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Reaching Zero with Renewables: Capturing Carbon

Presenter:

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SPEAKER

Martina Lyons
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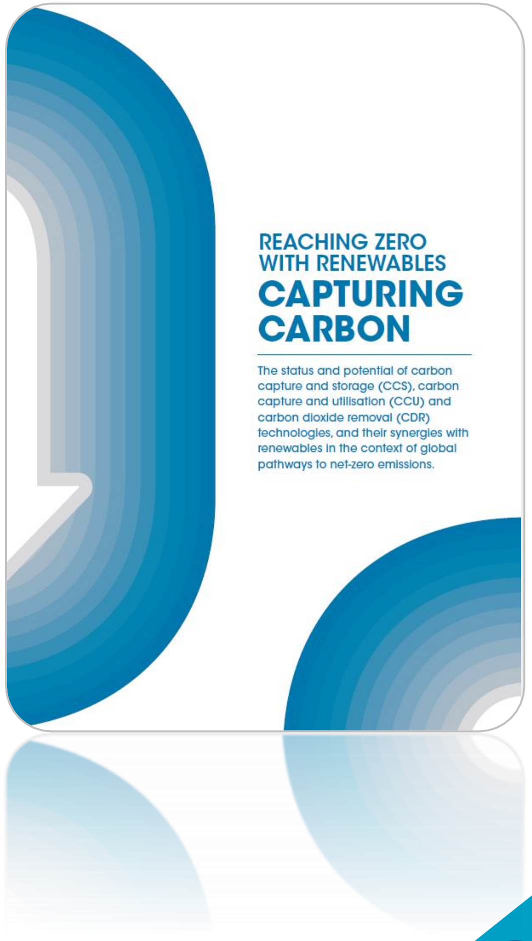
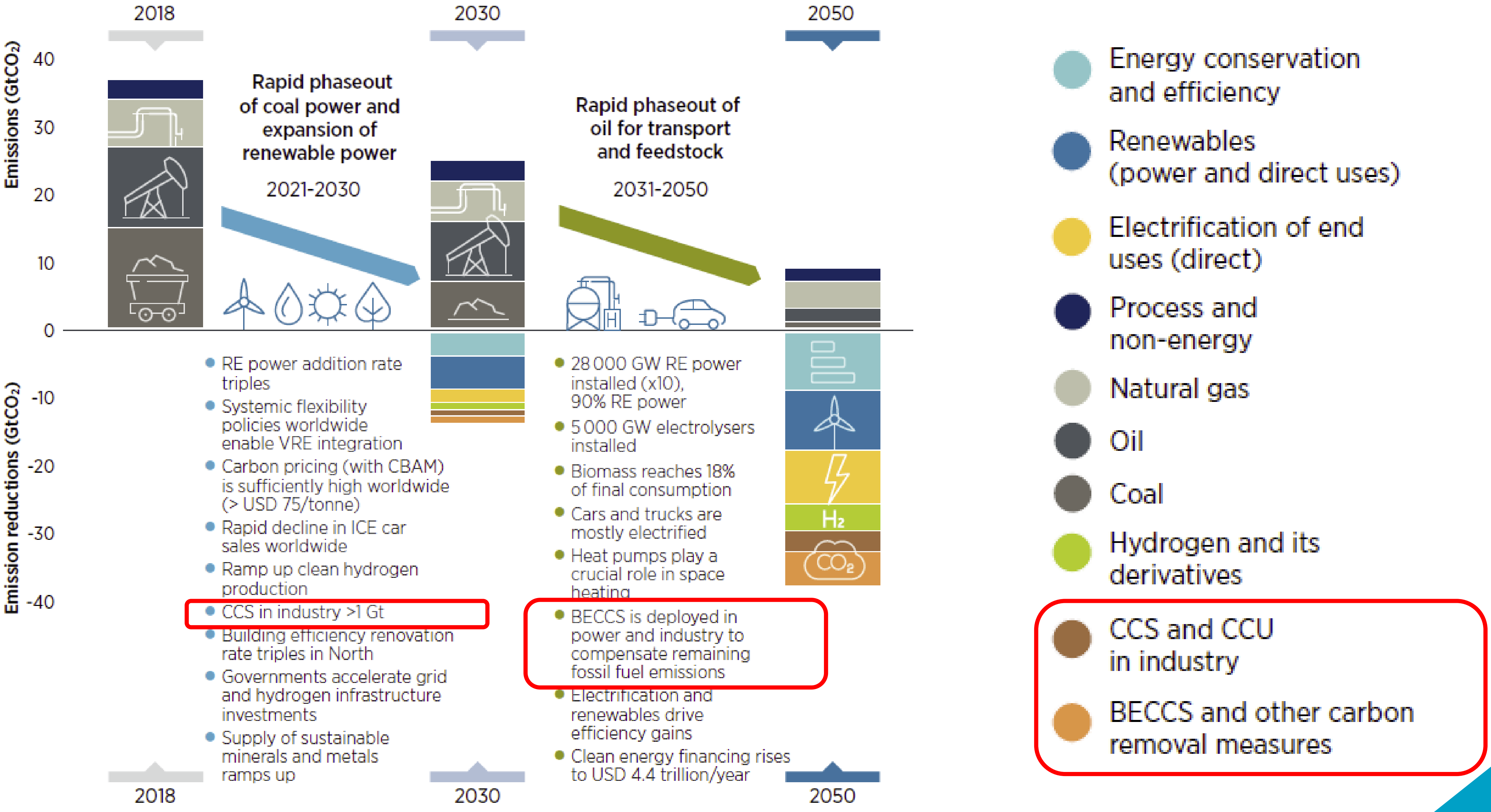
Reaching Zero with Renewables: Capturing Carbon

The status and potential of CCS, CCU and CDR technologies, and their synergies with renewables in the context of global pathways to net-zero emissions.



Holding the line at 1.5C means we need to act now



Potential of CCS, CCU and CDR in 1.5C Scenario

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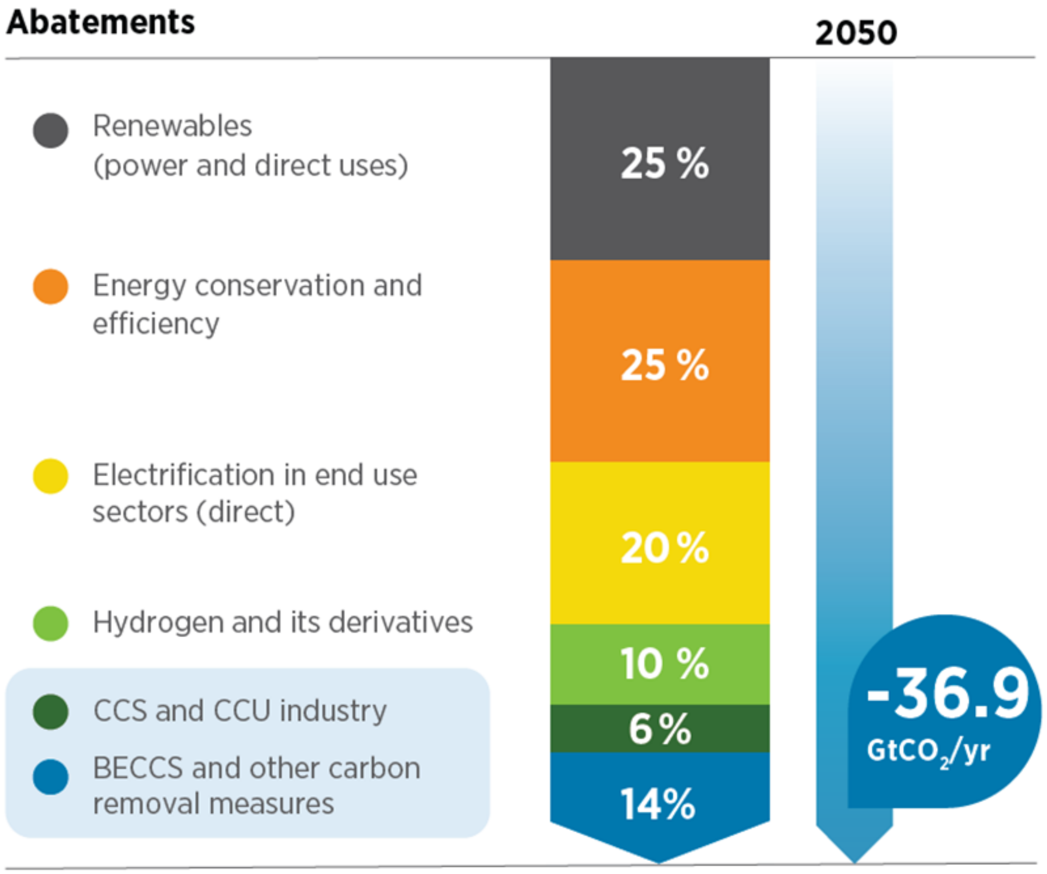
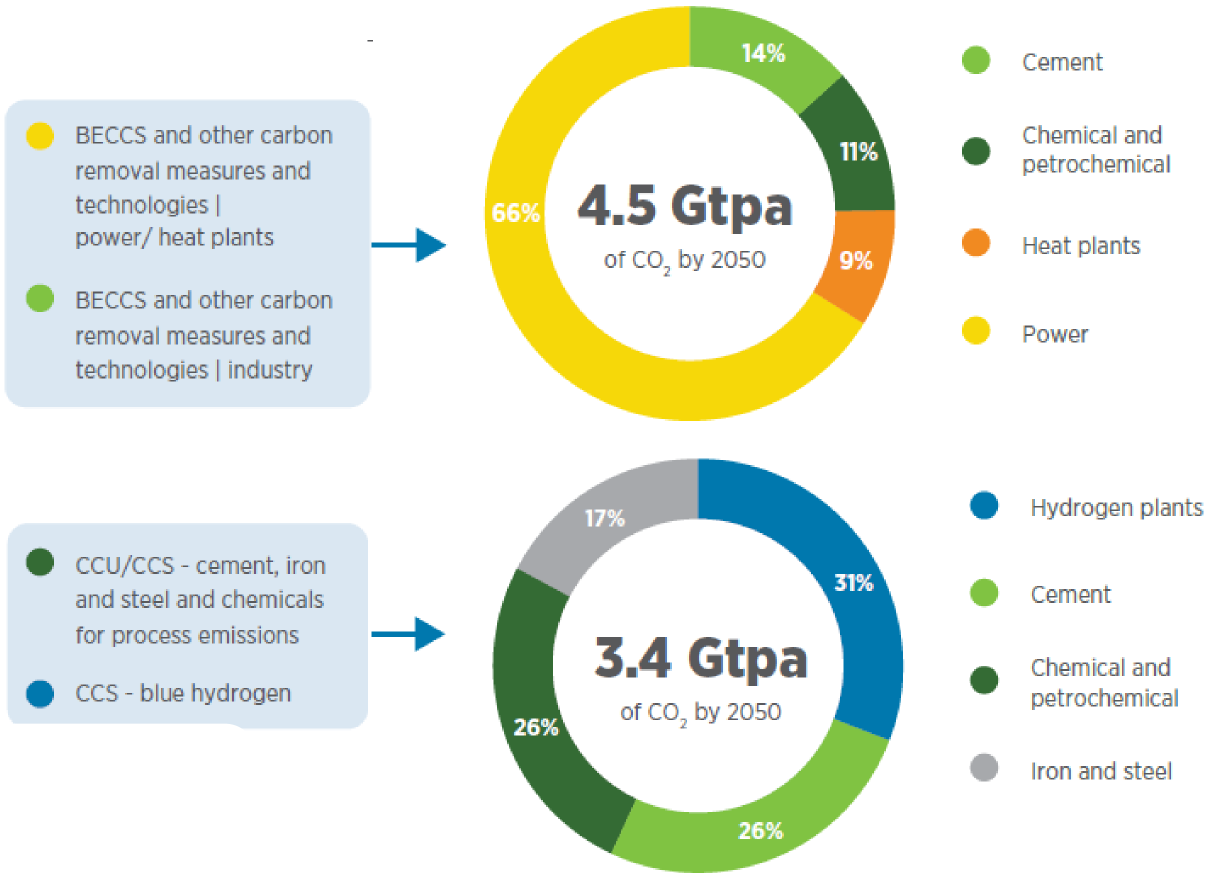
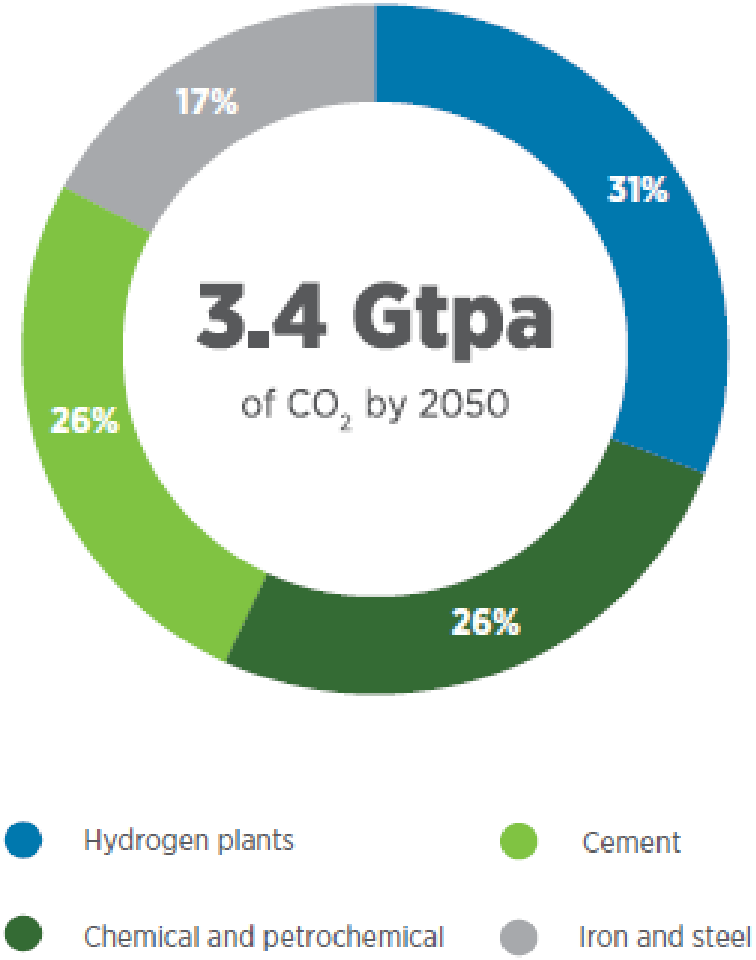
20% abatement potential with CCS, CCU and CDR





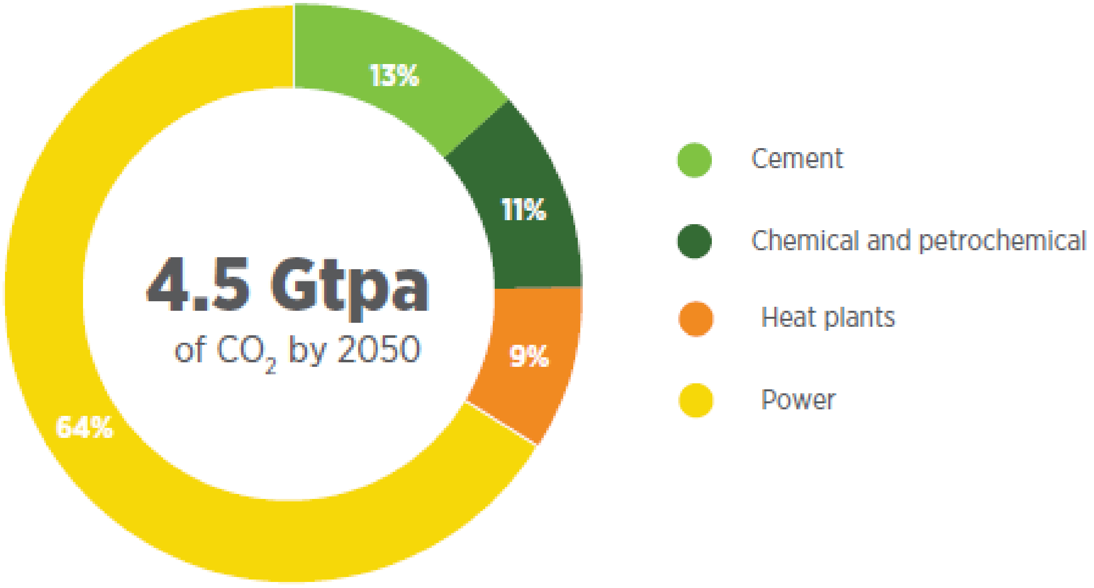
CCS and CCU in hard to abate sectors



- CCS, CCU for fossil fuel and process emissions in industry **aggressively scaled to reach 3.4 Gtpa by 2050** and
- Would require **cumulative investment of around USD 0.9 trillion** between 2021 and 2050
- CCS and CCU **limited to the most essential applications**, and excluded fossil-fuel based CCS for power production
- **2.3 Gtpa in 2050** for CCS applied in **cement**, **chemical** and iron and **steel** sectors
- **1.1 Gtpa in 2050** for the production of **blue hydrogen** from natural gas with CCS

A larger role for BECCS and BECCU

Process group	Biogenic carbon capture potential in 2050
	$GtCO_2$
Power	4.43
Heat	1.29
Cement	0.37
Iron and steel	0.03
Chemicals	1.18
Pulp and paper	0.35
Food sector	0.30
Biorefinery	2.15
Total	**10.12**



- BECCS **currently unproved** in most contexts
- Need for **40-50 EJ of biomass used with BECCS** (~1/3 of total biomass used in the energy systems)
- BECCS **utilized in a range of processes**, optimum application requires more detailed investigation of costs, logistics and sustainable biomass supply chains
- IRENA 1.5C Scenario: biomass-based processes from which **10.12 Gtpa could be potentially** captured and stored. Of that, the Scenario assumes **44% actually captured and stored**
- **Cumulative investment of around USD 1.1 trillion** between 2021 and 2050

DACCS/DACCU needs further development & validation

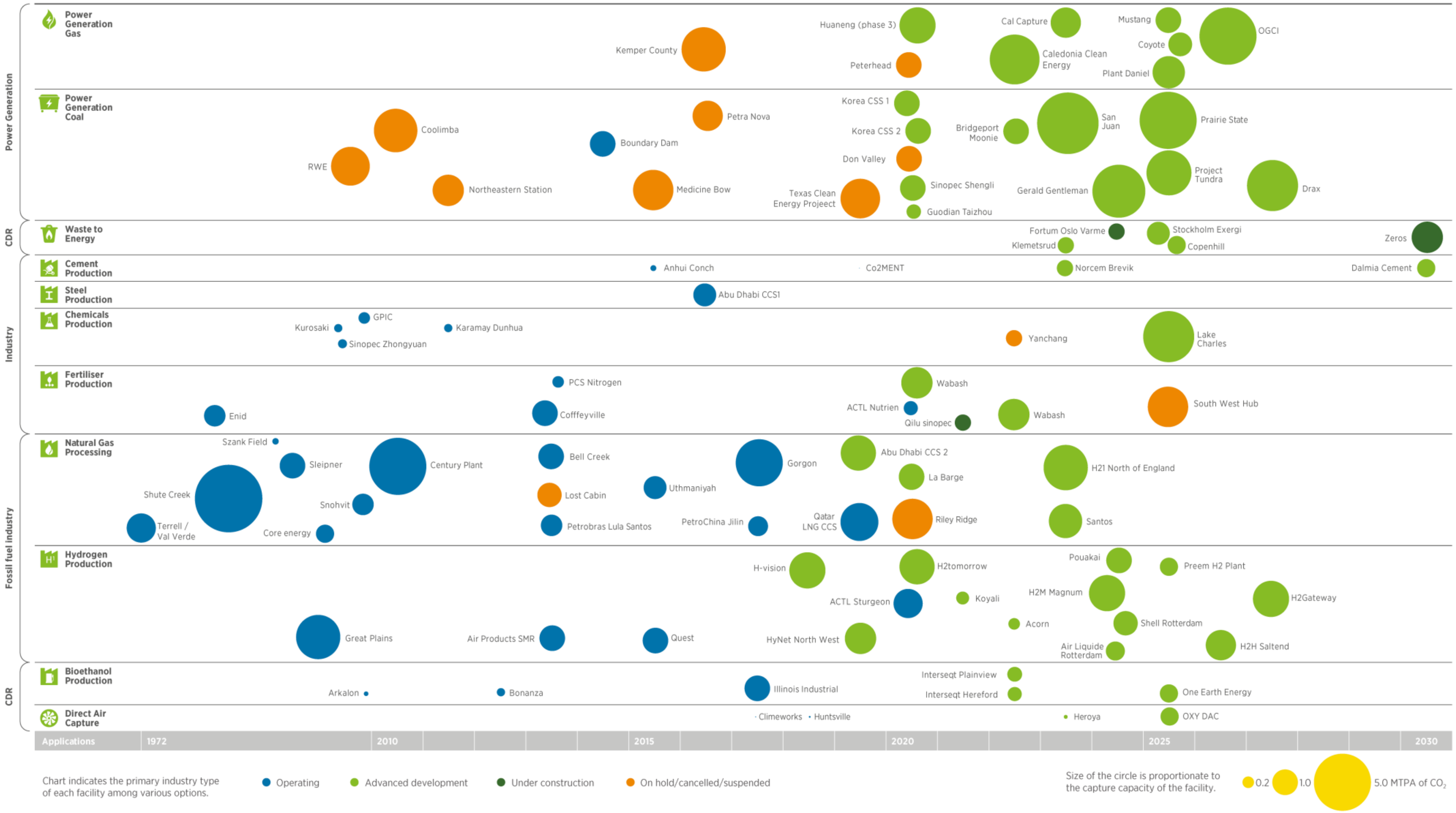
● Pilot and demonstration ● Commercial ● Laboratory

Facility	Location	Capacity Mtpa/CO_2	Status: Early development	Status: Under construction	Status: Operating	Status: Completed	Status: NA
Climeworks CELBICON	IT	0				● Pilot and demonstration	
Climeworks DAC-3	IT	0.00015				● Pilot and demonstration	
Climeworks Hinwil	CH	0.0009			● Commercial		
Climeworks ORCA	IS	0.004			● Pilot and demonstration		
CORAL	DE	0			● Pilot and demonstration		
Herøya	NO	0.021	● Commercial				
Huntsville	USA	0.004			● Commercial		
Infinitree	USA	-					● Laboratory
Kopernikus Project P2X	DE	-				● Pilot and demonstration	
Móstoles	ES	-	● Pilot and demonstration				
OXY and Carbon Engineering	USA	1	● Pilot and demonstration				
Palm Spring Demo	USA	-	● Pilot and demonstration				
Rapperswil	CA	-				● Pilot and demonstration	
Skytree	NL	-					● Laboratory
Soletair	FI	-			● Pilot and demonstration		
Squamish demonstration	CA	0.000365			● Pilot and demonstration		
SRI International, Menlo Park	USA	0			● Pilot and demonstration		
Synhelion	CH	-			● Pilot and demonstration		
Wallumbila - APA Renewable Methane Demonstration Project	AU	-		● Pilot and demonstration			
Zenid	NL	-	● Pilot and demonstration				

AU - Australia, CA - Canada, CH - Switzerland, DE - Germany, ES - Spain, FI - Finland, IT - Italy, IS - Iceland, NL - Netherlands, NO - Norway, USA - United States.
Source: Based on Geoengineering Monitor (2019, 2021); NASEM (2019); Viebahn, Scholz and Zelt (2019).

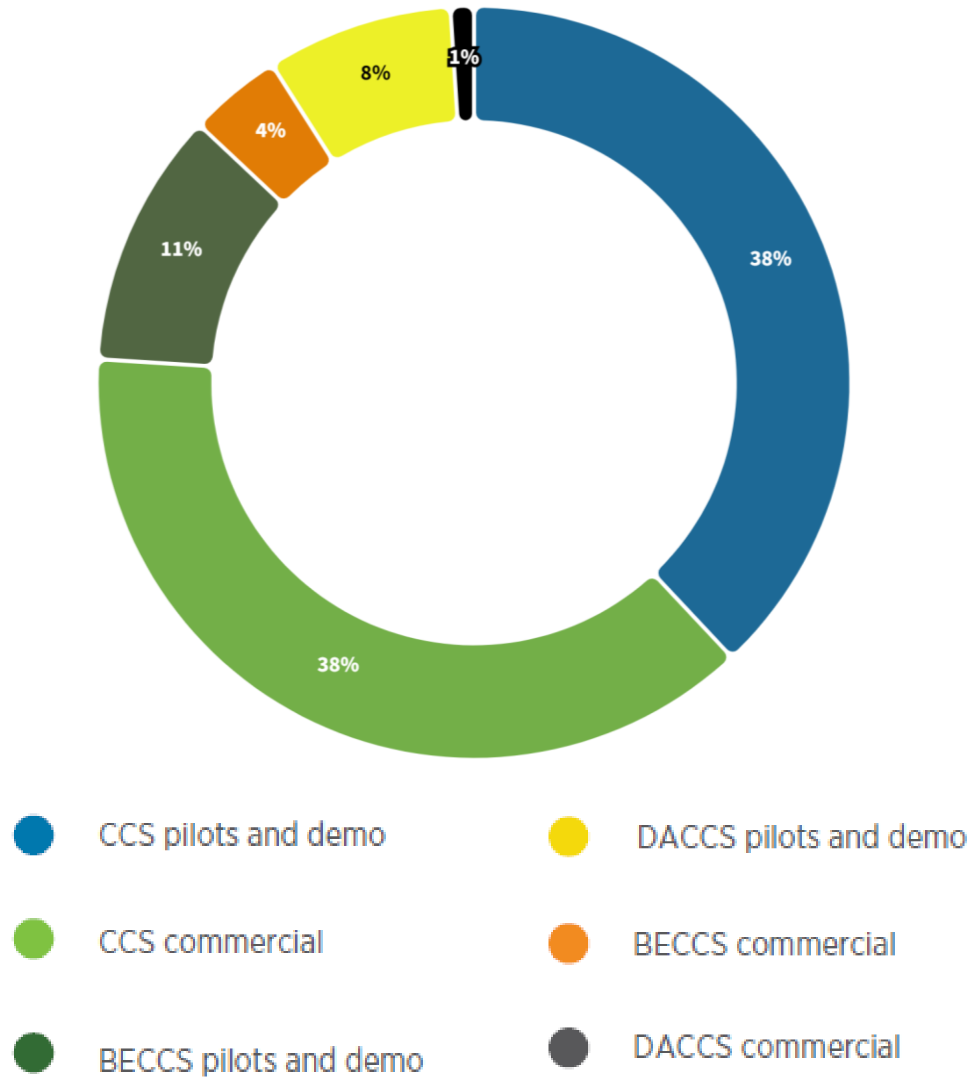
- DACCS/DACCU **in early stages of development**
- Current capture: **0.9 ktpa of CO2 capture,** other plant under development would add an additional 21 ktpa of CO2 capture
- Early experience: projects face **high energy**, **water and land requirements**, but offer **flexibility in terms of their location**
- Frequently quoted estimate at **USD 600-800 t/CO2 avoided**, newer studies lower costs **USD 94-232/tCO2 avoided and needs to be demonstrated**
- **Large financial commitments to speed-up DACCS deployment** - would allow offset some of the need for BECCS and capture historical emissions elsewhere

Progress in capturing CO2 is far too slow



- Current capture **~ 0.04 Gtpa**
- Equal **to 0.01%** of total global energy and process related emissions

Commercial and pilot/demo projects now

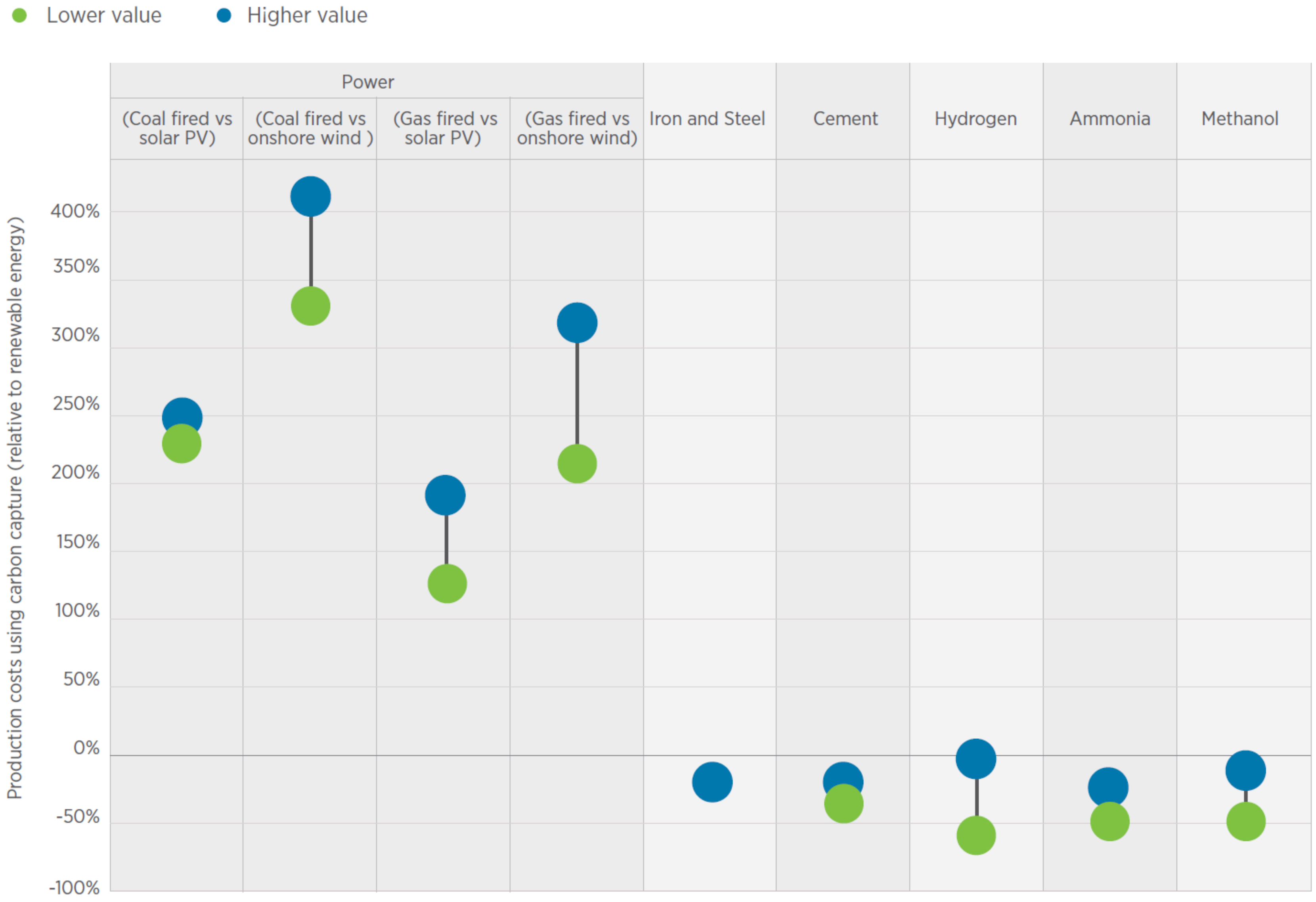


Current volume of **capture 0.04 Gtpa**

- **CCS/CCU:**
  - Commercial plants: over 20 in operation, 30 at various stages of development
  - Pilot and demonstration projects: almost 60 (closed, operating, in development)
- **BECCS/BECCU:**
  - Commercial: 3 in operation, 7 under development
  - Pilot and demonstration projects: 20 in various stages of development
- **DACCS/DACCU:**
  - Commercial: 2 in operation, 1 in development
  - Pilot and demonstration projects: 15 at various stages of development

With all **commercial plants** under development it may reach **0.1 Gtpa in 2030**

Renewables outcompete fossil fuel-based power plants with CCS



Costs are uncertain and vary by application

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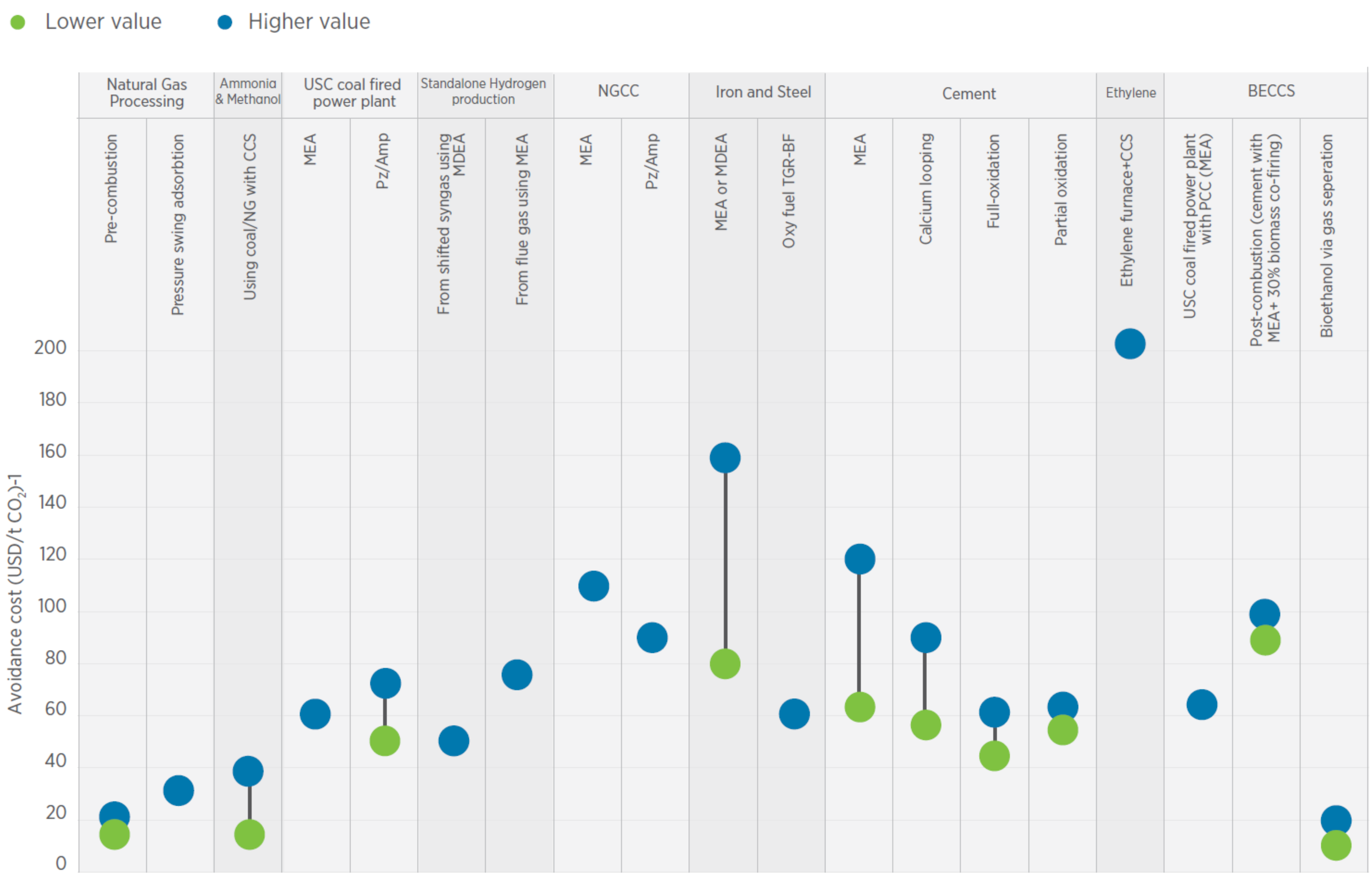

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CO_2 chain

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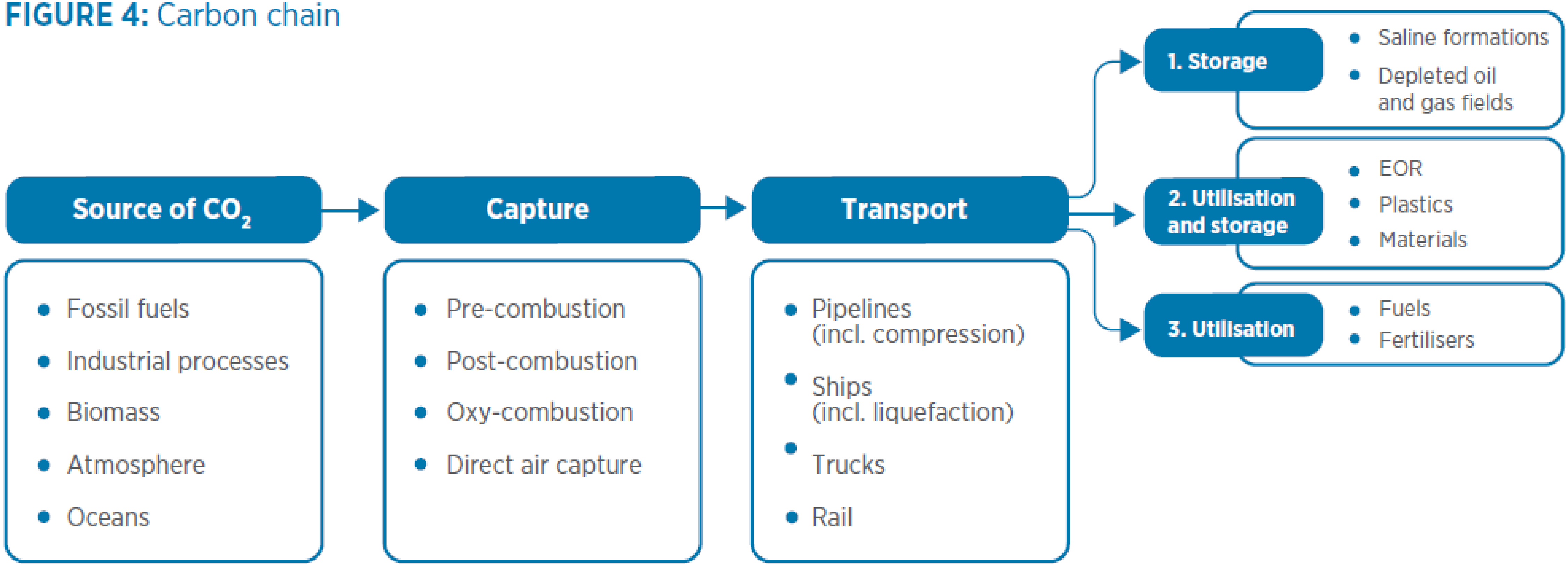
FIGURE 4: Carbon chain



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Increasing role of carbon capture and utilisation

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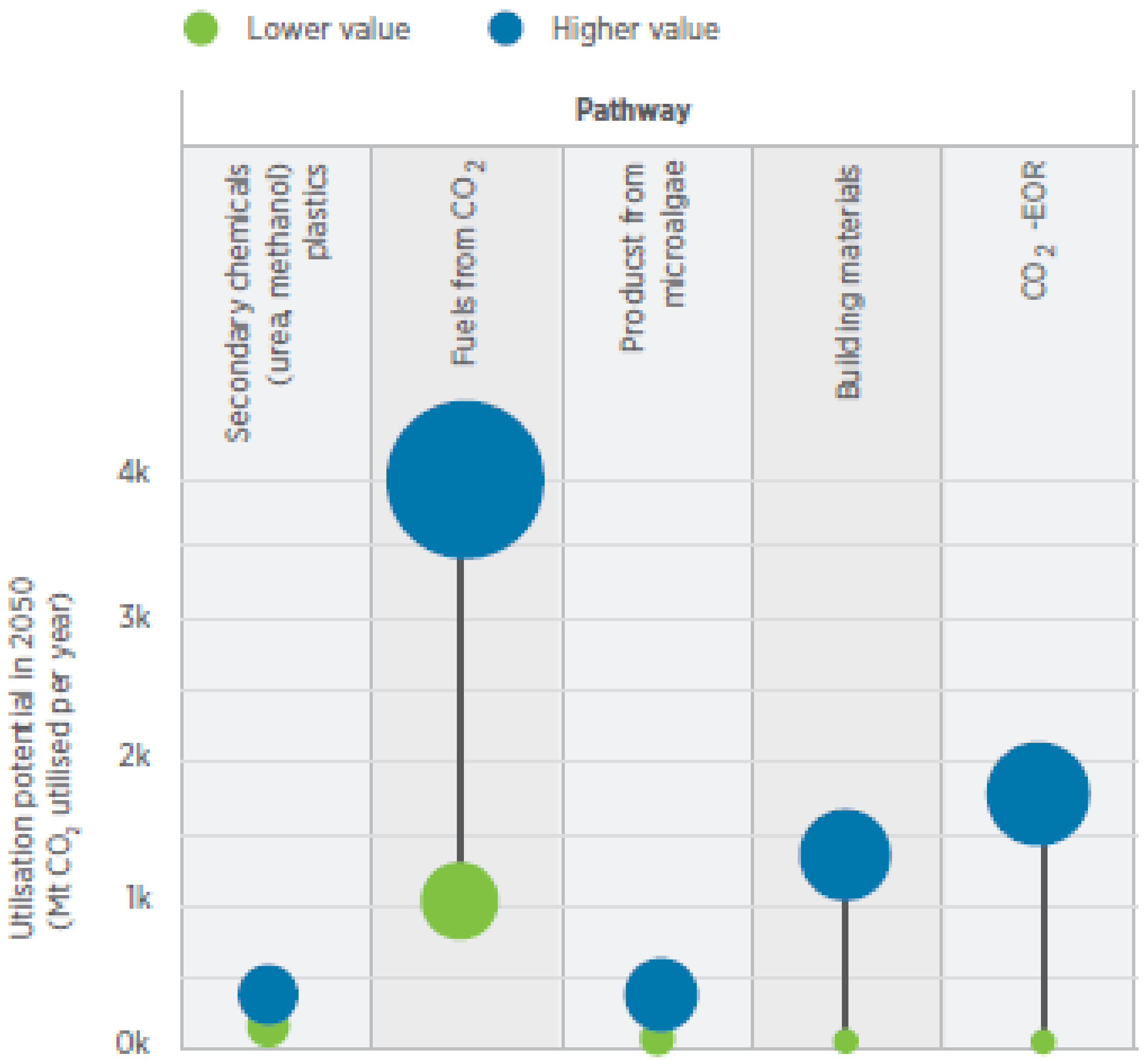
- **Utilisation has a role** in a net-zero pathway, **but** should be limited to applications that do not lead to later release of CO_2 back to the atmosphere
- Improves **economic feasibility** of CO_2 capture by creating a revenue stream and compensate for a lack of readily available and accessible CO_2 storage sites
- **Applications:**
  - ❖ CO_2 to fuels (largest opportunity)
  - ❖ Enhanced commodity production
  - ❖ Enhanced hydrocarbon recovery
  - ❖ CO_2 mineralization
  - ❖ Chemicals production
- **Requires**: maturation of technologies, proximate location of capture and utilisation plants, potential commercial market, social acceptance



Re-emission of utilised CO_2 and its time-scale

- Poses **questions about the long-term consequences** and difficult to trace CO_2 across multiple end-uses
- **Aim to lock-in CO_2** emissions for extended period of time
- **Conflicting** – plastics or EOR lock-in effect, but detrimental to the environment

Likelihood of release	Days	Weeks	Months	Decades	Centuries	Millenia
Low					Building materials	CO_2-EOR
High	Urea, methanol	CO_2 derived fuels (Fischer-Tropsch derived fuels, methane, etc)		Plastics		
High		Microalgae for biofuels, biomass or bioproducts				

Timescale of release of CO_2

A lot needs to be done on multiple fronts in the next decade

Scaled-up RD&D

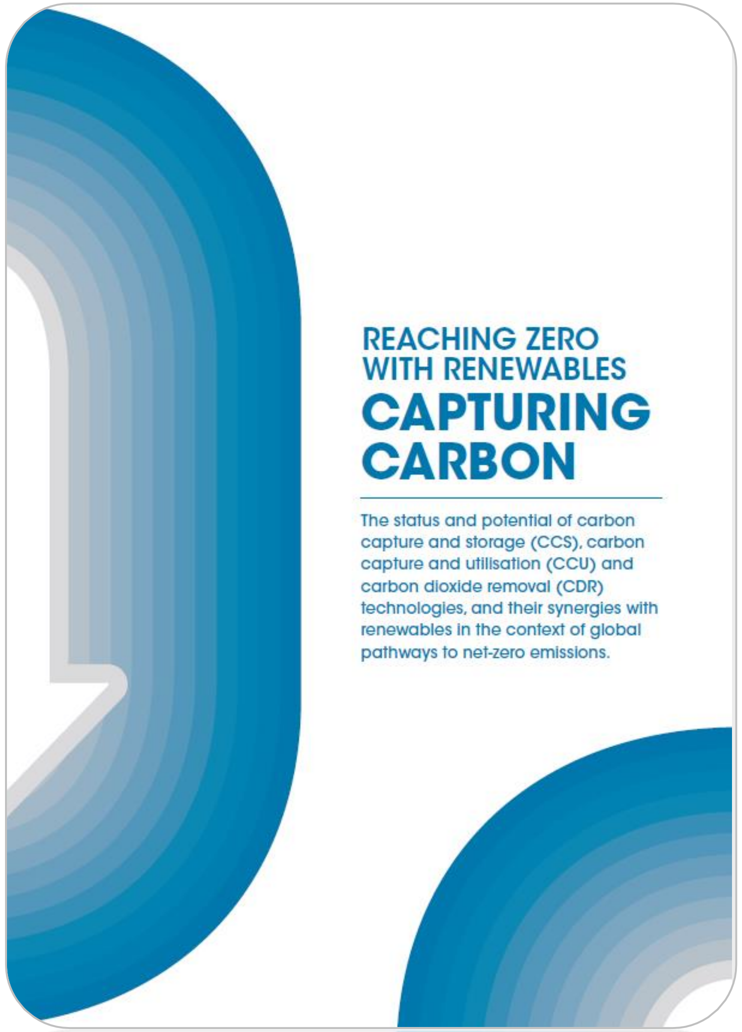
- Encourage public-private international RD&D
- Build FOAK, demonstration and lighthouses projects everywhere
- Study and understanding public perception

Enabling conditions

- Develop policies, regulations and standards
- Institutions & organisations
- Financial support
- Hub-transport/storage networks models
- Open access to information
- Deployment of clusters with hard-to-abate industry

Sustainability

- Sustainability of biomass for BECCS
- Consider LCA of emissions



Thank you for your attention!

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Q & A
10 min

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