NTNU

Norwegian University of Science and Technology

Gases – Hydrogen – Transport

Prof. Dr. Anne Neumann

EEM 2023 (LUT, Lappeenranta, Finland)

Department of Industrial Economics and Technology Management

- 130 employees
  - 80 academic staff
  - 14 administrative staff
  - 40-50 PhD-candidates
- 1.200 students
- 5 study programmes
  - Industrial Economics and Technology Management
  - NTNUs School of Entrepreneurship
  - HMS
  - Project Management
  - Logistics
  - Business Administration and Management
- PhD in Industrial Economics and Technology Management

Research in close collaboration with industry and business community

Research areas:

- Energy transition, energy markets and energy policy
- Natural resources, environmental and development economics
- Circular economy and sustainable business models
- Public economics
- Maritime transport optimization

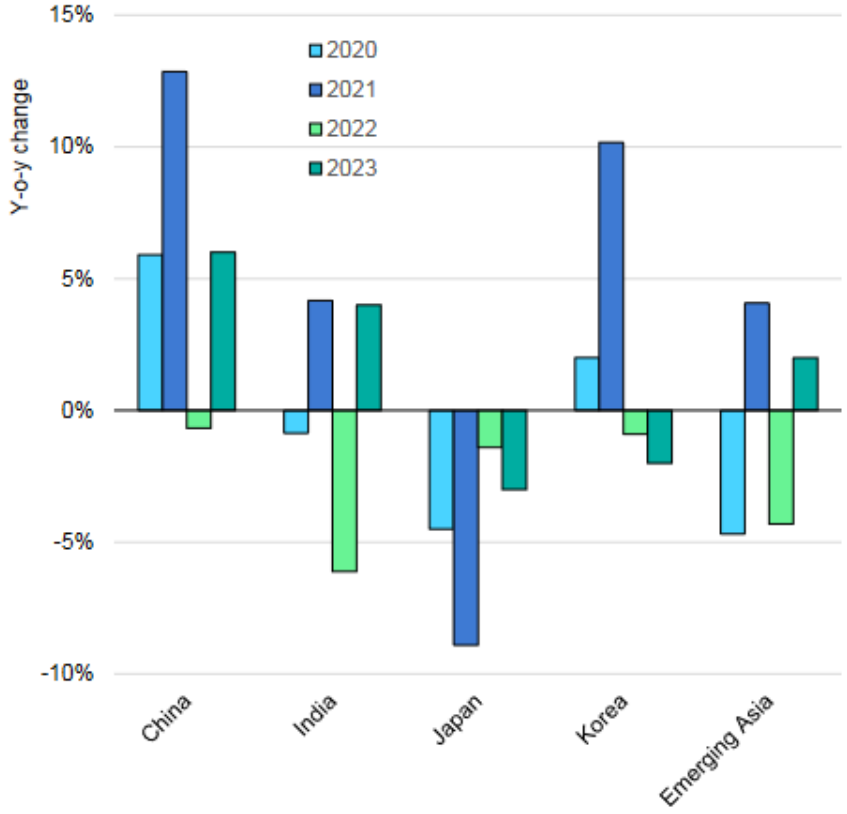
Today’s talk

- Trends in international natural gas markets
- Decarbonizing transport
- The future of gas

International Market Trends

with input from work by Johanne Vatne and David Jamissen (NTNU)

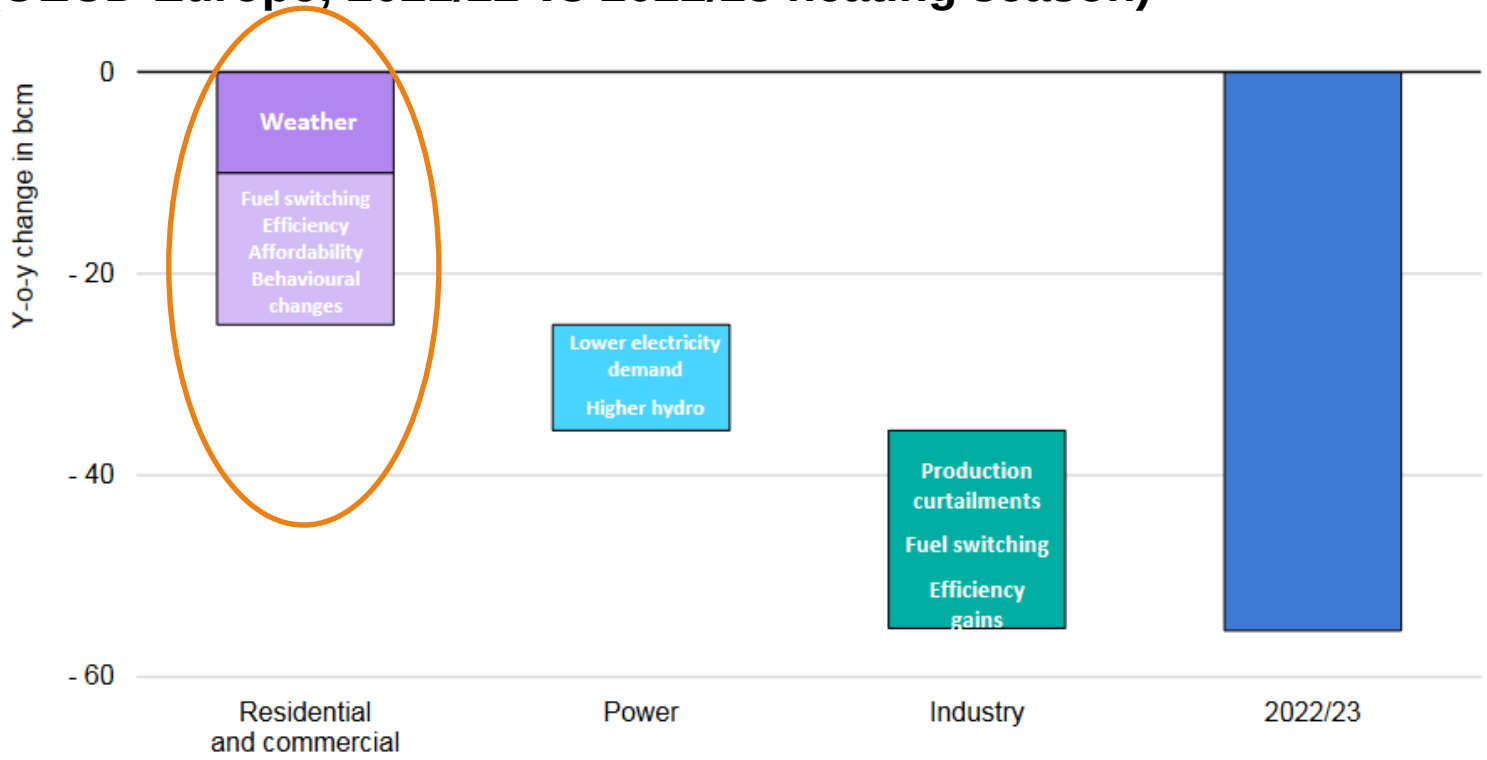
Growing appetite for LNG in Asia



Source: Gas market report Q2 2023, IEA

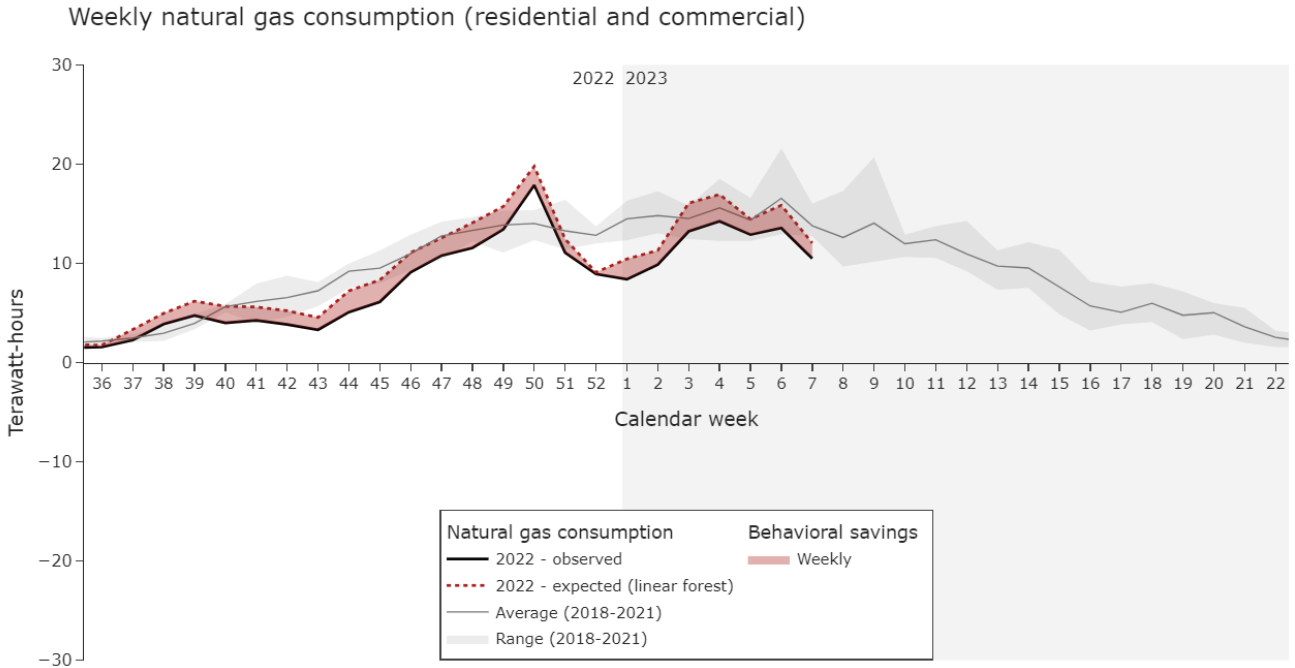
y-o-y change in gas demand

(OECD Europe; 2021/22 vs 2022/23 heating season)



Source: Gas market report Q2 2023, IEA

Gap in weather-adjusted weekly consumption



Source: DIW Open Energy Tracker

Drivers of this behavioral change

Step 1:
Establish a "state of the art" weather-based model

humidity
windspeed
cloud covering
temperature

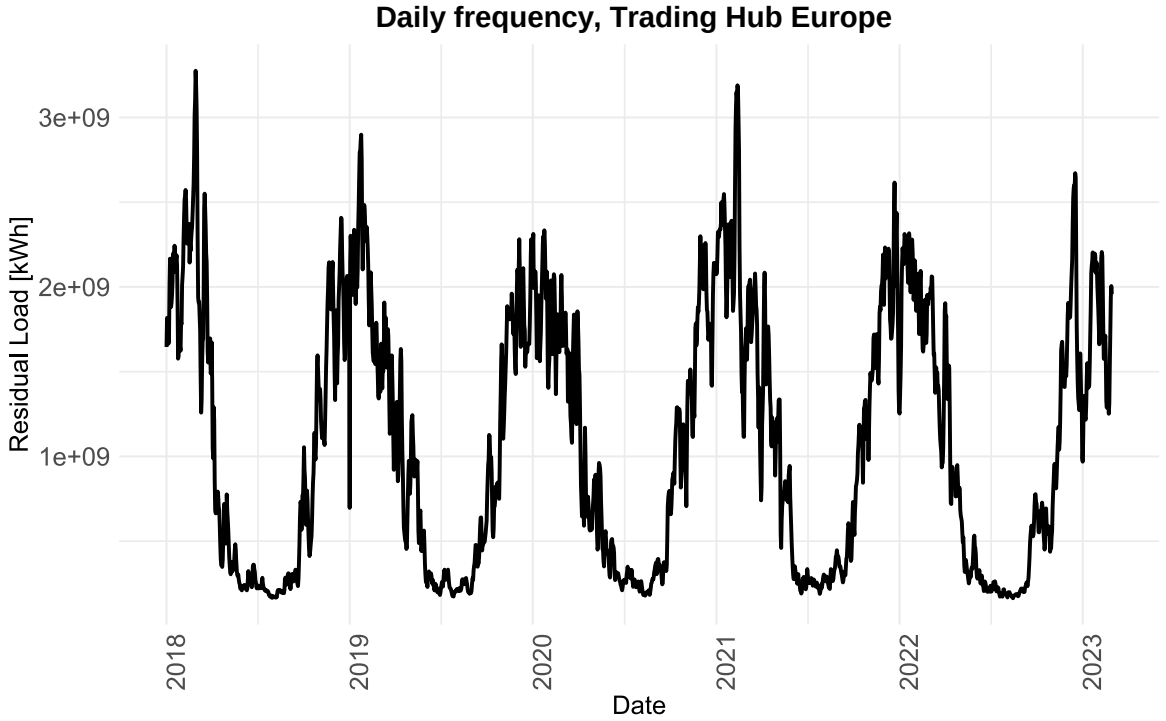
Step 2:
Estimate the magnitude of additional effects

google trends
gas flows
gaspreisbremse
price
Covid

Step 3:
Inference from a model explaining recent gas consumption

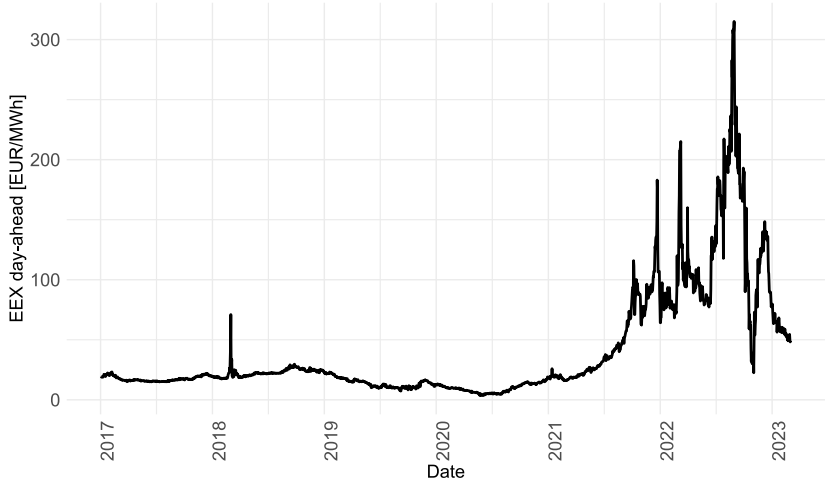
interactions
causality
Elasticities of demand

Aggregate residual load data from SLP consumers

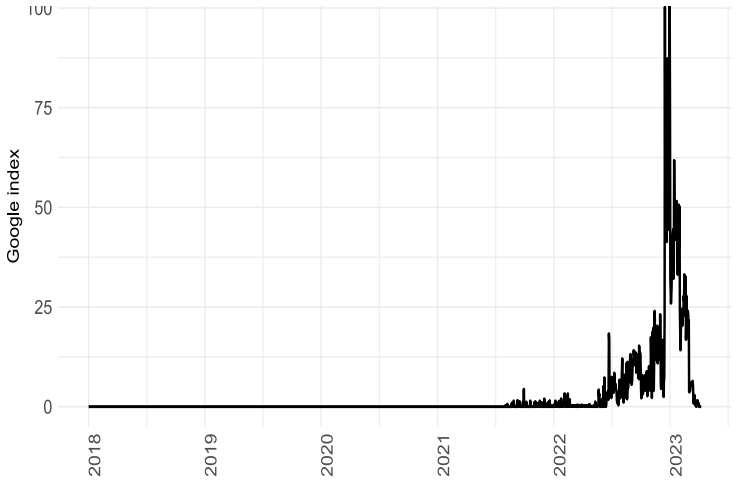


Potential response of wholesale prices

Day-ahead wholesale price



Google queries

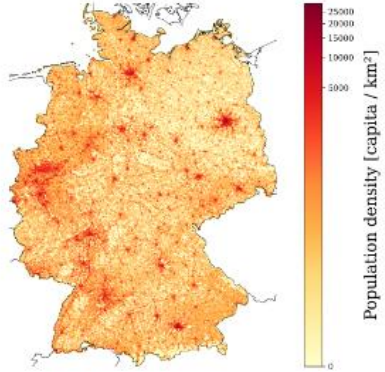


Energiekrise

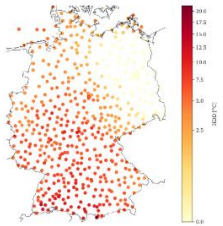
Abschlag Gas

Gas sparen

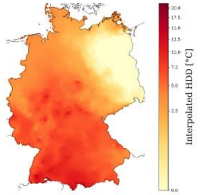
Precise weighted average for weather conditions (based on population data)



(c) Population density in Germany



(a) Heating Degree Days (HDD) at each weather station

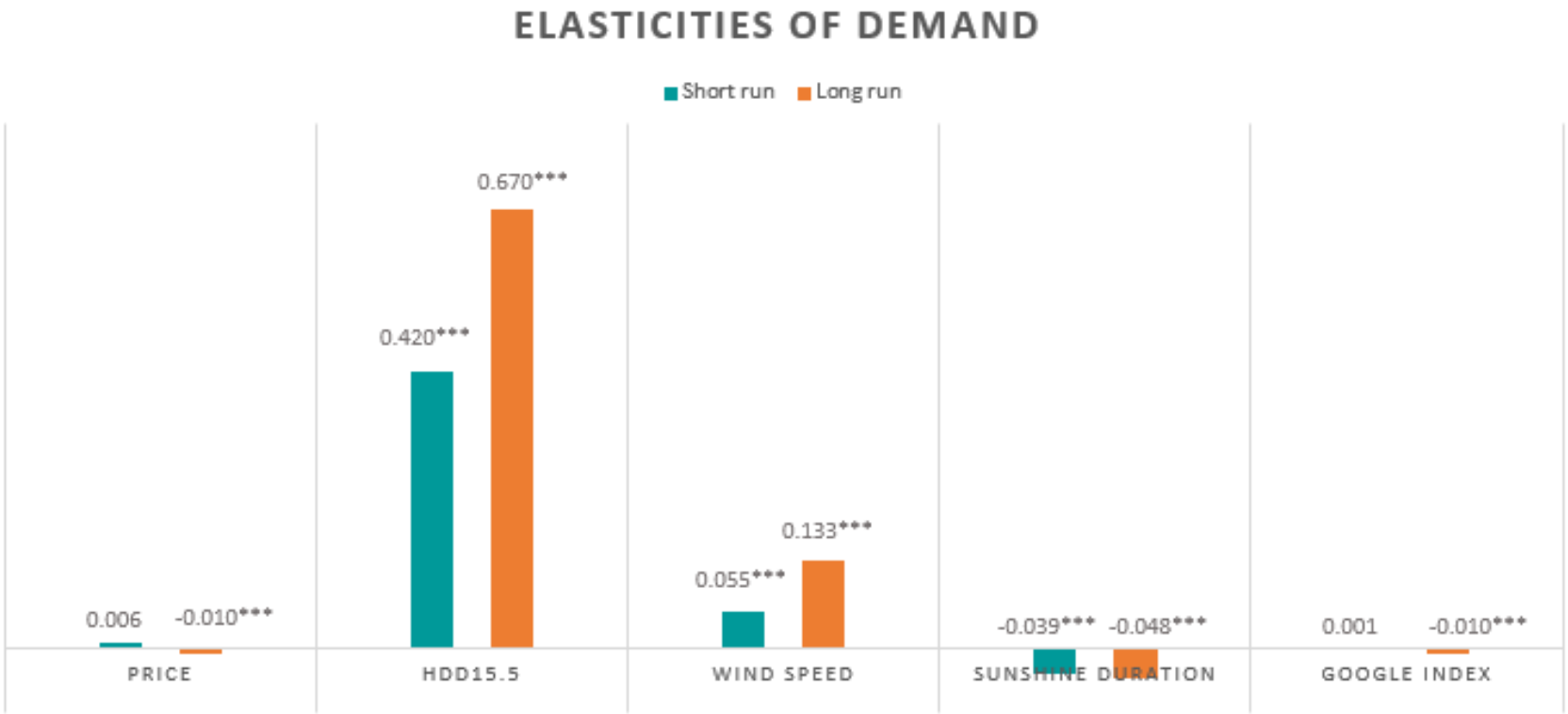


(b) Interpolated HDD with inverse distance weighting

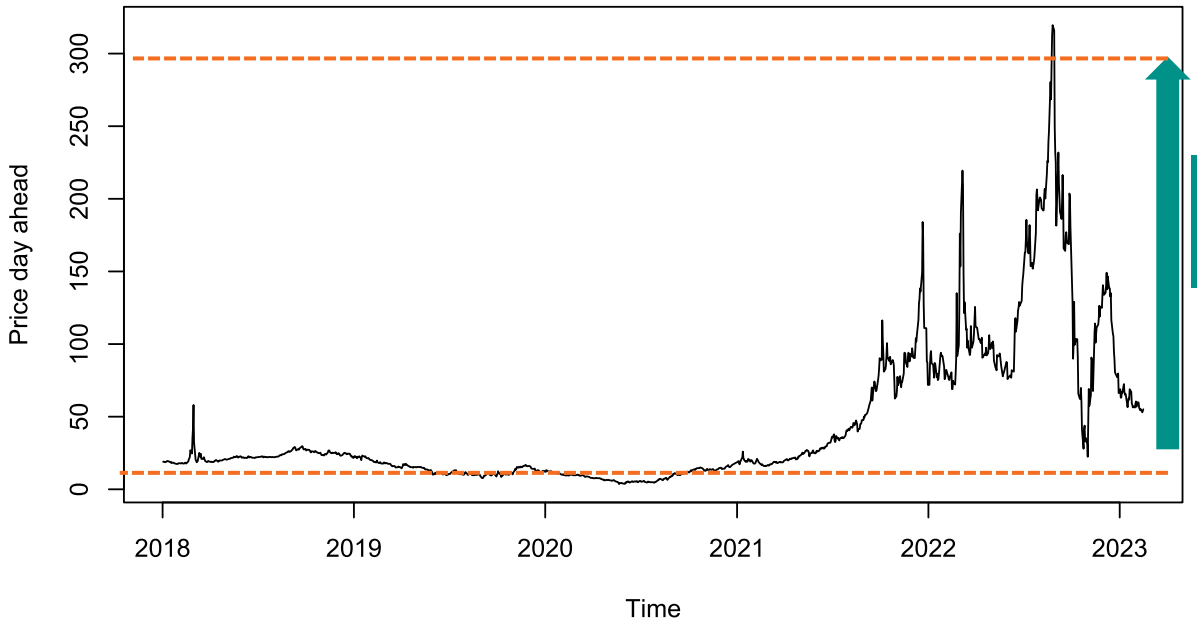
Weather station values and georeferenced population data from The Federal Statistical Office

Map population density to interpolated weather data with inverse distance weighting

Preliminary Results (ARDL model)



Elasticity estimates are small, but reasonable for wholesale prices in 2022



Given the estimates the demand reduction in the period would be

$$-0.010 \cdot 1400\% = -17\%$$

Decarbonizing Transport

- **Martin, Jonas**, A. Neumann and A. Ødegård (2022): Sustainable hydrogen fuels versus fossil fuels for trucking, shipping and aviation: A dynamic cost model. Working paper 2022-010. Cambridge, MA: MIT-CEEPR.

- **Martin, Jonas**, E. Dimanchev and A. Neumann (2022): Carbon abatement costs for hydrogen fuels in hard-to-abate transport sectors and potential climate policy mixes. Working paper 2022-017. Cambridge, MA: MIT-CEEPR.

Decarbonizing transport

Long-haul:
40 t semi-truck

~25 t

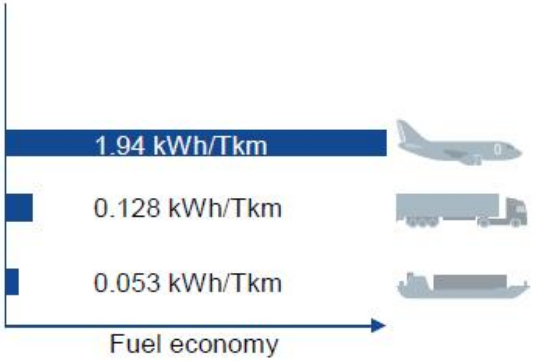
Short-sea:
7680 GT vessel

~ 9,450 t

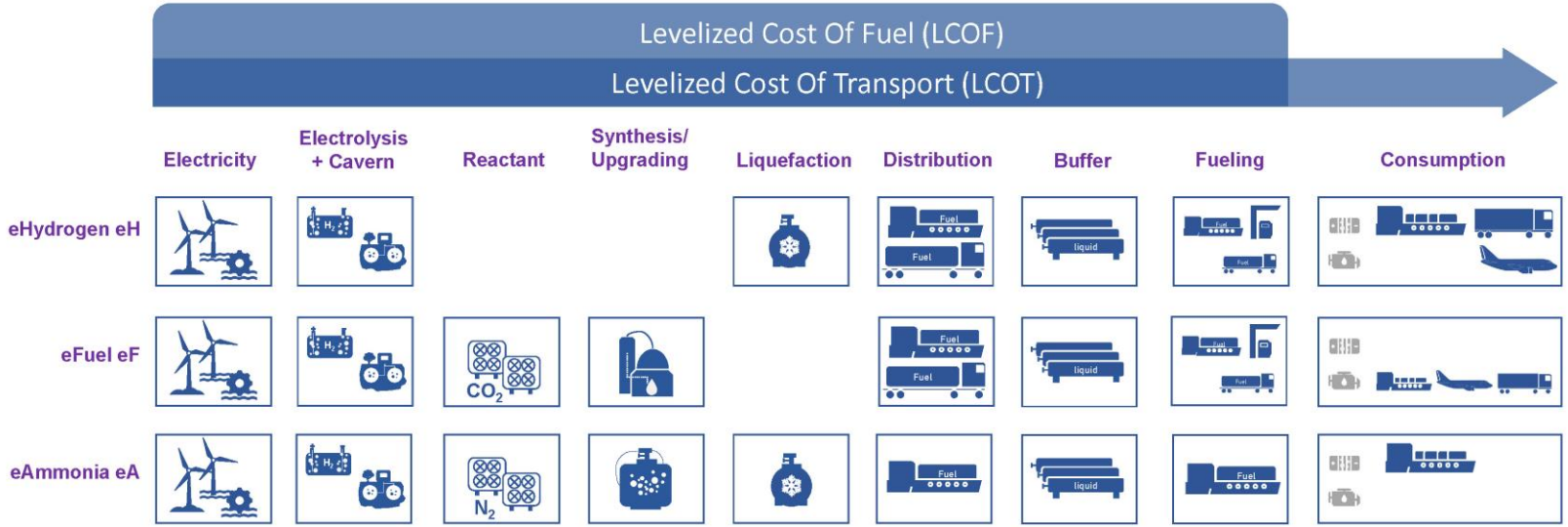
Competitive?

Short/mid-haul:
A320 freighter

~20 t

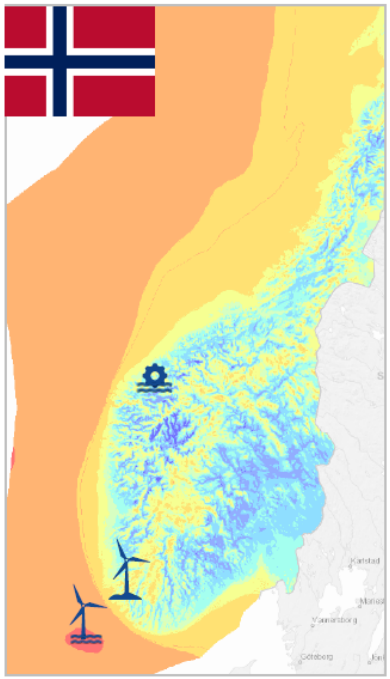


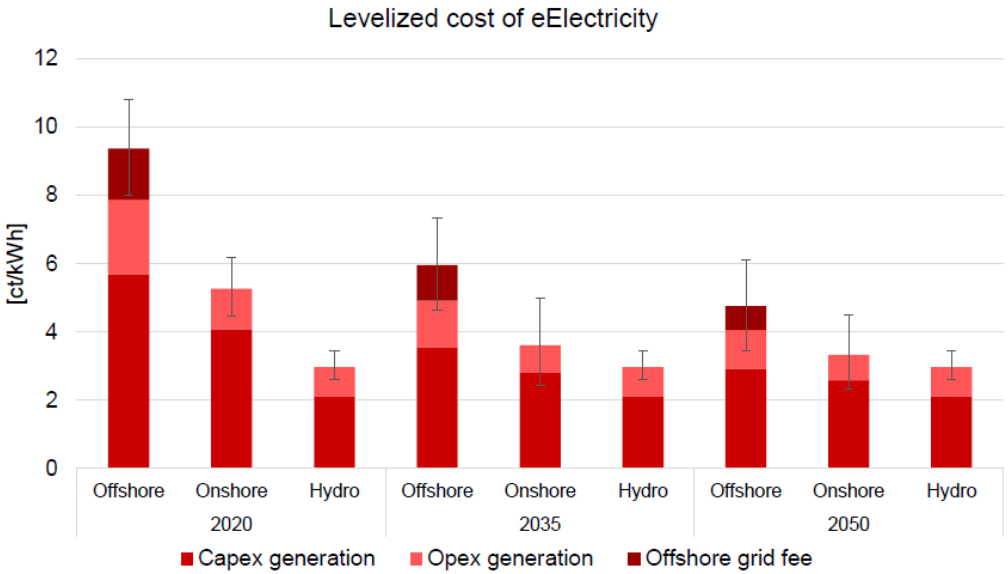
Holistic cost model



- ~ 140 techno-economic parameters along the value chain
- excluding taxes and subsidies

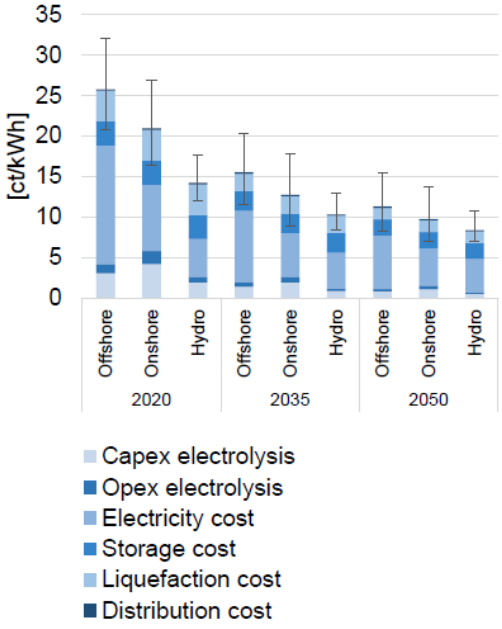
Levelized cost for eElectricity



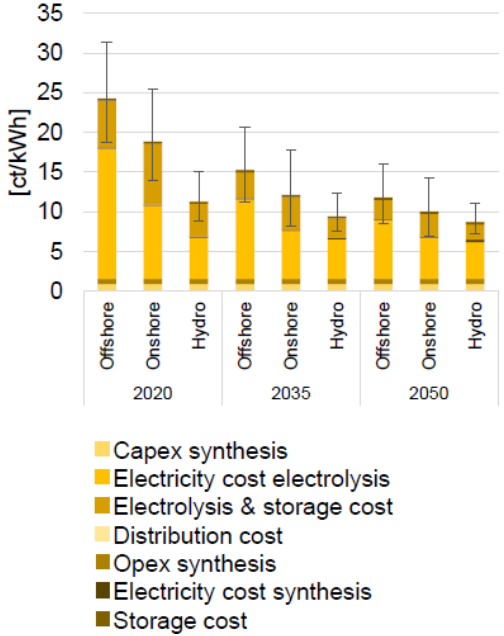


Levelized costs of fuels

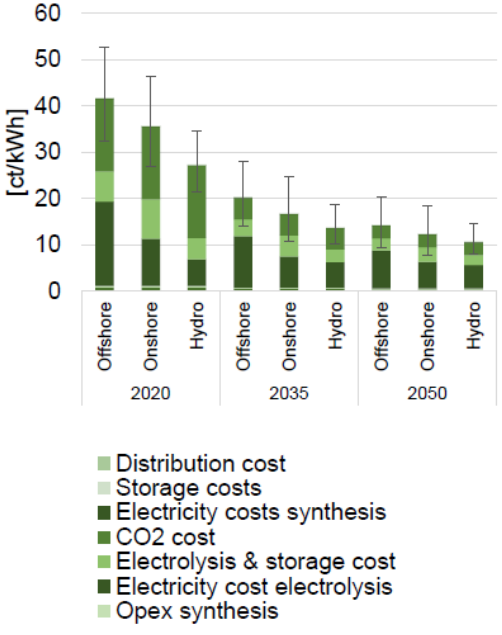
Hydrogen



Ammonia

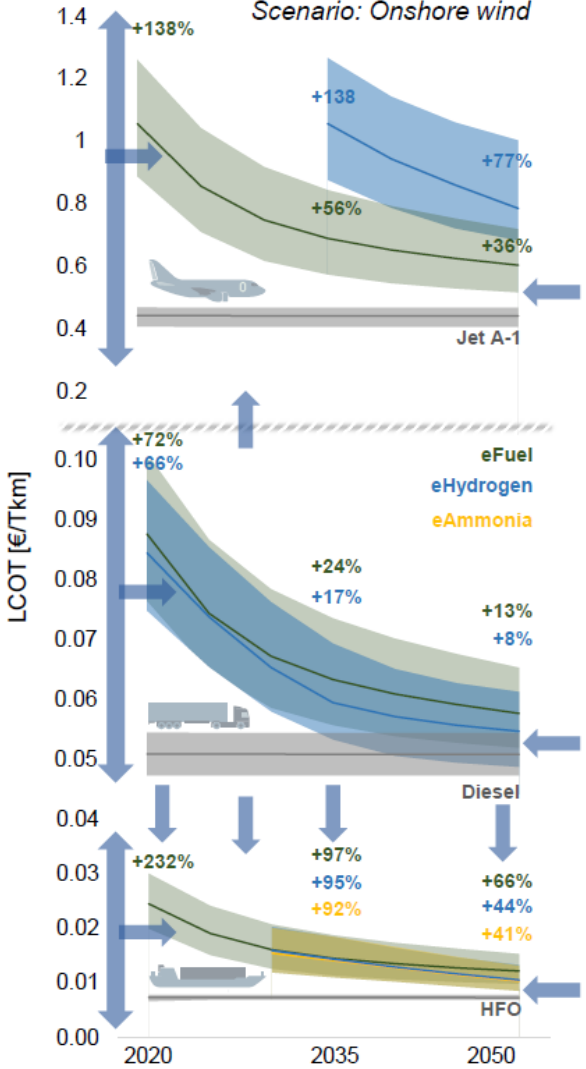


eFuel

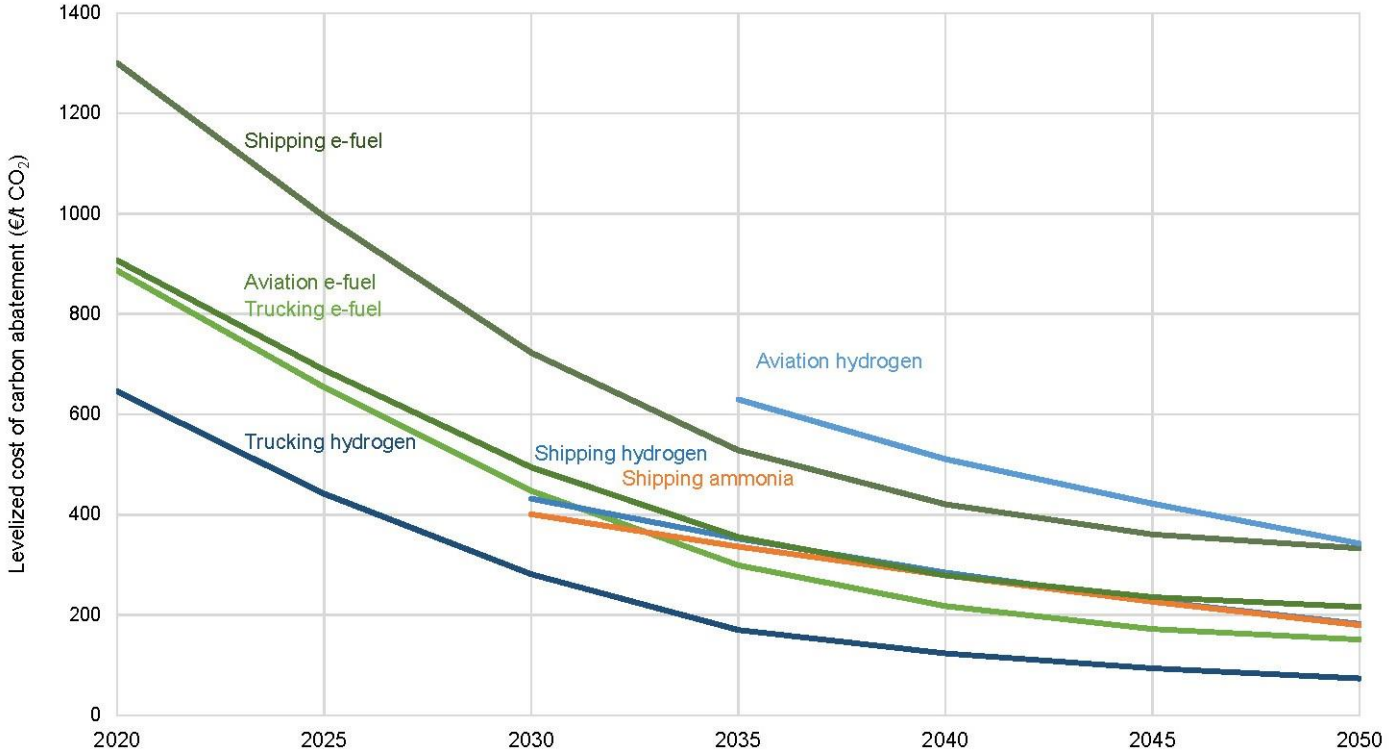


Key findings

- **Optimal fuel choices** are eH for trucking, eA and eH for shipping, eF for aviation (total cost of ownership approach)
- **Shipping** cost are most **sensitive**
- Alternative fuels do **not change the overall cost ranking**
- The choice of **electricity source** has significant impact on **early transport** decarbonization
- Decarbonization pathways are **out of reach** by 2050

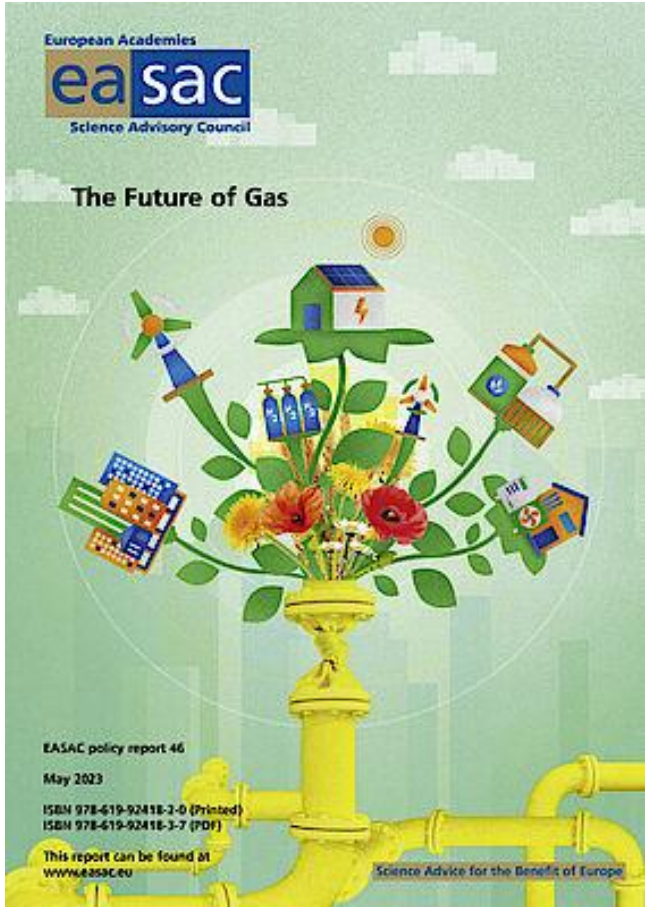


CO_2 abatement costs



Comments on

Future of Gas (May 2023)



European Academies
easac
Science Advisory Council

The future of gas

Key findings

- energy efficiency and demand reduction in buildings, industry, transport
- phase out unabated gas
- ban installation of new gas boilers (residential)
- produce sustainable technologies in Europe
- support vulnerable households and businesses
- re-skill and expand EU workforce

Outlook

- (re-)use of infrastructure & regulation thereof
- joint network development plans
- implementation of CO_2 pricing
- use of natural gas underground storage facilities
- globalization of commodity markets

Thank you.

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