CITIES 29.1.2014
Utilities, Data and Intelligent Energy Systems

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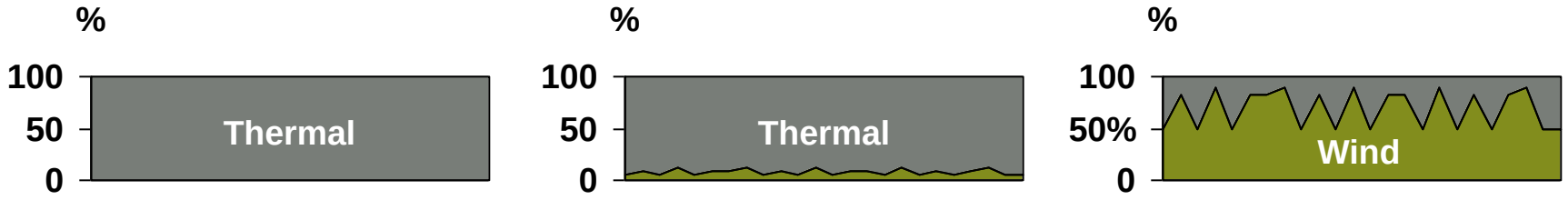
The Danish energy sector is on a journey towards a reliable, sustainable energy system rooted in an international market

Oil Coal Gas Biomass

Paradigm changes in the Danish energy system…

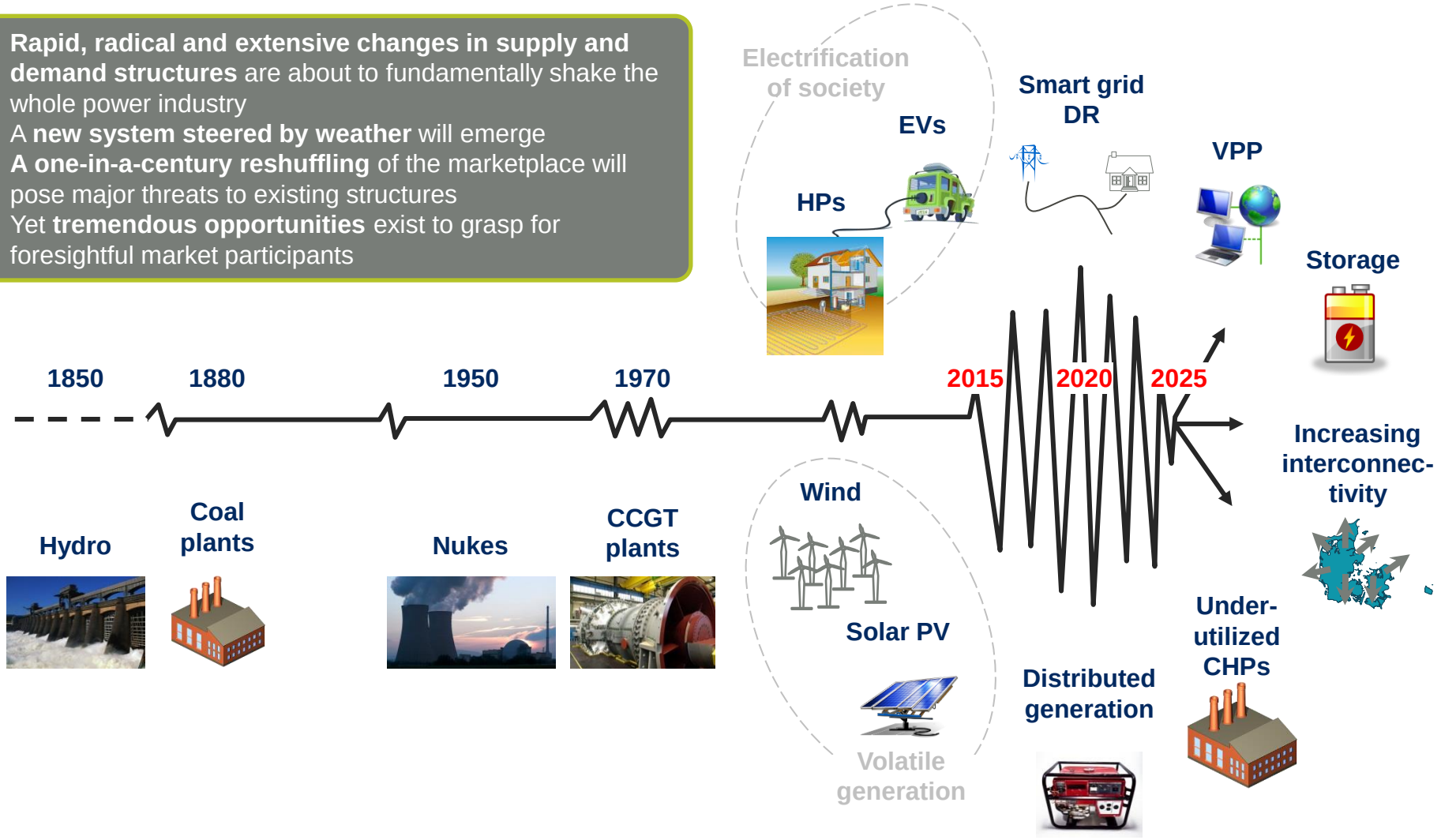
1970s	1980s	1990s	2000s	2010s
From oil to coal	**CHP champion**	**Wind power**	**Liberalization**	**Green & flexible**
• Oil fired plants • Oil crisis • Retrofit for coal	• State-of-the-art CHP • Gas network • Climate change starts to gain attention	• Wind power grows • From single turbines to wind farms • Interconnectors	• New market framework • Sector on commercial terms • Large scale offshore wind	• World leader in offshore wind • High share of green energy • Integration via flexibility • Smart energy

…cause changes in the underlying structure of the energy system



Flexibility services will have an increasing role in responding to the paradigm shift in the energy system

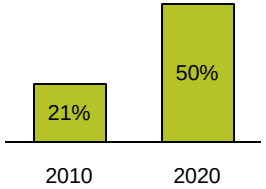
- **Rapid, radical and extensive changes in supply and demand structures** are about to fundamentally shake the whole power industry
- A **new system steered by weather** will emerge
- **A one-in-a-century reshuffling** of the marketplace will pose major threats to existing structures
- Yet **tremendous opportunities** exist to grasp for foresightful market participants



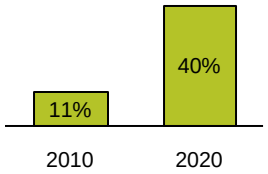
Government objectives put the Danish energy system under pressure for change…

Government targets are driving this process…

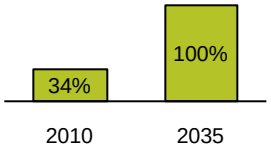
% Wind penetration relativ to demand



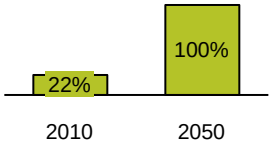
CO2 emission reduction relative to 1990



% RE in electricity and heating**



% RE in all sectors



Source: Danish Ministry of Climate, Energy and Building, Group Regulatory Affairs

Increasing proportion of intermittent power (wind)

Increasing proportion of new loads and local generation

… which has extensive impact on the energy value chain

Production

- Significant extension of wind and biomass to provide RE power
- Heat constrained operation on CHPs cause surplus power production

Transmission

- Need for increased interconnector capacity and enhancement of the transmission net
- Pressure to store RE within heating, cooling and the gas transmission.

Distribution

- Pressure on distribution net capacity and ability to integrate wind, local PV production and new loads

Consumption

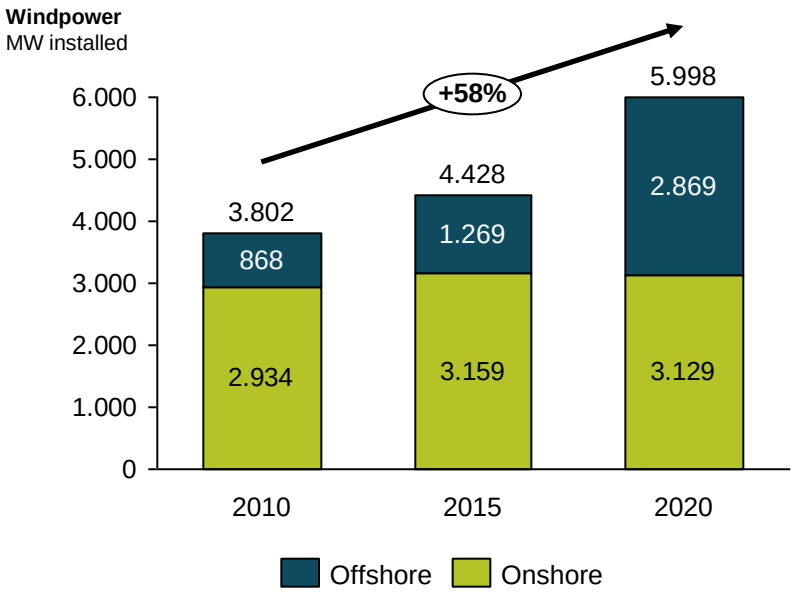
- Increase in “green" and efficient customer solutions
- Power based energy consumption
- Deployment of distributed generation

** Note: 11,4% refers to non-adjusted data. If the data is adjusted for the low emissions in 1990 due to large hydro reserve in the Nordics, the reduction is 23,8%. While the Kyoto target refer to non-adjusted data, it remains unclear what the Government target refers to.*

*** Note: No coal for power production, neither oil burners for heating in 2030*

The 50% wind integration challenge in 2020 is unprecedented in history!

Projected volumes of wind power in the energy system

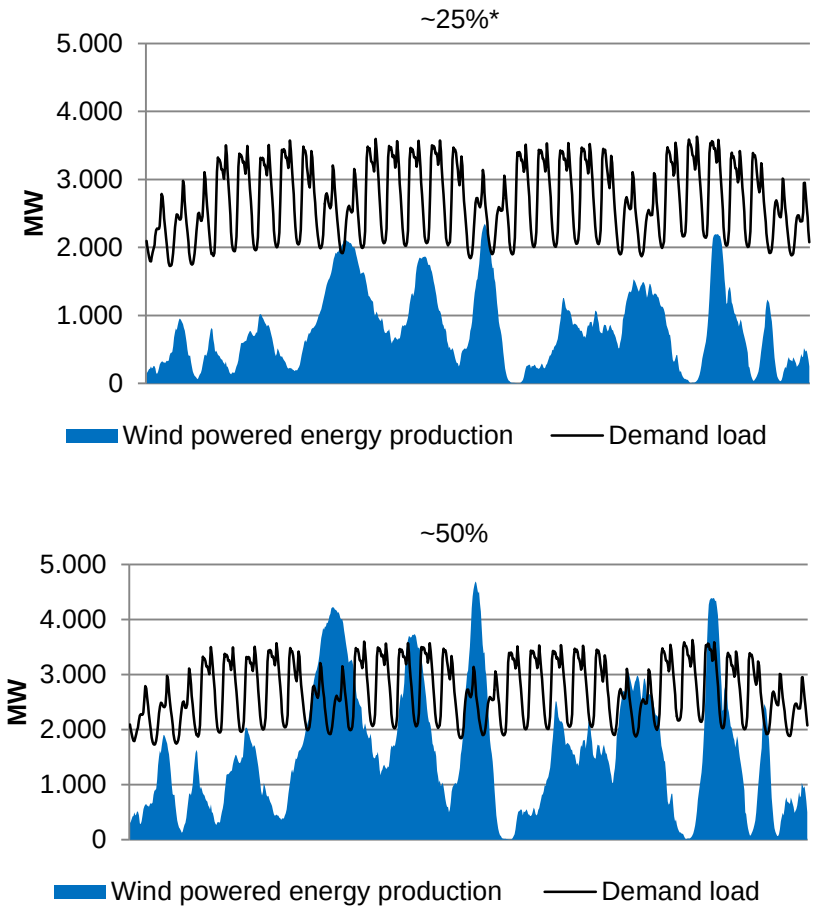


Note: distribution between onshore and offshore can vary

Key integration questions are…

- How do we store excess amounts of RE power?
- What will be our back-up power production during low or no wind?
- How do we handle the ramping from RE power production and new loads?
- How de we secure strong and reliable power grids?

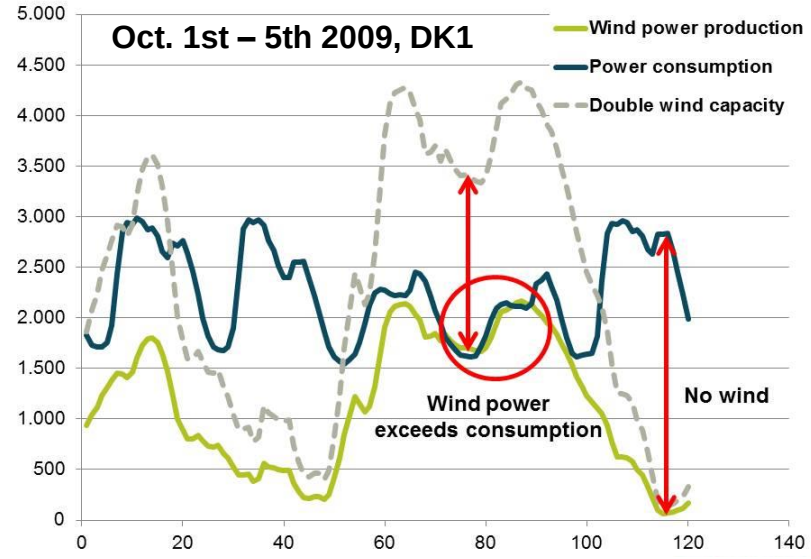
Potential impact for balancing

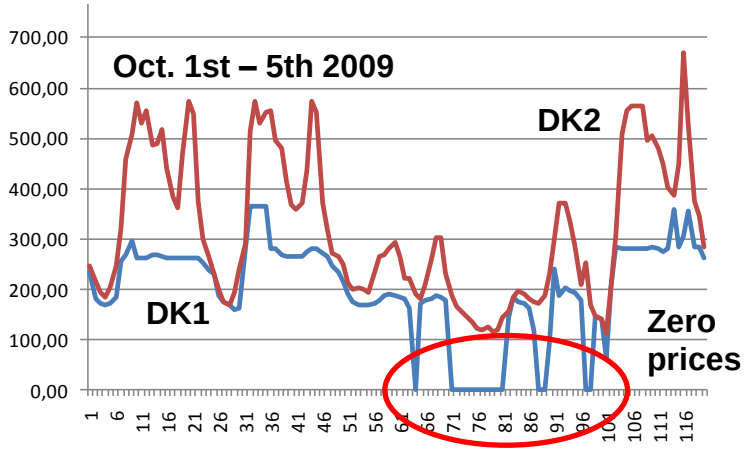


Source: Energistyrelsen

**Data from West Denmark, January 2010 (Energinet.dk – Markedsdata)*

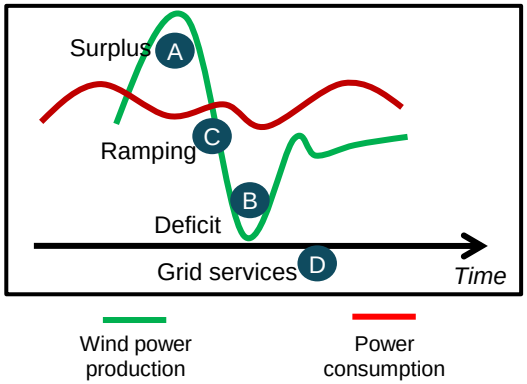
Example: Who will deliver system services in the hours when wind power push the CHPs out of the market ?



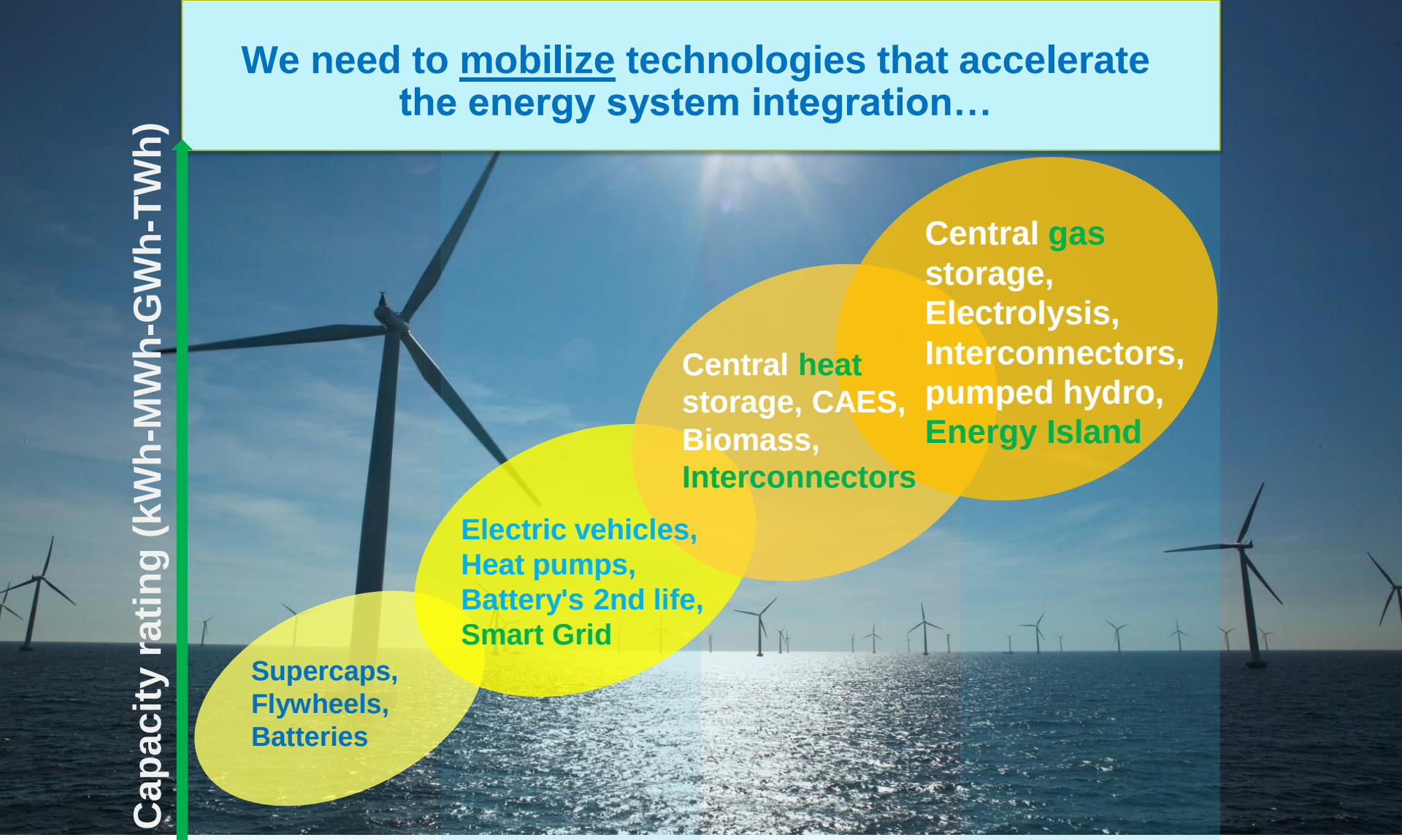


RES are stressing CHP operation and pushing them out of the market

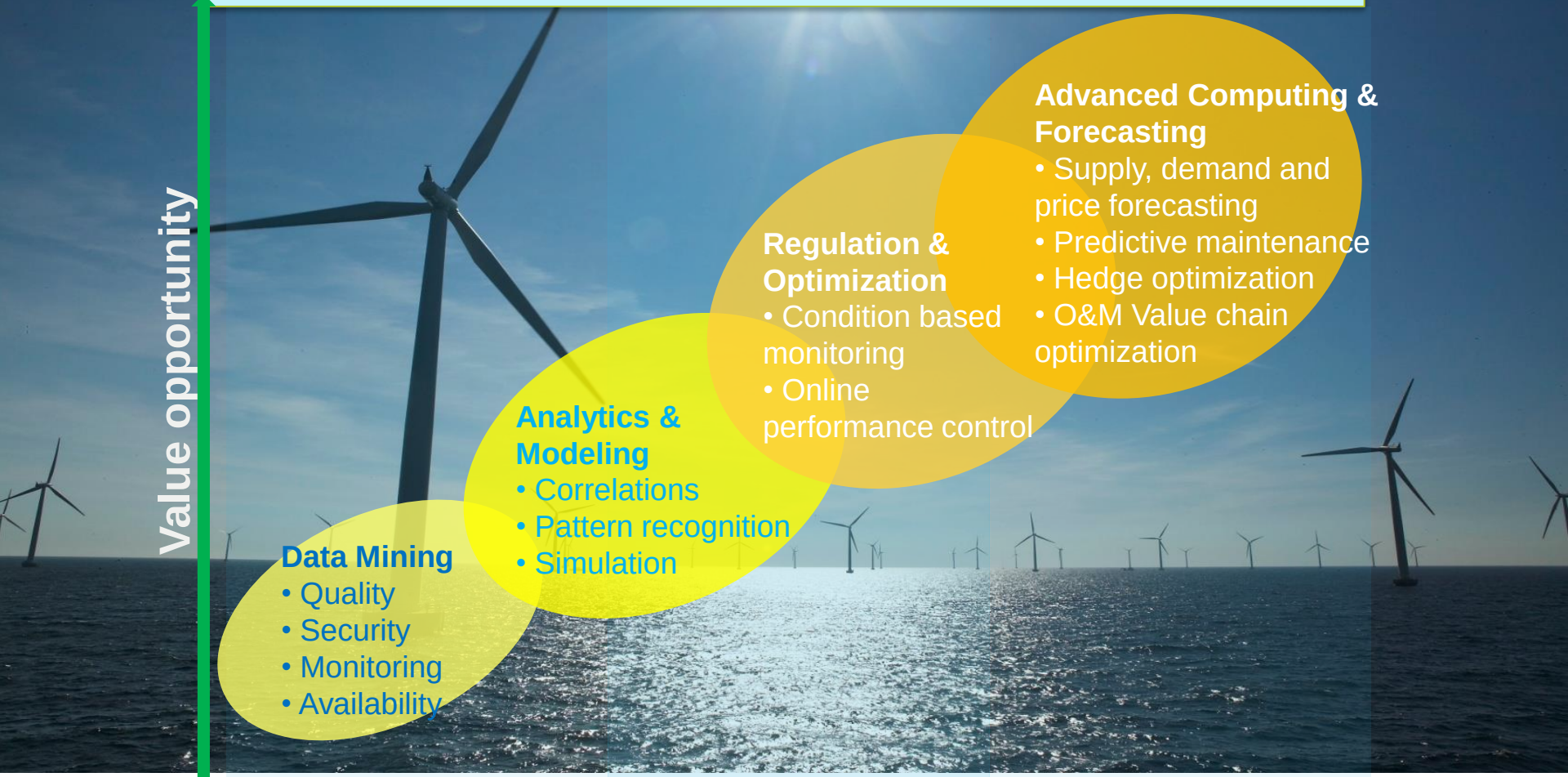
New flexibility providers are needed to handle the 4 main future challenges



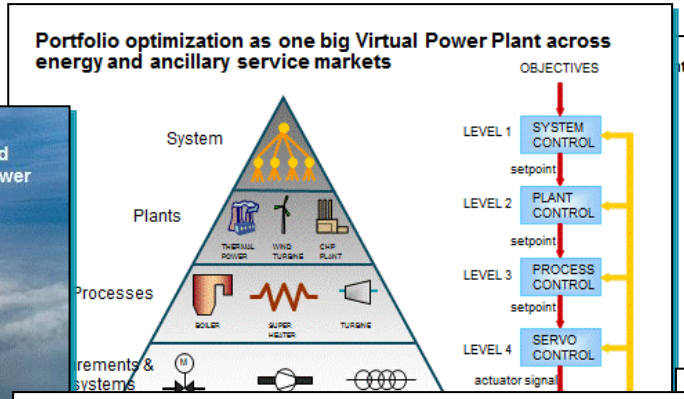
We need to mobilize technologies that accelerate the energy system integration…

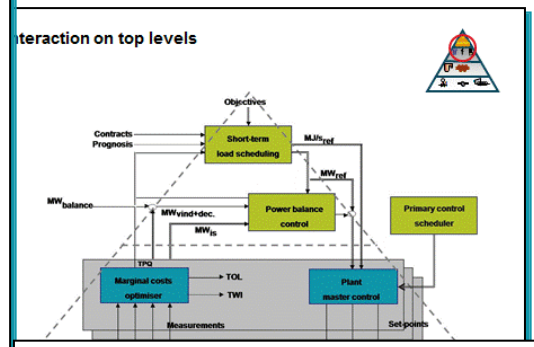


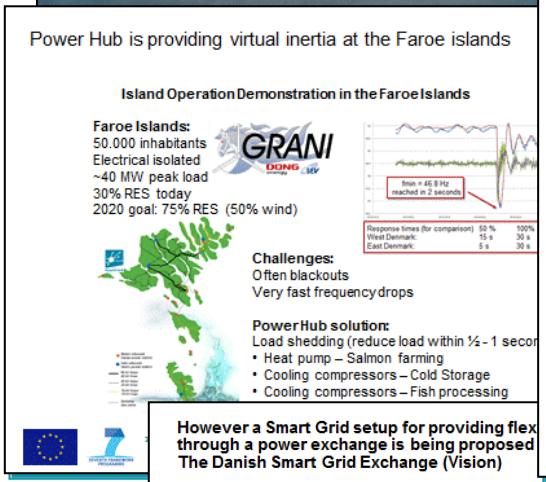
… and manage the system intelligently to maximize the value of available energy resources!

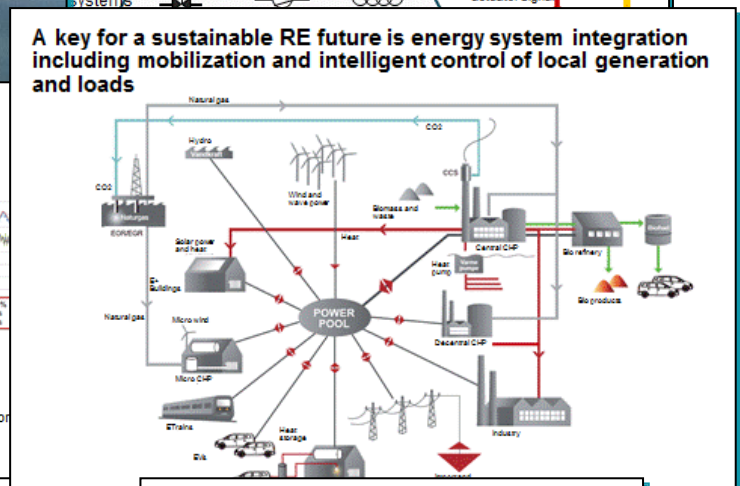


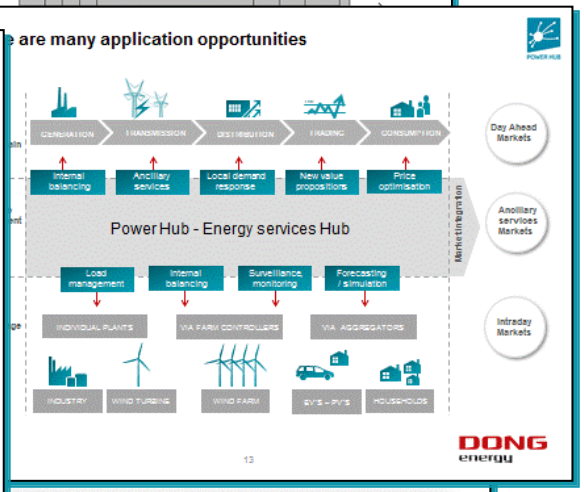
Key strands to solve the puzzle…

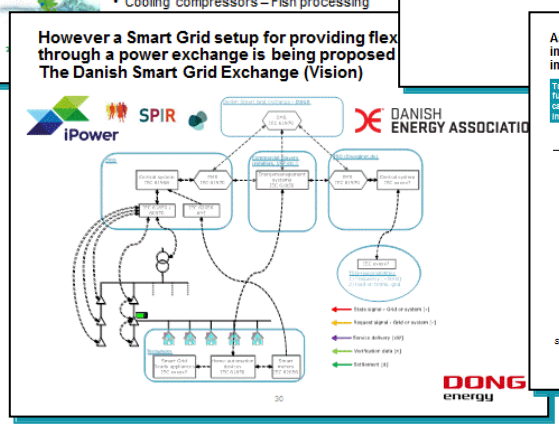


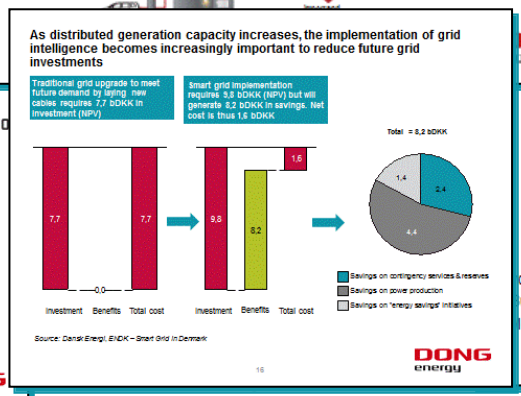


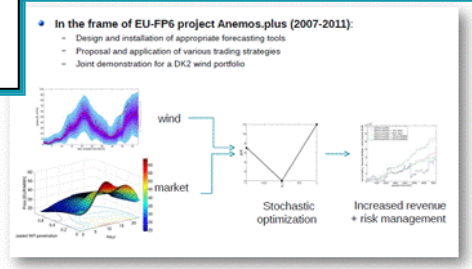








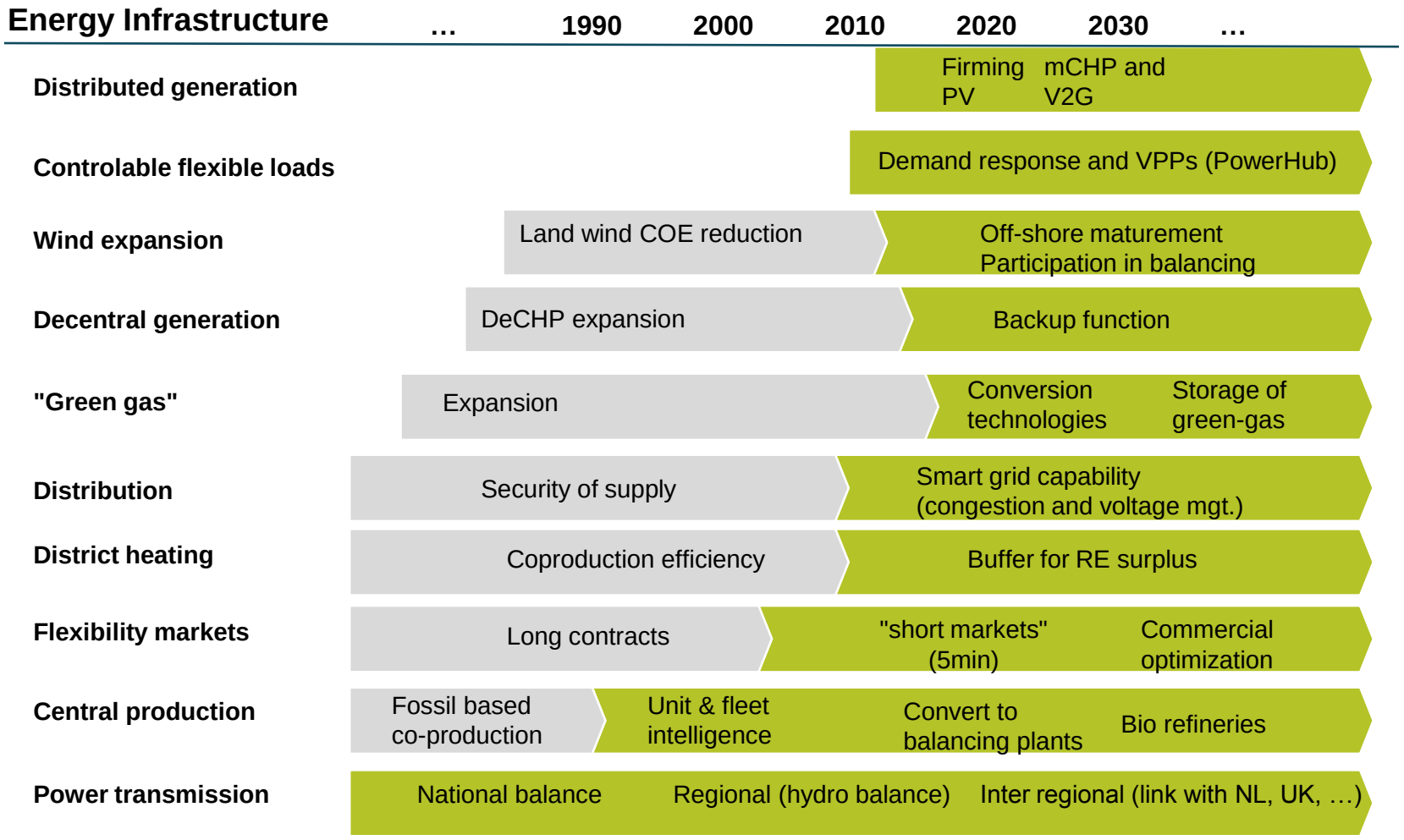




o dimensions of development
uild on top of current wind portfolio > win market position > offer as service
ove from wind integration > trade and arbitrage with optimized hedge position

DONG energy

Several energy infrastructures will be affected by the future RE/DER integration challenge



Thank you for listening

DONG energy