Carbon capture and storage (CCS) technology perspectives

The 21st APEC Workshop on Energy Statistics: Data collection on new energy products and technologies

12-14 September 2023 | Tokyo, Japan

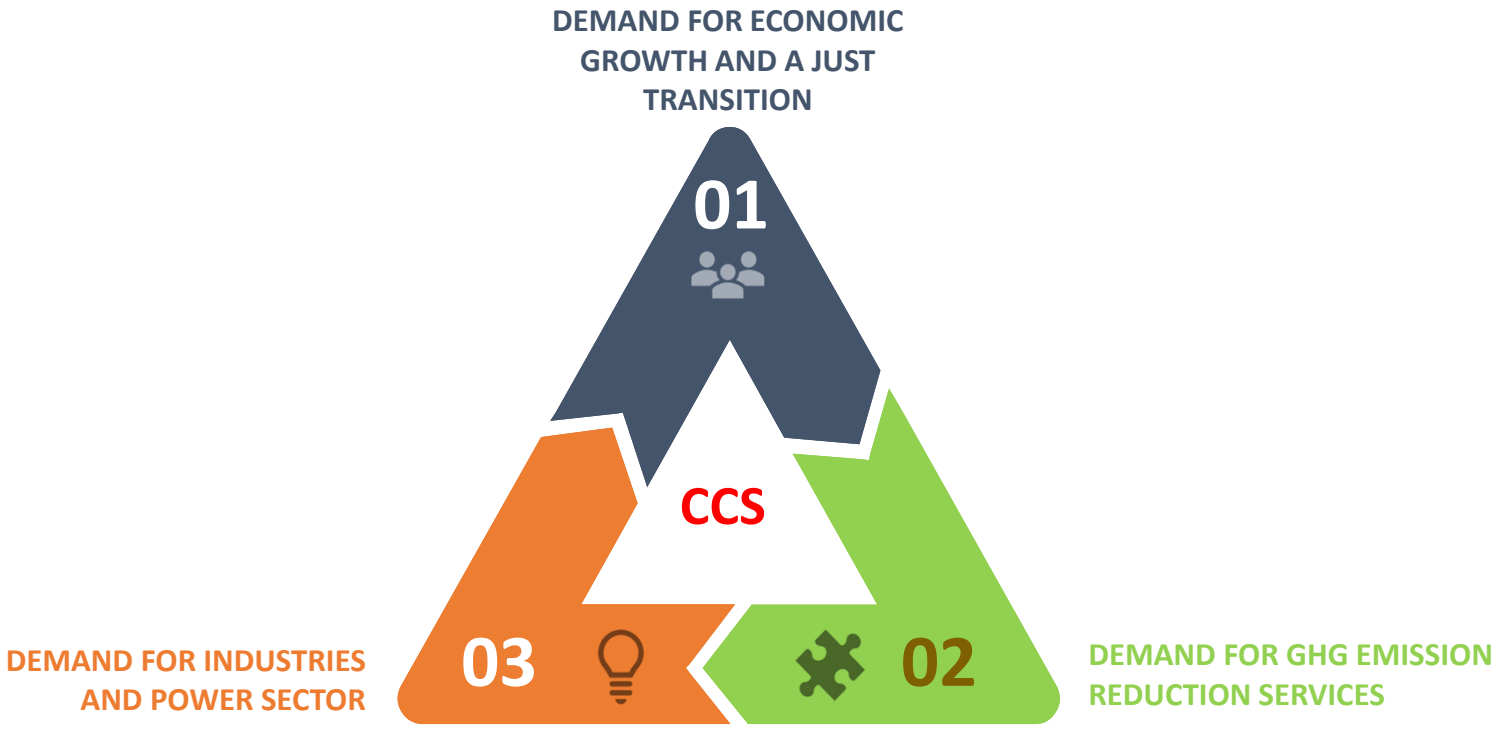
Phung Quoc HUY, Asia Pacific Energy Research Centre (APERC)

Contents

- Introduction
- CCS technology
- CCS development
- CCS cost and cost reduction
- Opportunities and challenges

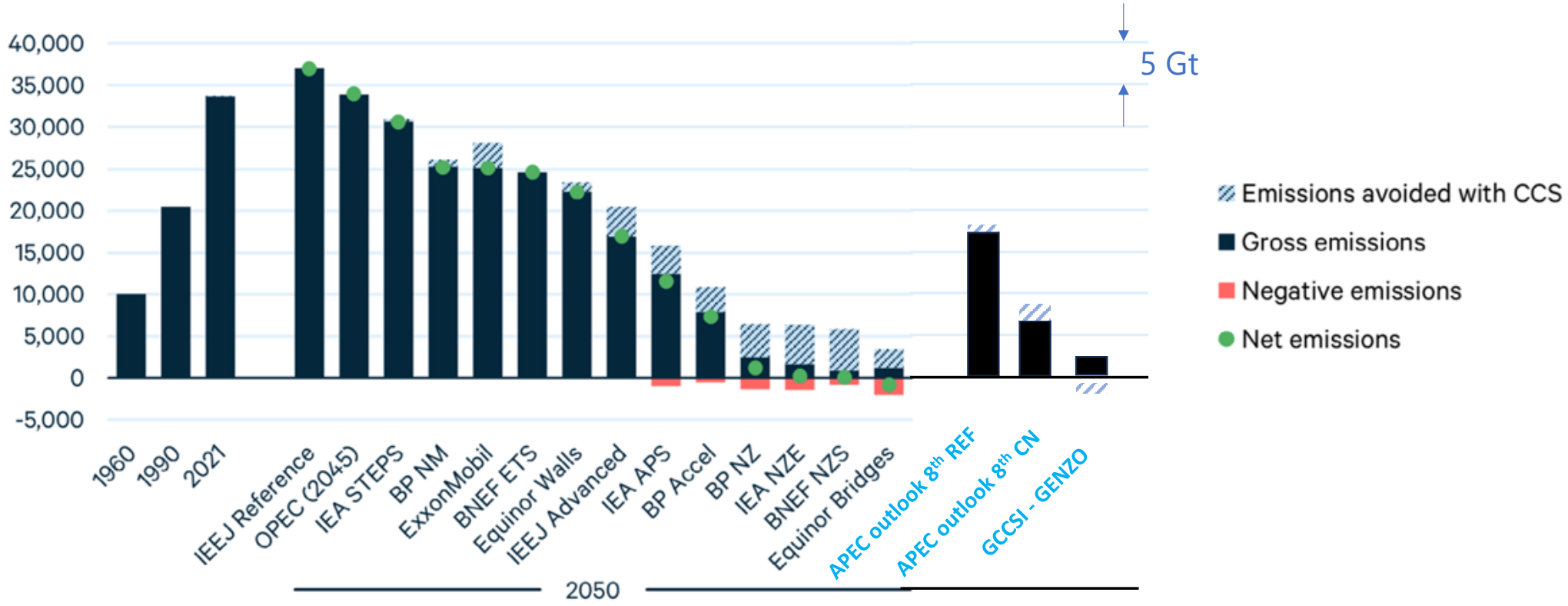
INTRODUCTION

Key demand drivers for CCS development



CCS in different projections

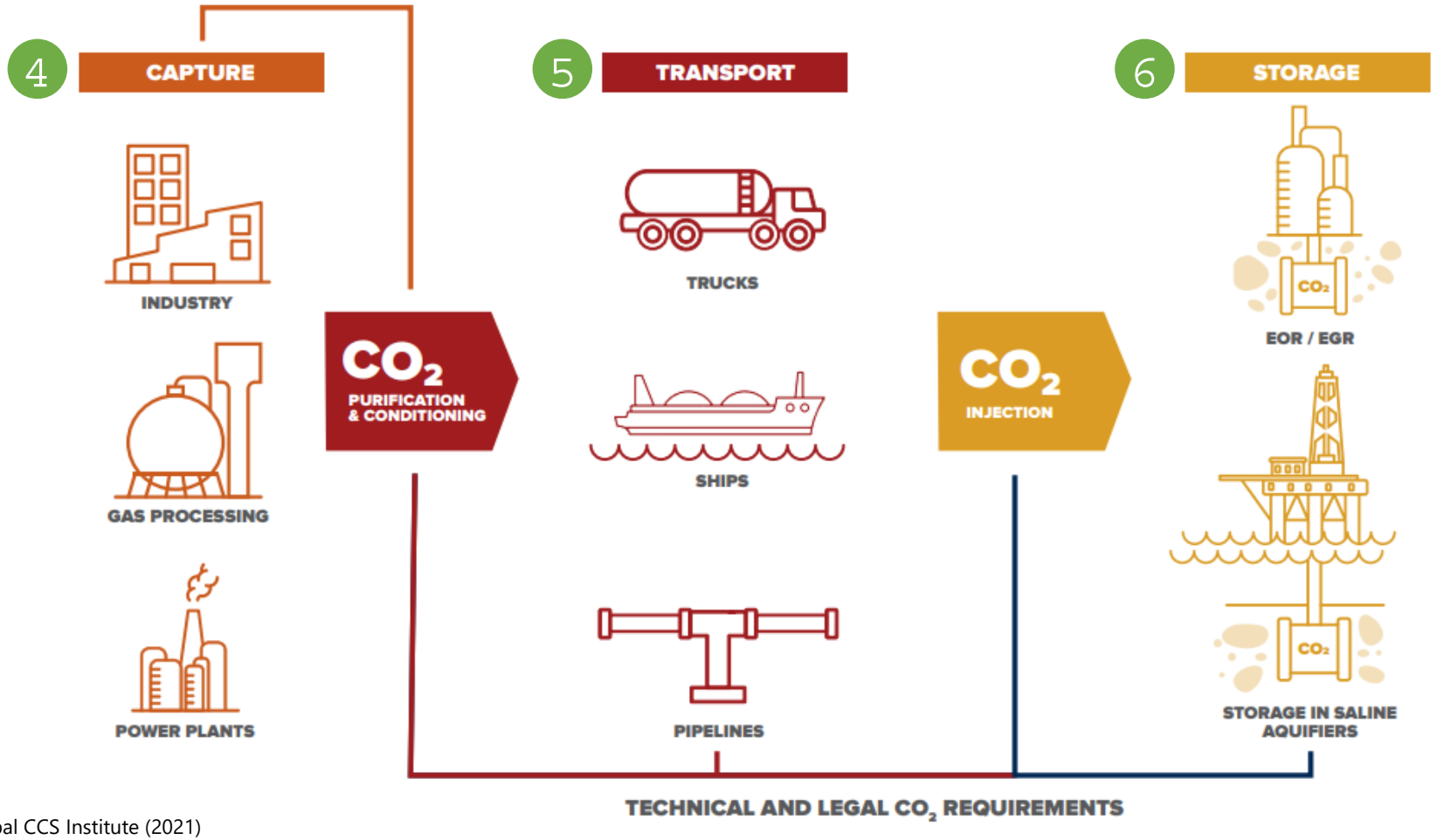
Global energy-related CO_2 emissions, Mt



Sources: Resources for the future (2023), APERC Outlook 8th (2022), Global CCS Institute (2023).

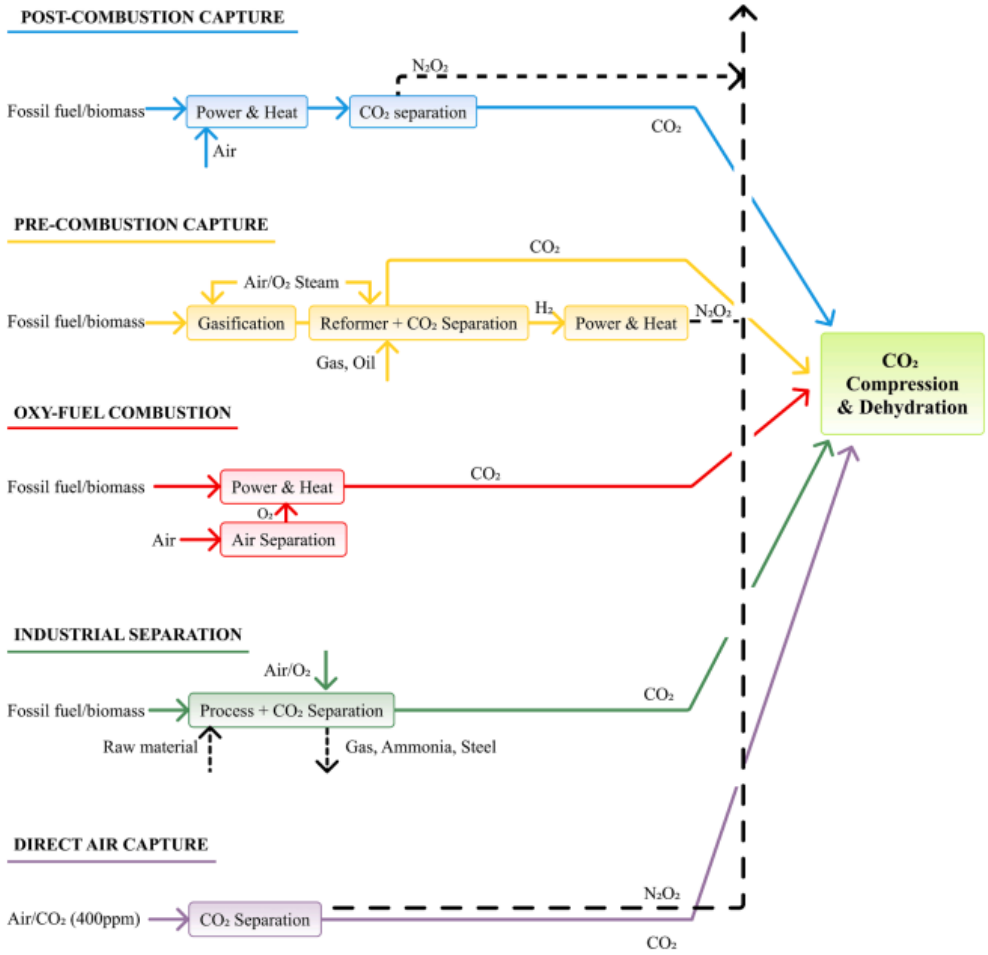
CCS TECHNOLOGY

CCS full value chain



Sources: Global CCS Institute (2021)

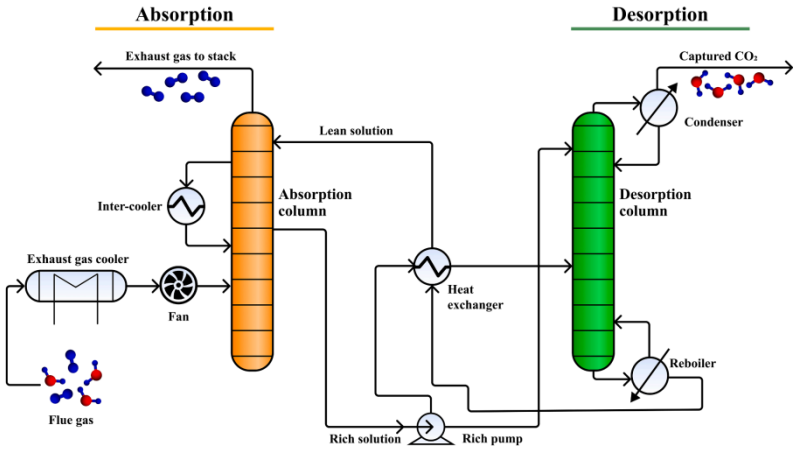
Carbon capture technologies (1)



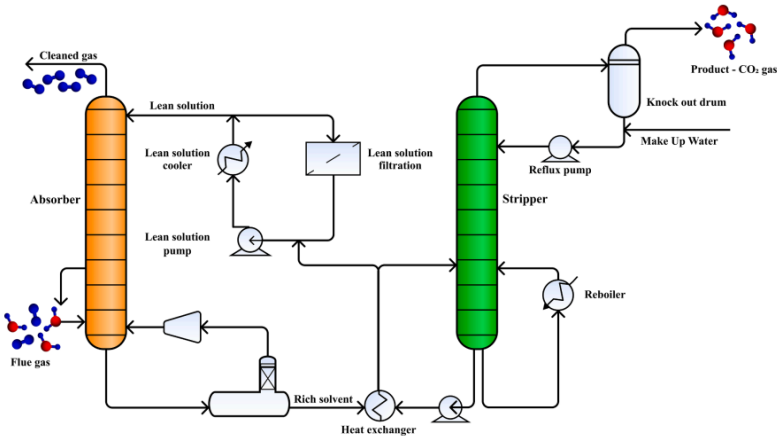
Sources: Bartosz Dziejarski (2023).

Carbon capture technologies (2)

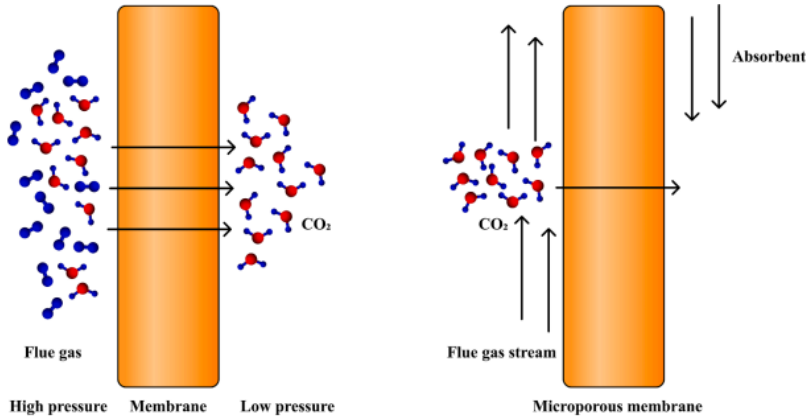
Chemical absorption method



Physical absorption method

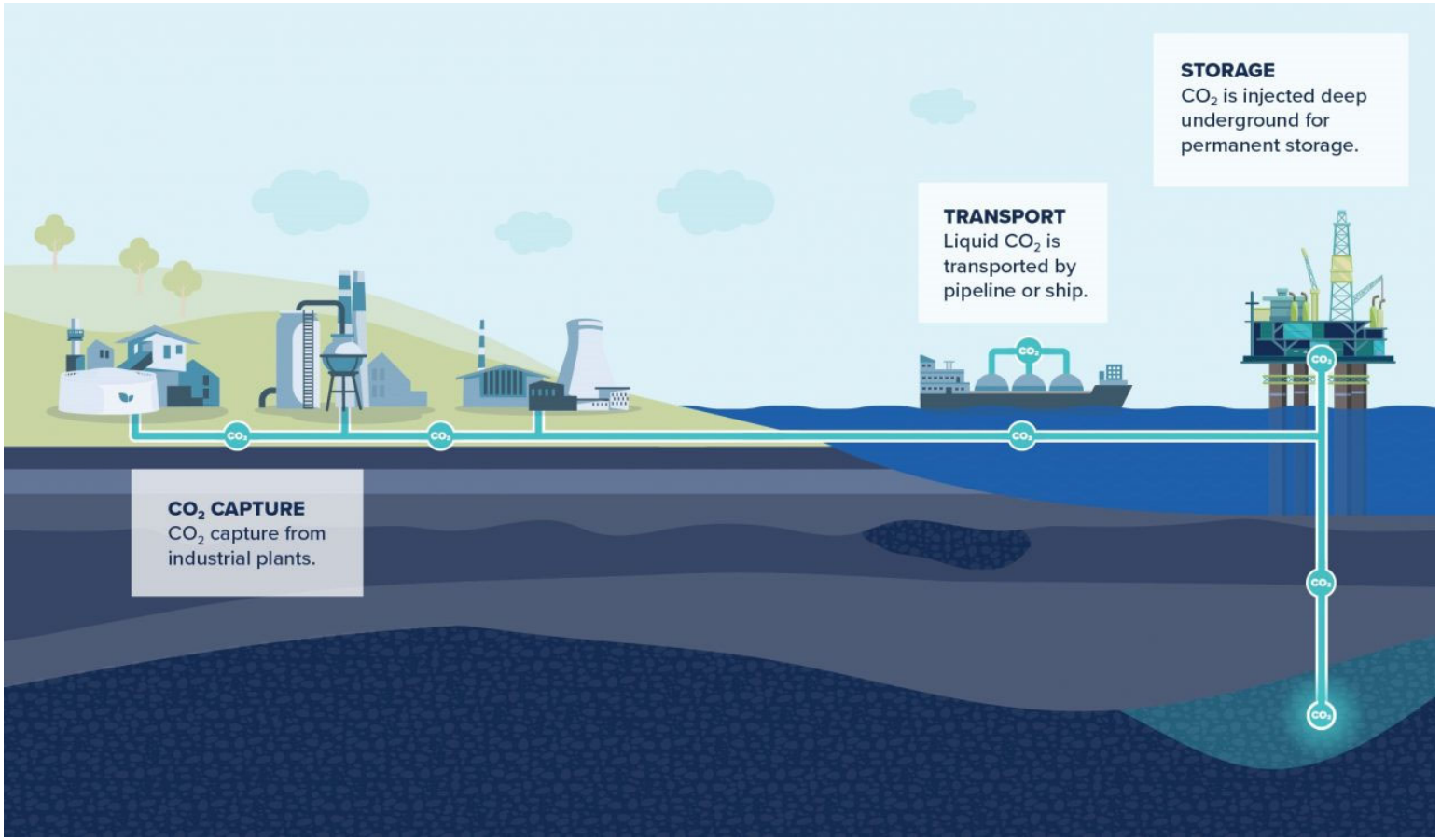


Membrane method



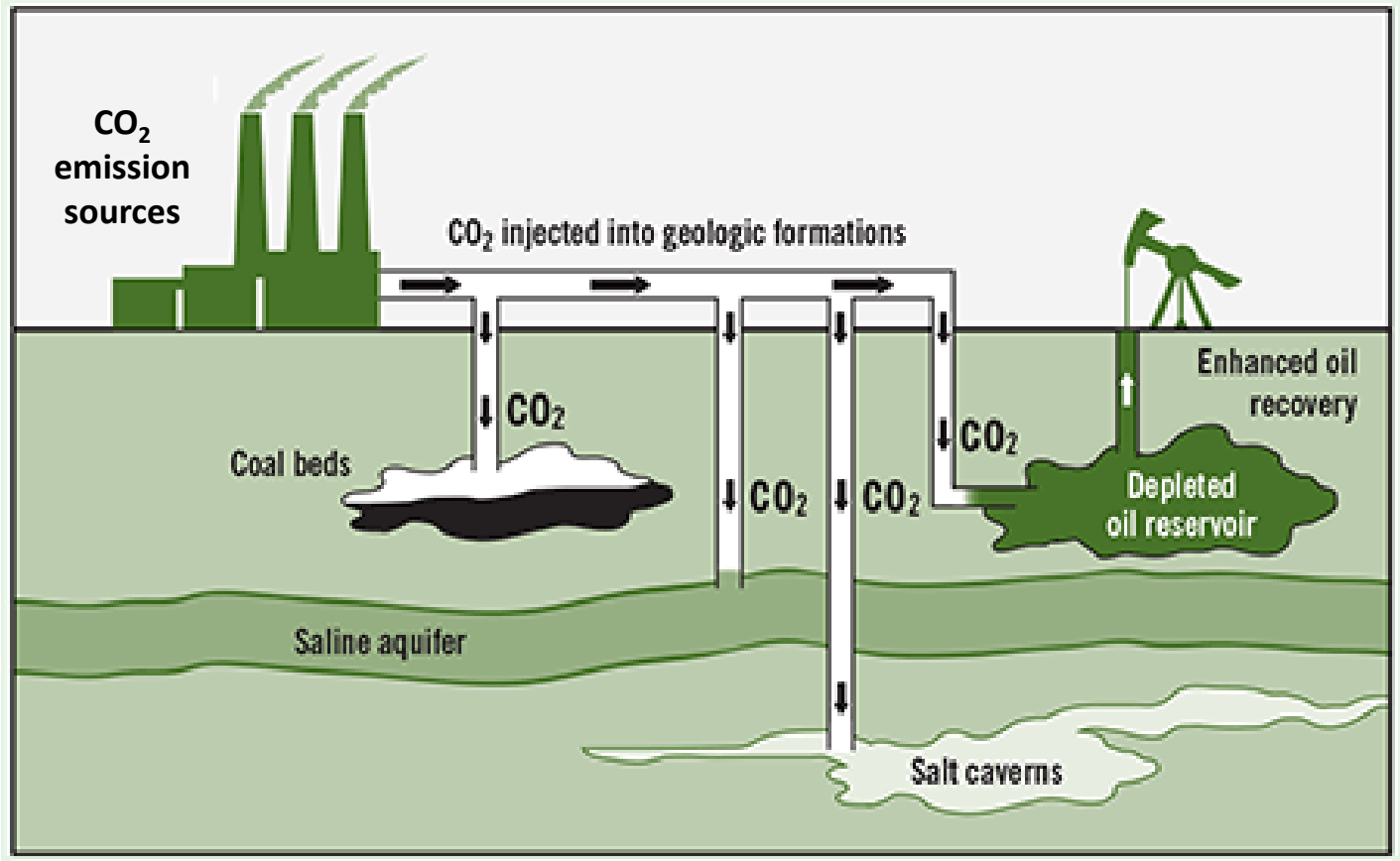
Sources: Bartosz Dziejarski (2023).

Carbon transport technologies



Sources: Global CCS Institute

Carbon storage technologies

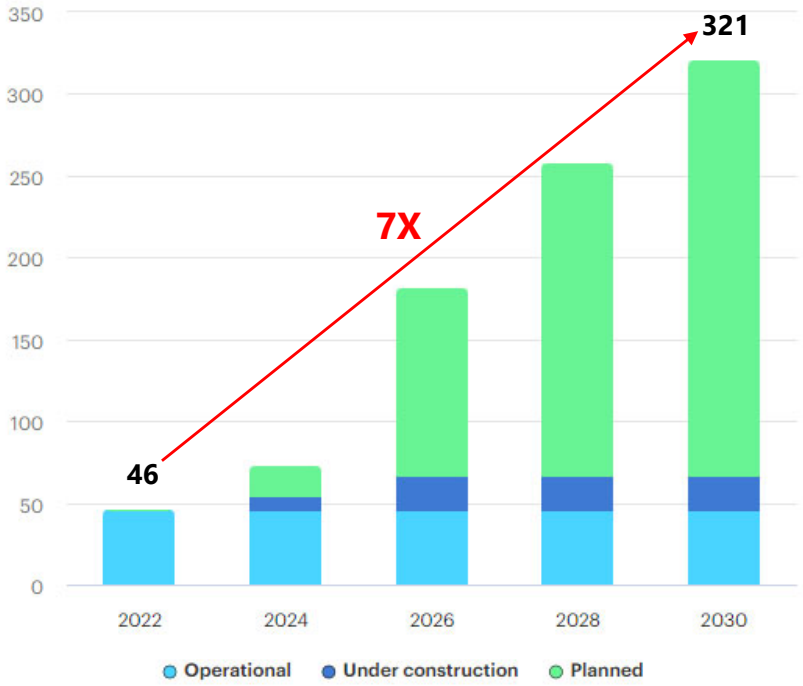


Sources: WatchWire

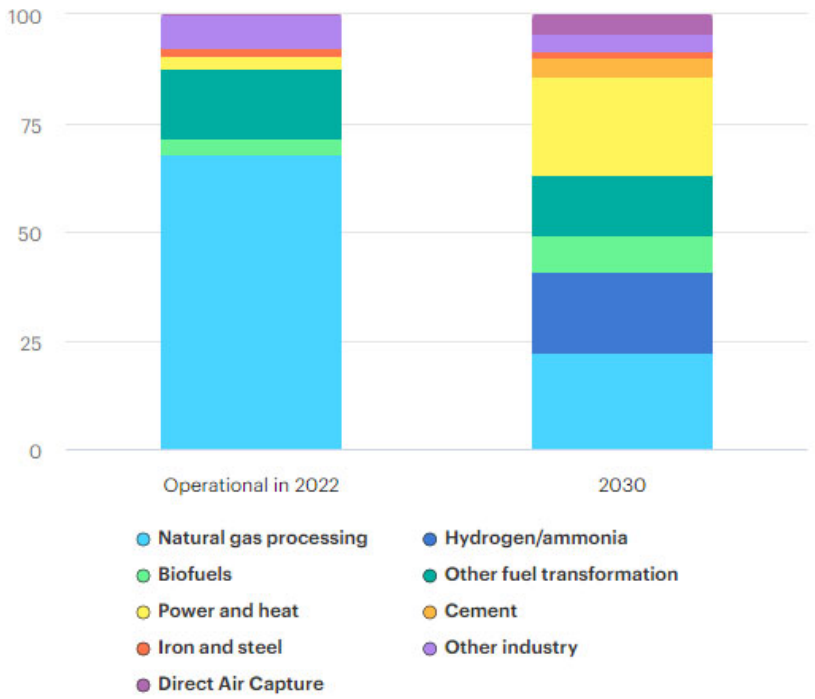
CCS DEVELOPMENT

Global CCS development

Announced capacity of CCS facilities, Mt CO_2/y



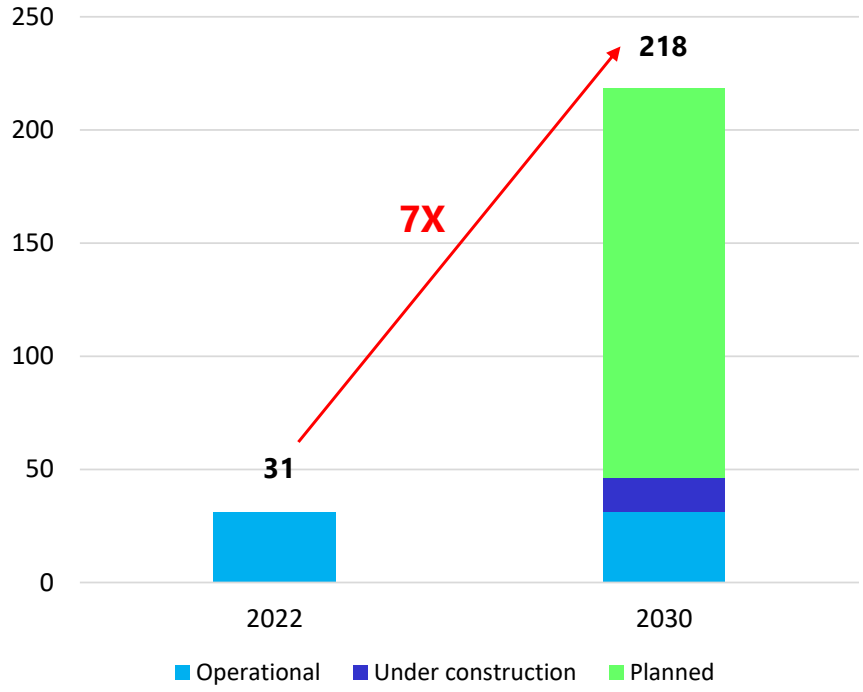
Share of CCS facilities by sector, %



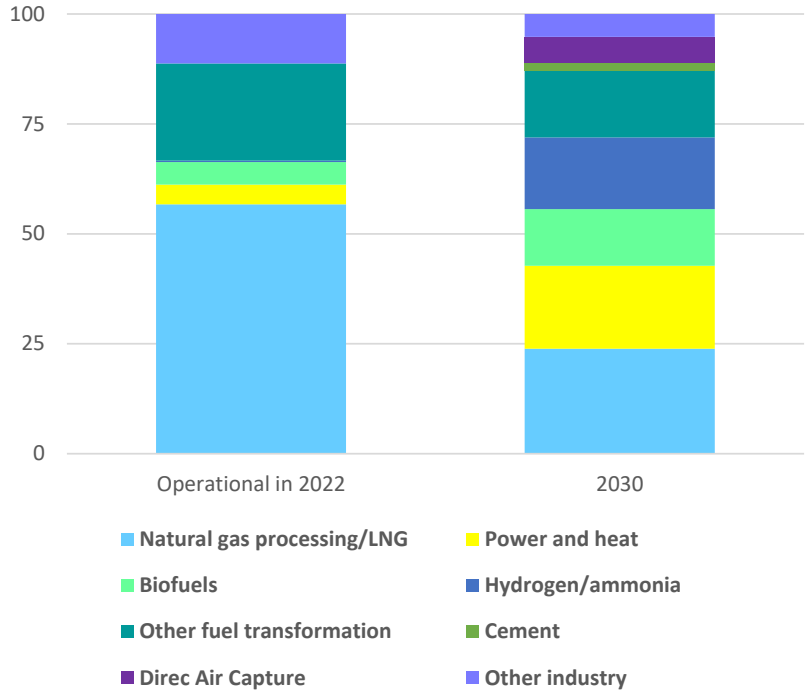
Sources: IEA (2023)

APEC CCS development (1)

Announced capacity of CCS facilities, Mt CO_2/y



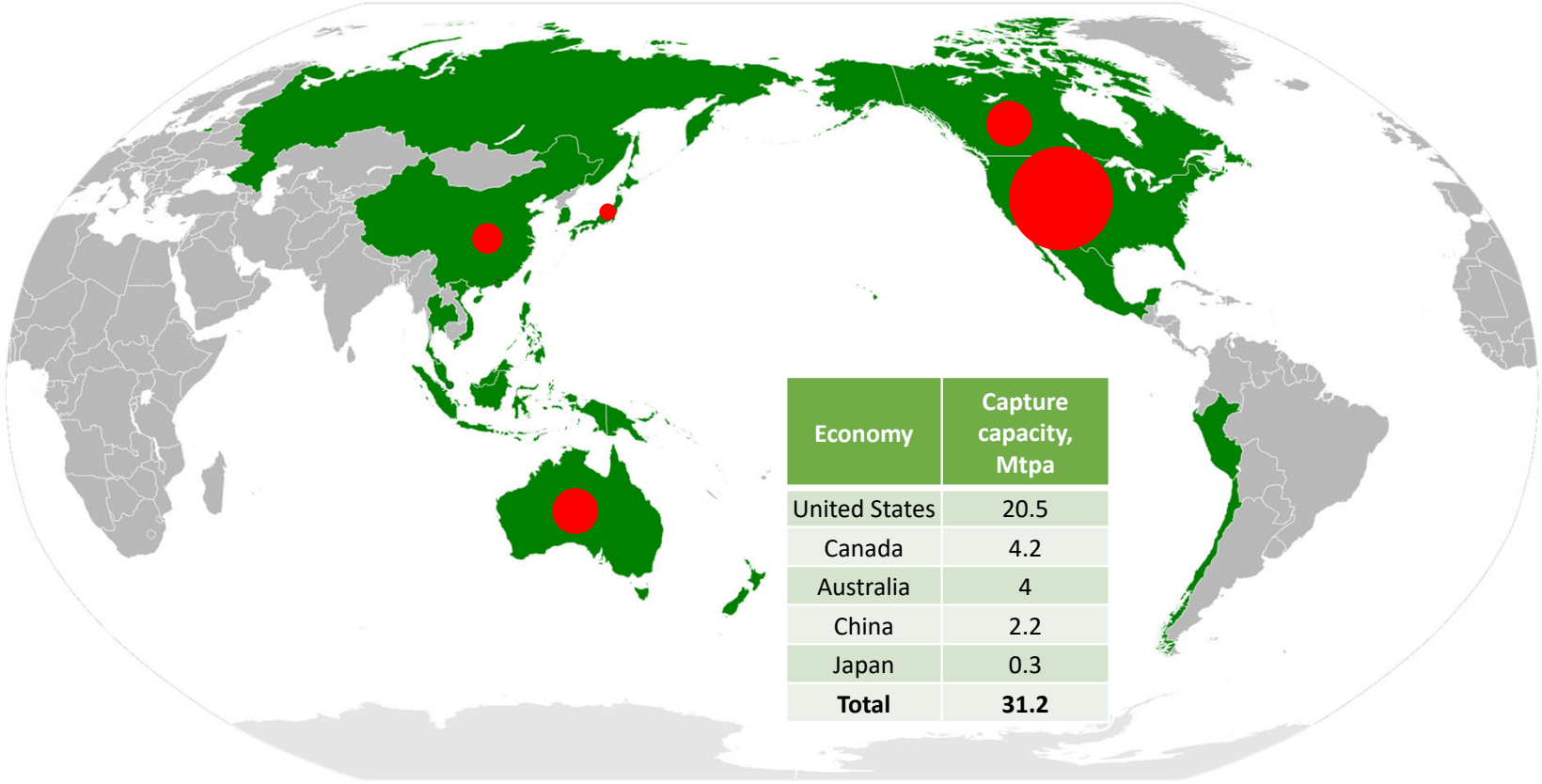
Share of CCS facilities by sector, %



Sources: IEA (2023), APERC analysis.

APEC CCS development (2)

Operational CCS capacity by economy



Economy	Capture capacity, Mtpa
United States	20.5
Canada	4.2
Australia	4
China	2.2
Japan	0.3
Total	**31.2**

Sources: IEA (2023)

APEC CCS development (3)

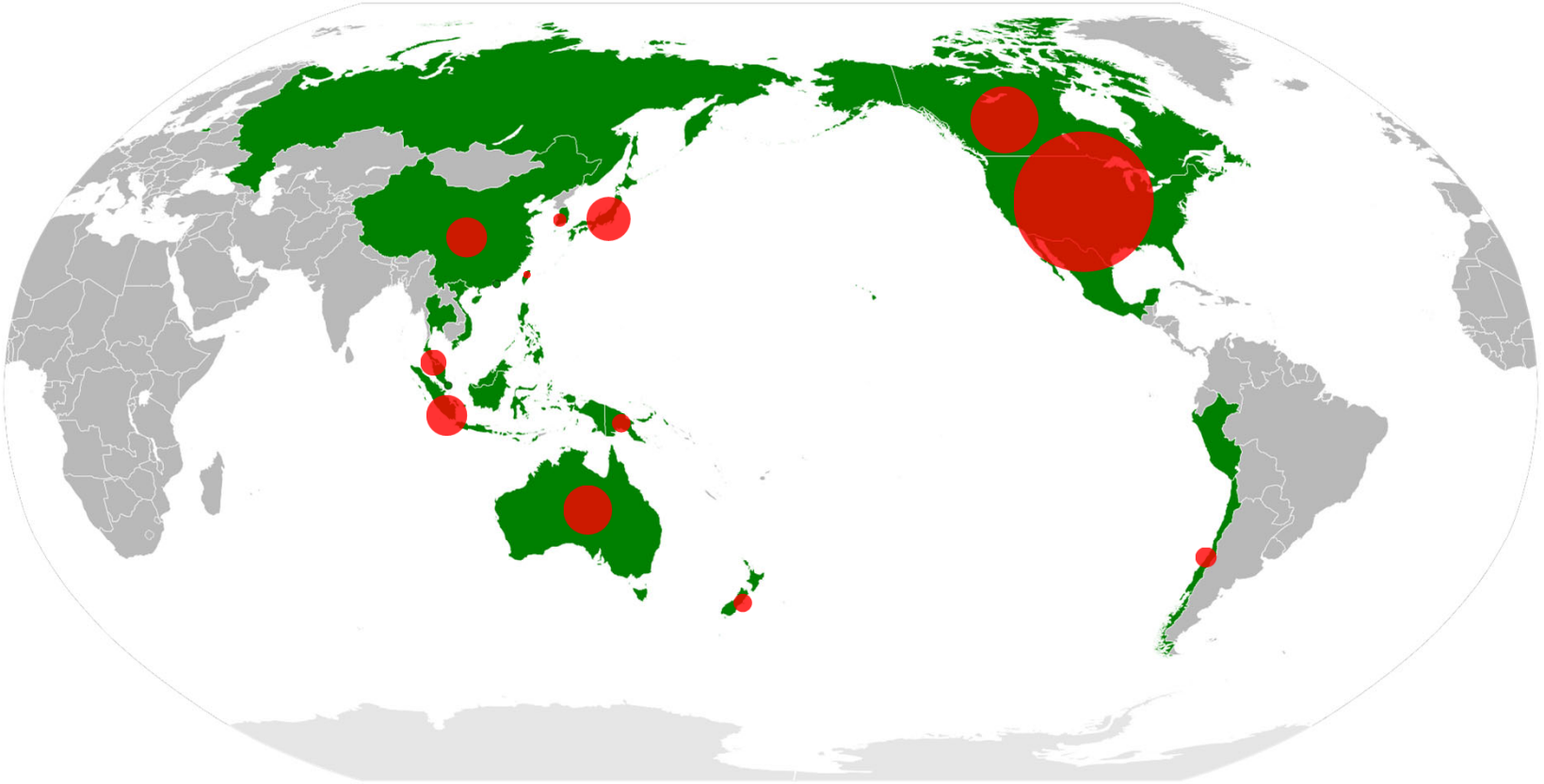
Operational CCS capacity by sector

Economy	Power and heat	Natural gas processing	Biofuels	Hydrogen/ ammonia	Other fuel transformation	Cement	Iron and steel	Chemicals	Other industry
United States		●	●		●				●
Canada	●				●				●
Australia		●							
China	●	●			●				●
Japan	●			●					

Sources: IEA (2023)

APEC CCS development (4)

Planned CCS capacity by economy



Economy	Planned capture capacity by 2030, Mtpa
United States	130.6
Canada	31.1
Australia	14.8
Japan	13
China	11.3
Indonesia	10
Malaysia	3.3
Chile	1.5
New Zealand	1
Papua New Guinea	1
Korea	0.6
Chinese Taipei	0.1
Total	**218.3**

Sources: IEA (2023)

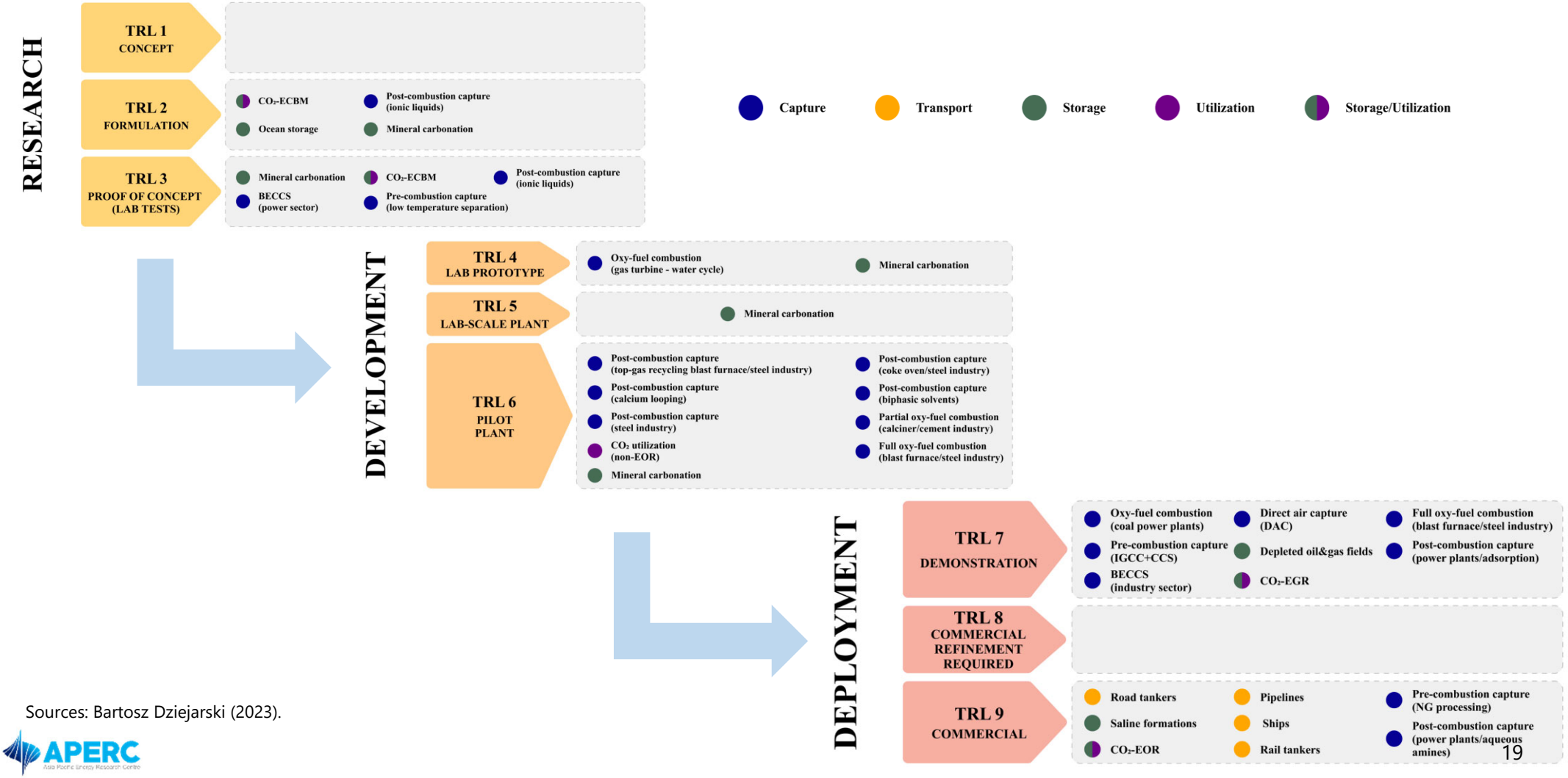
APEC CCS development (5)

Planned CCS capacity by sector

Economy	Power and heat	Natural gas processing	Biofuels	Hydrogen/ ammonia	Other fuel transformation	Cement	Iron and steel	Chemicals	Other industry	Direct air capture
United States	●	●	●	●	●	●			●	●
Canada	●		●	●	●	●			●	●
Australia	●	●		●					●	
Japan	●			●	●	●	●	●	●	
China	●	●			●				●	
Indonesia		●								
Malaysia		●								
Chile										●
New Zealand				●						
Papua New Guinea		●								
Korea				●	●					
Chinese Taipei						●				

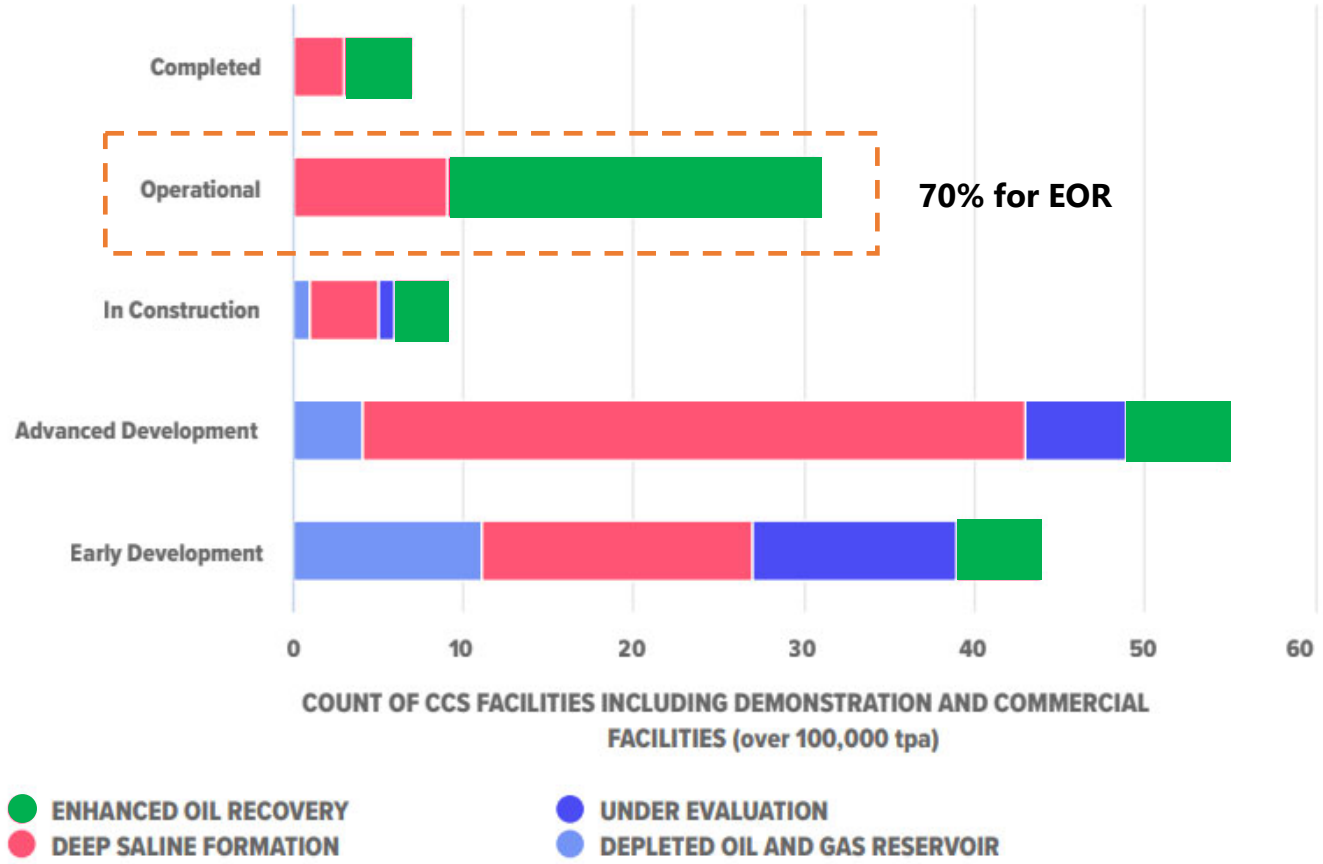
Sources: IEA (2023)

Technology readiness level (TRL)



Sources: Bartosz Dziejarski (2023).

CO_2 storage sites



Sources: Global CCS Institute (2022)

CO_2 storage capacity

No	Economies	Estimated CO_2 storage capacity (Gt)		Link for reference
		by Christopher *	by Jordan **	
1	Australia	227 - 702	595 - 4184	
2	Brunei Darussalam			
3	Canada	198 - 671	318 - 2236	* Christopher P. Consoli,* Neil Wildgust. Current status of global storage resources. Energy Procedia 114 (2017) 4623-4628
4	Chile			
5	China	1573	403 - 2830	
6	Hong Kong, China			
7	Indonesia	1.4 - 2	163 - 1144	
8	Japan	146	8 - 59	** Jordan Kearns, et al. Developing a consistent database for regional geologic CO_2 storage capacity worldwide. Energy Proceia 114 (2017) 4697-4709.
9	Korea	100	3 - 24	
10	Malaysia	28		
11	Mexico	100	138 - 967	
12	New Zealand	16		
13	PNG			
14	Peru			
15	Philippines	23		
16	Russia	6.8	1234 - 8673	
17	Singapore			
18	Chinese Taipei			
19	Thailand	10		
20	The United States	2367 - 21200	812 - 5708	
21	Viet Nam	12		

CCS COST AND COST REDUCTION

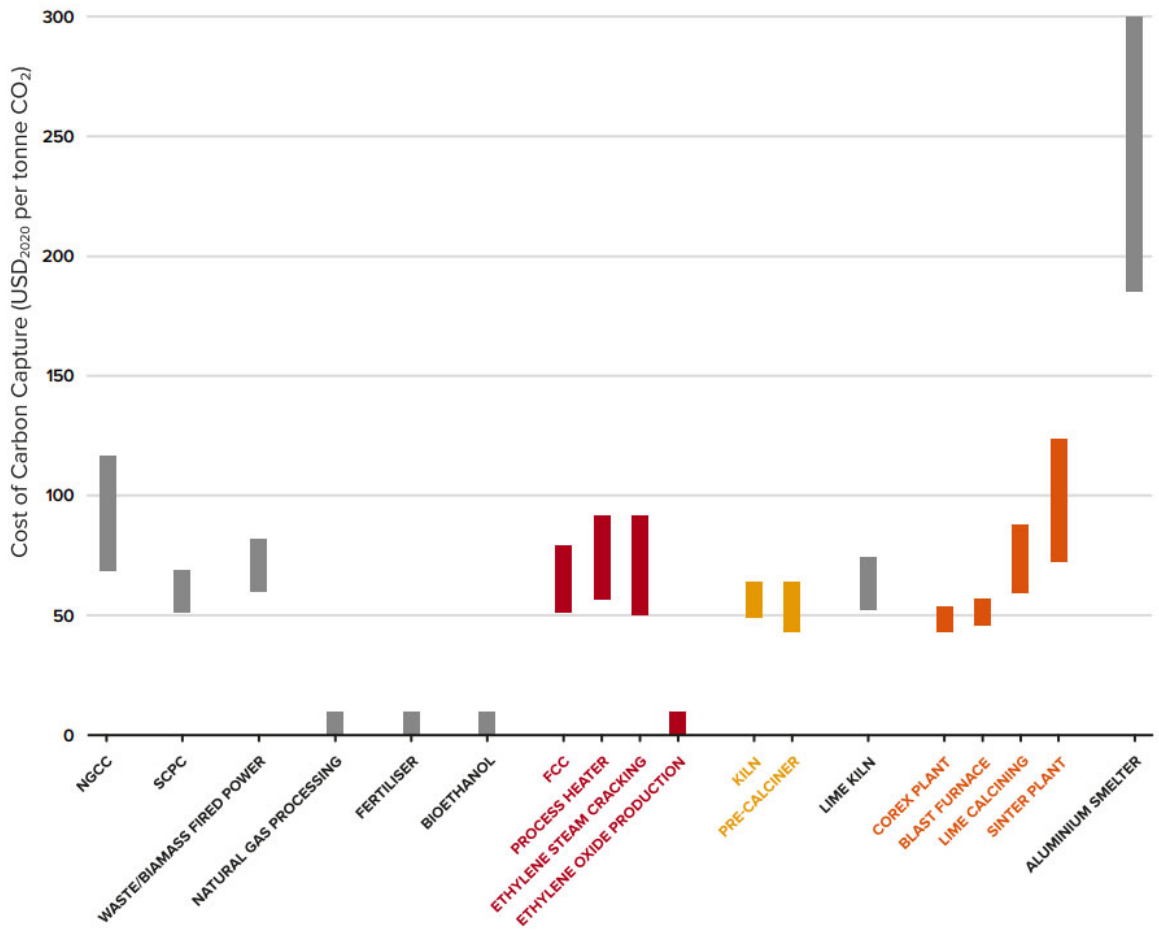
CCS cost components

Total CCS cost = Capture cost + Transport cost + Storage cost

Cost components	Tryfonas Pieri	ERIA	Bartosz Dziejarski
Capture cost	70% - 90%	73.1%	70% - 80%
Transport cost	N/A	1.5%	N/A
Storage cost	N/A	25.3%	N/A

Sources: Tryfonas Pieri (2021), ERIA (2021), Bartosz Dziejarski (2023).

Cost of carbon capture (1)

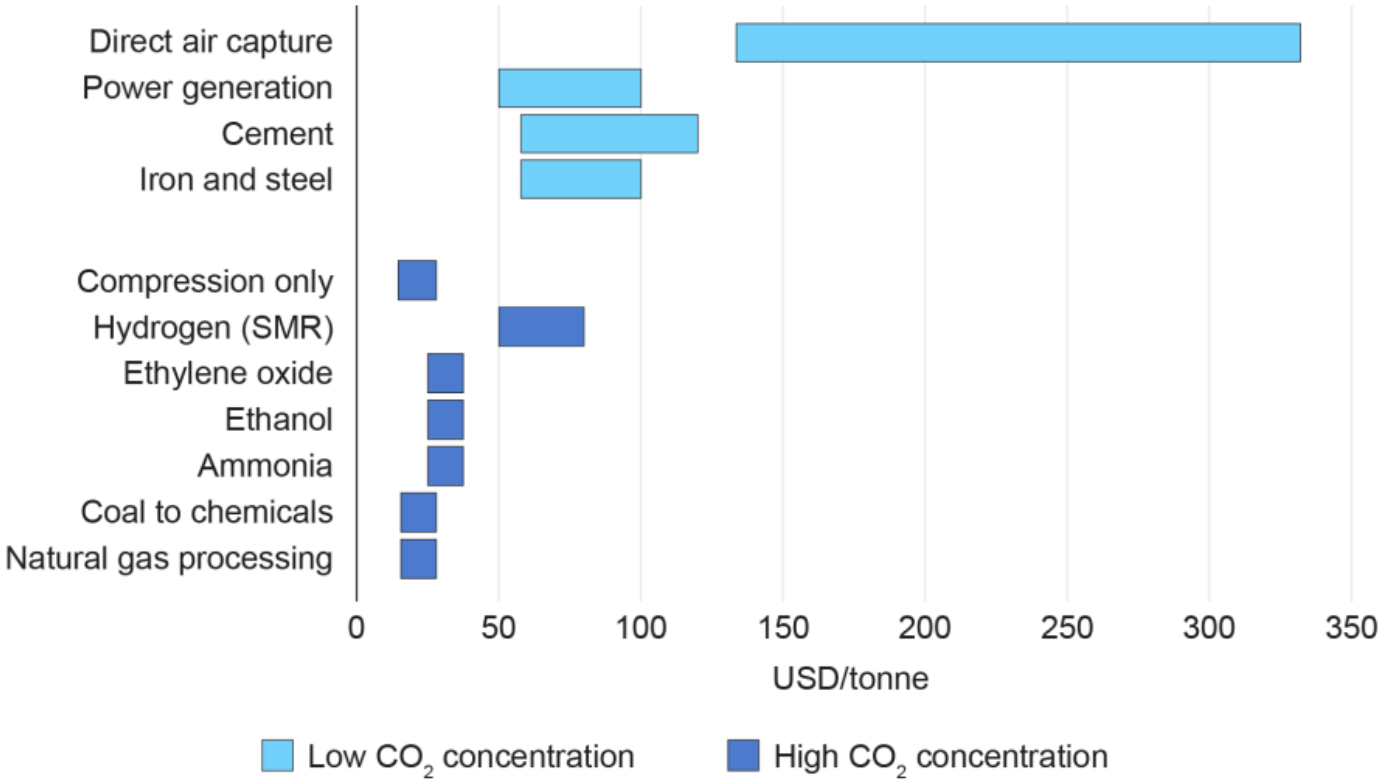


Sector	Categories	Cost, USD	
		Min	Max
Power	Natural gas combine cycle (NGCC)	68	116
	Supercritical pulverised coal (SCPC)	50	68
	Waste/biomass-fired power	59.5	81.5
Industry	Natural gas processing	0	8.9
	Fertiliser	0	8.9
	Bioethanol	0	8.9
	Fluid catalytic cracking	50	79
	Process heater	57	91.5
	Ethylene steam craking	50	91.5
	Ethylene oxide production	0	10
	Kiln	49.5	65
	Pre-calciner	42.5	65
	Lime kiln	52	75
	Corex plant	42.5	54
	Blast furnace	45.5	58
	Lime calcining	60	89
	Sinter plant	72.5	125
	Aluminum smelter	187.5	300

Sources: Global CCS Institute (2021)

Cost of carbon capture (2)

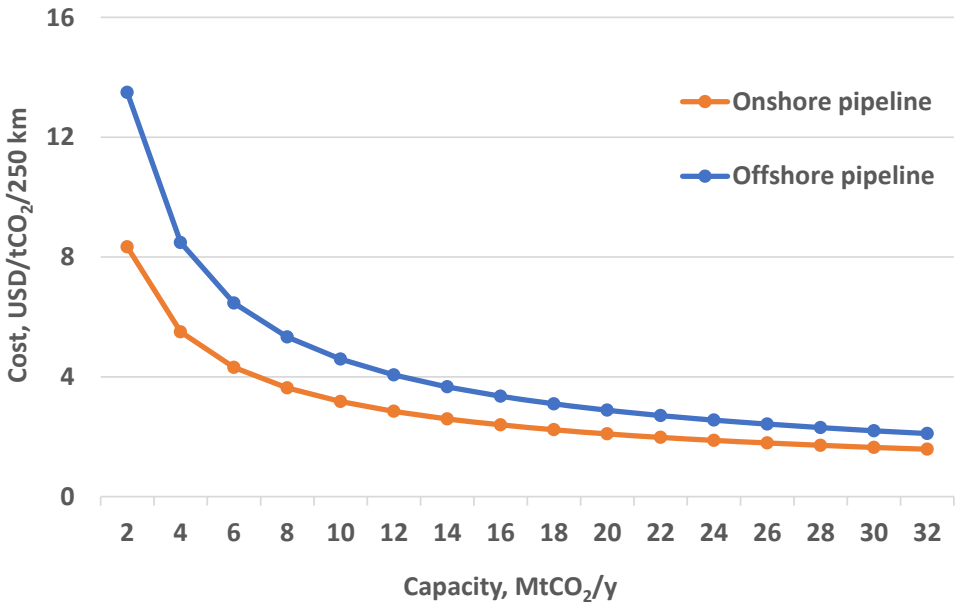
Levelised cost of CO_2 capture by sector and initial CO_2 concentration

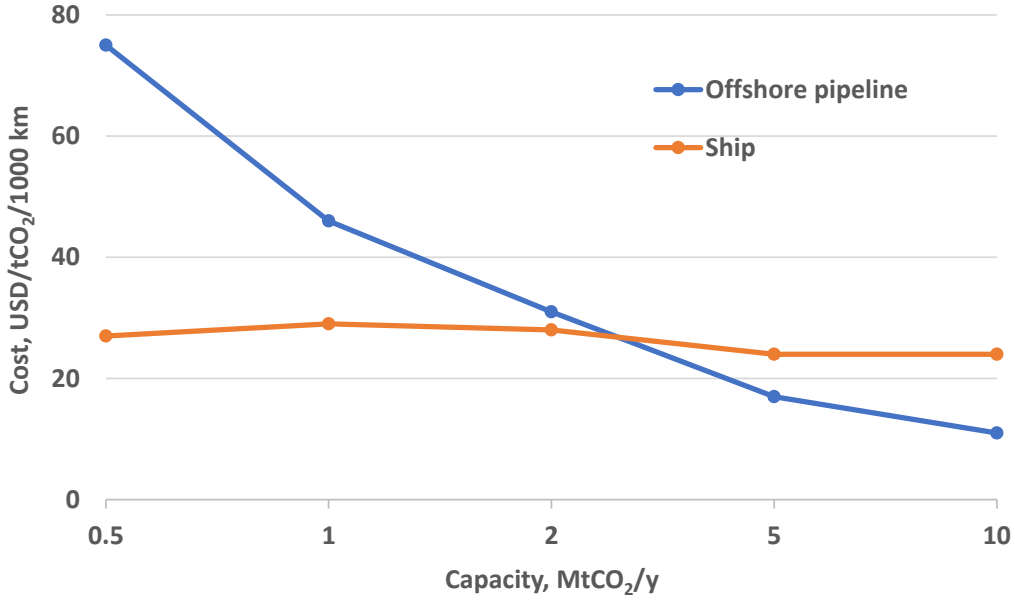


Sources: IEA (2020)

Cost of carbon transport

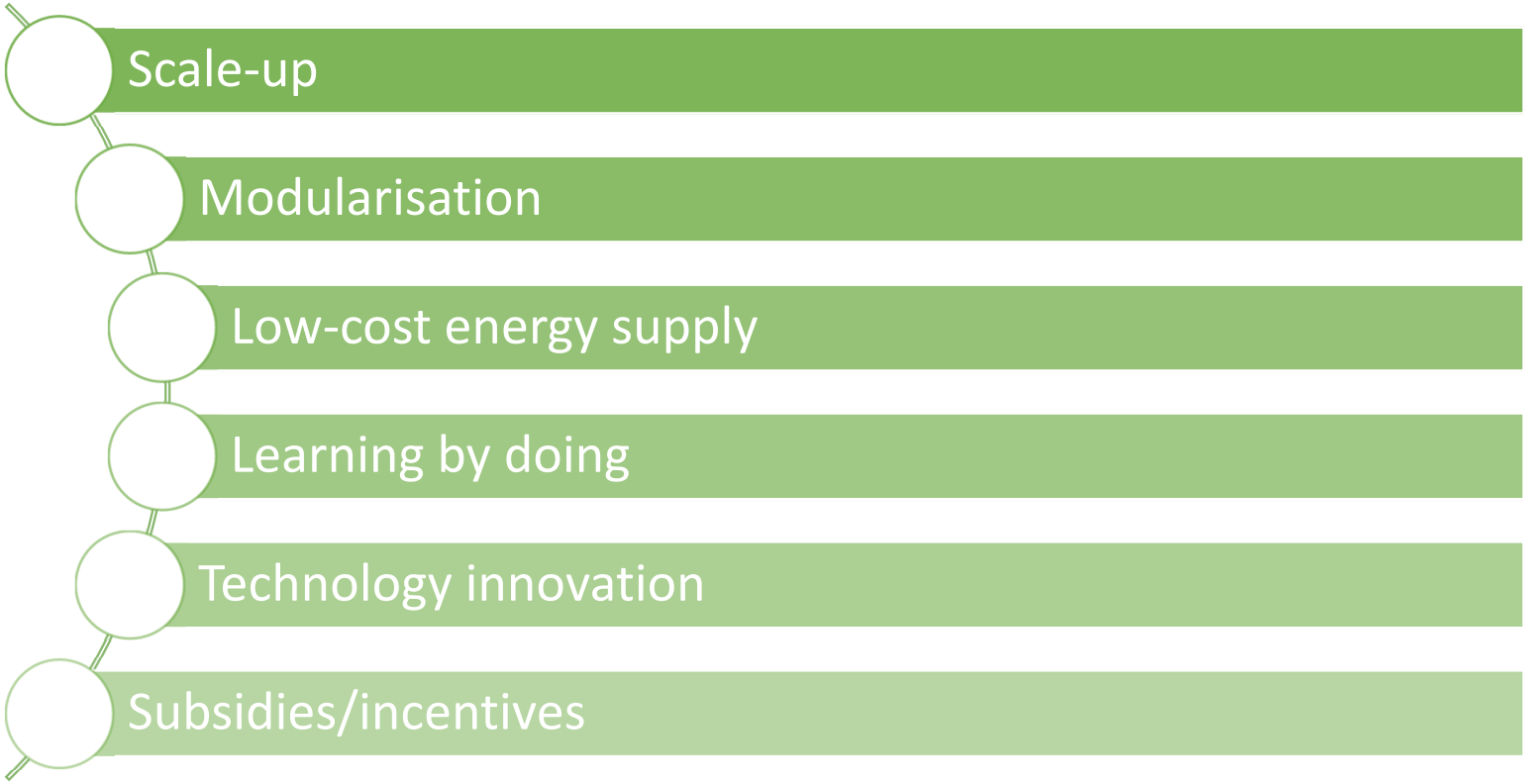
Cost of carbon transport by mode





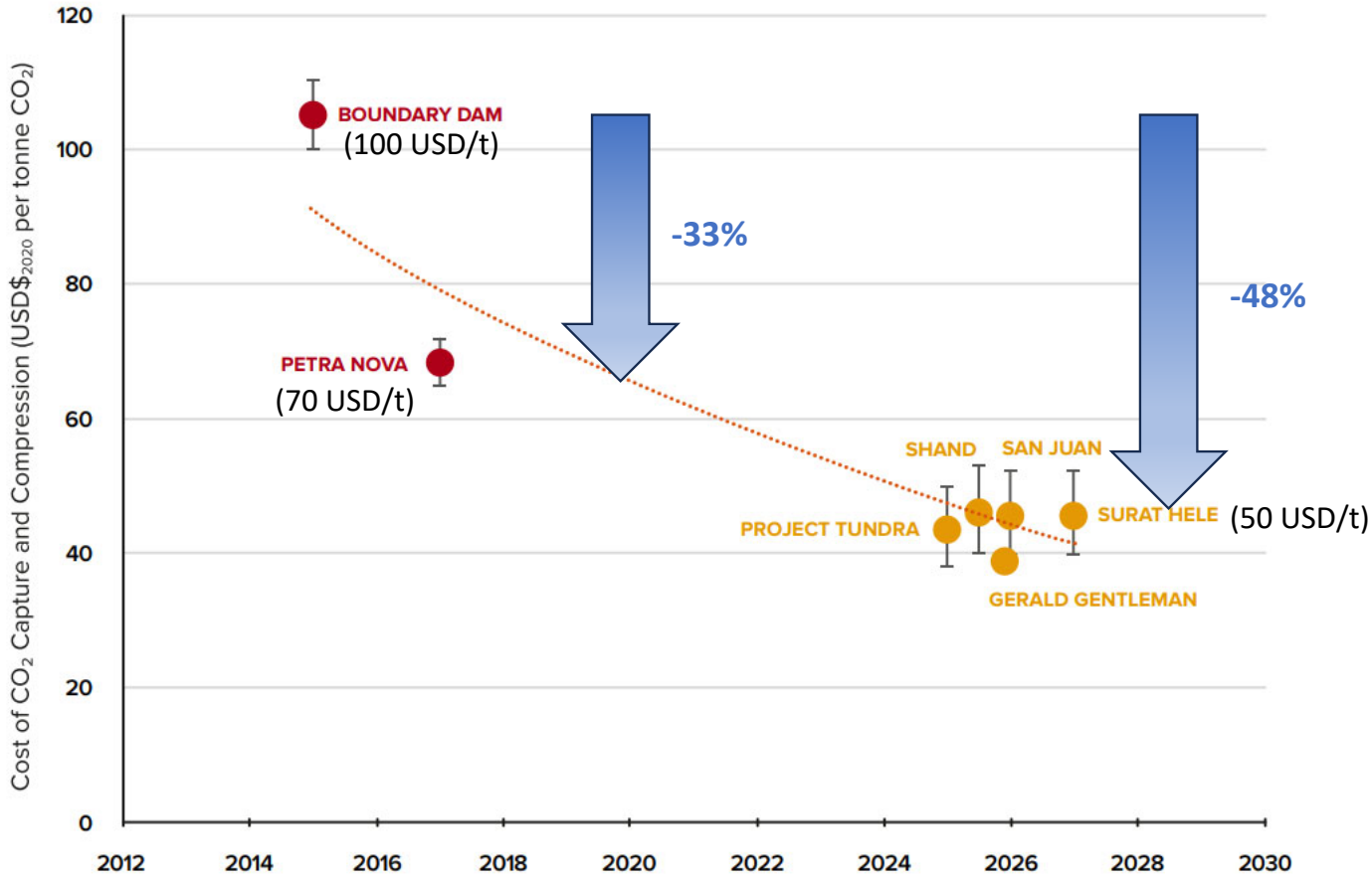
Sources: IEA (2020)

CCS cost reduction (1)



Sources: Global CCS Institute (2021)

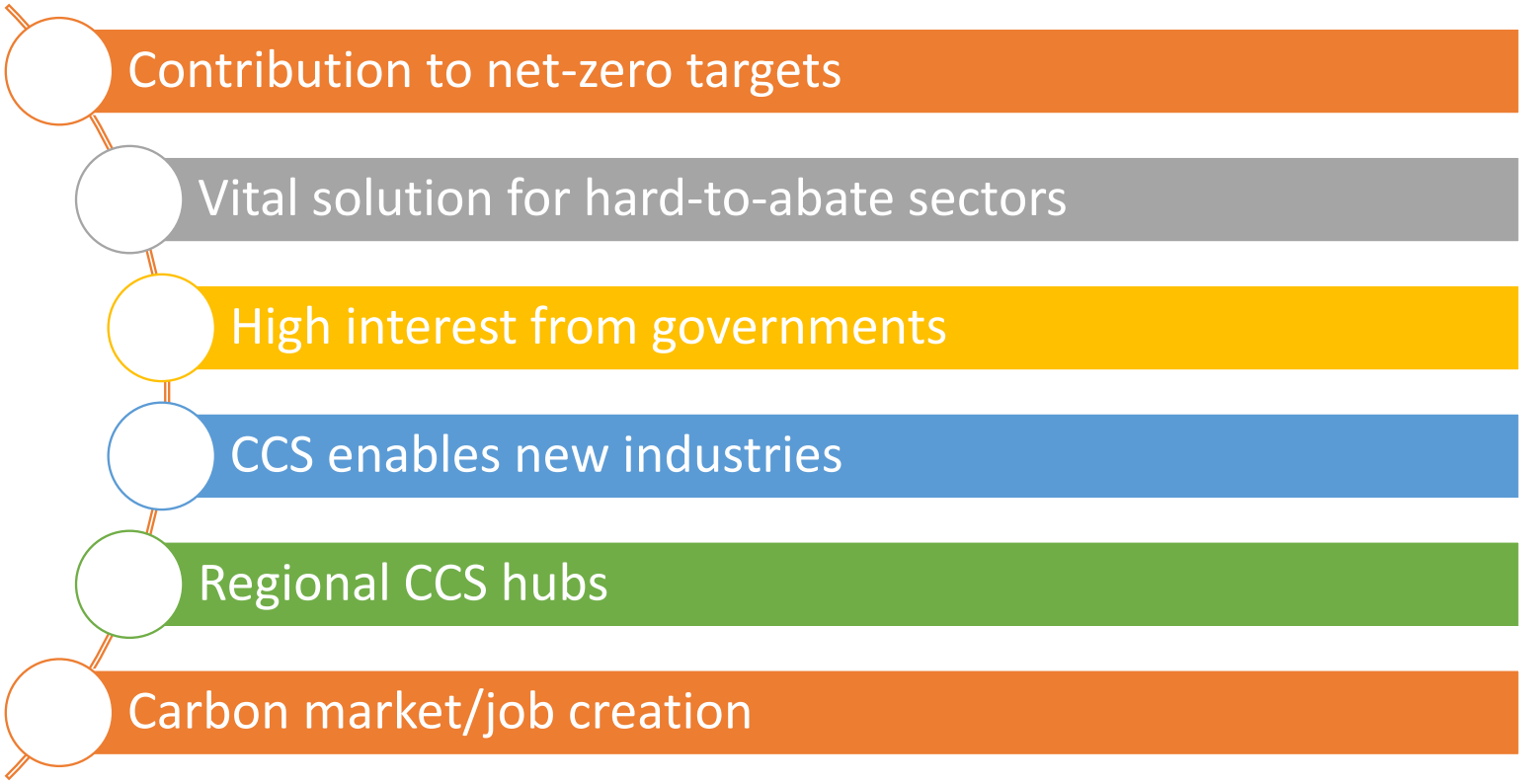
CCS cost reduction (2)



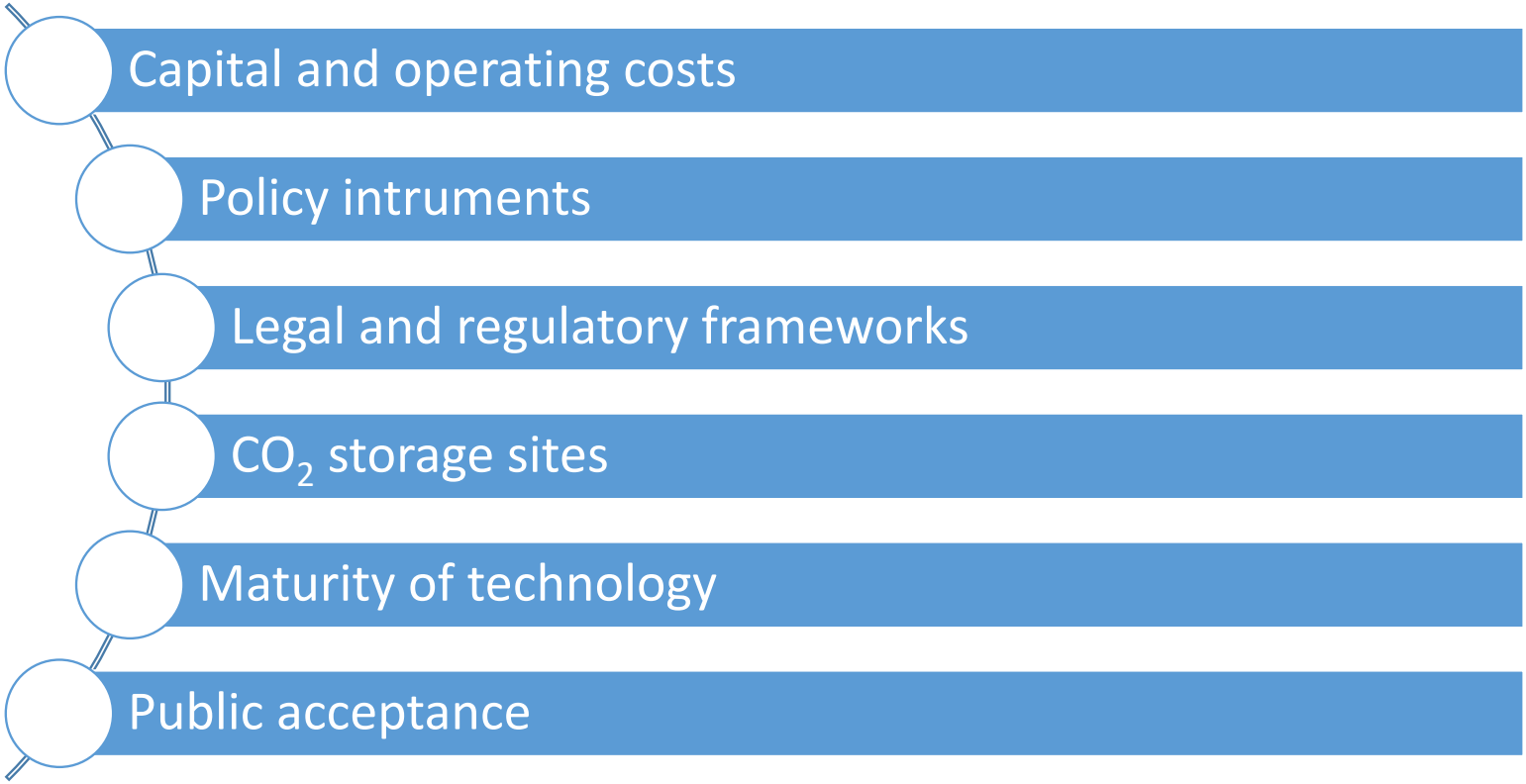
Sources: Global CCS Institute (2021)

OPPORTUNITIES AND CHALLENGES

Opportunities



Challenges


Capital and operating costs
Policy intruments
Legal and regulatory frameworks
CO_2 storage sites
Maturity of technology
Public acceptance

Thank you.

https://aperc.or.jp