Power-to-X as sector integration enabler

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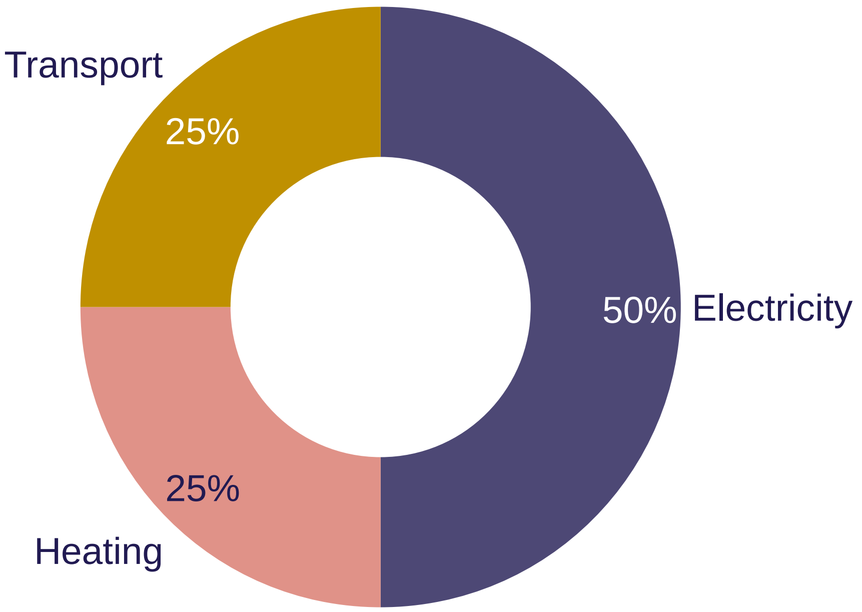
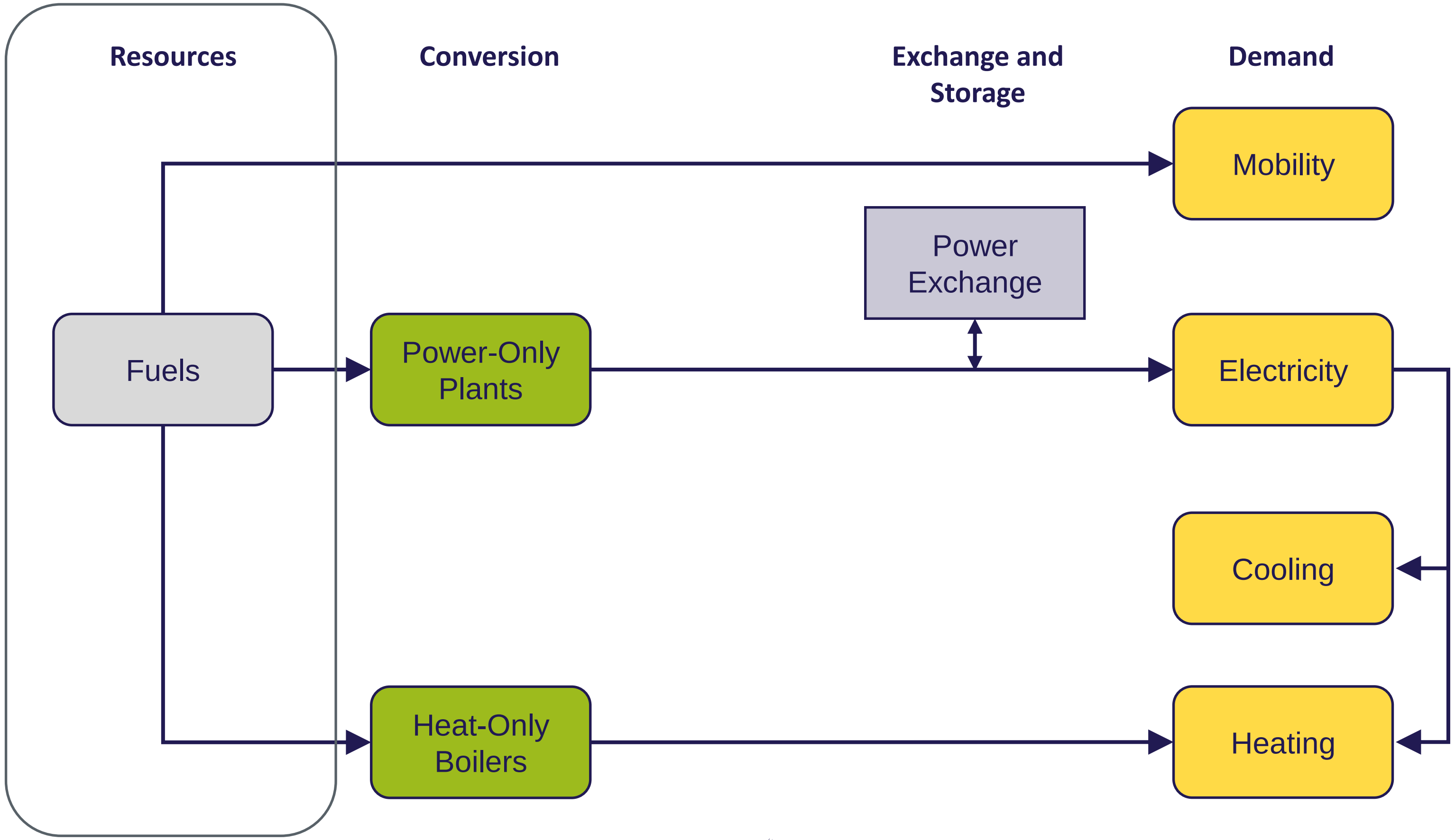
Solutions on the table

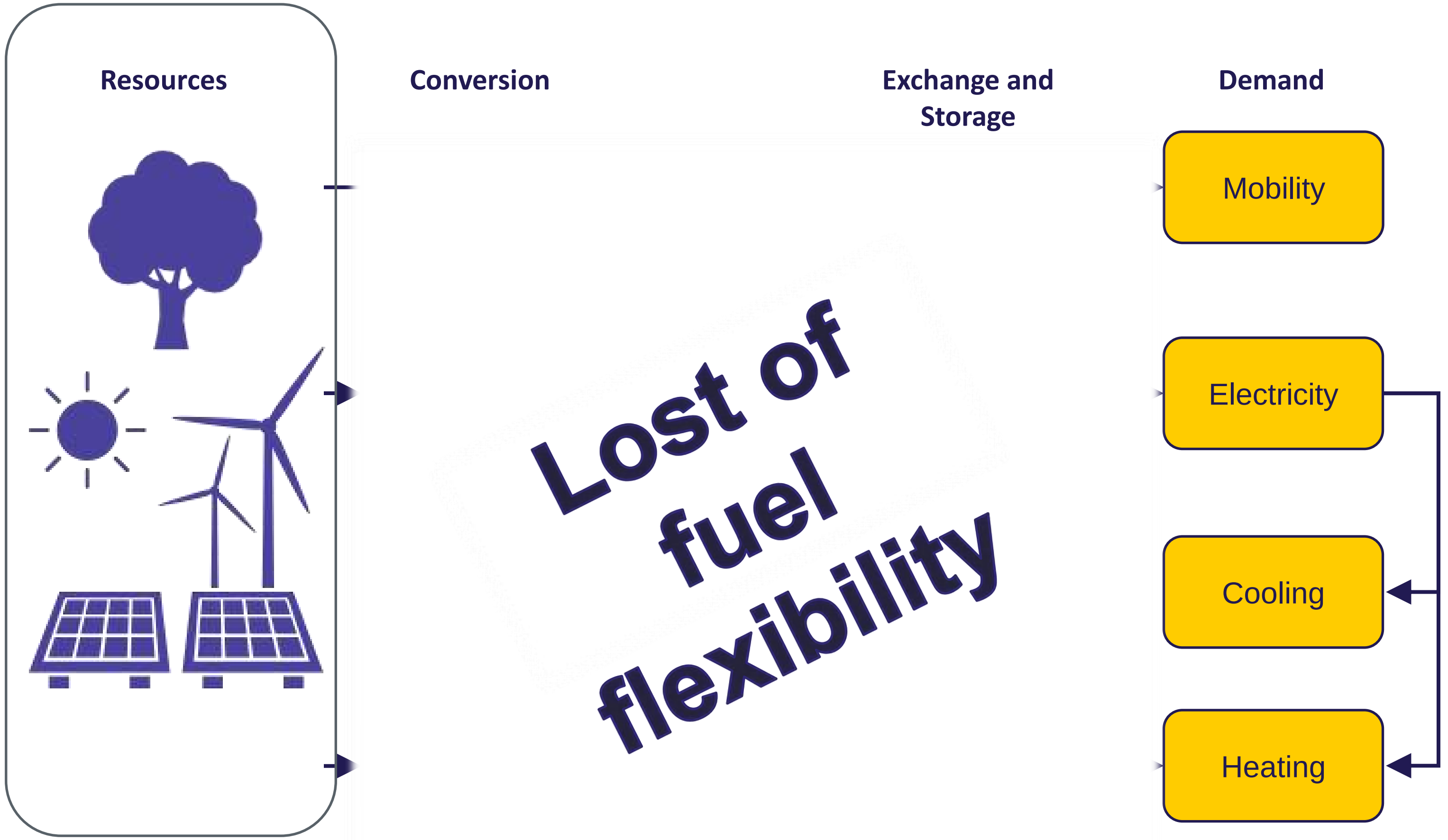
1. Interconnectors and trading
2. Flexible electricity demands and smart grids
3. Integrated efficient Smart Energy Systems



Energy system 0.0



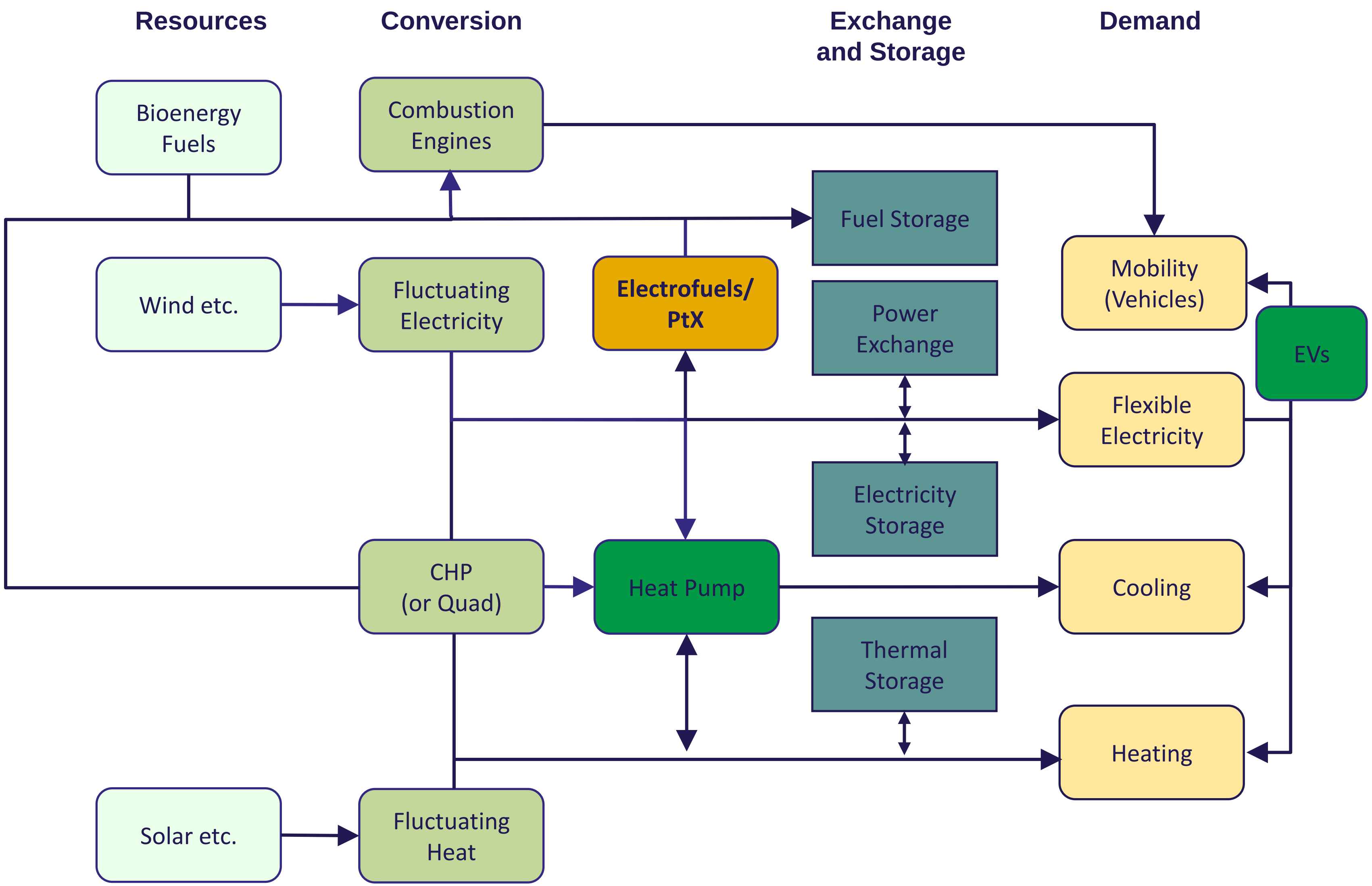
Future energy systems



Smart Energy Systems

Check:
www.EnergyPLAN.eu

Smart Energy Systems



EU Energy System Integration Strategy

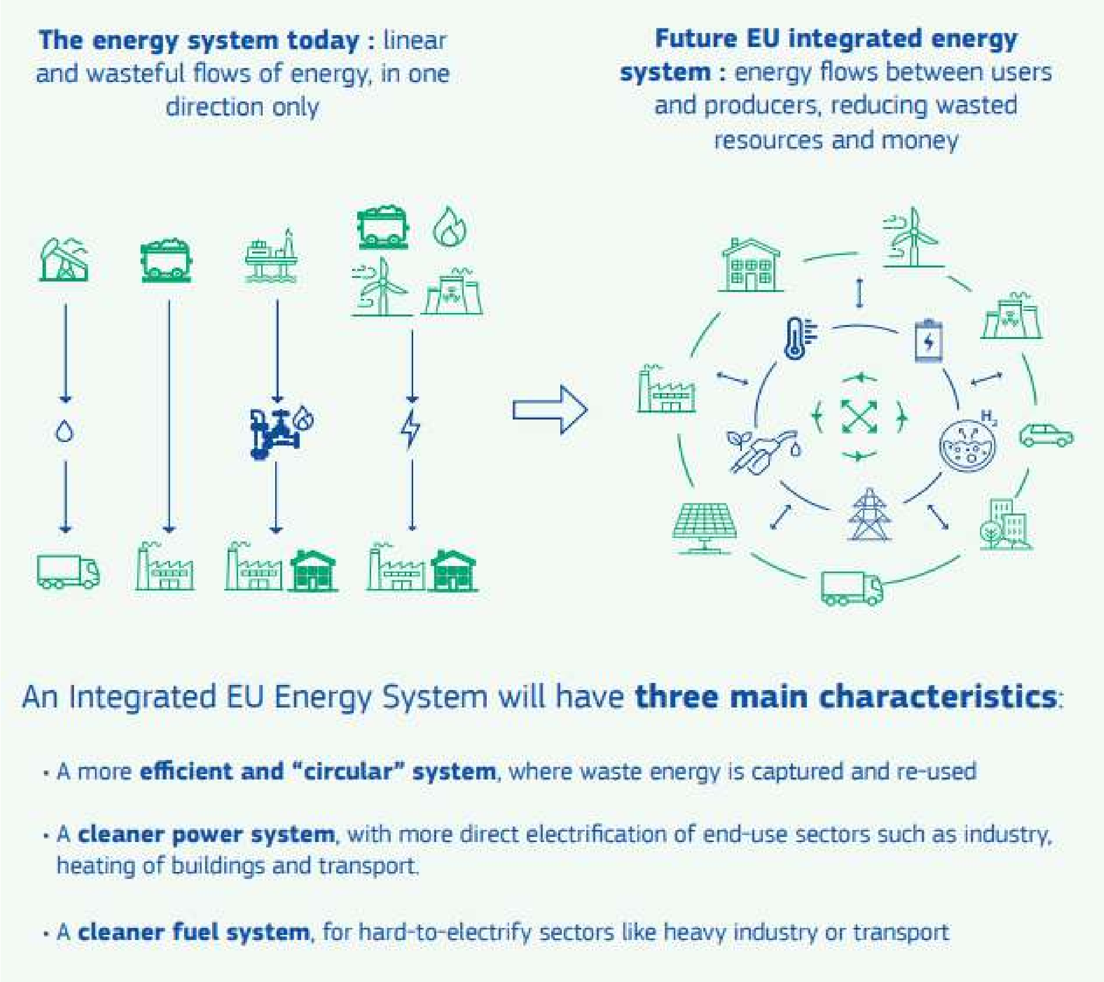
- From 2012 → 2020

EUROPEAN COMMISSION

Brussels, 8.7.2020
COM(2020) 299 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Powering a climate-neutral economy: An EU Strategy for Energy System Integration

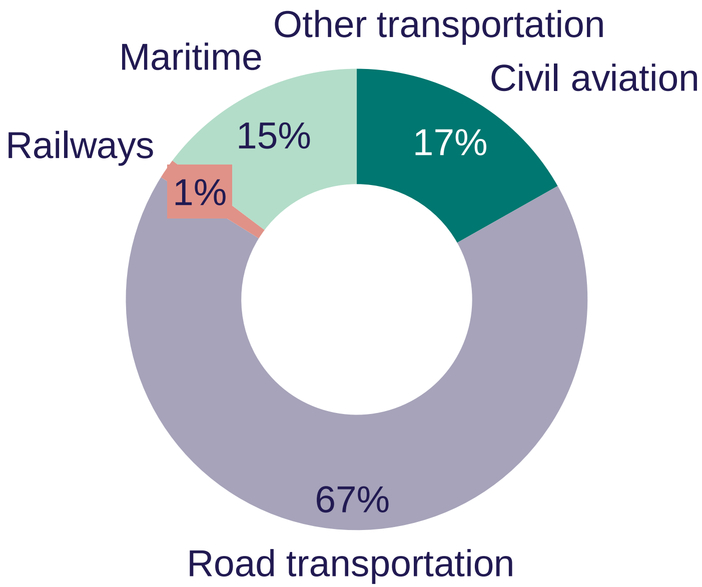


The burning platform:
PtX enable integration of renewables

To achieve climate neutrality, a 90% reduction in transport emissions is needed by 2050. 67% emissions are from road transport of which 26% is heavy-duty transport.

PtX/electrofuels can optimise the utilisation of our energy production by storing energy from renewable sources and displace the fossil fuels in heavy duty transport.

We have a solution for personal transportation, but we do not have a clear idea how to solve the heavy-duty transport nor it was something that was discussed until recently.



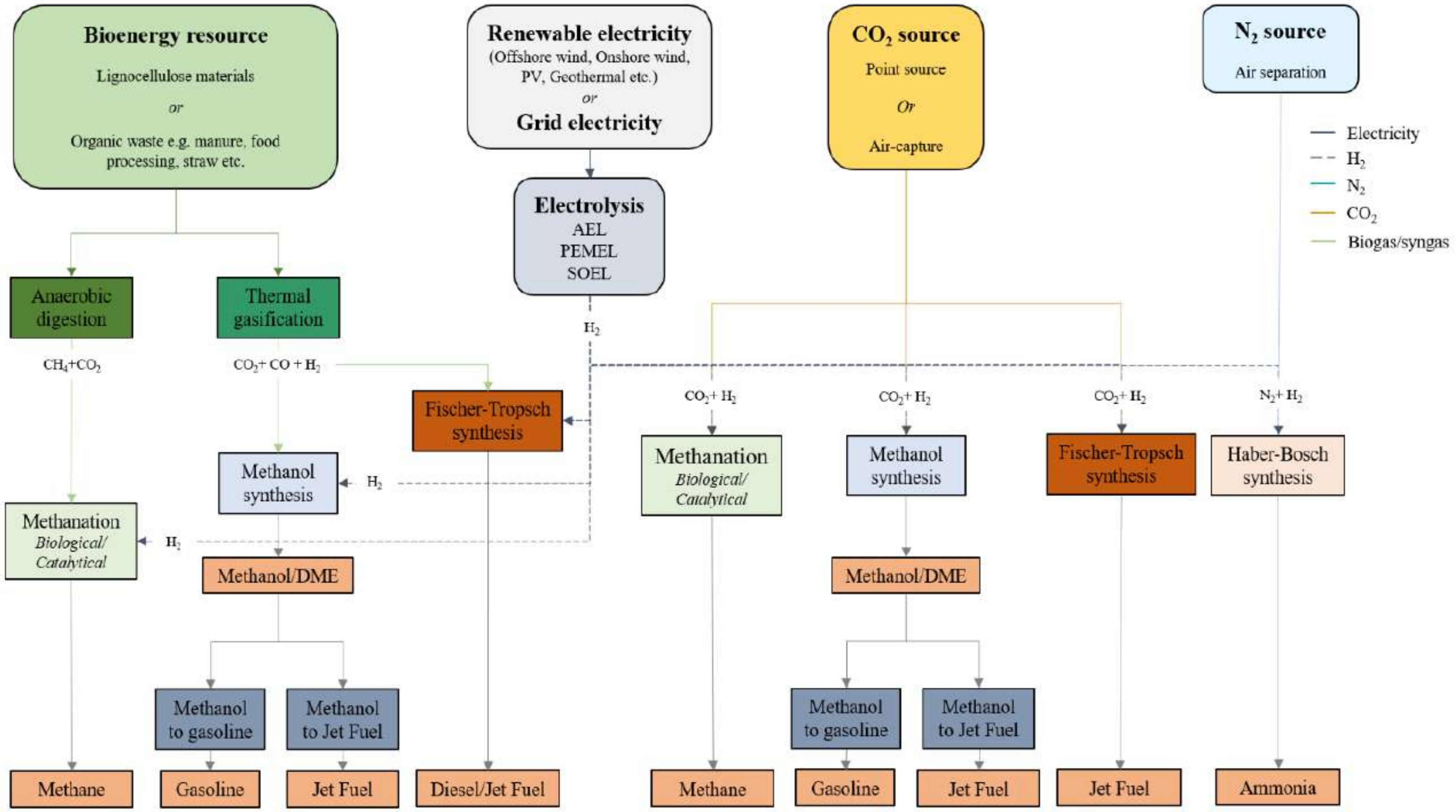
Current barriers:

Inhibitors for innovative first-movers

- Regulatory framework inhibits a sound business case.
- Certain effects of electrofuels are yet to be tested in large scale.
- Fuel engines and infrastructure needs to be adjusted to allow a large scale implementation of electrofuels.
- We need to create a competitive renewable fuel market.
- We need to talk about targets for different modes of transport – personal, road heavy-duty, marine and aviation.

PtX pathways

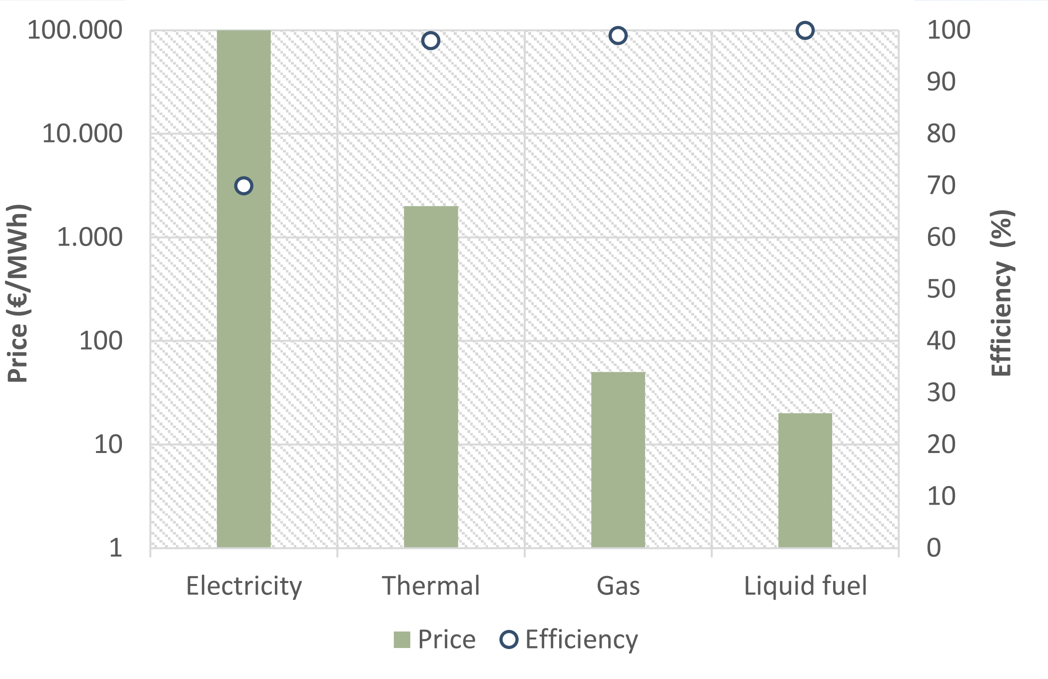
- The individual technologies more advanced than generally presumed
- The concept as an integrated production system remains to be proven on a larger scale.



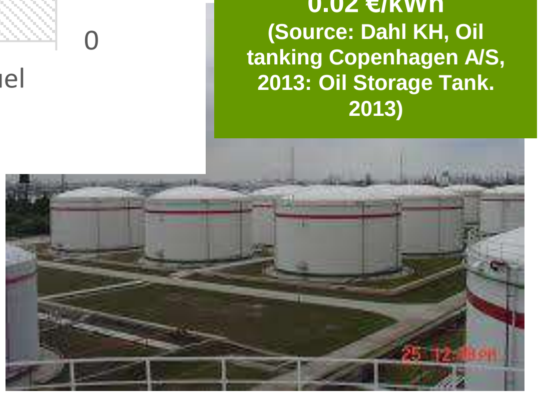
Storage comparison

Pump Hydro Storage
175 €/kWh
(Source: Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits. Electric Power Research Institute, 2010)

Thermal Storage
1-4 €/kWh
(Source: Danish Technology Catalogue, 2012)



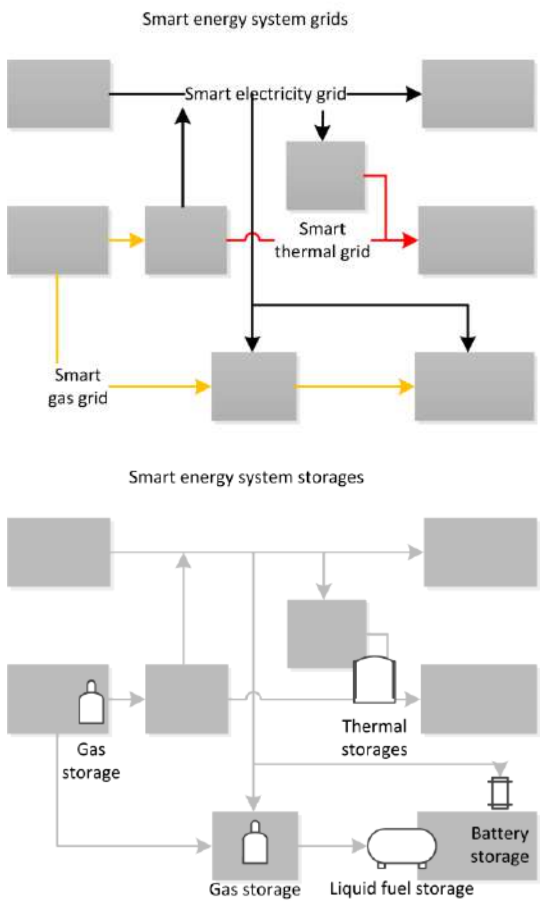
Oil Tank
0.02 €/kWh
(Source: Dahl KH, Oil tanking Copenhagen A/S, 2013: Oil Storage Tank. 2013)



Natural Gas Underground Storage
0.05 €/kWh
(Source: Current State Of and Issues Concerning Underground Natural Gas Storage. Federal Energy Regulatory Commission, 2004)

How to use storages long term..
(in Smart energy markets)

- Three crucial grids in Smart Energy Systems
  - Smart electricity grids
  - Smart thermal grids
  - Smart gas grids
- Electricity storage in transport (batteries and electrofuels)
- More district heating (and district cooling) with heat storages
- Large heat pumps with high capacity (Power-to-heat – 50% operation time)
- CHP, solar thermal, etc.
- High capacity electrolyses (Power-to-gas – 50% operation time)
- Production of green gasses and e-fuels
- … and bioenergy on the input side..



WWW.SMARTENERGYSYSTEMS.EU

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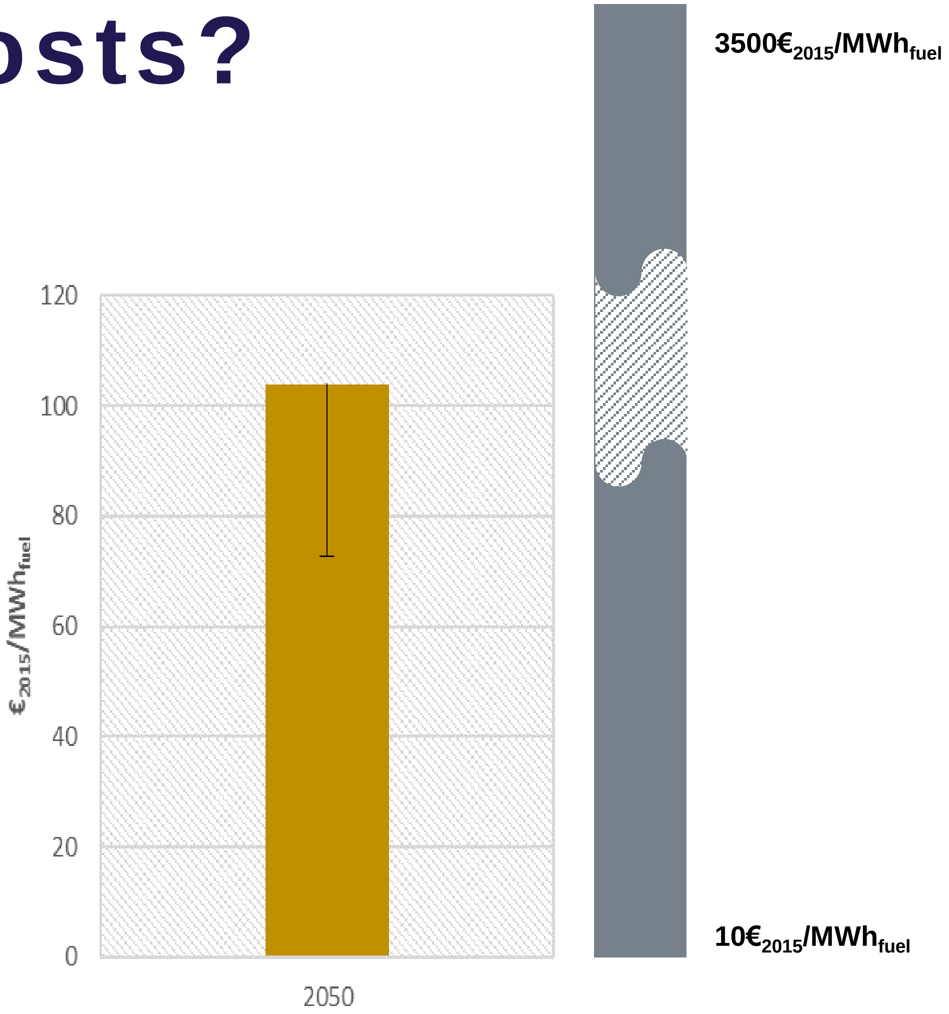
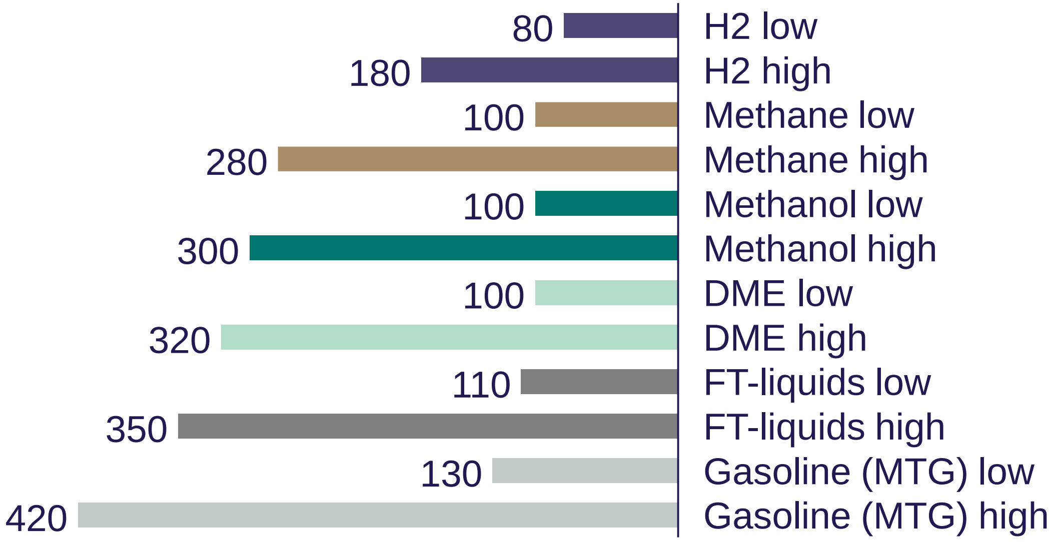
Costs?

HUGE COST DIFFERENCES DUE TO DIFFERENT ASSUMPTIONS



Brynolf et al (2018) Electrofuels for the transport sector: A review of production costs

Production costs* (€$_{2015}$/MWh)



**rounded numbers*

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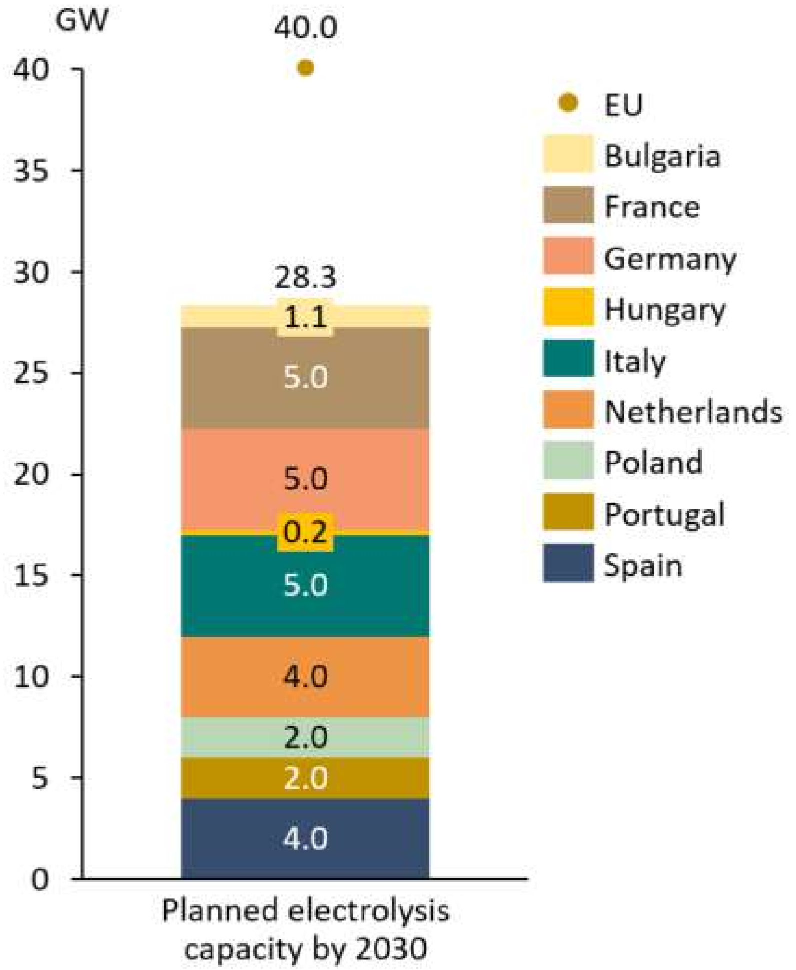
Current plans for PtX in Europe

- Member states level
  - National Hydrogen Strategies set such targets
  - Some countries mention PtX fuels as an option for aviation and maritime shipping



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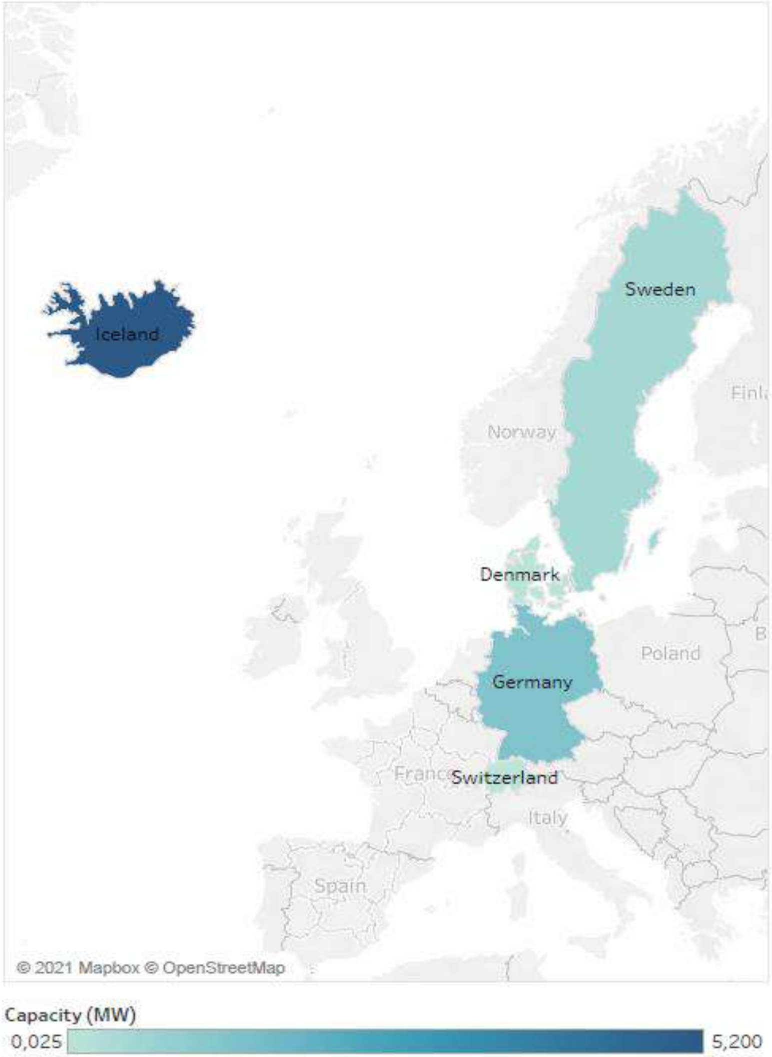
PtX demonstrators in Europe

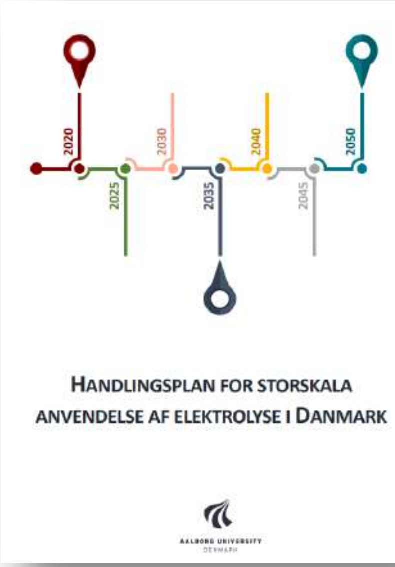
Projects commissioned before 2022



Projects commissioned after 2022

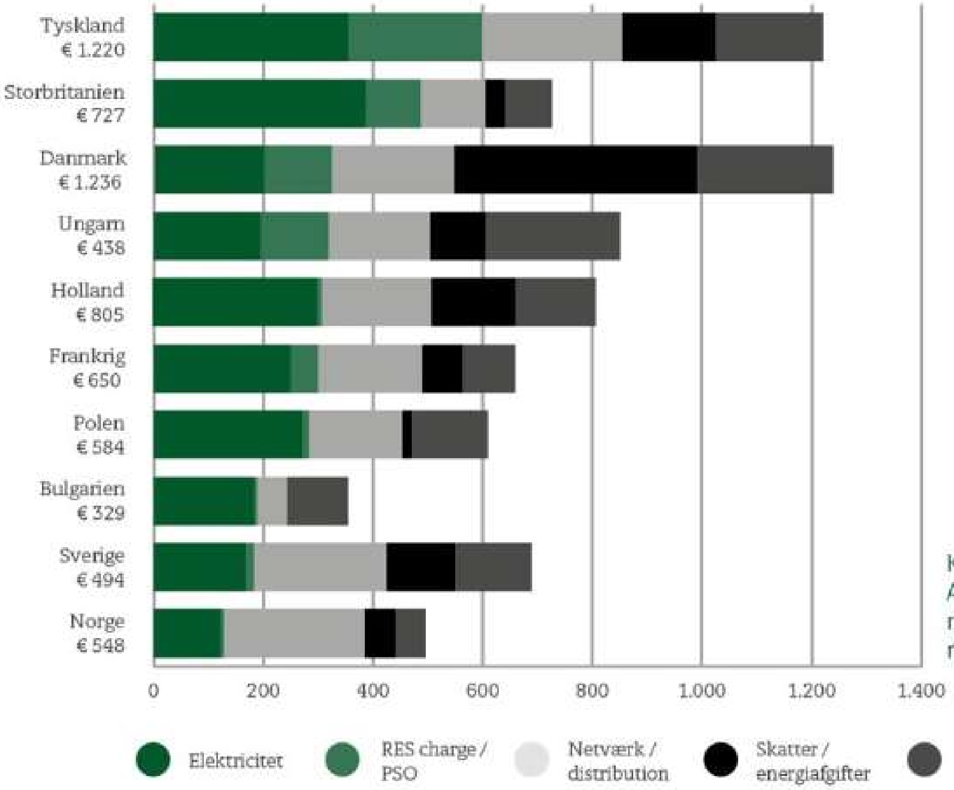
Why Denmark is an ideal test-bed and laboratory for large-scale electrolysis

- Use and storage of wind power
- Can test use of intermittent resources and help predict potential problems regarding integration of renewable energy and electricity grid
- Can be connected to district heating to utilise waste heat from fuel production processes
- Plan for 100% renewable energy in 2045 (including transport)
- Research in all three electrolysers types
- Producers of chemical synthesis and electrolysis



We have already cheapest electricity production..

- Plan for large expansion of off-shore wind
- We can be a fuel production plant for the EU

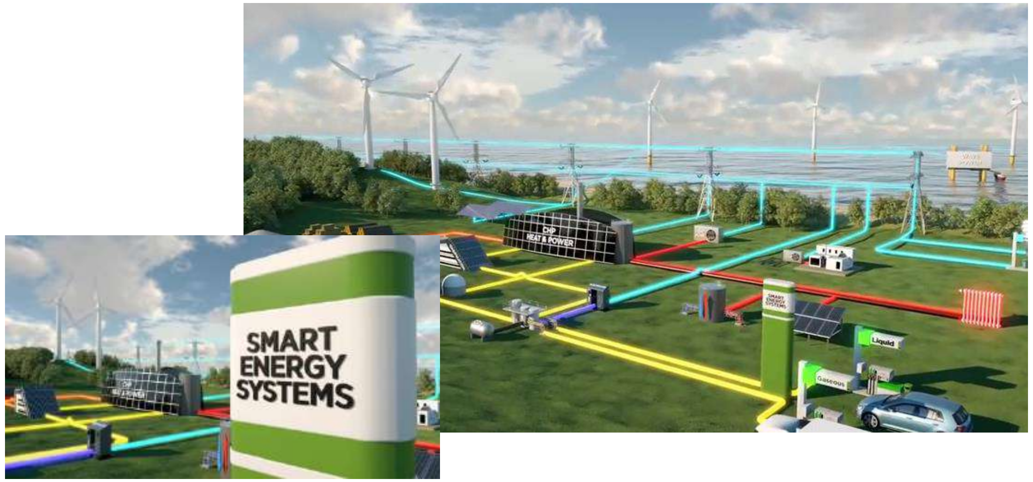


Kilde:
ACER market monitoring report 2015

PtX in Denmark

We need to think beyond 2030 and achieve emission reductions in 2030 that can lift the 100% renewable energy and CO_2 neutrality in 2045

- Choose the technologies before 2030 that can help further reductions in following years
- Focus on development of the new technologies like PtX that do not have a big role in 2030 but will be much needed towards 2045



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Power-to-X in Denmark:
An Analysis of Strengths, Weaknesses, Opportunities and Threats


energies

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Article

Power-to-X in Denmark: An Analysis of Strengths, Weaknesses, Opportunities and Threats

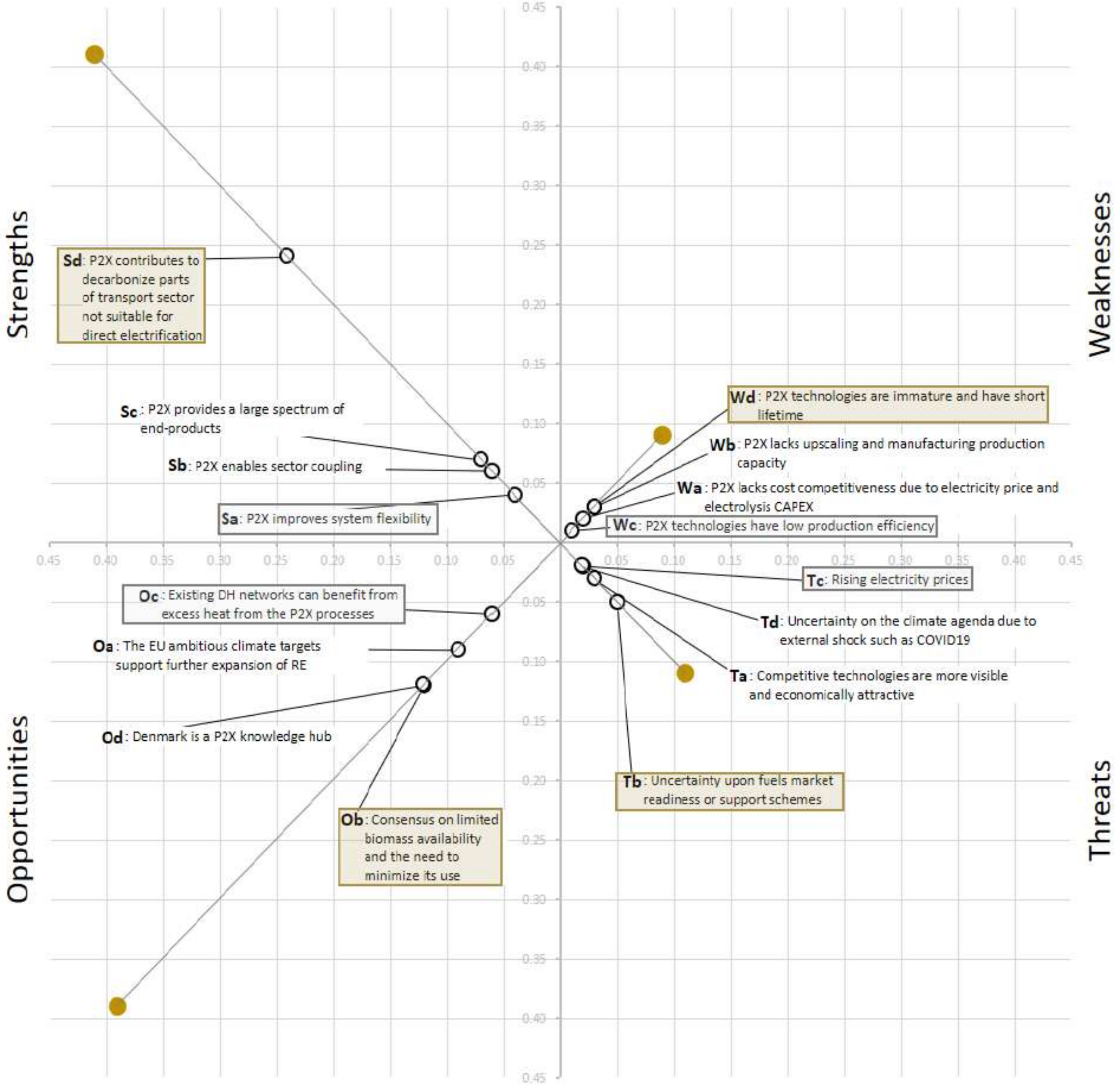
Iva Ridjan Skov [1,*], Noémi Schneider [1], Gerald Schweiger [2], Josef-Peter Schöggl [3,4] and Alfred Posch [5]

https://doi.org/10.3390/en14040913

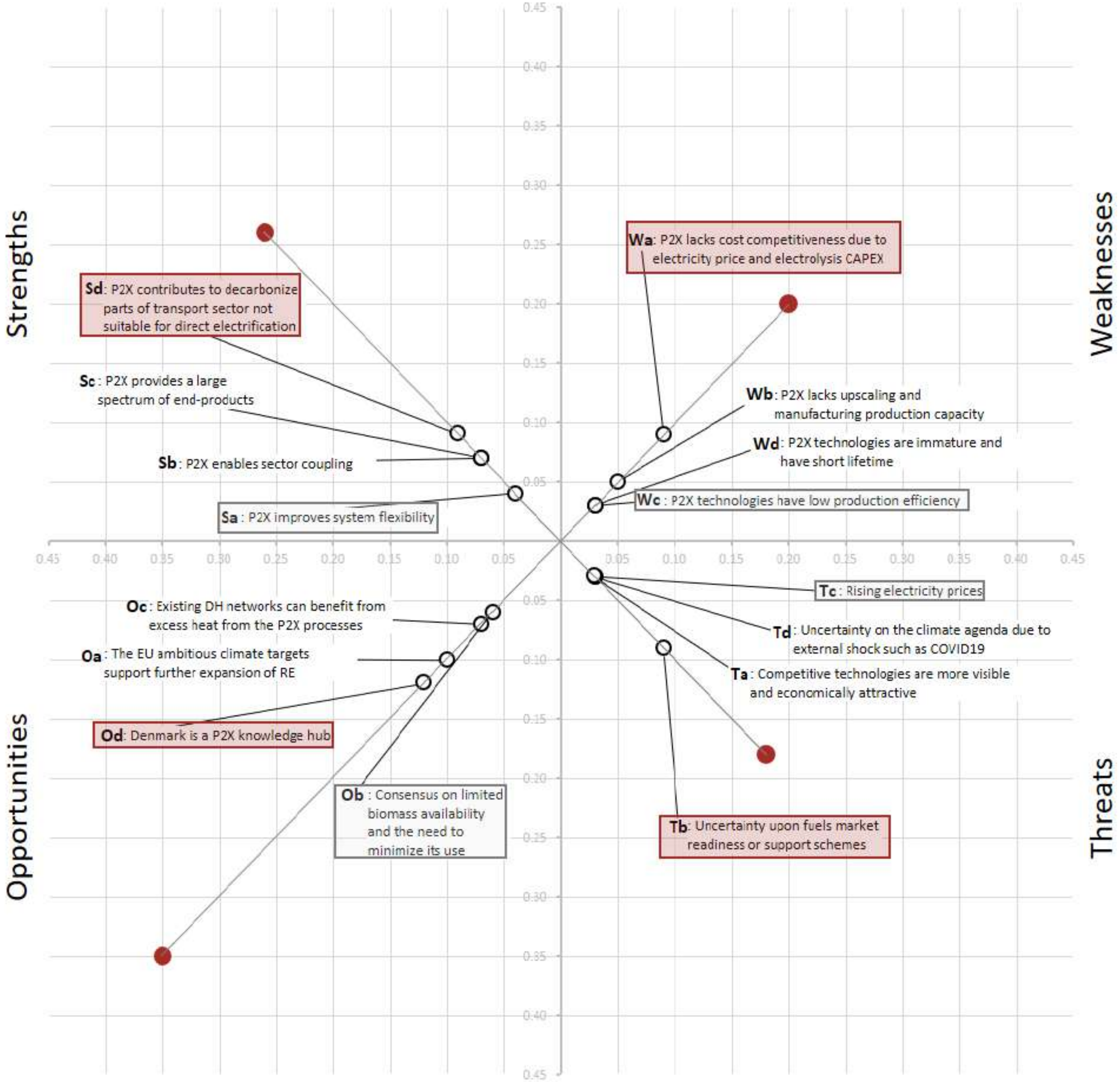
- 11 expert interviews in Phase 1
- 28 replies on online survey in Phase 2 (67 invitations sent out)

	Positive	Negative
Internal	**Strengths** Sa: P2X improves system flexibility Sb: P2X enables sector coupling Sc: P2X provides a large spectrum of end-products that are compatible with existing infrastructure and equipment Sd: P2X contributes to decarbonize parts of transport sector not suitable for direct electrification	**Weaknesses** Wa: P2X lacks cost competitiveness due to electricity price and electrolysis CAPEX Wb: P2X lacks upscaling and manufacturing production capacity Wc: P2X technologies have low production efficiency Wd: P2X technologies are immature and have short lifetime (electrolysis)
External	**Opportunities** Oa: The European Union ambitious climate targets support further expansion of renewable energy. Ob: Consensus on limited biomass availability and the need to minimise its use Oc: Existing district heating networks can benefit from excess heat from the P2X processes. Od: Denmark is a P2X knowledge hub.	**Threats** Ta: Competitive technologies are more visible and economically attractive Tb: Uncertainty upon fuel market readiness or support schemes. Tc: Rising electricity prices Td: Uncertainty on the climate agenda due to external shocks such as the COVID-19 pandemic

Academics



Practitioners



Fremtidens transportmidler kører på electrofuels

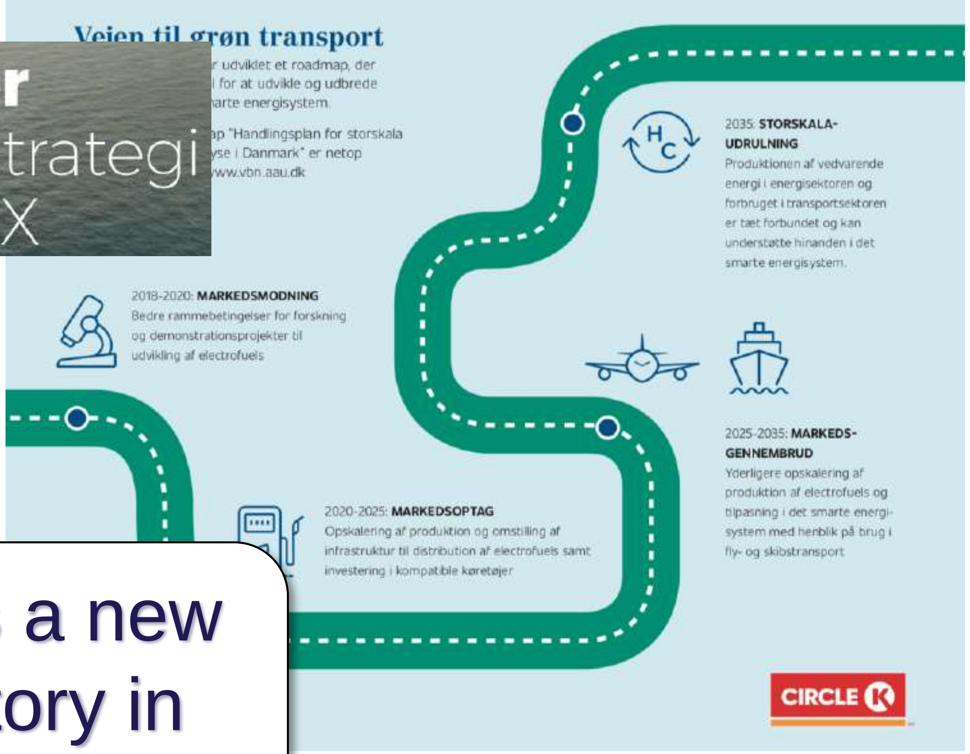
IDA

PTX I DANMARK FØR 2030

Potentiale for PtX i Danmark på kortere sigt i et sy

ENERGINET

Anbefalinger
til en dansk strategi
for Power-to-X



Shell vil bygge nordens stør
Danmark

Virksomhederne Shell og Everfuel har indgået et
nordens største power-to-X-anlæg i Fredericia.

PtX could be seen as a new industrial success story in Denmark!

VedvarendeEnergi: Electrofuels kan give fleksibilitet i energisystemet

Drømmen om grønt dansk flybrændstof lever

En ny rapport antyder, at det kan lade sig gøre at fremstille klimavenligt flybrændstof i Danmark ved hjælp af gylle og husholdningsaffald.

Vindmøllestrøm skal lagres som grøn ammoniak

21 august 2018 09:38 | Af Redaktionen/he | Tip redaktionen om en historie

Siemens Gamesa Renewable Energy og Energifonden Skive har indgået en samarbejdsaftale. Målet er etablering af et pilotanlæg i GreenLab Skive

Rederier, kunder og banker går sammen om at udvikle CO2-frie skibe fra 2030

Cleantech: En række af verdens store virksomheder i shipping går sammen med betydningsfulde selskaber inden for bl.a. energi og maskinproduktion om at udvikle et CO2-frit skib, der kan være på vandet i 2030. Maersk, Shell og MAN Energy Solutions er blot nogle af deltagerne i projektet.

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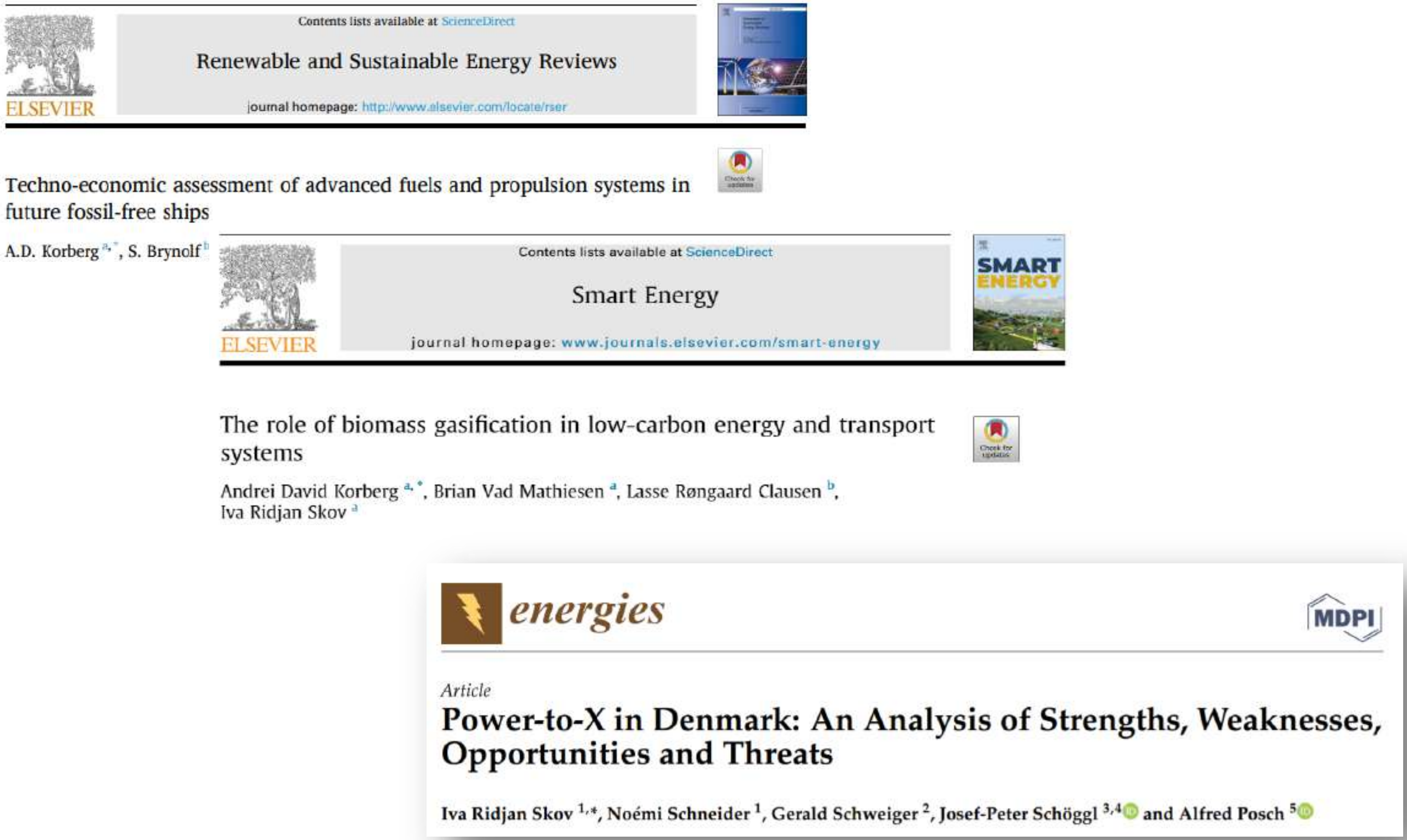
Thank you for your attention!

All publications: [Iva Ridjan Skov, Associate Professor, Sustainable Energy Planning research group]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Renewable and Sustainable Energy Reviews
journal homepage: http://www.elsevier.com/locate/rser
ELSEVIER

Techno-economic assessment of advanced fuels and propulsion systems in future fossil-free ships

A.D. Korberg [a,*], S. Brynolf [b]

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SMART ENERGY

The role of biomass gasification in low-carbon energy and transport systems

Andrei David Korberg [a,*], Brian Vad Mathiesen [a], Lasse Røngaard Clausen [b], Iva Ridjan Skov [a]

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