Carbon Capture and Utilization (CCU)

Suman khadka

Why CCU ?

- Anthropogenic greenhouse gases (GHGs) emissions are a major driver of climate change.

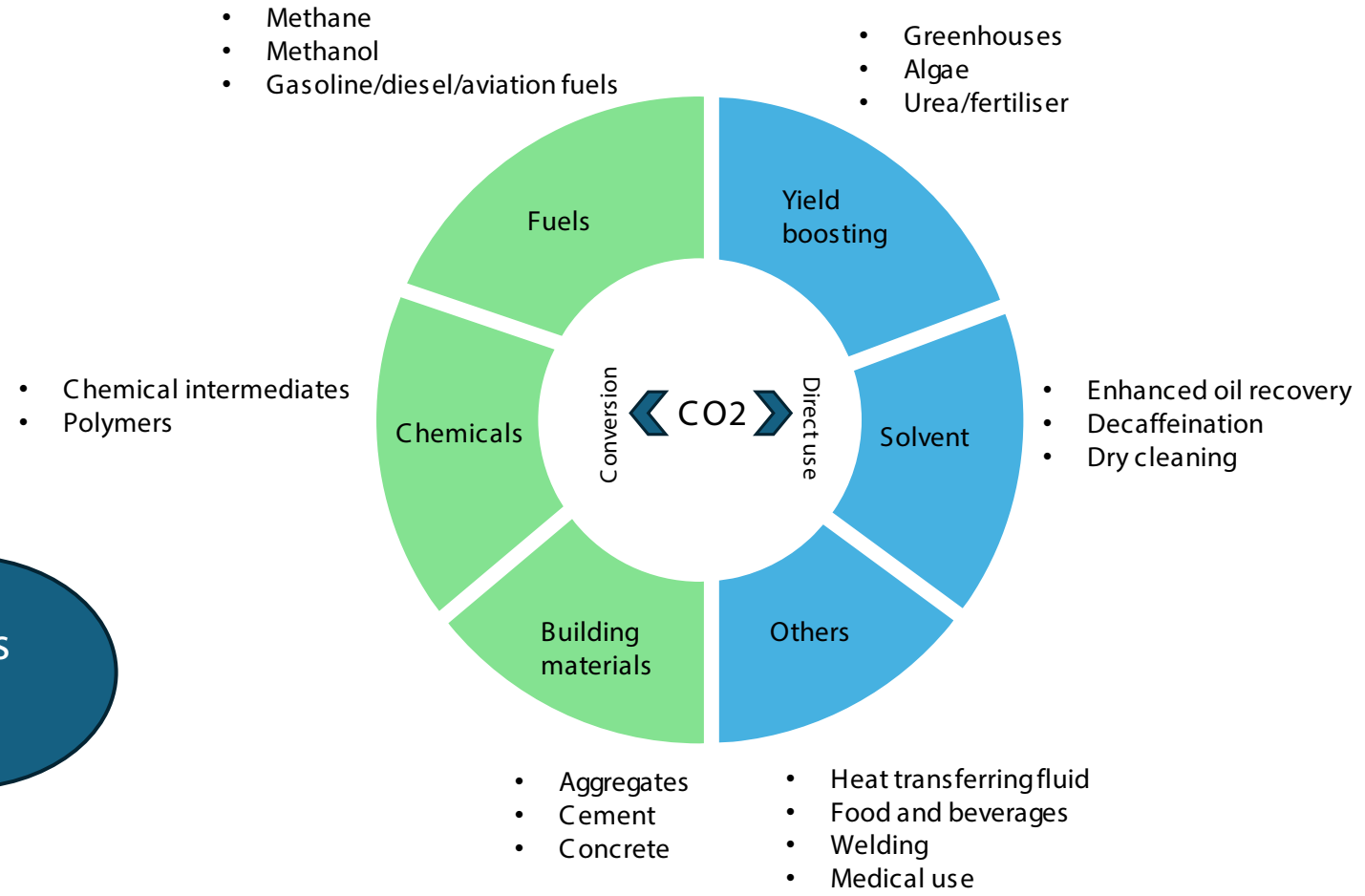
- The European Green deal sets a binding target to reduce GHG emission by 55% by 2030 compared to 1990 levels and carbon neutrality by 2050.
- Achieving these goals requires a combination of effective policies, technological innovation, strategic investments, and widespread societal collaboration.
- Synthetic fuels will play a crucial role in decarbonizing hard-to-abate sectors such as maritime transport, aviation, and certain industrial processes.

European Green Deal - Consilium

Pathway for use of CO2

- CCU implies capturing CO2 and converting it into valuable products.
- It facilitates both the reduction of GHG emissions and the promotion of economic development.

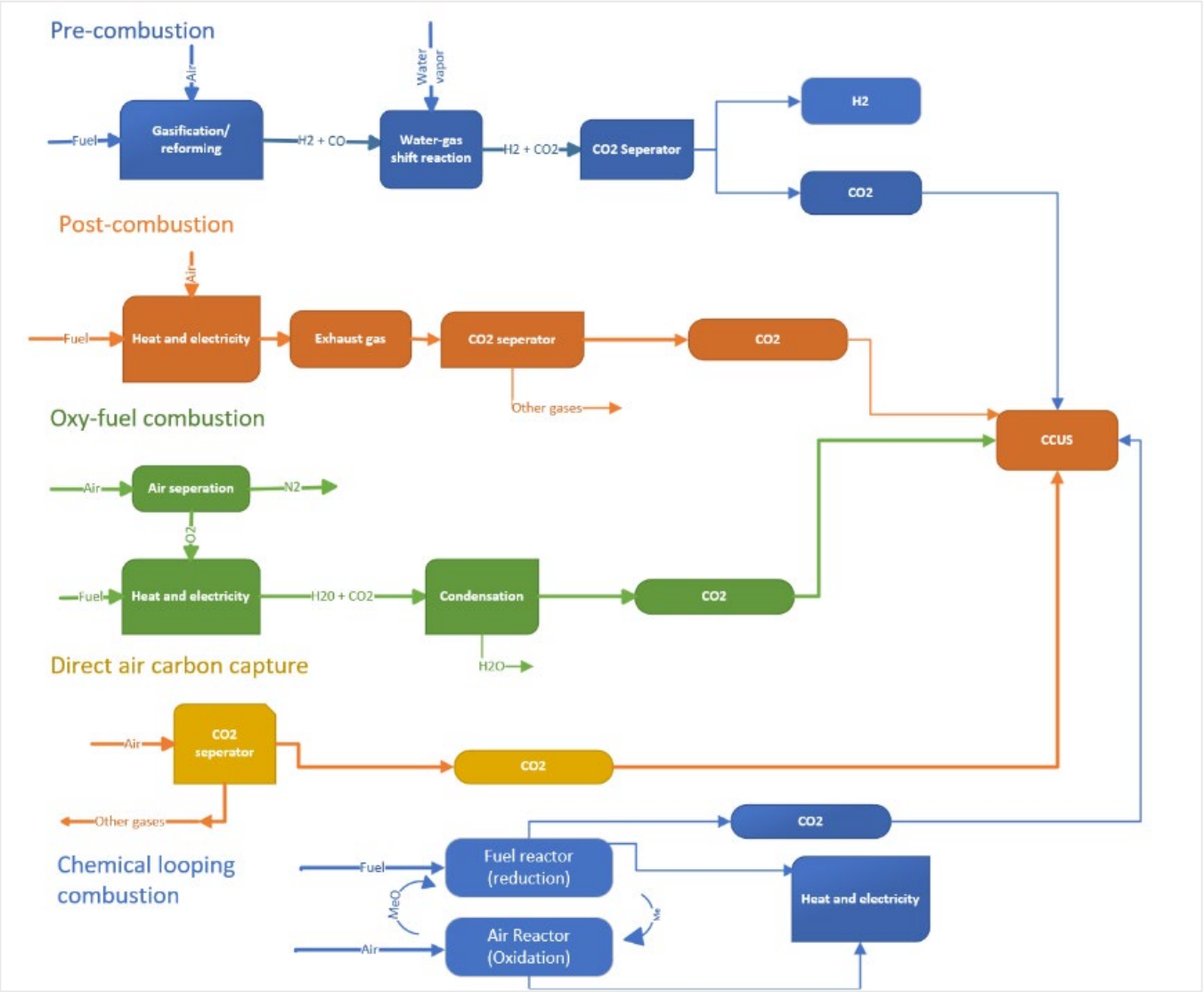
Projected global CO2 demand for 2025 is 272 Mt.



https://iea.blob.core.windows.net/assets/50652405-26db-4c41-82dc-c23657893059/Putting_CO2_to_Use.pdf
Carbon Dioxide Market Size, Growth & Forecast, 2035

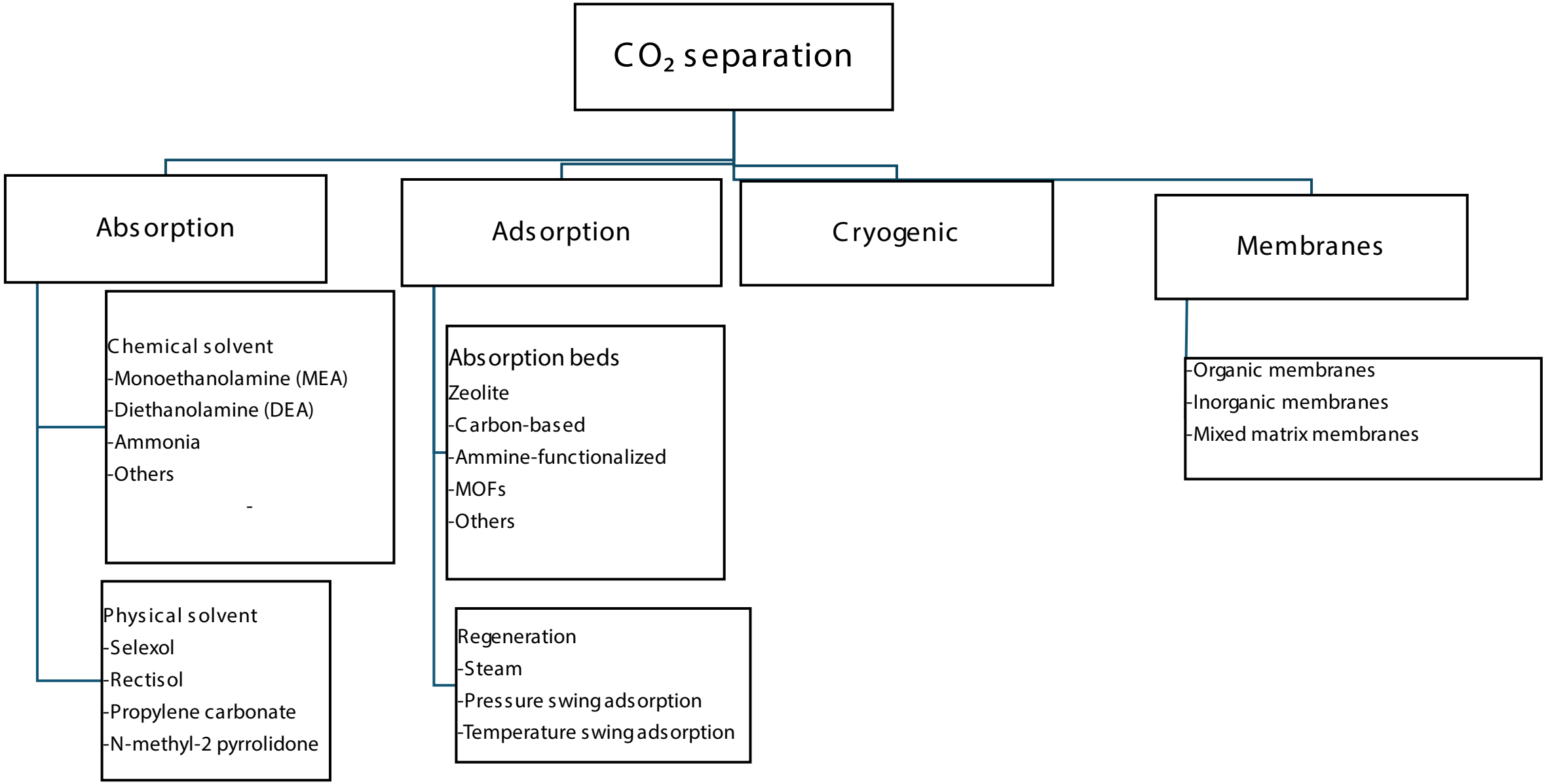
CO_2 capture routes

- CO_2 capture can be achieved from five different routes: pre-combustion, post-combustion, oxy-fuel combustion, direct air capture, and chemical looping.



Advancements in carbon capture technologies: A review - ScienceDirect

CO_2 separation methods

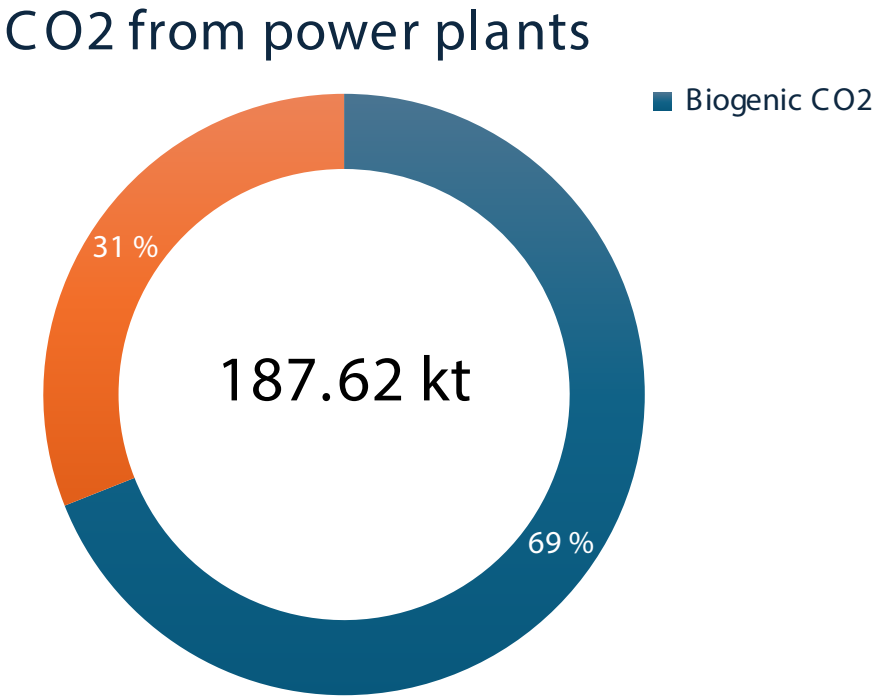


Advancements in carbon capture technologies: A review – ScienceDirect
Assessing absorption-based CO2 capture: Research progress and techno-economic assessment overview - ScienceDirect

CO_2 capture potential in Central Ostrobothnia region from Combined Heat and Power (CHP) and heat only plants

- There are 9 CHP and heat only plants in the region.

Sources of fuel (474.80 GWh):
- Biomass 67.59 %
- Peat 31.03%
- Light fuel oil : 1.38%



https://energia.fi/en/statistics/district-heating-statistics/

CO_2 capture potential from biogas plants in Central-Ostrobothnia region

- Total six biogas plants with estimated annual biogas production of 8.29 kt (40.74 GWh).
- The majority of plants use biogas to produce electricity and heat. CO2 normally released to atmosphere.
- Total CO_2 produced of 5.18 kt/a.
- Furthermore, the region has 673.98 kt/a side streams available. If used in biogas production, 59.44 kt of biogenic CO_2 can be captured.
- Future developments in bioenergy project and CCU projects:
  - Wega Oy => biogas => CO_2 , biomethane, e-methane
  - One1 Oy => biogas => biomethane, CO_2
  - Lampin voima Oy => biogas
  - Vanadis Fuels => synthetic fuels

Biogas plants	**Place**	**Biomethane upgradation**	kt CO_2 /a
Pohjanmaan Biokaasu Oy	Kokkola	No	0.55
Mty klemola	Kokkola	No	0.36
Wekas Oy, Wennströmin maatila	Toholampi	Partially	3.70
Paavola Petri ja Virpi	Kaustinen	No	0.16
Koskenniemen Maito Oy	Kaustinen	No	0.11
Uusitalo Group	Kannus	No	0.29
Total			**5.18**

https://visitkaustisenseutu.fi/site/assets/files/10918/biokaasuekosysteemi_kaustisella_5_3_2024_mk_final.pdf
https://wega.fi/project/kannuksen-biokaasulaitos/
https://www.both2nia.com/fi/ajankohtaista/total-eren-ja-aliceco-kehittavat-kokkolaan-yhden-euroopan-suurimmista-sahkopolttoainelaitoksista
https://biokaasulaskuri.luke.fi/
https://biomassa-atlas.luke.fi/?lang=fi
6.5.2022 YVA-Päätös, Biokaasulaitos, Lampin Voima Oy, Toholampi_0_0.pdf

Density of CO2 : 1.977 kg/m3, methane: 0.717 kg/m3, and biogas: 1.22 kg/m3

Conclusion

- Potential for CCU due to availability of CO_2 and renewable energy.
- Market is developing due to policy initiatives.
  - Revised Renewable Energy directive (REDIII): criteria for Renewable Fuels for Non-Biological Origin (RFNBO).
  - ReFuel EU Aviation regulation: Minimum share of synthetic aviation fuel .1.2% synthetic fuel should be used in all EU airport from 2030 and 35% from 2050
  - FuelEU maritime regulation: Sets maximum limits for the yearly average GHG intensity of the energy used by ships above 5,000 gross tonnage
- Small-scale and distributed CO_2 production make CCU challenging.
- Research and development is essential to develop small scale CO_2 capturing technologies.

Thank you for the attention