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Electric vehicles or use of hydrogen in the Norwegian transport sector in 2050?

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TOP NEST workshop - WP2

NIFU, Oslo, 2 June 2015



Agenda

- Research motivation
- STREAM model
- 2050 scenarios - reference, EV and H₂
- Scenario results
 - In a Nordic content



Research motivation Norway

- highest number of electric vehicles per capita in the world
 - 43,442 EV per December 2014

Radical restructuring of fuel use and vehicle stock

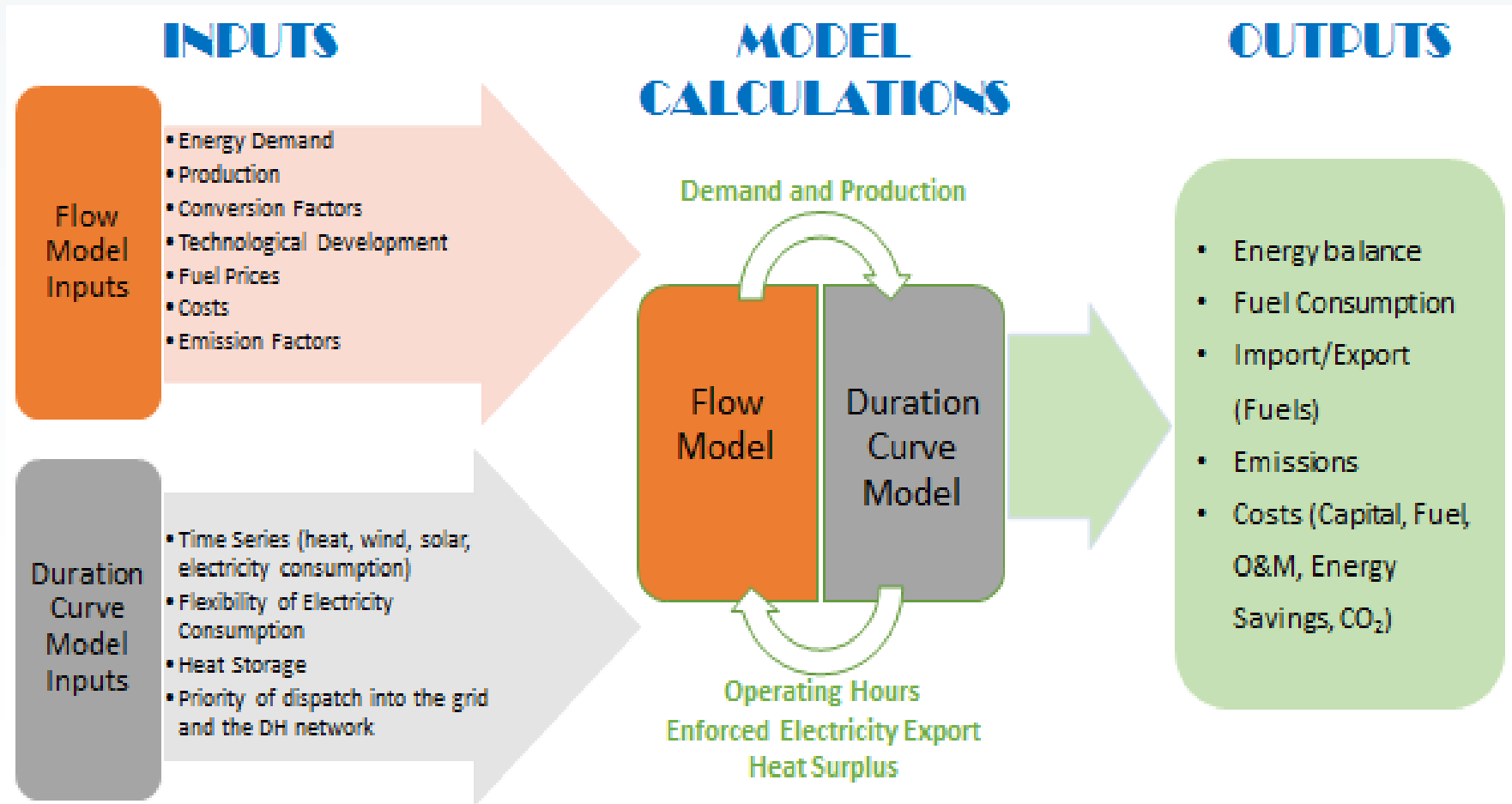
System integration with the electricity market

- A significant share of the electricity demand will come from the transport sector - directly or in-directly via H₂ production
- Larger share of wind in the power supply in the future
- Limited domestic biomass resources
- Need for a flexible demand?
- EV or H₂?
 - Which costs?
 - Interaction with the energy sectors?

**Need for holistic
systems analysis:
Model simulations**



STREAM model



Scenarios for 2050

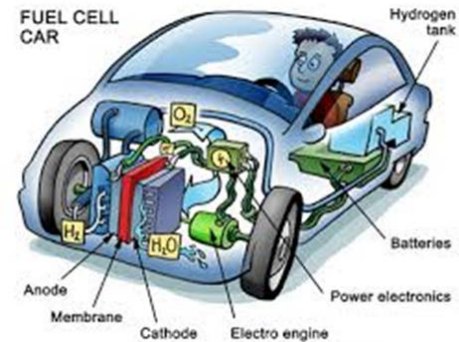
Carbon Neutral Scenario (CNS)
from NETP



Electric Vehicles (EV)



Hydrogen (H₂)



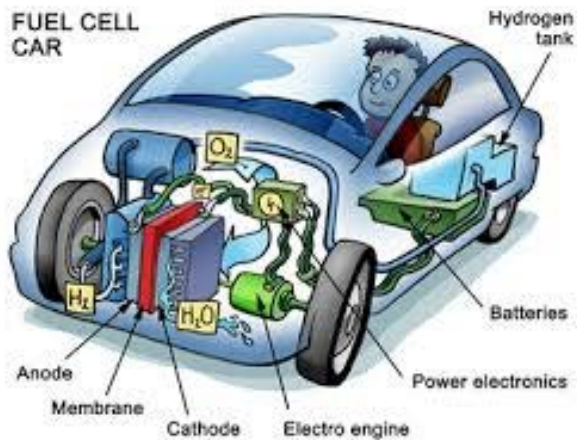
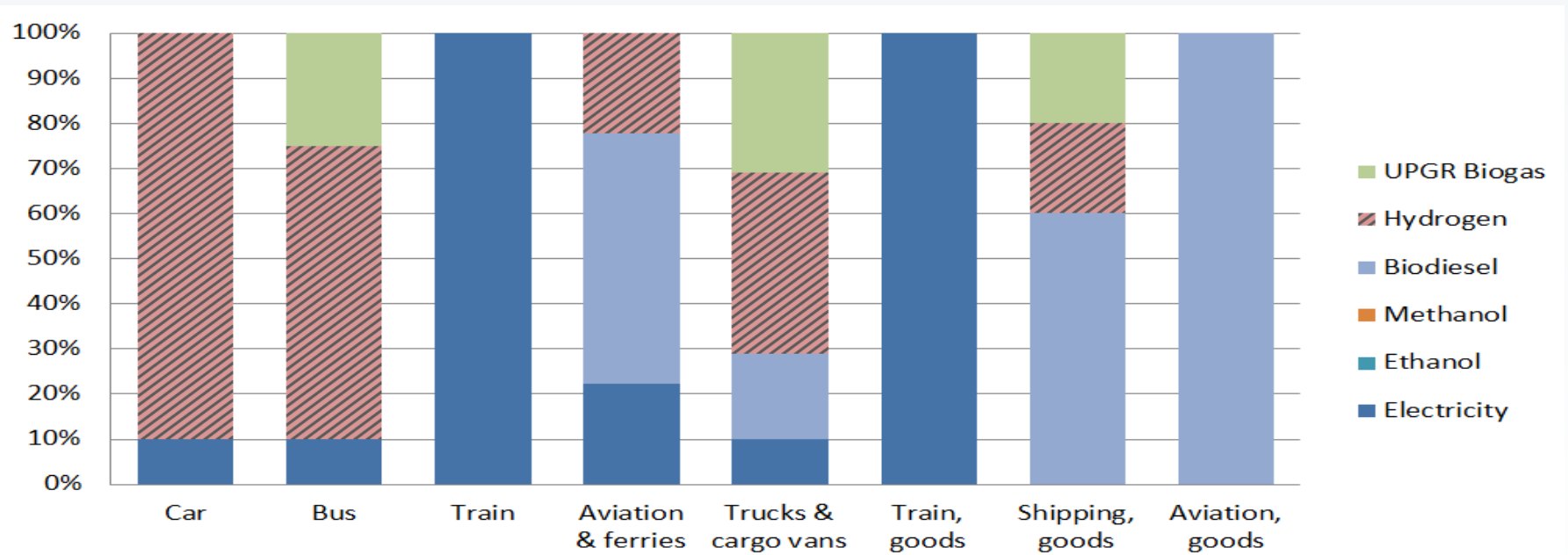
Reference - Carbon Neutral Scenario - CNS



Electric Vehicles Scenario - EV



Hydrogen Scenario - H₂

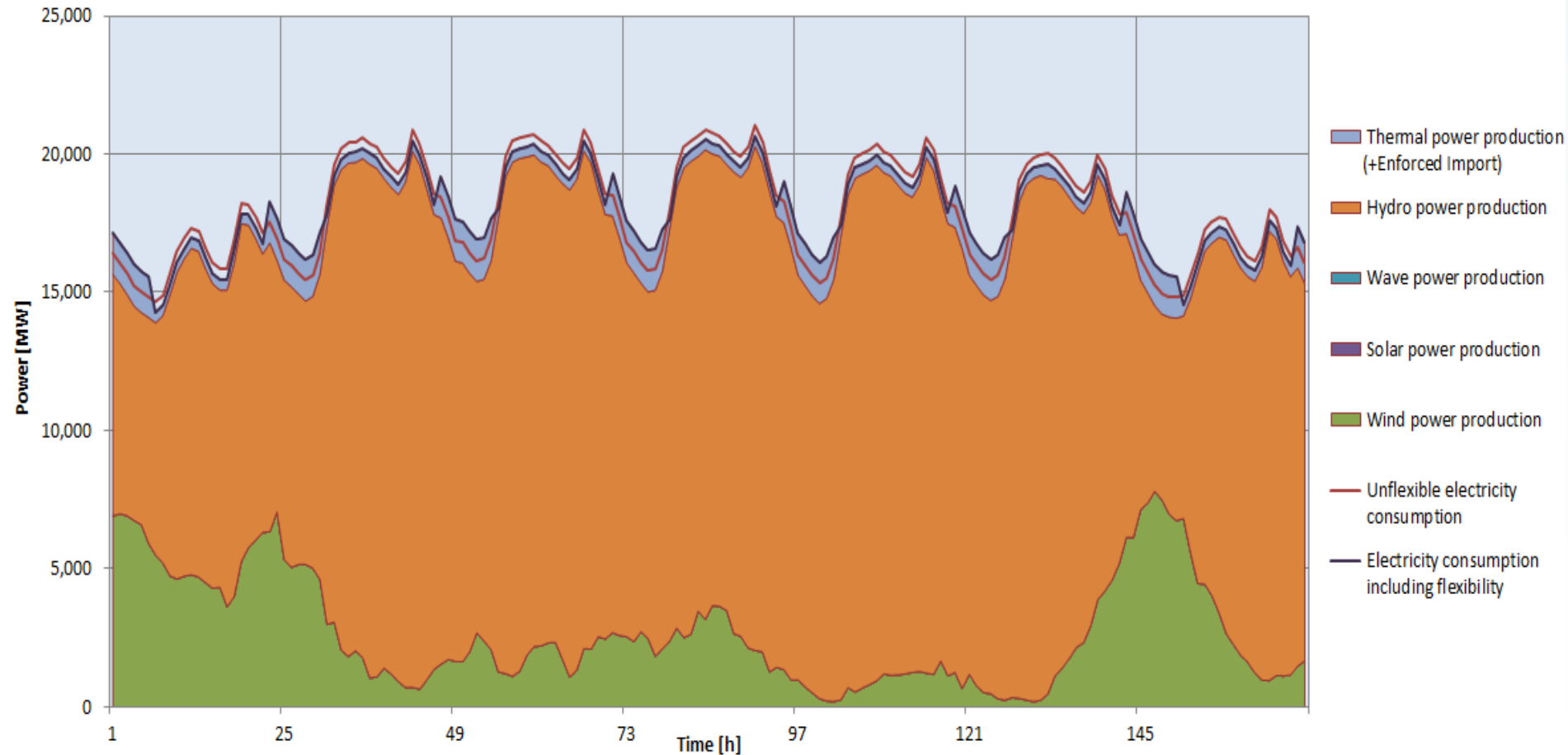


Technology mix in the electricity sector

Electricity production	Base	CNS 2050	EV	H ₂	Base	CNS 2050	EV	H ₂
					[TWh]	[TWh]	[TWh]	[TWh]
Coal Plant	0.1%	-	-	-	0.1	-	-	-
Gasturbine	4%	-	-	-	4.8	-	-	-
Wind, offshore	-	5%	5%	10%	-	5.9	7.7	15.1
Wind, onshore	1%	7%	12%	13%	0.9	8.7	16.8	19.7
Biomass	-	0.4%	0.4%	0.4%	0.5	0.5	0.6	0.6
Waste incineration	-	0.4%	0.4%	0.4%	-	0.5	0.6	0.6
Photo voltaic	-	-	-	-	-	-	-	-
Nuclear	-	-	-	-	-	-	-	-
Geothermal	-	-	-	-	-	-	-	-
Coal CCS	-	-	-	-	-	-	-	-
Biomass CCS	-	1%	-	-	-	1.3	-	-
Hydro	94%	87%	82%	76%	117.5	113.9	113.9	114
Electricity imports	1%	-	-	-	-	-	-	-
Total production		100%	100%	100%	123.8	130.9	139.5	149.9



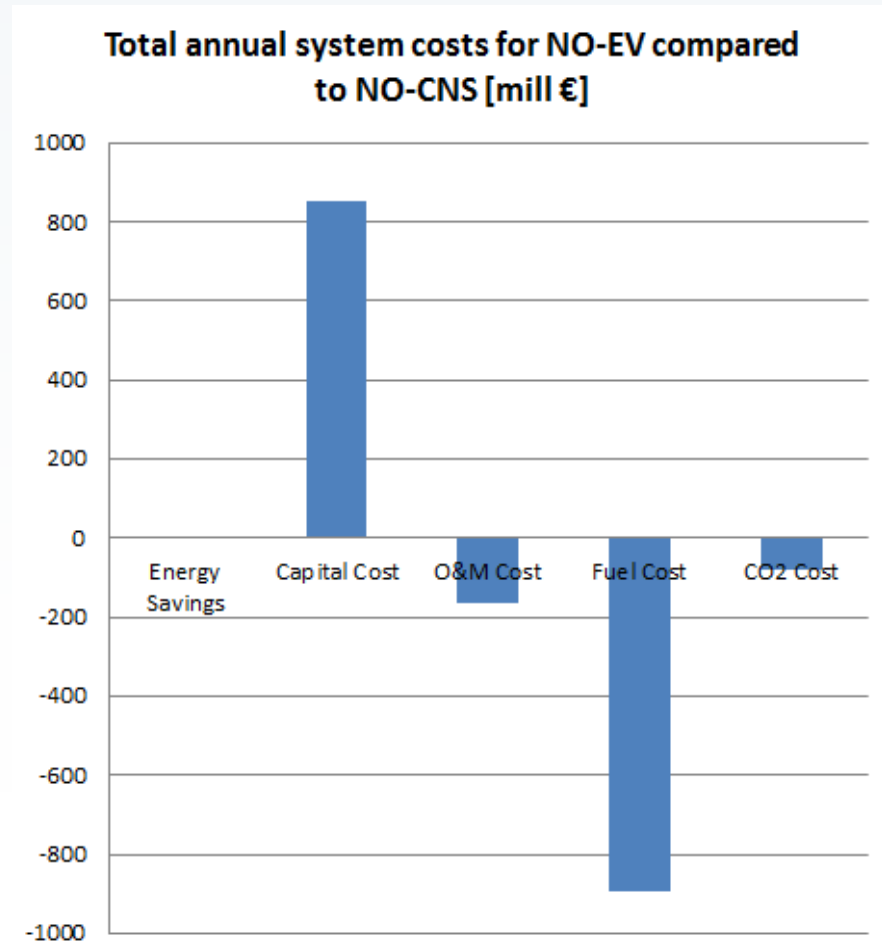
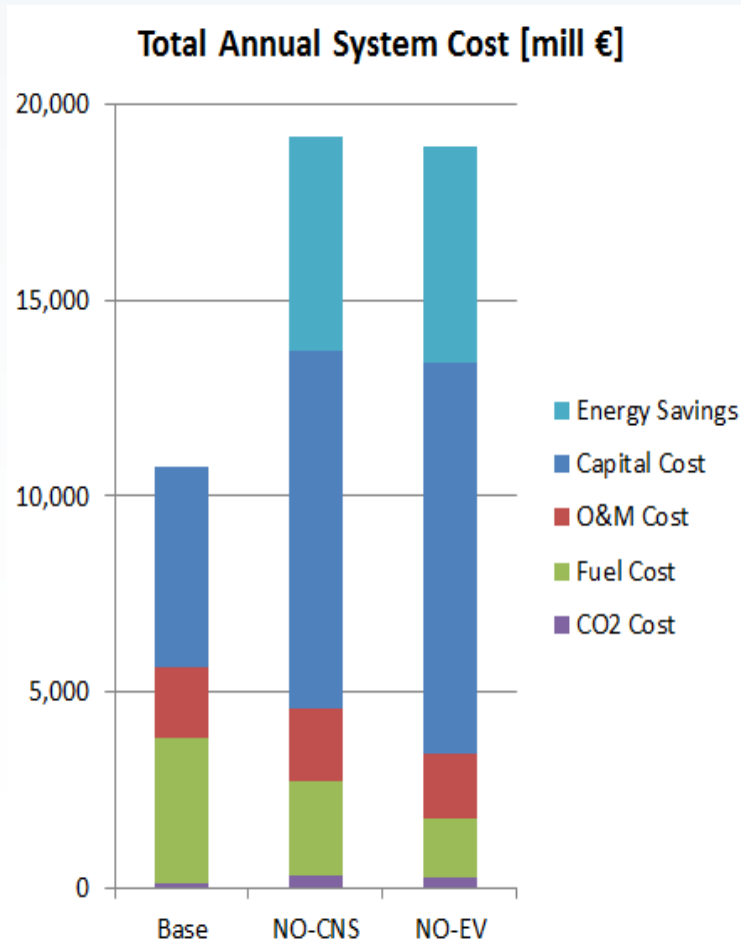
Scenario Results - EV



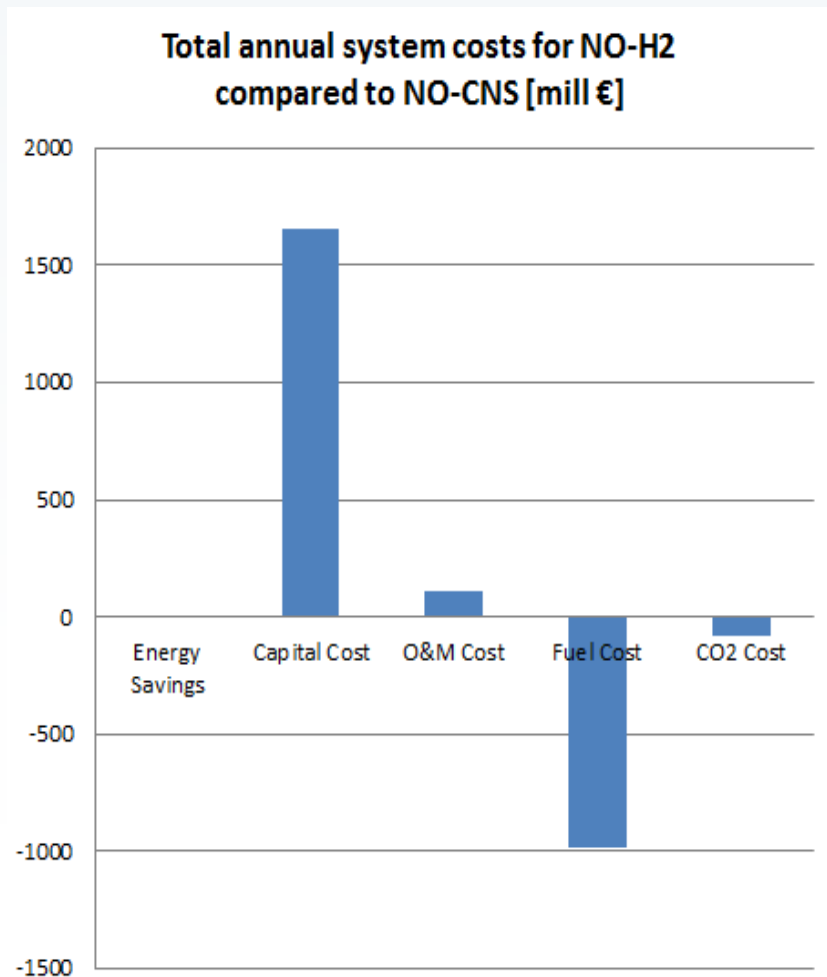
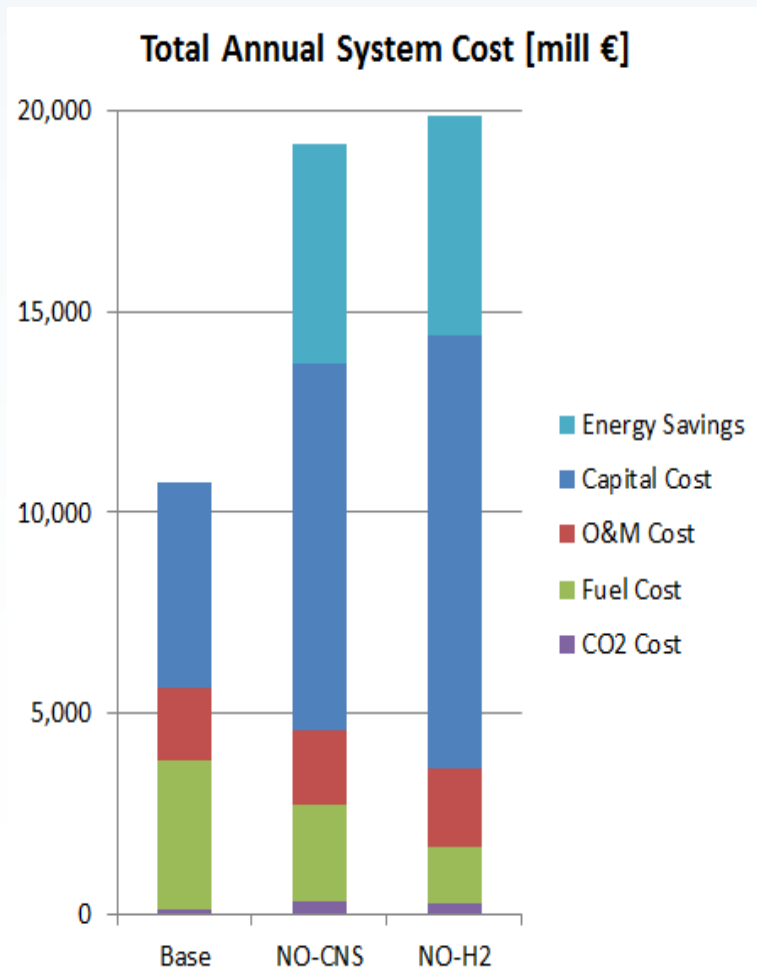
In contrast to the other Nordic countries, there is not a demand for the transport sector to have a flexible fuel demand in order for the Norwegian energy systems to adjust to a larger share of EV or H₂.



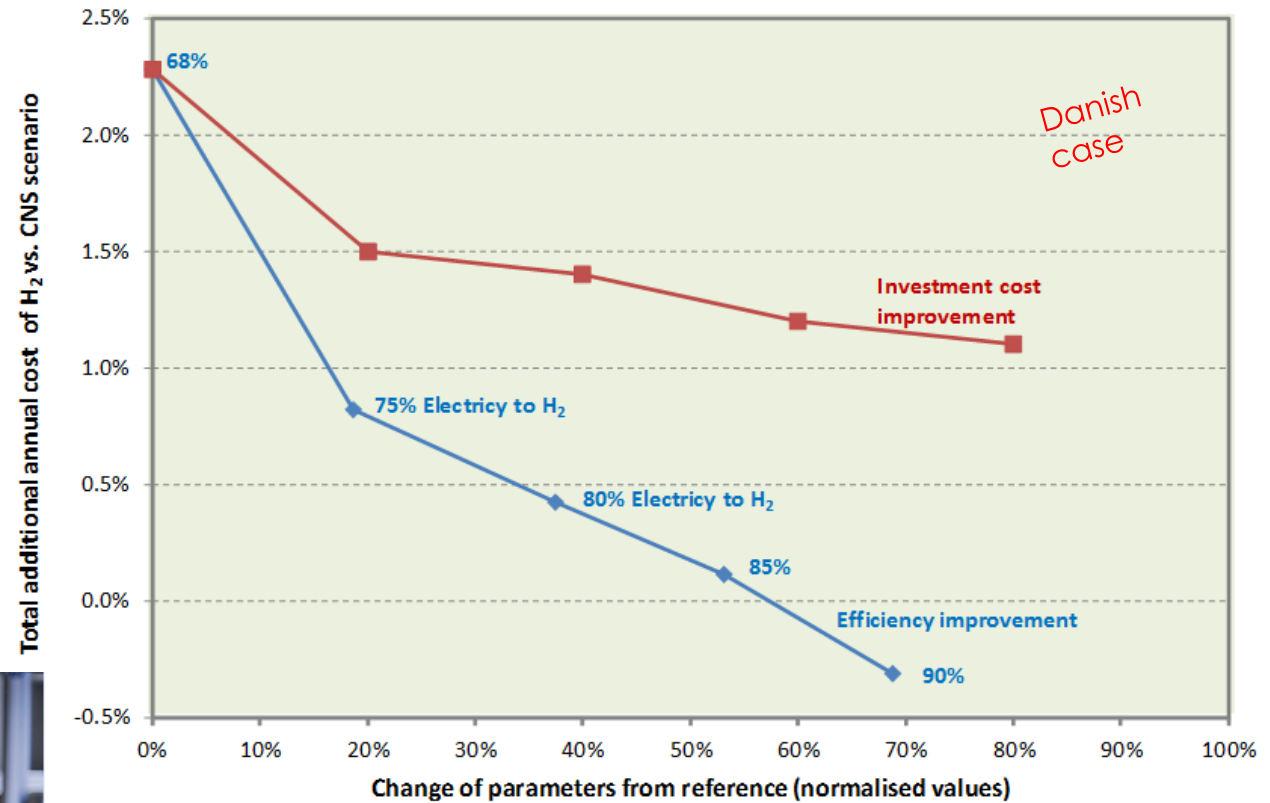
Total annual system costs and the difference between the CNS and the EV scenario (mill €)



Annual system costs and the difference between the CNS and the H₂ scenario (mill €)



Innovation and technological path - H₂



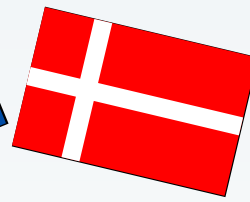
Danish case

Investment cost improvement

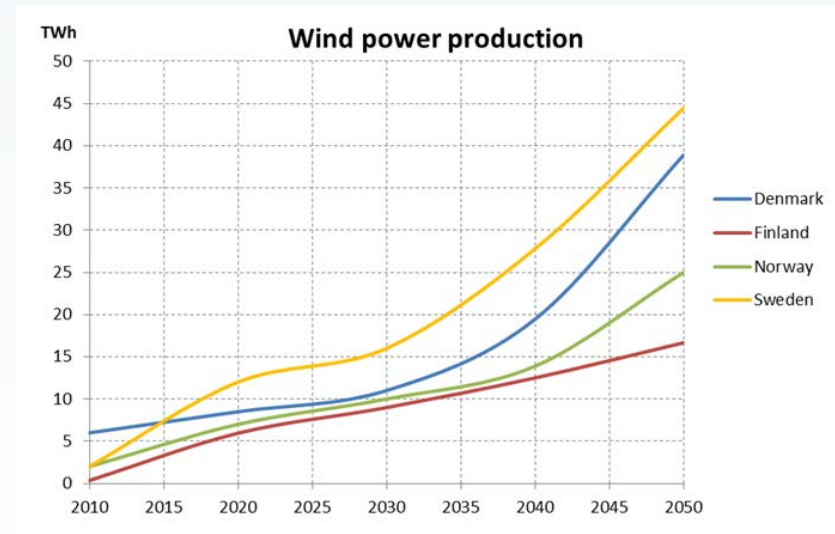
Efficiency improvement



In a Nordic content



- Large deployment of wind
- Need for flexibility - especially in DK
 - H₂ generation from electrolysis is more flexible than charging EV
- Hours with excess wind generation which release hydro-power capacity
 - Reduce the need for additional capacity in the H₂ scenario
 - Increase the value of Hydro power



- Biomass resources in Finland and Sweden
 - Bio-fuels cheaper
 - depends on the development of 2nd and 3th generation bio-refineries



Main findings

- EV could reduce the socio-economic cost of the system in 2050
- The Norwegian hydropower supply is very flexible and can therefore easily adjust to the variable electricity generation from wind energy
 - no demand for the transport sector to have a flexible fuel demand in order for the Norwegian energy systems to adjust to a larger share of EV or H₂.
- More Nordic integration and use of excess generation might decrease the cost of the H₂ scenario



Thank you for your interest

Questions ?



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Resources available and used (PJ)

