Mission Impossible? 100% Renewable Energy Society: The European Story - Denmark

Invited presentation for rap session

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Mission Impossible?
100% Renewable Energy Society:

The European Story – Denmark

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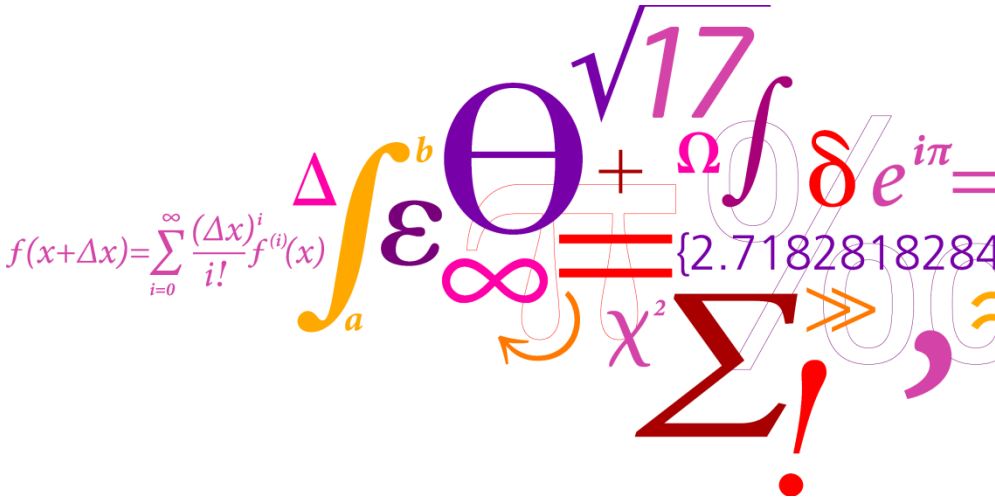
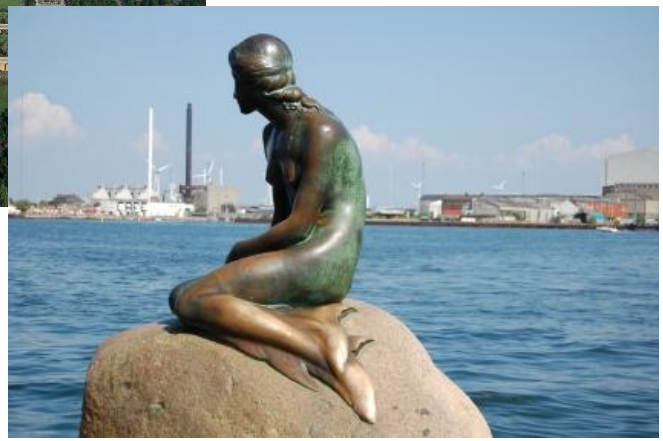


DTU Electrical Engineering
Department of Electrical Engineering

Technical University of Denmark (DTU)

- Based in Copenhagen, the Capital of Denmark
- 8200 students – 530 faculty – 1040 researchers
- Ranked 4th in Europe by THE based on citations per journal paper (http://www.timeshighereducation.co.uk/story.asp?storyCode=414302&sectioncode=26)



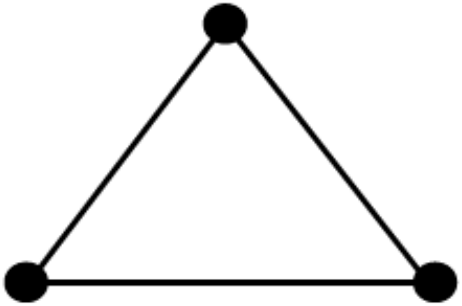
Europe after dark

- 20 – 20 – 20 targets for 2020
  - 20% reduction in greenhouse gas emissions compared to 1990
  - 20% renewable energy share
  - 20% reduction in energy consumption compared to projected values

Source: Danish Government – 2050 Energy Strategy

Europe is not an charity

COMPETITIVENESS
- cut Europe's energy bill by about € 200 billion / year in 2020
- lower households' bills by about €1000 per household / year
- create up to 2 million jobs by 2020
- boost R&D and create markets where EU can become a global leader



SECURITY OF SUPPLY
- decrease our energy dependence
- help balance our trade
- alleviate the need for gas pipelines and grid investments

SUSTAINABILITY
- help fight climate change:
  - 740 Mt CO2 / year in 2020
- limit environmental degradation

Source: European Commission, Feb. 2011

2050 European Objectives

- Reduce greenhouse gas emissions by 80-95% by 2050 compared to 1990

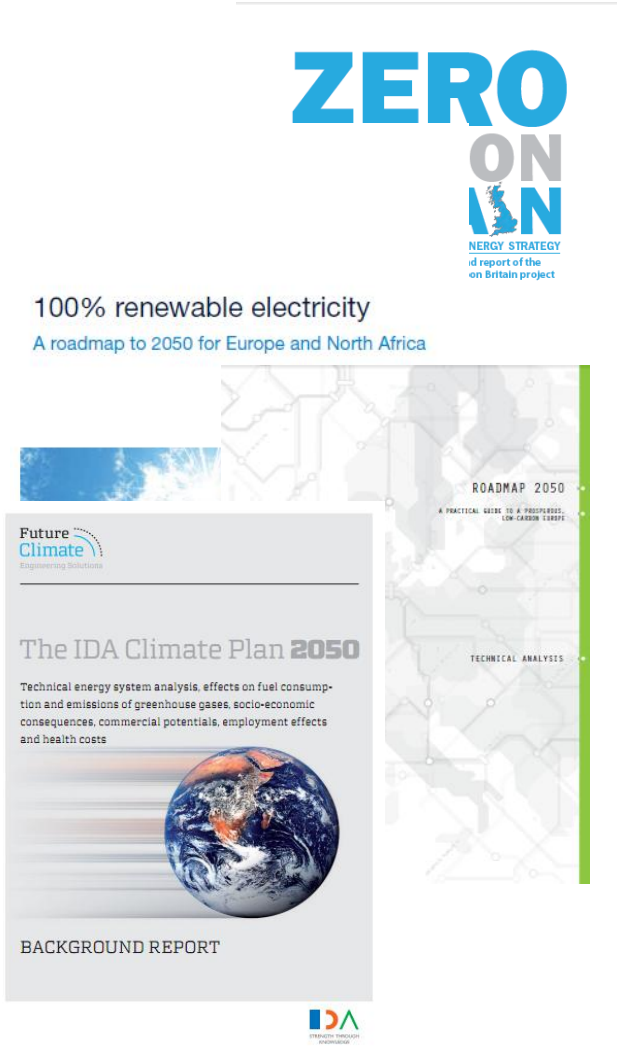
Illustrator: Giacomo Cardelli

Analysis and reports

- Zero Carbon Britain 2030

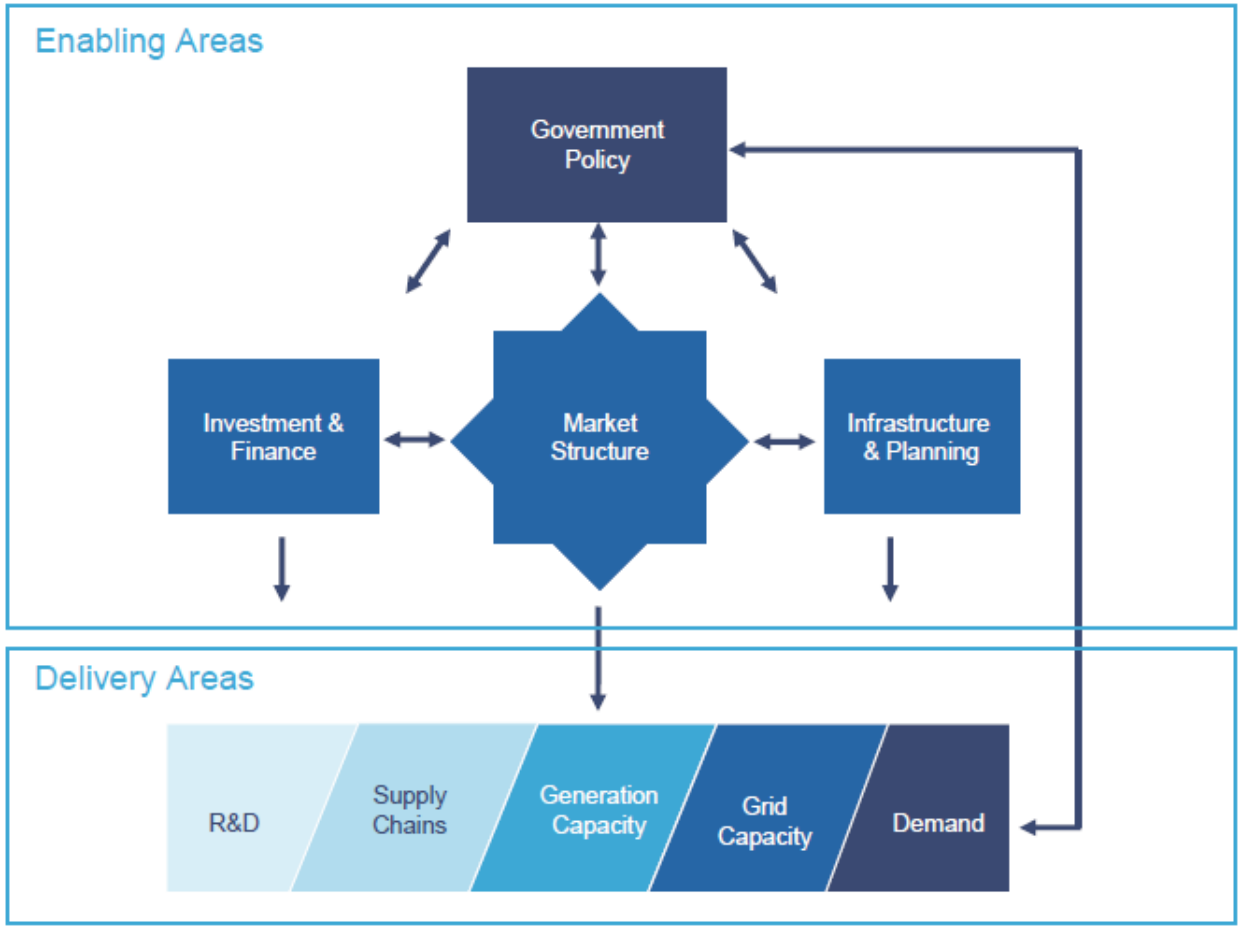
- PricewaterhouseCoopers LLP
  - 100% renewable electricity – A roadmap to 2050 for Europe and North Africa
- European Climate Foundation
  - Roadmap 2050 – A practical guide to a prosperous low-carbon Europe
- IDA (Engineering Association Denmark)
  - IDA's Climate Plan 2050

- Danish Government – first to set the target for fossil fuel free society 2050



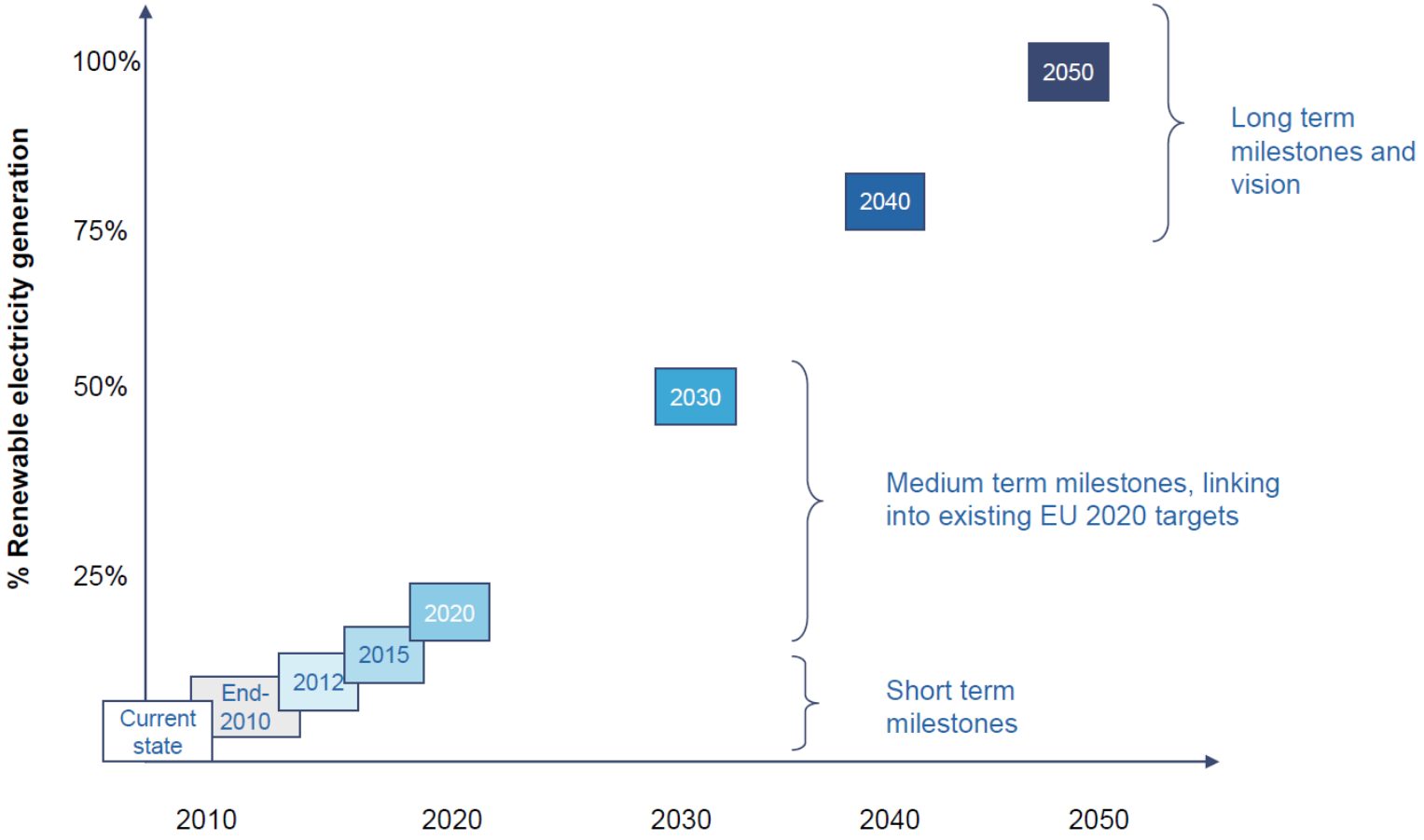
What is necessary?

- Policy
- Markets
- Investment
- Infrastructure



Source: www.pwc.com/sustainability

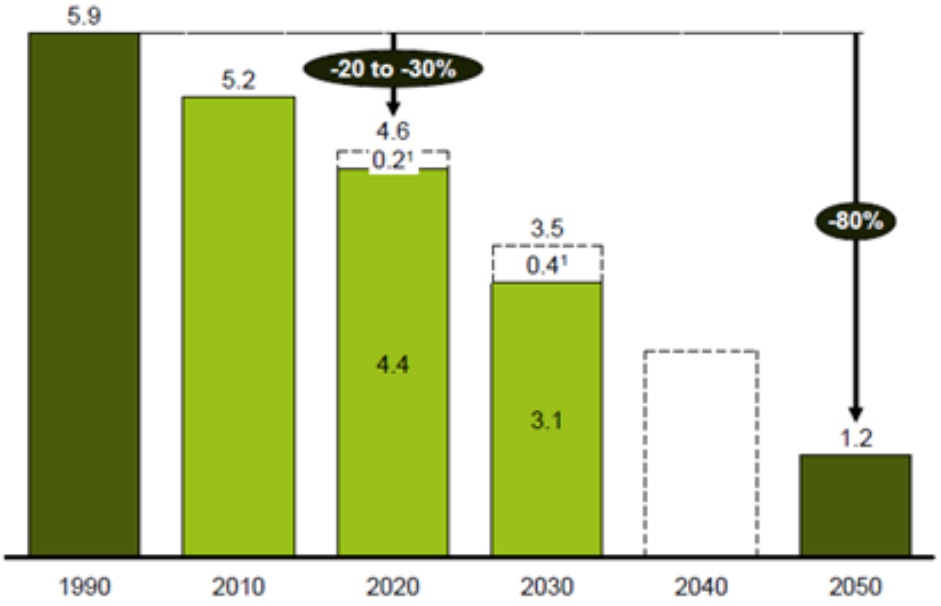
Short, Medium and Long term milestones and visions have to be set



Source: www.pwc.com/sustainability

European Climate Foundation Roadmap 2050

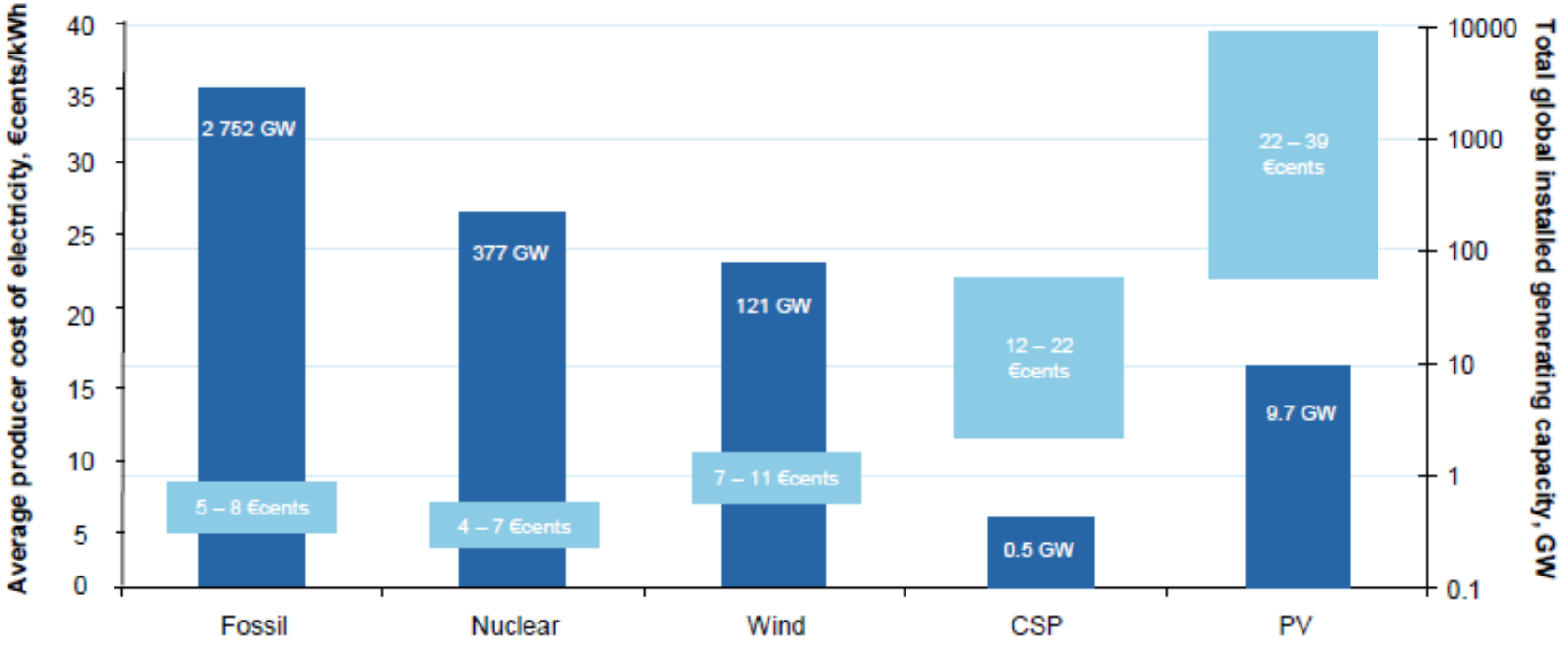
- Three scenarios are investigated:
  - 40%, 60% and 80% reduction in greenhouse gas emissions
- Cost of electricity will rise in the short term
  - due to investments
- This rise will disappear in the medium and long term
  - due to increasing fossil fuel prices
  - and reduction in CoE from renewable energy sources



Source: European Climate Foundation – Roadmap 2050

Relative costs and installed capacities of different technologies

- 121GW (2008) – 215GW (June 2011)

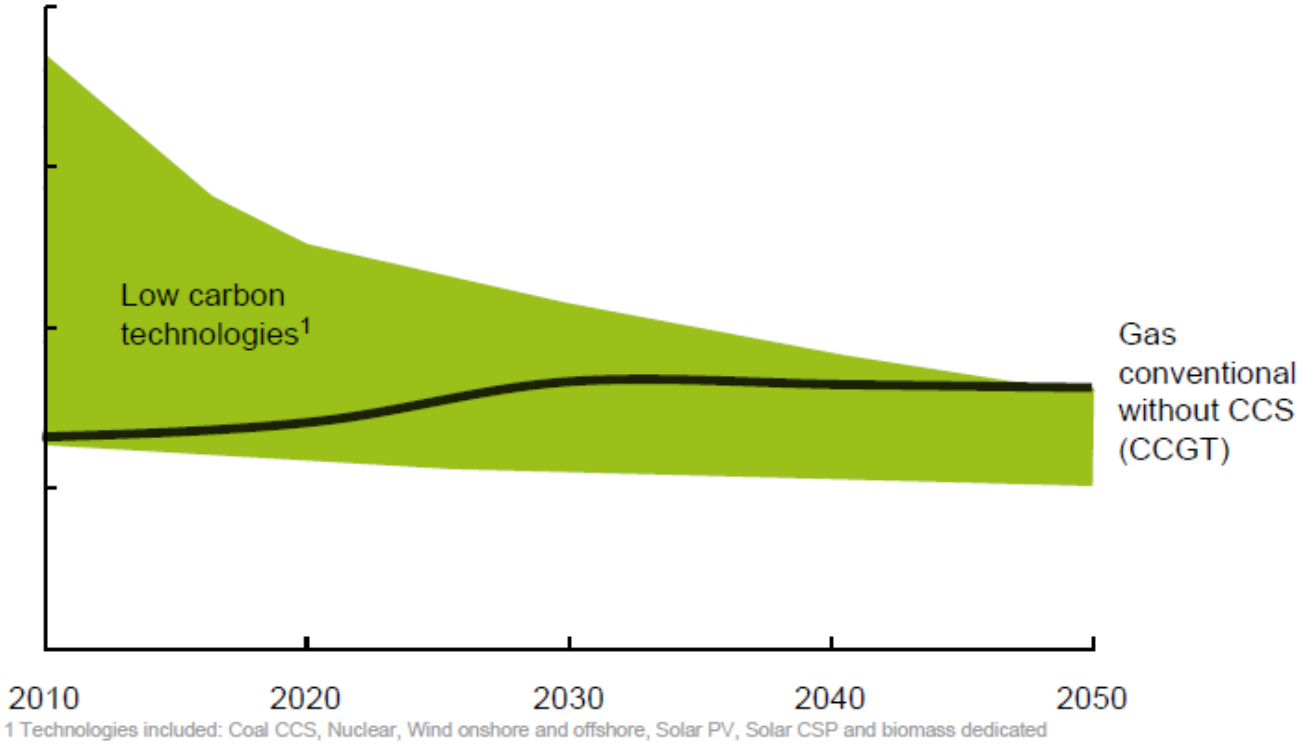


Source: www.pwc.com/sustainability

CoE from renewable energy sources will become lower than from fossil fuel sources

Low carbon technology costs decrease while gas plant costs increase

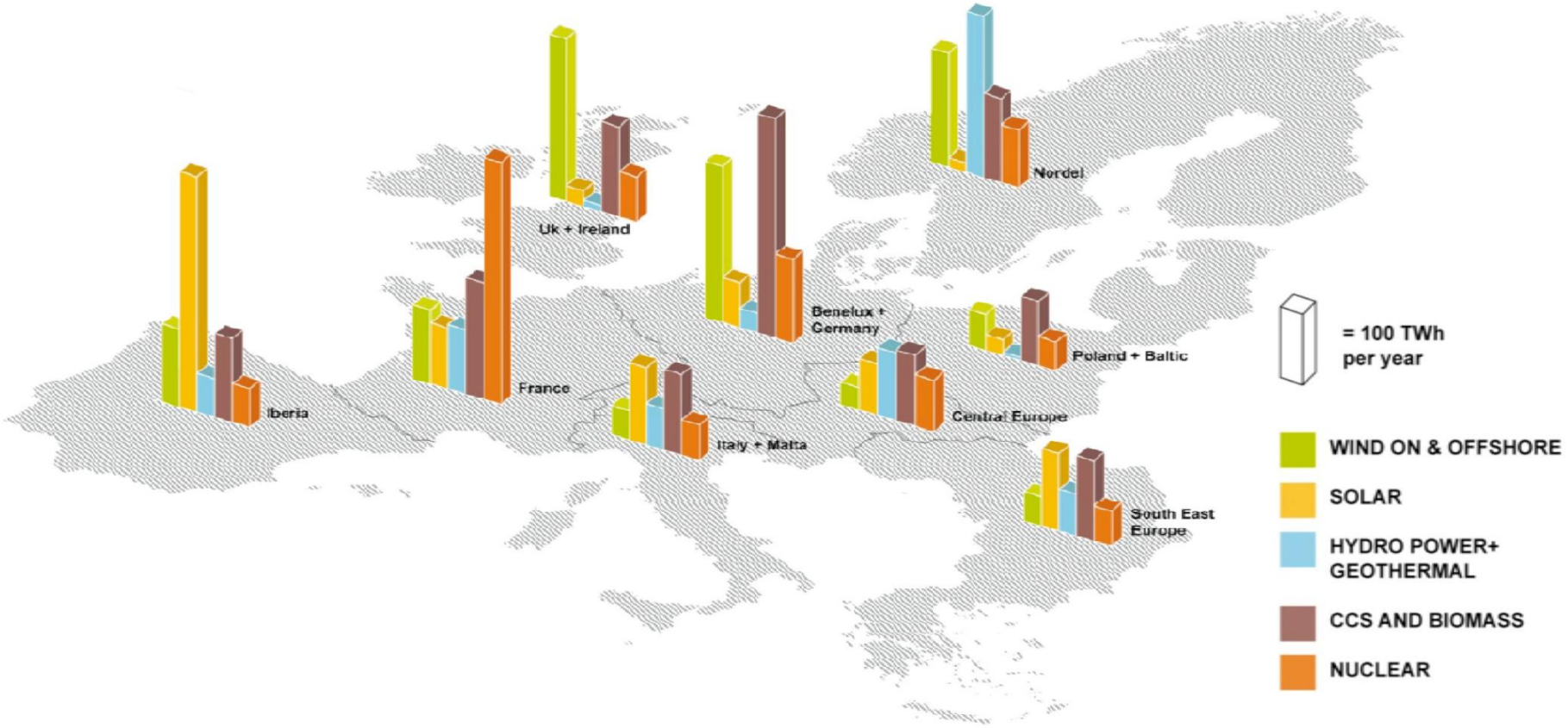
LCoE evolution of gas conventional compared to low carbon technologies, € per MWh (real terms)
Example based on the 60% RES / 20% nuclear / 20% CCS pathway, Iberia



1 Technologies included: Coal CCS, Nuclear, Wind onshore and offshore, Solar PV, Solar CSP and biomass dedicated

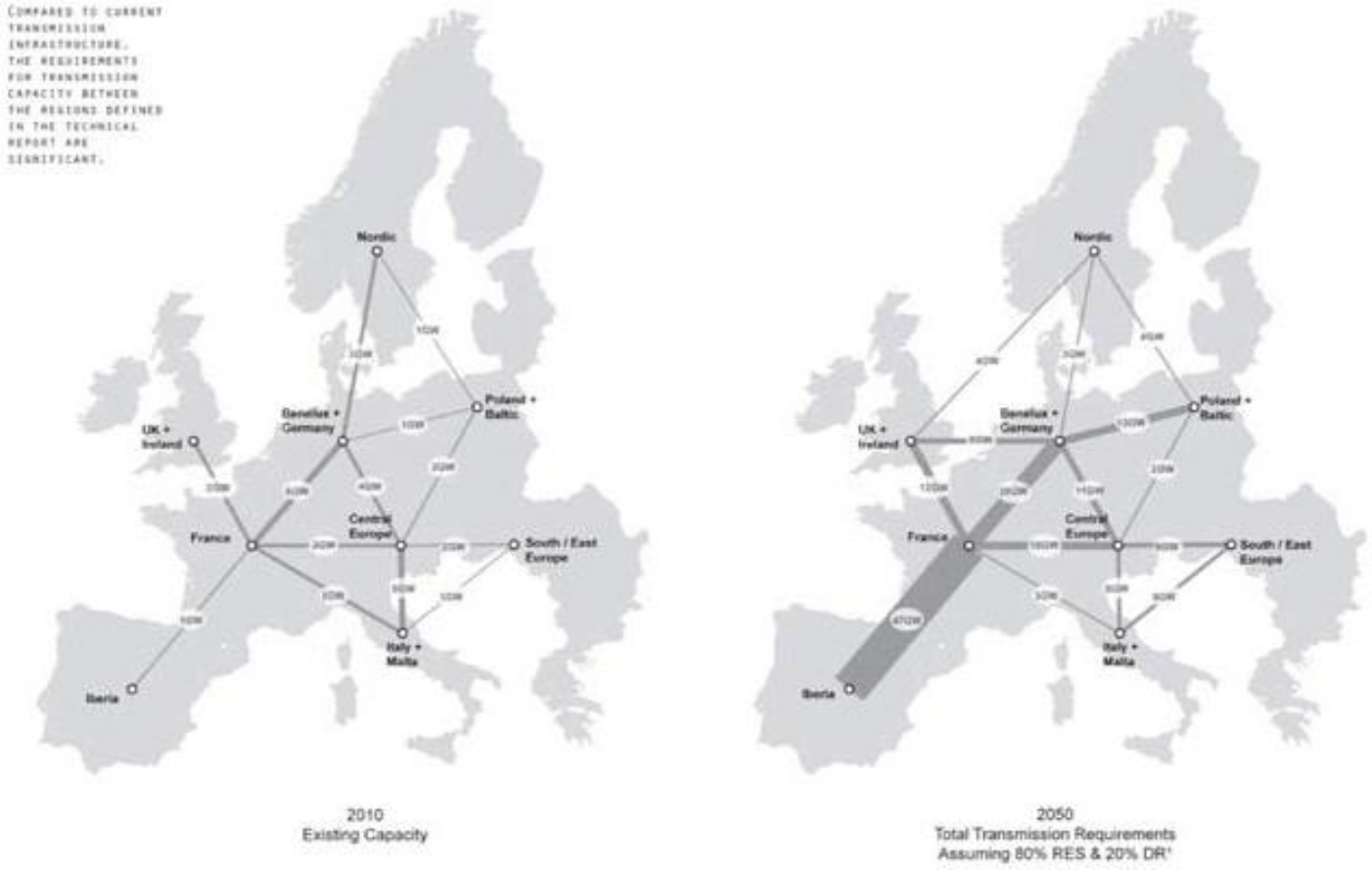
Source: European Climate Foundation – Roadmap 2050

Harvest the local renewable resources and "share" them



Source: European Climate Foundation – Roadmap 2050

Super-SmartGrid is required

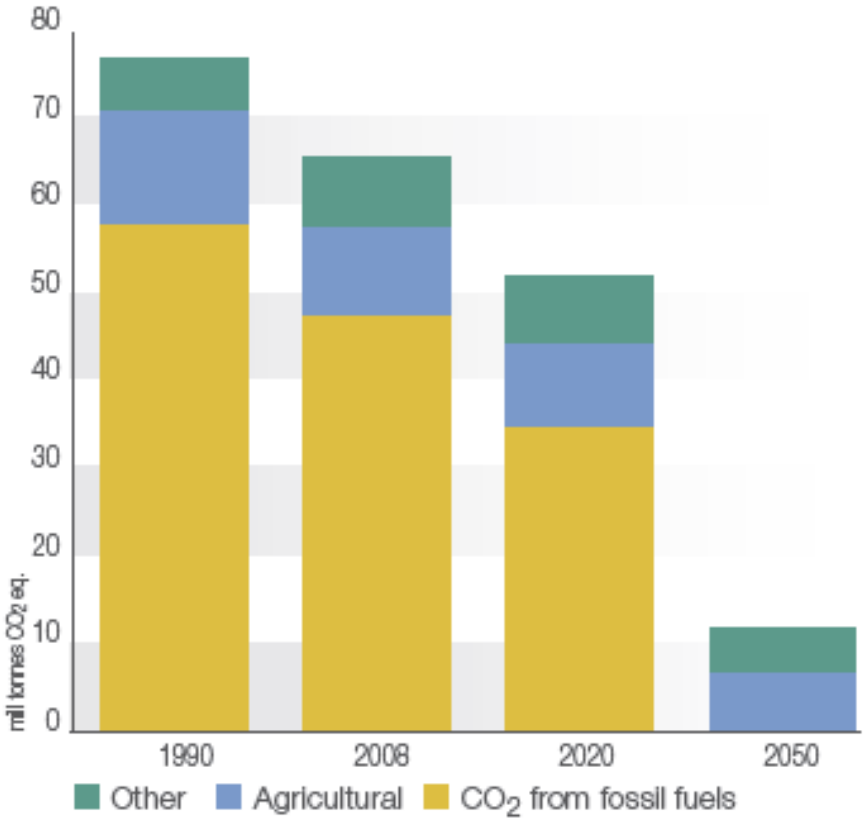


Source: European Climate Foundation – Roadmap 2050

Danish Government – 2050 Energy Strategy
A fossil fuel free society by 2050

- An unpredictable future demands flexible answers

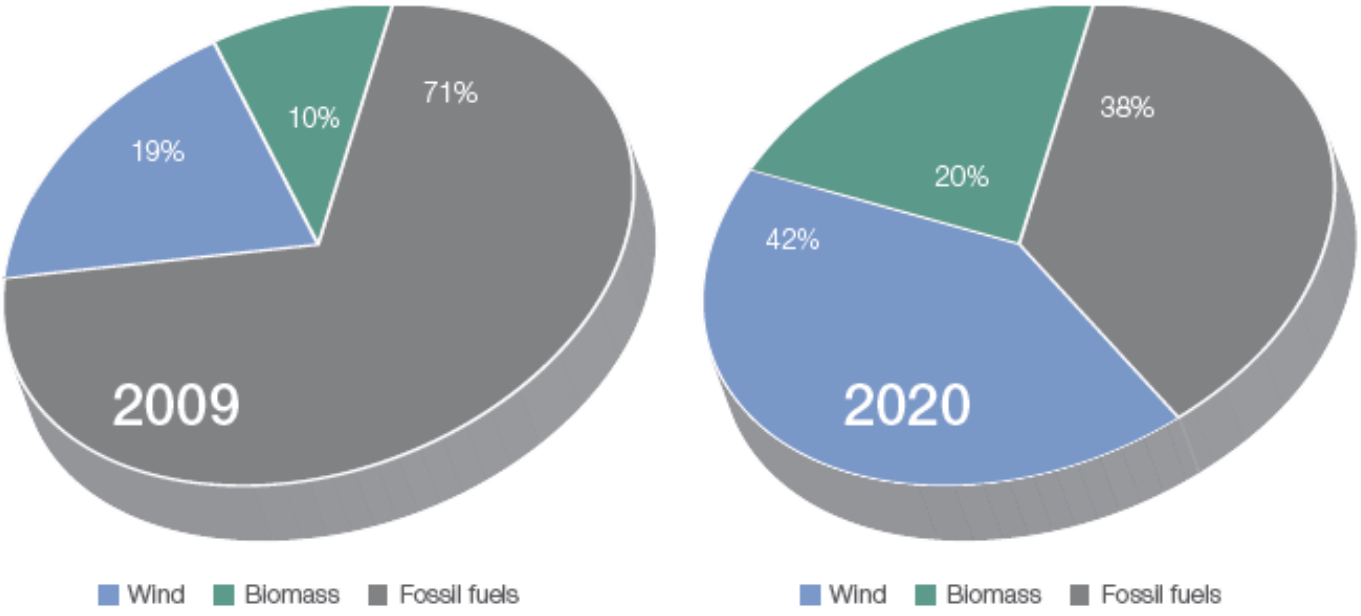
- Energy efficiency (50% more efficient use of energy in 2050 compared to 2010)
- Electrification (transportation, heating, etc.)
- More wind power (more offshore)
- More biomass
- Supplemented by wave energy and photovoltaic
- SmartGrids (Intelligent energy systems)
  - Energy storage (Hydro in Sweden and Norway, battery, etc.)



The Energy Strategy 2050 has to be achieved in steps – fully financed 2020 initiatives

- 33% renewable energy by 2020
- 33% reduction in greenhouse gas emissions by 2020 compared to 1990
- 6% reduction in energy consumption by 2020 compared to 2006
- Electricity production:

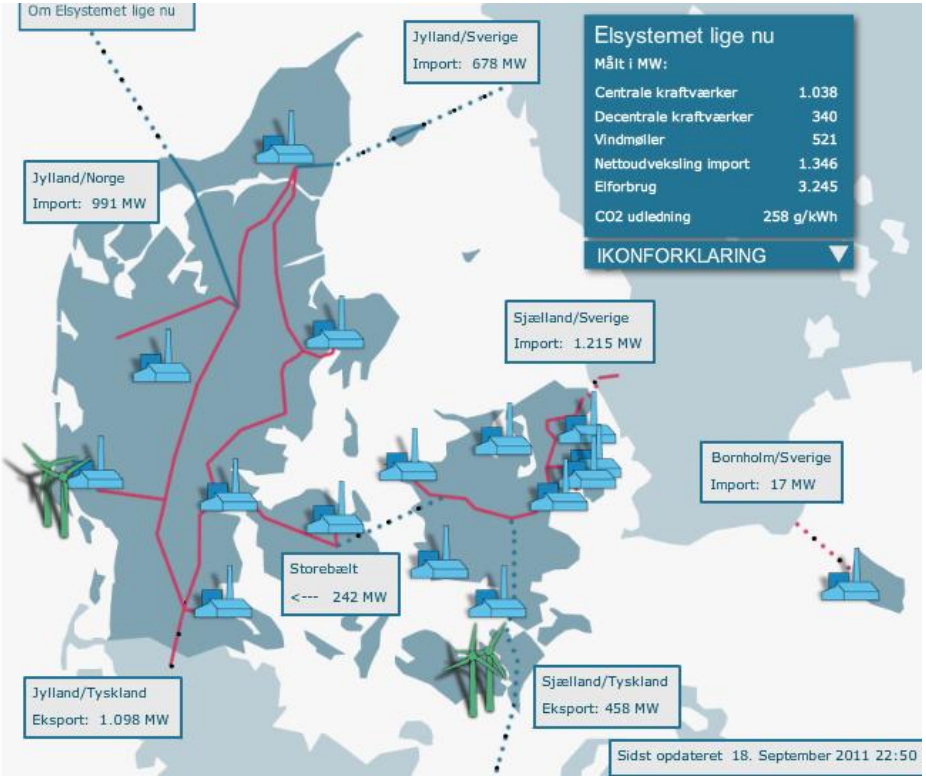
On the way towards fossil fuel independence by 2050 – effects and benefits of the government's initiatives

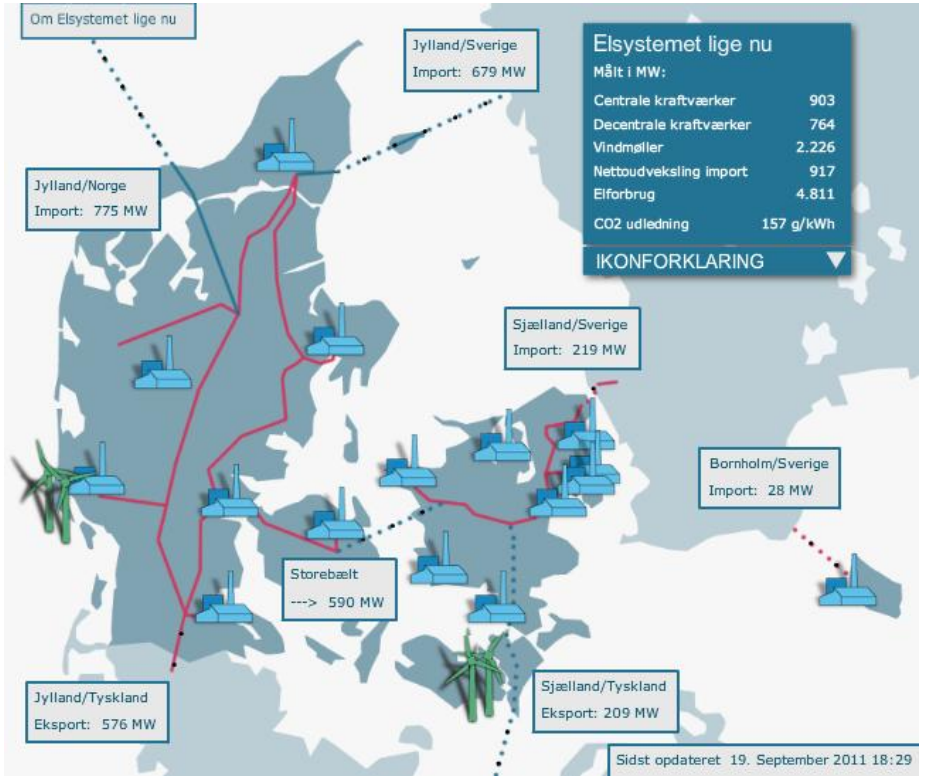


Source: Danish Government – 2050 Energy Strategy

Denmark in interconnected with its neighbours

- 521MW from wind out of 3245MW (total of 16% wind)
- 2226MW from wind out of 4811MW (total of 46% wind)





Source: http://energinet.dk/Flash/Forside/index.html

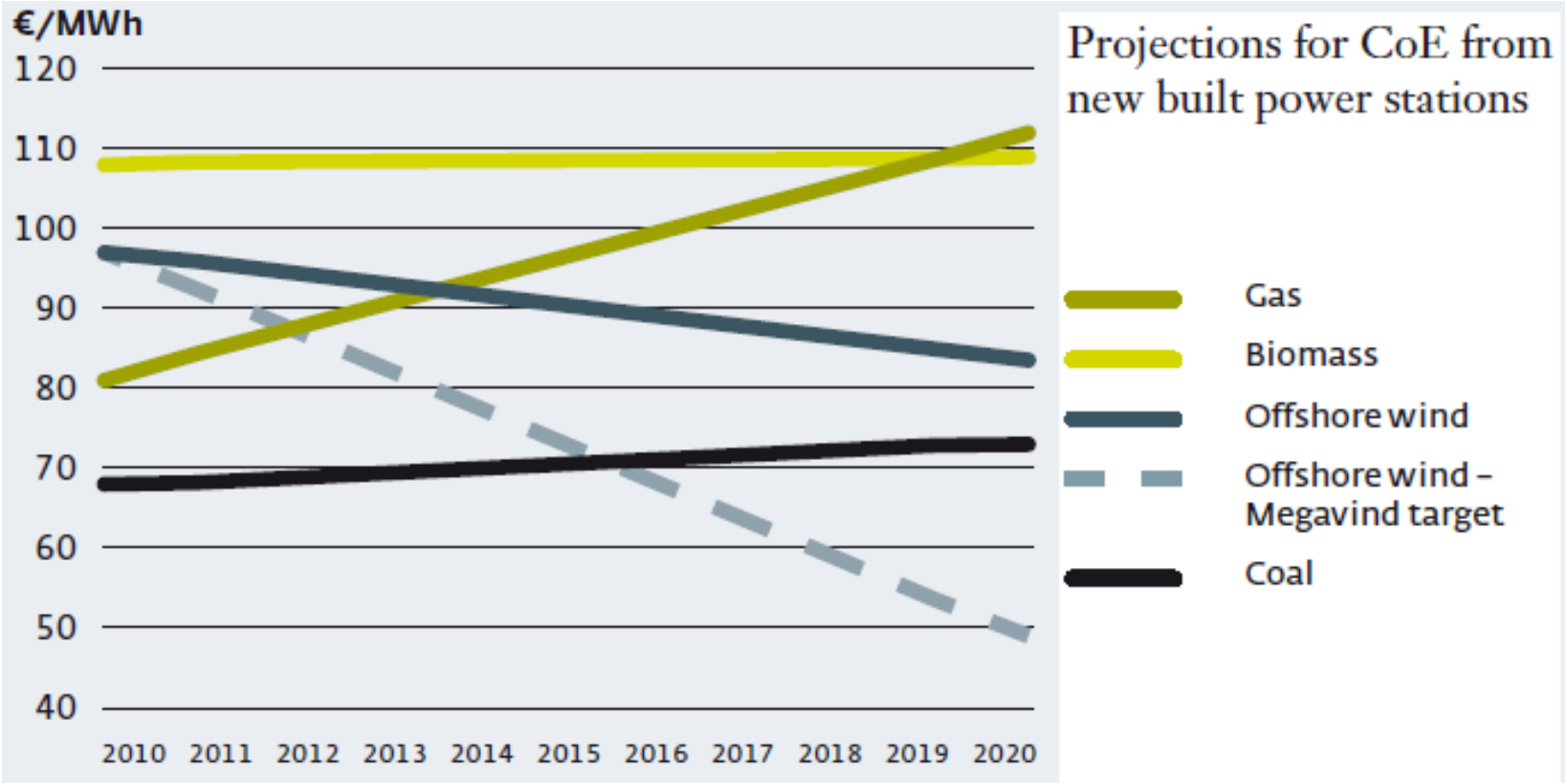
Danish Wind Industry Association MegaVind – 2020 Strategy

- Vestas Wind Systems
- Siemens Wind Power
- DONG Energy
- Grontmij
- Technical University of Denmark (DTU)
- Aalborg University

- Half CoE from offshore wind farms
- Achieved by:
  - 25% increase in capacity factor
  - 40% reduction in CAPEX
  - 50% reduction in OPEX

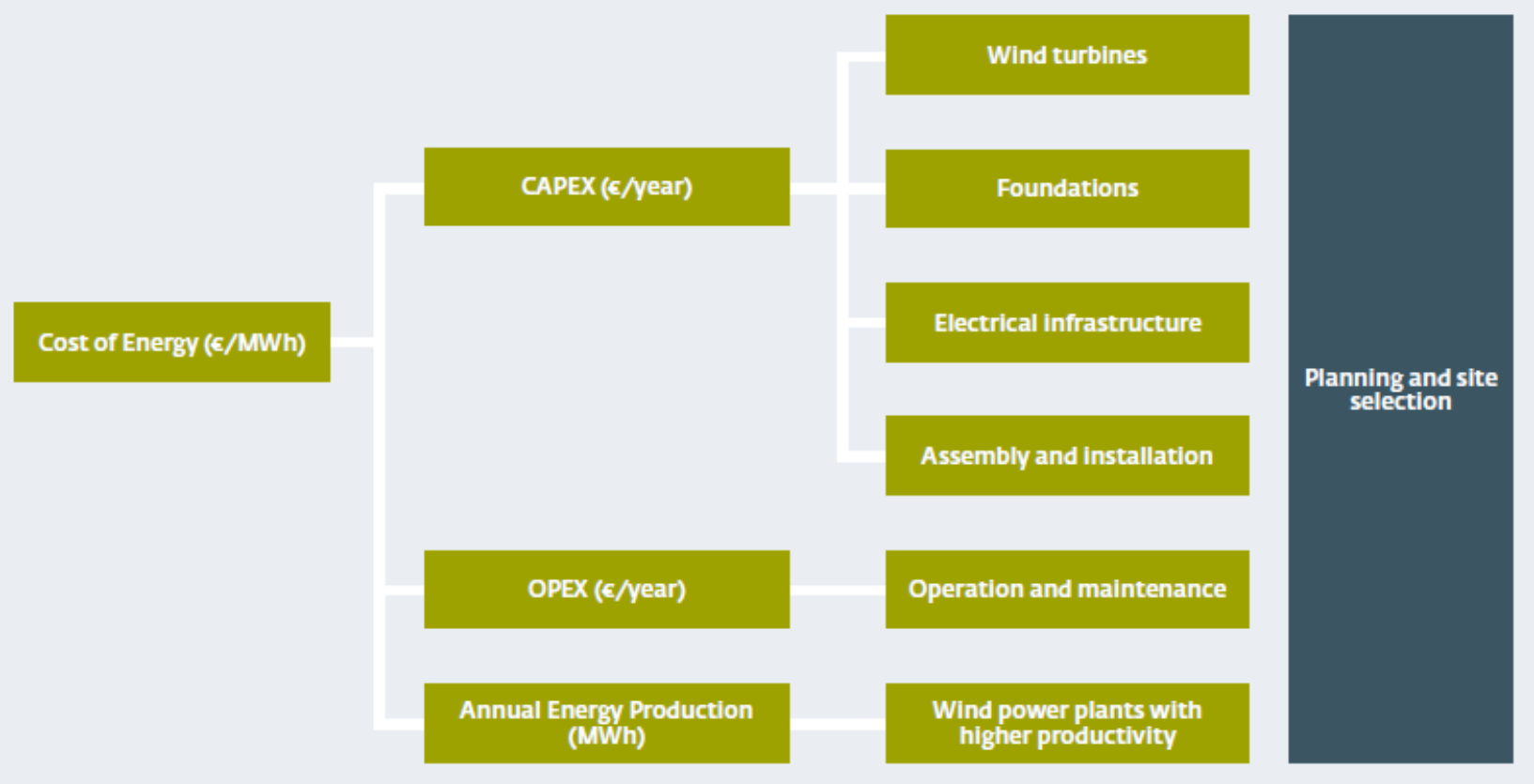
$$\text{CoE} = \frac{\text{Annualised CAPEX} + \text{Annualised OPEX}}{\text{Annual Energy Production}}$$

MegaVind – 2020 Strategy
50% reduction in CoE from offshore wind



Source: Danish Wind Industry Association – MegaVind Strategy

MegaVind – 2020 Strategy
Focus areas



Source: Danish Wind Industry Association – MegaVind Strategy

Conclusion

- European targets 2020
  - 20% reduction in greenhouse gas emissions compared to 1990
  - 20% renewable energy share
  - 20% reduction in energy consumption compared to projected values

- European objectives 2050
  - Reduce greenhouse gas emissions by 80-95% compared to 1990

- Denmark is even more ambitious
  - 33% reduction in greenhouse gas emissions by 2020 compared to 1990
  - 33% renewable energy share in 2020
  - 6% reduction in energy consumption by 2020 compared to 2006
  - Fossil fuel free by 2050

VIND I ØRESUND

Interreg IV A
ÖRESUND – KATTEGAT – SKAGERRAK

Technical University of Denmark

LUNDS UNIVERSITET

This presentation is part of an EU Interreg project, which is informing about projects connected to Wind in the Øresund-region of Eastern Denmark and Southern Sweden.

A collaboration between the Technical University of Denmark (DTU) and The Faculty of Engineering at Lund University (LTH).