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27.9. BIOENERGIAPÄIVÄT, HELSINKI

BIOGENIC CO_2
AS PART OF FINLAND'S STRATEGY

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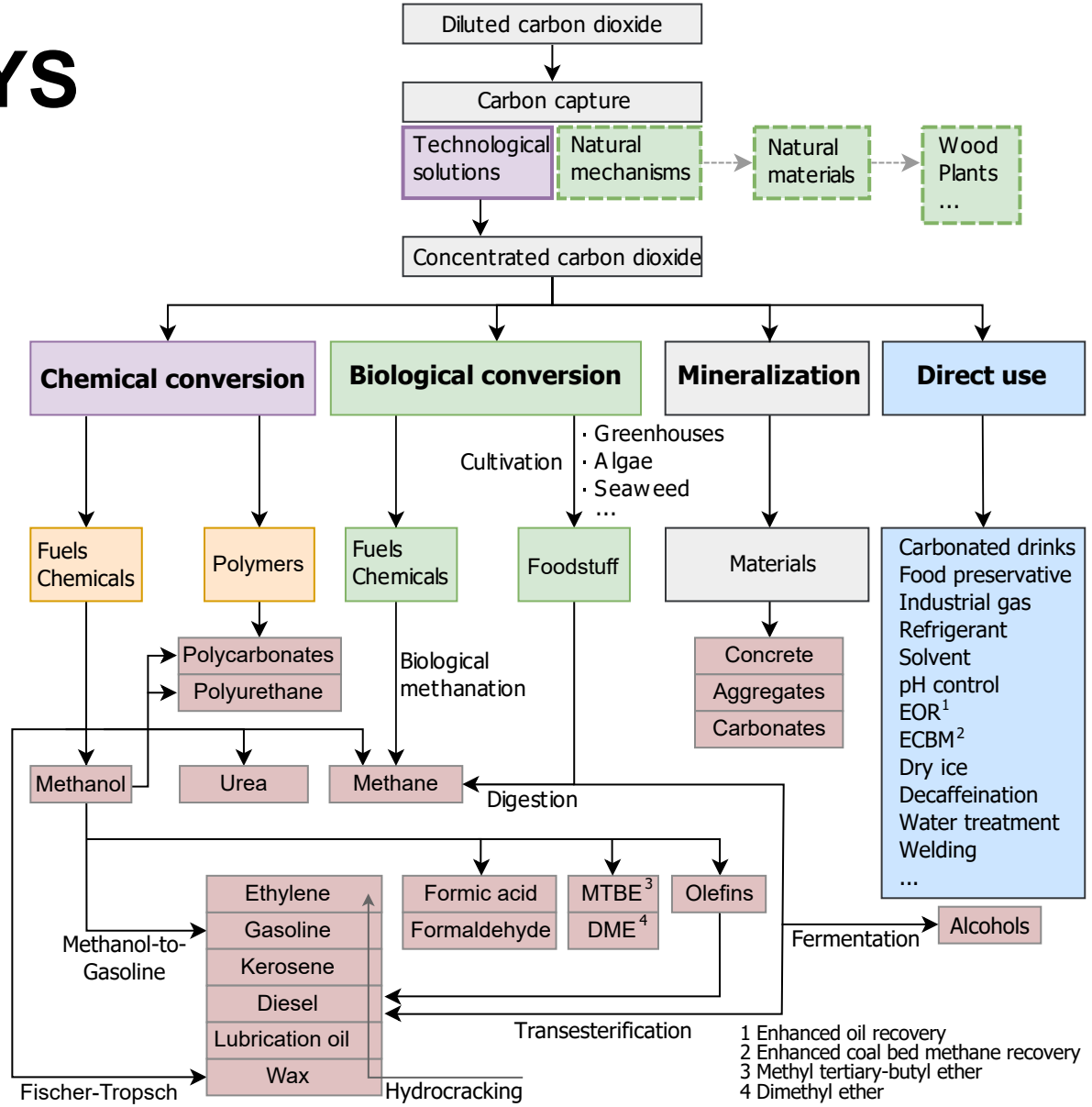
FINLAND'S STRATEGIC GOALS?

- **Climate act**
- Achieve emission neutrality by 2035
- Achieve specified emission reductions by 2030, 2040 and 2050

- **Carbon neutral Finland 2035 – national climate and energy strategy**
- "Increasing **international climate benefits**, also referred to as the carbon handprint, should therefore be set as a goal of Finland's climate policy in addition to reducing national emissions."
- "**security of supply** in energy production as well as a competitive energy price essential for energy users and economic growth"
- "system integration and electrification, hydrogen and **electrofuels**, future heating system, offshore wind power and emerging nuclear energy"
- "Approaches for supporting **technical solutions for the development of sinks** will be investigated"

CO_2 UTILIZATION PATHWAYS

- Focus on technical pathways in this speech
  - Start with a gaseous stream of diluted CO_2
- Bulk utilization volumes available for chemical conversion and mineralization



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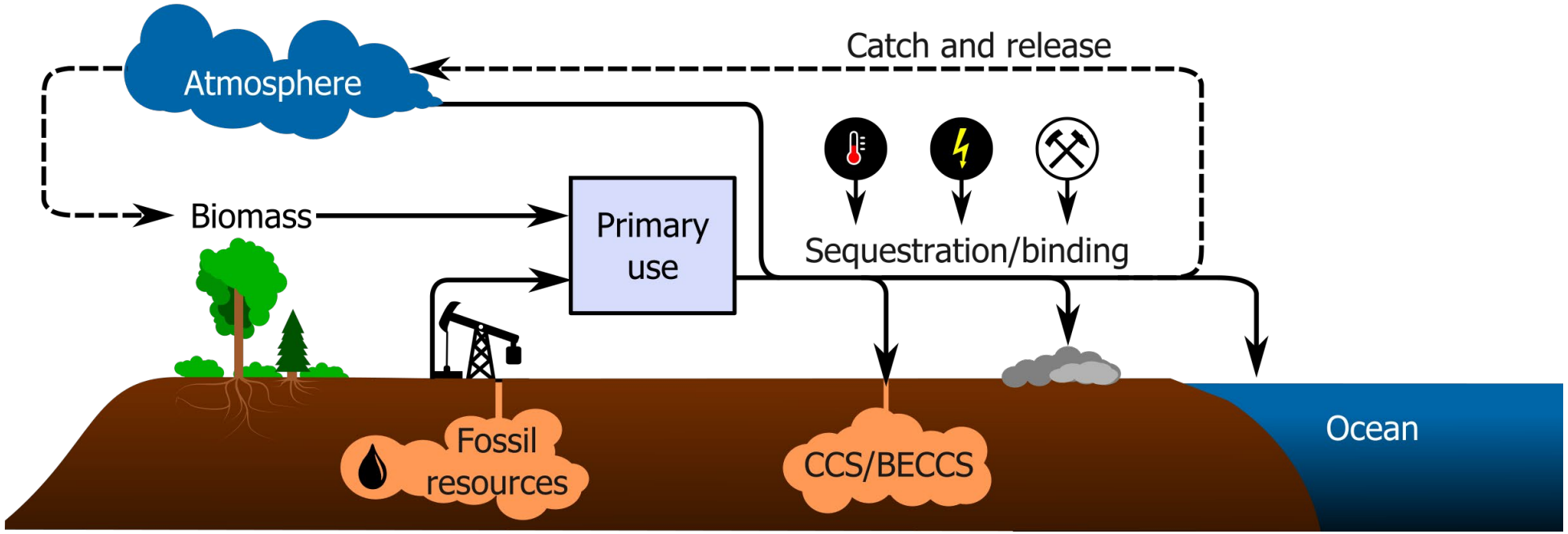
CLIMATE IMPACT OF CO_2 UTILIZATION

- Energy and material consumption critically affects environmental impact
- Few CO_2 products provide long-term binding potential
  - Can still be beneficial by replacing fossil feedstocks
  - Biogenic CO_2 has a special opportunity



GLOBAL EXISTING USE OF CO_2

Existing use	Current CO_2 demand (Mt/a)	Future potential CO_2 demand (Mt/a)
Urea manufacturing	100–130 †	30–300
Enhanced oil recovery	70–80 †	30–300
Beverage carbonation	8*	14*
Food processing, preservation, and packaging	8.5*	15*
Metal fabrication**	5* †	5–30 †
Other gas and oil applications	1–5	1–5
Water treatment	1–5	1–5
Coffee decaffeination	n.a.	1 - 5
Wine making	<1	<1
Horticulture	<1	1–5
Pharmaceutical processes	<1	<1
Pulp and paper processing	<1	<1
Supercritical CO_2 as a solvent	<1	<1
Electronics	<1	<1
Refrigerant gas	<1	<1

- Currently, CO_2 is used mostly for urea production and enhanced oil recovery

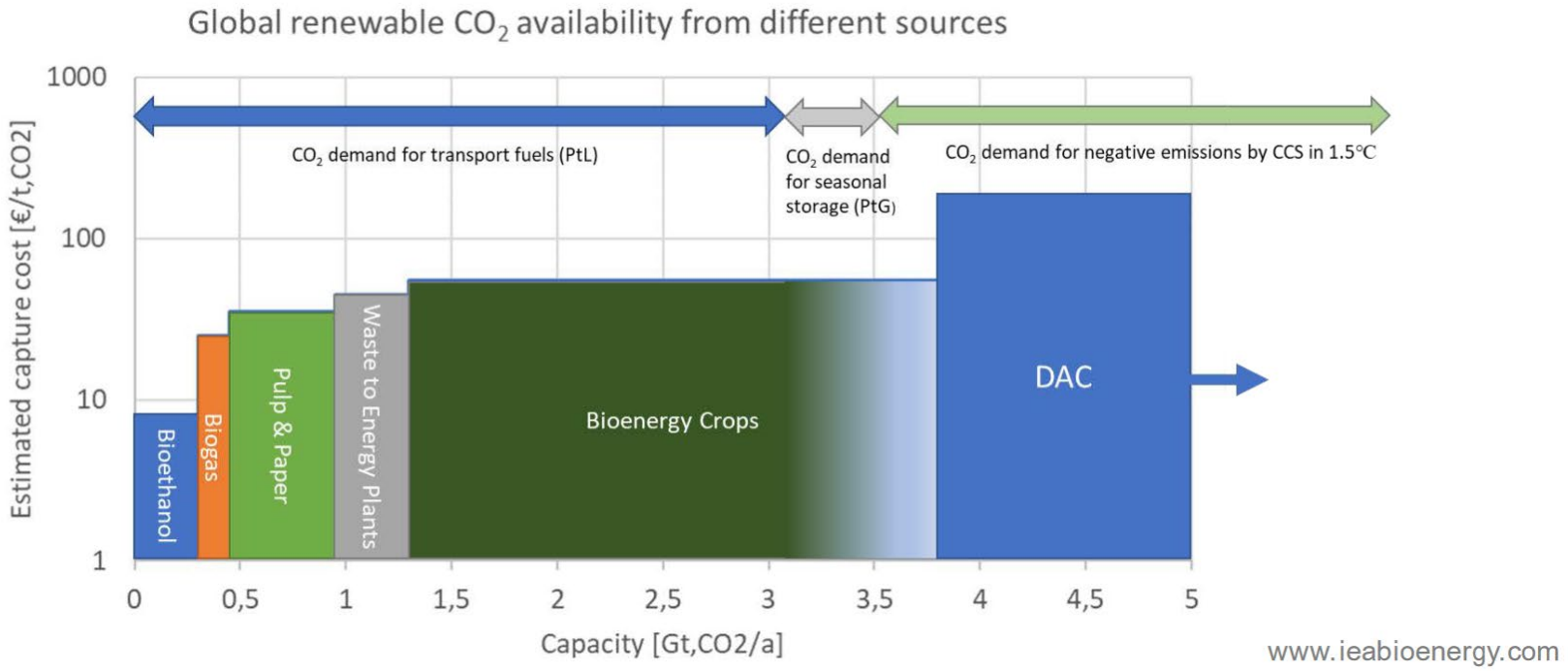
EMERGING USE OF CO_2

Emerging and possible use	
Algae cultivation	>300
Enhanced coal bed methane recovery	30–300
Enhanced geothermal systems	5–30
Polymer processing	5–30
Chemical synthesis (excl. fuels and polymers)	1–5
Power cycle working fluid	<1
Mineralization	
Calcium carbonate and magnesium carbonate	>300
CO_2 concrete curing	>300 ○
Bauxite residue treatment	5–30
Baking soda	<1
Fuels and chemicals	
Renewable methanol and ethanol	>300
Formic acid (as hydrogen carrier)	>300
Formic acid (as chemical)	1–5
Fuel production using micro-organisms	>300
Ethylene	>300 ‡
Methane	>300 §
Fischer-Tropsch fuels	>300 §

- Fuels and chemicals & mineralization are conceived to be dominant uses
- Demand projections range from 1 Gt to about 9 Gt
  - Today, about 0.2 Gt

WILL THERE BE A DEFICIT OF CO_2?

- Existing facilities (bioethanol, biogas, pulp&paper, waste) could provide perhaps 1.5 – 2.1 Gt/a
- DAC required after 2030? In multiple Gt scale?



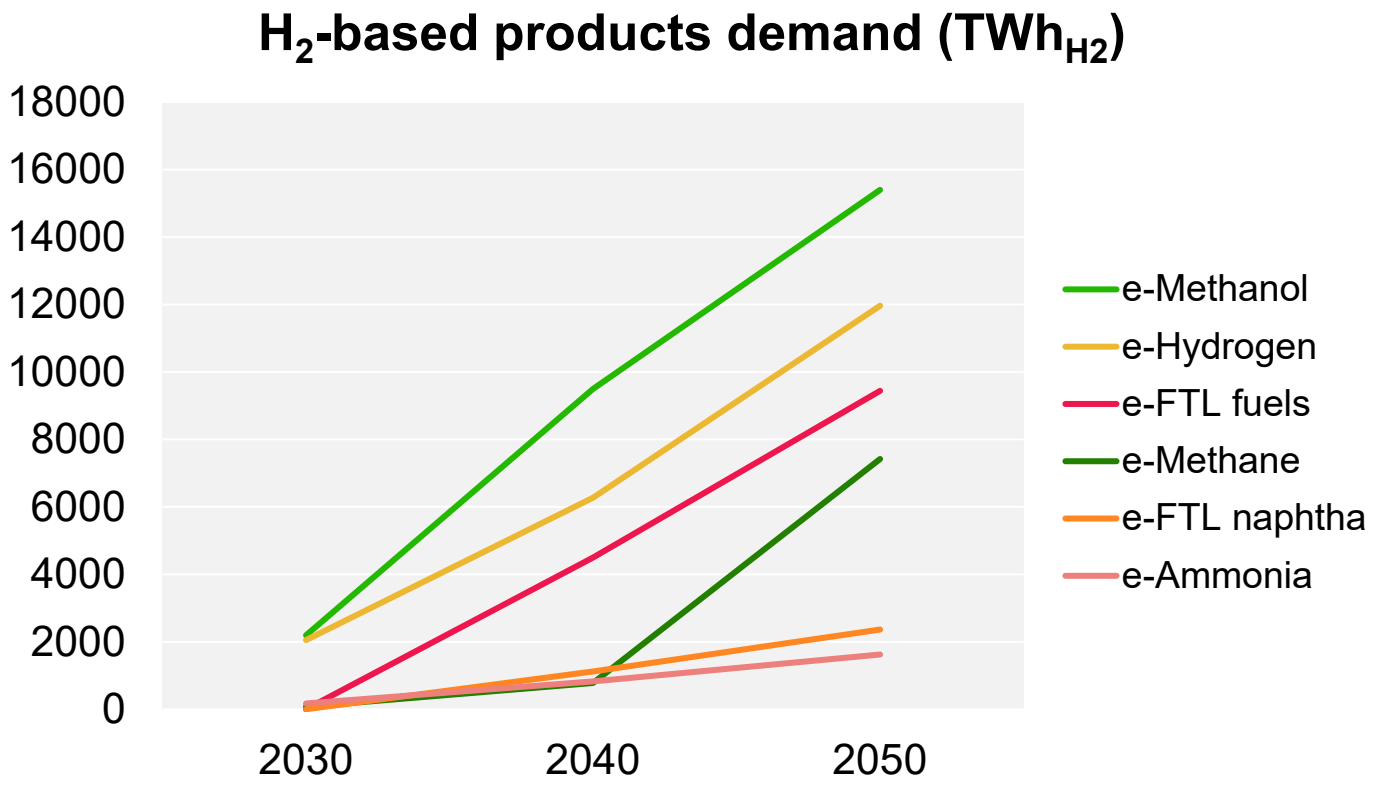
IEA Bioenergy

www.ieabioenergy.com

https://doi.org/10.1016/j.jclepro.2022.133920
Olsson, Tynjälä, Bang, Thrän. Deployment of BECCS/U – technologies, supply chain setup & policy options, IEA Bioenergy Task 40 webinar, 16 June 2020: https://www.ieabioenergy.com/wp-content/uploads/2020/06/BECCUS-Webinar-Slide-OO20200616-final.pdf

HYDROGEN PRODUCTS IN ENERGY TRANSITION

ONE VIEWPOINT FROM SCIENTIFIC LITERATURE

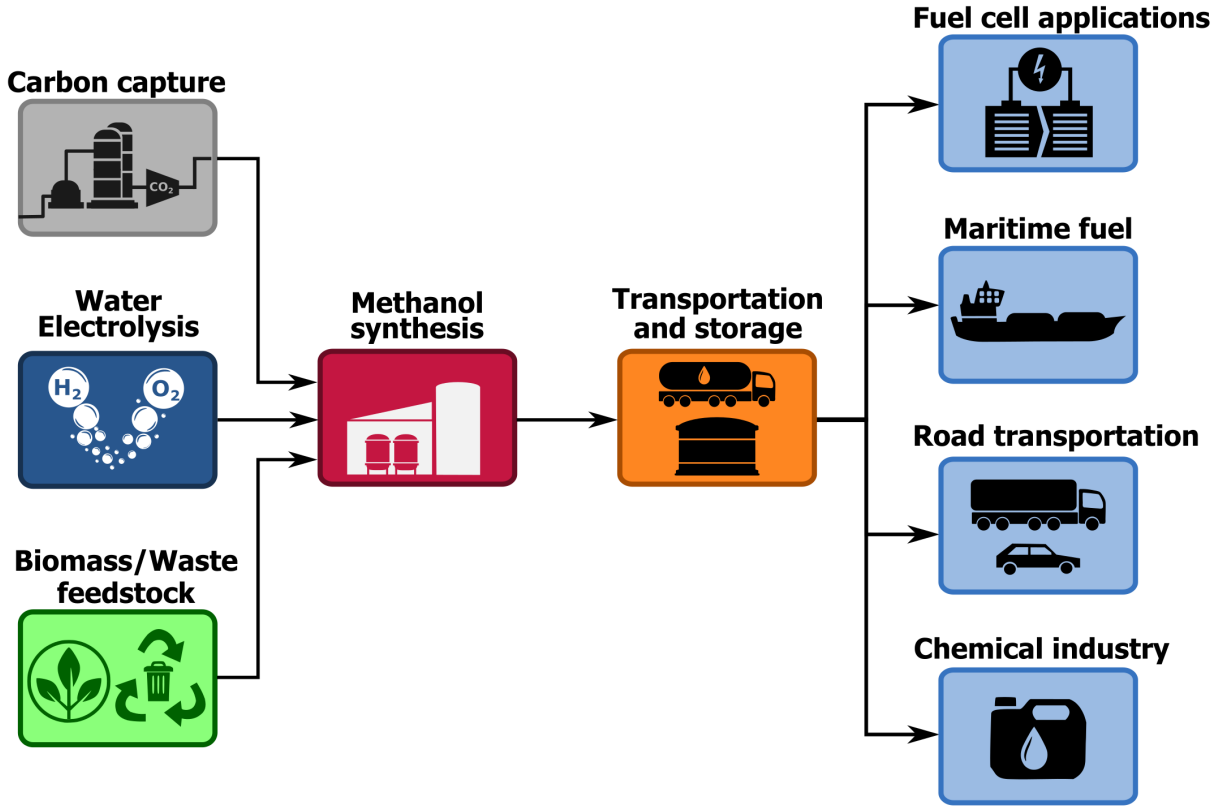


Product	CO_2 demand (Gt)
e-Methanol	4.1
e-FTL fuels	2.9
e-Methane	1.5
e-FTL naphtha	0.7
Total	**9.1**

The role of electricity-based hydrogen in the emerging power-to-X economy:
https://doi.org/10.1016/j.ijhydene.2023.08.170

TRANSPORTATION OF HYDROGEN VS ITS DERIVATIVES

- H_2 Shipping is costly
  - -250 °C
  - Rotterdam-Australia route
    - Liquid H_2 $2.09/kgH2
    - Ammonia $0.56/kgH2
    - Methanol $0.68/kgH2
- H2 pipe transport could be viable over medium distances
  - 0.11 – 0.21 €/kgH2 @ 1000 km
- The transportation of methanol and other derivatives can be more economical than transporting pure hydrogen
- If hydrogen needs to be converted in any case, why not do closer to the source



https://doi.org/10.1016/j.ijhydene.2022.04.156
https://ehb.eu/files/downloads/ehb-report-220428-17h00-interactive-1.pdf

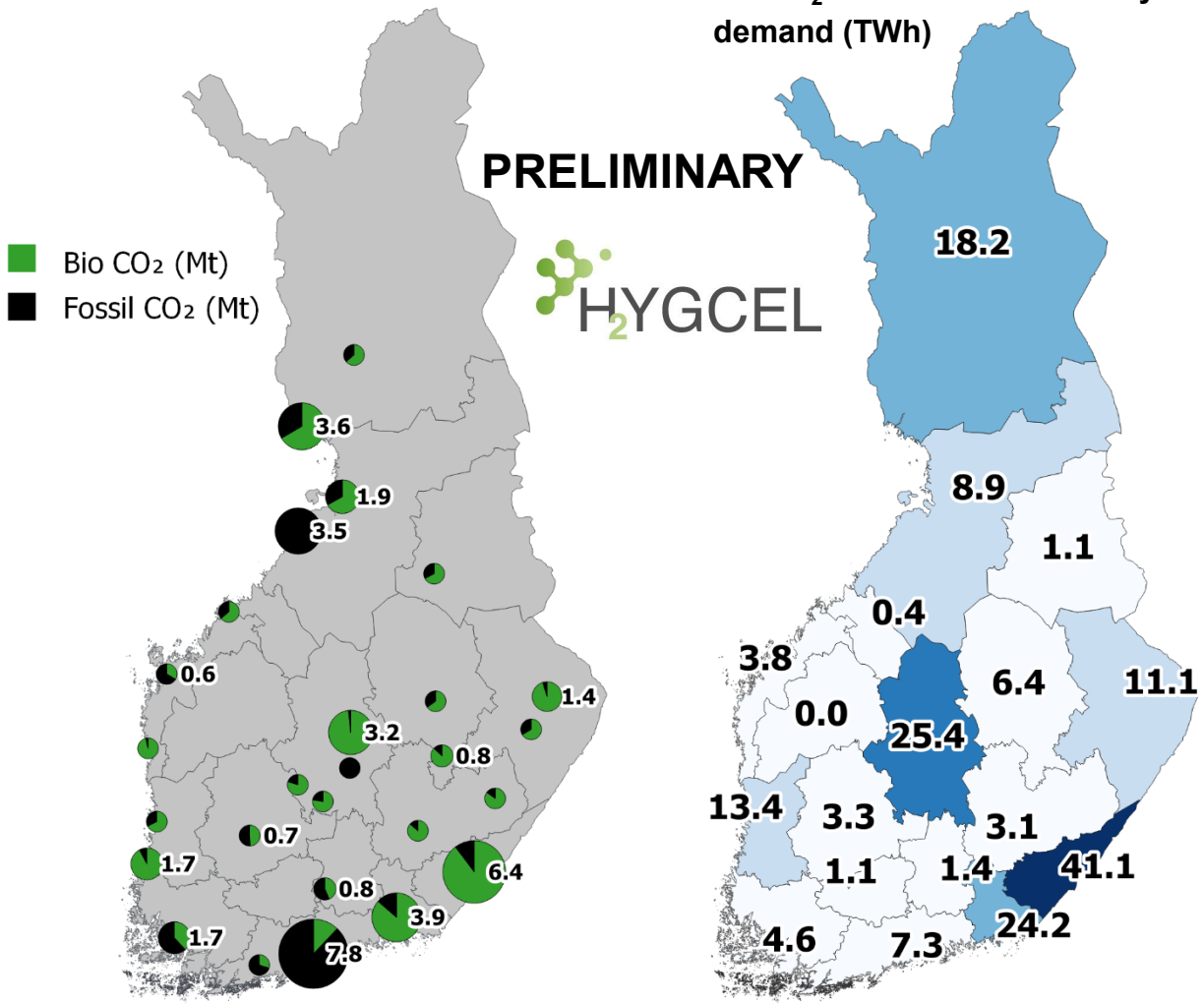
LARGE POINT SOURCES OF CO_2 IN FINLAND

- Large point sources in Finland could provide around 24 Mt/a
- Primarily form pulp mills
- Regional mismatch: renewable power vs CO_2

- 24 Mt bio-CO_2
- 175 TWh_{el}

→ H_xC_x

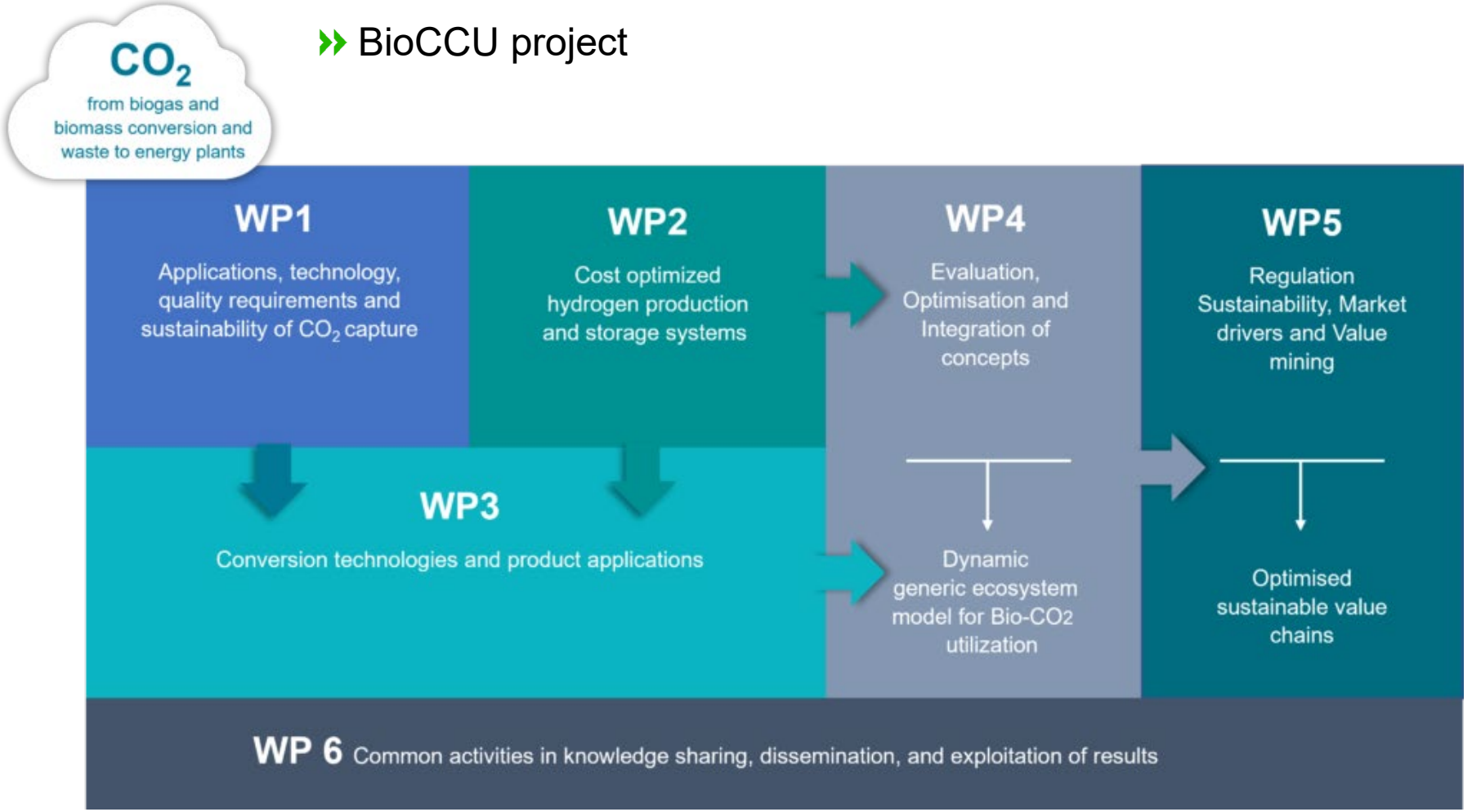
- $BioCO_2$ conversion electricity demand (TWh)



Contains data from the National Land Survey of Finland topographic database 01/23

ONGOING ACTIVITIES

- BioCCU project



CONCLUSION

- Globally, biogenic CO_2 will be a valuable and sought-after commodity in the long run
  - Projected demand exceeds availability
  - Regulation is key for ensuring deployment
  - Utilization in short-lived products more feasible than with fossil resources
- Methanol and other hydrogen-based derivatives may be easier to transport – will hydrogen infrastructure plans be realized?
- Infrastructure development will take time – is there time to develop it?
- Ongoing research for P2X hubs & biogenic CO_2 value chains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