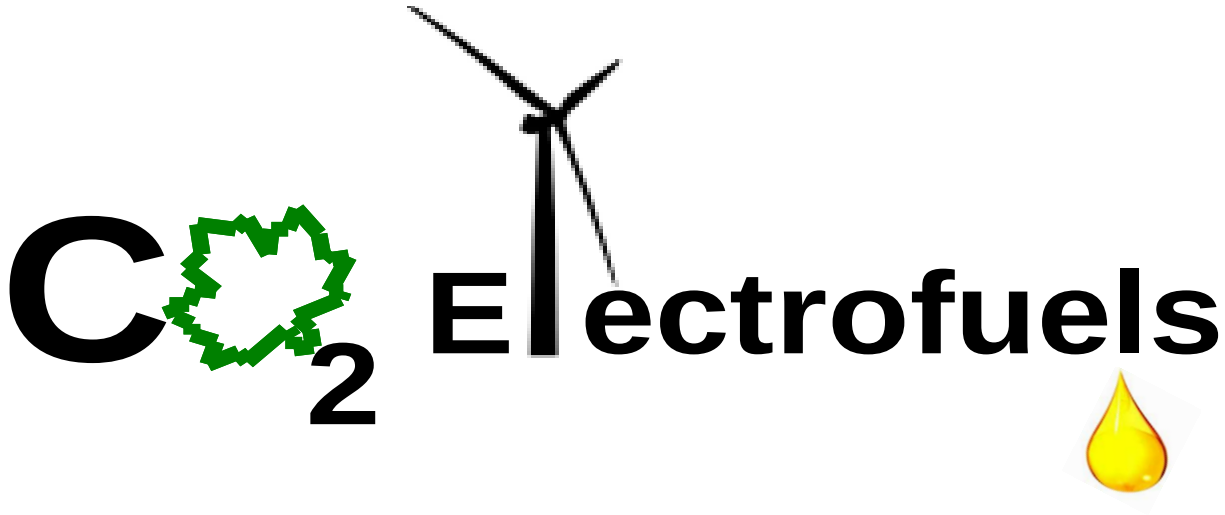

Electrolyzed Synthetic Fuels for Heavy Transportation & Electricity Load Balancing

Claus Friis Pedersen,

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http://www.co2-electrofuels.org/

norden
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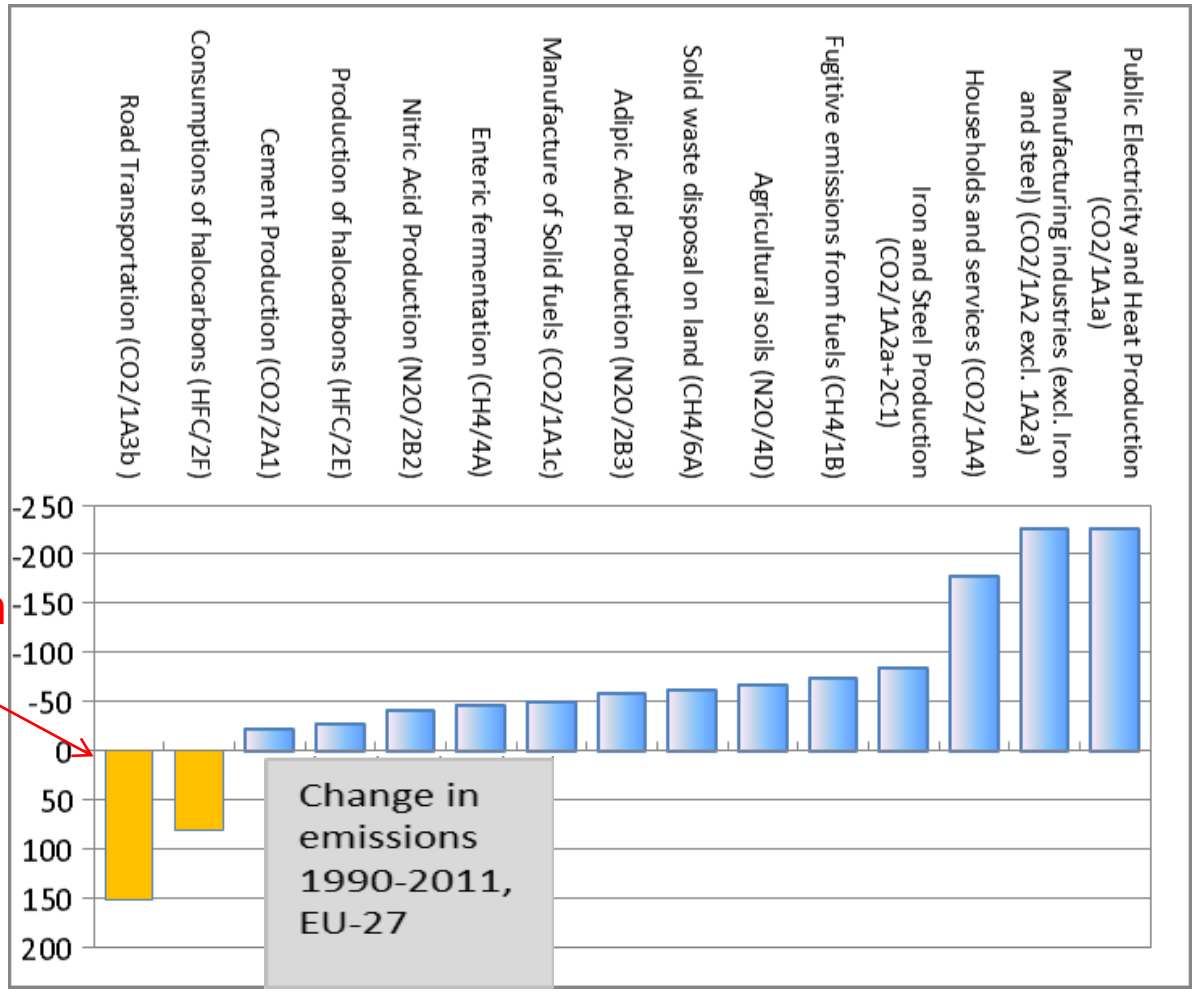
Outline

- Introduction - Energy system challenges
- Key technologies & Project focus
- Successes & Challenges
- Summary

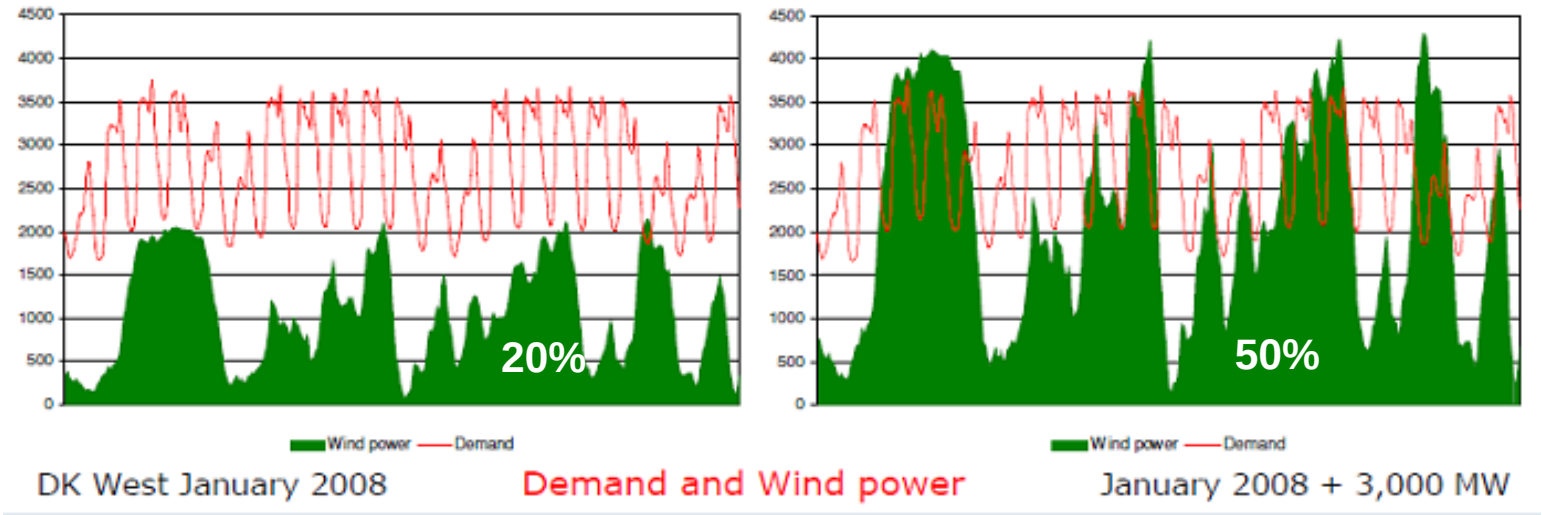
EU-27 CO2 emission evolution

Road Transportation



Renewable energy

- *From 2008 to 2020 the Danish power production will increase from 20 to 50%"*



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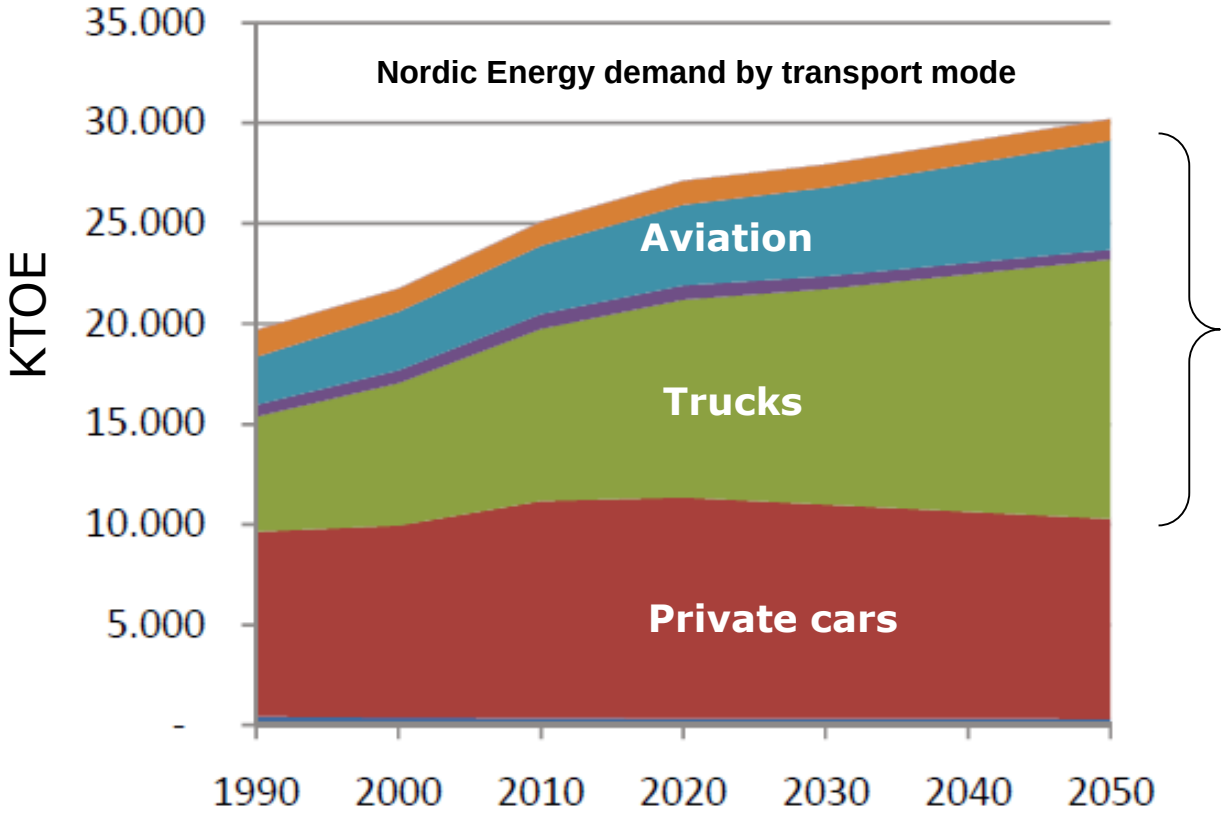
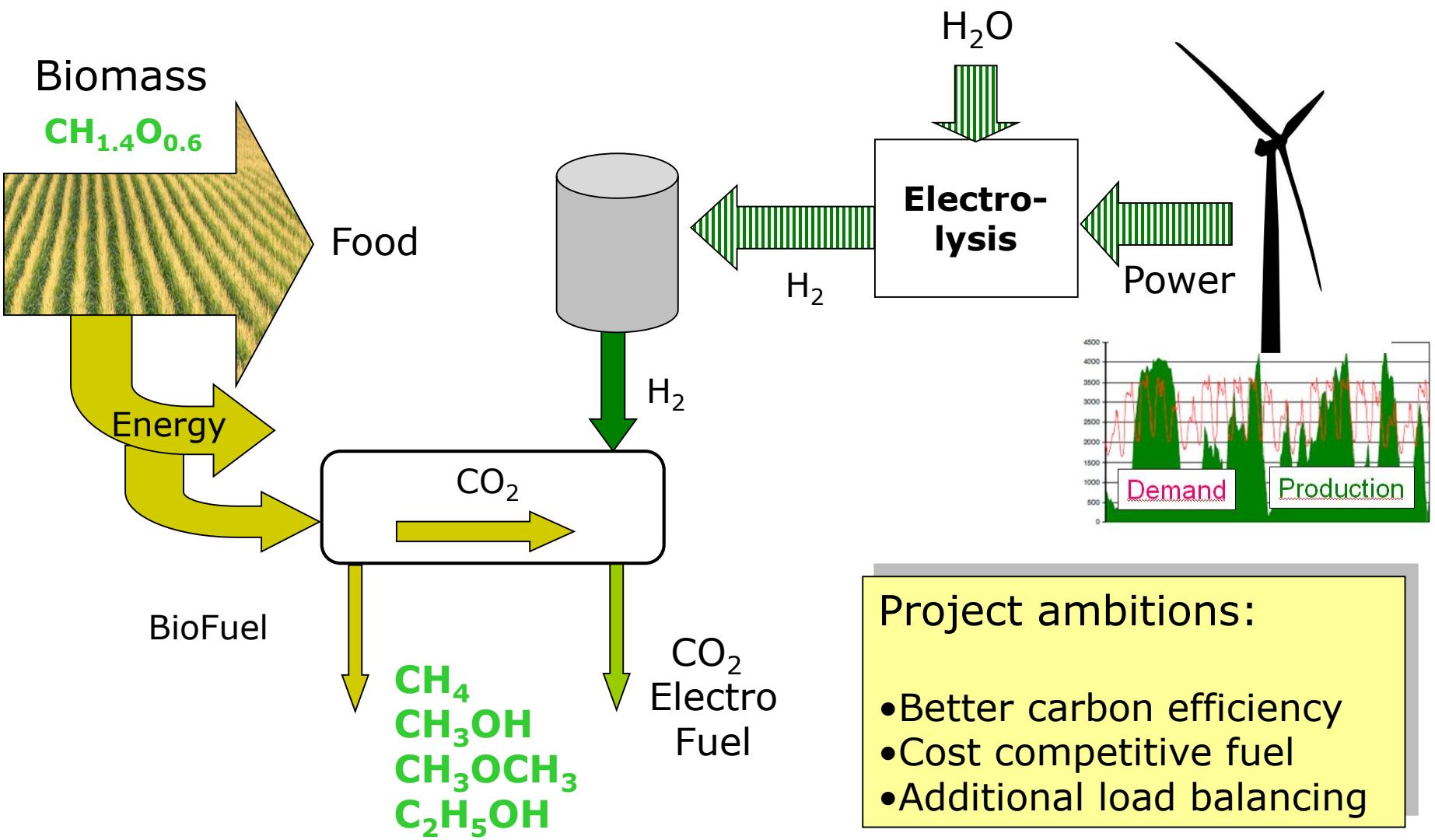
Transport mode distribution



Hydro-Carbon fuels

CO_2 Electrofuels



Project ambitions:

- Better carbon efficiency
- Cost competitive fuel
- Additional load balancing

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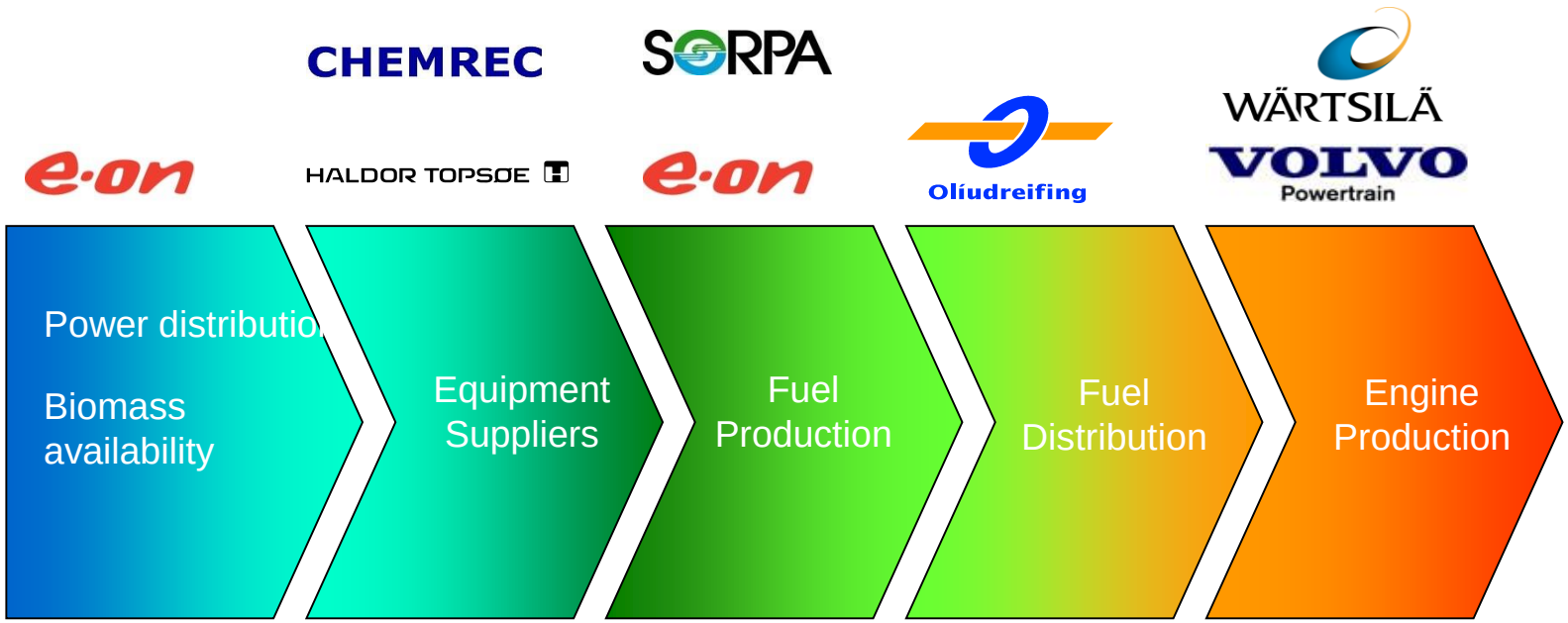
The CO_2 Electrofuel Participants



Nýsköpunarmiðstöð Íslands

DTU

Ea Energy Analyses

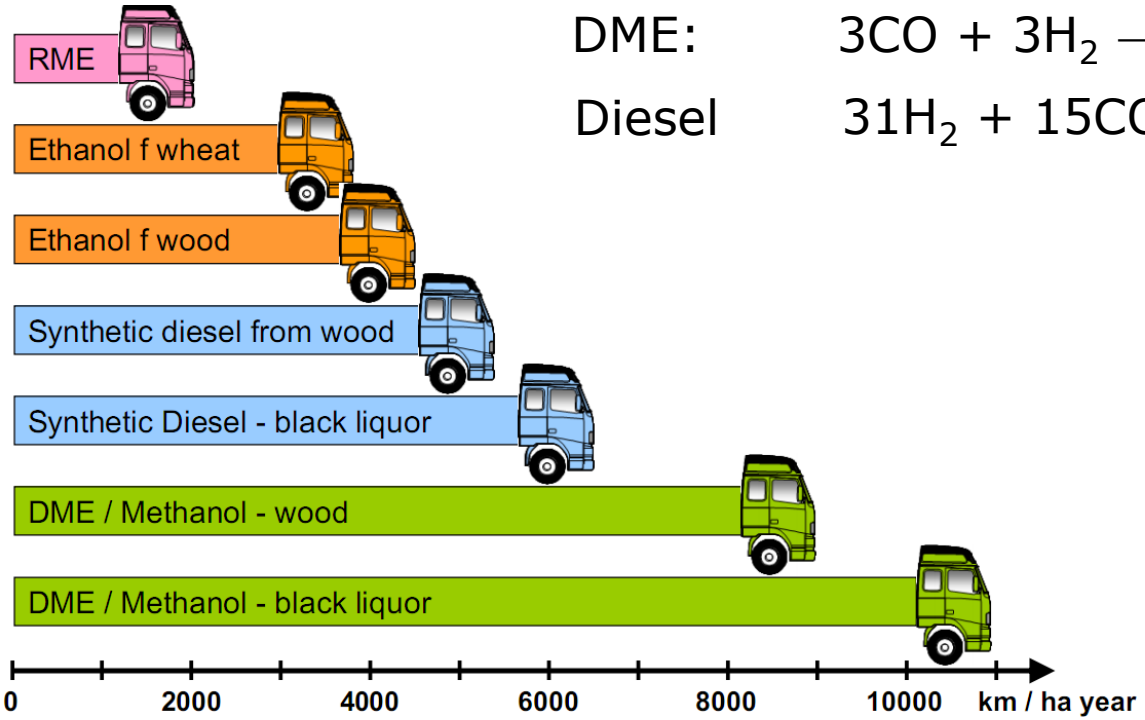
Full value chain coverage

Commercial focus

Fuel efficiency

Synthesis gas: $CO + H_2 + CO_2$

Methane:	$CO + 3H_2 \rightarrow CH_4 + H_2O$	-21%
Methanol:	$CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$	-12%
DME:	$3CO + 3H_2 \rightarrow CH_3OCH_3 + CO2$	-16%
Diesel	$31H_2 + 15CO \rightarrow C_{15}H_{32} + 15H_2O$	-22%



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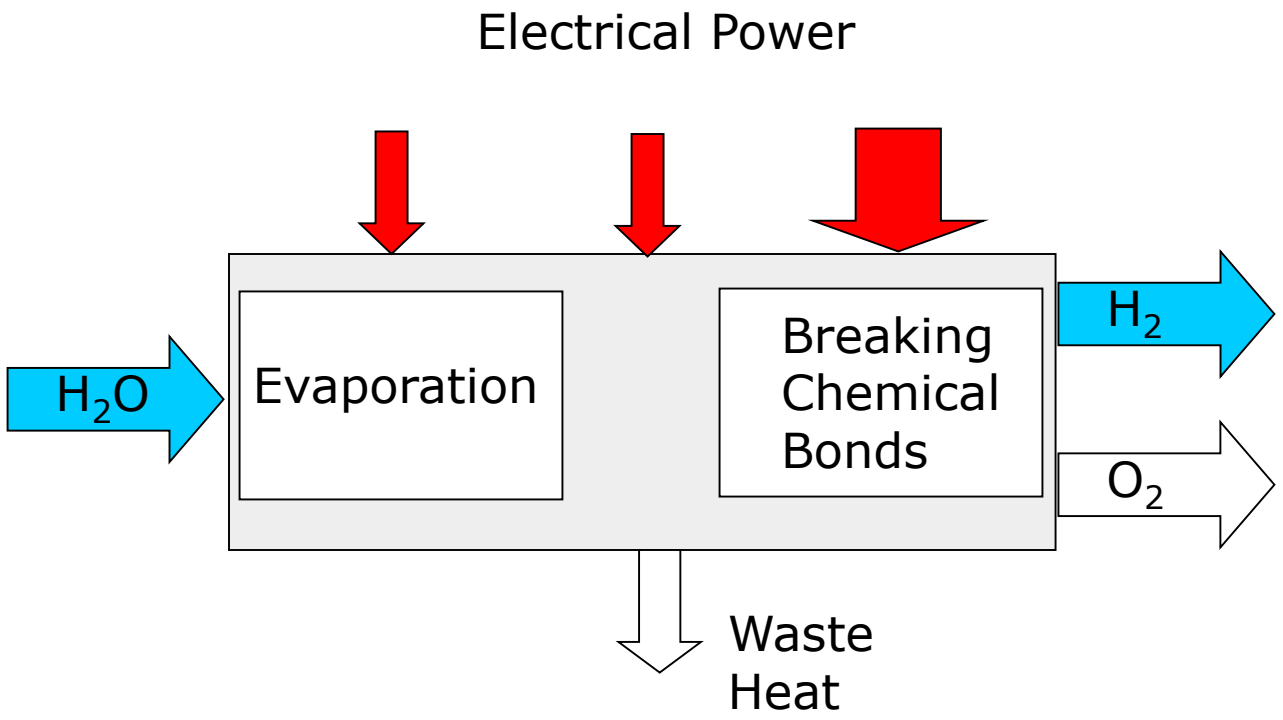
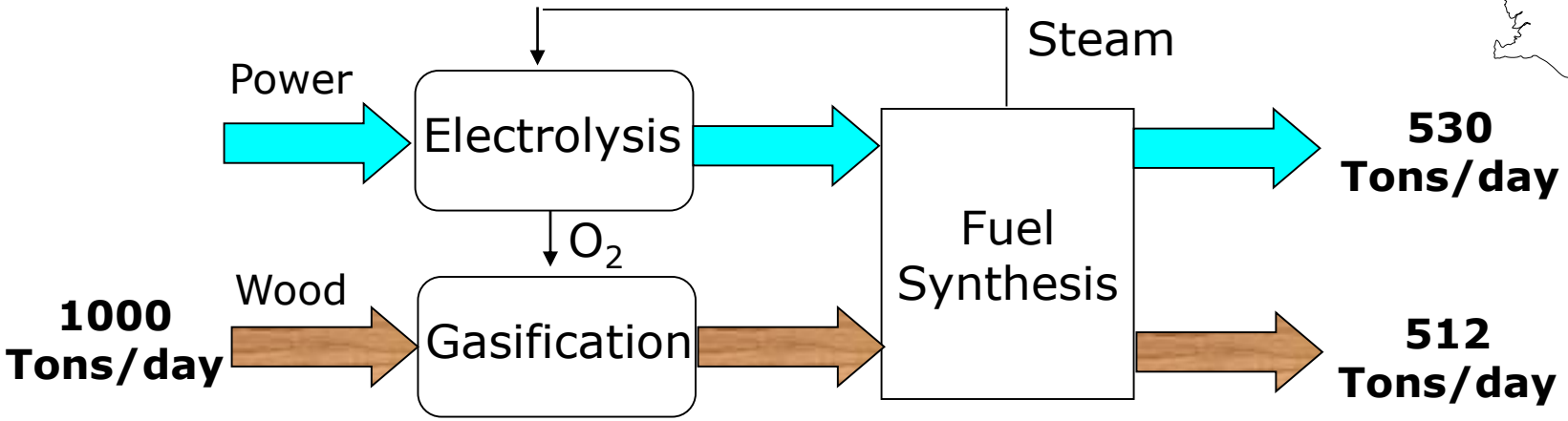
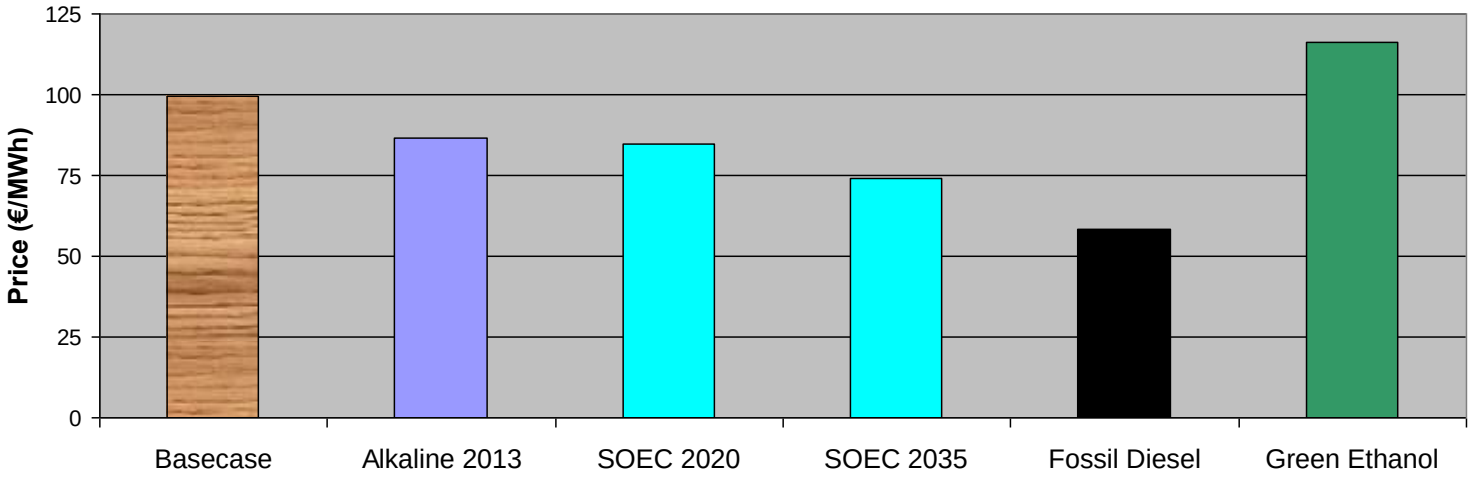
Solid Oxide Electrolysis



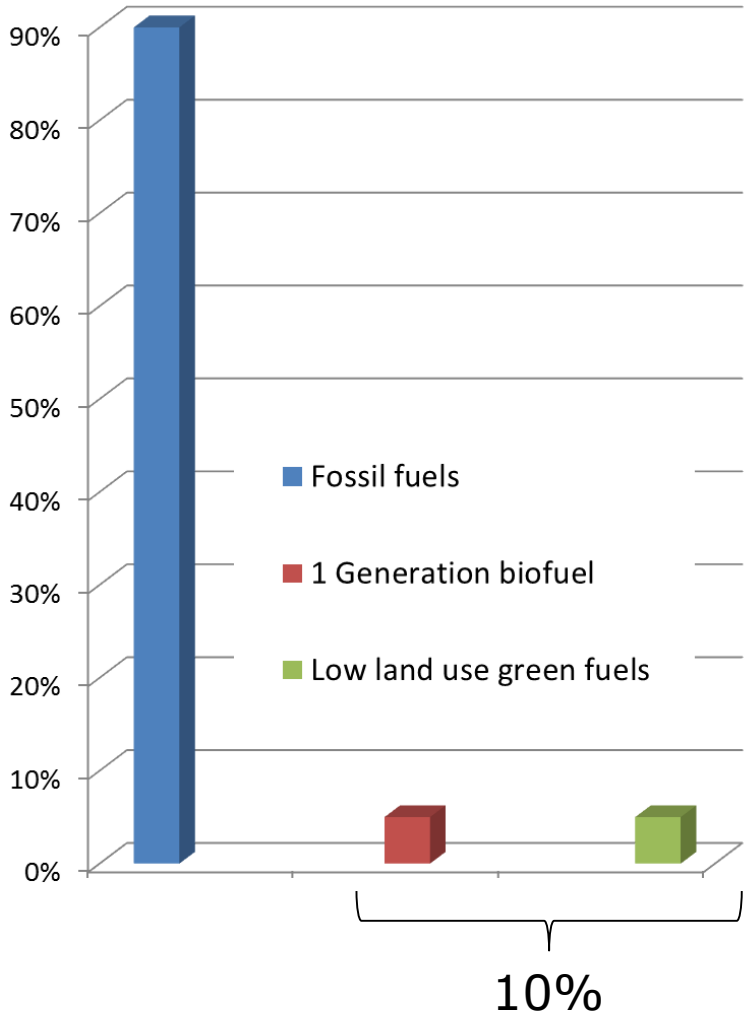
SOEC (high temperature electrolysis) is typically 50% more efficient than traditional room temperature electrolysis

Example 1. Wood –> Methanol





A Green fuel market



Proposed amendment to the Renewable Energy Directive (RED) 2009/28 /EC

- "ILUC Amendment" - October 2012
- 10% of transport energy is from renewable sources
- Only 5% of energy should come from first generation biofuels

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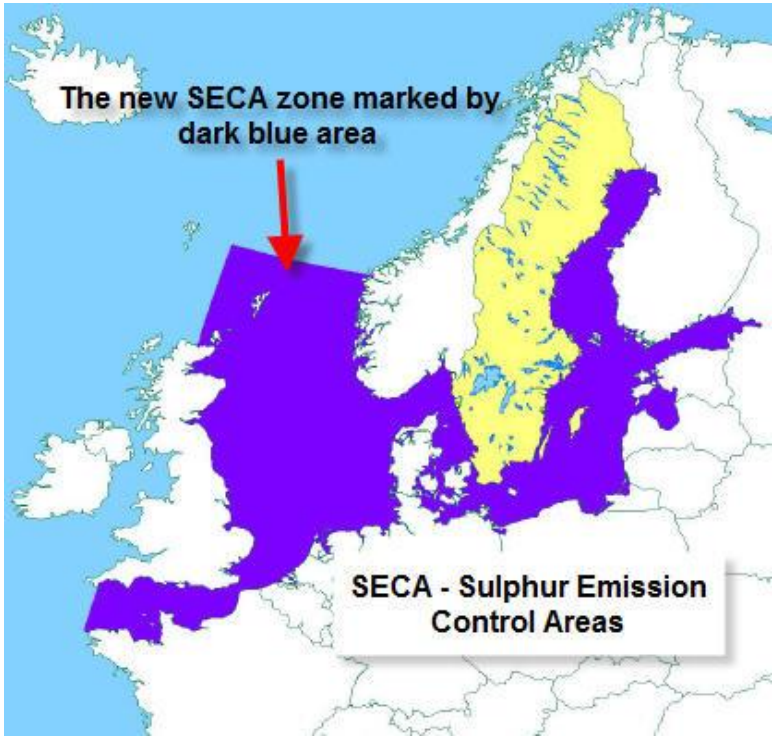
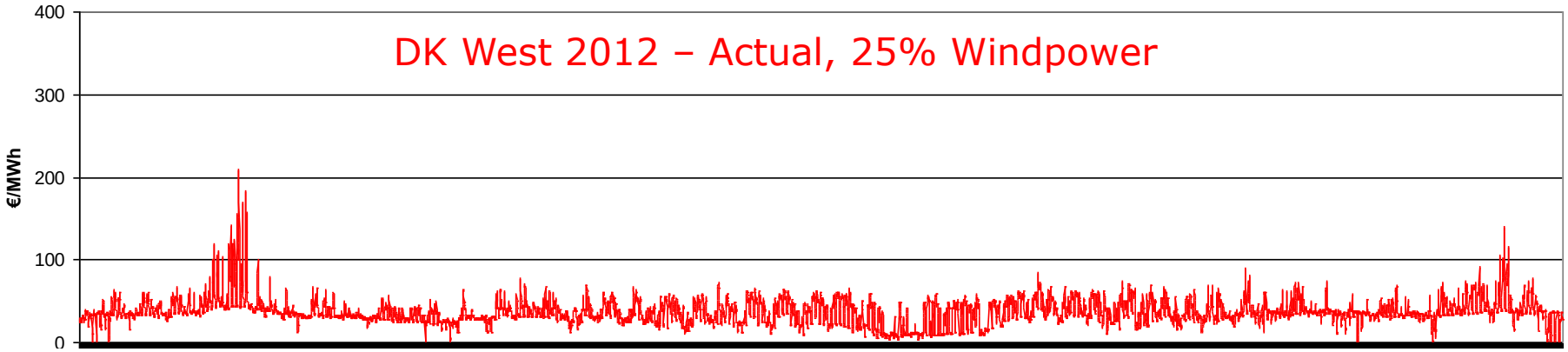
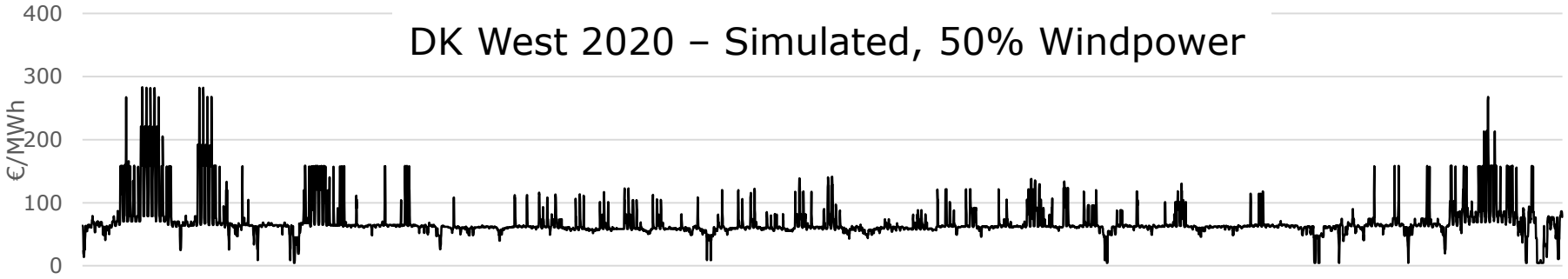
New marine fuels



Electricity prices & Load balancing





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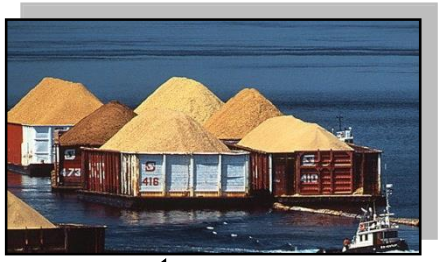
Six Nordic cases

Wood to MeOH



Landfill gas

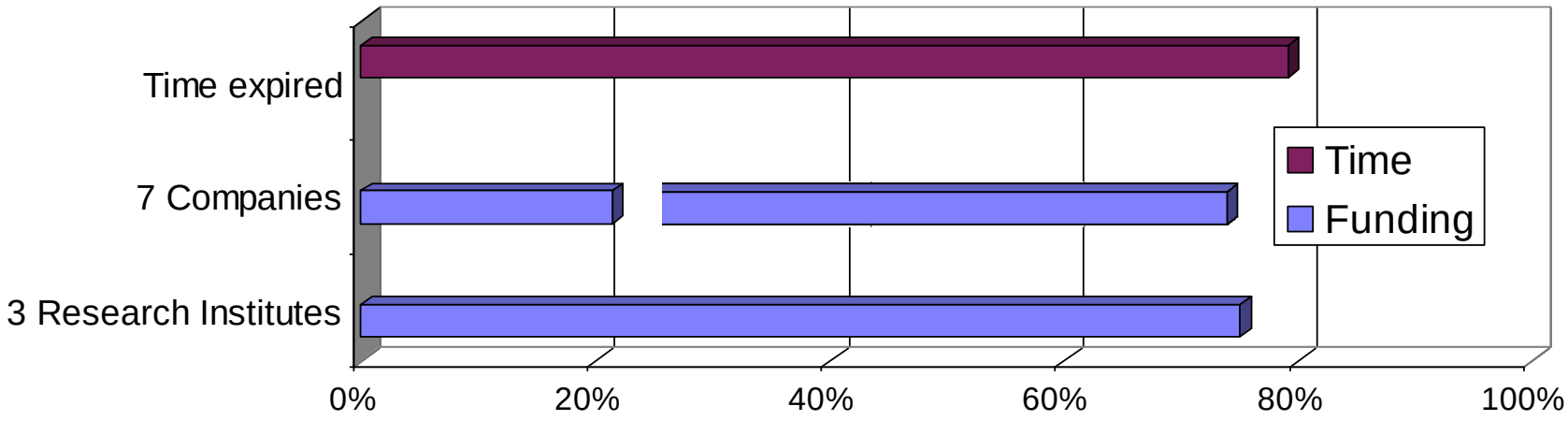
CO_2 to Methane

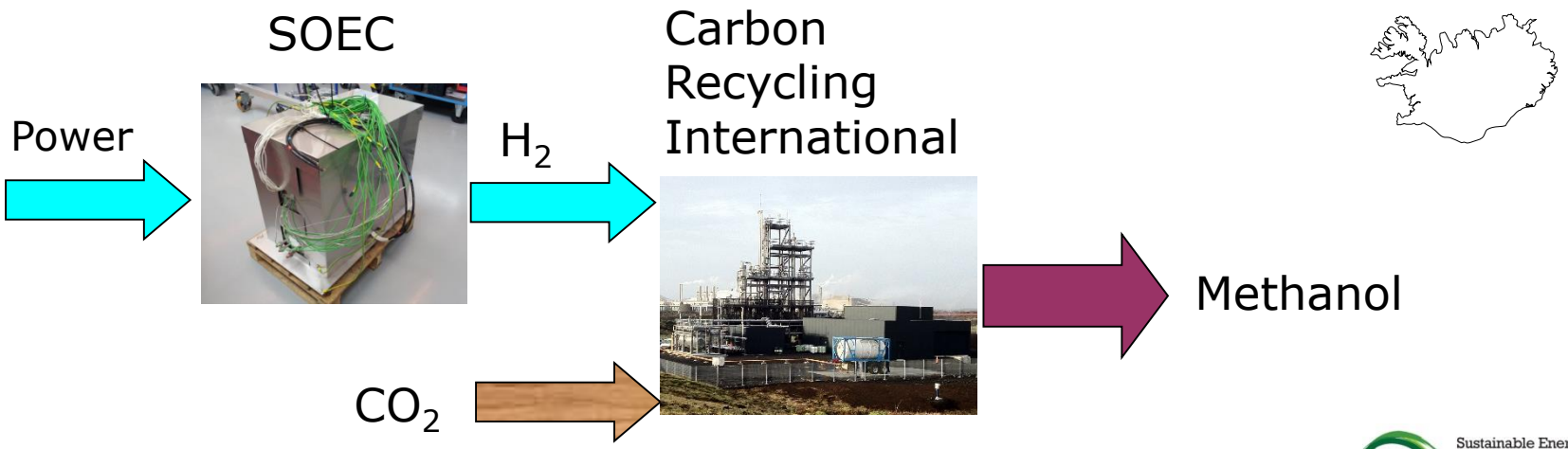
Biogas

Black Liquer to DME

Wood to Methane

Funding used & New tasks





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Summary

- Green hydrocarbon based fuels are essential for a sustainable transport sector
- Combining electrolysis and biomass can increase capacity and reduce cost
- 'Land use' considerations make the the CO2 Electrofuels business case look attractive for regions with low electricity cost
  - Difficult to quantify future electricity cost fluctiations and hence to make the business case for other regions

Next step is to demonstrate CO2 Electrofuels w. SOEC on Iceland