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The Nordic low carbon transition and lessons for other countries

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BY THE NUMBERS

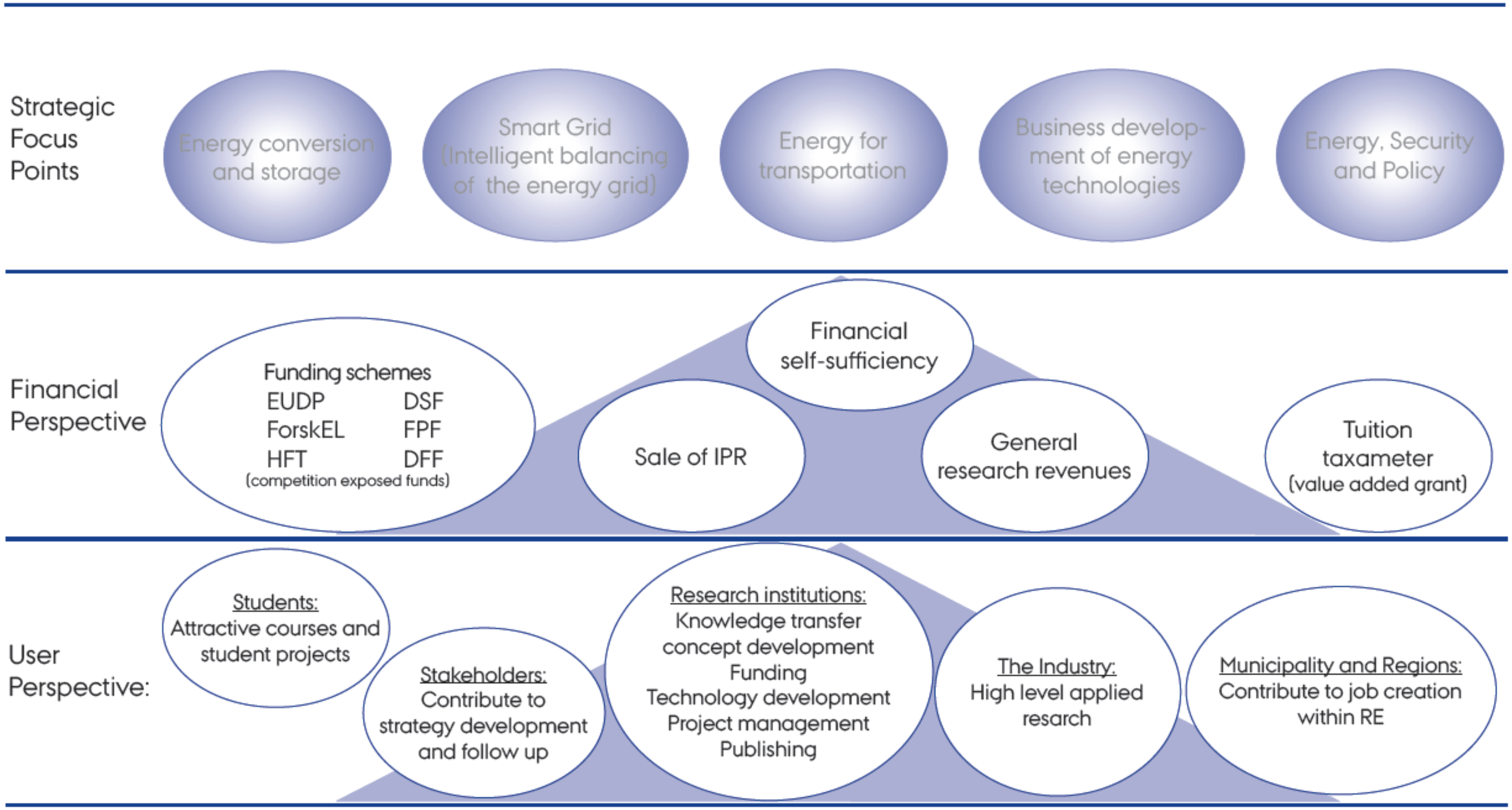
- 44,500 students
- 11,550 employees
- Graduates in 2013
  - Bachelor degrees: 4,445
  - Master's degrees: 4,002
  - PhDs: 450
- Top 100 university on world rankings
  - Leiden rankings: 51
  - ARWU Shanghai: 81
  - QS world university ranking: 91
  - Times higher education world ranking: 138

CENTER FOR ENERGY TECHNOLOGIES

STRATEGY MAP

VISION

Promote supply, conversion and use of renewable energy sources through contributions to policy, business and technology



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The need for better energy systems

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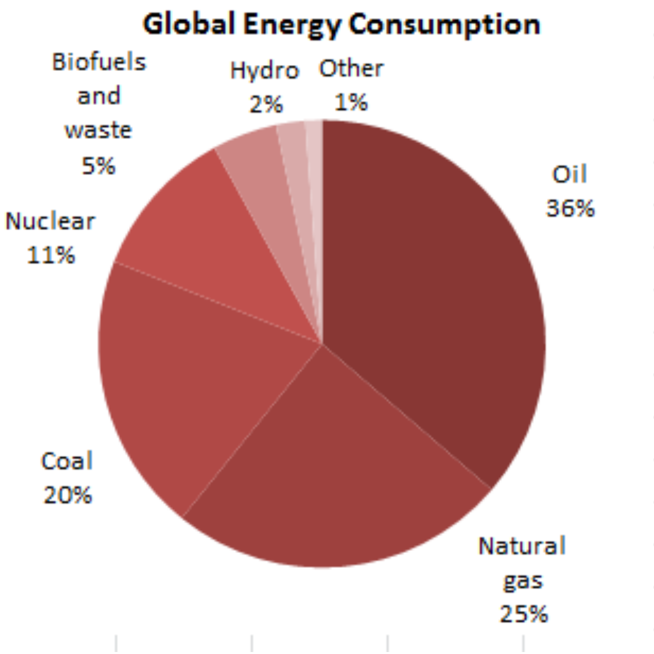
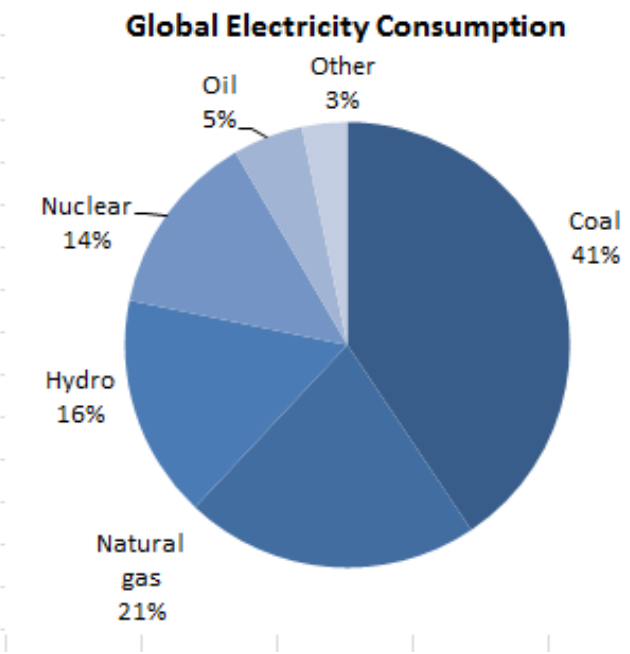
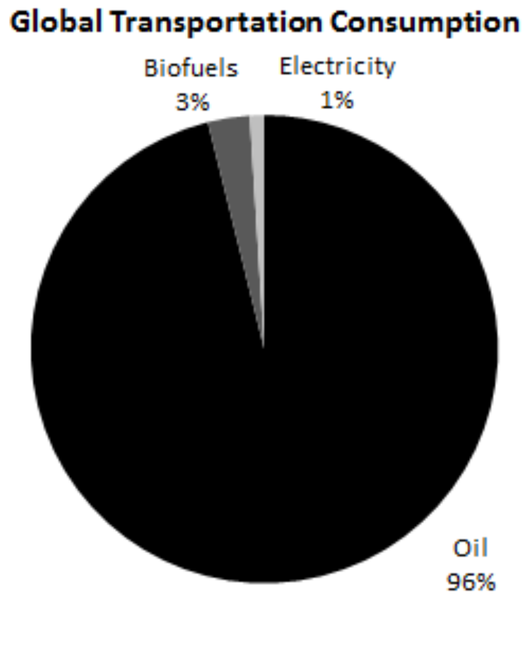
Global Final Energy Consumption, 2010



Amount = 5,413 mtoe



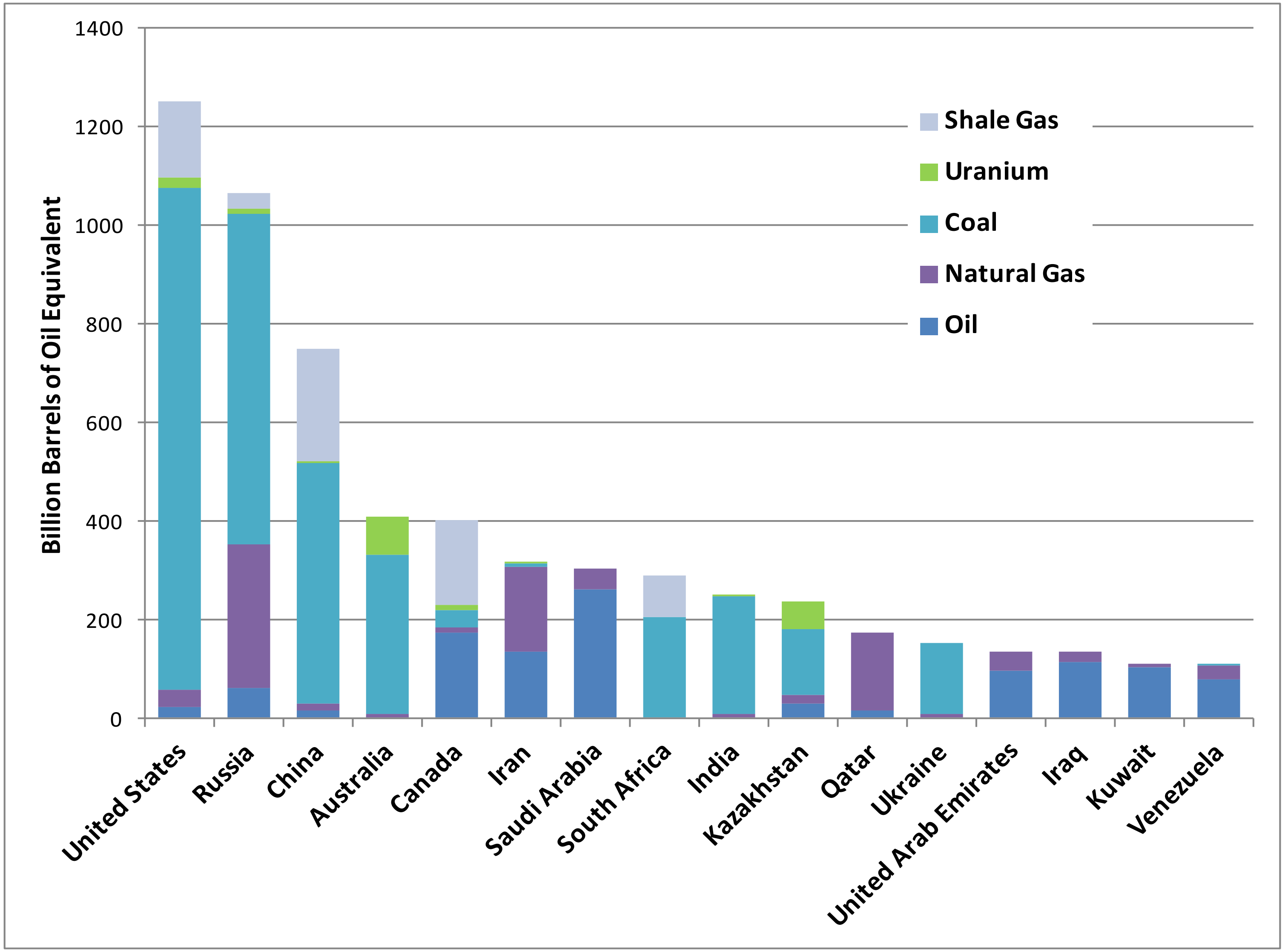
Amount = 20,055 TWh



Amount = 88 mbd

Renewable energy is largely the “other”!

Major Global Energy Reserves for Leading Energy Nations, 2012



Life Expectancy of Proven Fossil Fuel and Uranium Resources, 2012

	Proven Reserves	Current Production	Life Expectancy (Years)		
			0% Annual Production Growth Rate	1.6% Production Growth Rate	2.5% Production Growth Rate
Coal	930,400 million short tons	6,807 million short tons	137	85	61
Natural Gas	6,189 trillion cubic feet	104.0 trillion cubic feet	60	42	37
Petroleum	1317 billion barrels	30.560 billion barrels	43	33	30
Uranium	4,743,000 tons (at $130/kgU)	40,260 tons	118	67	56

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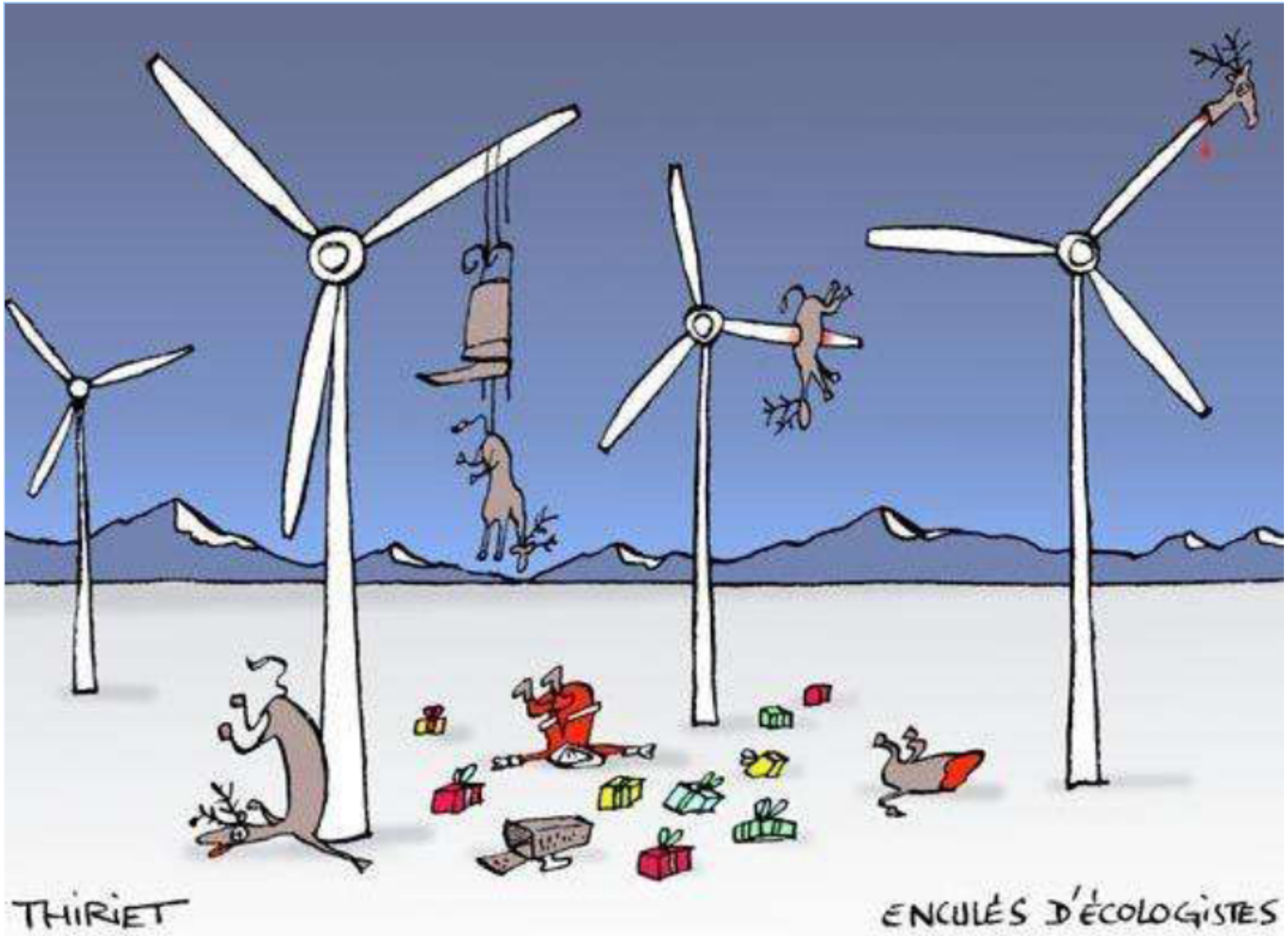
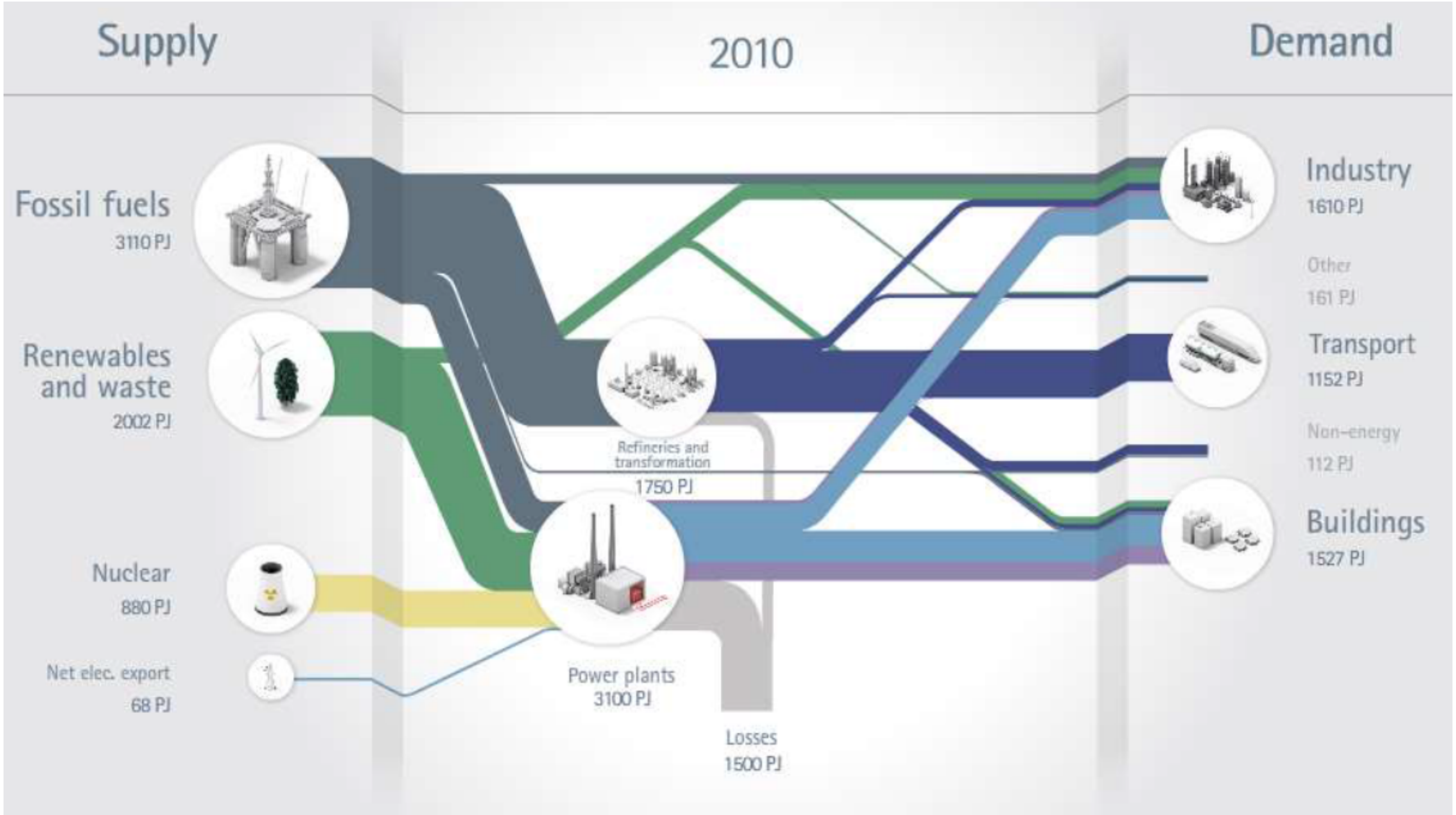


- The Nordic perspective

Nordic Energy Flows



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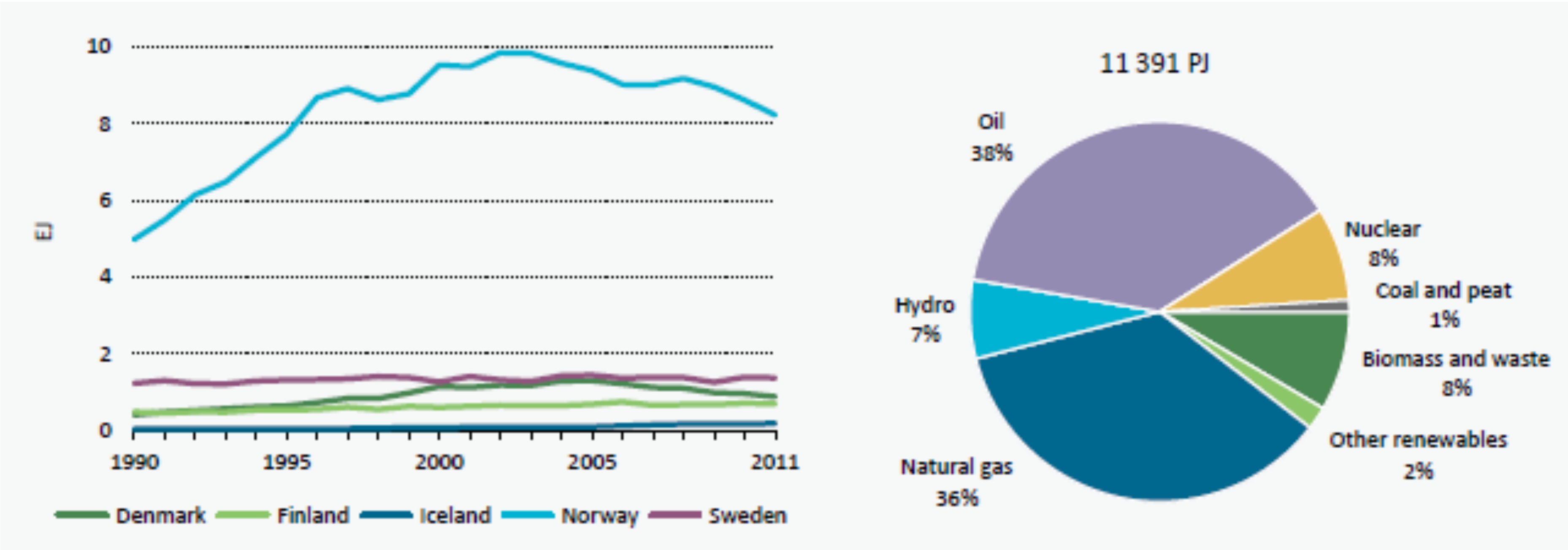
Primary energy production in Nordic countries; share of production by fuel, 2011



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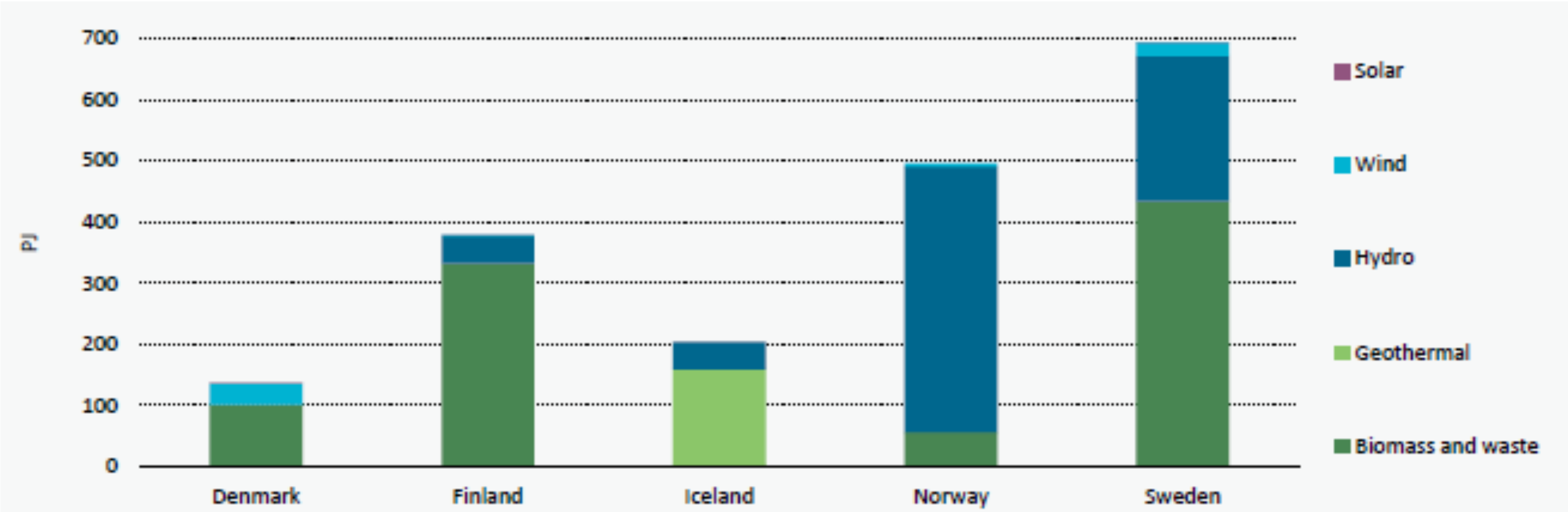
Four “hot” areas of innovation needed to meet Nordic low-carbon goals

#1: Renewable electricity (but mostly bio-energy and hydro)

Primary renewable energy production in the Nordic countries, 2011



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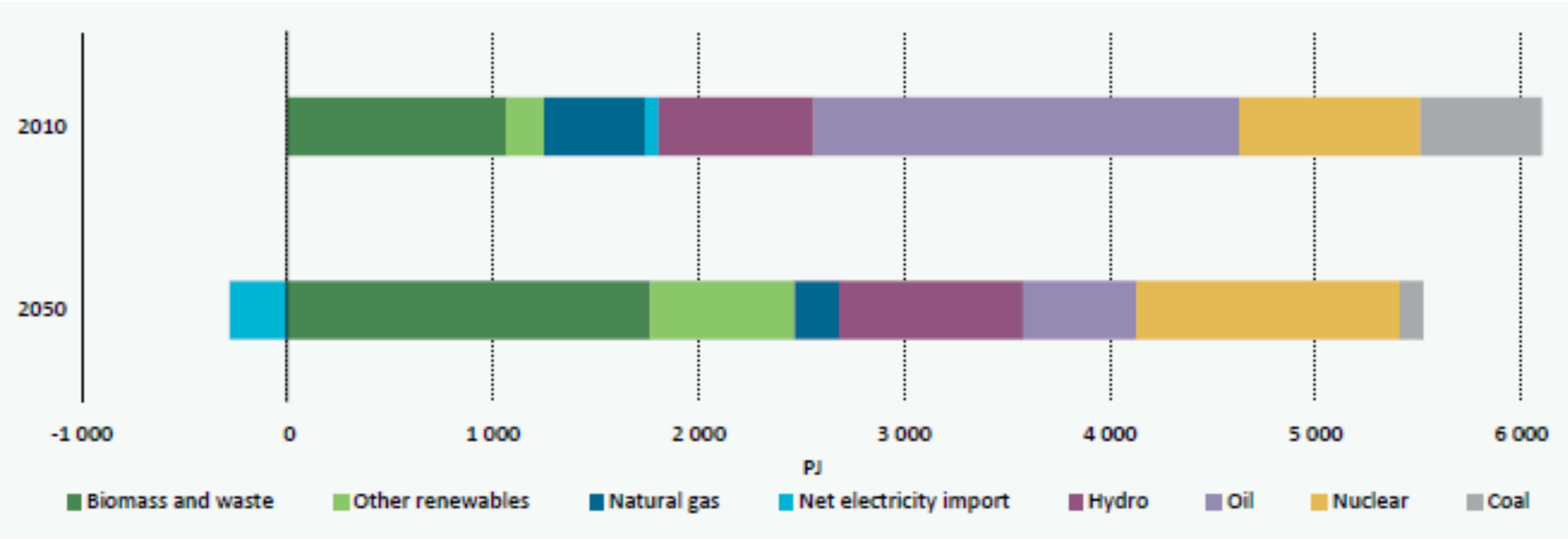
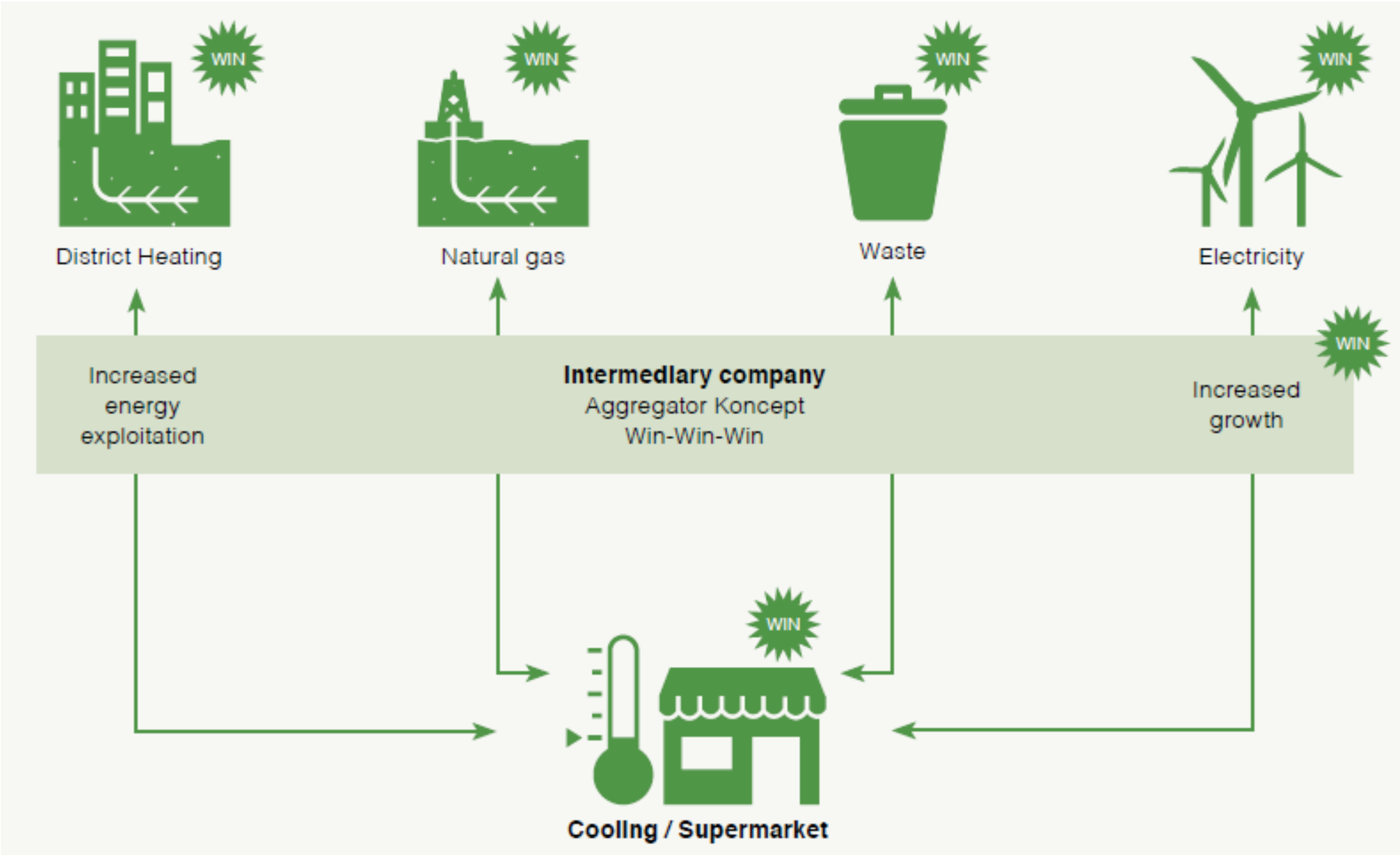
Nordic total primary energy supply in the Carbon-Neutral Scenario



The import of a diversified portfolio



#2: Energy efficiency in buildings

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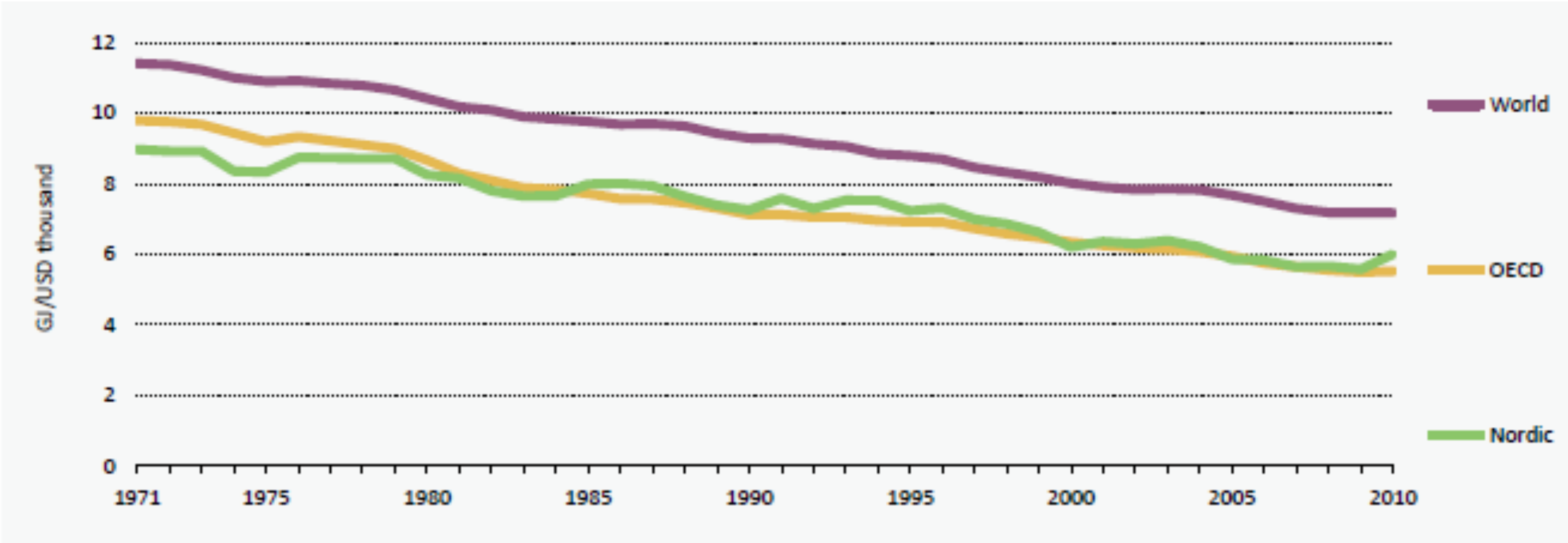
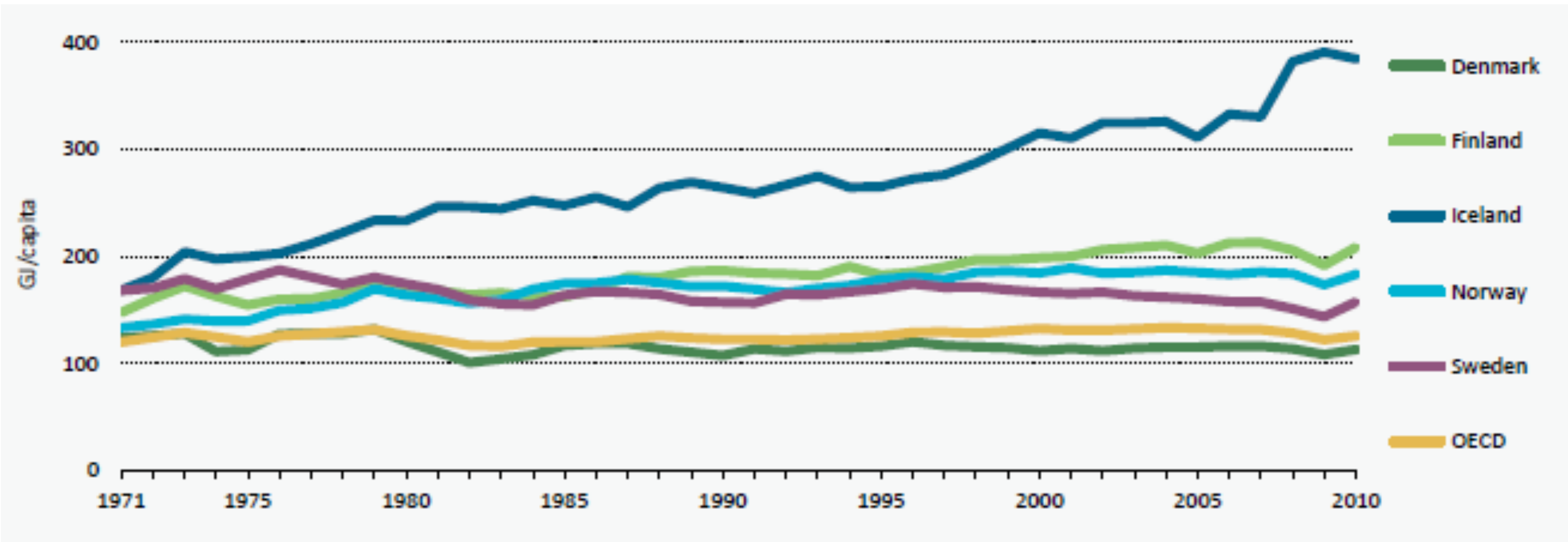
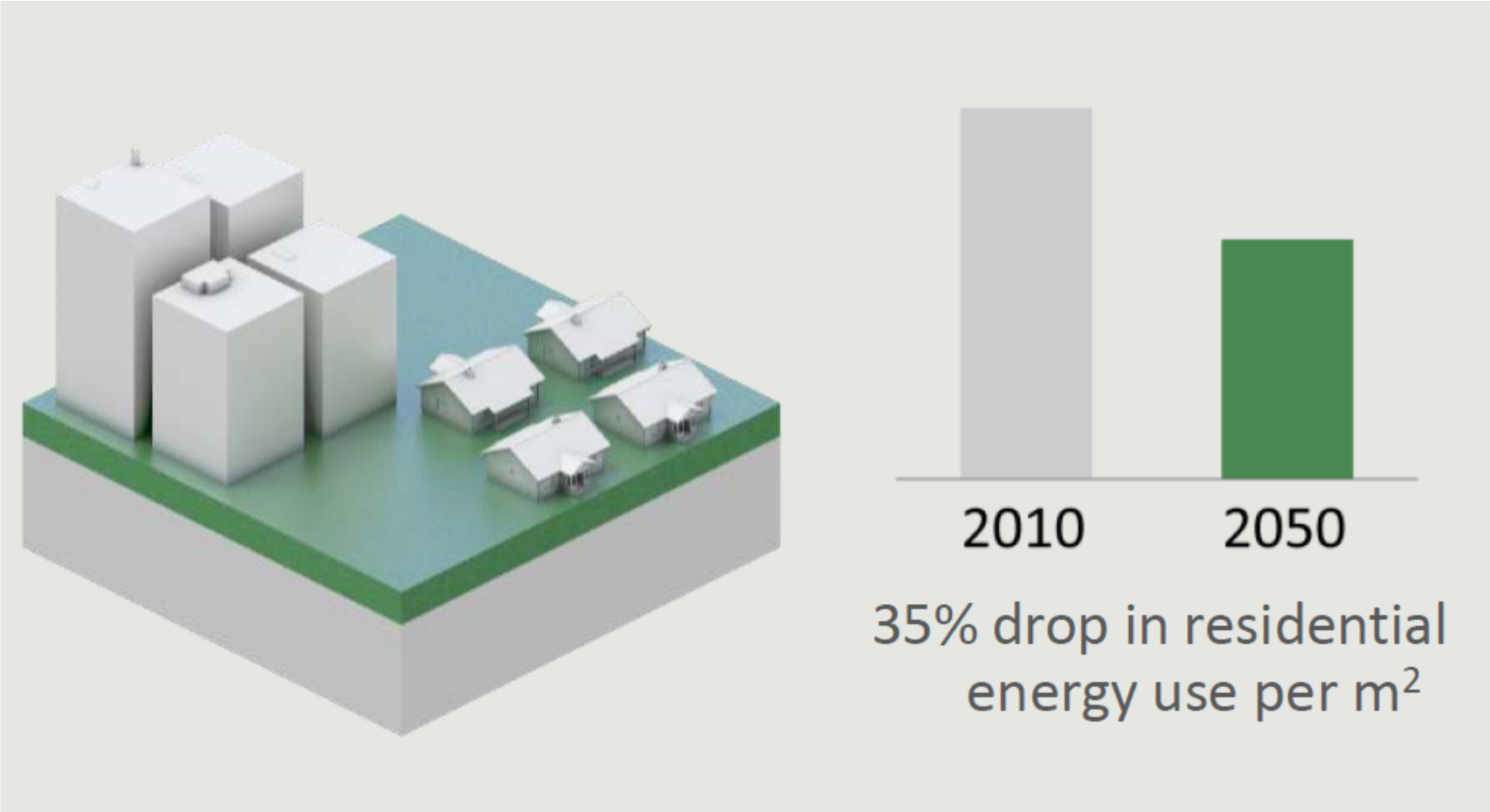
Energy intensity in the Nordic region, and globally



Final energy consumption per capita, Nordic countries and OECD average



Buildings need energy efficiency improvements



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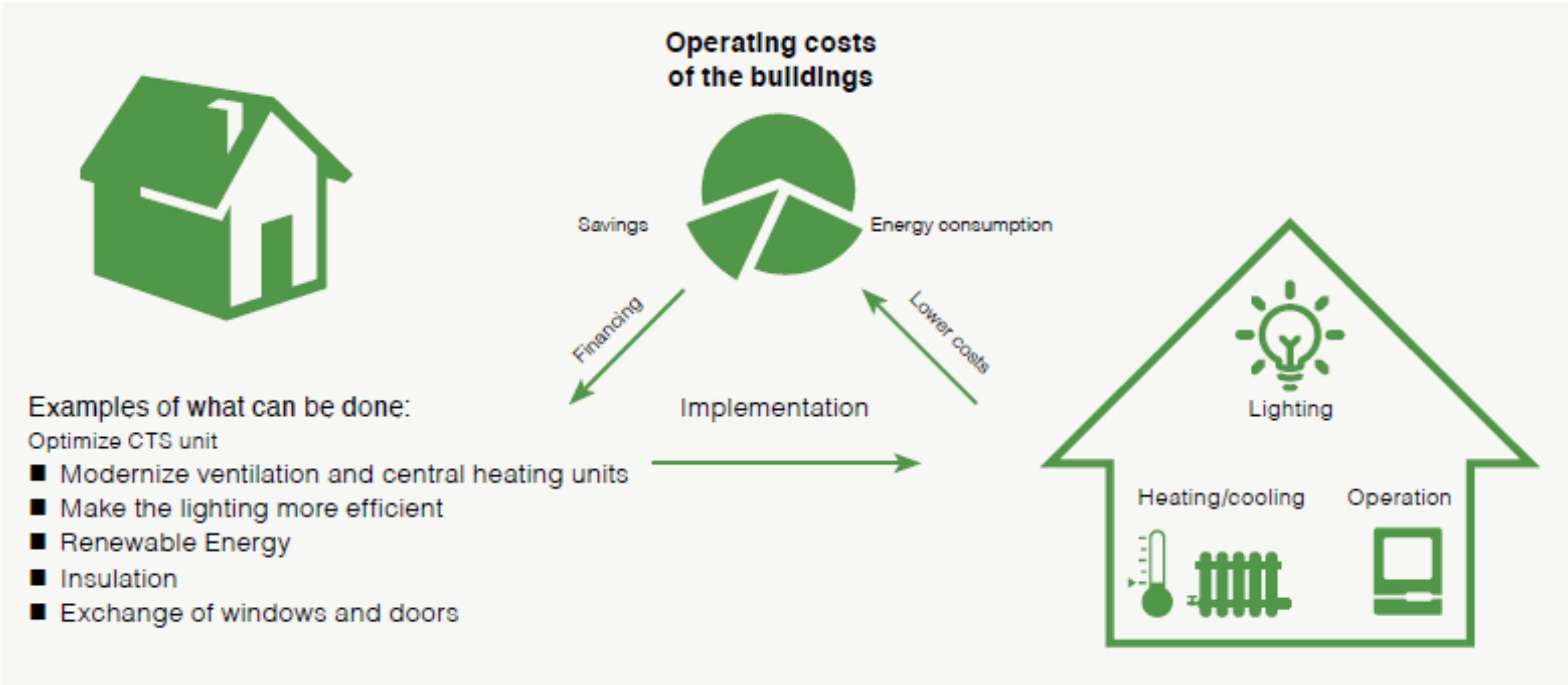
Net zero homes and energy efficiency



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The first ZERO+ house in Denmark to produce more energy than it consumes.

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#3: Transportation (but it's hydrogen, biofuels, and EVs)

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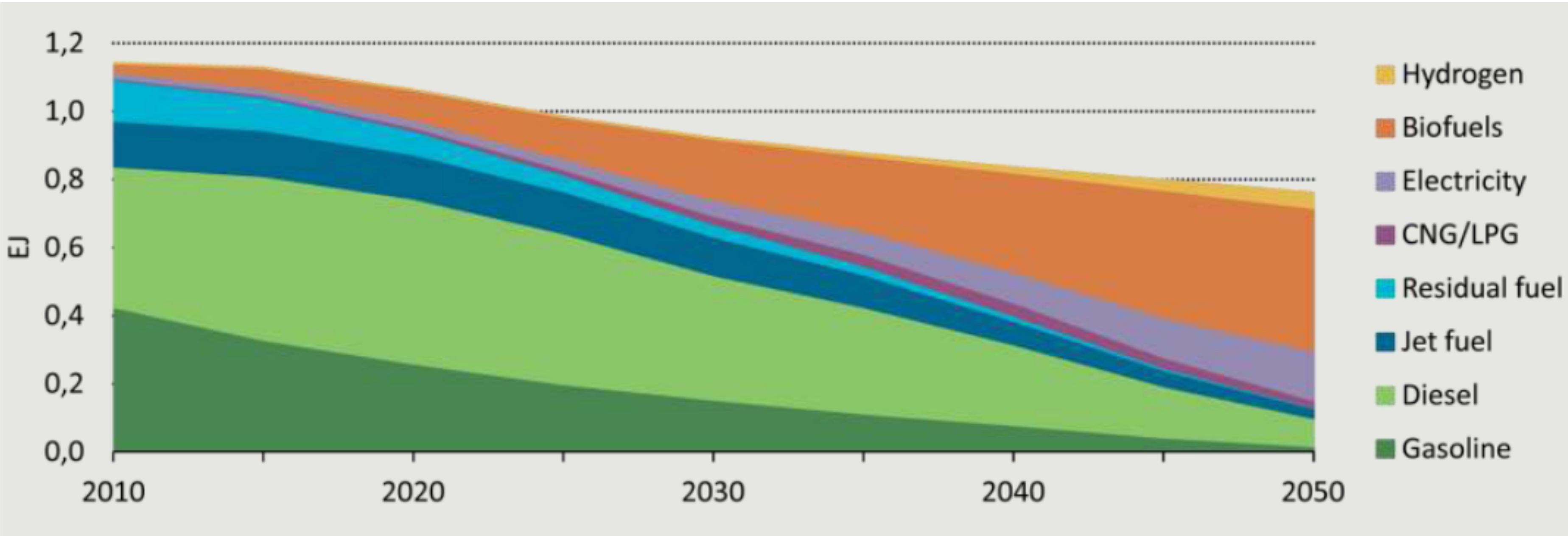
Nordic energy use in transport



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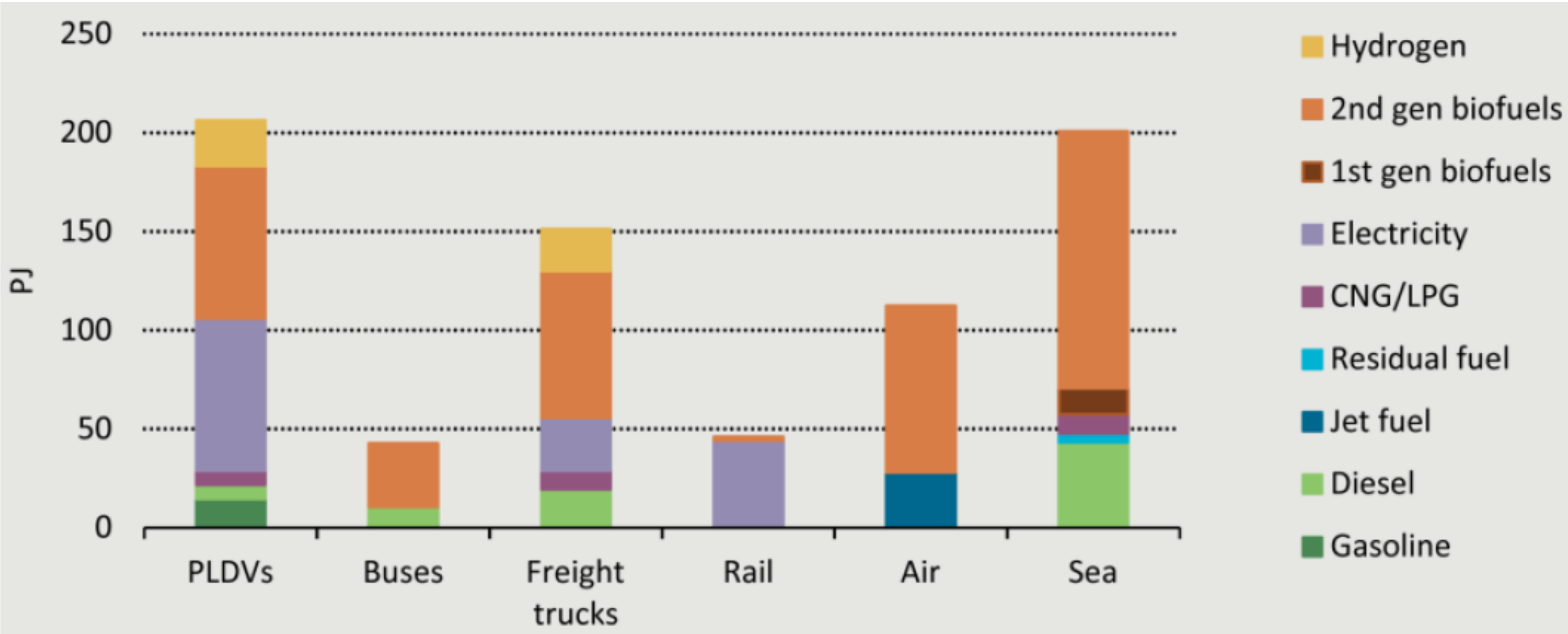
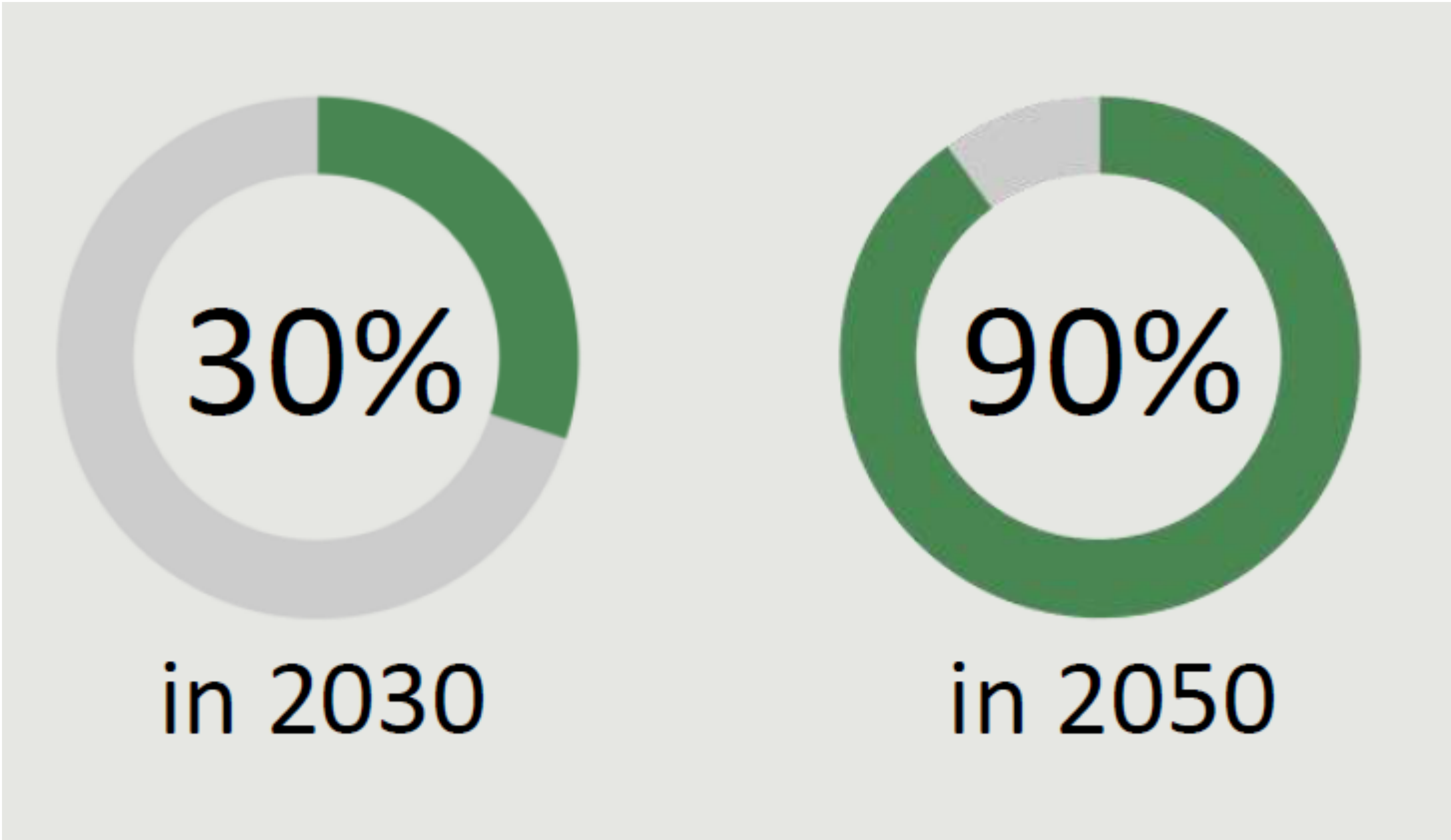
2050 energy use in transport



EV share of total Nordic (passenger) car sales




DW 31 956
DW 31 954
DW 56 226
DW 31 958
DW 31 957

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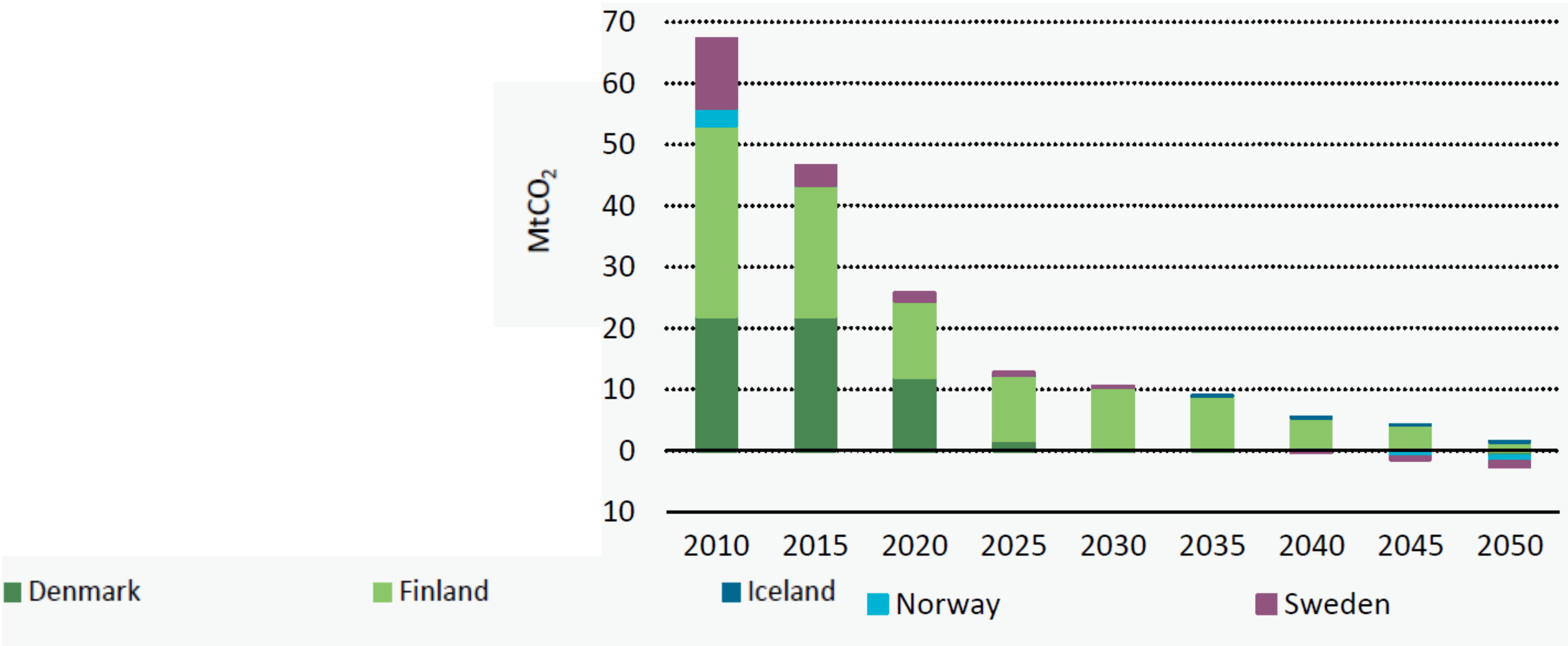
#4: Carbon Capture and Storage (CCS)

Carbon capture and storage is key

“Carbon capture and storage (CCS) represents the most important option among new technologies for reducing industrial CO2 emissions after 2030. Currently, great uncertainties exist as to how to deploy CCS, and therefore both CCS demonstrations and closer Nordic collaboration would be needed to overcome the barriers.”



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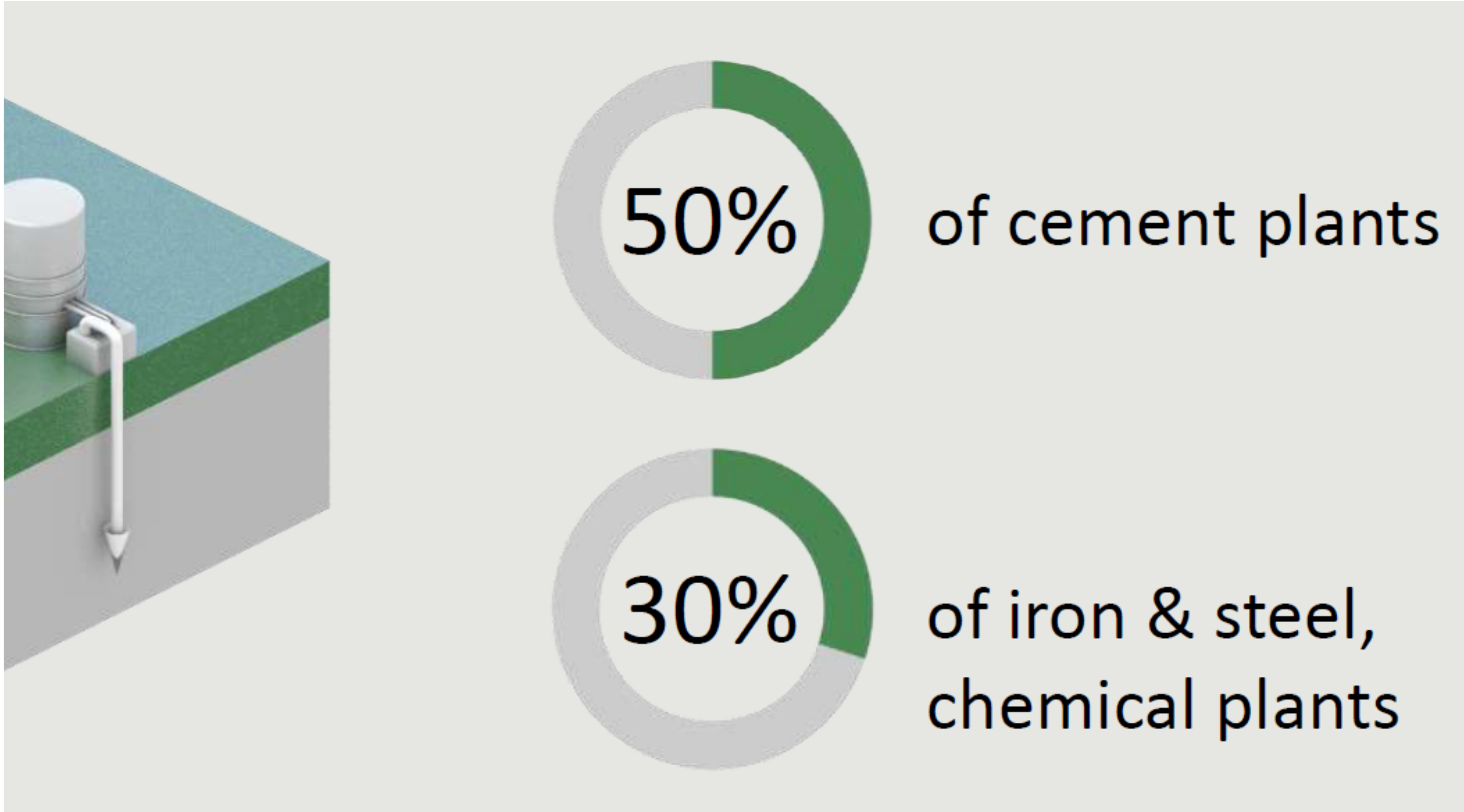
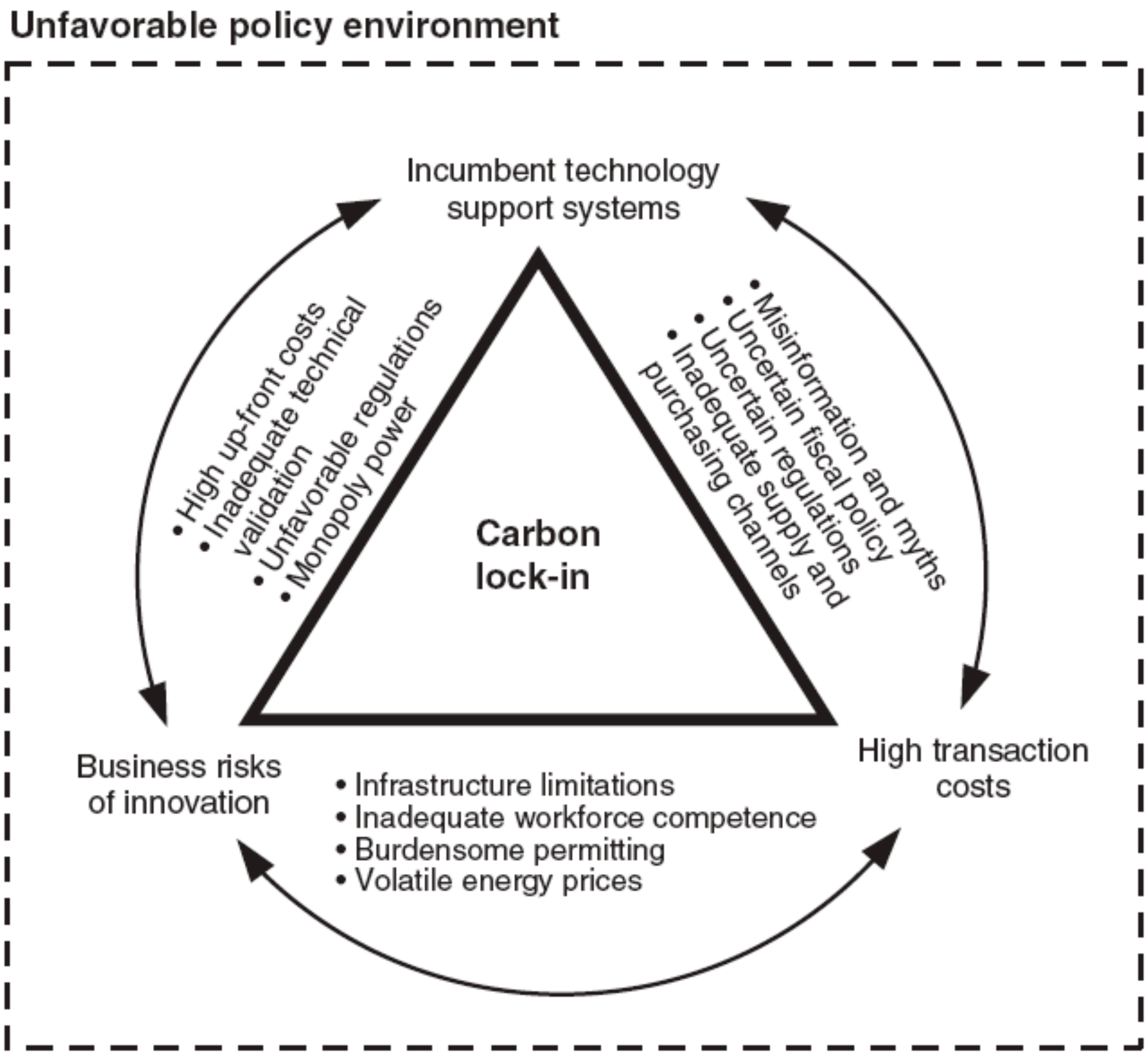
CCS utilization in industry by 2050



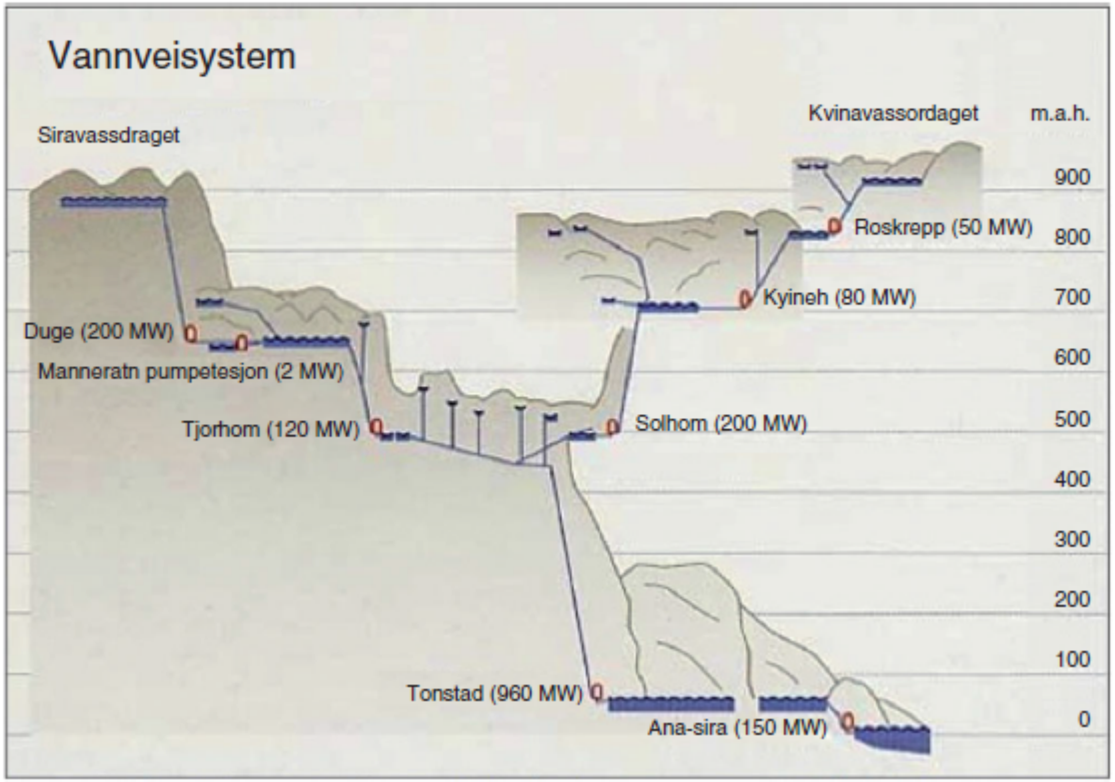
Conclusion: #1 The transition must be systematic

- Energy transitions involve overcoming particularly difficult and “wicked” barriers
- Change must be cross-sectoral and encompass the “seamless” socio-technical web



Conclusion #2: Even here, the transition is contingent

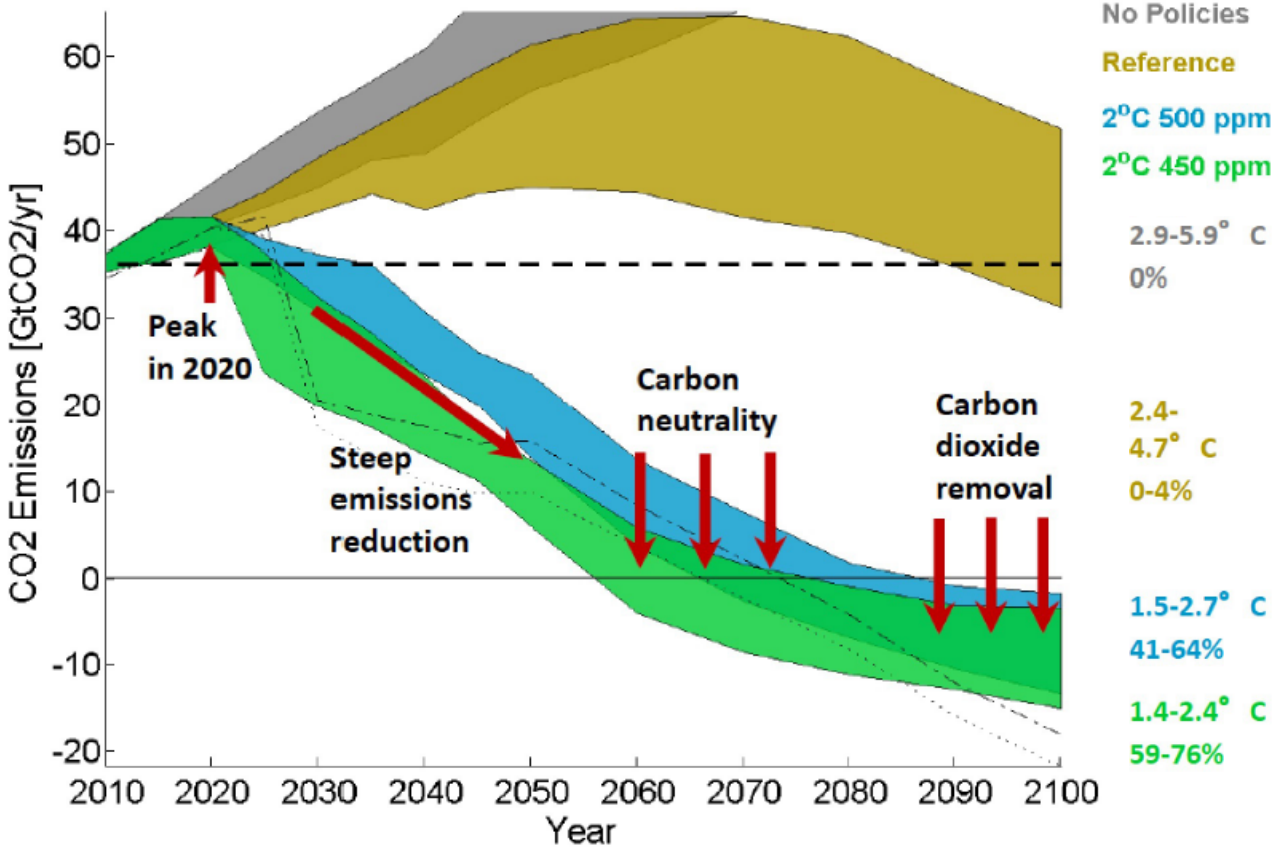
- It will depend on technological breakthroughs, but these are not necessarily obvious:
  - Biogas and hydro more than wind
  - CCS more than advanced oil recovery or shale gas
  - EVs more than hydrogen fuel cells
  - Efficiency rather than nuclear power



Sketch of the Norwegian hydropower system Sira-Kvina

Conclusion #3: The transition won't be rapid, nor universal

- It will still take decades for the relatively small, wealthy Nordic states with a strong environmental ethic and high prices, and that's if it all goes as planned
- The blueprint will most certainly *not* be adopted globally



Phases of decarbonization (from the IPCC AR5)

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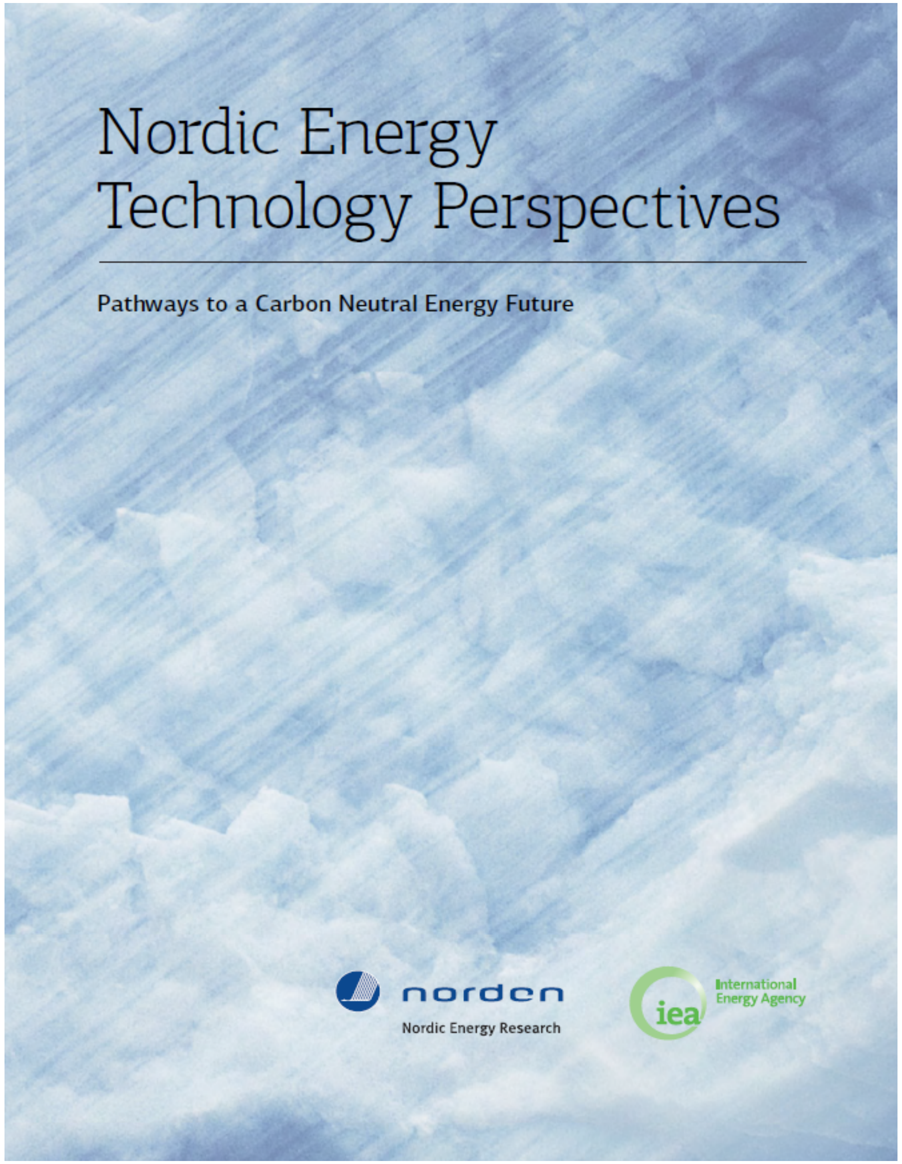
Primary data sources:



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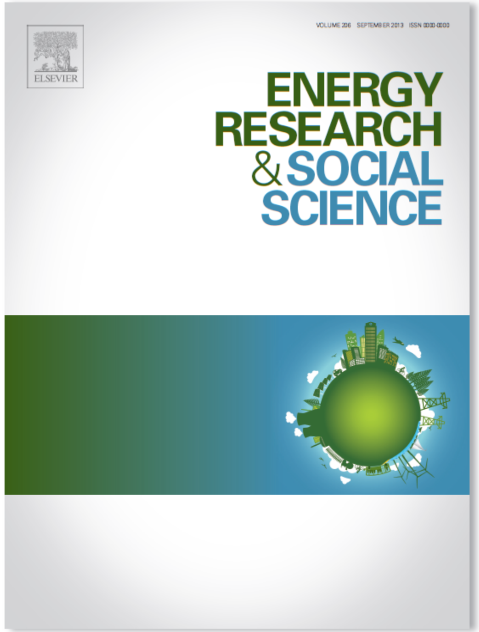
Contact Information



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