CCS TARGETING CLIMATE CHANGE

BRIEF FOR POLICYMAKERS

GLOBAL CCS INSTITUTE

GLOBAL STATUS OF CCS 2019 TARGETING CLIMATE CHANGE

ABOUT THE GLOBAL CCS INSTITUTE

The Global CCS Institute is an international think tank whose mission is to accelerate the deployment of carbon capture and storage (CCS), a vital suite of technologies to tackle climate change.

Working with and on behalf of our Members, we drive the adoption of CCS as quickly and cost effectively as possible; sharing expertise, building capacity and providing advice and support so CCS can play its part in reducing greenhouse gas emissions.

Our diverse international membership includes governments, companies, research bodies and nongovernmental organisations; all committed to CCS as an integral part of a net-zero emissions future.

FIND OUT MORE

For more information on CCS, including its progress and key developments as well as key information on Facilities and its various applications, download the full 2019 Global Status of CCS Report at globalccsinstitute.com/statusCCS19.

The Global CCS Institute provides knowledge, data, networking and advocacy services to its members and offers a comprehensive range of consultancy services related to CCS. To connect with the Global CCS Institute to arrange a briefing, please contact us in your region:

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GLOBAL CCS INSTITUTE

GLOBAL STATUS OF CCS REPORT 2019: KEY FINDINGS

CCS FACILITIES AROUND THE WORLD

There are now 51 large-scale CCS facilities globally. These include 19 in operation, four under construction, and 28 in various stages of development. Of all the facilities in operation, 17 are in the industrial sector and two are in power.

51

IN OPERATION 19

IN CONSTRUCTION 4

VARIOUS STAGES OF DEVELOPMENT 28

The Americas continue to lead the way with 24 large-scale CCS facilities in operation and various stages of development, followed by 12 in Europe, 12 in Asia Pacific, three in the Middle East.

24 AMERICAS

12 APAC

3 MIDDLE EAST

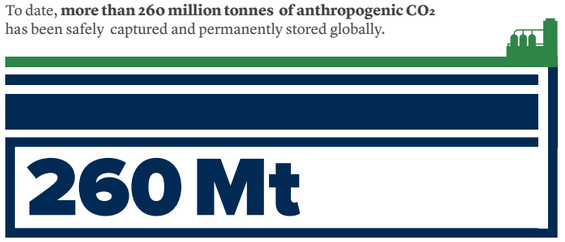
12 EUROPE

CCS developments, innovation milestones and project announcements across **natural gas, waste to energy, hydrogen production, direct air capture and more.**

STATUS OF CO_2 CAPTURE

The total capture capacity of all large-scale CCS facilities at all stages of development has risen by 51 per cent since 2017, which equals 97.5 million tonnes per annum (Mtpa) of CO_2.

To date, **more than 260 million tonnes of anthropogenic CO_2** has been safely captured and permanently stored globally.



HUBS AND CLUSTERS

The next wave of CCS facilities will most likely be characterised by hubs and clusters. Instead of relying on a single sink, single source model, hubs and clusters aggregate emissions from numerous industrial and power plants. **This model will help reduce operational and commercial risks and lead to lower costs through economies of scale.**

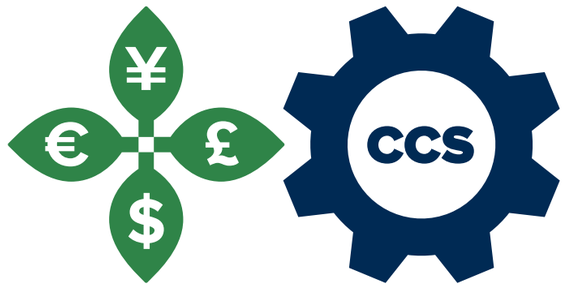
DELIVERING GLOBAL CLIMATE CHANGE TARGETS

An estimated 2,000+ large-scale CCS facilities, capturing more than 2,000 Mtpa of CO_2, are needed to achieve global climate targets.

Energy-related CO_2 emissions rose by 1.7 per cent globally in 2018, underlining the urgency with which the world must reduce emissions to achieve net-zero emissions by mid-century.

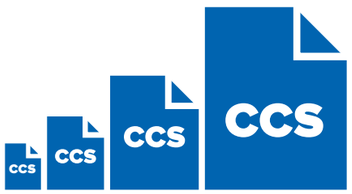
FINANCE

CCS is entering the sustainable finance discussions. **It is being recognised as an important clean energy technology under environmental, social and governance criteria with proposed inclusion in the Sustainable Finance Taxonomy in Europe.**



POLICY

Policy confidence is improving with CCS-specific policies being introduced on national and sub-national levels in countries around the world.



2019 saw a major milestone accomplished for cross-border transport and storage of CO_2 when parties to the London Protocol decided to allow provisional application of the 2009 amendment of Article 6, thereby **enabling countries to export CO_2 streams for offshore geological storage.**

ABOUT CARBON CAPTURE AND STORAGE (CCS)

DELIVERING ON AMBITIOUS GLOBAL CLIMATE CHANGE TARGETS REQUIRES URGENT ACTION TO PREVENT CO_2 FROM ENTERING THE ATMOSPHERE AND ACHIEVE NEGATIVE EMISSIONS.

CCS technology is versatile in its application, commercially available today and delivers the large-scale emissions abatement required to meet global climate goals.

HOW CCS WORKS

CCS is a proven and safe technology that prevents carbon dioxide (CO_2) from being released into the atmosphere. The technology involves capturing CO_2 produced by large industrial plants such as steel mills, cement plants, coal and natural gas fired-power plants, and refineries, compressing it for transportation and then injecting it deep underground - at least 800m below the surface - into a carefully selected and safe geological storage site, where it is permanently stored through being trapped in porous rock. CCS has three major components:

1

CAPTURE

Capture involves the separation of CO_2 from other gases produced at large industrial process facilities such as coal and natural-gas-fired power plants, steel mills, cement plants and refineries.

2

TRANSPORT

Once separated, the CO_2 is compressed and transported via pipelines, trucks, ships or other methods to a suitable site for geological storage.

3

STORAGE

CO_2 is injected into deep underground rock formations at depths of 800m or more.

WHY DO WE NEED CCS?

VITAL

CCS is vital to reduce emissions to net-zero by mid-century and achieve global climate change targets. The Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5°C clearly underlined that it is no longer possible to mitigate dangerous climate change by focusing only on reducing emissions; we must eliminate emissions to get to net-zero by 2050 and for that the world conclusively needs carbon dioxide removal (CDR). Indeed, all four IPCC Special Report 15 Illustrative Pathways have CDR and three of them include CCS at scale.

VERSATILE

CCS is versatile in its application and can contribute to meeting climate targets through three different ways:

1. It can help to reduce emissions dramatically from power generation and industry. In fact, in some sectors of industry such as steel and cement it is the key decarbonisation option available today.
2. In combination with direct air capture (DAC) or bioenergy (BECCS), carbon capture technologies can help remove carbon dioxide from the air and store it underground to deliver negative emissions.
3. CCS enables the production of low-carbon hydrogen from fossil fuels or biomass, which can be used as a fuel in industry, home heating and transportation and when combusted only produces heat and water. As a result, CCS can open the door to a new energy economy, one that creates jobs and sustains communities.

PROVEN

CCS technologies have been in operation since the 1970s. The current capture capacity in operation is around 40 Mtpa and close to 260 Mt of anthropogenic CO_2 has been captured and stored to date.

ENABLER

CCS is a conduit to a new clean energy economy (e.g. clean hydrogen, chemicals, fertiliser production). Investment in CCS enables the re-use of existing infrastructure, retaining people in jobs and sustaining communities. CCS deployment creates new high paying jobs and ensures industrial competitiveness.

"Over the last 20 years, the role of carbon capture and storage has evolved from "nice to have," to "necessary,"and now, CCUS is inevitable."

Professor Sally Benson
Co-Director, Precourt Institute for Energy;
Director, Global Climate & Energy Project;
Professor, Energy Resources Engineering Department;
Senior Fellow, Precourt Institute for Energy,
Stanford University

CCS IS VITAL TO ACHIEVE GLOBAL CLIMATE CHANGE TARGETS

Despite both the urgent need for action to mitigate climate change, and the rapid take-up of renewable energy over the past 20 years, there has been no reduction in global greenhouse gas emissions. Approximately 80 per cent of primary energy is still supplied by fossil fuels, the same as 45 years ago. Global energy-related CO_2 emissions are on an upward trend again—having temporarily stabilised for a few years, they rose by 1.7 per cent in 2018[1]. Current government commitments do not bridge the gap between current emissions and the remaining global carbon budget.

Analysis by the IPCC and International Energy Agency (IEA) has consistently shown that CCS is an essential technology towards meeting climate targets. The IPCC's Fifth Annual Assessment Report (AR5) showed that excluding CCS from the portfolio of technologies used to reduce emissions would lead, on average, to a doubling in cost - the largest cost increase from the exclusion of any technology.

The 2018 IPCC SR15 Report[2] reinforced the important role of CCS in avoiding the dangerous impacts of climate change. It underlined that reducing emissions alone is no longer enough. To limit global temperature rises to 1.5°C above pre-industrial levels, the world must reach net zero emissions by 2050. Most modelling scenarios show that this will require significant deployment of carbon removal technologies.

ANALYSIS BY THE IPCC AND INTERNATIONAL ENERGY AGENCY (IEA) HAS CONSISTENTLY SHOWN THAT CCS IS AN ESSENTIAL TECHNOLOGY FOR MEETING CLIMATE TARGETS.

BENEFITS OF CCS DEPLOYMENT

To meet climate mitigation targets, an estimated 2000-plus large-scale CCS facilities must be deployed by 2040.

CCS provides a wealth of benefits in addition to its ability to significantly reduce CO_2 emissions in key sectors of the global economy. It enables a just transition to a low-carbon economy for communities economically reliant on emissions intensive industries. It can protect people from the severe economic and social disruption that otherwise results from closing local industries.

CCS CREATES JOBS

Supports high paying jobs, supports employment retention and creates new employment opportunities.

CCS REDUCES OPERATIONAL COSTS

Reduces total system costs of electricity supply by providing reliable, dispatchable generation capacity when fitted to flexible fossil fuel power plants.

CCS EXTENDS EXISTING INFRASTRUCTURE

Utilises existing infrastructure that would otherwise be decommissioned, helping to defer shut-down costs.

CCS UNLOCKS CLEAN GROWTH

Provides knowledge spill overs that can support innovation-based economic growth.

CCS IS DEPLOYED AROUND THE WORLD

The world map shown on these pages demonstrates the global deployment of CCS. In 2019, the number of large-scale CCS facilities increased to 51 from 43 in 2018. Of these:

- 19 are operating;
- four are under construction;
- 10 are in advanced development using a dedicated front-end engineering design (FEED) approach; and
- 18 are in early development.

The facilities currently in operation have the capacity to capture and permanently store around 40 million tonnes of CO_2 every year. This is expected to increase by about one million tonnes in the next 12-18 months. In addition to the large-scale facilities, there are also 39 pilot and demonstration scale CCS facilities (operating or about to be commissioned) and nine CCS technology test centres.

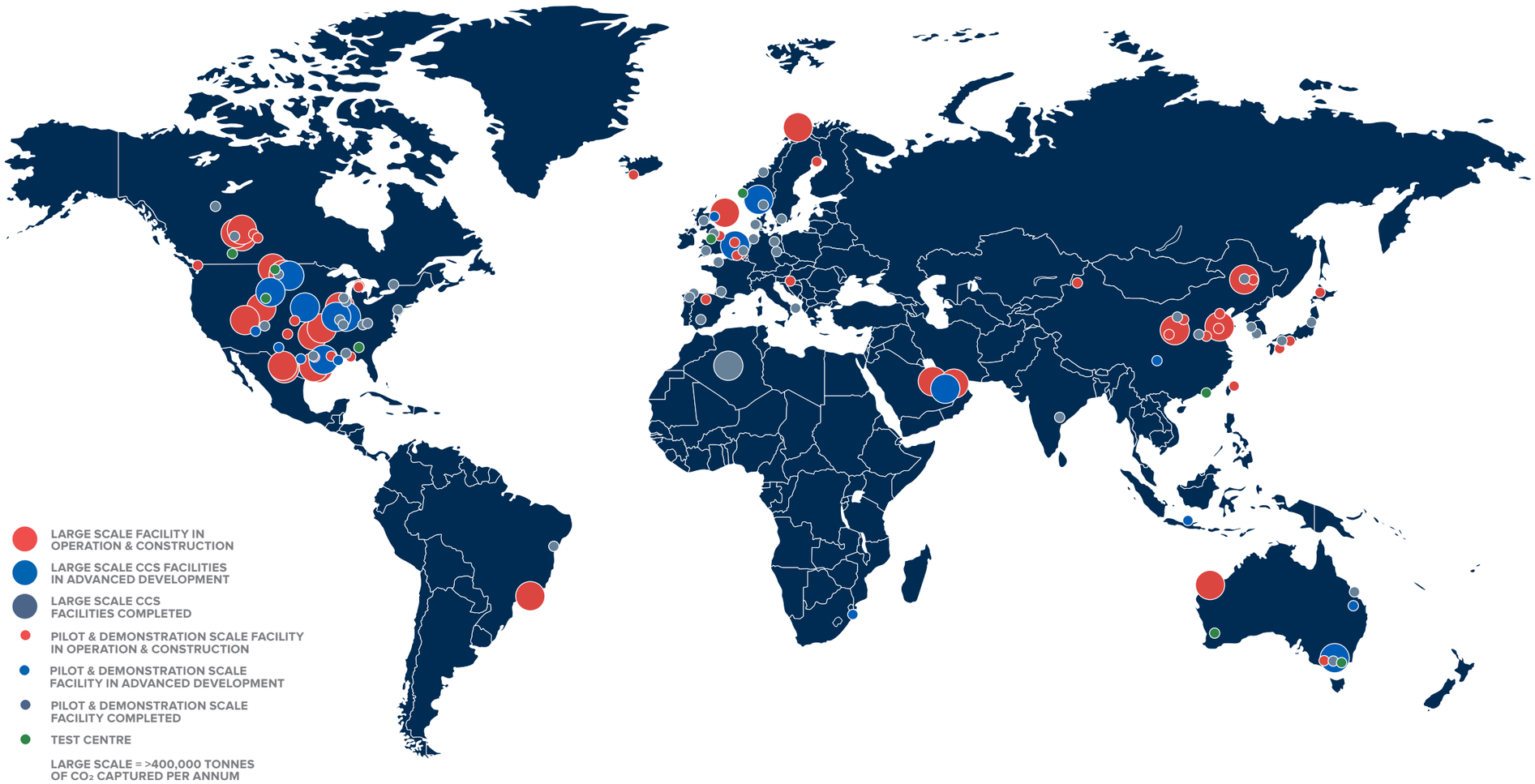


FIGURE 1 CURRENT CCS FACILITIES AROUND THE WORLD[5]

KEY REGIONAL DEVELOPMENTS

THE AMERICAS

- Home to 13 of the world's large-scale operating CCS facilities.
- In the US, policy confidence and sustained government support is driving project announcements, with eight facilities added to the Institute's database (co2re.co) in 2019.
- Several of these new facilities came as a result of policy confidence provided through incentive mechanisms such as the 45Q tax credit and California's Low Carbon Fuel Standard's CCS Protocol.
- Further policy proposals focusing on CO_2 transportation infrastructure as well as financing mechanisms are being discussed at the US federal level, while states are introducing key climate and CCS policies as well.

EUROPE

- Europe experienced a resurgence of CCS in the climate and energy policy discussions in 2019, framed by the inclusion of the technology in the European Commission's Long-Term Strategy for a climate neutral Europe.
- Two operating large-scale CCS facilities in Europe, both in Norway, with an additional 10 large-scale CCS facilities are in various stages of development in Ireland, the Netherlands and UK.
- Several of these facilities in planning involve hydrogen production, and most of the European CCS facilities in the pipeline are focused on decarbonising major European industrial clusters.
- The EU's Innovation Fund is expected to become one of the world's largest funding programs for low-carbon technologies including CCS. The UK is also assessing the design of business models to bolster the commercial case for CCS.
- In November, the European Commission released its 4th Projects of Common Interest list in which five CO_2 transport and storage network development projects were featured; these projects will have access to Connecting Europe Facility funding.
- In the UK, there are six facilities are under development, a number of which involve industrial hubs and clusters. After the launch of the CCUS Action Plan in 2018, several milestones were achieved in 2019, most notably the legislation of a 2050 UK net-zero target and the consultations on business models and infrastructure re-use for CCUS.

MIDDLE EAST

- Two large-scale CCS facilities are operating, one in the United Arab Emirates (UAE) on iron and steel production, and one in Saudi Arabia on natural gas processing.
- In 2019, one new CCS facility in the Middle East was added to the Institute's database. Based in the UAE, it will capture emissions from natural gas processing.

ASIA PACIFIC

- Australia welcomed the start-up of world's 19th large-scale CCS project Gorgon. When fully operational, this facility will be the largest dedicated geological storage facility in the world with a capture capacity of 3.4-4 Mtpa.
- In China, the government published an updated CCUS Roadmap with several CCS projects going ahead.
- Japan continues to pursue CCS as part of its ambition to transition to a hydrogen society. With Japan hosting this year's G20, CCS was included for the first time in the Summit's final communique.

THE CCS FACILITIES PIPELINE IS REPLENISHING, BUT NOT FAST ENOUGH

THE CCS PIPELINE

The CCS industry has been regaining momentum since 2017 and there are roughly four times as many large-scale CCS facilities operating today than there were in 2010. Several factors have driven the increase in CCS project development observed in 2018 and 2019.

The 2015 Paris Agreement established a clear level of ambition to limit global warming, refocusing governments, the private sector and civil society towards climate mitigation. In 2018, the pivotal IPCC Special Report on Global Warming of 1.5°C exposed the urgent need for stronger climate policy development. It provided scientific evidence of the threat of global warming, creating further impetus to reduce emissions, and facilitated increased movement of capital into the low-carbon transition.

CCS, as a versatile suite of technologies that reduce emissions from industry, power generation and hydrogen production and enable negative emissions through BECCS and DAC, is an essential solution for mitigating climate change. Figure 3 demonstrates the versatility of CCS across a range of industrial applications and displays the pipeline of CCS large-scale facilities expected to come online in the coming years.

While the recent uptick in investment in CCS is encouraging, it is far from enough to meet climate targets. The IEA's 'Tracking Clean Energy' progress indicator[3], provides a status snapshot of 39 critical energy technologies needed to meet a less than 2°C target under its Sustainable Development Scenario (SDS). Only seven of the technologies assessed are "on-track". Critically CCS in power, and in industry and transformation, are "off-track". To achieve the levels outlined in the SDS, the number of industrial scale facilities needs to increase one hundredfold, from 19 in operation now to more than 2,000 by 2040.

If all facilities in the CCS pipeline now (see Figure 3) were operational in 2040 and no more entered the pipeline, CO_2 capture capacity would still be approximately a factor of 20 below what is required. There is an urgent need for stronger government policy to incentivise private sector investment in CCS.

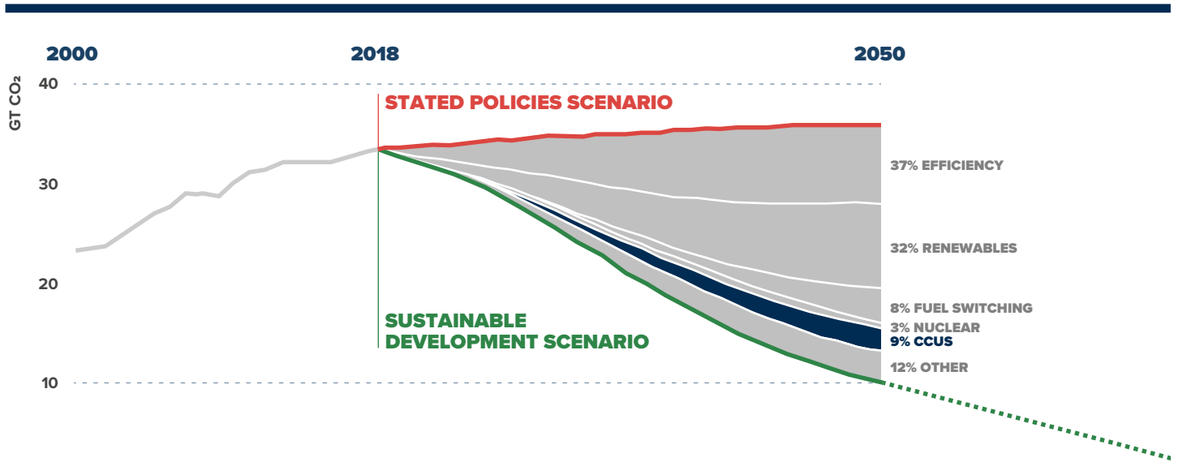


FIGURE 2 EMISSIONS REDUCTIONS IN THE IEA'S SUSTAINABLE DEVELOPMENT SCENARIO (SDS)[4]

Note: CCUS (carbon capture utilisation and storage)

SUPPORTIVE POLICY IS URGENTLY NEEDED

While the critical role of CCS has been demonstrated by the IPCC, the IEA and others, the policies in place today are insufficient to ensure CCS deployment at scale in the timelines required to achieve global climate targets. Looking ahead, there are multiple ways to support CCS deployment with the right policy framework.

1. PLACING A VALUE ON EMISSION REDUCTIONS

A fundamental part of any policy framework to support climate change mitigation is the presence of a sufficient value on carbon. Without this, there is no incentive to reduce emissions. Policymakers have a wide range of policy options to choose from when putting a value on carbon, including carbon taxes, emissions trading and tax credits or payments linked to delivered emission reductions.

2. MOBILISING EARLY INVESTMENT

Like all large infrastructure projects, the development and construction of CCS facilities is capital intensive. Governments will need to play a key role in facilitating the early deployment of CCS as, compared to mature industries, there is relatively limited experience developing commercial CCS facilities. Until risks are perceived to be well managed, banks are unwilling to qualify CCS projects for debt financing or offer competitive interest rates to project developers. By working collaboratively with the private sector— which is well placed to manage general project risks such as technical, construction and operational performance risks—governments can play a pivotal role in risk-sharing, enabling private sector investment.

3. ADDRESSING HARD TO REDUCE RISKS

Robust policy frameworks can address market failures that lead to hard-to-reduce risks, such as cross-chain, and long-term liability risks. Government can de-risk investments by taking on risks that cannot be borne by the private sector; for example, cross-chain risk can be mitigated through the development of shared transport and storage networks, and liability risk can be reduced through robust legal and regulatory frameworks.

To explore further detail on policy priorities for policymakers and how to stimulate investment in CCS, download our 2019 **Thought Leadership Report Policy** priorities to incentivise large scale deployment of CCS at globalccsinstitute.com

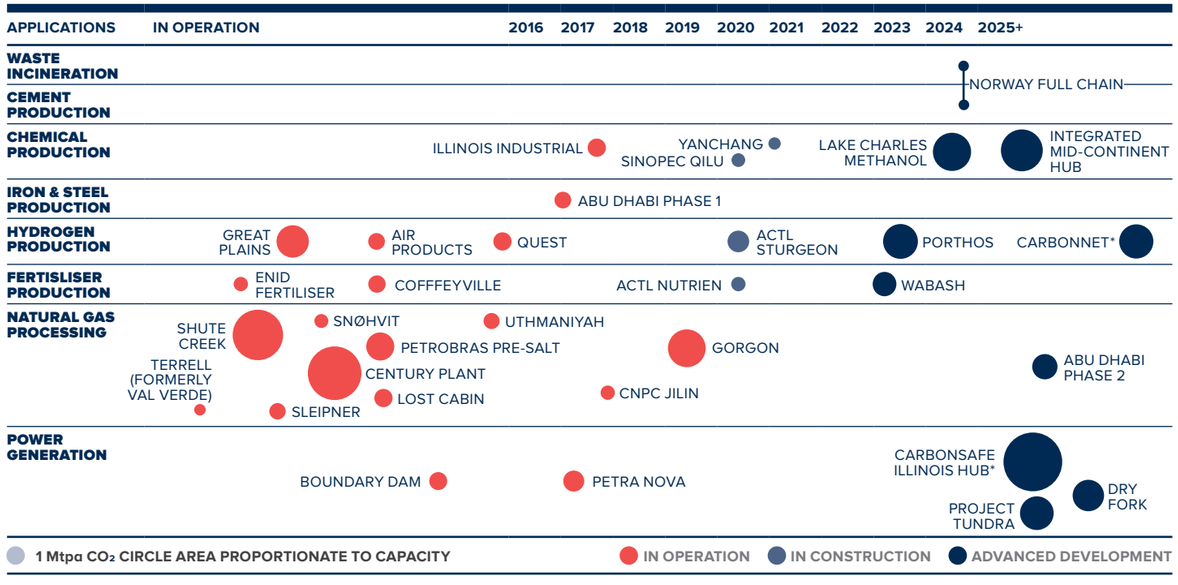


FIGURE 3 POWER AND INDUSTRIAL APPLICATIONS OF LARGE-SCALE CCS FACILITIES IN OPERATION, UNDER CONSTRUCTION AND IN ADVANCED DEVELOPMENT

*Size of the circle is proportional to the capture capacity of the facility. Indicates the primary industry type of the facility among various options.

REFERENCES

1. International Energy Agency (2019), *Global Energy and CO_2 Status Report*, accessed from <https://www.International Energy Agency.org/geco/>.
2. Intergovernmental Panel on Climate Change (2018), *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change*, accessed from <https://www.ipcc.ch/sr15/>.
3. International Energy Agency (2019) *Tracking Clean Energy Progress*, accessed from <https://www.International Energy Agency.org/tcep/>.
4. International Energy Agency (2019), *World Energy Outlook 2019*, available at <www.International Energy Agency.org/ weo>.
5. Data from the Global CCS Institute CO_2RE database as of November 2019 (Global CCS Institute 2019a).

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