ARTICLE

# Carbon capture, utilisation and storage in the GCC

## An opportunity for the region to achieve decarbonization targets and lead by example

Roland Berger

# Contents

# 1 CCUS: A crucial building block for net zero

To keep global warming to no more than 1.5°C by 2100 – under the Paris Agreement – emissions need to be reduced by approximately 45% by 2030 (vs. 2010 levels)[1] and reach net zero by 2050.

Together with renewable energy and clean fuels, CCUS (carbon capture, utilization, and storage) technologies will play a major role on the path towards global decarbonization. CCUS is the only piece of the energy transition puzzle that meaningfully addresses emissions of difficult and slow to decarbonize industries and captures unavoidable and previously released emissions, both of which are crucial elements of achieving net zero objectives on time.

Currently, global CCUS capacity is about 45 $MtCO_2$/p.a.[2], which is around 0.1% of the annual emissions from the energy and industrial sectors [total $CO_2$ emissions being 37.12 Gt]. In the past three years, momentum has picked up significantly, with over 300 CCUS initiatives announced globally to date, with the ambition to sequester some 300 $MtCO_2$/p.a., equating to approximately 7 times the current capacity being captured by 2030.

However, to fulfill the Paris Agreement and achieve net zero, CCUS rollout needs to be 28 times higher than current capacity by 2030 and 145 times higher by 2050 and reach over 6,200 $MtCO_2$/p.a.[2]. ▶ A

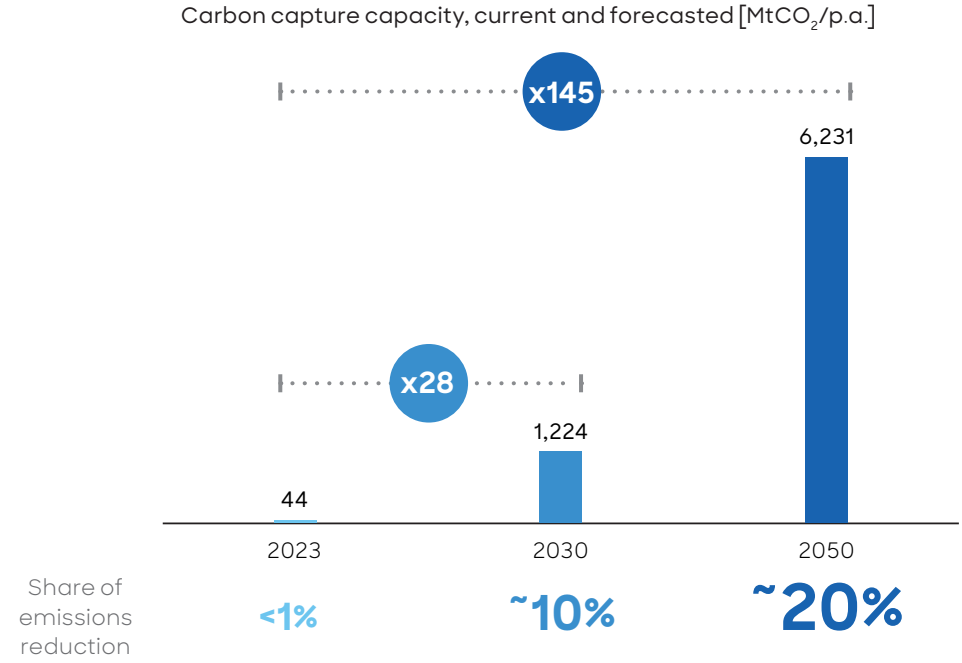
In a net zero scenario by 2050, CCUS would account for one tenth of global emissions reductions by 2030 and up to one fifth by 2050:

- 40% of capture is expected to come from industrial processes,
- 20% from the power sector (mostly for coal-fired plants),
- 30% from fuel production (e.g. hydrogen, biofuels, and oil refining).

1 Source: United Nations Climate Action

2 Source: EIA

**A Global Carbon Capture required to meet Net Zero Emissions**




Source: Roland Berger

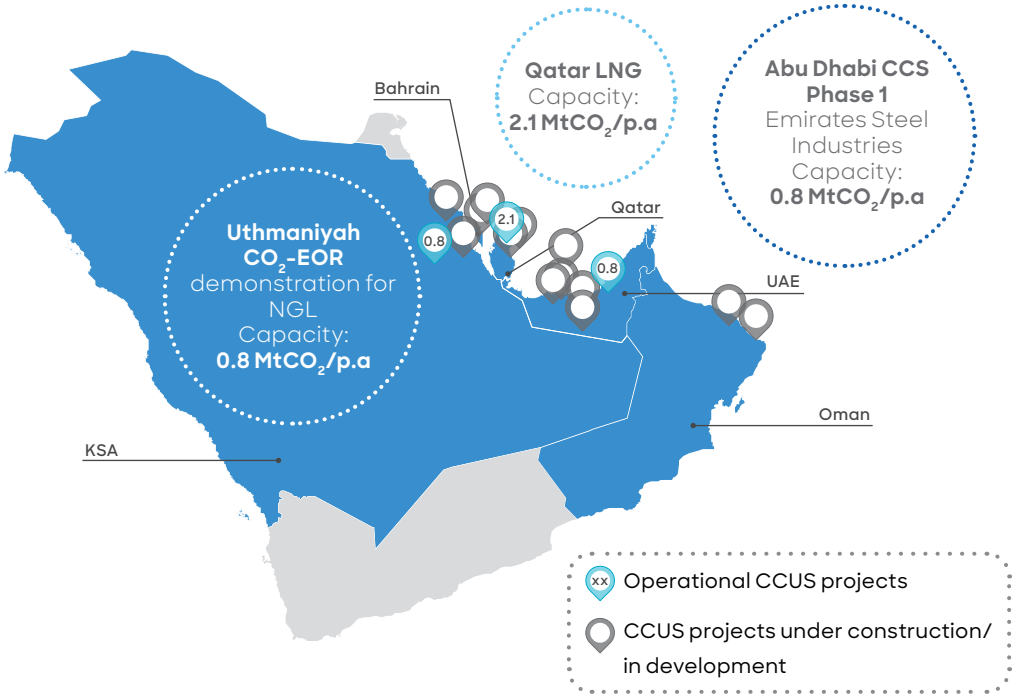
# 2 GCC's strong foundation in CCUS

The GCC has a head start in CCUS, with a current carbon capture capacity of 3.7 $MtCO_2$/p.a., accounting for about 8% of known global capacity and hosting three CCS facilities in Saudi Arabia, UAE, and Qatar in the natural gas and steel industries, with the use of carbon focused on enhanced oil recovery (EOR):

- **Saudi Arabia:** Uthmaniyah $CO_2$-EOR facility has an annual capacity of 0.8 $MtCO_2$/p.a., and since 2015 it has been processing and dehydrating $CO_2$ from a natural gas liquids recovery plant, which is subsequently utilized in the Ghawar oil field for EOR.
- **United Arab Emirates:** Abu Dhabi CCS, the world's first commercial facility in the iron and steel industry, has been active since 2016, capturing up to 0.8 $MtCO_2$/p.a., which is then transported to ADNOC for EOR.
- **Qatar:** Ras Laffan LNG production facility has been sequestering and storing $CO_2$ since 2019 with a capacity of 2.1 $MtCO_2$/p.a.

The GCC continues to power ahead, with 13 new projects expected to become operational in the second part of the decade in Saudi Arabia, UAE, Qatar, as well as in Oman and Bahrain, a first for the two countries. Efforts are focused on key regional strengths – the capture of emissions from natural gas and hydrogen/derivatives production, and the capture of emissions from heavy industries (e.g. steel, aluminum). New projects range in capacity from about 2 $MtCO_2$/p.a. for capture to around 9 $MtCO_2$/p.a. for transportation and storage, and are concentrated in key emitting locations (e.g. Abu Dhabi's industrial areas and KSA's Eastern Province) and in proximity to $CO_2$ demand (i.e. oil fields for EOR), laying the foundations for the creation of regional CCUS hubs. ▶ **B**

## B CCUS facilities in the GCC




Source: Roland Berger

# 3 GCC's vision for decarbonization with CCUS as key pillar

As the region progresses towards decarbonization and countries announce their pledges (UAE and Oman are targeting net zero by 2050, while Saudi Arabia, Bahrain, and Kuwait target net zero by 2060 and Qatar has committed to emissions reductions of 25% by 2030), CCUS is expected to play a key role in reducing the emissions of industrial and hard to abate sectors. ▶ C

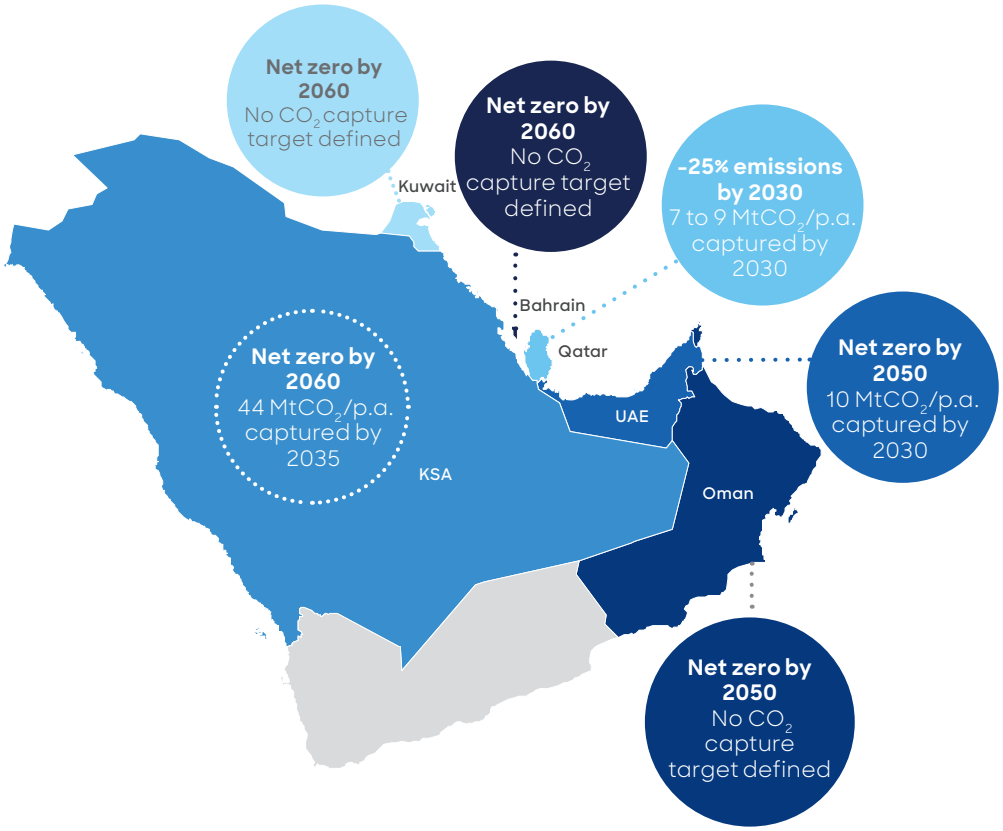
GCC countries and their National Oil Companies (NOCs) have already taken the lead in defining specific CCUS targets, reflecting a growing regional commitment to CCUS in the overall effort to reduce carbon emissions and combat climate change:

- UAE's NOC plans to grow its carbon capture capacity to 10 $MtCO_2$/p.a. by 2030,
- Saudi Arabia is aiming to reach a carbon capture capacity of 44 $MtCO_2$/p.a. by 2035,
- Qatar's NOC targets the capture and sequestration of 7 to 9 $MtCO_2$/p.a. by 2030.

The combined announced target capacity of UAE, KSA, and Qatar amounts to almost 65 $MtCO_2$/p.a. by 2030–2035. Announced projects to date have a combined capacity of around 11 $MtCO_2$/p.a. by 2030, leaving about 55 Mt p.a. of capture capacity by 2035 to be announced in order to meet the targets.

Oman, Kuwait, and Bahrain also hold substantial potential for deploying CCUS at scale, with targets expected to be announced in the very near future. Beyond the announced targets, the potential to develop CCUS in the GCC could be significantly greater.

## C Decarbonization ambitions and CCUS targets in the GCC




Source: Roland Berger

# 4 GCC's opportunity in CCUS

At present, the GCC countries collectively emit about 1,400 $MtCO_2/p.a$[3]. Three sectors are the main contributors of emitted $CO_2$, accounting for roughly 80% of the total annual emissions: ▶ D

- Power is responsible for 34% of $CO_2$ emitted,
- Industrial processes (e.g. aluminum, steel, cement, chemicals) account for 25%,
- Fuel operations (production and refining) represent 22% of $CO_2$ emissions.

**Fossil-fuel-based power plants** in the GCC are predominantly CCGTs, and while oil power generation remains present in KSA it is expected to transition to gas in the mid term. Although globally the introduction of CCUS in fossil fuel power plants is primarily for coal power plant retrofits until 2030, new CCGT plants built with integrated carbon capture and retrofits with CCUS are also expected to pick up in the 2030-2050 period as CCUS costs go down and the cost of carbon goes up[4]. In fact, it was announced in early 2023 that all new thermal power plants built in the Kingdom of Saudi Arabia will be mandated to add capabilities for carbon capture[5].

**For GCC heavy industries**, prominent ones being steel and cement among others, CCUS is expected to play a key role, being in some cases the only viable solution for decarbonization. CCUS can be directly integrated into production facilities to capture $CO_2$ emissions from industrial processes and energy-related activities. This can be accomplished by retrofitting existing plants as well as building new ones with embedded capture capabilities.

Three prominent industrial segments in the GCC are significant $CO_2$ emitters: cement, steel, and aluminum production. With the building and infrastructure sector, the main end user of these products, forecasted to continue its rapid growth in the region throughout this decade and beyond, emissions incurred to manufacture these products are expected to follow a growth trajectory.

- **In cement manufacturing**, most $CO_2$ emissions are a byproduct of the process, and these emissions would persist even if it were to be electrified or powered with bioenergy, making CCUS a must to decarbonize the sector. In a net zero scenario by 2050, CCUS technologies are expected to account for over 35% of emissions reductions in the cement sector[6].
- **In steel manufacturing,** approximately 70% of emissions are emitted during the production itself (due to carbon being used as a reduction agent and production being thermal-energy intensive), while 30% happen during the mining of iron ore and coal[7]. CCUS and fuel shifts (from coal to natural gas, hydrogen, and bioenergy) are expected to play the biggest role in reducing the sector's emissions: CCUS alone are expected to account for some 20% of emissions reductions in a net zero scenario by 2050[8].
- **In the case of aluminum**, direct emissions from the use of thermal energy and process emissions account for about 30% of total $CO_2$ production emissions, while electricity use accounts for over 60% of the total. Switching to clean energy (electricity and heat) and processes (e.g. the use of non-carbon anodes) will be key to the sector's decarbonization. One of the most prominent aluminum smelters in the GCC is exploring the use of CCUS in their operations to capture $CO_2$ from flue gas.

3 Source: Climate Trace

4 Source: IEA

5 Source: Saudi Gazette: Saudi Arabia will not build any future power generation without carbon capture

6 Source: Global Cement and Concrete Association

7 Source: Carbon Chain

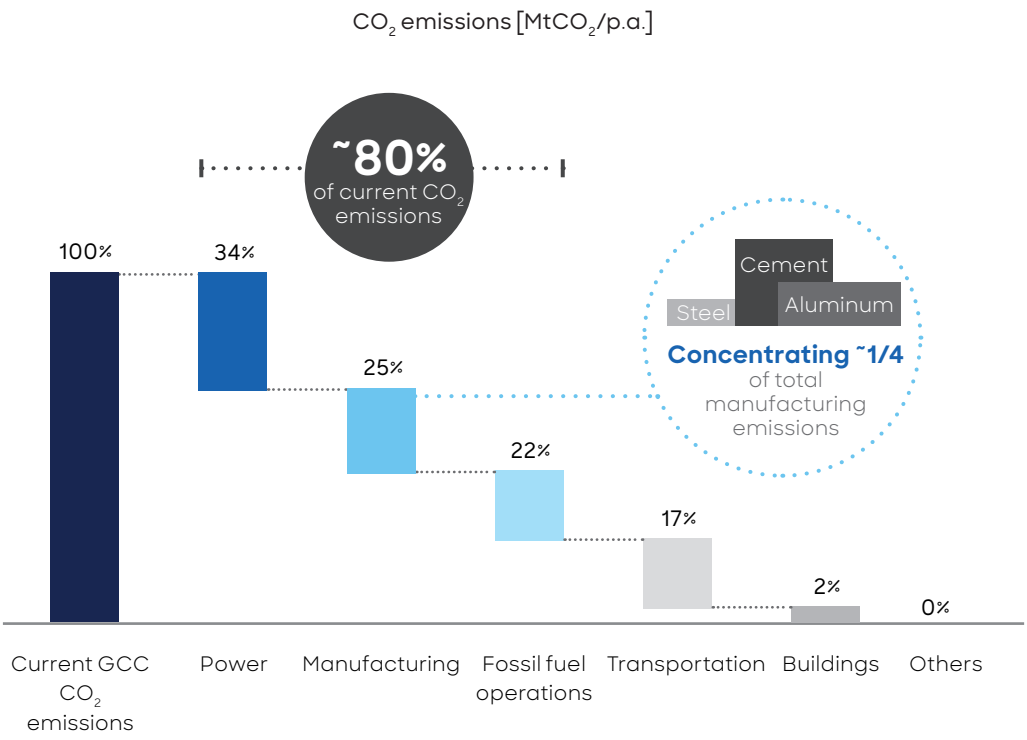
8 Source: WEF, Making Net-Zero Steel Possible

The oil and gas sector has been one of the pioneers in embracing carbon capture and storage since the 1970s with a focus on enhanced oil recovery (EOR). In natural gas processing, highly concentrated streams of $CO_2$ are produced, which can be transported and stored easily; this is one of the easiest and most cost-effective applications of CCS. CCUS is also applied in oil refining, including steam methane reformers, catalytic crackers and combined heat and power (CHP) units.

In addition, CCUS is expected to play a central role in the production of low-carbon fuels such as blue hydrogen. CCUS will be required for the expected rapid scaling of low-carbon hydrogen production to cater to existing and future needs across the transportation, industrial, and building sectors, as the GCC aims to be a global exporter of this energy vector.

Overall, key sources of emissions in the GCC are good candidates for CCUS as a key solution to decarbonize the sectors, which can be combined with process improvements, electrification, and fuel switching to lead the way to net zero.

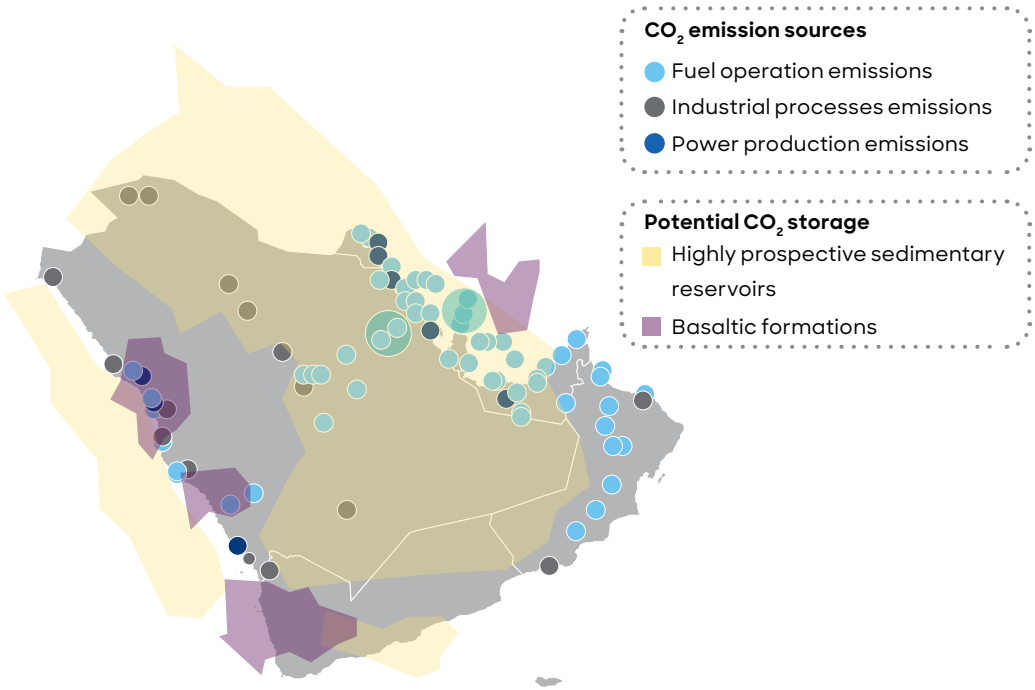
## D Current $CO_2$ emissions in the GCC




Source: Roland Berger

Finally, major $CO_2$ emissions sources in the GCC are geographically concentrated (mostly along the Gulf coast of Saudi Arabia, Qatar, and UAE) and are in close proximity to potential geological storage in depleted oil and gas reservoirs and saline aquifers. This presents the opportunity to adopt a hub approach to the development of CCUS in the region, enabling stakeholders to build scale, share infrastructure (e.g. for transportation and storage), and build ecosystems around the carbon economy. ▶ E

**E** **Location of $CO_2$ emissions in the GCC and potential $CO_2$ storage in the GCC**




Source: Climate Trace, Roland Berger

5

## Roadmap towards acceleration of CCUS deployment

The time is now for GCC governments and industries to take a first mover advantage regionally and globally. With immense potential to deploy CCUS at scale as a crucial decarbonization solution for the region and first steps already taken in this direction, GCC countries could accelerate CCUS deployment and be positioned as global front-runners:

- In the short term, pursue the announced CCUS targets by deploying actionable initiatives, as a significant portion of capture targets for 2030-2035 are yet to be claimed.
- In the mid term, establish strong local expertise, invest in R&D to support the technology's advancement and harness the sector's value at a local level by scaling up efforts to establish a robust knowledge base while promoting industrial growth and job creation.
- In the long term, become not just a major user of CCUS technology but also a key contributor to its development and export knowledge and technology to other nations to support global progress towards net zero emissions.

However, governments need to ensure that key regulatory, financial, and infrastructure enablers are in place to accelerate CCUS development and adoption in the region. These include defined CCUS strategies, policies, and roadmaps at the country level, with clear targets to ensure commitment and support the net zero ambitions. It is also important to strengthen local carbon regulation with a clear and effective price for carbon. Finally, clear, ambitious, and realistic CCUS cluster masterplans will facilitate private adoption to enable infrastructure sharing and optimal development on a regional scale.

## AUTHORS

**Vatche Kourkejian**
Senior Partner & Head of Energy, Roland Berger Middle East
vatche.kourkejian@rolandberger.com

**David Frans**
Senior Partner & Global Head of CCUS, Roland Berger Germany
david.frans@rolandberger.com

**Chris Petrov**
Principal, Roland Berger Middle East
chris.petrov@rolandberger.com

**Celia Garcia Oliver**
Senior Consultant, Roland Berger Middle East
celia.garciaoliver@rolandberger.com

## FURTHER CONTACTS

**Alex Xu**
Senior Partner, Roland Berger China
alex.xu@rolandberger.com

**Dan Gabaldon**
Senior Partner, Roland Berger USA
dan.gabaldon@rolandberger.com

**Emmanuel Fages**
Senior Partner, Roland Berger France
emmanuel.fages@rolandberger.com

**Hani Tohme**
Senior Partner & Managing Director, Roland Berger Middle East
hani.tohme@rolandberger.com

**Arindam Das**
Principal, Roland Berger UK
arindam.das@rolandberger.com

**Ben Lowe**
Principal, Roland Berger USA
ben.lowe@rolandberger.com

**Clement Audouin**
Principal, Roland Berger France
clement.audouin@rolandberger.com



11.2023

**ROLANDBERGER.COM**

**ROLAND BERGER** is the only management consultancy of European heritage with a strong international footprint. As an independent firm, solely owned by our Partners, we operate 51 offices in all major markets. Our 3000 employees offer a unique combination of an analytical approach and an empathic attitude. Driven by our values of entrepreneurship, excellence and empathy, we at Roland Berger are convinced that the world needs a new sustainable paradigm that takes the entire value cycle into account. Working in cross-competence teams across all relevant industries and business functions, we provide the best expertise to meet the profound challenges of today and tomorrow.


## Publisher

**Roland Berger Middle East**
Innovation Hub Building 2B, 3rd Floor
P.O. Box 502254
Dubai, UAE
+971 4 446 4080