MASDAR BEEAH tadweer group

Emirates Waste to Energy

Waste-to-Energy with CCUS
The Next Frontier

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Introduction

The increasing global population and rapid urbanization have escalated the generation of waste, posing significant environmental challenges.

In response, the adoption of sustainable waste management practices and the promotion of circular economy principles have gained momentum as effective strategies to mitigate environmental impacts and harness economic benefits.

Waste to Energy is and will continue to be part of the solution

Figure 3: Projections of global municipal solid waste generation per year in 2030, 2040 and 2050 if urgent action is not taken.

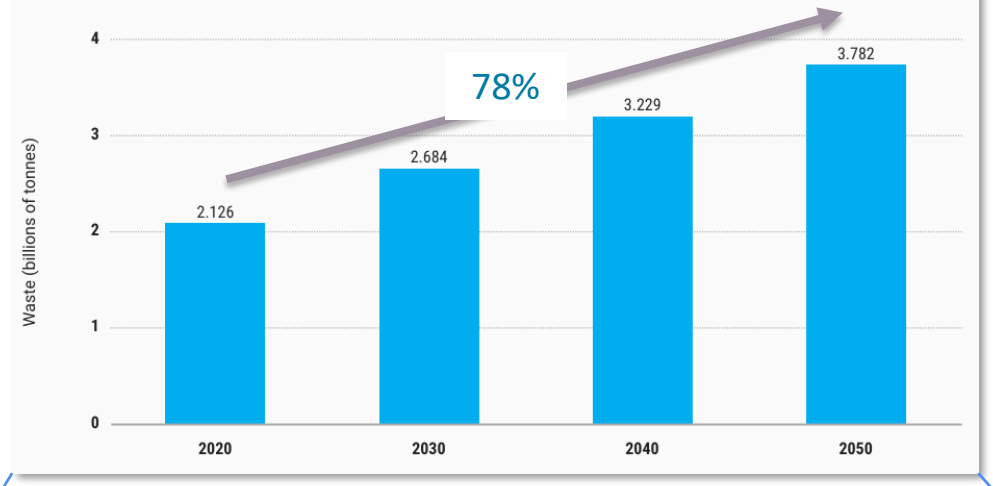
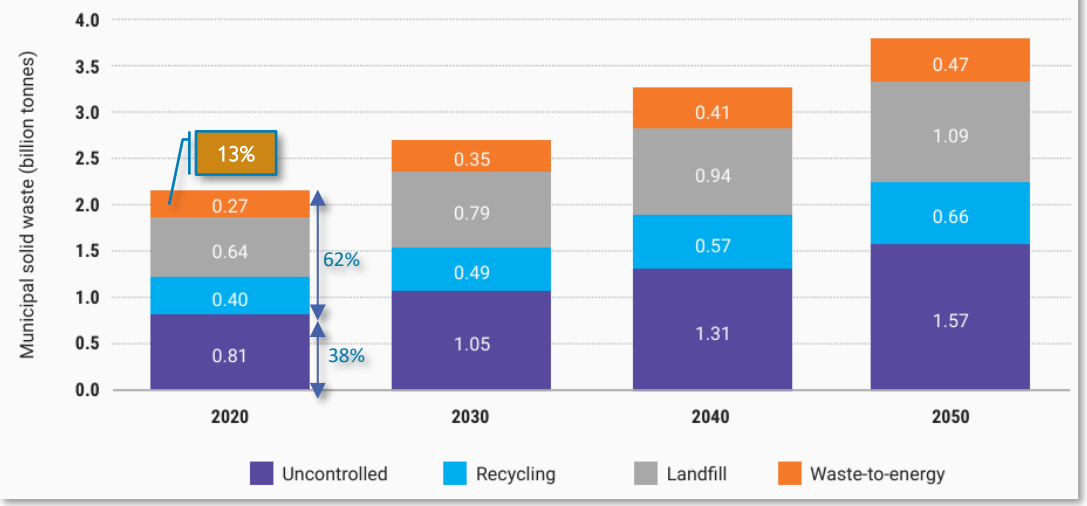
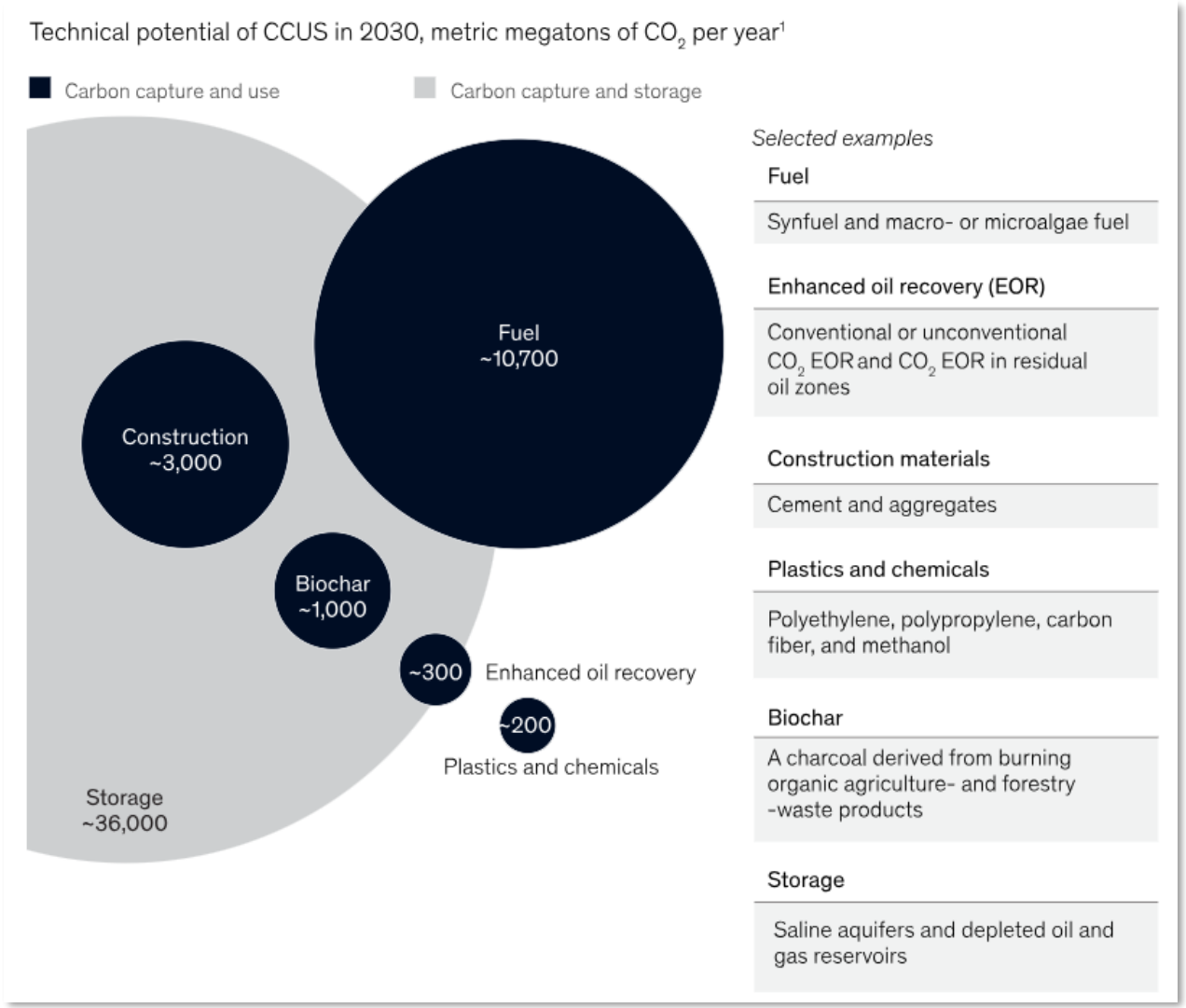


Figure 9: Projected global municipal solid waste destinations in 2030, 2040 and 2050 compared with 2020.



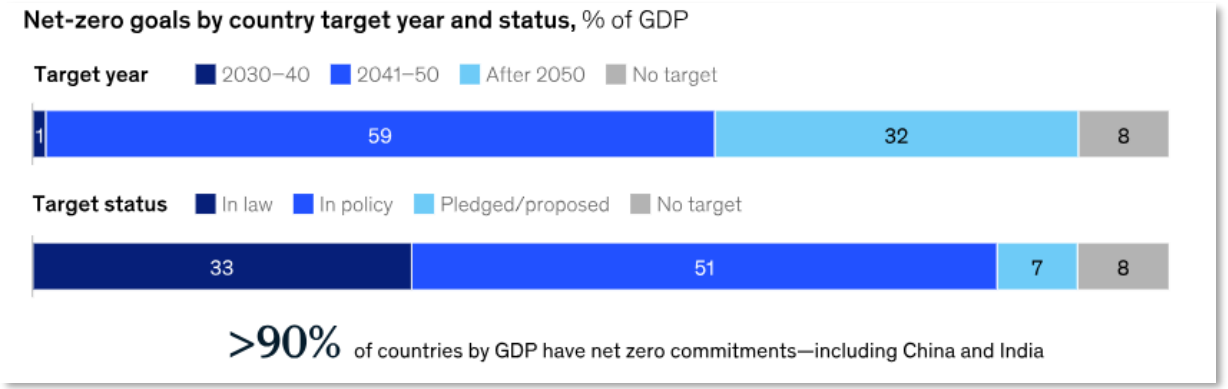
Source: UN Environmental Program, Global Waste Management Outlook 2024. As Usual scenario

CCUS Potential and the Political drivers

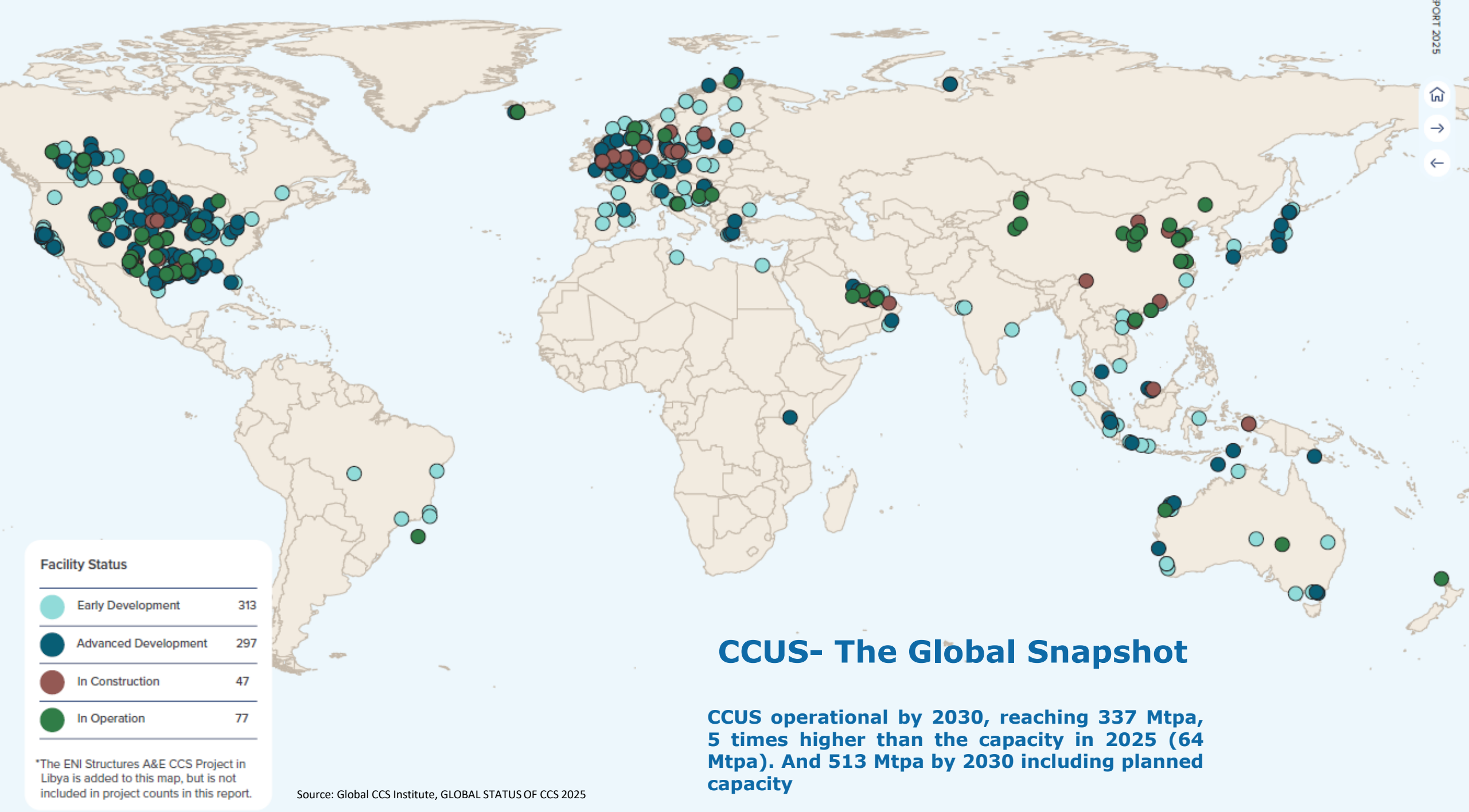


Source: McKinsey &Co, September 2020, Carbon capture, use, and storage could create significant 'negative emissions' by 2030

Accelerated deployment of decarbonization technologies will be needed to meet the rising number of net-zero targets



Source: McKinsey &Co, The energy transition: Where are we, really? August 27, 2024

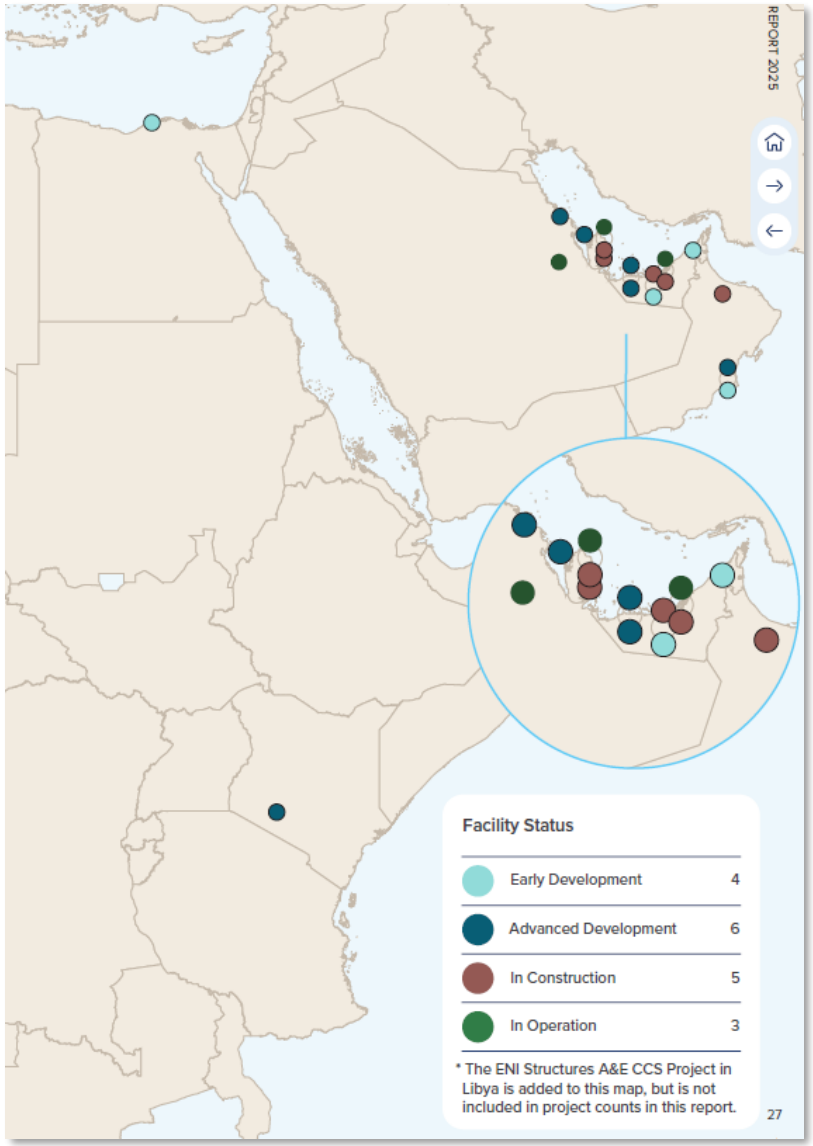


CCUS- The Global Snapshot

CCUS operational by 2030, reaching 337 Mtpa, 5 times higher than the capacity in 2025 (64 Mtpa). And 513 Mtpa by 2030 including planned capacity

Source: Global CCS Institute, GLOBAL STATUS OF CCS 2025

CCUS - The MEA Regional Snapshot



Source: Global CCS Institute, GLOBAL STATUS OF CCS 2025

Middle East and Africa significant progress over the past years , translating CCUS strategies into tangible projects, investments and policy frameworks. growing momentum towards decarbonisation

- **Focus** –prioritising CCUS hub development and integrated value chains for domestic decarbonisation and low-carbon exports. Embedding CCS into national strategies, enabling early deployment and exploring cross-border cooperation and international market access.
- **Drivers** – net zero targets, industrial decarbonisation mandates, and competitiveness under global carbon rules. Public policy shifts, growing private sector engagement, and partnerships with international players are accelerating investment and innovation.
- **Progress** – The first regional CCUS hub is emerging in Saudi Arabia; and legal frameworks are being established in the UAE and Oman. Kuwait, Nigeria, and South Africa are progressing on storage assessments, pilot projects, and core policy tools to support scale-up.
- **Challenges** – CCUS faces key challenges in MEA, including the absence of regulatory frameworks for transport and storage, high upfront costs and limited access to finance.

CCUS Projects in the GCC

Project name	Country or economy	Operation	Project Status	Announced capacity (Mt CO2/yr)	Sector	Fate of carbon
Emirates Steel Industries	United Arab Emirates	2016	Operational	0.8	Iron and steel	EOR
Habshan-Bab gas plant	United Arab Emirates	2026	Under construction	1.5	Natural gas processing/LNG	EOR
Shah gas plant (Abu Dhabi CCS Phase 2)	United Arab Emirates	2030	Planned	2.3	Natural gas processing/LNG	EOR
Aluminium Bahrain Mistubishi Heavy Industries capture	Bahrain		Planned		Other industry	Unknown/unspecified
Hail and Gasha CO2 Management	United Arab Emirates	2028	Under construction	1.5	Natural gas processing/LNG	Dedicated storage
Qatar LNG	Qatar	2019	Operational	1.23 - 2.1	Natural gas processing/LNG	Dedicated storage
Qatar North Field East Project CCS	Qatar	2025	Under construction	2.9 - 4.3	Natural gas processing/LNG	Dedicated storage
TA'ZIZ blue ammonia	United Arab Emirates	2030	Planned		Hydrogen or ammonia	Unknown/unspecified
Uthmaniyah CO2-EOR demonstration	Saudi Arabia	2015	Operational	0.8	Natural gas processing/LNG	EOR and use
MoU ADNOC ENEOS Mitsui Ruwais Industrial Area	United Arab Emirates		Planned	0.46	Chemicals	Unknown/unspecified
Jubail CCS Hub (*capture sources under evaluation)	Saudi Arabia	2027	Planned	9	T&S	Dedicated storage
Omifco ammonia capture	Oman		Planned		Hydrogen or ammonia	Unknown/unspecified
Mission Zero Technologies pilot 2	Oman	2026	Planned	0 - 0	DAC	Dedicated storage
Sharjah Hub	United Arab Emirates		Planned		T&S	Dedicated storage
Oxy/ADNOC UAE DAC	United Arab Emirates		Planned	1	DAC	Dedicated storage
ADNOC CO2 storage hub (Phase 2 of fertiglobe pilot)	United Arab Emirates	2030	Planned	5	Storage	Dedicated storage
Bapco MOL CCUS value chain	Bahrain		Planned		T&S	Dedicated storage
Rumah1 and Rumah 2 plants	Saudi Arabia		Planned		Power and heat	Unknown/unspecified
Nairyah1 and Nairyah 2 plants	Saudi Arabia		Planned		Power and heat	Unknown/unspecified
7 Blue Ammonia Facility	Qatar	2026	Under construction	1.5	Hydrogen or ammonia	Unknown/unspecified
Blue Horizon	Oman		Planned		Hydrogen or ammonia	Dedicated storage
GE Vernova FEED studies	Saudi Arabia		Planned		Power and heat	Unknown/unspecified
Aramco gas plants (3 facilities)	Saudi Arabia	2027	Planned	6	Natural gas processing/LNG	Dedicated storage
Linde H2 Plant Jubail	Saudi Arabia		Planned		Hydrogen or ammonia	Dedicated storage

Source: IEA (2025), CCUS Projects Database

~30/50 Mt CO2yr by 2030

Key CCUS Projects in GCC

SPONSORS	EMSTEEL / ADNOC / MASDAR	aramco	QatarEnergy	44.01	Emirates Waste to Energy / SNOC
PROJECT NAME	**Al Reyadah CCUS Project**	**Uthmaniyah CO_2-EOR Project**	**Qatar LNG CCUS Integration**	**Carbon Mineralization**	**Waste to Energy with CCS**
PURPOSE	Reduce UAE'S carbon footprint, enhance oil recovery	Enhance oil recovery in the Ghawar field, assess CO_2 sequestration	Reduce CO_2 emissions from LNG production facilities	Permanent sequestration through mineralization in peridotite rocks	Permanent sequestration in Sharjah depleted gas wells
OFFTAKER	ADNOC	SAUDI ARAMCO	Qatar Energy	PDO	SNOC
CO_2 CAPACITY	800,000 tones/year	800,000 tones/year	4.3 million tones/year	50-60 tones/day (scaling to 100 tones/day)	400,000 tones /year*
REVENUE STREAMS	Enhanced Oil Recovery (EOR), Carbon Credits	Enhanced Oil Recovery (EOR), Carbon Credits	Carbon Credits, Sustainability Credentials	Carbon Credits, Carbon Removal Services	Carbon Credits, Sustainability Credentials
OPERATIONAL DETAILS	CO_2 captured from Emsteel, transported via 43 km pipeline to ADNOC oil fields	CO_2 captured from natural gas processing, transported via 85 km pipeline to Uthmaniyah fields	CO_2 from LNG trains captured, compressed, and injected into wells integrated with 2.1 Mtpa CCS facility	Injection of CO_2 into peridotite rock formations for permanent mineralization	Injection of CO_2 into Sharjah depleted gas wells that has overall storage capacity of 300MT
CURRENT STATUS	Operational since 2016	Operational since 2015	2.1 Mtpa Operational since 2019	Scaling operations after securing $37 million in Series A funding in 2024	Pre-feasibility Study

** Amount calculated based on CO2 concentration in the average flue gas flow rate for a year, and considering 95% capture efficiency*

WtE with CCUS- The Sharjah Case

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Sharjah WTE could represent a candidate to contribute to the CO_2 reduction and permanent sequestration and be a Partner of the SNOC hub

The captured CO_2 from the Sharjah WtE plant would be transported it thru new pipeline and store the CO_2 into the Sajaa gas field owned by SNOC.

"During Carbon Capture MENA 2025, Masoud Al Hamadi, Executive Director of Upstream at Sharjah National Oil Corporation on the SNOC's unique CCS vision, which focuses on permanent CO_2 storage with the capacity to store 300 million tons of CO_2 in depleted gas fields"

Announced Waste to Energy projects with CCUS

Project name	Country or economy	Project type	Operation	Project Status	Announced capacity (Mt CO2/yr)
Suez Tees Valley / Haverton Hill Waste to Energy CCS	United Kingdom	Capture	2027	Planned	0.24
BIR Waste-to-Energy Bergen	Norway	Capture		Planned	0.1
KVA Linth Waste-to-Energy Niederurnen	Switzerland	Capture	2026	Planned	0.1
ARGO waste-to-energy plant	Denmark	Capture	2030	Planned	
Fortum waste solutions Nyborg	Denmark	Capture		Planned	0.17
Waste-to-energy Aker Carbon Capture (unknown facility)	France	Capture		Planned	0.2
Limeco Waste-to-Energy Dietikon	Switzerland	Capture		Planned	
Waste to energy CCU to TES Wilhemshaven (unknown facility)	Germany	CCU		Planned	0.4
Aker Carbon Capture waste to energy Northern Europe (unknown facility)	Unknown	Capture		Planned	
Capsol feasibility study waste to energy Germany	Germany	Capture		Planned	0.18
Waste to Energy CCS in Edmonton	Canada	Capture	2027	Cancelled	0.1
Mustasaari waste-to-energy plant	Finland	CCU		Planned	
Malarenergi waste to energy Vasteras	Sweden	Capture		Planned	0.4
European Energy/Brønderslev PtX (Biogas or waste incineration plants in Northern Jutland)	Denmark	CCU	2030	Planned	0.15
Waste to hydrogen Boson Energy (H2-BEAM)	Spain	Capture		Planned	
Waste to hydrogen Boson Energy (BEH2X DE)	Germany	Capture		Planned	
Waste to hydrogen Boson Energy (BEH2X LUX)	Luxembourg	Capture		Planned	
Koping - Waste-to-Hydrogen	Sweden	Capture		Planned	0.175
Idemitsu Biomass Waste to Hydrogen	Japan	Capture	2030	Planned	

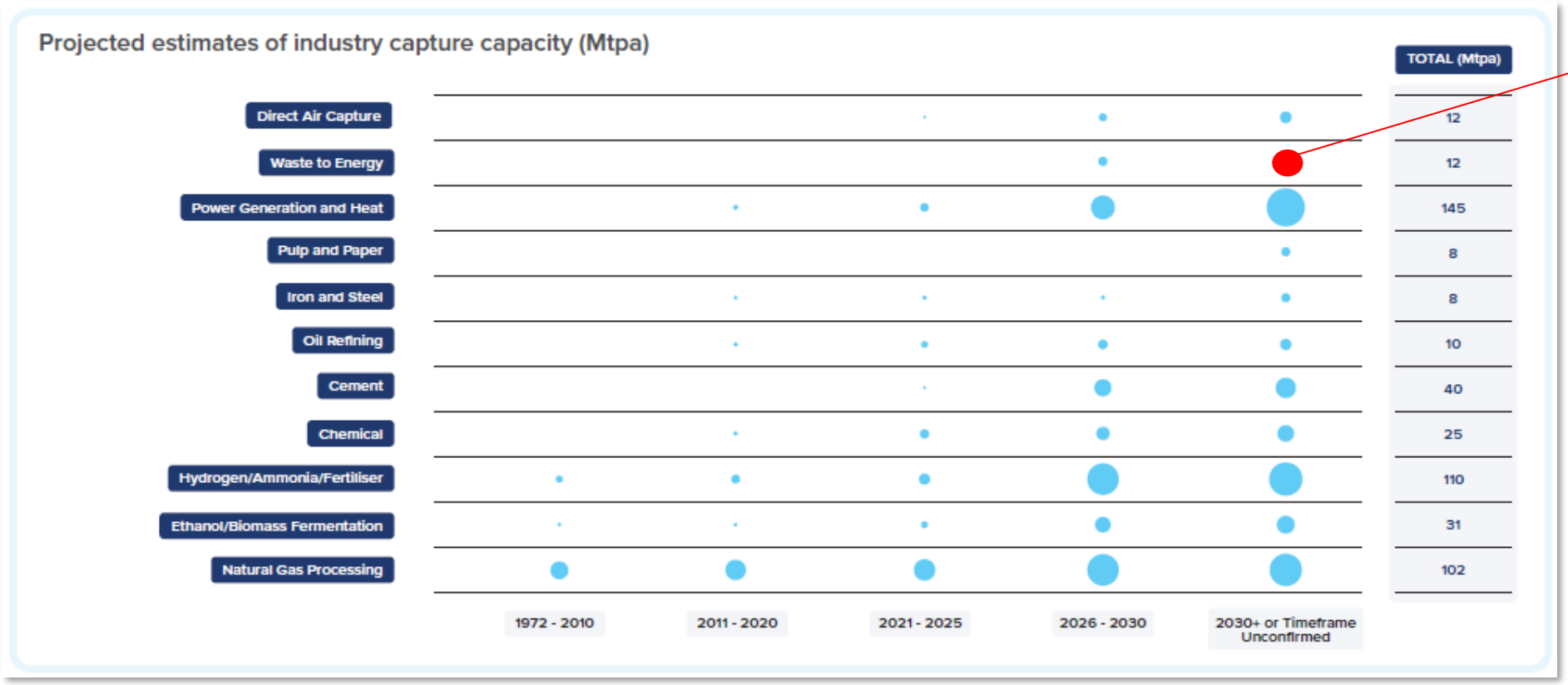
Source: IEA (2025), CCUS Projects Database

* Only CO2 captured at plant, do not include CO2 eq. avoided due to the diversion from landfill

~2/3 Mt CO2yr by 2030*

Why CCUS on Waste-to-Energy Plants is important

Integrating CCUS into WtE plants helps achieving net-zero emissions at a Global and Regional scale meanwhile contributing to the circular economy targets.

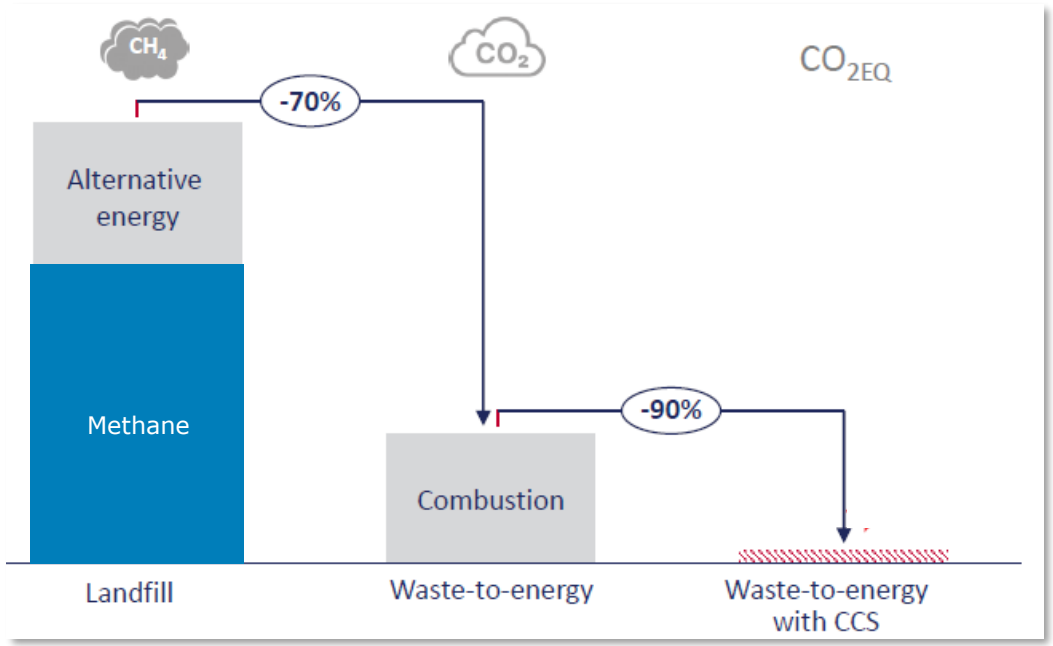


WtE with CCUS - A Pivotal Solution for Greenhouse Gas Mitigation

A Punctual Sink for CO2:
Unlike landfills, which release greenhouse gases over vast areas, WtE plants act as centralized, controlled points of CO2 potential Capture , significantly reducing the environmental impact.

A Step Toward Net-Zero Emissions:
WtE+CCUS, a transformative approach to waste management and energy production, enabling a shift toward a sustainable, circular economy.
WtE+CCUS mitigates climate change, supports global decarbonization goals turning non recyclable waste into resources.

Enhanced Carbon Capture Opportunities:
WtE create an ideal environment for implementing CCUS. Captured CO_2 can be repurposed for high-value applications such as eFuels, chemicals, and building materials, EOR, or stored permanently in geological formations



Waste-to-Energy a critical alternative to landfills, preventing the release of potent greenhouse gases like methane, which is 25 times more harmful than CO_2 in terms of global warming potential.

WtE with CCUS – The next frontier
Barriers to implementation

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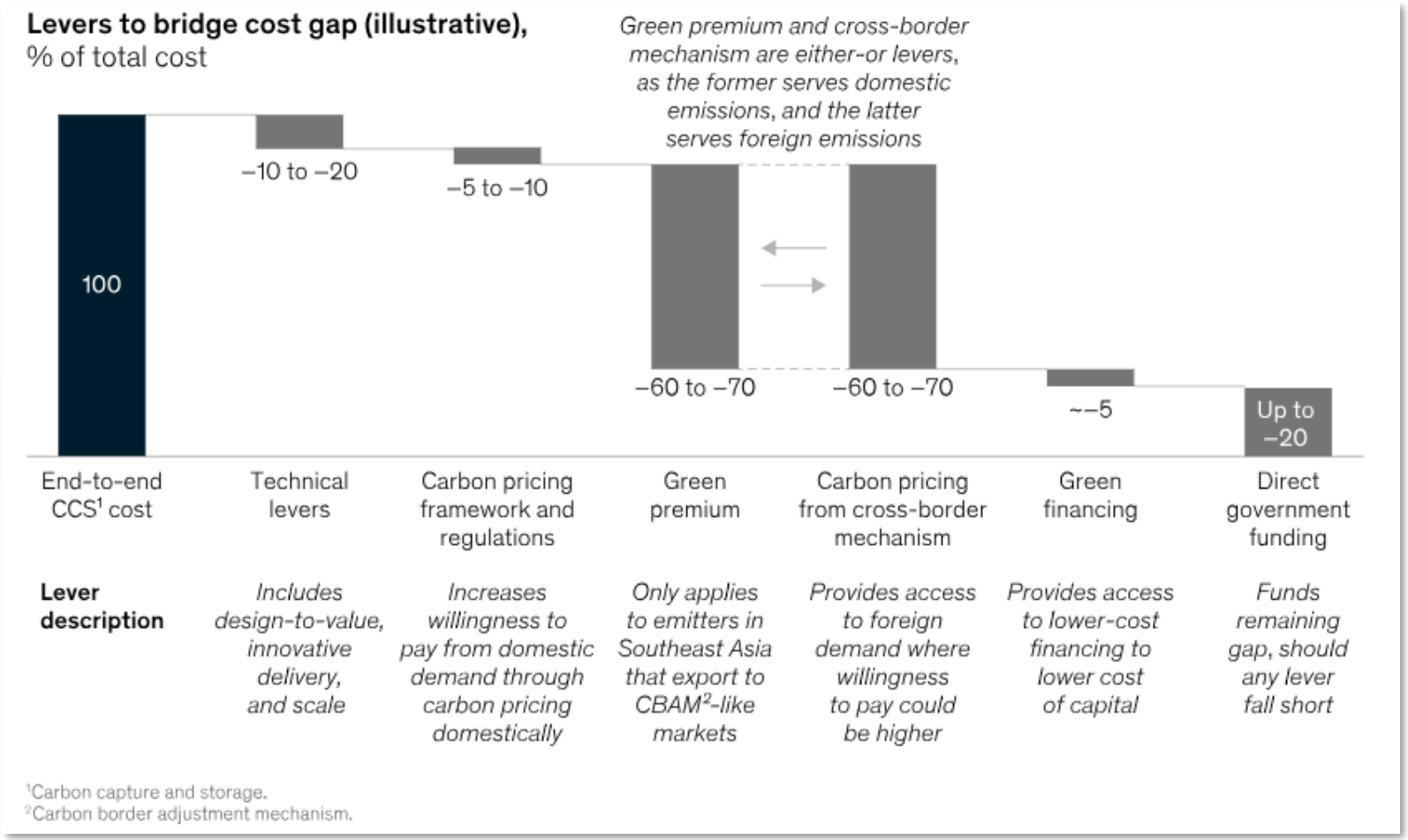
الإمارات لتحويل النفايات إلى طاقة

Bridge the gap between cost and willingness to pay



Source: McKinsey &Co, CCS in Southeast Asia: An opportunity or distant reality? February 2023

WtE with CCUS – The next frontier
Barriers to implementation

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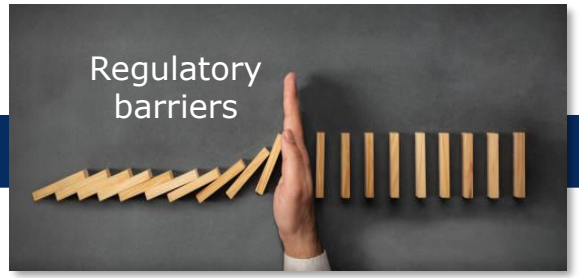
الإمارات لتحويل النفايات إلى طاقة

Waste to Energy



Waste to Energy with CCUS

Government pivotal role in the development of CCUS, by acting as the lead coordinator for the private sector

Regulatory frameworks especially for transport and storage in emerging Countries

Premium pricing for low-carbon products or definitive storage subsidies to reach net-zero country targets can make CCUS economically viable

Monetizing captured CO_2 through industrial applications (e.g., polymers, synthetic fuels) offsets capture costs

Negative-emissions credits can be monetized, with growing new demand for high-quality offsets: (data centres, etc.)

Combination of gate fees, energy prices and carbon credit pricing enabling attractive project economics

Technical/logical innovation: Efficiency in designing for the purpose: Heat Integration and optimization, Improve Gross electricity efficiency,…

Strategically position the WtE Plant: CO2 hub

Design Capture ready WtE Projects

Tax credits, subsidies, and product standards are driving adoption in Europe and North America

Hub models: coordinated efforts to build CO_2 pipeline and storage networks to overcome safety concerns and reduce costs

Conclusion and Key considerations

WtE with CCUS represent the next frontier as one of the pillar for a more sustainable Circular Economy and an asset for climate change mitigation

Challenges and Opportunities need to be tackled with a cohesive stakeholders approach

Let’s make it happen and move from plans to progress!

Thank You