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

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DTU Management Engineering

Department of Management Engineering

Agenda



Research motivation

STREAM model

■ 2050 scenarios - reference, EV and H₂

Scenario results

In a Nordic content



Research motivation Norway

DTU

- 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?



STREAM model



OUTDUTS

INPUTS



MODEL



Carbon Neutral Scenario (CNS) from NETP

Electric Vehicles (EV)

Hydrogen (H_2)

Scenarios for 2050









Reference - Carbon Neutral Scenario - CNS







Hydrogen Scenario - H₂









Technology mix in the electricity sector

	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





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





Total annual system costs for NO-EV compared to NO-CNS [mill €]



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





Innovation and technological path - H₂







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 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 H₂.
- More Nordic integration and use of excess generation might decrease the cost of the H₂ scenario



Thank you for your interest







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