

# Framtida bränsleval för flyg, sjöfart och vägtransporter ur ett systemperspektiv

**Julia Hansson (IVL)**, Selma Brynolf, Karna Dahal, Elin Malmgren  
Maria Grahn (all Chalmers), Erik Fridell & Martin Hagberg (IVL)



# Decarbonizing Nordic Transports – the Role of Different Alternative Transport Fuels

## Main messages:

- Introduction of alternative aviation and shipping fuels will play crucial role in decarbonizing Nordic transport sector.
- Bio-jet fuels and shipping biofuels represent cost-effective mitigation measures in Scandinavia.
- CCS and BECCS (carbon capture and storage from biomass) important as well as policies.
- The potential role for hydrogen as fuel in the Nordics need to be further assessed.

# Aim

- To assess what alternative fuel options that are cost-effective for aviation, shipping and road transport (heavy and light) in the future Scandinavian region (Sweden, Norway and Denmark) in an energy system context given carbon reduction requirements
- Identify key factors that influences the prerequisites for different options

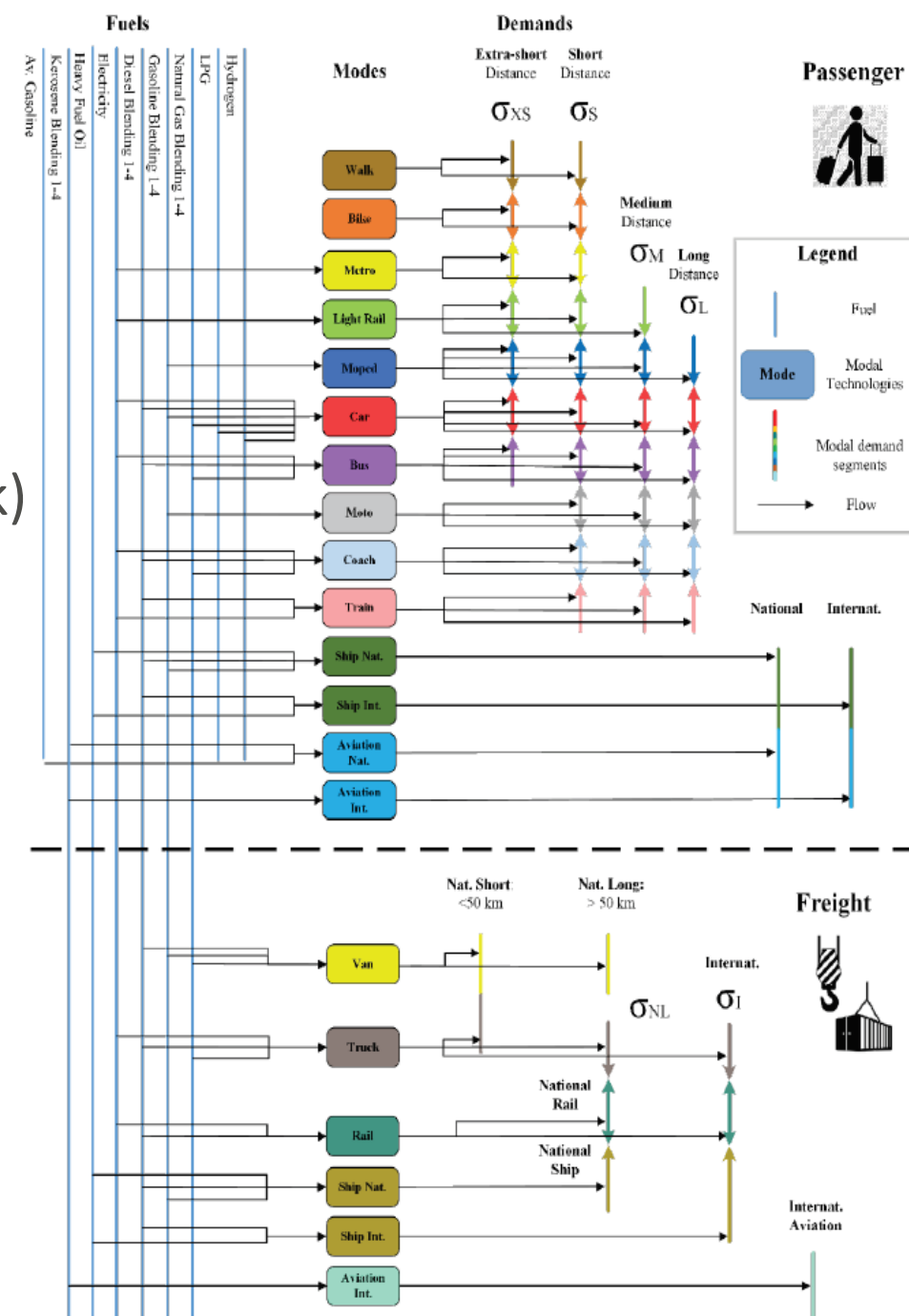
# Background

- The potential role of different alternative transport fuels in different sectors will beside technical and cost development depend on the development in other sectors



# Approach and focus:

- TIMES Nordic model: Cost minimization optimization energy system model (for Sweden, Norway and Denmark)
- Covering the entire national energy system
- Consider cost estimates, technical performance, CO2 emissions
- Compulsory target: **No net CO2 emissions by 2050**
- **Fuel choices in 2030 and 2050** when meeting CO2 target at lowest cost

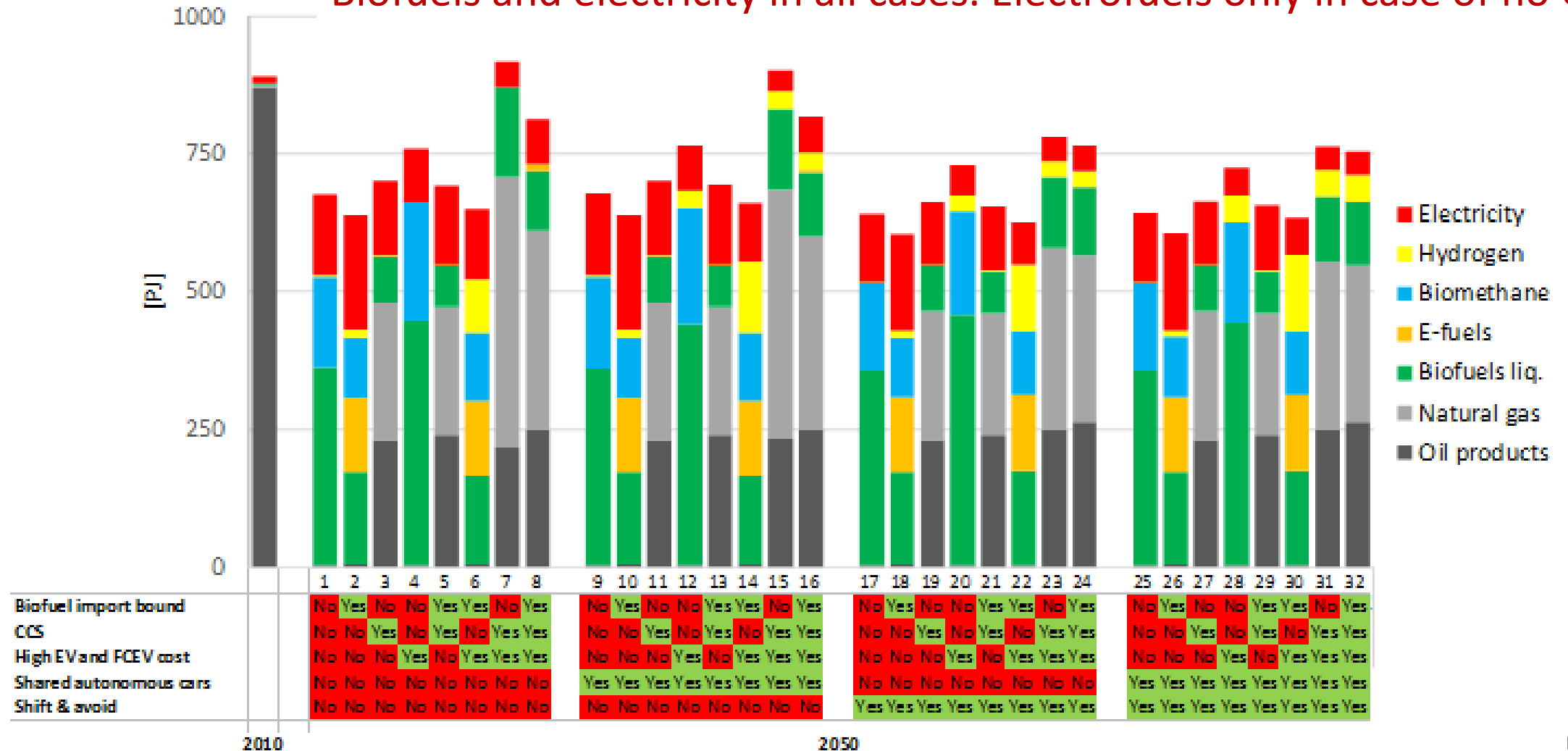


# Important assumptions

- Road transport fuel options: conventional fossil fuels, biofuels (liquid and gas), electricity, hydrogen and electrofuels
- Aviation and shipping fuel options: conventional fuels, biofuels, hydrogen and electrofuels
- Domestic and international shipping and aviation is included (represented by the share filled in the included countries)
- Several scenario cases:
  - biofuel import bound,
  - carbon capture and storage (CCS),
  - high cost for electric and fuel cell vehicles,
  - shift & avoid measure (transport demand)
  - ...

# Scenarios for fuel use in entire Scandinavian transport sector - no net CO2 emissions by 2050

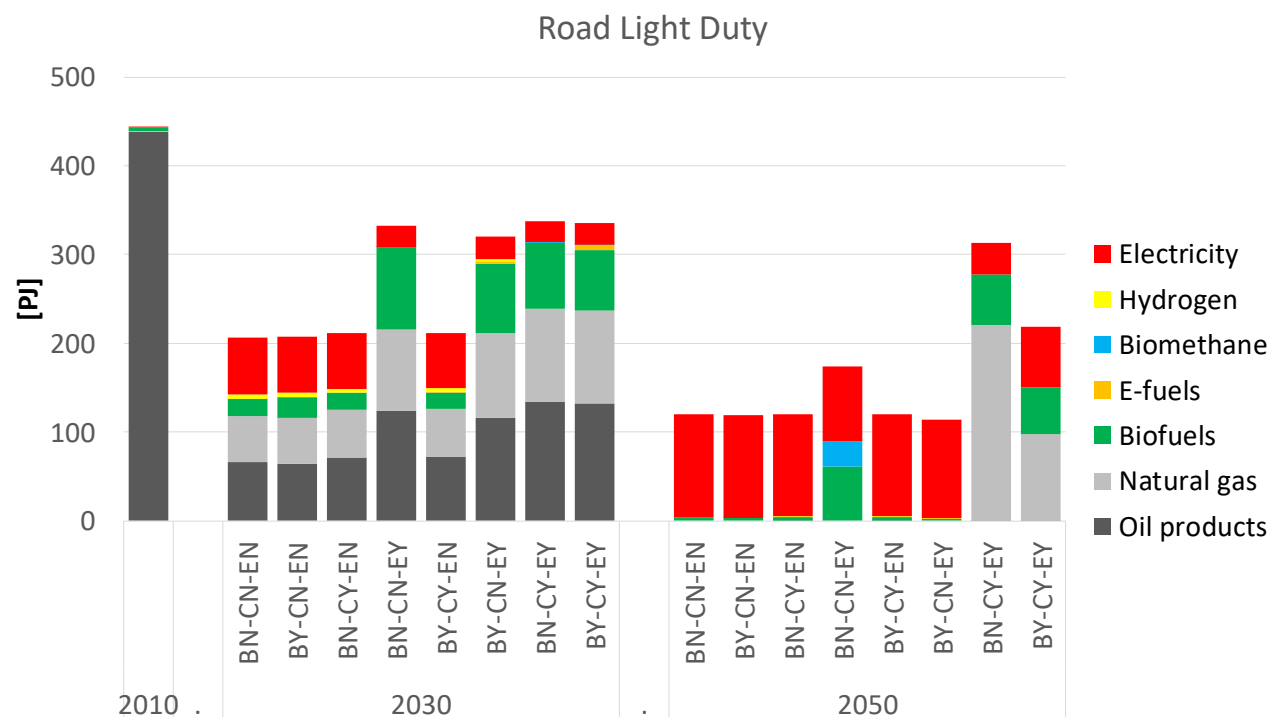
Biofuels and electricity in all cases. Electrofuels only in case of no CCS



# Fuel use in Scandinavian road sector (light duty) in 2030 and 2050 for 8 different scenario cases

No net CO2 emissions by 2050

**Strong electrification, Role of biofuels, No electrofuels**



E-fuels: electrofuels (produced from CO2 and H2O using electricity)

BN/Y: biofuel import bound Yes/No,

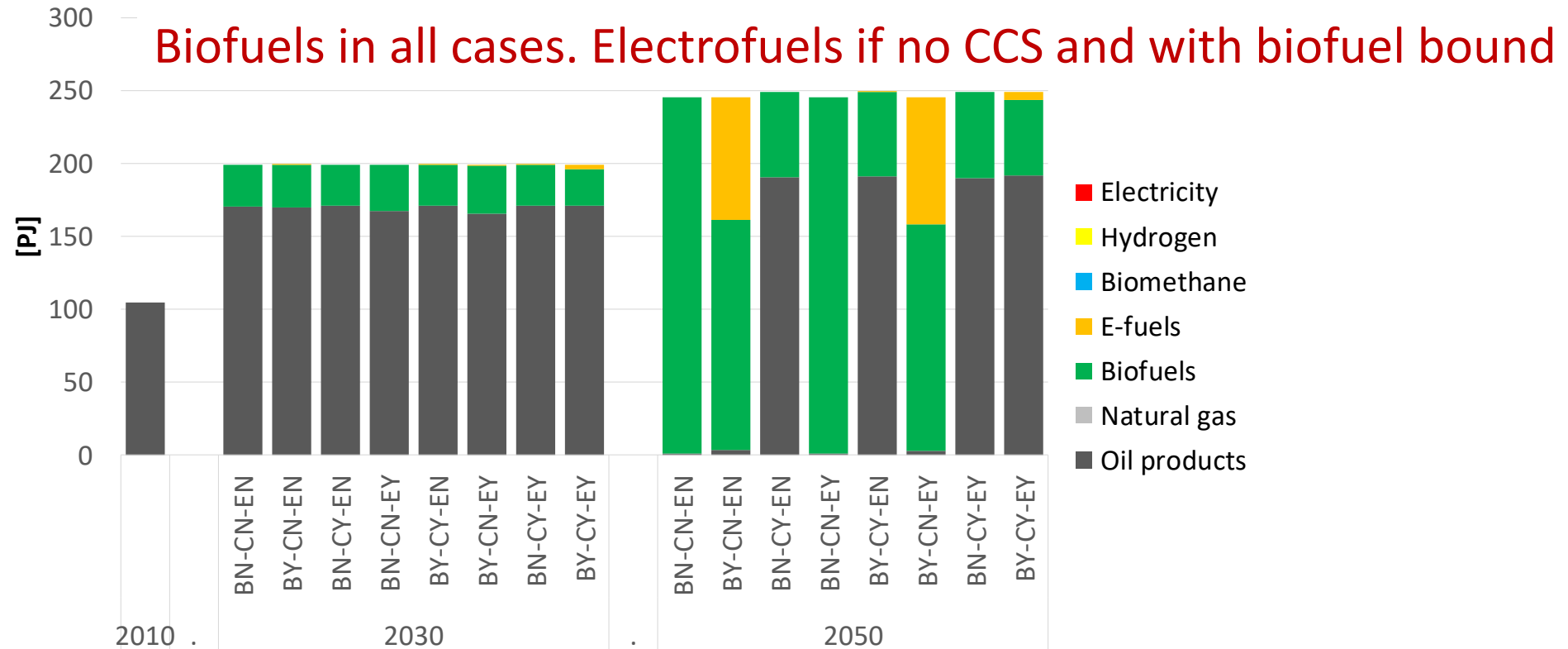
CN/Y: Carbon capture and storage (CCS) Yes/No,

EN/Y: High electric and fuel cell vehicle cost Yes/NO

# Fuel use in Scandinavian aviation sector in 2030 and 2050 for 8 different scenario cases

No net CO2 emissions by 2050

Aviation



E-fuels: electrofuels (produced from CO2 and H2O using electricity)

BN/Y: biofuel import bound Yes/No,

CN/Y: Carbon capture and storage (CCS) Yes/No,

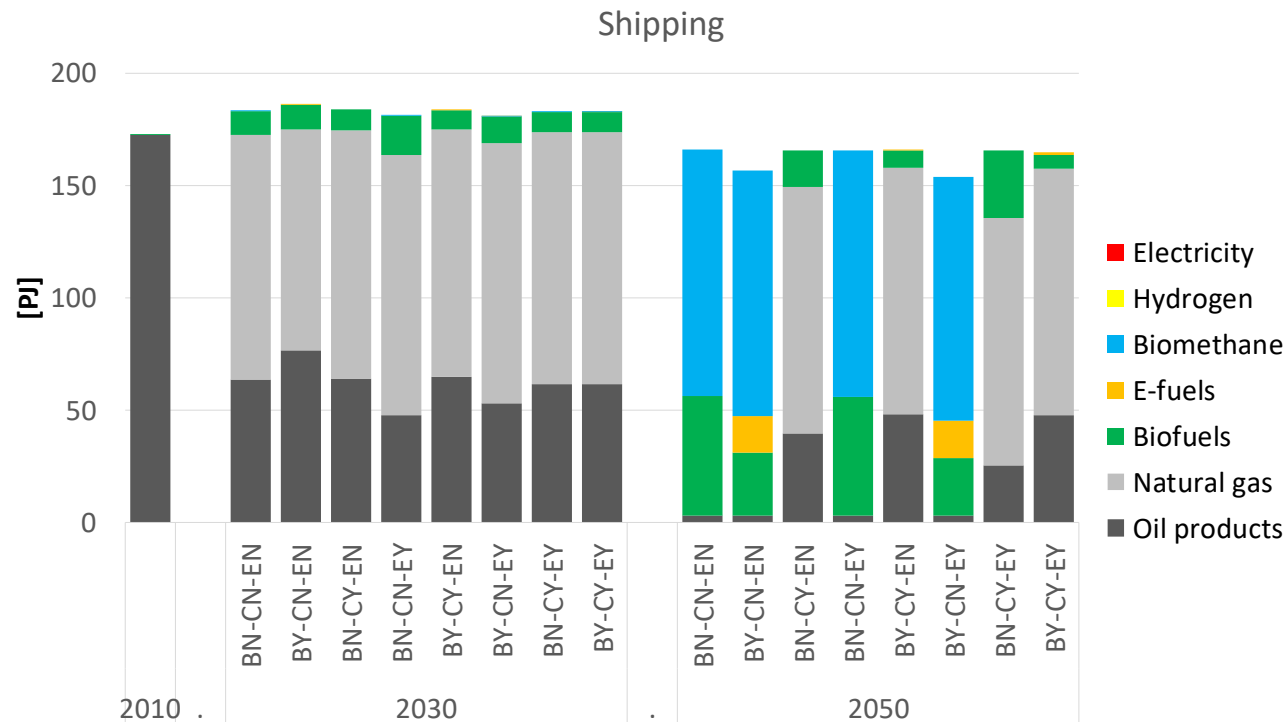
EN/Y: High electric and fuel cell vehicle cost Yes/NO



# Fuel use in Scandinavian shipping sector in 2030 and 2050 for 8 different scenario cases

No net CO2 emissions by 2050

Biofuels in all cases. Electrofuels if no CCS and with biofuel bound



**Heavy duty road transport: Biofuels initially, More unclear in long-term (biofuels, electricity and hydrogen)**

E-fuels: electrofuels (produced from CO2 and H2O using electricity)

BN/Y: biofuel import bound Yes/No,

CN/Y: Carbon capture and storage (CCS) Yes/No,

EN/Y: High electric and fuel cell vehicle cost Yes/NO

# Main findings (1/2)

- Fuel switch and more efficient use of transport: A combination of transport mitigation measures is cost-effective.
- A considerable electrification and shift towards low energy intense modes cost-effective for road transport.
- Biofuels are needed, not least in shipping and aviation.
- A cost-effective fuel and technology mix in the Nordic transport sector depend on several key factors including:
  - development of CCS and bio-CCS
  - expansion of low-carbon electricity generation
  - availability of sustainable biofuels
  - cost development of electrified options
  - development of hydrogen based solutions

# Main findings (2/2)

- Introduction of alternative aviation and shipping fuels will play crucial role in decarbonizing Nordic transport sector.
- Bio-jet fuels and shipping biofuels is indicated to represent cost-effective mitigation measures in Scandinavia for 2030 and 2050 in all studied scenarios. **BECCS important**
- Electrofuels to some extent also a cost-effective option but only when CCS is not deployed in large-scale.
- Further assessment needed on the potential role for hydrogen in the Nordics. Globally different case?
- **Policies and their design one key!**

Tack för er uppmärksamhet!

Frågor?

[julia.hansson@ivl.se](mailto:julia.hansson@ivl.se)

Det här projektet genomförs inom samverkansprogrammet *Förnybara drivmedel och system* som finansieras av Energimyndigheten och f3 Svenskt kunskapscentrum för förnybara drivmedel.

[www.f3centre.se/samverkansprogram](http://www.f3centre.se/samverkansprogram)



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