



Global Developments with Carbon Capture, Use and Storage Deployment Programmes

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Global CCUS Policy Developments

July 2023

Dear reader,

This slide deck contains a snapshot of carbon capture, use and storage (CCUS) policy and programme developments across the Clean Energy Ministerial CCUS Initiative Members.

To combat climate change, CCUS technologies can play a significant role in decarbonizing several industrial and energy sectors, and in providing the necessary removal of CO₂ from the atmosphere. Deploying CCUS will however require significant government programmes, to kickstart the CCUS industry. Several countries have enacted CCUS programmes and policies, and this document provides a high-level snapshot into today's status.

These slides are published at the 14th Clean Energy Ministerial meeting hosted by India, on 19-22 July in Goa.

If you are interested in these developments, or in the work of the CEM CCUS Initiative, we would be delighted to hear from you. Please email us at info@cemccus.org.



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CEM CCUS Members

Australia

Climate Change Policies

- **Climate Change Act 2022:** The Australian Government legislated an updated National Determined Contribution of **43 per cent below 2005 levels by 2030, and net zero emissions by 2050**. This is aligned with the Government's ambition to be a **renewable energy superpower**.

Current government position for CCUS

- The Australian government understands that **a range of technologies, including CCUS will be required** to ensure Australia meets its climate targets.
- The government is focused on **ensuring the right policy and regulatory settings** are in place for project proponents to make commercial decisions for CCUS projects.

Deployment policies and programmes in place to support decarbonisation

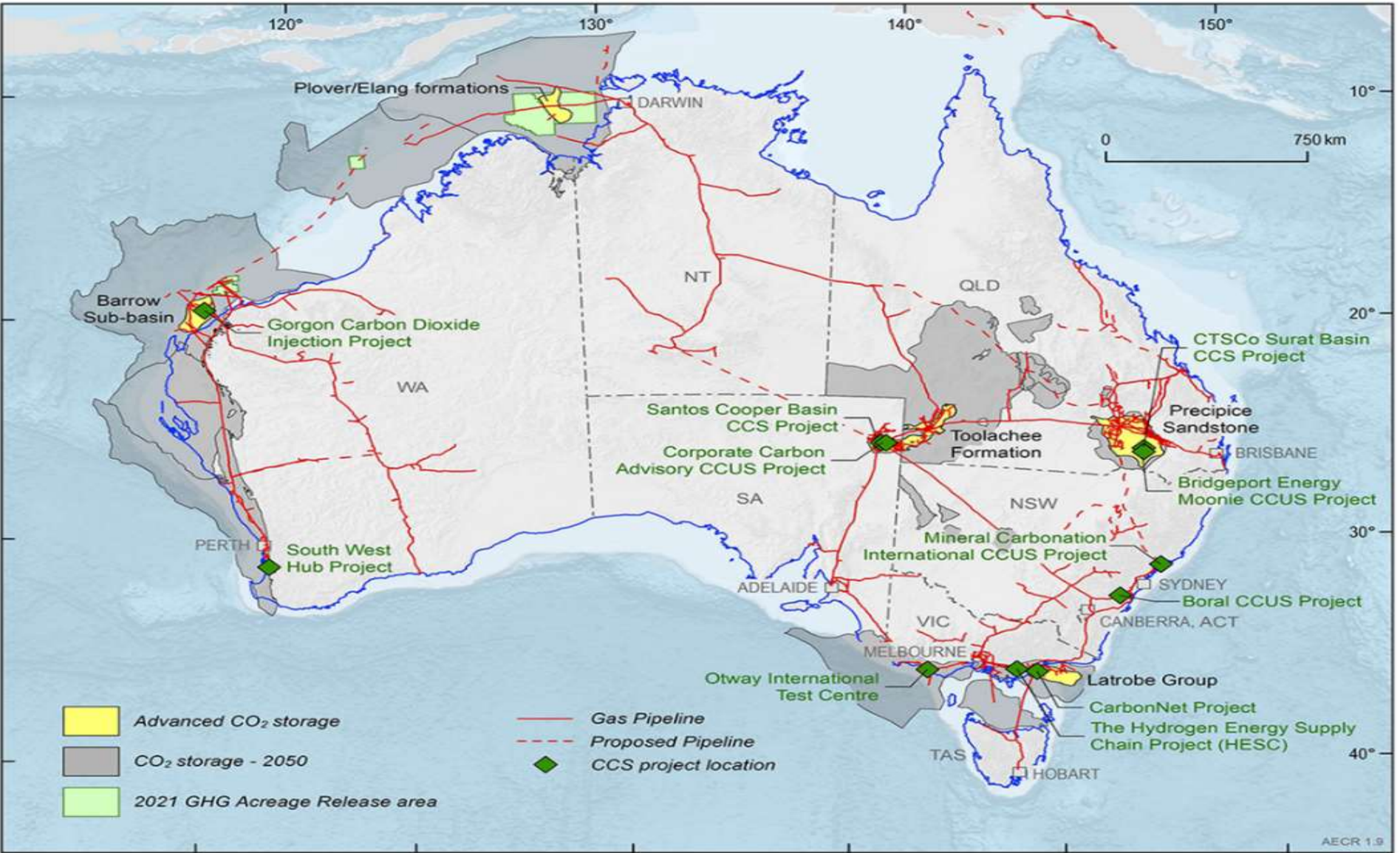
- The Government is implementing the **Carbon Capture Technologies Program**. This will focus support into novel CCU technologies, and its applications for hard-to-abate sectors. It will be a competitive grants program that will open later this year.
- The **Powering the Regions Fund** (PRF) supports regional Australia to reduce emissions in existing industries, foster new clean energy industries, and develop associated workforces. Through the *Powering the Regions Fund* (PRF), the Australian Government has allocated funding to two competitive grant programs, under which CCUS technologies could be eligible to apply:
 - AUD\$600 million to the **Safeguard Transformation Stream** (STS) to support trade-exposed facilities covered by the **Safeguard Mechanism** to reduce direct (scope 1) emissions, excluding new or expanding coal and gas facilities.
 - AUD\$200 million to the **Critical Inputs to Clean Energy Industries** (CICEI) grant program to support hard-to-abate sectors – cement and lime, alumina and aluminium – where CCUS technologies may play a role.
- The **Safeguard Mechanism** ensures that Australia's largest emitters (facilities with Scope 1 emissions >100,000 tonnes of CO₂e/year) contribute to our national net zero by 2050 target.
- The Government introduced a Bill to amend the 2009 and 2013 Amendments to the London Protocol on 22nd June 2023 - **The Environment Protection (Sea Dumping) Amendment (Using New Technologies to Fight Climate Change) Bill 2023**.
- **Modernisation of Offshore Regulatory Framework** – In the May 2023 Budget, the Government committed **AUD\$12million over 3 years** for a review of the environmental management regime for offshore petroleum and greenhouse gas storage activities, to ensure it is fit-for-purpose for a decarbonising economy.
- The Government awarded permits for 5 offshore areas for CO₂ storage through the 2021 **Greenhouse Gas Offshore Acreage Release**. Public consultation for seven proposed areas offshore around Australia under the 2023 offshore greenhouse gas storage acreage release has been opened and will close 30 June 2023. This will be followed by areas released for bidding, after considering the feedback from the public consultation process.



LARGE-SCALE CCUS PROJECTS

- **Operational:** *Gorgon CO₂ Injection Project* (Chevron Australia): 8 Mt of CO₂ equivalent stored since August 2019. The project aims to reduce greenhouse gas emissions by more than 100 Mt over the life of the project.
- **Future:** *Moomba CCS Hub Project* (Santos): Moomba CCS Hub Project (Santos and Beach Energy): Santos has announced it has made a final investment decision to develop a CCS plant in the onshore Cooper basin in South Australia. Expected to be operational in 2024 and store 1.7 Mtpa of CO₂.

Australia – Map of Projects



Sources: Geoscience Australia; GPInfo. Pipeline routes from the GPInfo petroleum database. Note: LNG = liquefied natural gas.

Canada

Current Government Approach to CCUS

- Contribute to “**net-zero by 2050**” goals. Canada’s most recent-submission to the UNFCCC, projects opportunities for CCUS to reduce 2030 emissions by 16.3 Mt of CO₂ per year; 3.8Mt of this is projected to result from CCUS-enabled hydrogen production.
- Build on Canada’s **CCUS advantages**, incl. domestic projects that have already captured & stored millions of tonnes.

Federal Policies / Funding

- **CCUS Investment Tax Credit (ITC)** for projects which permanently store CO₂ in dedicated geological storage or in concrete. Available for expenses starting in 2022, valued at CAD \$7.6B to 2030. To be released for consultation in the coming months.
 - 2022-2030 rates: 60% for DAC; 50% for capture equipment in all other projects; 37.5% for transportation, storage, and utilization.
 - Runs to 2041, rates to be reduced by 50% in 2031 (to incentivize projects this decade).
 - Initially expected to include dedicated geological projects in the British Columbia, Alberta, and Saskatchewan.
- CCUS-related credit creation under the **Clean Fuel Regulations**: CCS and CO₂-EOR projects that reduce the lifecycle carbon intensity of liquid fossil fuels, DAC-to-fuels, and clean H₂ that displaces traditional liquid or gaseous fuels.
- **Carbon Pricing** (federal/provincial equivalents): 2023 price is \$65/t, rising to \$170/t in 2030 as per **Strengthened Climate Plan**.
- **\$15B Canada Growth Fund (CGF)** The Fall Economic Statement 2022 identified low-carbon hydrogen and CCUS as key technologies for accelerated deployment; Also identified Carbon Contracts for Difference (CCfDs) as one of the CGF’s investment tools.
- **Strategic Innovation Fund - Net Zero Accelerator** received an additional \$500M over ten years (increasing the total fund from \$8B to \$8.5B) to support the development of clean technologies (including CCUS). The Strategic Innovation Fund will also direct up to \$1.5B of its existing resources towards projects in sectors including clean technologies and industrial transformation.
- Budget 2022 expanded the role of the **Canada Infrastructure Bank (CIB)** to invest in private-led CCUS infrastructure projects.

Future Priorities

- **A Carbon Management (CM) Strategy** is in development, to be released in 2023. CM is expected to be critical to **5 key pathways**: decarbonizing heavy industries & power; low-carbon H₂ production, CDR, and CO₂ based industries.
- Canada’s **GHG Offset Credit System Regulations**: A DACCS protocol is under development and BECCS has been identified as a priority for the next round of protocol development.



LARGE-SCALE CCUS PROJECTS - CURRENT

- **Alberta Carbon Trunk Line**: 240-km pipeline delivering ~1.6 Mt of CO₂ / year from a fertilizer plant & new refinery for EOR – up to 14.6Mt / year capacity
- **Quest**: >6Mt CO₂ captured & stored at 3 hydrogen production units at oil sands upgrader since 2015
- **Boundary Dam**: >4Mt captured via post-combustion capture technology at coal-fired power plant, operating since 2014
- **Weyburn-Midale**: >40 Mt stored via CO₂ -EOR project (since 2000)
- **Glacier** (Phase 1): world’s first commercial project to capture & store CO₂ from NG combustion (Phase 1a: 47kt/year capacity, Phase 1b (16kt/year) to commence 2023)

PLANNED PROJECTS & HUBS

As part of \$319M being provided for CCUS RD&D/7 years:

- **11 successful applicants** for Canada’s **CCUS RD&D FEED studies call** are currently under review.
- **Second call** (2022-2023) to support earlier-stage RD&D across capture, storage/sequestration, and utilization. Deadline for storage & transportation focus area applications was Apr 17, 2023.

Alberta’s Carbon Sequestration Tenure Management Competition resulted in the selection of **25 proposed hubs** that will further evaluate if they can safely and permanently store CO₂ emissions throughout the province.

China

Current government strategy for CCUS

- National 14th Five-year Plan
- Opinions of the Central Committee of the CPC and the State Council on Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementing of the New Development Philosophy
- Action Plan for Carbon Dioxide Peaking Before 2030
- Scientific and Technological Deployment Strategy for Carbon Dioxide Peaking and Carbon Neutrality (2022 - 2030)
- Implementation Plan for Synergetic Reduction of Pollution and Carbon Emissions
- Implementation Plan for Carbon Peaking in the Industrial Sector

Deployment policies and programmes in place

- CCUS research projects supported by the National Key R&D Programme
- China Carbon Emission Trade Exchange (CCETE) officially launched
- National guidance for promoting CCUS demo projects

Priorities going forward:

- CO₂ utilisation
- CO₂ capture in industrial sectors
- Offshore CO₂ sequestration
- Emission restrictive & CCUS incentive policy
- Large-scale integrated demonstration and pipeline system
- Opportunities for low-carbon hydrogen production with CCUS in China (ACCA21 & IEA)



CURRENT LARGE-SCALE CCUS PROJECTS

- Sinopec ShengLi Oil Field 1Mt/a CCUS Project
- CNPC JiLin 0.4Mt/a CO₂-EOR Commercial Project
- YanChang Petroleum YanAn 0.3Mt/a Full-Chain CCUS Project (EOR)
- CHN Energy JinJie 150 Kt/a Power Plant Full-chain CCUS Project
- QiangNai Jiaozuo 10 Kt CO₂ to Concrete Project
- CHN Energy Taizhou 0.5Mt/a Thermal Power CCUS Demonstration Project
- CNOOC Enping Oilfield 0.3Mt/a Offshore CO₂ Sequestration Project

POTENTIAL FUTURE PROJECTS

- OGCI&CNPC XinJiang CCUS Hub
- CNOOC DaYa Bay CCUS Cluster
- HuaNeng Group ZhengNing Power Plant Post-Combustion CCUS Project
- Cement Plant CCUS (Hailuo, Jinyu)
- Steel Plant CCUS (Baogang, HBIS)
- DunHua Petroleum XinJiang Hydrogen Energy CCUS Project
- CHN Energy & CNPC Ningdong 3 Mt/a CCUS Demonstration Project (CO₂ Capture+EOR)
- Huaneng Gansu Longdong Energy Company 1.5 Mt/a CCUS R&D Project

European Union *



Current government strategy for CCUS

- EU financial support to CCUS research, innovation and demonstration

Deployment policies and programmes in place

- Innovation Fund, TEN-E and Connecting Europe Facility, Horizon 2020 and Horizon Europe, Recovery – NextGenerationEU, Sustainable carbon cycles communication

Priorities going forward:

- Foster the deployment of large-scale, innovative projects
- Propose certification of carbon removals (2022)
- Publish strategic CCUS Vision Paper (2023)
- Assess CO2 infrastructure investment needs and CO2 infrastructure regulatory needs

CURRENT LARGE-SCALE CCUS PROJECTS

Currently there are no large-scale CCUS projects running in the EU

POTENTIAL FUTURE PROJECTS

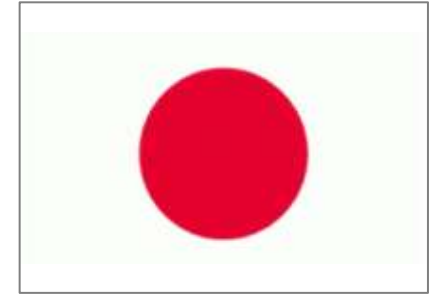
CO2 transportation projects included in the 5th list of “Projects of Common Interest”:

- CO2 TransPorts, part of PORTHOS (Netherlands), Northern lights project (Norway), ATHOS (Netherlands), Aramis project (Netherlands), Dartagnan project (France), EU CCS Interconnector (Poland)

CCS and CCU projects supported from the Innovation Fund:

- Kairos-at-C, Port of Antwerp – CO2 capture from hydrogen, ammonia and ethylene oxide production (Belgium), BECCS Stockholm - Bio-energy CO2 capture at a CHP plant (Sweden), K6 – CO2 capture at cement plant, reuse & storage (France), SHARC - Green hydrogen and blue hydrogen with CCS (Finland)
- C2B: Carbon2Business - Oxyfuel CO2 capture and use for methanol production (Germany), ANRAV: Oxy-fuel in cement production (Bulgaria), Coda Terminal: CO2 mineral storage hub in onshore basalt formation (Iceland), AIR: Methanol production from renewable hydrogen and carbon capture (Sweden), HySkies: Sustainable Aviation Fuel from RES H2 and CCU (Sweden), GO4ECOPLANET: Cryocap CO2 capture in cement (Poland), CalCC: CO2 capture in lime production (France)

Japan



Key climate policy targets

- Achieve carbon neutrality in 2050
- Reduce Japan's GHG emissions by 46% in FY2030 from its FY2013 level

CCS long-term roadmap (released on March 10)

Tentative target: 120-240 million tons stored by 2050, or an increase of 6 – 1.2 million tons annually from 2030

Improve a business environment toward the start of CCS business by 2030

Deployment policies and programs in place

- Enhance JOGMEC's functions through an amendment to the JOGMEC act last year
 - Investment and debt guarantee services for CCS and geological surveys
- R&Ds on monitoring systems for injected CO₂, capture technologies, liquefied CO₂ transportation through NEDO

Support of development and operation of advanced CCS projects that can be models for other projects (details are in the next slide)

Priorities going forward:

Developing legal frameworks for CCS business (as soon as possible)

- Leveraging Asia CCUS Network to establish CCUS market in Asia and develop import/export mechanisms for CO₂
- Establish liquefied CO₂ ship transportation technology

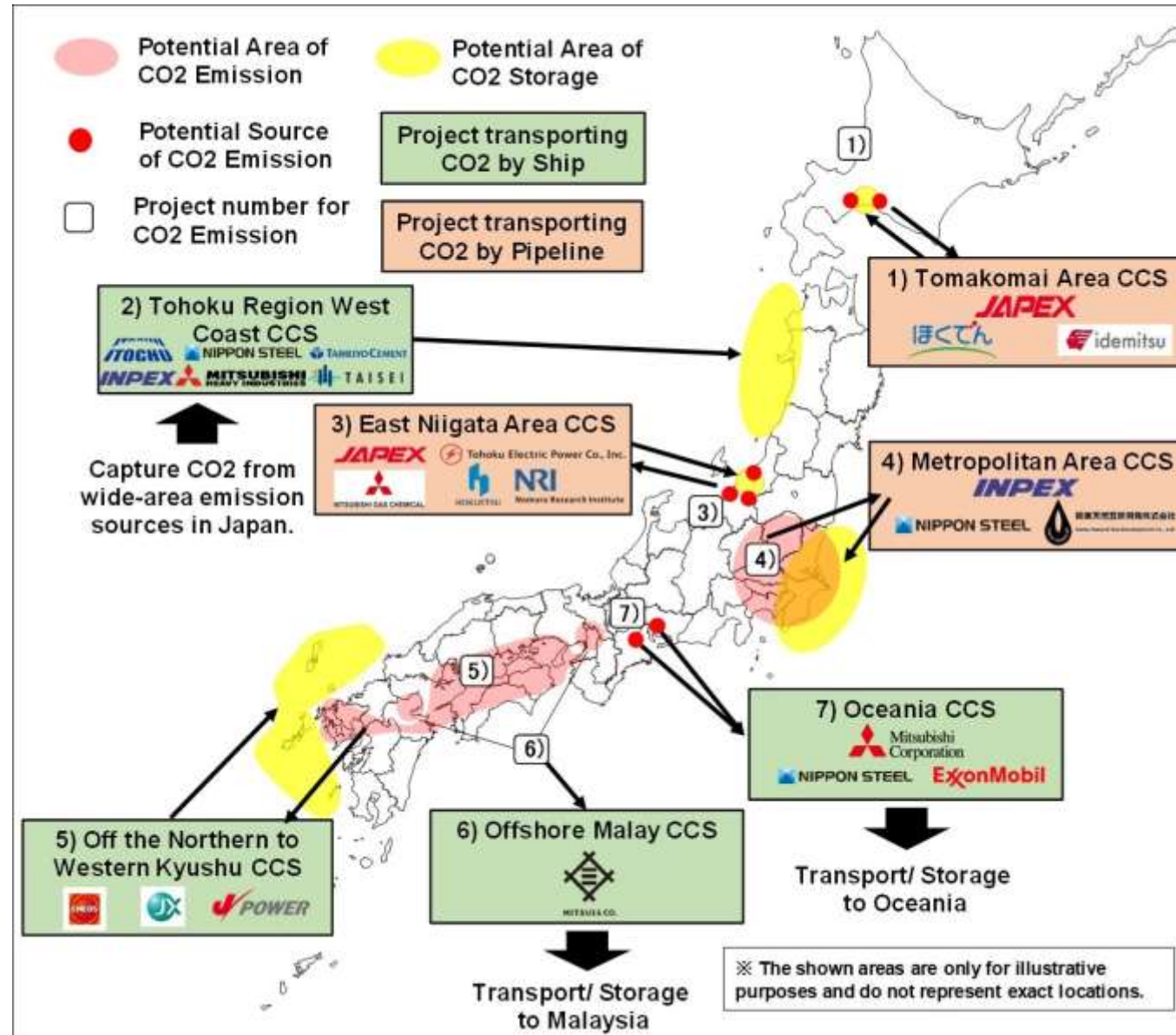
CURRENT LARGE-SCALE CCUS PROJECTS

- Tomakomai CCUS demonstration project (Post-injection monitoring ongoing)
- Liquefied CO₂ ship transportation demonstration project
- Feasibility Study on JCM-CCS in ASEAN countries
- Several CCS projects were selected under the Advanced CCS Program, which supports CCS operations through 2030

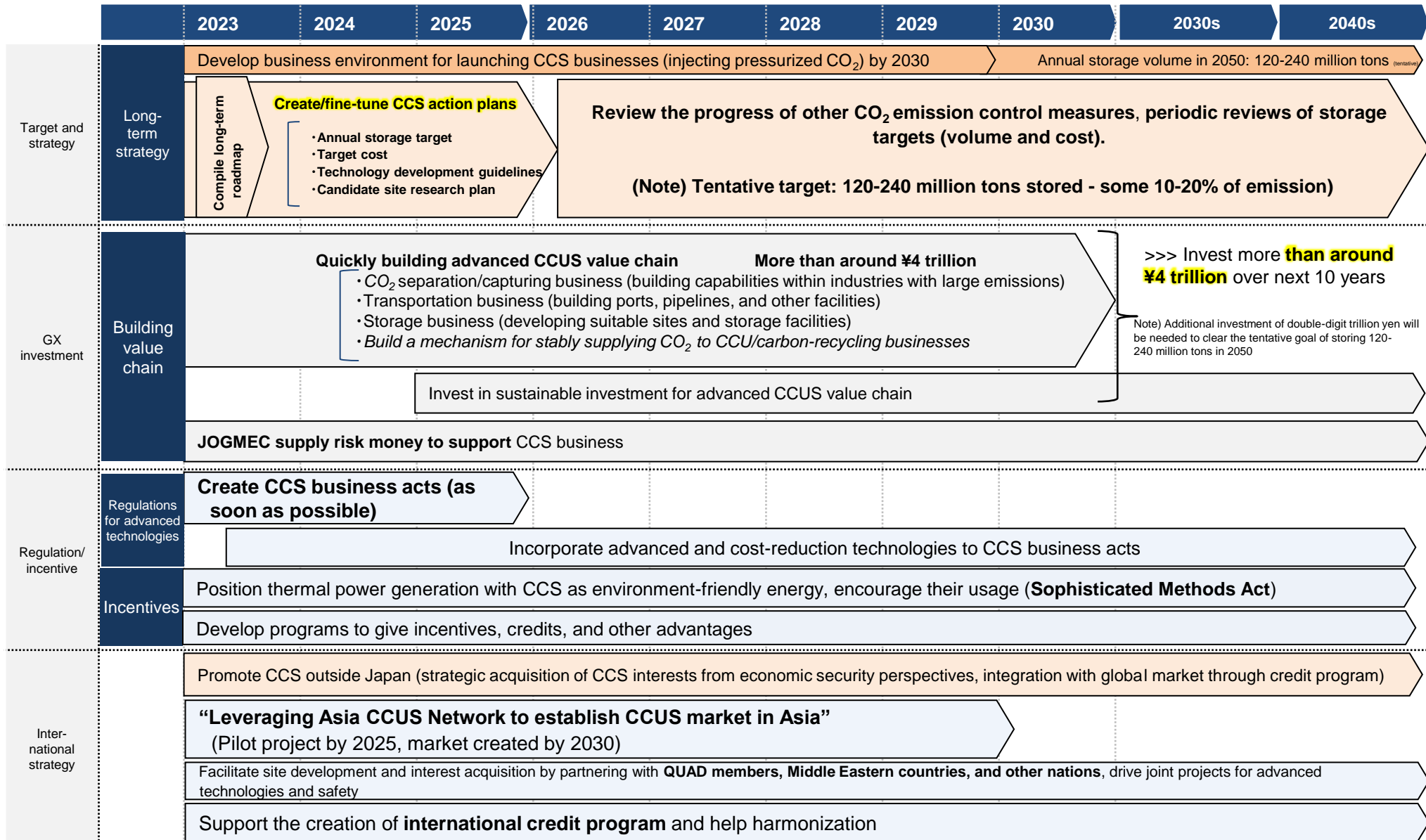
POTENTIAL FUTURE PROJECTS

- Prompt legislation of domestic acts governing CCS business
- Selecting several CCS projects under "advanced CCS program" that supports CCS operation by 2030
- Development of import/export mechanisms for CO₂

Japan - Map of the selected projects and companies



- In order to secure the annual CCS capacity required for achieving carbon neutrality by 2050, build advanced CCUS value chain and win CCUS markets in Asia over the next 10 years, and also develop CCS business acts as quickly as possible to create business environment for launching businesses by 2030.



The Netherlands

Current government strategy for CCUS

- CCUS important technology to reduce CO₂ emissions in industry
- Large scale deployment of CCS before 2030
- De-risking CCUS projects by providing financial support
- Subsidy only where no cost-effective alternatives for CCS exist
- Fossil CCS as a transition technology but CO₂ storage necessary for negative emissions

Deployment policies and programmes in place

- Subsidy scheme for CO₂ reduction in industry (SDE++), covers unprofitable top (total cost for capture, transport and storage minus ETS price and national CO₂-levy) for a period of 15 years.
- CCUS feasibility studies (pre-FEED) and FEED studies (subsidy)
- Subsidies for R&D programmes
- EU (CEF, Innovation Fund)

Priorities going forward:

- Successful realization of the first projects
- Issues relating to nitrogen deposits (permitting)

CURRENT LARGE-SCALE CCUS PROJECTS

- CO₂ from Shell refinery + bio-ethanol (Alco) → greenhouses by pipeline (~0,5 Mton/year)
- CO₂ from Yara (fertilizer) → greenhouses by pipeline
- CO₂ from waste incineration (AVR) → greenhouses by truck (50 kton/year)

POTENTIAL FUTURE PROJECTS

- Porthos (Rotterdam): operational foreseen in 2026 with a capacity of 2.5 mtpa; capture from 4 industrial sources with support from the SDE++ (2.1 bln euros in subsidy allocation in 2020), storage in P-18 gas fields offshore.
- Aramis (Rotterdam): operations foreseen in 2027/28. Total pipeline capacity of 22 mtpa (open access). Launch phase of 7.5 mtpa (3 stores). Capture from several industrial sources. Dutch emitters supported through SDE++ (6.7 bln Euros in subsidy allocation in 2022).
- Multiple transport/infrastructure initiatives: EU2NSEA, Noordkaap, Delta Rhine Corridor, Carbon Collectors (shipping solution).

Nigeria

Updated Key Climate Policy targets:

- National Technology Action Plan (NTAP) for Climate Change Mitigation and Adaptation in key economic sectors approved by the Federal Executive Council on 3rd May, 2023 to serve as Technology roadmap for meeting Nigeria's NDC commitment under the Paris Agreement;
- CCUS prioritized as a key technology in the NTAP;
- Revised NDC update: 20% unconditional and 47% conditional targets by 2030;
- Net Zero target (Energy Transition) by 2060; and
- Long-Term Emissions Reduction Plan to achieve 50% by 2050 using a climate technology led approach.

Current Government Strategies for CCUS Development having prioritized CCUS technology in NTAP:

- Identify near-term needs and opportunities for CCUS development and deployment that are consistent with Nigeria's net zero emission target by 2060;
- Create an enabling environment through identifying storage resources; matching emission point sources and industrial clusters with CO2 storage; developing legal and regulatory frameworks; performing techno-economic assessments; engaging with stakeholders; supporting capacity development; and ultimately piloting and demonstration of CCUS in industrial settings and;
- African Carbon Management Technology and Innovation Centre of Excellence.

Deployment Policies, Programmes and Frameworks in place:

- Energy Transition Plan;
- National Technology Action Plan for Climate Change Mitigation and Adaptation and
- National Council on Climate Change (NCCC) established.

Priorities going forward:

- Industrial CO2 CCUS Diagnostic and Scoping Study;
- Legal and Regulatory Assessment & frameworks and
- Institutional capacity development.



CURRENT LARGE-SCALE CCUS PROJECTS

N/A

POTENTIAL FUTURE PROJECTS:

- CCUS gas development – blue hydrogen
- Carbon dioxide removal.

Norway



Current government strategy for CCUS

- Develop CCS projects in a cost-efficient manner
- Facilitate large-scale infrastructure and storage opportunities at NCS
- Decarbonize hard-to-abate industry
- Focus on low carbon H2 deployment
- Share knowledge and best-practice

Deployment policies and programmes in place

- CO2 tax and the European Trading Scheme
- Ratified the amendment to the London Protocol and deposited a declaration on provisional application
- Financial support for the Longship project

Priorities going forward:

- Establish a business case for CO2-storage
- Establish bilateral agreements with relevant countries as foreseen under the LP
- New acreage for CO2 storage

CURRENT LARGE-SCALE CCUS PROJECTS

- Sleipner (1 mill. tons per year)
- Snøhvit (0.8 mill. tons per year)

PROJECTS UNDER DEVELOPMENT

- The full chain CCS project: “Longship” (start 2025)
 - Capture at a cement plant (Norcem), a waste incineration plant (Celsio) and Yara in the NL
 - The Northern Lights (transport and Storage at the NCS)

POTENTIAL FUTURE DEVELOPMENTS

- Northern Lights part 2
- Develop additional CCS projects
- 5 new exploration permits for CO2 storage acreage, in the North Sea and the Barents Sea respectively

Saudi Arabia



Current Management strategy for CCUS

- Carbon Capture strategy identified 20 initiatives across CCUS value Chain; this include:
 - 12 Technical Initiative
 - 4 Regulation/Governance Initiatives
 - 2 R&D Initiatives
 - 2 Enablers Initiatives

Deployment policies and programs in place

- Ministry of Energy established Circular Carbon Economy National Program (CCE-NP) to supervising implementation across Hydrogen and Carbon management with a steering Committee from government entities, research institutes and national champion to enable CCUS.

Priorities going forward:

- Carbon Management is one of the focus areas in the Circular Carbon Economy national program and its key objectives are to review initiatives implementation, provide guidance & facilitation and ensure alignment in CCUS.
- Implementation process activated 12 dedicated taskforces aligned with major KSA stakeholders (government entities, research institutes and national champion)
- Raise CCUS profile to G20 leaders

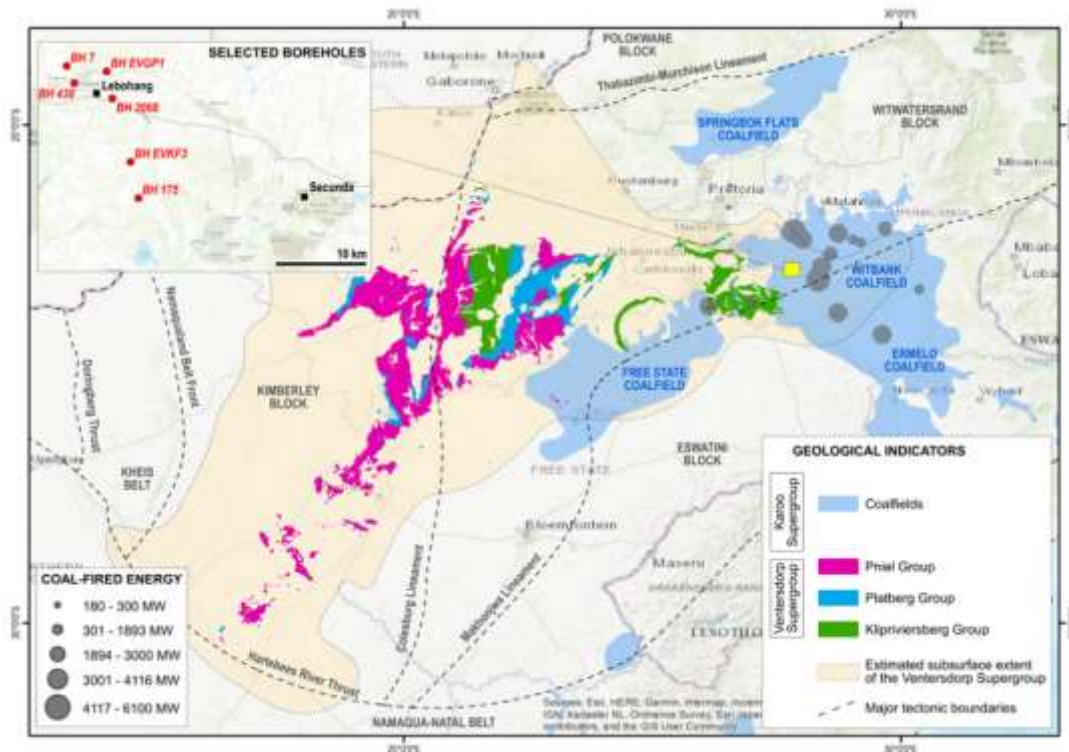
CURRENT LARGE-SCALE CCUS PROJECTS

- The Kingdom has announced its ambition to capture 44 Mtpa of CO₂ by 2035 as announced during the first version of the Saudi Green Initiative (SGI) held by October 2021. Building on that, a Joint Development Agreement (JDA) between Saudi Aramco, SLB and Linde has been announced during the second version of the SGI and held by November 2022 in order to develop Phase I of the CCS Project in Jubail with 9 MTPA by 2027 as one of the largest CCS hub in the region
- In 2015, Saudi Aramco launched the Kingdom's first carbon capture and sequestration (CCS) project and CO₂ Enhanced Oil Recovery (EOR) project at its 'Uthmaniyah and Hawiyah NGL facilities. The CO₂ EOR project is the largest CCS project in the Middle East.
- In 2015, SABIC built the largest facility of its kind in the world of carbon capture and utilization (CCU) at United, a SABIC affiliate, with a capacity of 500,000 tons of CO₂ captured and utilized annually.

South Africa

Current strategy for CCUS

- CCUS identified as a key enabler of the Just Transition in SA as part of 2050 developmental goals.
- A pilot project is initiated, targeted finalisation in the 2023/24 financial year.



Regional map of pilot site, Mpumalanga, South Africa

Priorities for the implementation of CCUS

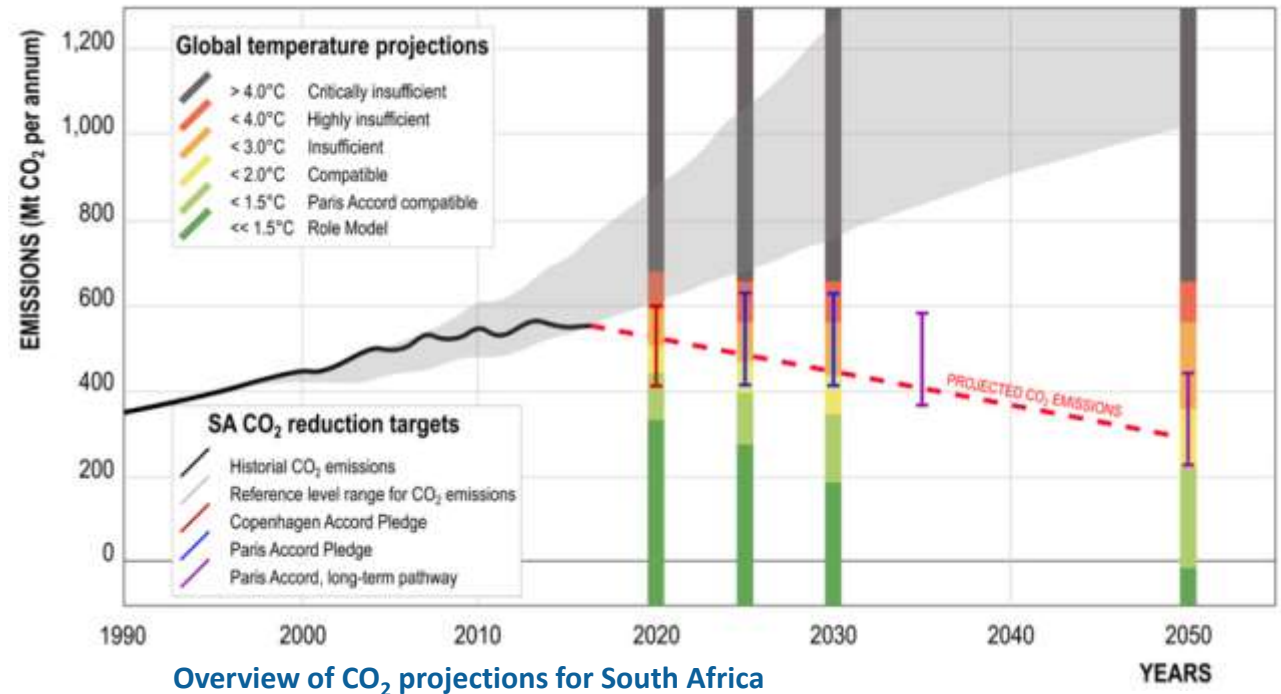
- Integrated geoscience research and focus on utilisation and socioeconomic aspects.



South Africa

Future programmes

- Basaltic injection near major point-source CO₂ emitters and large coalfields.
- Adaption of current coal-fired fleet.



Overview of CO₂ projections for South Africa

United Arab Emirates



Key climate policy targets

- UAE Net Zero by 2050 strategic initiative and currently UAE working on the National Net Zero Strategy 2050
- 2nd Nationally Determined Contribution – NDC on 2020 with United Arab Emirates (UAE) presents an economy-wide emission reduction target relative to BAU. The country projects the BAU scenario to reach 310MtCO₂ in 2030. The country aims to reduce 23.5% by 2030, relative to the BAU scenario (UAE NDC, 2020).
- UAE Hydrogen Leadership roadmap (2021)
- 2022- UAE is on track to submit its revised 2nd Nationally Determined Contribution (NDC).
- 2022- UAE launched the National Net Zero by 2050 Pathway, which sets the timeframe and identifies the mechanisms of implementing the UAE Net Zero by 2050 Strategic Initiative, introduced in October 2021.
- 2023- UAE submit its revised 3rd edition to the 2nd Nationally Determined Contribution (NDC)

Current government initiatives/strategy for CCUS

- Hosted a CCUS Workshop that brought together the finance sector as well as industry to accelerate financing and deployment of CCUS projects.
- 2023: Launch the Updating the National Energy Strategy 2050 in partnership with Khalifa University (KU) and the International Renewable Energy Agency (IRENA)
- 2023: Launch the National Hydrogen Strategy which will include the CCUS/CCS hubs
- 2023 Hydrogen Regulatory framework (on going)

Deployment policies and programmes in place

- ADNOC Announces Comprehensive 2030 Sustainability Goals and CCUS expansion capacity of 500% in the next 10 years.
- 2023 – UAE Announce Carbon Capture and Mineralization (CCM) technology project to eliminate CO₂ from the atmosphere was announced. Fujairah pilot will be the region's first CCM project by ADNOC, 44.01's Earthshot prize-winning and include FNRC and Masdar, the pilot technology that permanently mineralizes carbon dioxide (CO₂) within rock formations found in the Emirate of Fujairah and it will be, due to commence in January 2023, The project will be powered by solar energy supplied by Masdar. A successful pilot would open the possibility of mineralizing billions of tons of captured CO₂ across the region.
- Hosting the MENA headquarters of the Global Carbon Capture and Storage Institute at Masdar city underlines the UAE's commitment to practical solutions to climate challenges.

Priorities going forward:

- 2023/2024- CCUS hubs roadmap
- Development of CCUS Policy.
- Continuous support towards the CCUS Initiative.

CURRENT LARGE-SCALE CCUS PROJECTS

- Al Reyadah Plant: which is the largest carbon capture steel project, that captures 800,000 tonnes of CO₂ that is injected for EOR.

POTENTIAL FUTURE PROJECTS

- ADNOC expansion of CCUS initiatives
 - Shah gas plant, which has the potential to capture 2.3 million tonnes of CO₂ per year
 - Habshan-Bab gas plant, which has the potential to enable the capture of 1.9 million tonnes of CO₂ per year
- The equivalent of a forest area that is twice the size of the UAE.



وزارة الطاقة والبنية التحتية
MINISTRY OF ENERGY & INFRASTRUCTURE

UAE National Hydrogen Strategy

July 2023

We aspire for the UAE to become among the leading countries for hydrogen production by 2031

In line with the 'We the UAE 2031' vision

10 steps and enablers have been identified within three main stages in the National Hydrogen Strategy to reach the targets set by 2031



Develop a resilient hydrogen supply chain to support the growth of the local industry

Consolidate the UAE's role as a leading global producer and supplier of low-carbon hydrogen

Promote innovation in industrial zones in the UAE

Establish a robust hydrogen economy that can support the country's nationwide decarbonization efforts



2031 Targets

2050 Targets

25%

Reduce emissions in hard-to-abate sectors by

100%

1.4 MTPA

Hydrogen production per year

15 MTPA

Establishing a hydrogen R&D center

Hydrogen center

A globally recognized innovation center for hydrogen

2 hydrogen oases

Establishing several hydrogen oases in the UAE

5 hydrogen oases

10 steps and enablers have been identified within three main stages in the National Hydrogen Strategy to reach the targets set by 2031.

Global Collaboration

Building international partnerships and creating investment opportunities to drive the global transition to a hydrogen economy.



Resources and Assets

Leveraging natural resources and existing assets to competitively lead future energy markets.



Climate, Safety and Social Drivers

Guiding society to embrace hydrogen and unlocking the common good as a result of global carbon mitigation.



Enabling Infrastructure

Creating the infrastructure necessary to link production with demand, accelerating hydrogen availability and utilisation.



Research and Innovation

Incubating and accelerating next generation hydrogen technology developments across the value chain.



Policy, Regulation and Standards

Establishing the legislative mechanisms to support the low-carbon hydrogen transition, including hydrogen certification and guarantees of origin.



Finance and Investments

Creating an attractive investment environment to support the hydrogen transition, as well as developing green finance mechanisms domestically.



Industry Development and Demand Activation

Providing the certainty, predictability and confidence industry needs to transition to hydrogen.



Sustainable Commercial and Economic Models

Achieving and maintaining globally competitive hydrogen pricing through a long-term market driven support mechanism.



Skills and Education

Nurturing and growing a highly skilled workforce to drive forward the transition to hydrogen.



UAE: Hydrogen and CCUS Initiatives (as of Q1 2022)

- 1**  **Taziz - Ruwais chemical hub**
 - 1 mtpa blue ammonia production plant located in the Taziz chemicals hub
 - 0.2 mtpa H2 equivalent capacity
- 2**  **Masdar – Demonstration plant**
 - Green H2 initially for road transport, then expanding to e-kerosene synthesis and ocean shipping
 - Demonstration scale
- 3**  **UAE Hydrogen Hub**
 - Initial development of 1GW of low carbon hydrogen together with BP as well as pioneering decarbonized air corridors between the UK and UAE
 - 0.1-0.2 mtpa H2 equivalent capacity
- 5**  **Mohammed bin Rashid Al Maktoum Solar Park**
 - Mohammed bin Rashid Al Maktoum Solar Park First solar PV and green hydrogen producing facility in the MENA region
 - Demonstration scale
- 6**  **Abu Dhabi, Khalifa Industrial Zone**
 - Final goal of 200kt of ammonia and 40kt of H2 annual production
 - 0.1 mtpa H2 equivalent capacity
- 7**  **TAQA & Abu Dhabi Ports**
 - Green ammonia project under discussion powered by a 2 GW solar based electrolyzer facility
 - 0.1 mtpa H2 equivalent capacity
- 8**  **TAQA & Emirates Steel**
 - MOU for large-scale green hydrogen project enabling the first green steel produced in the MENA region
- ESMA** 
 - The first technical regulation of Hydrogen powered vehicles in the UAE



- 9**  **Sharjah Waste-to-H2 Plant**
 - The facility will use up to 37.5 tonnes (t) of unrecyclable solid waste an hour to generate 30MW of electricity.
 - Developer: Bee'ah - Masdar
- 10**  **Mubadala & Siemens Energy (E-fuel Project)**
 - Mubadala signed a Memorandum of Understanding with Siemens Energy and other energy players to accelerate green hydrogen capabilities in UAE, goals:
 - Produce e-fuel with airlines as off-takers
 - Promote hydrogen-based ecosystems.
- 11**  **ADNOC & TAQA**
 - New Green Hydrogen Venture
 - The two energy giants will create a clean energy powerhouse, with a total generating capacity of at least 30 gigawatts (GW) of renewable energy by 2030
- 12**  **Ruwais Ammonia (FERTIL-I and II)**
 - Capacity: 370,000 tH2/
 - Developer: Borouge
 - Integration with CCUS: NO
- 13**  **Ruwais Hydrogen Plant**
 - Capacity: 24,000 tH2/y
 - Developer: ADNOC
 - Integration with CCUS: NO
- 14**  **CO2 pilot injection project at Rumaitha field**
 - Capacity: Injected 60 tCO2/d
 - Developer: ADNOC and Masdar
 - Operational: 2012
- 15**  **Al Reyadah CCUS plant (Emirates Steel) Phase I**
 - Capacity: Injected 800,000 tCO2/d
 - Developer: ADNOC and Masdar
 - Operational: 2016
- 16**  **Barakah Plant: UAE can produce 1 mil mt/year of hydrogen from nuclear units at full capacity**

United Kingdom

Current government strategy for CCUS

- The UK is committed to progressing CCUS as part of our **2050 Net Zero Strategy**, using industrial "clusters" to capture and store **20-30 MtCO₂ per year by 2030** to help us meet our legally binding target of 78% emissions reductions by 2035.
- We are committed to deploying two CCUS clusters by the mid-2020s and a further two by 2030.
- The UK has potential to store more than **78 billion tonnes of carbon dioxide** in its continental shelf, one of the largest storage potentials in Europe.

Deployment and programmes

- **First Track-1 clusters** announced as **HyNet and East Coast Cluster** (Oct '21) and **Track-1 project negotiation list confirmed 8 projects** which we have selected through the Cluster Sequencing Process to progress to negotiations to form the first two CCUS clusters (Mar '23 – see map).
- Published an update to the **UK CCUS Investment Roadmap** (Apr '23) outlining the investment landscape for UK CCUS.
- Designed the CCUS (Industrial Carbon Capture [ICC], Waste ICC, Power, Transport and Storage [T&S]) **business models** to provide clear, long-term sight of revenue models and a stable investment environment.

Funding

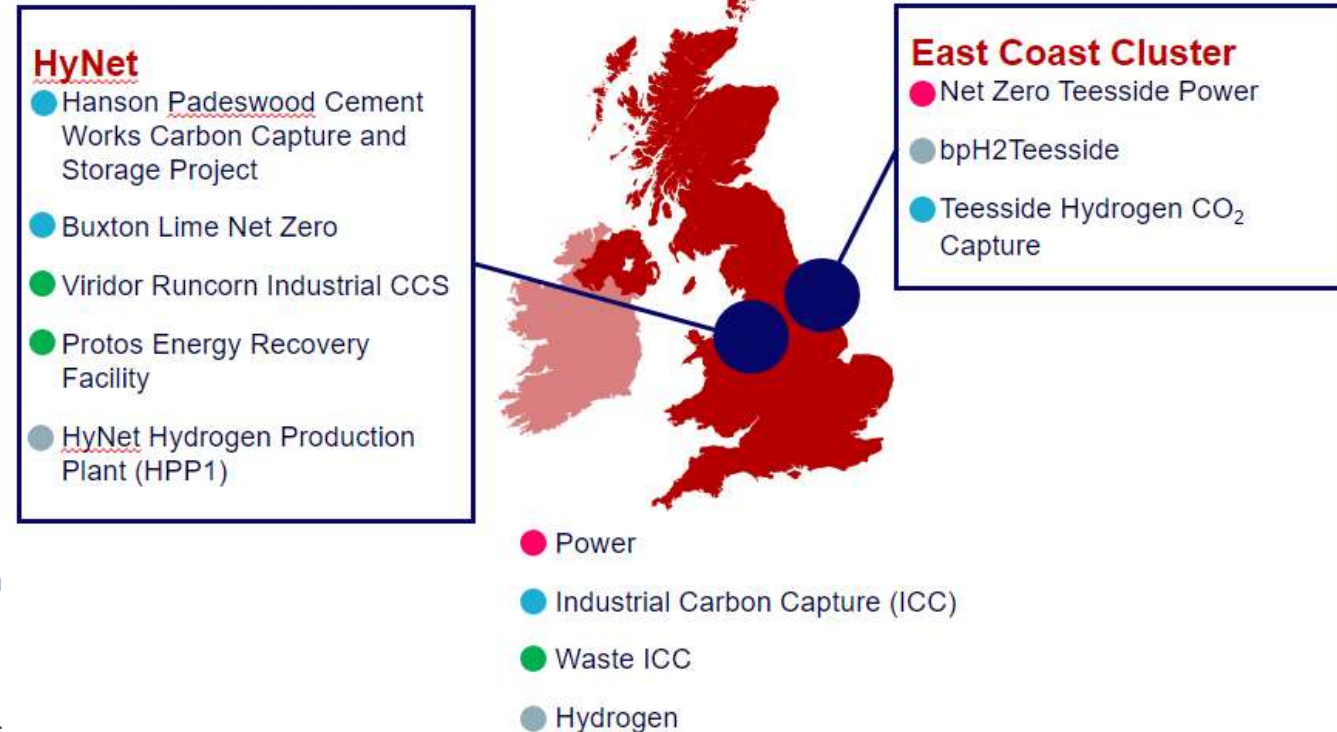
- **£20 billion investment in the early deployment of CCUS**, including the £1 billion CCUS Infrastructure Fund to support the capital costs of strategic CCUS infrastructure, T&S networks, and ICC projects.
- **Industrial Decarbonisation and Hydrogen Revenue Support scheme** to fund business models for low carbon hydrogen production and industrial carbon capture that give investors long-term revenue certainty.



United Kingdom

Priorities going forward

- We launched **Track-2 of the CCUS Cluster Sequencing Process** and will announce next steps for this in the summer. We will launch a process to enable **expansion of the Track-1 clusters**, beyond the initial deployment, later this year (2023).



United States



United States

Key climate policy targets: New climate goals: 50% emissions reduction by 2030, 100% clean electricity by 2035, and net-zero carbon emissions by 2050

Current government strategy for CCUS

- New goals on justice and equity and community engagement

Deployment policies and programmes in place

- **Inflation Reduction Act:** Reduce greenhouse gas emissions by about 1 gigaton in 2030, or a billion metric tons
 - Includes enhancements to 45Q tax credit (e.g., credit value increases to \$50 - \$85, direct pay, extension of commence construction window, lower capture threshold)
- **Bipartisan Infrastructure Law:** \$12 billion for carbon management approaches
- **CHIPS and Science Act:** \$1 billion for carbon dioxide removal RD&D (\$67 billion total for DOE)
- Loan programs and state policies/mechanisms
- Regional Initiative to Accelerate CCUS Deployment, Carbon Storage Assurance Facility Enterprise (CarbonSAFE), Carbon Dioxide Transportation Infrastructure Finance and Innovation Act (CIFIA), CCUS Demonstrations, and FEED Studies

Priorities going forward:

- Point-source carbon capture, hydrogen, carbon dioxide removal, industrial decarbonization

CURRENT LARGE-SCALE CCUS PROJECTS

- Air Products Port Arthur Project: 8.62 MMT of CO₂ captured (March 2023)
- Illinois ICCS Project: 3.11 MMT of CO₂ injected (March 2023)
- Over 35 active CCUS projects in the U.S.
 - On variety of applications—power, ethanol, industrial projects, and DAC

POTENTIAL FUTURE PROJECTS

- Many projects announced since the 45Q tax credit values were increased
- Projects are in various stages of development, ranging from early planning stages to those ready for construction
- Over 90 EPA Class VI well permits pending

Further partner countries

Denmark

Official climate policy targets and potential

- Targets: 70% reduction by 2030, climate neutrality by 2045, 110 pct. net-negative by 2050
- CCUS is necessary for reducing emissions in otherwise hard-to-abate sectors e.g. cement, heavy industry, waste incineration, while also providing negative emissions from BECCS
- Capture potential is estimated at 5,4-10,8 mill. tons pr. year in 2030
- Geological storage potential many times greater than current DK emissions, thus Denmark wants to become an international hub for storing CCS from other countries

National strategy for CCUS

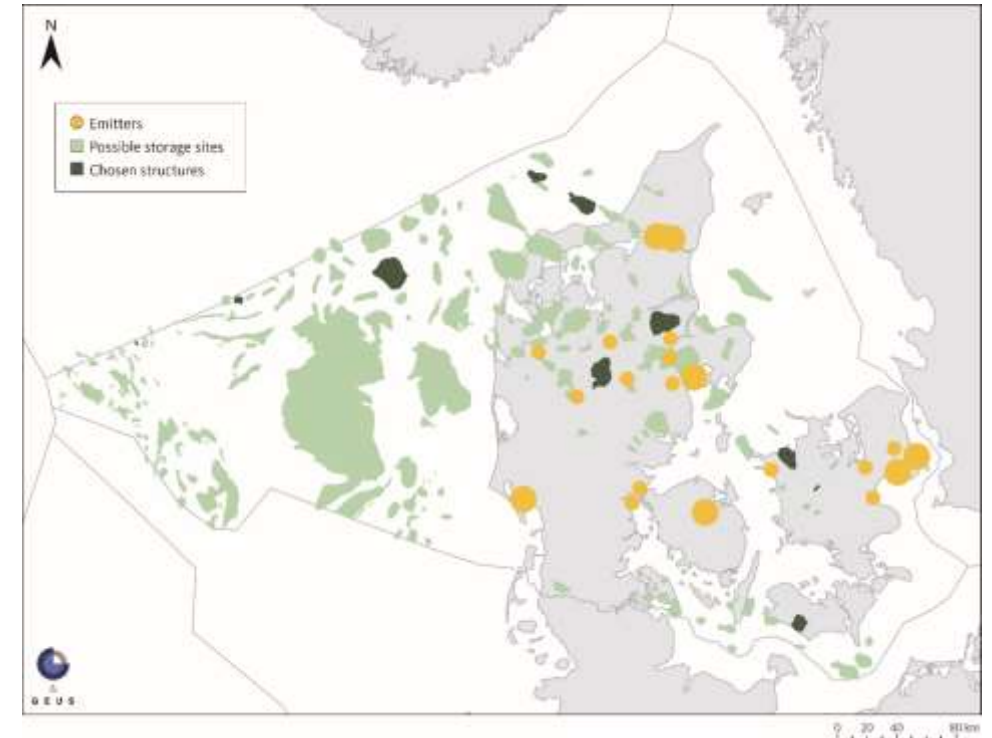
- Part 1&2: Storage (June 2021) and Capture and Transportation (Dec. 2021)
- Part 3: PtX strategy (March 2022)
- Part 4: State participation in CCS storage activities (June 2022)
- Green tax reform implementing CO2 tax of DKK 750 per tonne in 2030 for companies outside ETS and DKK 375 per tonne in 2030 for ETS companies (June 2022)

Deployment

- 2023: Combined CCUS funding scheme is now approx. 5 bill. EUR (2023-prices) with a total reduction estimate of 3,2 mill. ton CO2 yearly from 2030
- August 2022: Three companies pre-qualified for first tender round of CCUS funding scheme (Vestforbrændingen (MSW), Ørsted Bioenergy & Thermal Power, and Aalborg Portland).
- February 2023: First three full-scale exploration licenses for investigation of CO2 storage in Danish North Sea awarded to INEOS and TotalEnergies.
- March 2023: World's first CO2 from full cross-border value chain injected in depleted oil field in Danish North Sea (Project Greensand pilot phase)

Priorities going forward:

- Enabling transportation of CO2 across Denmark and across borders, bilateral agreements, focus on promoting holistic CCS approach in the EU



KNOWN CO2 STORAGE PROJECTS

- Project Greensands (INEOS and partners), expected storage capacity up to 1,5 mill. ton CO2 /y by 2025 and up to 8 mill. ton CO2 /y by 2030.
- Bifrost (TotalEnergies and partners), expected storage capacity up to 2-3 mill. ton CO2 /y by 2029-2030 and up to 10-15 mill. ton CO2/y by 2030-2032.
- Danish Norne, expected storage capacity up to 2.3 mill. ton CO2/y by 2026 and 18.7 mill. ton CO2/y by 2030.
- Ruby, expected storage capacity up to 1 mill. ton CO2/y by 2027 and up to 5-10 mill. ton CO2/y by 2030.
- Pilot at Stenlille, expected storage capacity of 0,5 mill. ton CO2 /y by 2025

Finland

The new Government programme (June 2023) highlights the role of BECCS

- “Finland aims to promote the capture of all carbon dioxide and make it easier to recognise the capture and use of wood-based carbon dioxide in EU climate policy.”
- “The capture and utilisation of carbon dioxide from bio-combustion combined with increased hydrogen production will create a platform for producing fuels, chemicals and materials from a sustainable carbon source and will reduce Finland’s dependence on fossil raw materials.”
- “The Government will promote the capture of wood-based carbon dioxide in industry and energy production and its conversion into long-lived high value added products and synthetic fuels.”
- “The Government will set a target for the use of technological sinks to a significant extent already during the 2020s.”
- “After conducting a study on the matter, the Government will introduce a reverse auction of negative emissions or a similar mechanism to encourage the capture of carbon dioxide.”



Radical CCU innovations

- Finland currently hosts an active business cluster and investment portfolio of carbon capture and utilisation projects (e.g e-fuels production) . Also opportunities for long-term storage and permanent storage (CCS) are being studied by the companies
- Investment pipeline is around 20 projects corresponding investments of approximately 1 billion euros. Many investments include hydrogen production.
- Examples
 - A Finnish start-up is constructing a plant to produce proteins out of thin air thus utilising CO2 in the air
 - Another start-up is developing CCU solution to be installed to HVAC systems in buildings



Germany *



Key climate policy targets

- Climate Law : 65 % by 2030, Climate Neutrality by 2045 and negative emission from 2050

Current government strategy for CCUS

- Coalition Agreement:
“We acknowledge the need also for technical negative emissions and will develop a long-term strategy for dealing with the approximately 5 percent of unavoidable residual emissions.”

Deployment policies and programmes in place

- On State(Länder)-level North Rhine-Westphalia released new Carbon Management Strategy in Oct. 2021

Priorities going forward:

- Evaluating current legal framework in Germany till the end of 2022
- Clarify government policy on CCU/CCS and draft a Carbon Management Strategy on federal level accordingly in 2023

Studies, Small scale projects and future large scale projects

- Funding for CDR R&D (10 Research networks, 21 Mio.€)
- Study by CapTransCO2: Network of the Chemical Industry in the center of Germany – CCU/CCS including Total, Linde etc
- Heidelberg Cement (Leilac 2, 100.000 t CO2/a), Cement industry as a whole very active
- Carbon2Chem - (ThyssenKrupp et al) using carbon from steel production for chemical materials, 100 Mio in R&D Phase, 1 Bio in Commercialisation Phase
- HyScale100 (Holcim Cement Plant capture 1 Mio t CO2/a for Methanol from green hydrogen)

Indonesia

Key climate policy targets

- **NZE 2060**
 - Modeling roadmap NZE 2060, in balance of high ambition, science and the real economy
 - Inter-ministerial discussion on Long Term Strategy for Low Carbon and Climate Resilient (LTS-LCCR) for target carbon emission from energy sector.
 - Include CCS option in carbon reduction strategy for industry.
- **NDC 2030**
 - Alignment strategic plan 2030 into energy sector long term strategy NZ 2060
 - Considering 2030 zero routine flaring policy for upstream oil and gas (UOG) activities (under discussion)

Current government strategy for CCS-CCUS

- Involving universities and research institutions as center of Experts on CCS-CCUS
- Strengthening cooperation to deploy CCS-CCUS project

Deployment policies and programmes in place

- **Carbon pricing system, cap and trade, cap and tax scheme in place,**
 - Issuance Act No. 7 Year of 2021 regarding Harmonized Taxation,
 - Issuance Presidential Regulation Number 98 of 2021 regarding carbon pricing.
- **CCS/CCUS Implementation**
 - Issuance Ministerial Regulation No. 2 year 2023 regarding CCS/CCUS Implementation on Upstream Oil and Gas
 - Current PSCs scheme accommodate CCS-CCUS from upstream oil and gas,
 - Include CCS-CCUS operating cost charges within petroleum operation cost

Priorities going forward:

- **Legislation program**
 - Include CCS-CCUS activities into revision of Oil and Gas Act
 - Under discussion to start formulating regulation regarding CCS Hub
- **Establishing international cooperation on CCS-CCUS implementation**



Approved Plan CCUS Project

- **CCUS Project**
UCC Project by BP Berau Ltd., Ubadari Field Development, and Vorwata EGR/CCUS and onshore compression, to increase production 500 BSCF by 2045 and reduce CO₂ emission up to 33 MT by 2045

Potential Future CCS-CCUS Project

- PT Pertamina EP Gundih CCUS-EGR Project (2028), Potentially reduce CO₂ 3 MT for 10 years
- PT Pertamina EP Sukowati CCUS-EOR Project (2031), Potentially reduce CO₂ 10 MT for 15 years
- Repsol Sakakemang CCS Project
- Inpex Abadi CCS Project, Potential native CO₂ around 2.8 MTPA or 70MT for 25 years
- Blue Ammonia + CCS Central Sulawesi (Pertamina, PT PAU, JOGMEC, Mitsubishi & ITB), Potential CO₂ around 19 MT for 20 years
- Arun CCS (Joint Venture Carbon Aceh & PEMA),
- Ramba CCUS (Pertamina),
- Central Sumatera Basin CCS/CCUS Hubs (Pertamina & Mitsui),
- Asri Basin CCS Hubs (Pertamina & ExxonMobil),
- East Kalimantan CCS/CCUS Study (Pertamina & Chevron),
- East Kalimantan CCS/CCUS Study (Kaltim Parna Industri & ITB), surface facility study
- CCU to Methanol RU V (Pertamina & Air Liquide)
- CCUS CO₂-EOR Gemah
- CCUS CO₂-EOR Jatibarang (Pertamina & JOGMEC), ongoing field trial

MT = million tons; MTPA = million tons per annum

Sweden *

Key climate policy targets

- 85 % reduction target by 2045, baseline 1990, after 2045 negative emissions
- CCS important technology to reduce emissions in otherwise hard to abate sectors
- Bio-CCS important as supplementary measure, most likely the biggest source – large potential at least 10 millions tonnes p.a. 2030

Government actions and assignments CCS

- National centre for CCS as a part of the Swedish Energy Agency
- Treaty with Norway – London protocol
- Reporting and accounting (Swedish Energy Agency & The Swedish Environmental Protection Agency)

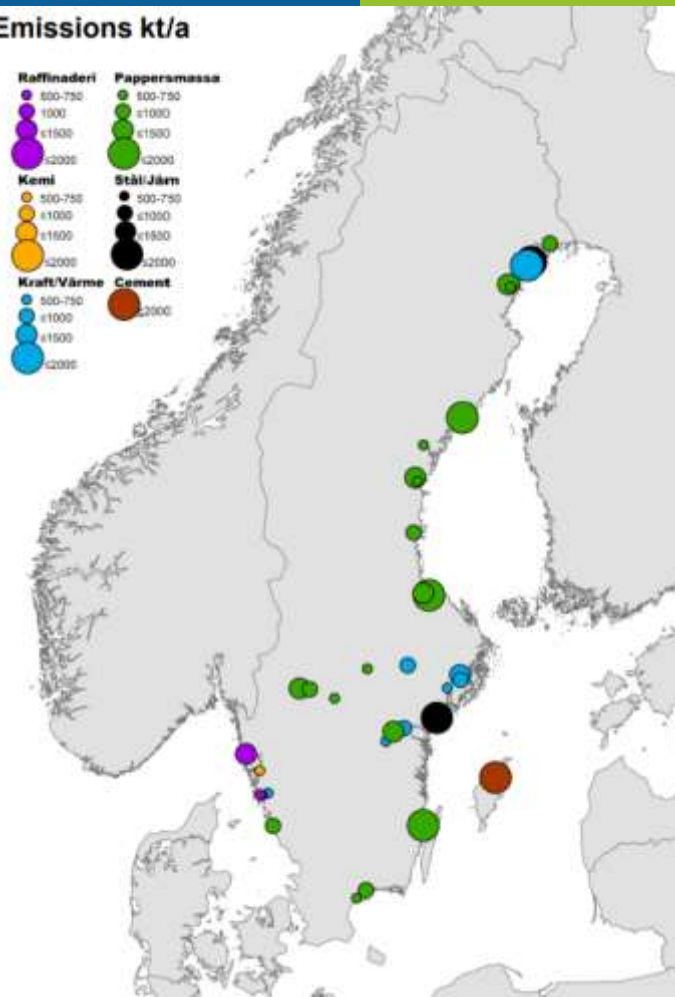
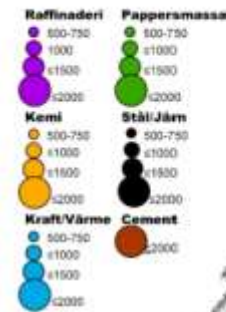
Deployment policies and programmes in place

- The Industrial Leap shall support huge and complex technology leaps, focus on carbon dioxide intensive industries, long term 2018-2040. 70 million €/year 2020-2022 whereof 10 million €/year to bio-CCS.
- Support scheme for bio-CCS. Reverse auctions first auction 2023.

Priorities going forward:

- Reporting and accounting, Article 6, facilitate a market for CDR-all connected.

Emissions kt/a



Raffinaderi=Refinery
Pappersmassa=Pulp and paper
Kemi=Chemistry
Stål/Järn=Iron/steel
Kraft/Värme=Heat & Power
Cement=Cement

(From Johnsson & Kjærstad, 2019)

Sweden total emission 51 Mt CO₂e

Future and ongoing projects

- Stockholm Exergi full scale bio-CCS facility about 800 000 tonnes p.a.
- Several feasibility studies on bio-CCS – first step to participate in auction, mainly CHP and WtE
- Test facilities on plants

* Situation September 2022

Brief overview of CEM CCUS Initiative

Clean Energy Ministerial CCUS Initiative

Fourteen Member Countries:

Lead countries



Norway



Saudi Arabia



United Kingdom



United States

Participating Members



Australia



Canada



China



EU Commission



Japan



Mexico



Netherlands



Nigeria



South Africa



United Arab Emirates

Other countries and Partners:

Links to further countries: Brazil, Denmark, Finland, Germany, India, Indonesia, Malaysia, Singapore, Sweden etc.

Industry: Oil and Gas Climate Initiative, Global Cement and Concrete Association, worldsteel

Financial institutions: Multilateral Development Banks, private banks, investment firms

Organizations: Carbon Sequestration Leadership Forum (CSLF), International Energy Agency (IEA), IEA Greenhouse Gas R&D Programme (IEAGHG), Mission Innovation (MI), Global CCS Institute (GCCSI)

CEM CCUS Initiative: accelerating CCUS together by:



Actively **including CCUS** within Clean Energy Ministerial agenda and global clean energy discussions.



Facilitating identification of both near and longer-term **investment opportunities**.



Bringing **together** governments, the private sector and the investment community.



Disseminating **best practice** in CCUS policy, regulation and investment.

Disseminating country experience and facilitating dialogue

MEMBERS' MEETINGS: MONTHLY AND ANNUAL

Australia

- Introduction to Australia's CCUS landscape
- Key projects: SINOPEC, Gorgon, and others
- Government support and regulatory framework

Denmark

- CCUS as a key technology for decarbonization
- Major projects: CO2m, NEMO, and others
- Government strategy and public acceptance

India

- Government's commitment to CCUS
- Key projects: Chandrapur, Baramulla, and others
- Regulatory and financial challenges

Nigeria

- CCUS for industrial decarbonization
- Key projects: Dangote Cement, and others
- Government strategy and public acceptance

REGIONAL WORKSHOPS

Workshop summary

Accelerating CCUS in fossil-fueled regions and the Gulf Region

Workshop on 11 January 2020

Hosted by: Clean Energy Solutions Center

Location: Doha, Qatar

The workshop focused on the challenges and opportunities of CCUS in fossil-fueled regions and the Gulf Region. It brought together experts from various countries to discuss the technical, economic, and policy aspects of CCUS. Key topics included:

- Current status of CCUS in fossil-fueled regions
- Technical challenges and opportunities
- Economic and policy considerations
- Role of government and industry

Workshop agenda

Accelerating CCUS in fossil-fueled regions and the Gulf Region

Workshop on 11 January 2020

Hosted by: Clean Energy Solutions Center

Location: Doha, Qatar

09:00 Registration & Welcome coffee

09:30 Breakfast networking

10:00 Presentation: Strengthening CCUS in fossil-fueled regions

10:30 Keynote: Accelerating CCUS in fossil-fueled regions and the Gulf Region

11:00 Coffee break

11:30 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

12:00 Lunch

12:30 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

13:00 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

13:30 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

14:00 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

14:30 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

15:00 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

15:30 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

16:00 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

16:30 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

17:00 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

17:30 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

18:00 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

18:30 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

19:00 Panel discussion: Accelerating CCUS in fossil-fueled regions and the Gulf Region

WEBINARS: TO DISSEMINATE EXPERIENCE

Clean Energy Solutions Center

19 videos • 1.57K views • Last updated on Mar 12, 2022

CEM: Carbon Capture, Utilization and Storage

19 videos • 1.57K views • Last updated on Mar 12, 2022

Multilateral Development Banks as Drivers for CCUS

Approaching Final Investment Decision: CCUS Developments in Norway

Financing CCUS - A Key Clean Technology for Industry

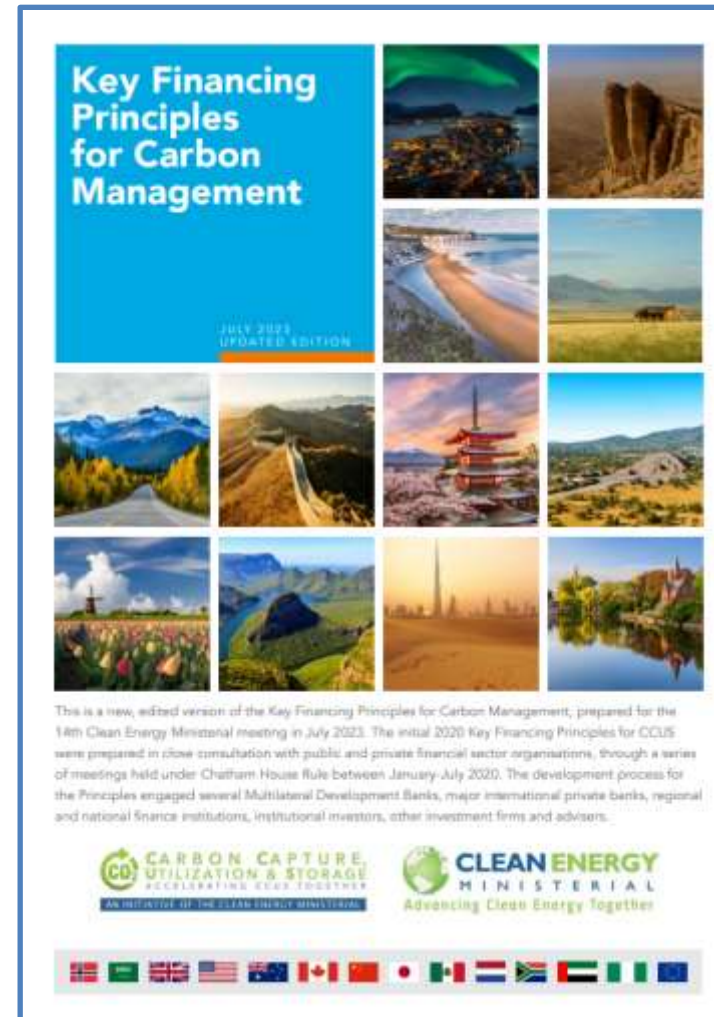
Romess Carbon Renewal and Storage (RCRS)

Environmental, Social, and Governance (ESG) Assessments and CCUS

Updated “Key Financing Principles for Carbon Management”

Ten key principles to be considered by governments, industry and the finance sector, to

- support the establishment of a business case for carbon management and
- kick-start the financing of CCUS projects globally.



Released at the 14th Clean Energy Ministerial meeting in Goa, India, July 2023.

Document available on CEM website:

<https://www.cleanenergyministerial.org/initiatives-campaigns/carbon-capture-utilization-and-storage/>



<https://www.linkedin.com/company/clean-energy-ministerial-ccus-initiative/>



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<https://www.youtube.com/user/cleanenergypolicy/playlists>



info@cemccus.org