The role of PtX in meeting the 2 and well below 2 °C mitigation targets

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Two case studies

1. Integrated bioeconomy and low carbon economy scenarios until 2050 for Finland

- Starting point: Forest covers a greater share of land in Finland than in any other European country
- How to best utilize Finland's biomass resources to increase sustainable growth of the Finnish economy and reduce GHG emissions 80-95 % by 2050 (compared with 1990 levels)?

→ The role of PtG and PtL in Finland to by 2050

2. Global pathways to post-fossil economy in a well below 2 degrees C world

- Starting point: how to phase-out fossil fuels by 2100 and reach the 1.5 °C mitigation targets?

→ The role of PtG, PtL and PtX (e.g. hydrocarbon chemicals and other materials)

→ The role of DAC (direct air capture) to reach the 1.5 °C

What do we mean with PtX?

1. Finnish case study

- Processes, where hydrogen is produced via electrolysis
- Hydrogen is used directly for energy of synthesized further to gaseous and liquid fuels by FT synthesis. Carbon is captured from prcess gases or other sources (e.g. CCU but no DAC)
- In addition, hydrogen boosted FT-diesel from biomass is included

2. Global case study

- All the above processes, but DAC included as an mitigation option in addition to CCU
- Secondly, synthesis of chemicals and other materials, which are currently produced from fossil fuels are modelled (e.g. PtX with DAC and/or CCU)

Growth by integrating bioeconomy and low-carbon economy

Finnish government’s targets and spearhead programmes:

Cost efficient transformation to carbon free, clean and renewable energy

Share of renewable energy over 50 % and energy self sufficiency over 50 % by 2030.

Wood resources in use and new products from forests

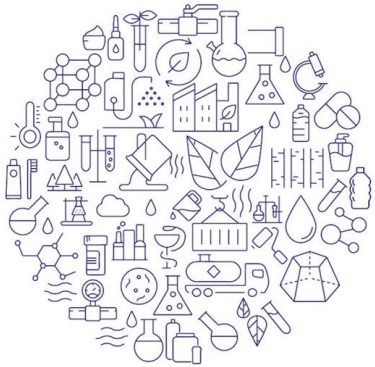
Diversify use of wood and increase value added.

Make Finnish food production feasible and increase trade balance

Promote domestic use and export of Finnish food products.

Brake through of circular economy

Increase recovery of nutrients by processing 50% of manure.



Two alternative scenarios to reach low carbon targets by 2050

Baseline

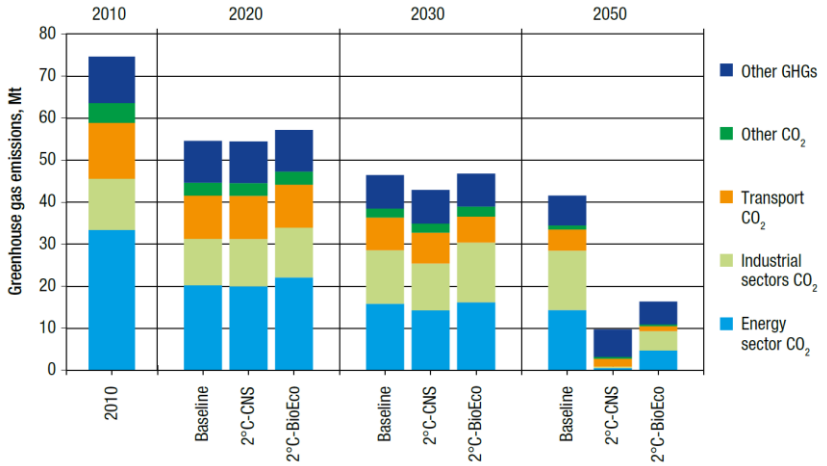
Business as usual in structure of economy, industry etc. Includes 2030 energy and climate targets.

Low carbon scenario (CNS)

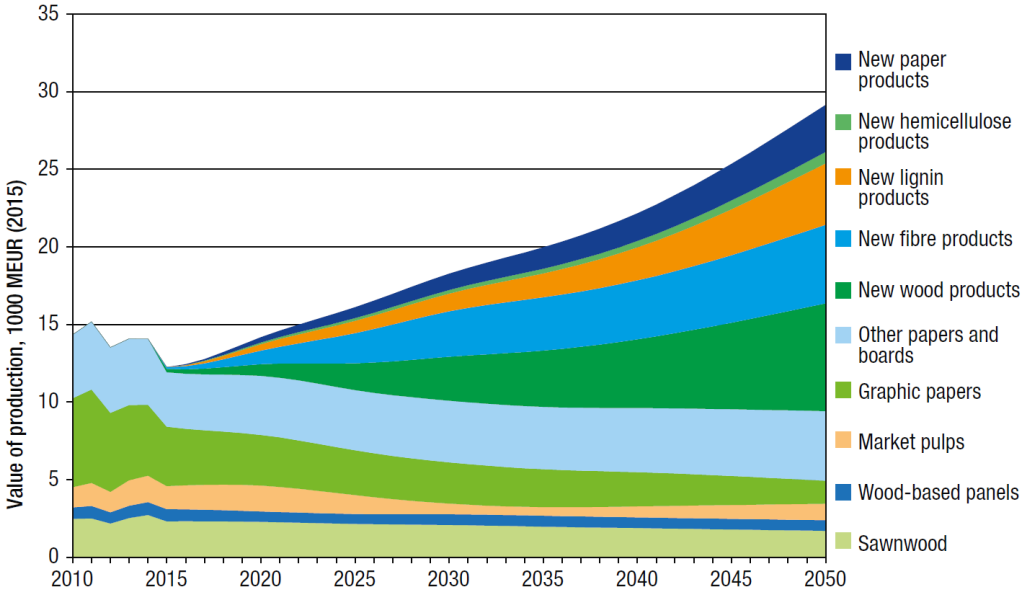
Optimal GHG emission reduction pathway for Finland. No significant structural changes in industry, but optimistic new energy technology adaptation pathway.

Bio economy scenario (BioEco)

New bioeconomy products from forest and agriculture and optimal use of side streams and residues. No fossil-CCS, strict sustainability criteria for the use of biomass.



New forest sector products can double the value added of forest sector



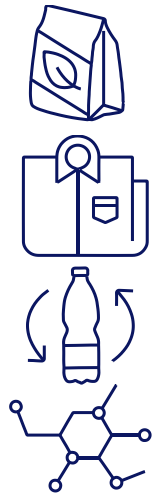
Value added pulp and paper products

Textiles and hygiene

Replacing plastics

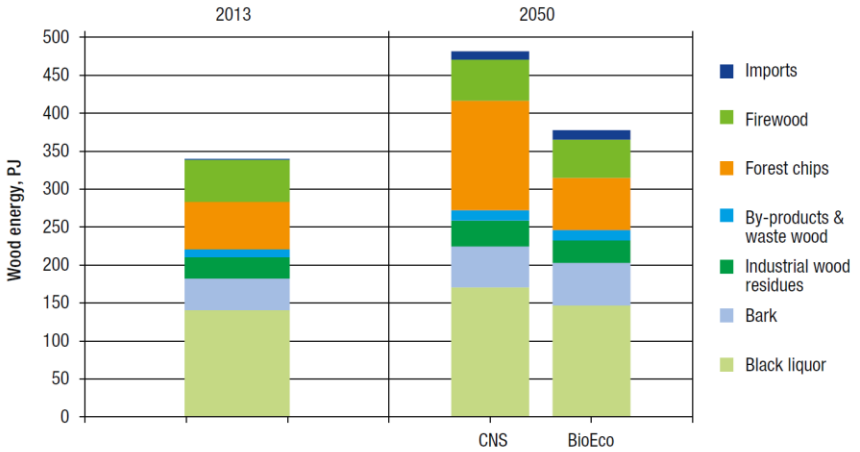
Resins, chemicals

Plasticizers

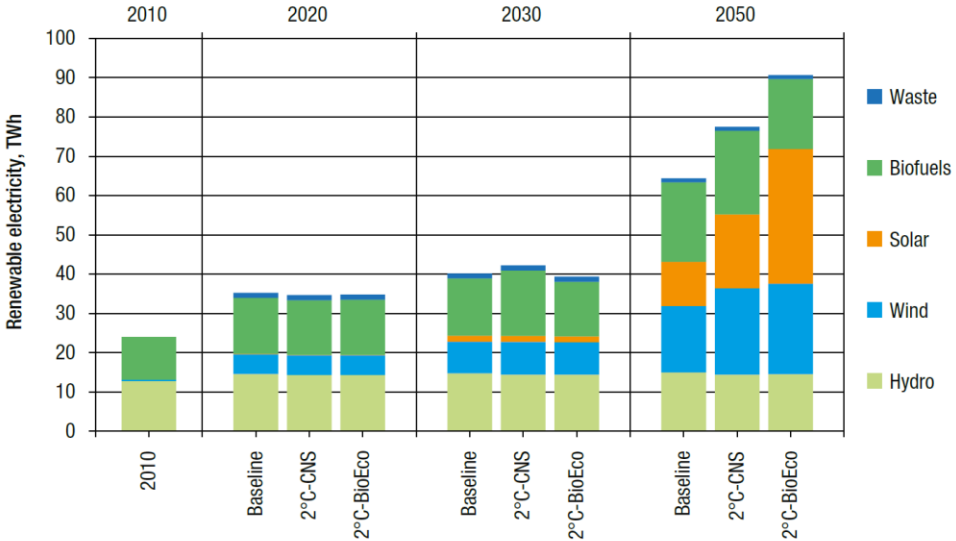


Versatile renewable energy in Finland

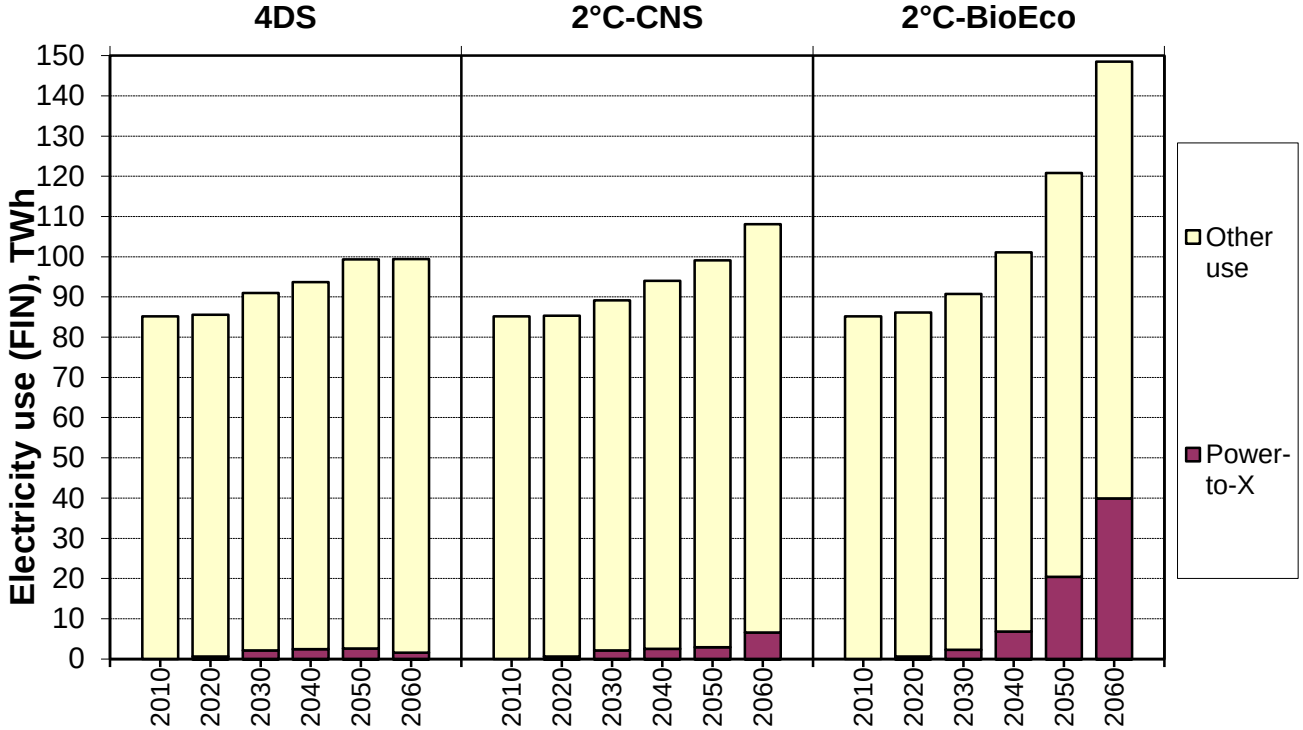
Bioenergy transition



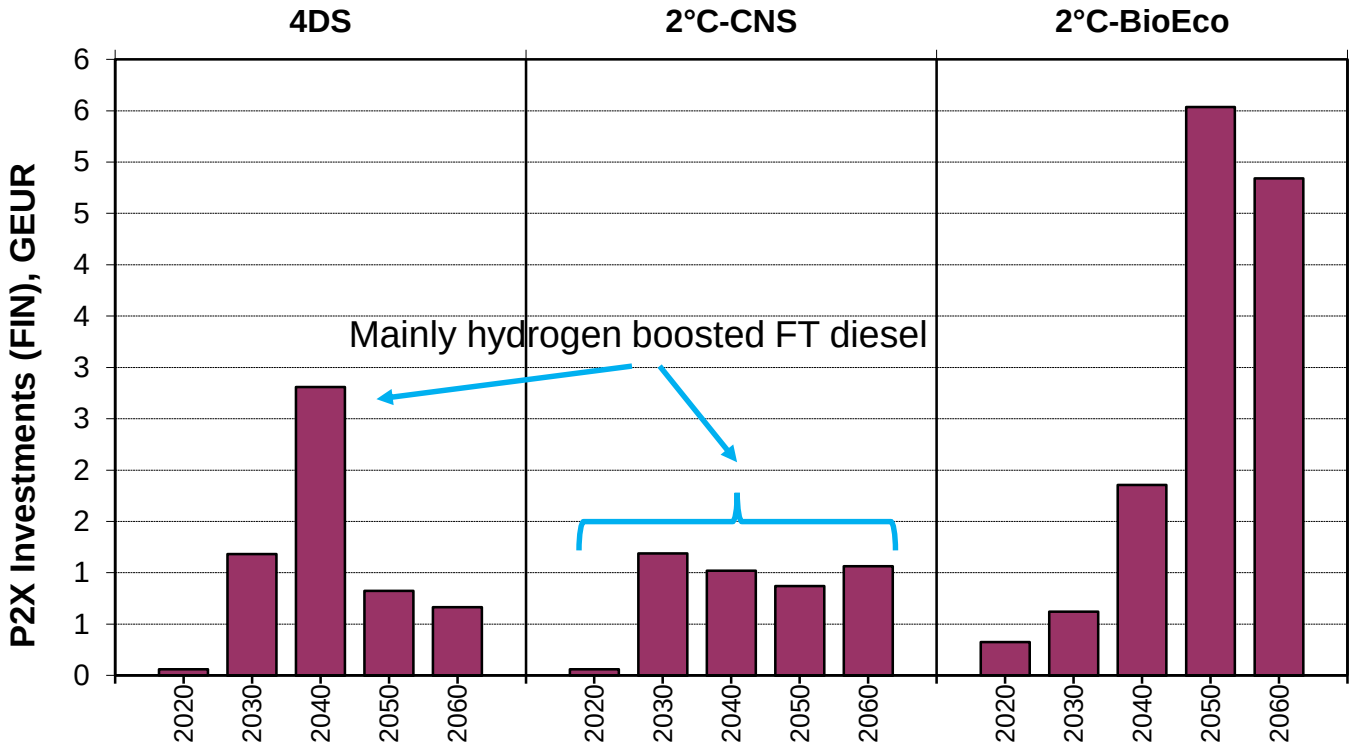
Renewable energy transition



Share of electricity use to PtX starts to grow rapidly after 2040



Investments to P2X show the similar trend



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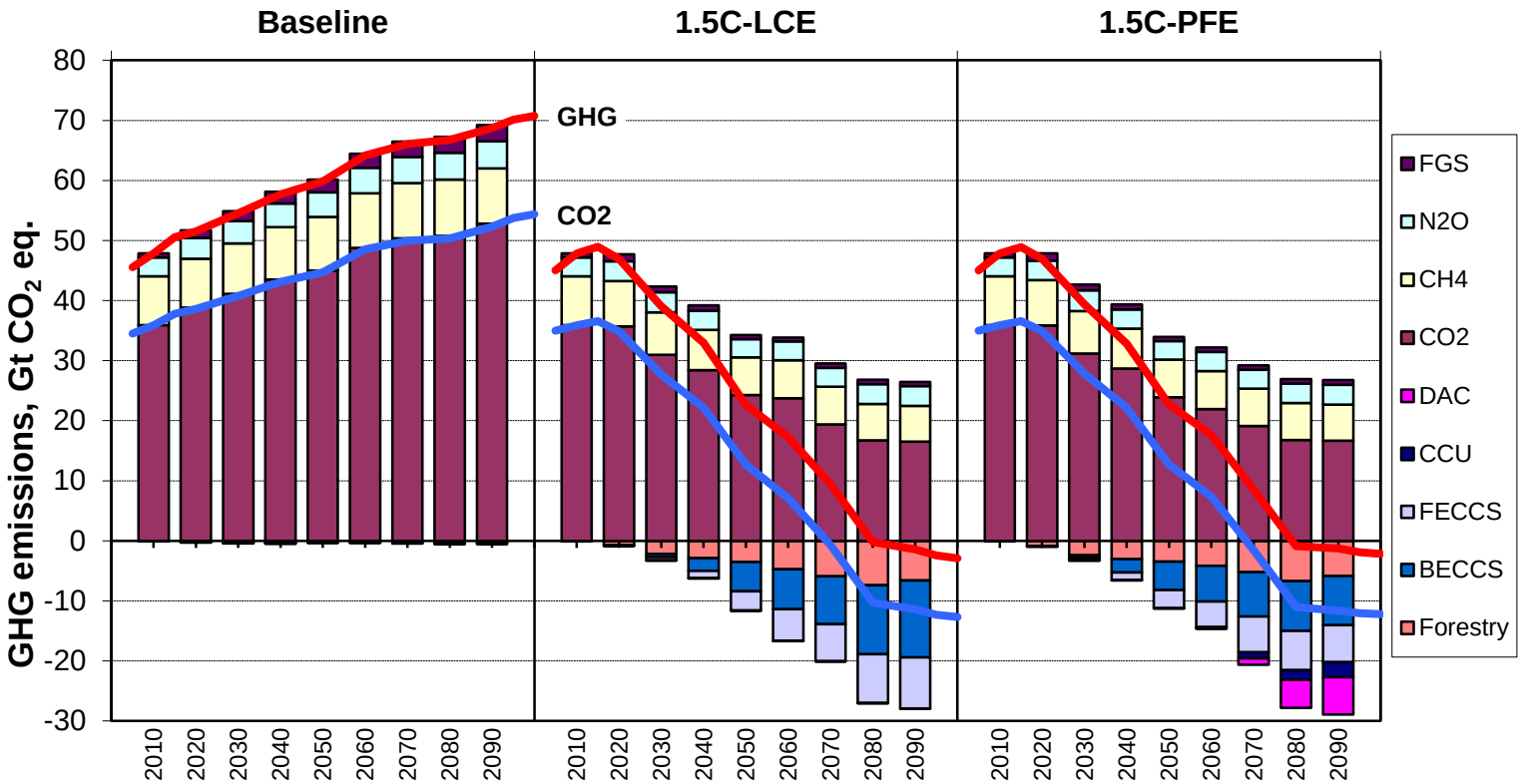
Pathways to Post-fossil Economy in a Well Below 2°C World

Table 1. Scenarios considered in the analysis.

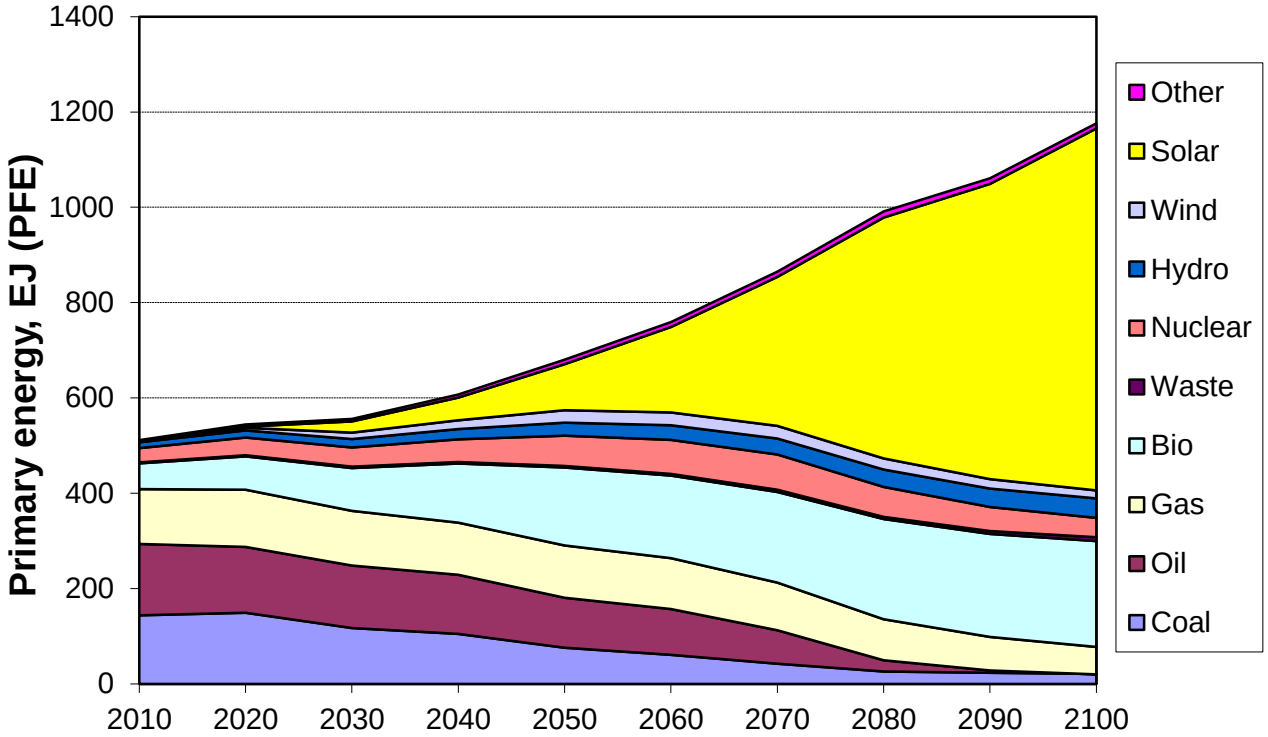
Scenario	Description	Climate target	GHG price variants
Baseline	Existing policies + INDCs, EU 2030 policies	None	€200, €250, €300, €350, €400, €450 per tonne CO_2 eq.
1.5C-LCE	Representative well-below 2°C with overshooting, low-carbon economy	Forcing trajectory corresponding to a climate sensitivity of 2.75°C (Table 2).	None
1.5C-PFE	Representative well-below 2°C with overshooting, rapid transition to a post-fossil economy	Forcing trajectory corresponding to a climate sensitivity of 2.75°C (Table 2).	None

Lehtilä, A. & Koljonen, T. In: Lect.Notes Energy, Vol. 64, George Giannakidis et al. (Eds): Limiting Global Warming to Well Below 2°C: Energy System Modelling and Policy Development

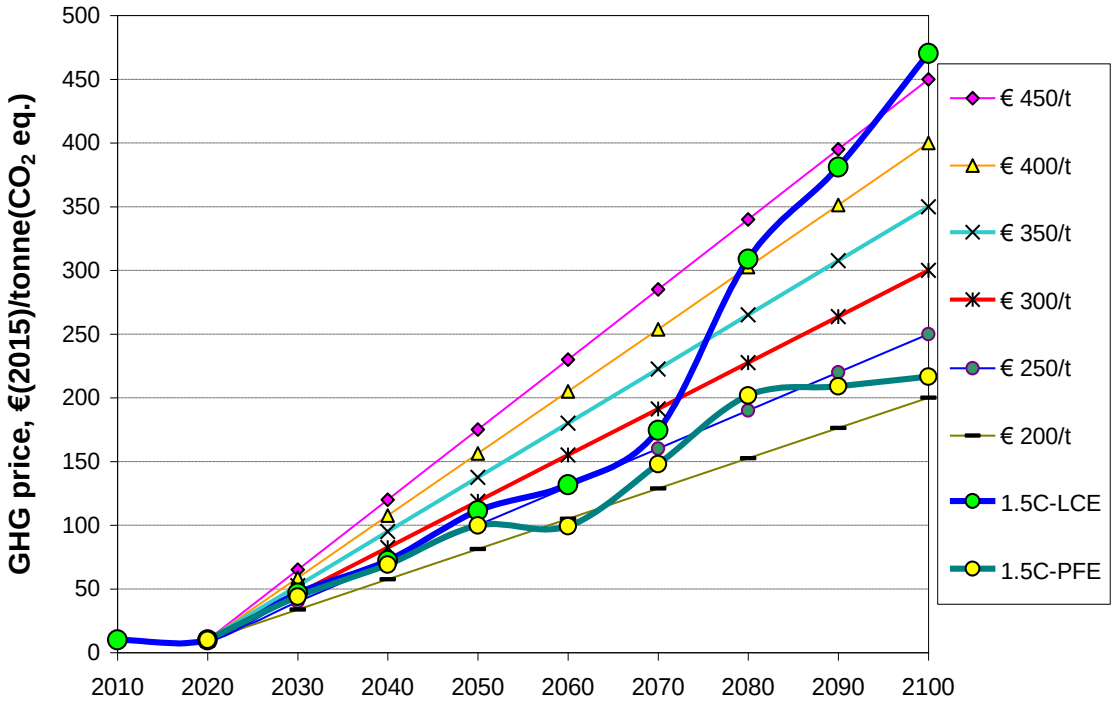
Both LCE and PFE scenarios find a solution for 1.5 °C target



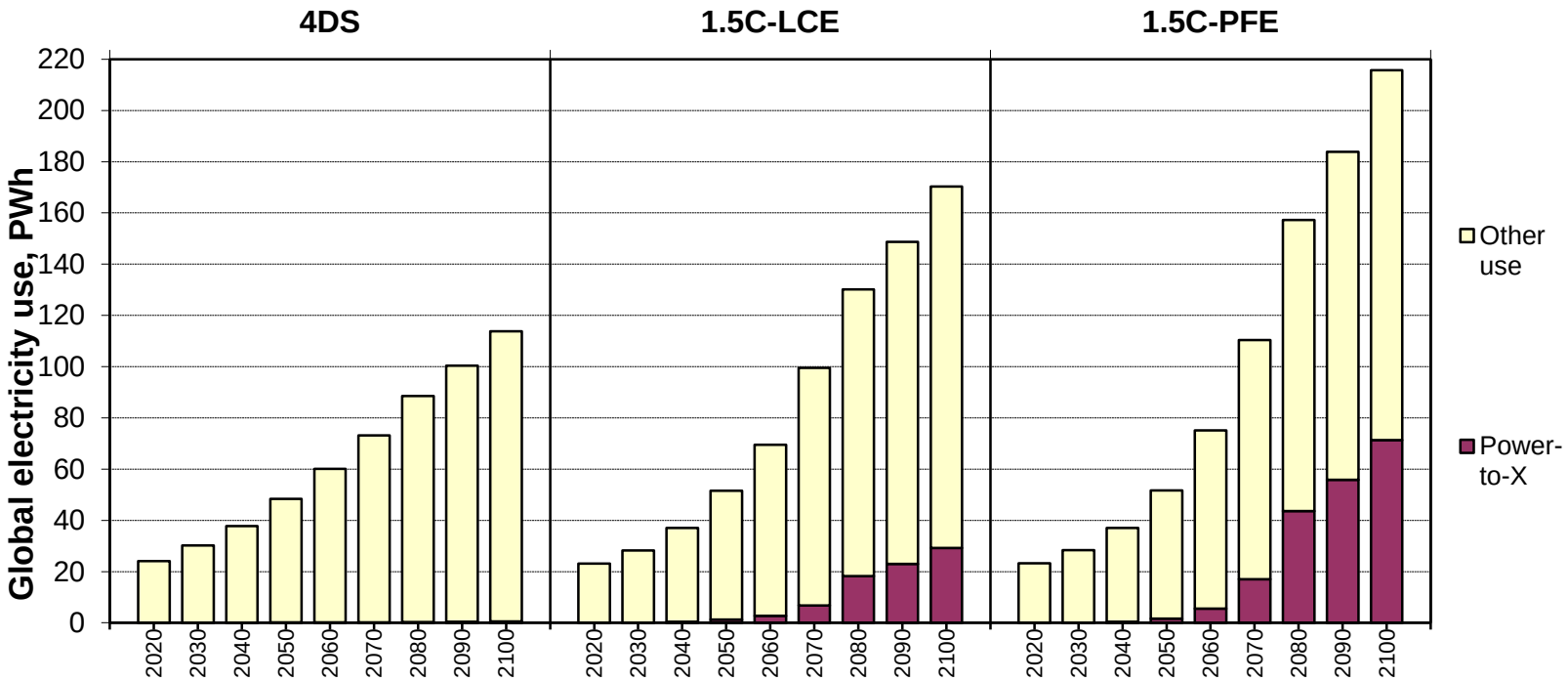
In 1.5C-PFE solar becomes a dominant energy source



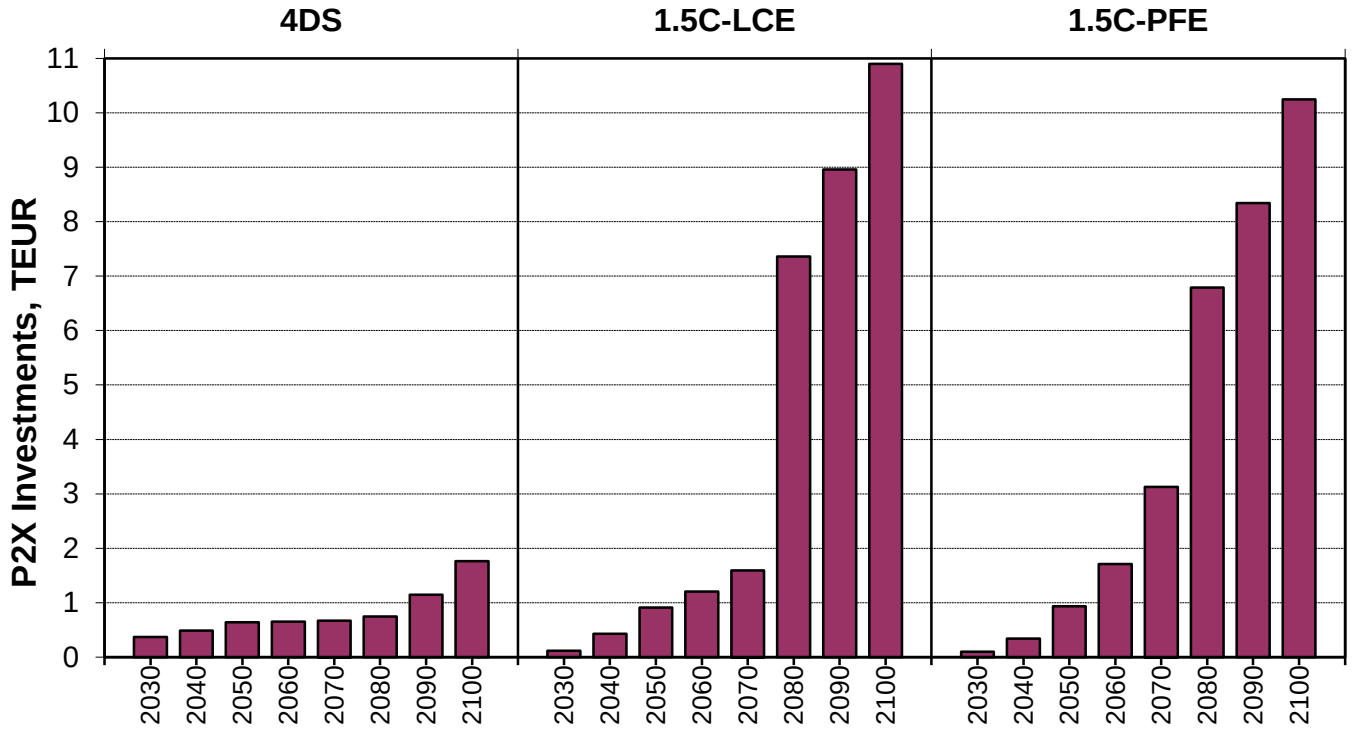
With PtX the 1.5 °C mitigation target could be achieved with reasonable costs



Also globally PtX seems to become important after 2050



… and the same happens for the PtX investments



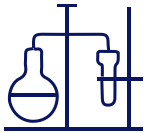
Conclusions and next steps

PtX offers an important pathway for increasing the RES shares of all the energy sectors, especially when fossil CCS and/or bioenergy are constrained

Seasonal storage of RES with PtX would become essential with high RES shares

Transformation to a post-fossil economy is extremely complicated

A lot of work is required for more detailed modelling of power to chemicals and other materials



It is possible that supply of certain metals and minerals would constrain the development of post-fossil economy

Model and database development is underway – first results/case-studies will be ready by the end of this year

Other PtX options, like food, and assessments of other sustainability dimensions need to be considered

Water and other natural resources, land, acceptability, etc.

A brighter future is created through science-based innovations.

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