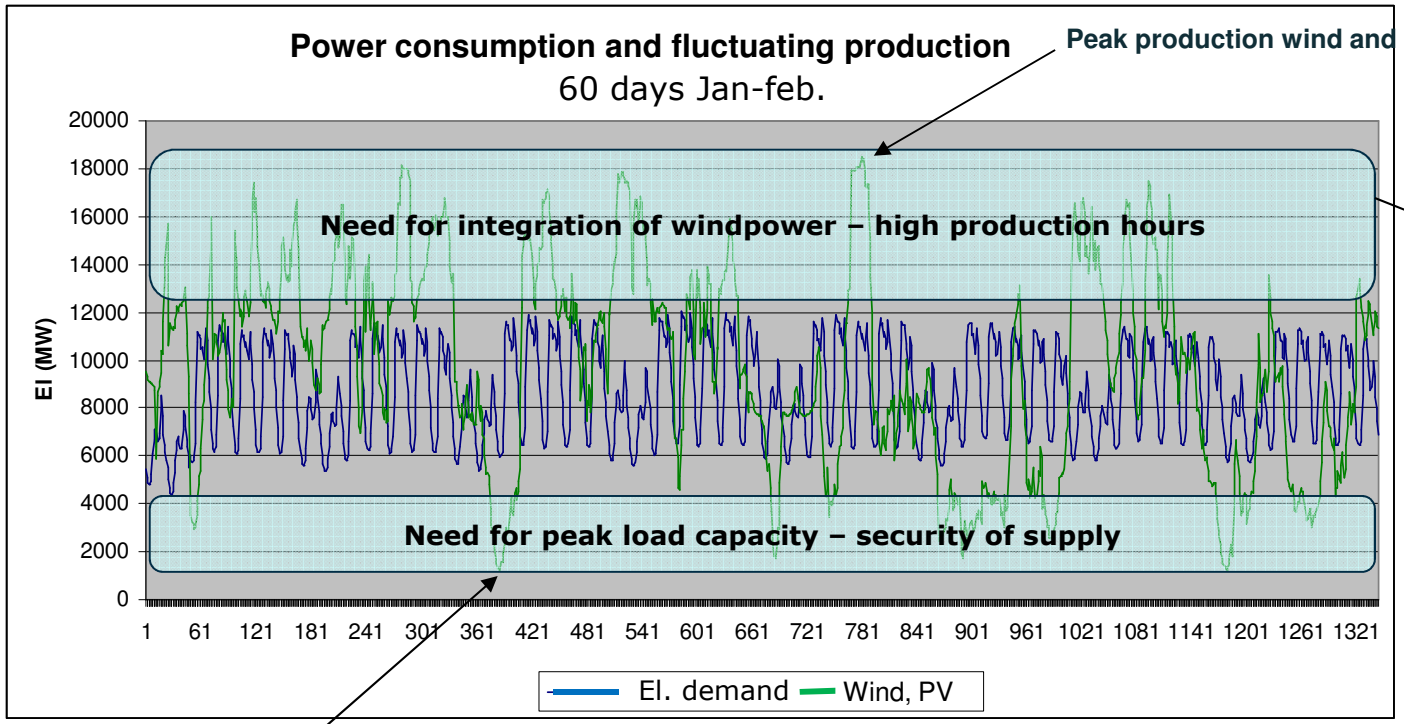


Electricity production in windpower scenario



Power system balance 2050 Windscenario

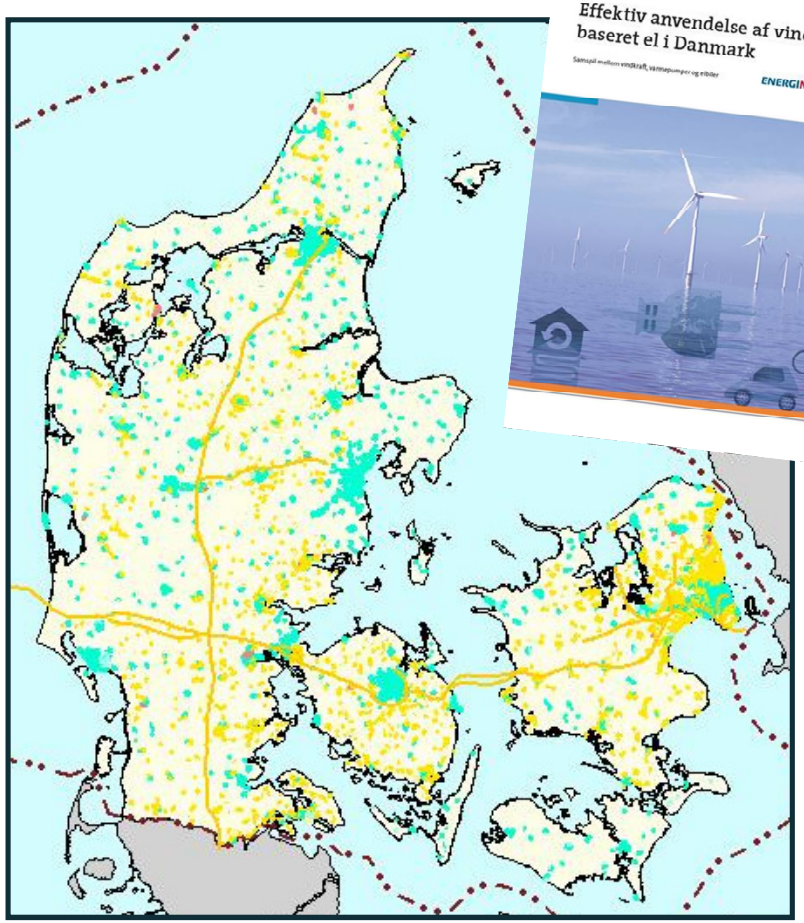
Need for integration of biomass in a volatile power system



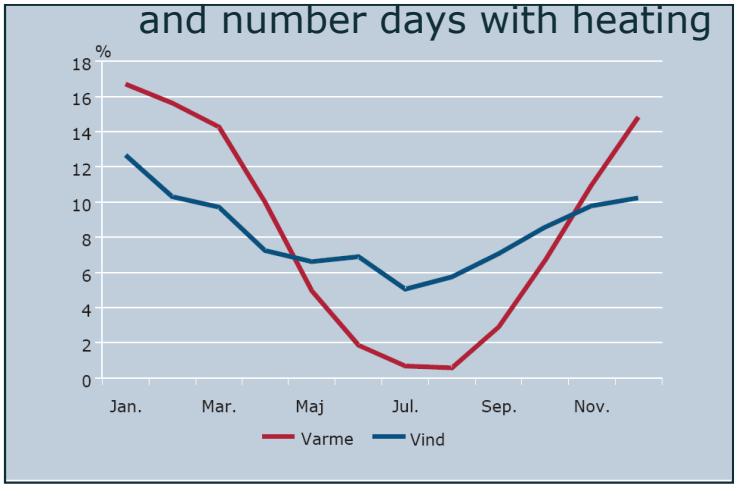
Need for fuels for non electrified services

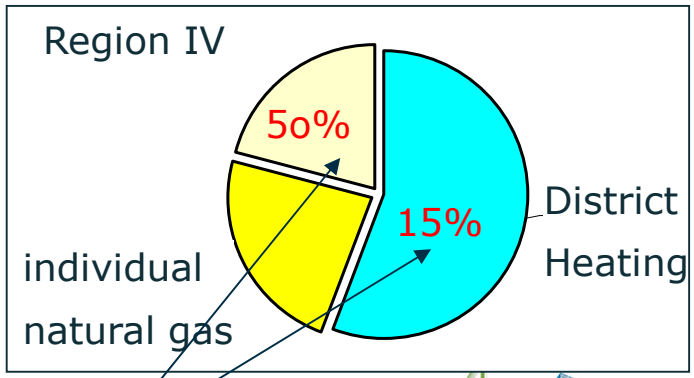
Low production wind, photovoltage, wave

Heating in Denmark … Increase use of Heat pumps!



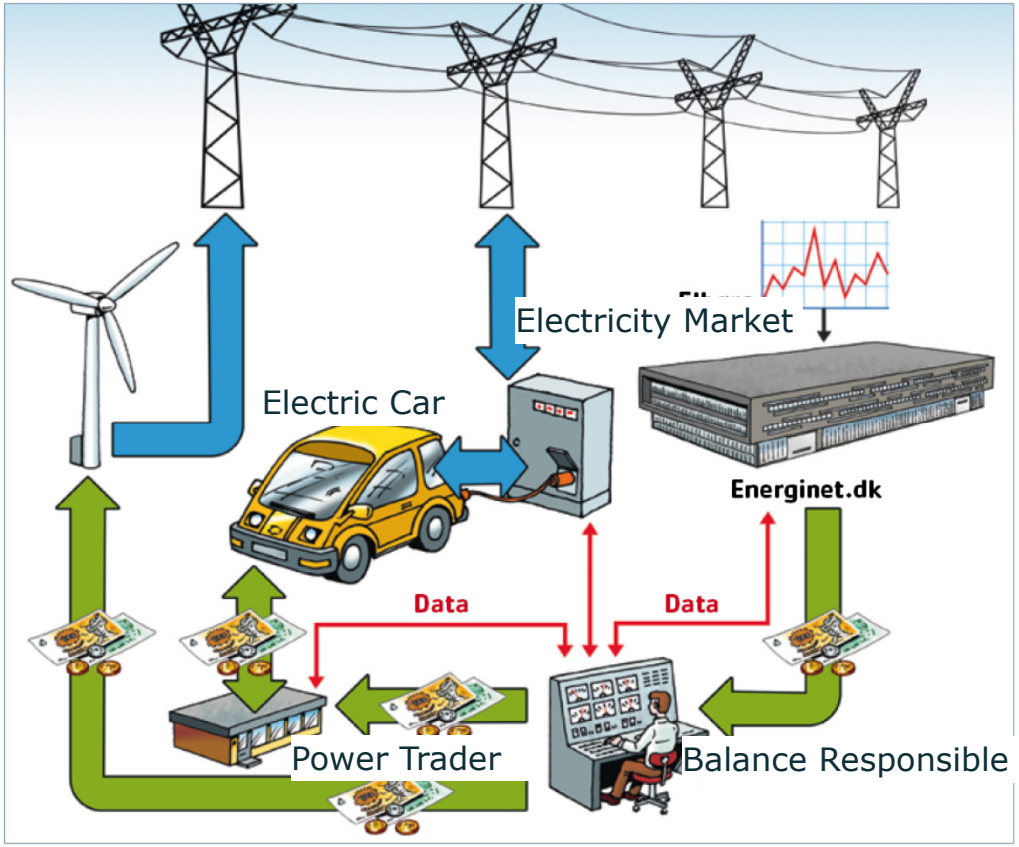
10-years annual vind production and number days with heating





assumed share of heat pumps

Integrating Transportation into the Market…



…is also an issue of data-management

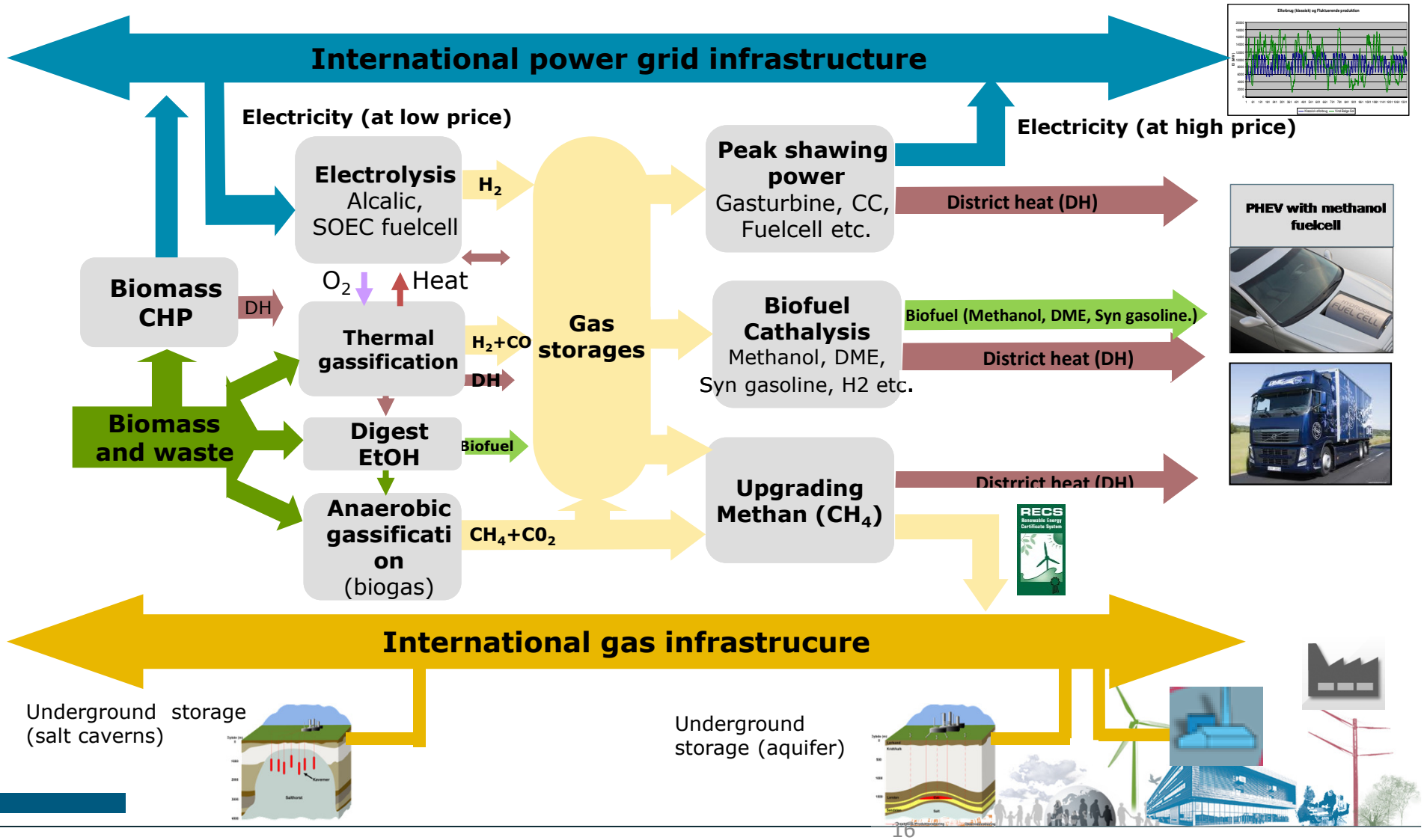
=> Development of a DATA HUB

Assumptions:

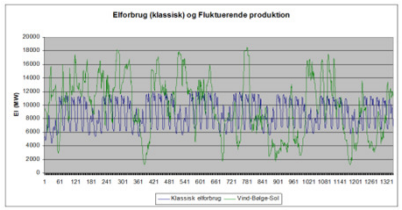
15% of Transport by electric cars

=> 25% indiv. cars & 15% of good-transport/ busses

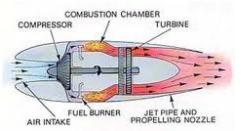
Integration of electricity, gas and heat systems



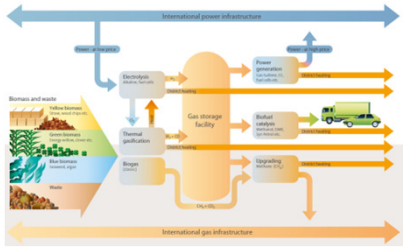
Conclusions Part 2 & 3



- In order to reach the target, the means are:
  - strong grid + interconnectors, functioning markets,
  - increase of flexibility in the system by integrating heat / transport/ gas sector
  - promotion of smart grid solutions



- Integration of gas sector contributes to <u>flexible</u> integration of variable electricity (wind, solar) with biomass and waste:
- RE-gas is very suited for
  - <u>peak load electricity capacity</u> and purposes not suited for electrical supply (transport, process heat, fuel cells etc.),
  - RE-gas can be integrated with liquid fuel production (methanol etc)



- The <u>gas system</u> can serve as a very flexible and adaptable storage of hydrocarbons and as a system integrator

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The International Plan:

Integration of Offshore Wind Power as multinational Task

North Sea Countries' Offshore Grid Initiative (NSCOGI)

Governments

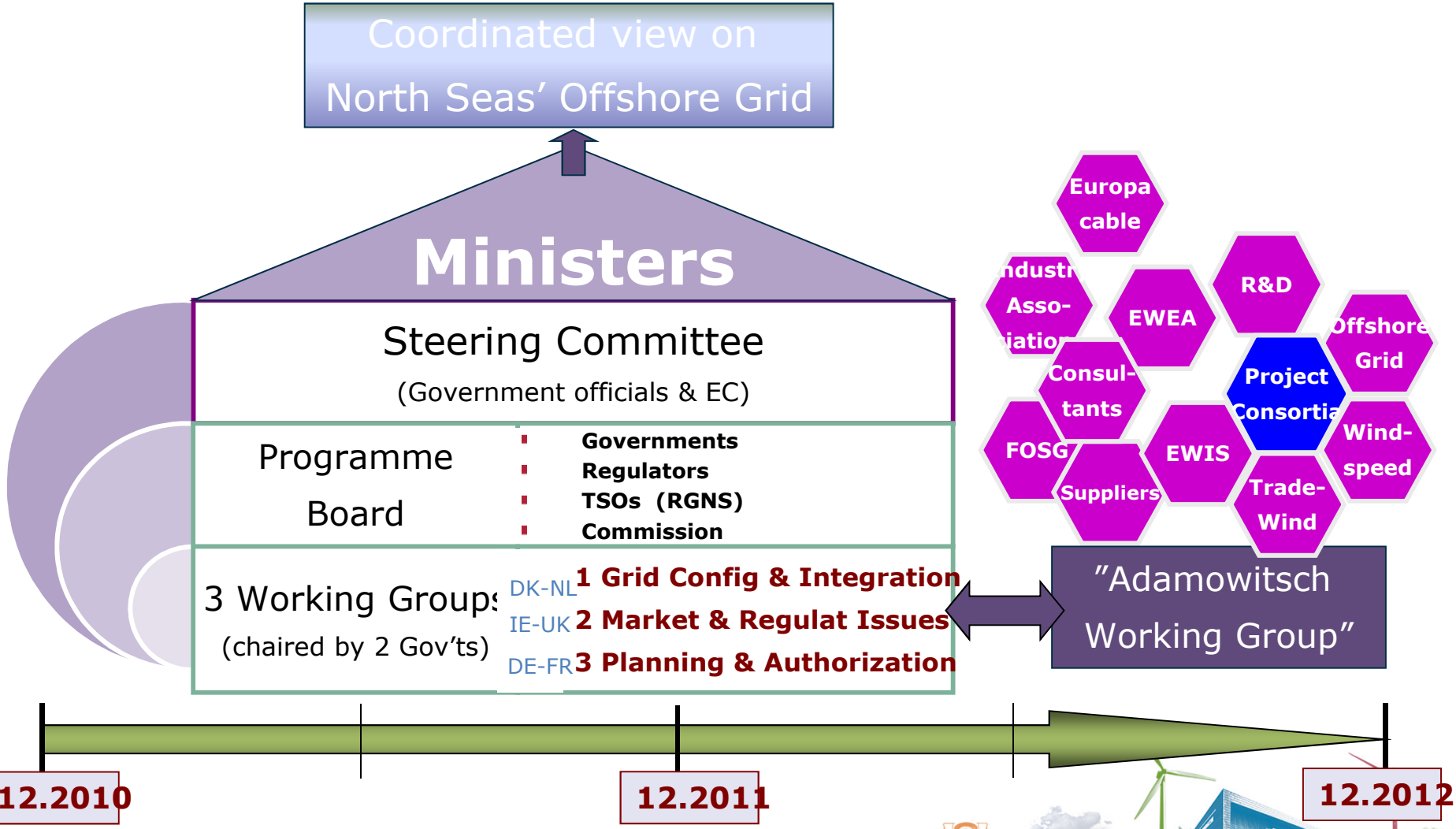
Regulators

TSOs

Industry

Signing the MoU, December 2010

NSCOGI: Reporting Structure



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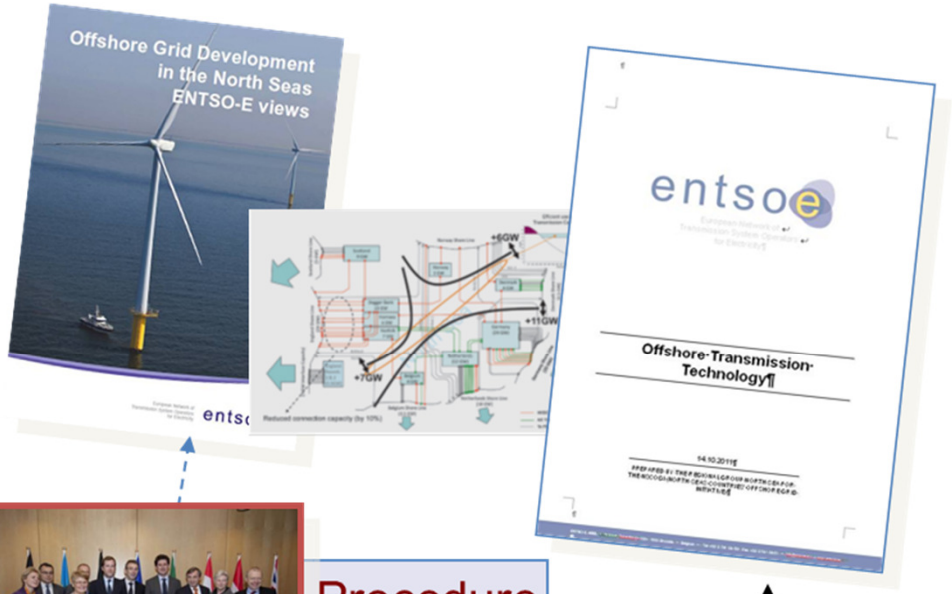
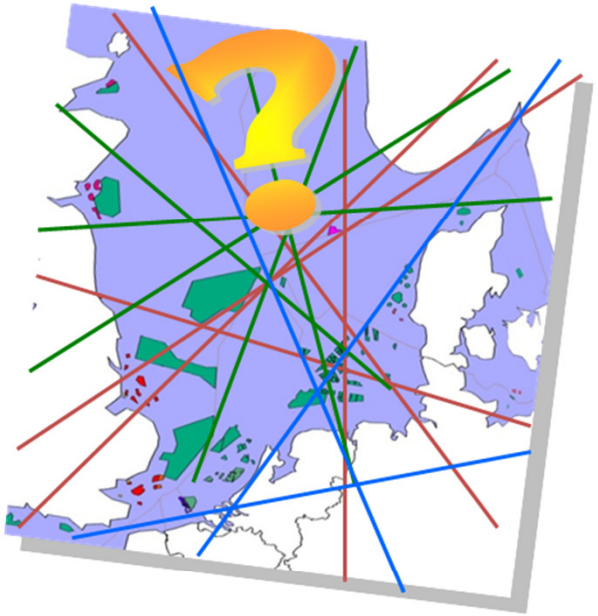
International Implementation:

North Sea Grid – Status Quo and Outlook

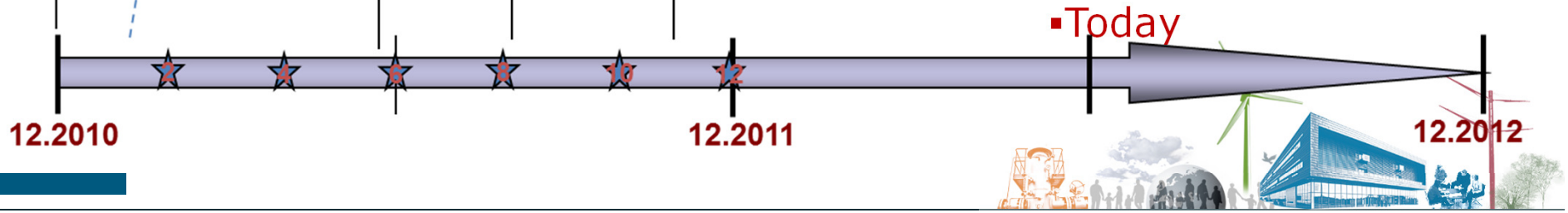
Some Results (WG1)



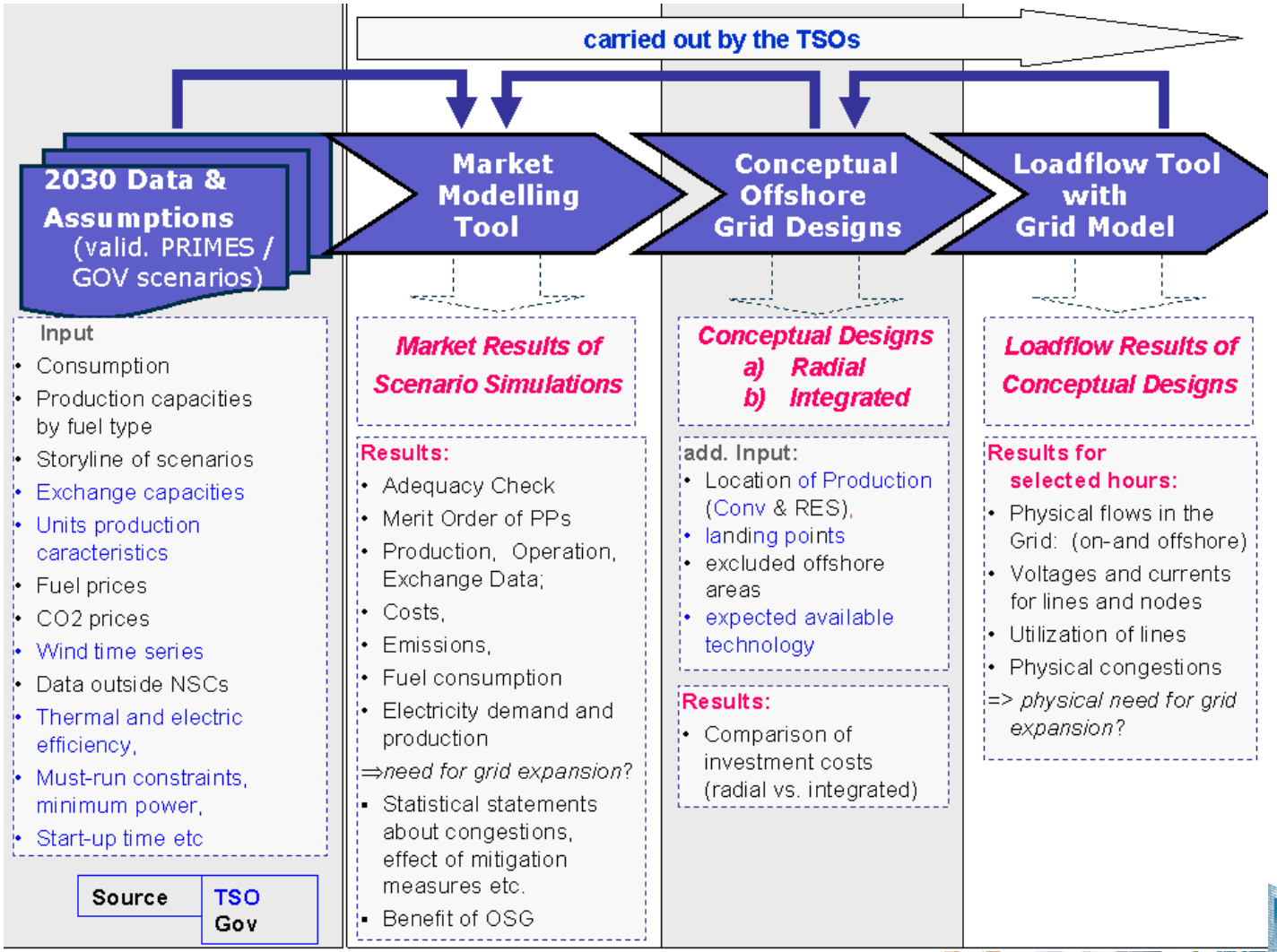


Procedure EC data

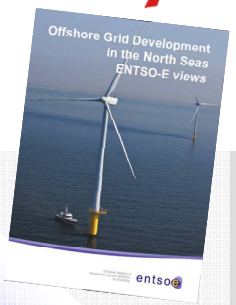
Datacheck with govs, MM Results

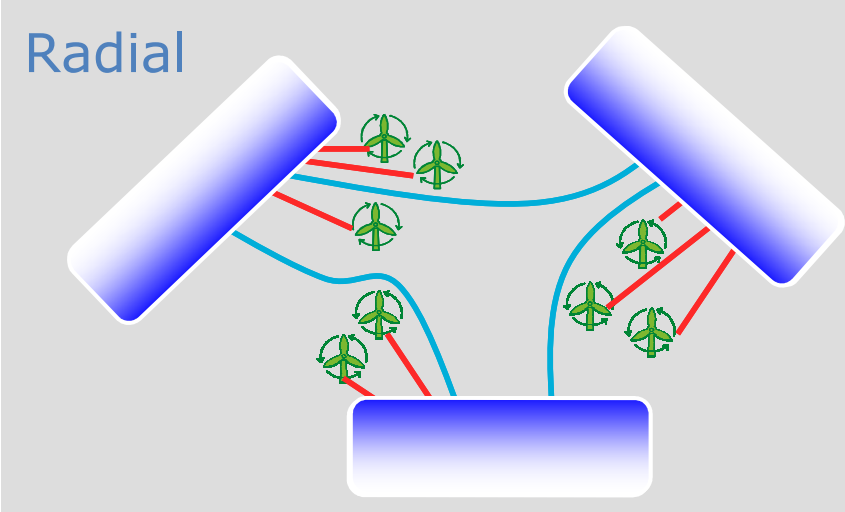


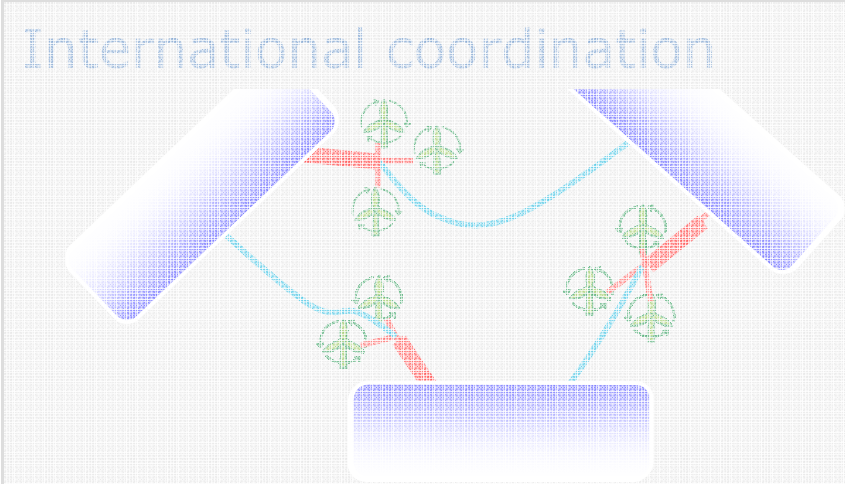
Procedure: Grid Configuration

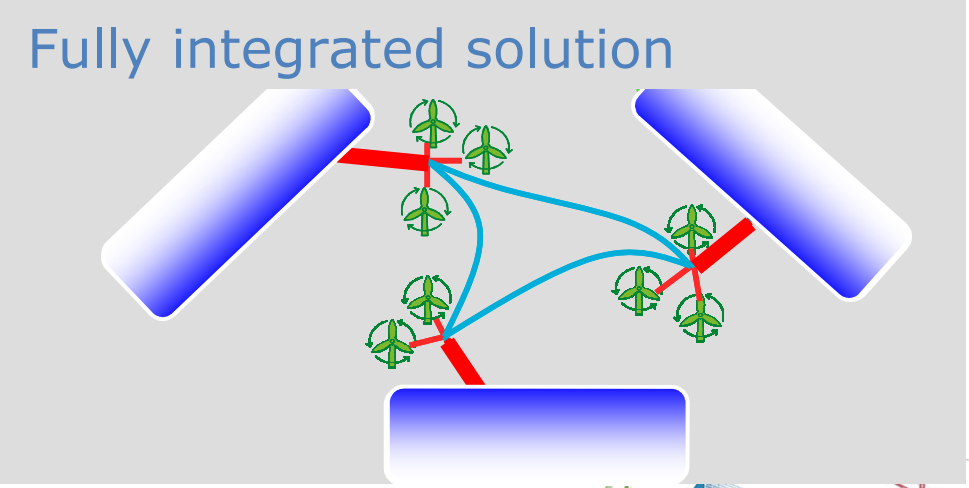


New Technology and stepwise Development







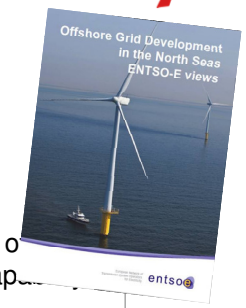


This development and the information from the ”Technology Report” is used for the development of designs

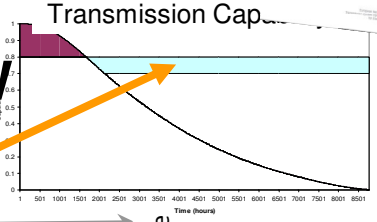
Results of Preliminary Study Feb 2011: Optimised Integrated Offshore Grid Development

ENERGINET.DK

Scope of the **preliminary** outlook from 02/2011: Central North Sea: (**simplified** by leaving out: Ireland & France)



Efficient use o
Transmission Cap



Norway Shore Line

+6GW

Scotland Shore L (5 GW)

Scotland 9 GW

Norway 1 GW

SK1-3

SK4

Denmark 4 GW

Denmark Shore Line (3.5 GW)

Dogger Bank 13 GW

Hornsea 4 GW

Norfolk 7 GW

England Shore Line (24 GW)

+11GW

Germany 24 GW

Netherlands 12 GW

Germany Shore Line (20 GW)

(7 GW Interface Capacity)

Englan d Rounds 1 & 2 (6GW)

+7GW

Belgium 4 GW

Reduced connection capacity (10%)

Belgium Shore Line (3.5 GW)

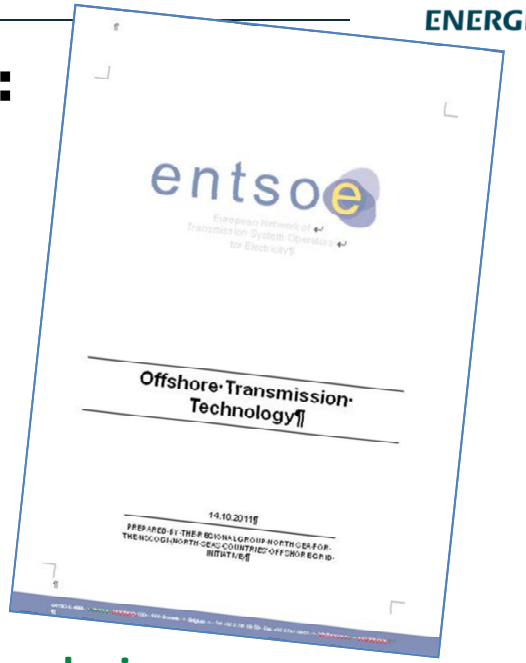
Netherlands Shore Line (10 GW)

HVDC Transmission

AC Transmission

'In Flight' or current

Input for Technical Data / Prices: HVDC Technology Report



Technology

- HVDC
- Cable
- Offshore Platforms

HVDC Projects

Costing Information

- HVDC
- HV Plant
- Cable Systems
- Connecting to AC Land Systems
- Offshore Platforms
- Subsea Cable Installation

Some Conclusions:

Supply chain constraints; limited:

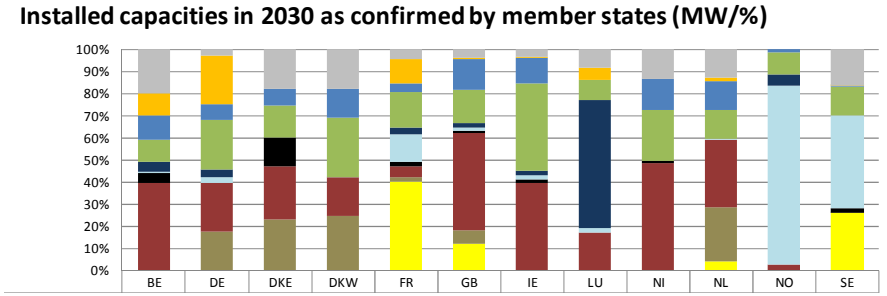
- Factories,
- Installation Vessels
- HR for maintenance and Repair

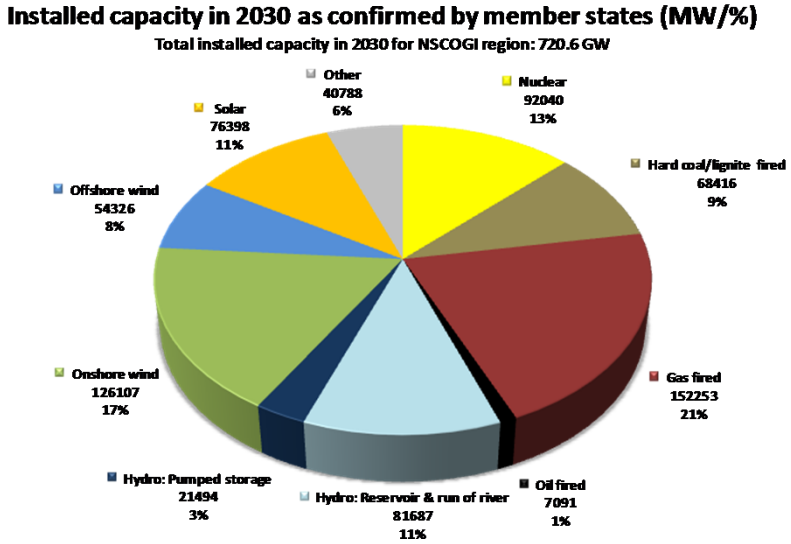
=> Suppliers need clear marked signals to increase ressources!

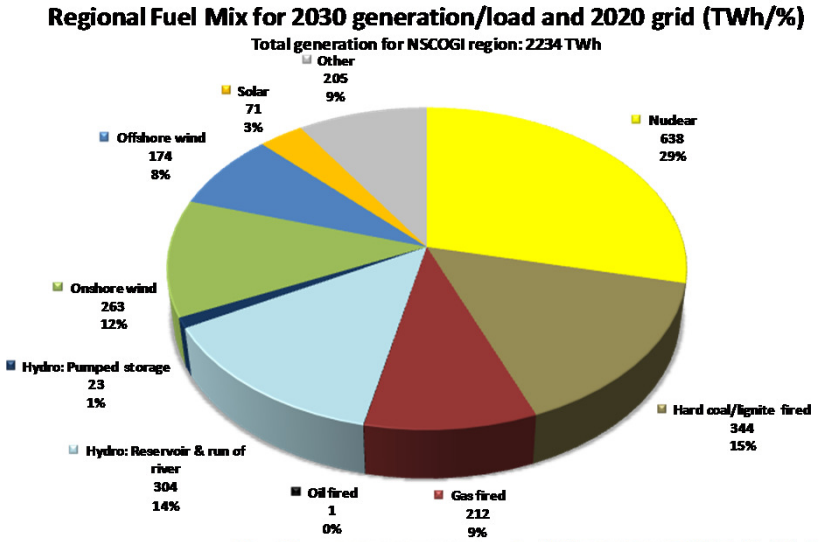
https://www.entsoe.eu/fileadmin/user_upload/_library/publications/entsoe/SDC/European_offshore_grid_-_Offshore_Technology_-_FINALversion.pdf

2030 Data and Assumptions – Reference Scenario

- Provided by 10 governments
- Demand projections per country
- Installed capacities by type per country
- Locations of new generation facilities including offshore wind parks
- High variety in fuel mixes between countries







Status

- Study provides a baseline for the most economic elements of an offshore grid, based on governmental data.
- Initial results indicate a tendency to meshed grid design in some areas,
  - costs: radial > meshed;
  - Meshed provides future flexibility and optimizing opportunities, but more complicated,
  - both need onshore reinforcement;
  - Interactions between mixed HVAC/HVDC systems to be analysed
- results are sensitive to:
  - input parameters (scenarios, investment candidates, technology…) → impacts network topology
  - policy parameters (priority access policy, curtailment/penalty costs) → impacts network scale
- results are still being challenged and undergoing sanity check

Conclusions Part 4 & 5

- A **longer term international coordinated plan** is the only way to deliver benefits related to the integration of large international offshore wind generation;
  => NSCOGI = efficient forum.
- Preliminary investigations have shown:
  - **potential for responsible use of natural and manufactural resources,**
  - **cost saving potential,**
  - **Improvement of SoS,**

- Although, the meshed solution is expected to be more complex than classical solutions

Thank you!