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Bundesamt für Energie BFE
Office fédéral de l'énergie OFEN
Ufficio federale dell'energia UFE
Swiss Federal Office of Energy SFOE



HOW TO GET RID OF THE REST?

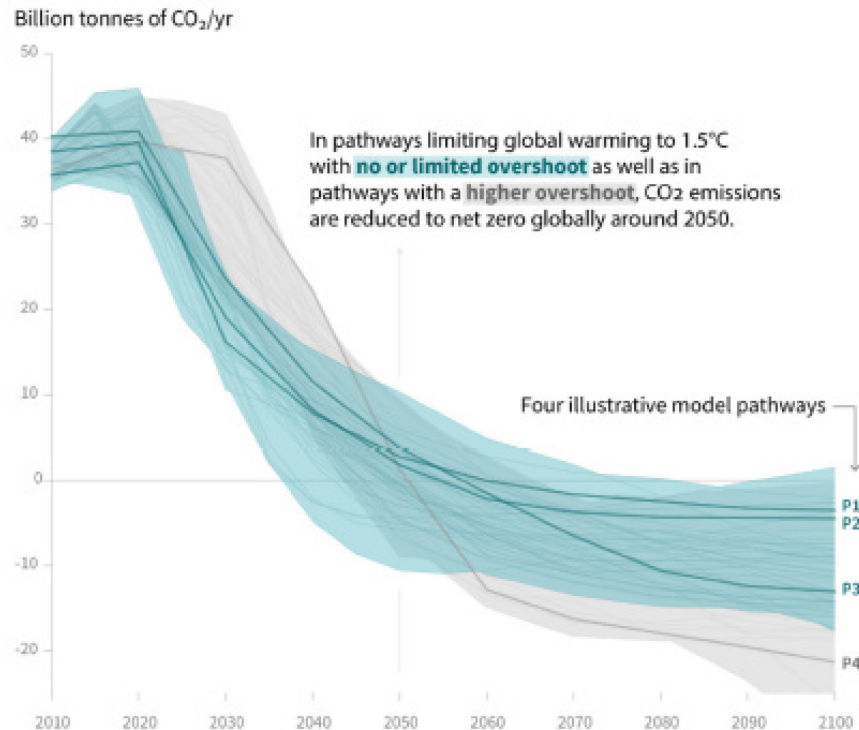
THE ROLE OF CCUS/NET IN DECARBONIZATION

Valentin Gischig - Representative to the ExCo of the IEA Greenhouse Gas TCP
IEA Networking day, 19 May 2022



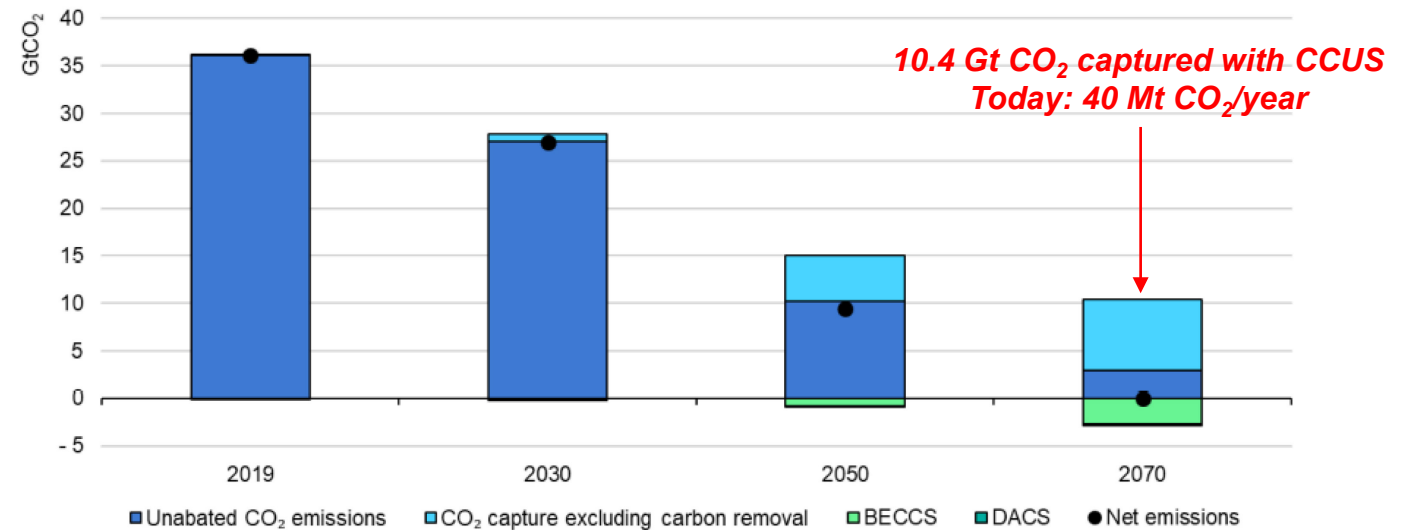
GLOBAL PERSPECTIVE ON CO₂-REDUCTION

Global total net CO₂ emissions



IPCC, 2018

Figure 2.4 Global CO₂ emissions and capture across the energy system in the Sustainable Development Scenario, 2019-70



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Note: CO₂ emissions include both energy-related and process emissions.

BECCS and DACS enable the global energy system to reach net-zero emissions by 2070 in the Sustainable Development Scenario.

IEA ETP 2020, Special Report on Carbon Capture, Utilisation and Storage

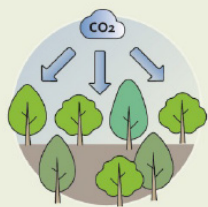


WHAT ARE OUR OPTIONS?

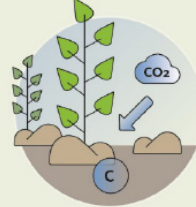
NET - Negative Emission Technologies

Mögliche Ansätze für negative Emissionen

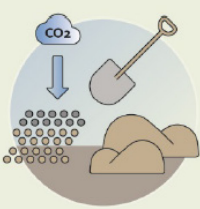
Aufforstung, Wiederaufforstung, Waldbewirtschaftung und Holznutzung
Baumwachstum entzieht der Luft CO₂. Dieses kann in Bäumen, Böden und Holzprodukten gespeichert werden.



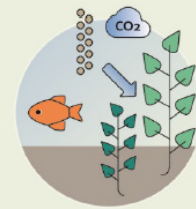
Bodenmanagement (inkl. Pflanzenkohle)
Einbringung von Kohlenstoff (C) in die Böden, z. B. mittels Ernterückständen oder Pflanzenkohle, kann C im Boden anreichern.



Beschleunigte Verwitterung
Zerkleinerte Mineralien binden chemisch CO₂ und können anschliessend in Produkten, im Boden oder im Meer gelagert werden.



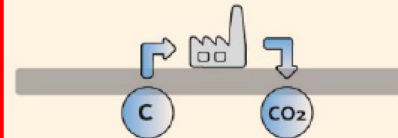
Ozeandüngung
Eisen oder andere Nährstoffe werden dem Ozean zuge-setzt, um die CO₂-Aufnahme durch Algen zu erhöhen.



CO₂-
Quelle

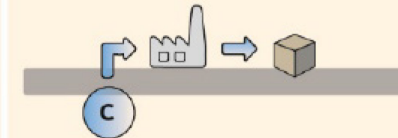
Fossile Quelle

Carbon Capture and Storage (CCS)

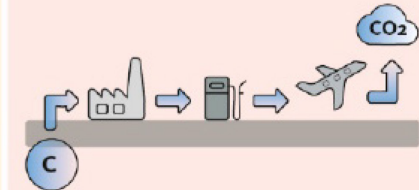


Carbon Capture and Utilisation (CCU)

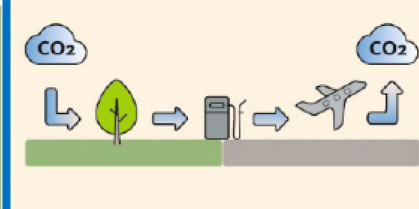
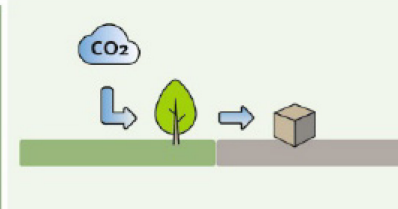
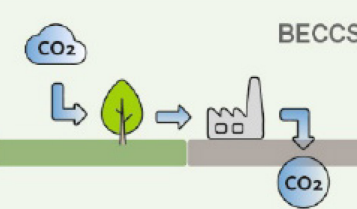
Materialien



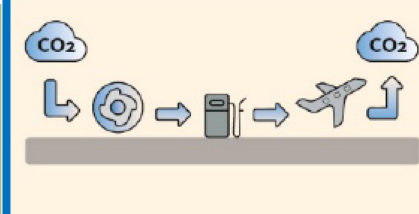
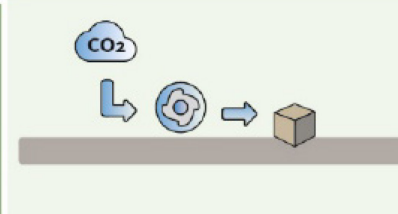
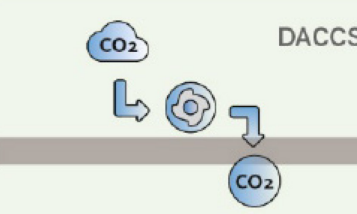
Power-to-X



Biomasse



Direkt aus
Atmosphäre



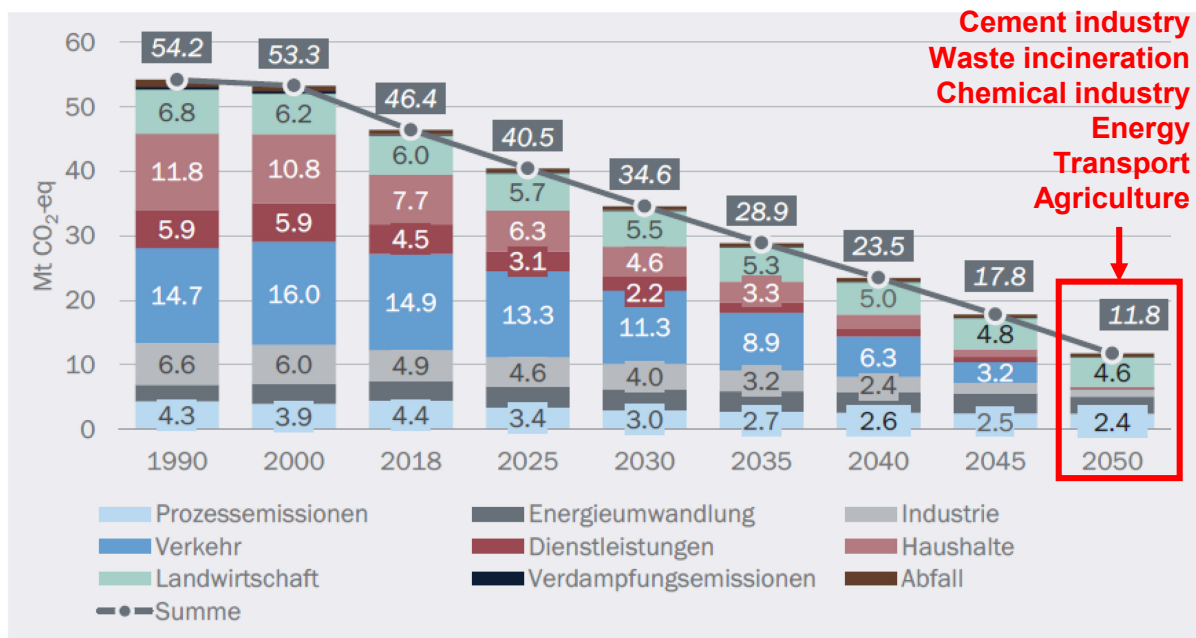
CCUS – Carbon Capture, Utilization and Storage

Es wird davon ausgegangen, dass die verwendete Energie klimafreundlich gewonnen wurde.

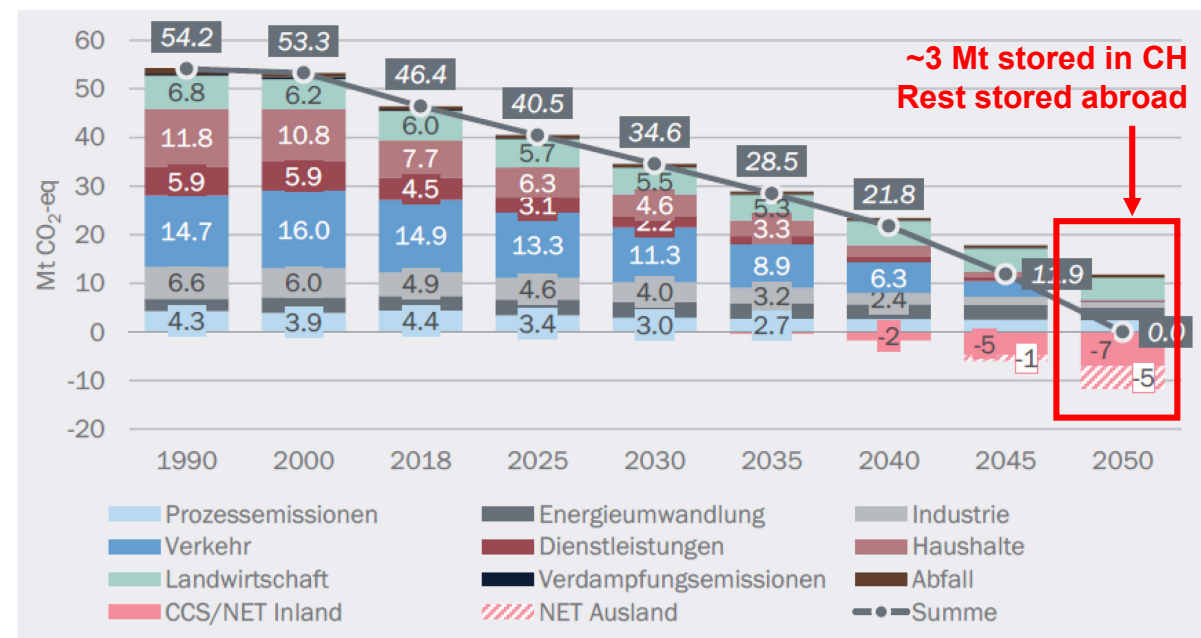


SWISS PERSPECTIVES ON CO₂-REDUCTION

Development of GHG emissions without CCS and CO₂ removal between 1990 and 2050 in Switzerland



GHG Emissions with CCS and CO₂-removal in Switzerland

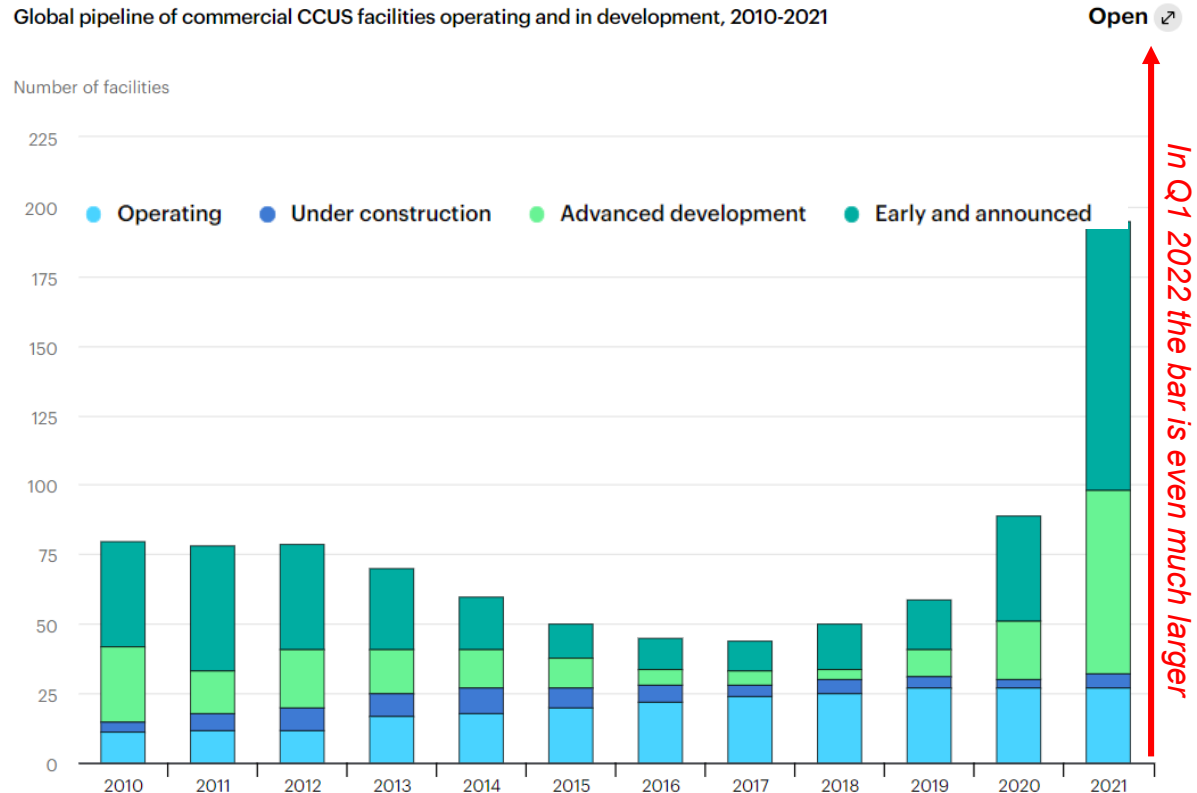


Transport and storage abroad (e.g. Iceland or Northern Lights) is necessary (see also P+D projects DemoUpCarma and DemoUpStorage)



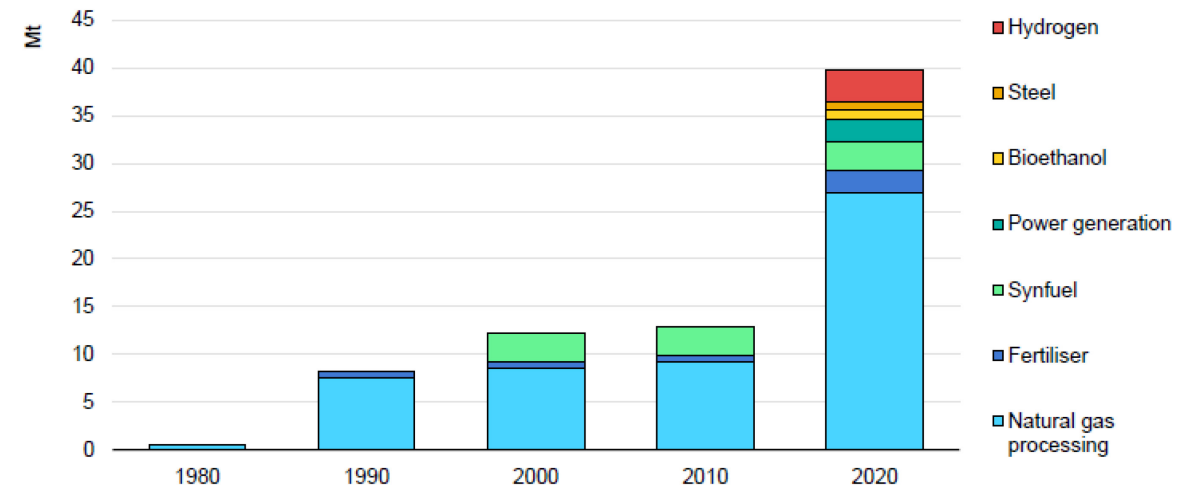
GLOBAL CCS PROGRESS

Global pipeline of commercial CCUS facilities operating and in development, 2010-2021



“Carbon capture in 2021: Off and running or another false start?” IEA blog

But still: currently 40 MtCO₂/year being stored, but 1 – 10 GtCO₂/year required by 2050!!



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THE IEA GREENHOUSE GAS TCP



Significant participation of oil and gas industry

IEAGHG is part of the working party on fossil energy

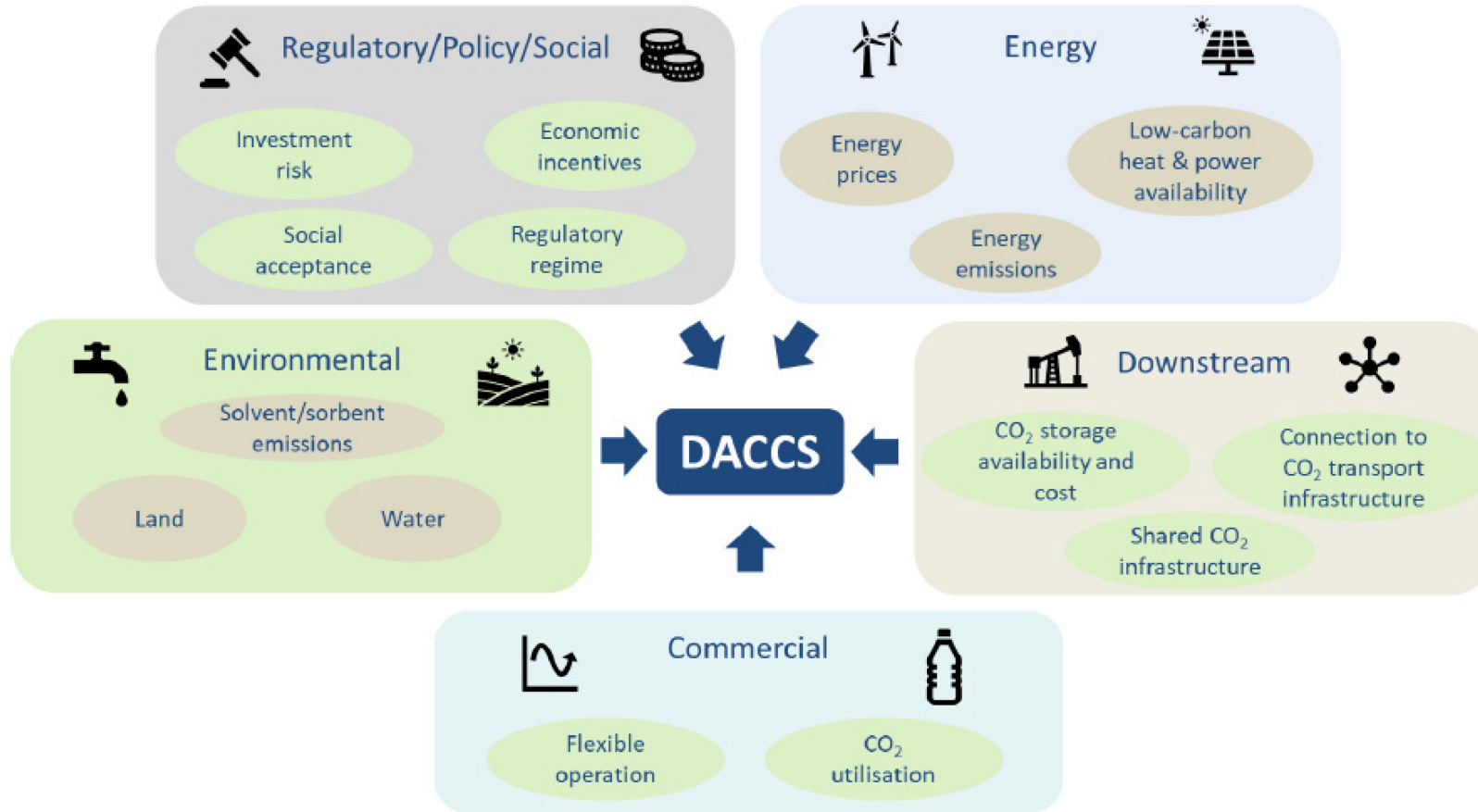


IEAGHG ACTIVITIES

- Operating agent consisting of 10 employees «runs the show»
 - Organizes Greenhouse Gas Technology Conference every second year.
Next GHGT-16 in Lyon, France 23 – 27 October 2022
 - Organizes Post Combustion Capture Conference (PCCC) every alternating year.
Next one PCCC-7 in Pittsburgh, USA, 2nd half of 2023
 - Organizes CCS Summer Schools
Next one in Bandung, Indonesia, 27 November – 4 December 2022
 - Various webinars throughout each year
 - Contributes expertise on CCS/NET to IPCC reports
 - 1th March 2022 joint virtual workshop with IEGHG and IETS TCP
 - **Many reports are commissioned every year on topics proposed and voted on by members.**
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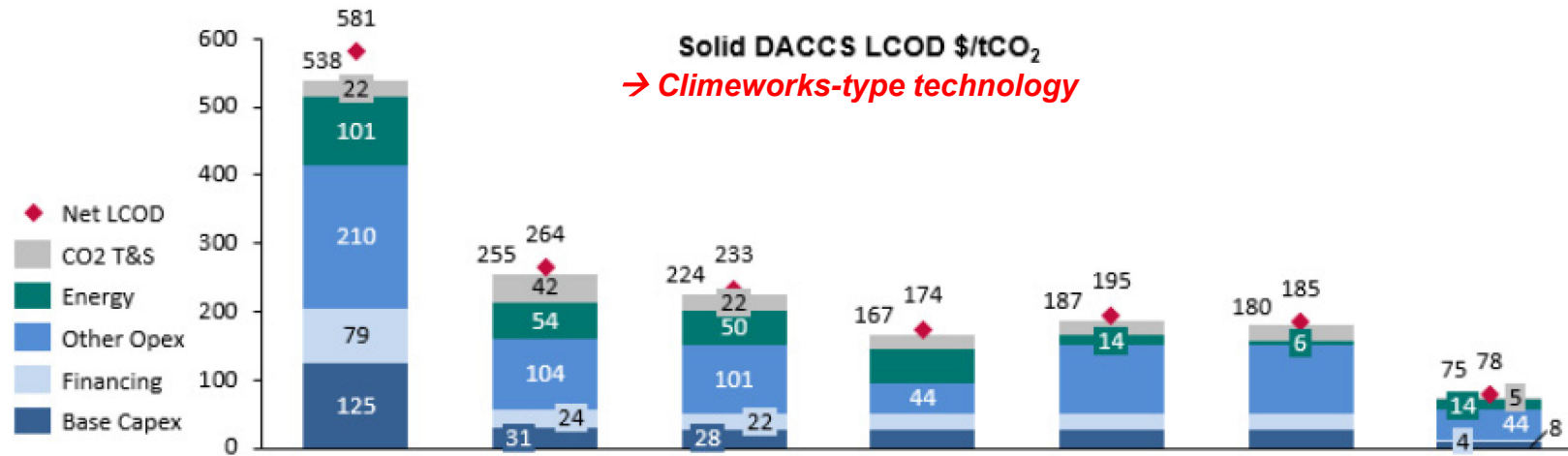
EXAMPLE STUDY: COSTS OF DACCS



- Given the limited potential of all NET approaches (e.g. Bioenergy is limited through the available biomass, potential conflicts with food productions, etc.), Direct Air Capture will have to play a role as a «last resort» technology
- Current estimates of the future costs are very uncertain (100 – 1000\$/tCO₂ in literature, EP2050+ 900 CHF/tCO₂ in 2020, 300 CHF/tCO₂ in 2050).
- To this end, IEAGHG commissioned a study providing site- and context-specific cost estimates



EXAMPLE STUDY: COSTS OF DACCS (by ElementEnergy)



Only under very optimistic assumptions can DACCS costs fall below the 100\$/tCO₂

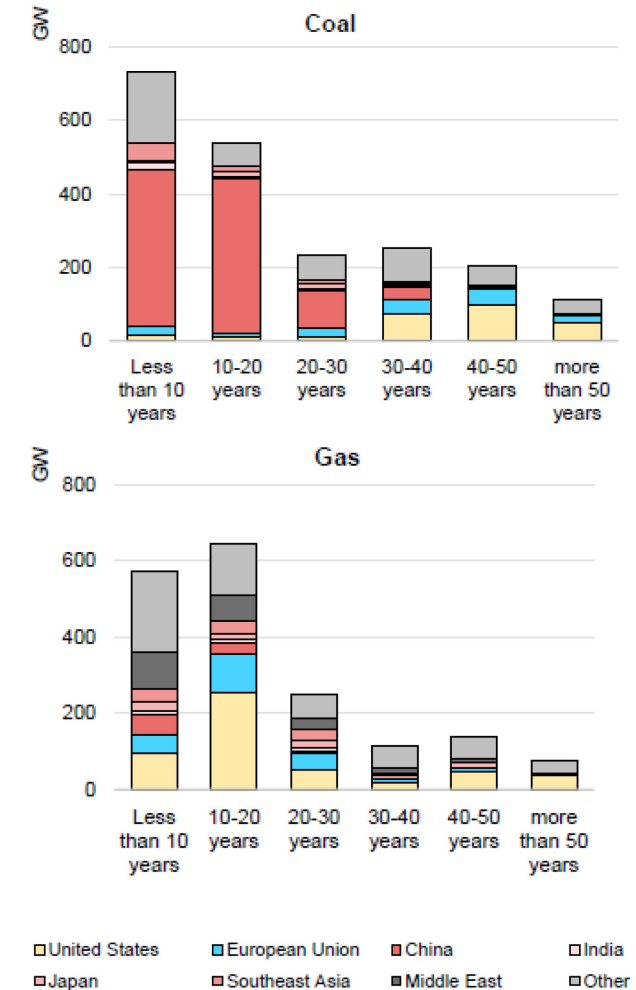
Case	1- Early Hybrid	2- Small Plant	3- Base Electric	4- Low-Cost Adsorbent	5- Low-Cost Electricity	6- Low-Cost Energy Hybrid	7- Very Ambitious
Timeline	FOAK 2020s	NOAK 2050s	NOAK 2050s	NOAK 2050s	NOAK 2050s	NOAK 2050s	NOAK 2050s
Technology	Hybrid	Hybrid	Electric	Electric	Electric	Hybrid	Electric
Capex, Fixed Opex, Consumables	Base Case- Early Plant	Base Case- 100kt/yr Plant	Base Case	Low Sorbent Cost	Base Case	Base Case	Low Sorbent Cost & High Learning Rate
Electricity Source	Solar PV – Base Case (\$68/MWh)	Solar PV – Base Case (\$50/MWh)	Solar PV – Base Case (\$50/MWh)	Solar PV – Low (\$50/MWh)	Solar PV – Low (\$14/MWh)	Solar PV – Low (\$14/MWh)	Solar PV – Low (\$14/MWh)
Heat Source	Nuclear (\$19/MWh)	Nuclear (\$19/MWh)	-	-	-	Free Waste Heat	-
CO ₂ T&S	Base Case (\$22/tCO ₂)	Base Case (\$22/tCO ₂)	Base Case (\$22/tCO ₂)	Base Case (\$22/tCO ₂)	Base Case (\$22/tCO ₂)	Base Case (\$22/tCO ₂)	In Cluster (\$5/tCO ₂)
Cost of Capital	10%	5%	5%	5%	5%	5%	3%



ROLE OF CCUS

“Carbon dioxide removal (CDR) is not an alternative to cutting emissions or an excuse for delaying action, but is part of a comprehensive strategy for “net” zero – where emissions being released are ultimately balanced with emissions removed.” IEA Report on DAC, 2022

- CCS is a key technology for decarbonization of hard-to-abate emissions (**cement, chemicals, long-distance transport, waste incineration**, steel etc.)
- Carbon dioxide removal / Negative emission technologies are essential components for reaching net zero goals. They are part of the solution portfolio.
- CCS is a key technology for decarbonization of existing **«young» assets**: around a third of existing coal and gas-fired power capacity worldwide was added over the last decade. Turning them off pre-maturely would have very expensive socio-economic consequences.
- Yes, it may be a commercial opportunity for oil and gas industry, but they are indispensable players, because they have long-standing experience for capture, transport and storage.





CCS / NET: AN INHERENTLY COMPLEX AND MULTIDISCIPLINARY FIELD

- The challenge of CCS (NET) is that it involves a wide range of processes: **C**apture (various applications), **T**ransport, **U**se (various applications), **S**torage
- Given the multidisciplinary nature there are various interfaces with other IEA TCPs: bioenergy, advanced motor fuels, hydrogen, clean and efficient combustion, industrial energy-related technologies and systems, (Geothermics), etc.
- IEAGHG is a splendid resource for information related to all CCUS options and the entire process chain
- SFOE funds CCS/NET through R&D programs, P&D program (e.g. DemoUpCarma) and the **upcoming SWEET call on NET opening early 2024**

Please get into contact for specific information!



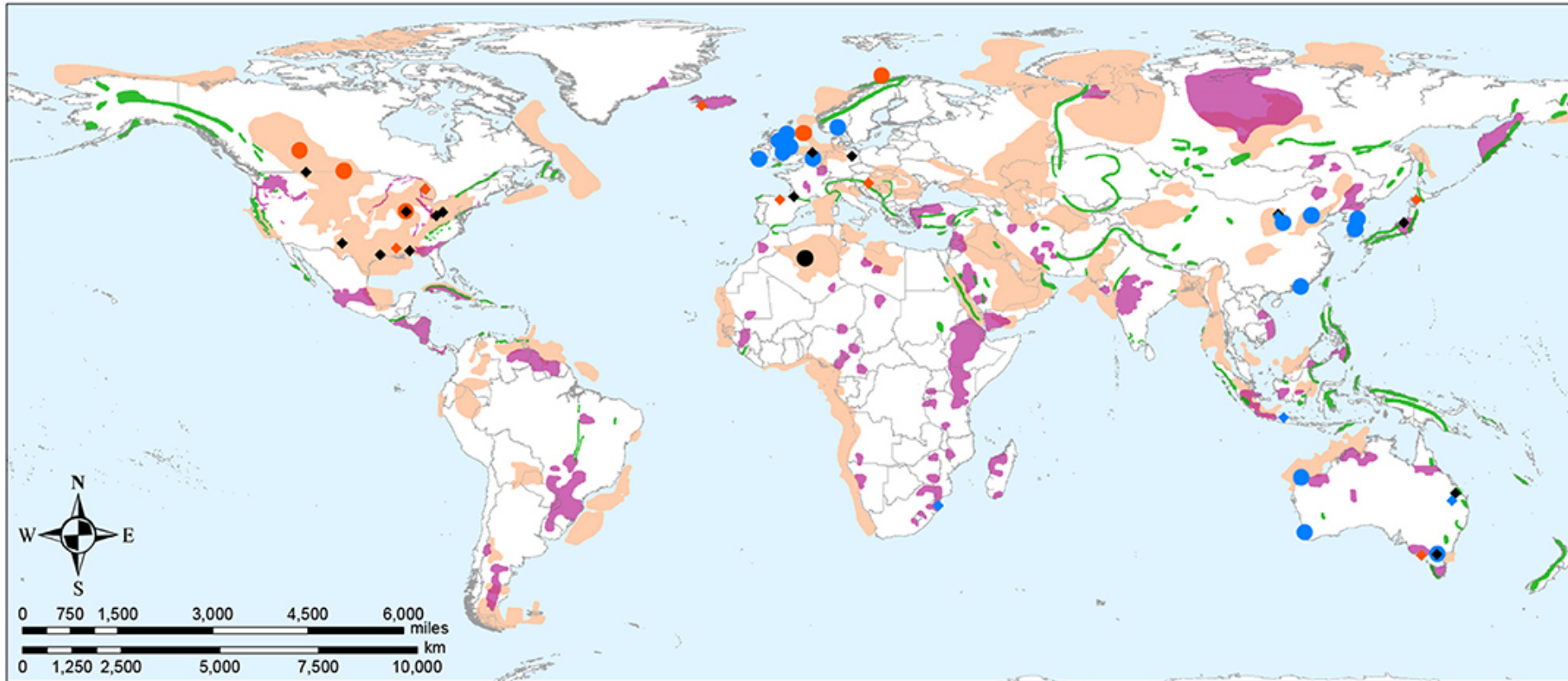
LATEST IEAGHG REPORTS

Title	Contractor	Report number	Publication date	Title	Author	Report number	Publication date
CO ₂ as a Feedstock: Comparison of CCU Pathways	Element Energy	2021-02	23/11/21	Current State of Knowledge Regarding the Risk of Induced Seismicity at CO ₂ Storage Projects	BEG, UoTX	2022-02	01/02/22
CO ₂ Utilisation: Hydrogenation Pathways	Element Energy	2021-03	16/11/2021	Prime Solvent Candidates for Next Generation of PCC Plants	Khalifa University	2022-03	28/02/2022
Techno-economic Performance, Opportunities, and Challenges of NETs	Imperial Consultants (ICON)	2021-04	02/02/22	From CO ₂ to Building Materials - Improving Process Efficiency	Imperial Consultants (ICON)	2022-04	02/03/2022
Global Assessment of DAC	Element Energy	2021-05	19/01/22	Feasibility Study on Achieving Deep Decarbonization in Worldwide Fertilizer Production	Wood (Italy)	2022-05	03/03/2022
Criteria for Depleted Reservoirs to be Developed for CO ₂ Storage	BEG, UoTX	2022-01	17/01/22	PCCC6 6 th Post Combustion Capture Conference Summary 19-21 October 2021	Keith Burnard / Abdul'Aziz Aliyu		14/03/22

- Example of upcoming reports:
- Monitoring, Reporting and Verification (MRV) for Greenhouse Gas Removals (GGR)
- Consequences of CO₂ Migration to the Surface or the Shallow Subsurface



GLOBAL STORAGE POTENTIAL



CO₂ sequestration facilities, projects, and opportunities

<https://doi.org/10.3389/fclim.2019.00009>

Large scale facilities

- completed (1)
- operating (5)
- future (15)

Pilot projects

- ◆ completed (15)
- ◆ operating (7)
- ◆ future (6)

CO₂ sequestration

- Highly prospective sedimentary reservoirs
- Basaltic formations
- Ultramafic formations

Potential storage:

- Saline aquifers
- Depleted gas reservoirs
- Basaltic/ultramafic formations

In CH: total storage volume estimated to be 50 MtCO₂

BUT THIS VERY UNCERTAIN!!!