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

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

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Agenda

- Research motivation
- STREAM model
- 2050 scenarios - reference, EV and H_2
- 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

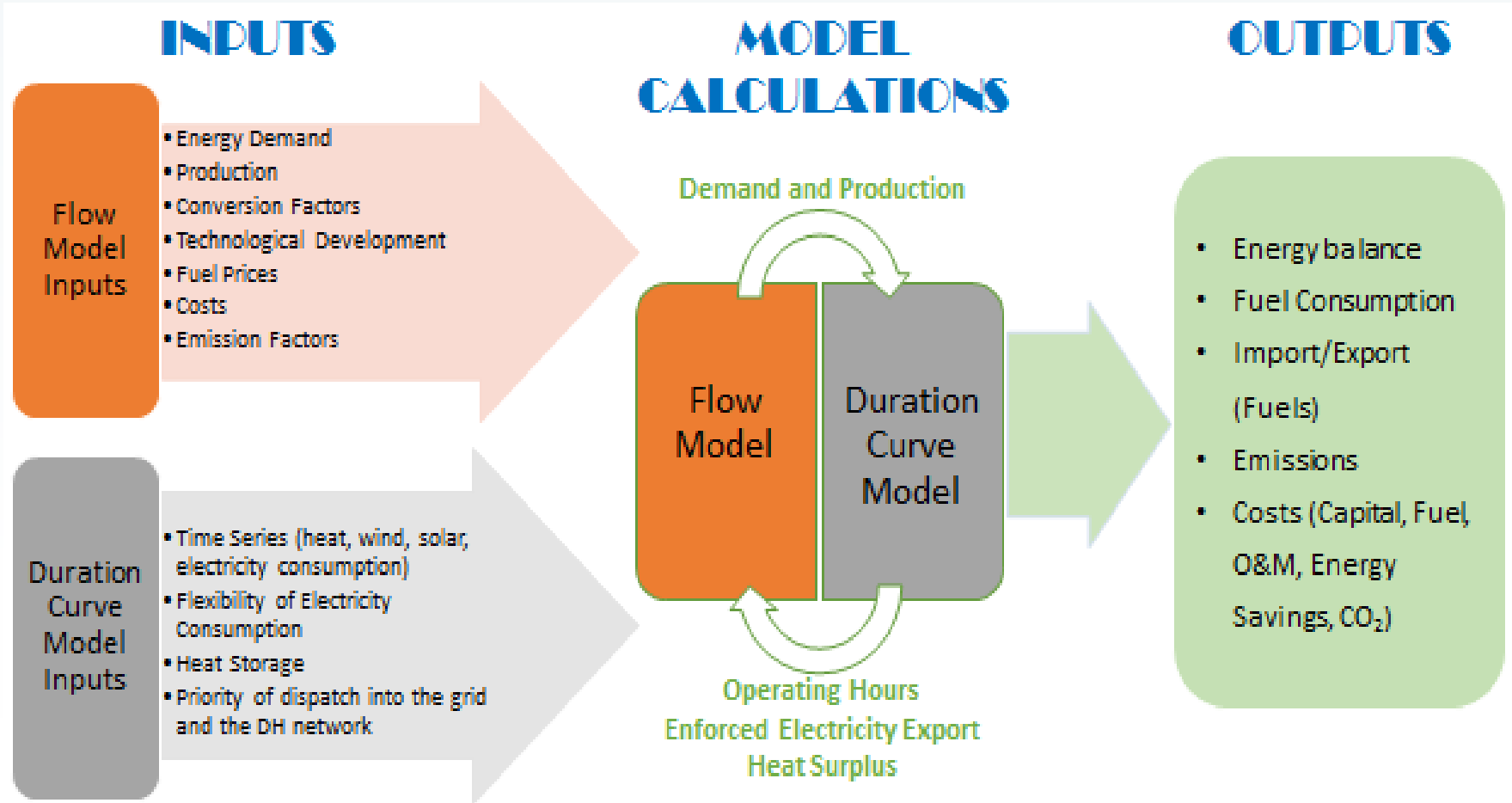
- A significant share of the electricity demand will come from the transport sector - directly or in-directly via H_2 production

- Larger share of wind in the power supply in the future
- Limited domestic biomass resources
- Need for a flexible demand?

- EV or H_2?
  Which costs?
  Interaction with the energy sectors?

Need for holistic systems analysis: Model simulations

STREAM model

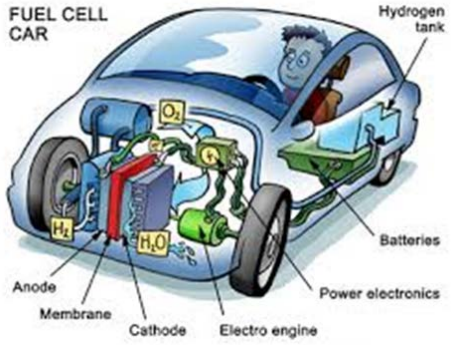


Scenarios for 2050

Carbon Neutral Scenario (CNS) from NETP

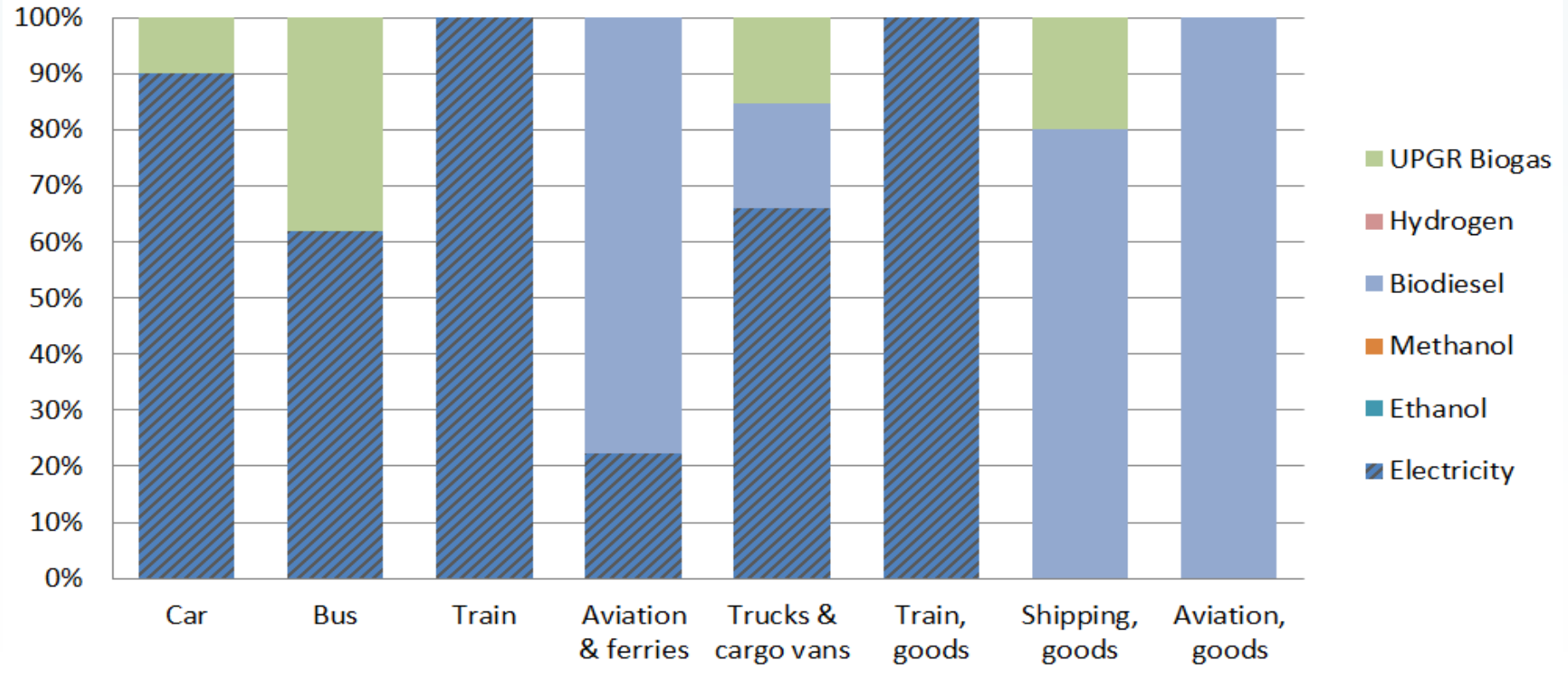
Electric Vehicles (EV)

Hydrogen (H_2)

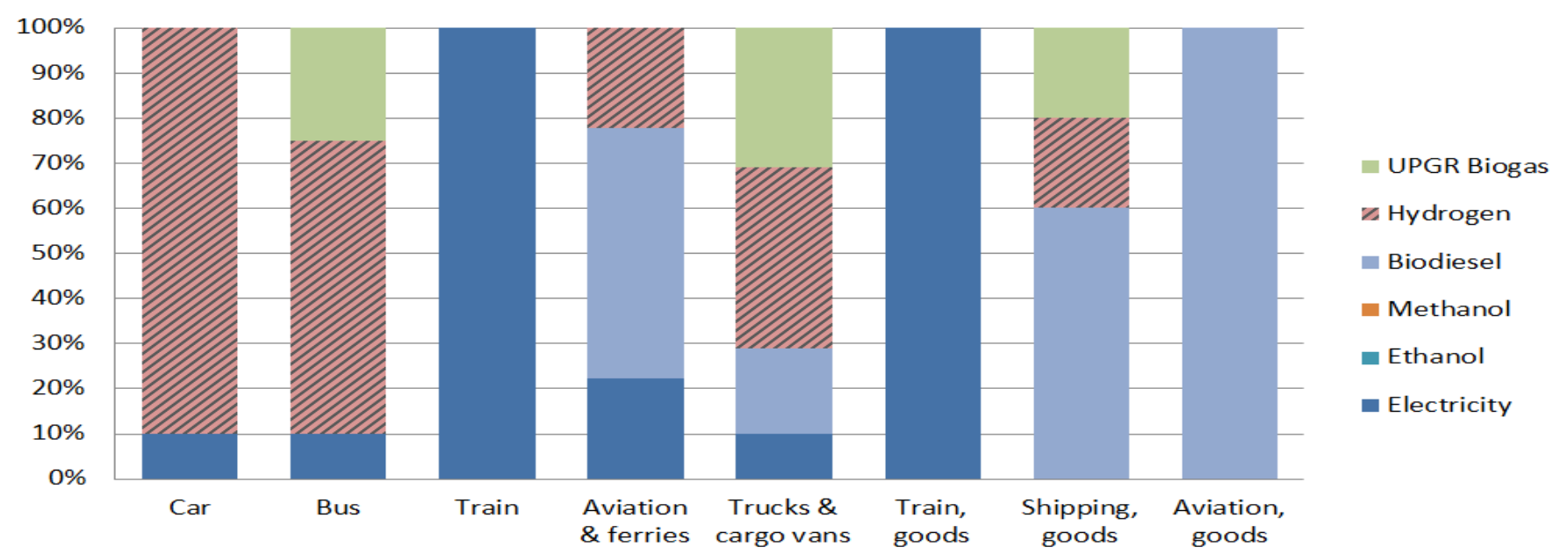


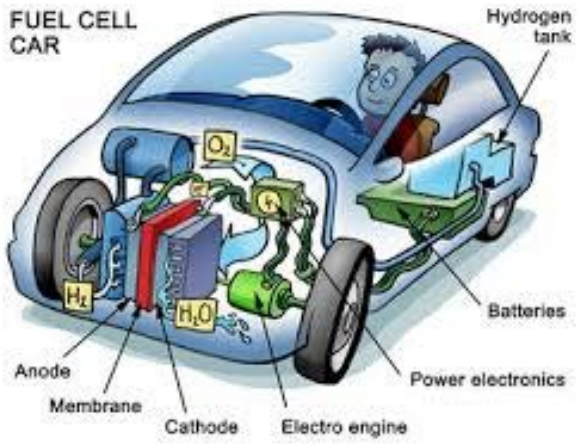
Reference - Carbon Neutral Scenario - CNS

Electric Vehicles Scenario - EV



Hydrogen Scenario - H_2



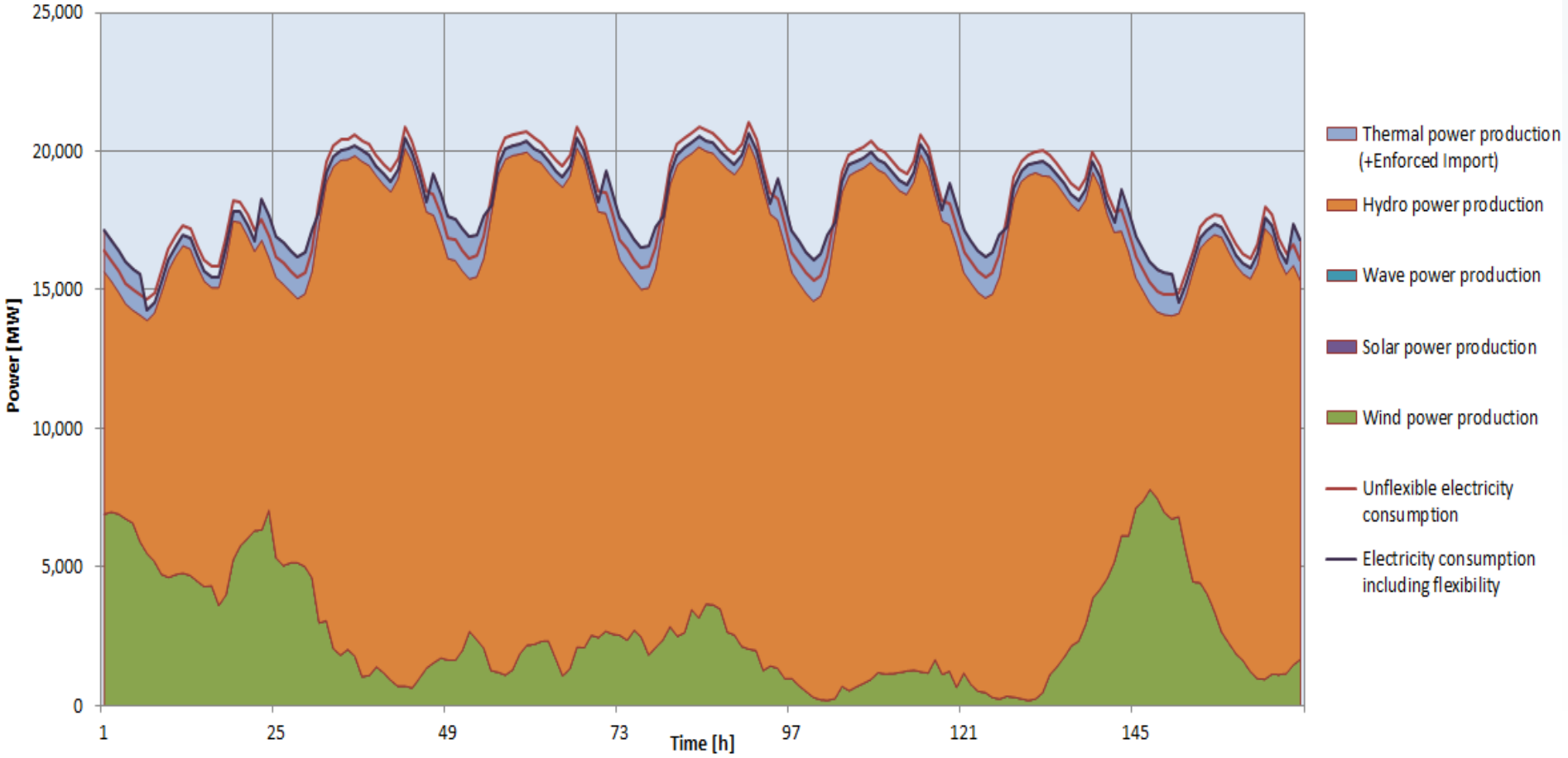


Technology mix in the electricity sector

Electricity production

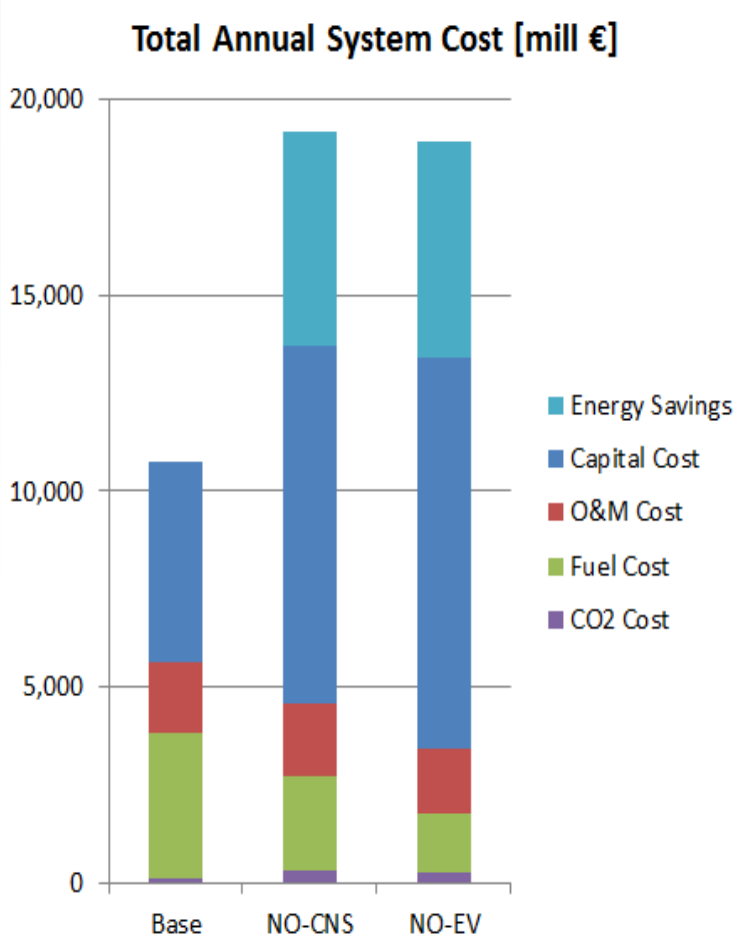
	Base	CNS 2050	EV	H_2	Base	CNS 2050	EV	H_2
					[TWh]	[TWh]	[TWh]	[TWh]
Coal Plant	0.1%	-	-	-	0.1	-	-	-
Gasturbine	4%	-	-	-	4.8	-	-	-
Wind, offshore	**-**	**5%**	**5%**	**10%**	-	5.9	7.7	15.1
Wind, onshore	**1%**	**7%**	**12%**	**13%**	0.9	8.7	16.8	19.7
Biomass	-	0.4%	0.4%	0.4%	0.5	0.5	0.6	0.6
Waste incineration	-	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

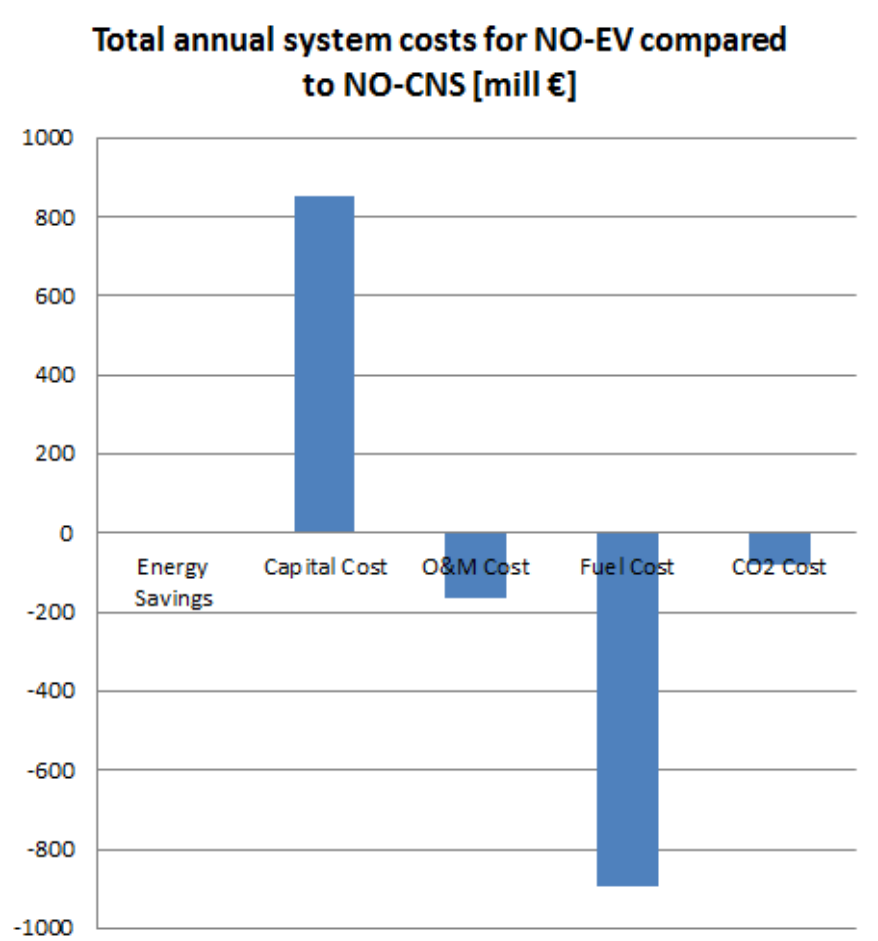
Scenario Results - EV



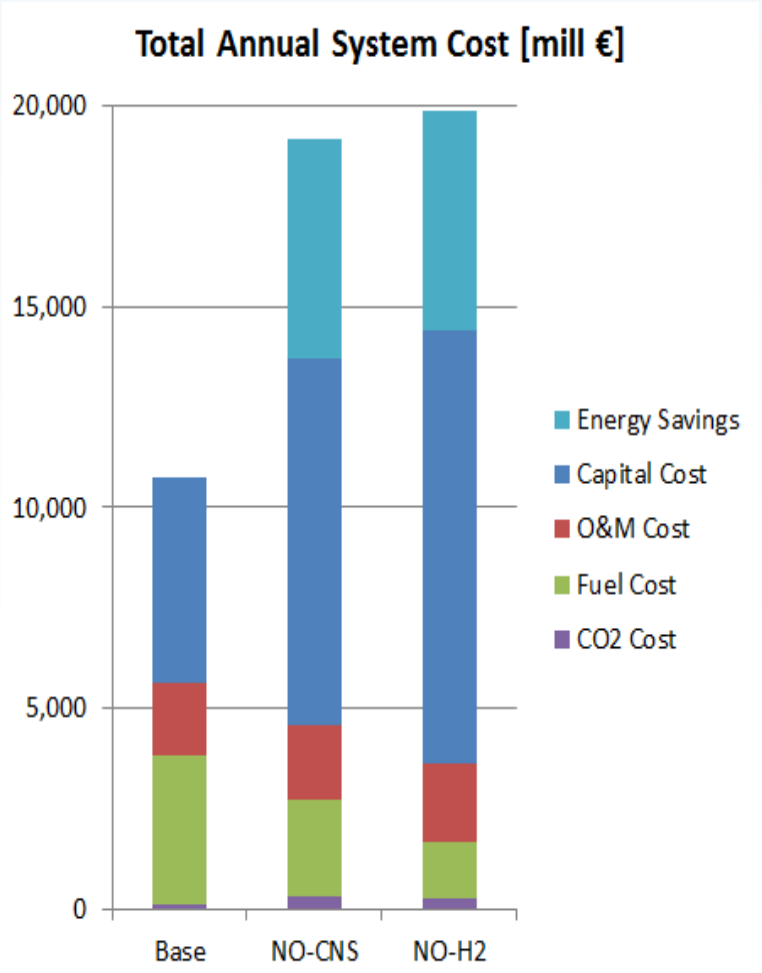
In contrast to the other Nordic countries, there is not a demand for the transport sector to have a flexible fuel demand in order for the Norwegian energy systems to adjust to a larger share of EV or H_2.

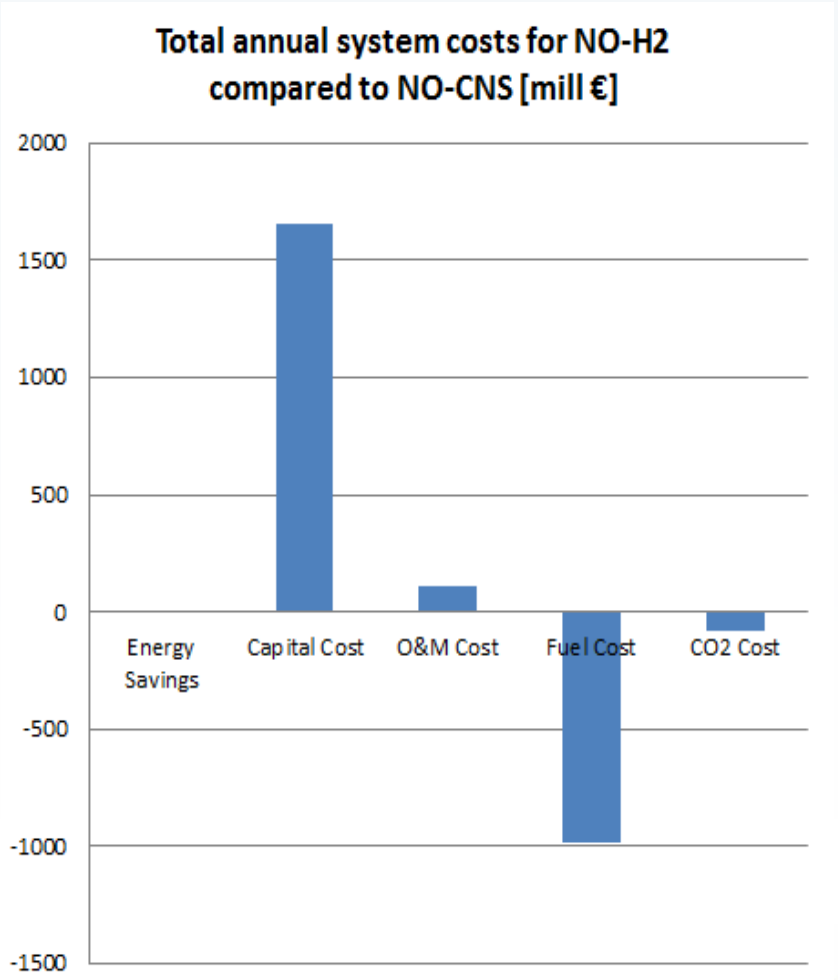
Total annual system costs and the difference between the CNS and the EV scenario (mill €)



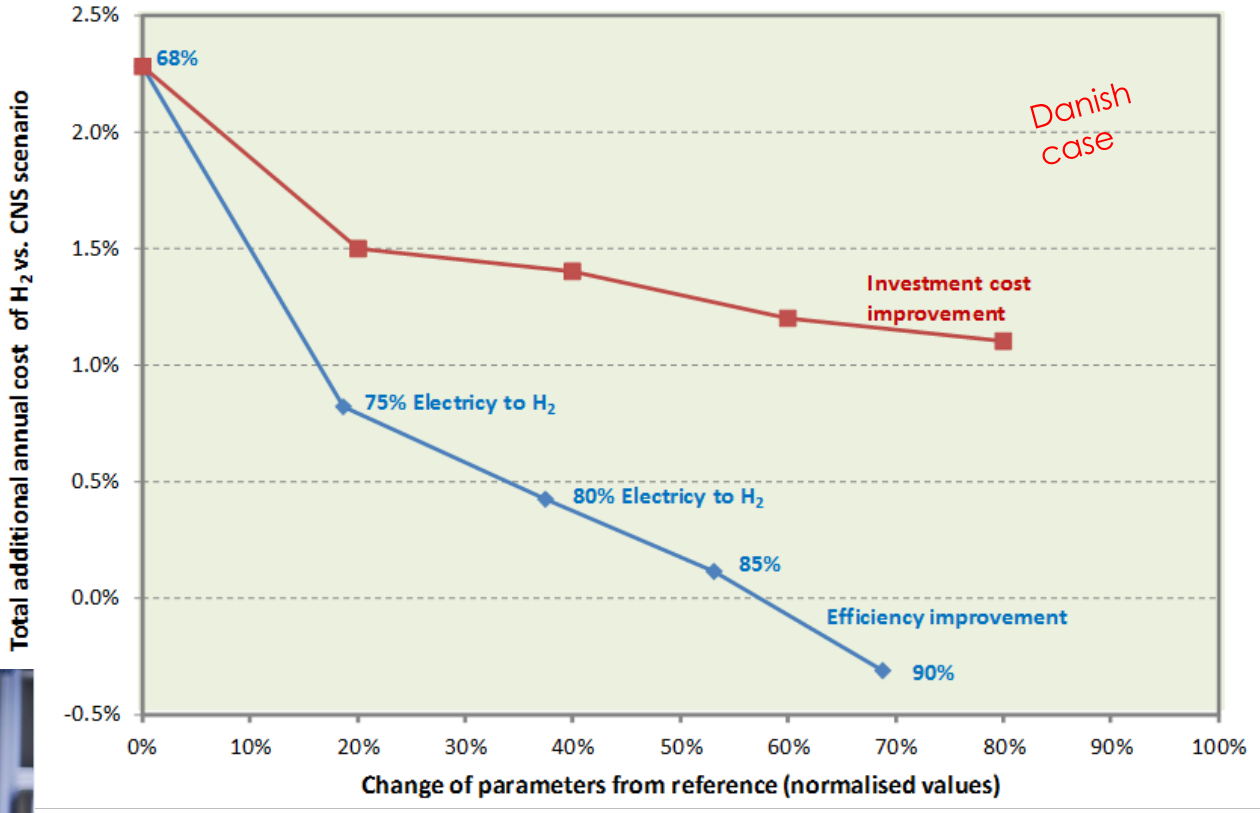


Annual system costs and the difference between the CNS and the H_2 scenario (mill €)

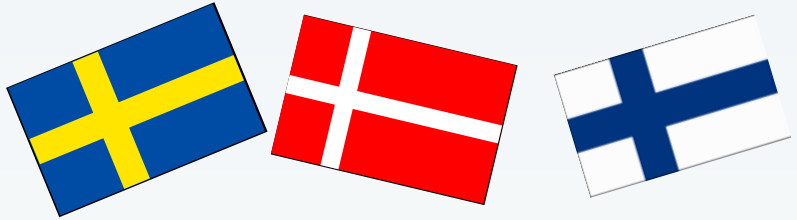




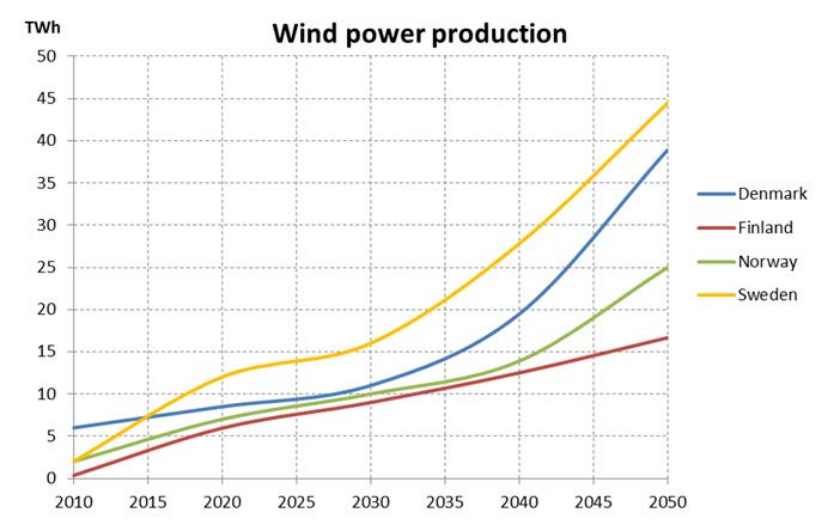
Innovation and technological path - H_2



In a Nordic content



- Large deployment of wind
- Need for flexibility - especially in DK
  - H_2 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 H_2 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 therefor 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 H_2.
- More Nordic integration and use of excess generation might decrease the cost of the H_2 scenario

Thank you for your interest

Questions ?

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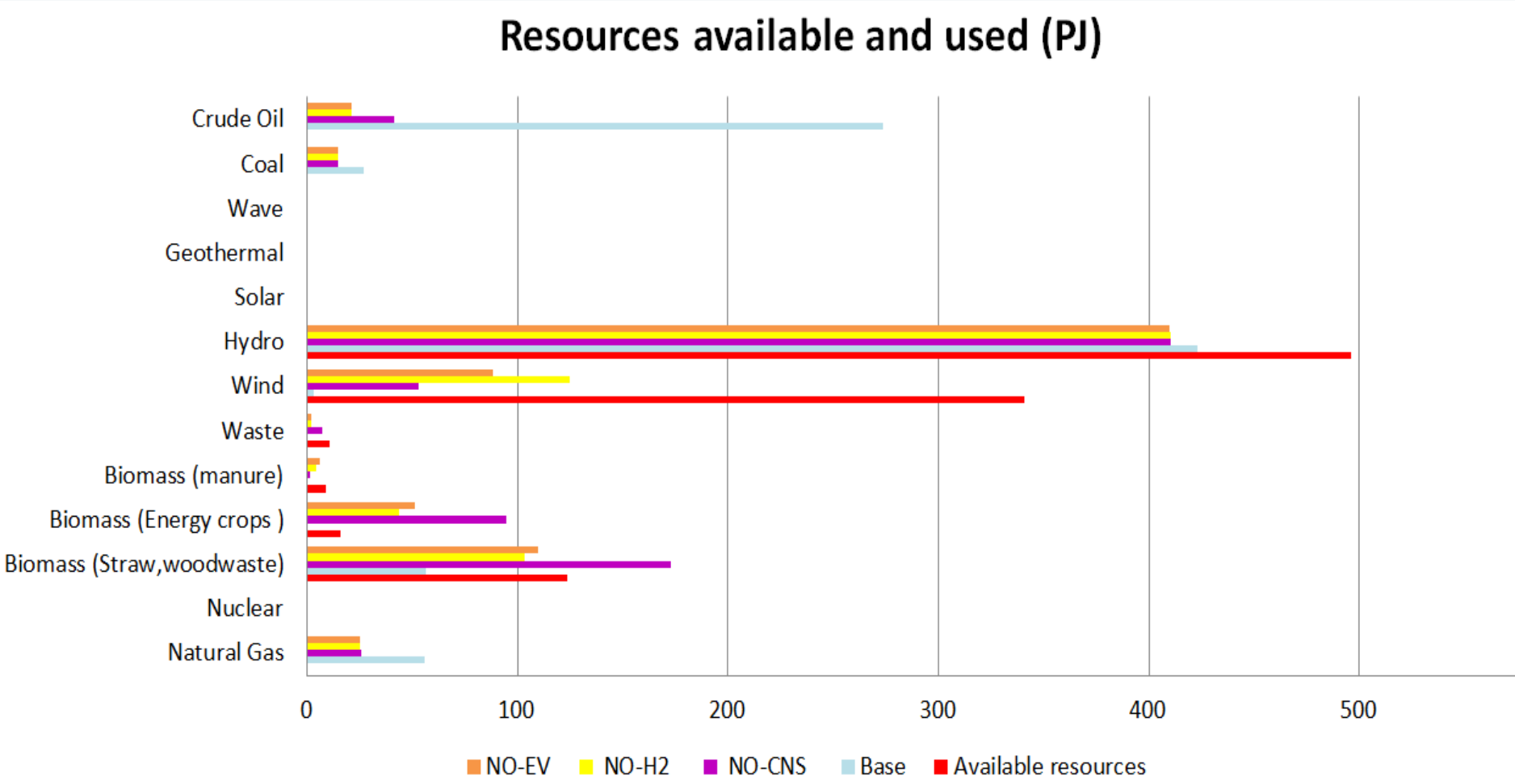
Resources available and used (PJ)
Crude Oil
Coal
Wave
Geothermal
Solar
Hydro
Wind
Waste
Biomass (manure)
Biomass (Energy crops)
Biomass (Straw,woodwaste)
Nuclear
Natural Gas
0
100
200
300
400
500
NO-EV
NO-H2
NO-CNS
Base
Available resources