GLOBAL CCS INSTITUTE

THE GLOBAL STATUS OF CCS

FEBRUARY 2014

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EXECUTIVE SUMMARY

This report, *The Global Status of CCS: February 2014*, summarises the current status of large-scale integrated carbon capture and storage (CCS) projects worldwide and provides an overview of significant international CCS project and policy, legal and regulatory developments.

CCS is essential if we are to keep global temperature increases below two degrees Celsius. It is a vital part of a least cost portfolio of low-carbon technologies required to deal with climate change. In the past few months there have been a series of expert reports acknowledging this reality. A broad chorus of leading voices is to be welcomed, especially if it encourages decision makers to take action to progress CCS technology. Despite continuing progress in large-scale CCS projects moving into construction and operation in most regions, the overall global effort to date has been slower than ideal.

Nonetheless, there are positive signals that decision makers may act to accelerate CCS implementation. The 5th Carbon Sequestration Leadership Forum (CSLF) Ministerial Meeting in November 2013 emphasised the importance of CCS in tackling climate change and identified actions to reenergise the global momentum for the deployment of CCS. This is needed to support existing activity and advance new projects.

As of February 2014 there are 12 projects in operation globally, nine under construction and another 39 in various stages of development planning, of which six may make a final investment decision during 2014. The 21 projects in operation or under construction represent a 50% increase since 2011, a sign of growing confidence in the application of CCS technology at large scale.

North America is leading in the implementation of CCS technology and China is quickly increasing in importance. Momentum has been regained in the United Kingdom (UK) though prospective project start dates are towards the end of this decade. Continental Europe on the other hand has lost a project leadership position that it aspired to several years ago, though the importance of CCS technologies at large scale and continued robust research and development efforts have been recognised by a number of European bodies in recent months.

The first large-scale CCS projects in the power sector – the Boundary Dam Integrated Carbon Capture and Sequestration Project and the Kemper County Integrated Gasification Combined Cycle (IGCC) Project – are nearing operational status in North America. These projects are of global importance to the development of CCS. Similarly, in the Middle East, the world's first large-scale CCS project in the iron and steel sector has progressed into construction.

Projects such as these will build confidence by showing the technology in action, and through innovation combined with advances in capture technology, bring down costs.

Notwithstanding the significant progress in CCS development in recent years, the momentum for further development and widespread deployment must be increased. CCS has a vital role to play in a portfolio of low-carbon technologies to tackle climate change at least cost to the world economy.

Key actions that would act as a stimulus to momentum include:

- boosting short-term support for the implementation of demonstration projects globally, especially in continental Europe where project development has stalled
- introducing long-term commitments to climate change mitigation and strong policy action and market-based mechanisms that ensure CCS is not disadvantaged compared to other low-carbon technologies
- implementing measures to deal with the remaining critical regulatory uncertainties, such as long-term liabilities, and
- continuing funding support for CCS research and development activities along with fostering collaborative approaches to knowledge sharing.

CCS IS VITAL

In our *Global Status of CCS: 2013* report the Institute emphasised that the urgency for action to reduce carbon dioxide (CO_2) emissions continues to grow as each year passes. Achieving decarbonisation at least cost is a challenge requiring the use of a number of clean energy solutions, including the use of CCS with fossil fuels and biomass. Over the past few months a substantial number of independent studies and reports by government and industry bodies have reinforced these points.

1. The International Energy Agency (IEA) in its *World Energy Outlook* 2013 notes:

   'Carbon capture and storage (CCS) has been identified as an essential technology to meet the internationally agreed goal of limiting the temperature increase to 2°C. Deploying CCS technologies and retrofitting fossil fuel plants with CCS avoids the need to retire large parts of this fleet prematurely. This improves the economic feasibility of attaining the climate objective….. However, progress in developing CCS has been disappointingly slow.'

   'Beyond 2020, when demonstrated and deployed at new high efficiency plants, or retrofitted at suitable existing plants, CCS may play a key role in curbing CO_2 emissions from coal-based power generation and industry…..potentially reducing the overall cost of power sector decarbonisation by around US$1 trillion between 2012 and 2035.'

2. The World Energy Council (WEC) *World Energy Insight 2013* notes:

   'For Energy Sustainability and Environmental Impact mitigation there is a clear differentiation [between the scenarios]. In Jazz, CO_2 emissions only level out at the end of the period; the world continues to depend on fossil fuels and will have to focus on adaptation to climate change. In Symphony, CO_2 emissions begin to drop before 2030 and we get close to achieving the 450 ppm atmospheric stabilisation level for CO_2.… in Symphony we do see a big increase in renewables especially solar, wide adoption of Carbon Capture and Storage, and progress with nuclear.'

   WEC adopted a musical theme for its two scenarios to 2050. As an energy scenario, 'Jazz' has a focus on energy equity, with priority given to achieving individual access and affordability of energy through economic growth. As an energy scenario, 'Symphony' has a focus on achieving environmental sustainability through internationally coordinated policies and practices.

3. The Energy Modeling Forum (EMF) 27 *Study on Global Technology and Climate Policy Strategies* notes:

   'A robust finding [of the study] is that the unavailability of carbon capture and storage and limited availability of bioenergy have the largest impact on feasibility and macroeconomic costs for stabilizing atmospheric concentrations at low levels'

   '..a substantial number of models were not able to produce 450 ppm without CCS. Indeed, the vast majority of situations in which models could not produce scenarios were those in which CCS was assumed to be unavailable'

   '….unlike other technologies assessed in this study, it is a very versatile technology that has the potential to contribute to decarbonization via different processes, such as electricity generation and synthetic fuel production from different feedstock and in industry.'

   The EMF27 project is a global model comparison exercise that includes a worldwide consortium of research institutes and is led by the Stanford Energy Modeling Forum, the Potsdam Institute for Climate Impacts Research, International Institute for Applied Systems Analysis, among other institutes.

4. In the UK, the independent Committee on Climate Change reviewed updated evidence on cost-effective abatement potential and notes:

   'There is scope for significant cost reduction such that offshore wind and CCS become cost effective compared to gas generation under central carbon prices during the 2020s or soon after. These technologies are potentially important in the long run, suggesting that deployment to drive down costs is desirable.'

5. The European Commission (EC) highlights the importance of CCS in its *Policy Framework for Climate and Energy in the period from 2020 to 2030*, stating that CCS may be the only option available to reduce direct emissions from industrial processes at the large scale needed in the longer term. The framework also endorses increased research and development efforts and commercial demonstration of CCS, stating they are *'essential over the next decade so that it can be deployed in the 2030 timeframe'*.

6. In the US, an emphasis on research and development is highlighted in the *U.S. Climate Action Report 2014* where research and development efforts across a wide range of innovative low-carbon technologies in advanced fossil fuel and renewable energy are highlighted, leading the report authors to state:

   'When transformational CCS technologies emerge, a relatively modest "price" for CO_2 is expected to be adequate for CCS to be cost-effective without CO_2 utilization'.

In addition to these important analyses and policy documents, the Ministerial communiqué following the 5th meeting of the CSLF Ministers in November 2013 clearly emphasised the importance of CCS in tackling climate change and the need to increase implementation momentum. The CSLF is currently comprised of 23 members, including 22 countries and the EC.

Specifically, the communiqué stated:

'We, the Ministers and Heads of Delegation of the CSLF Members, are convinced that the research and development (R&D), demonstration and global deployment of Carbon Capture and Storage (CCS) must be accelerate... We are committed to taking necessary actions individually and collaboratively to promote the further development and deployment of CCS.'

'Building on valuable experience gained during the past decades, the next seven years are critically important for creating the conditions for CCS to be ready for large-scale deployment by the end of the decade. Our common goal is to ensure that the conditions are right for all CCS projects currently under construction or in advanced stages of planning to be completed, and we must increase the number of new large CCS demonstrations by 2020 to expand commercial deployment in the 2020's.'

Much of today's large-scale project activity reflects policy actions taken 5-10 years ago. This was supported primarily by economic stimulus programs and partnerships with industry, created in the aftermath of the global financial crisis. Reaffirmation of the importance of CCS and calls to increase momentum in its implementation are important; however, in order for this to become a reality governments must take further action on policy and regulatory frameworks needed to support CCS investments in markets worldwide.

PROJECTS, POLICY AND MARKETS

Overall, there are 21 'active' large-scale CCS projects (those in operation or under construction) globally, with a total capture capacity of almost 40 million tonnes of CO_2 per annum (Figures 1, 2 and 5).

There are currently 12 large-scale projects operational in markets around the world with one more project expected to begin operation in the first half of 2014 and another later in the year. The two CCS projects nearing operation, located in North America, mark a particularly important development as they are the first CCS projects to be developed at large scale in the power sector.

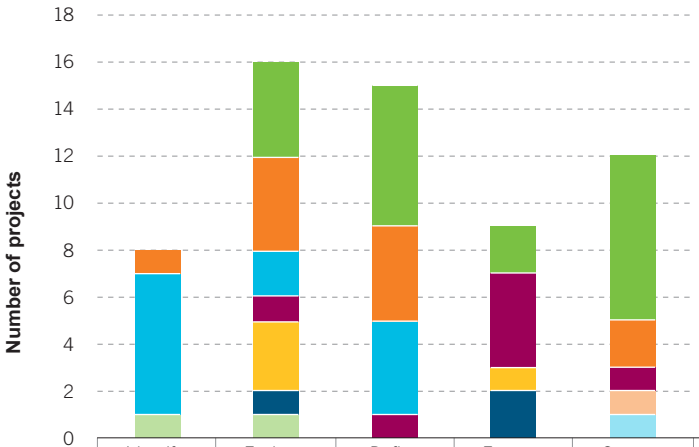
Another significant development is that a large-scale CCS project in the iron and steel sector has progressed to the 'Execute' or construction stage. This project, located in the Middle East, takes the number of projects in execution to nine (including the two above mentioned projects in the power sector).

There are indications that the steady progress of large-scale CCS projects into construction will continue. Six projects in advanced stages of development planning, with a combined capture capacity of over 10 million tonnes of CO_2 per annum, may be in a position to make a final investment decision during 2014. These are the Lake Charles CCS Project, the NRG Energy Parish CCS Project and the Texas Clean Energy Project in the United States (US), the Yanchang Integrated Carbon Capture and Storage Demonstration Project and the Sinopec Qilu Petrochemical CCS Project in China, and the ROAD Project in the Netherlands.

In the UK, one project has advanced into front end engineering design (FEED) and another may do so shortly. In continental Europe, however, a number of projects have been cancelled or put on hold in recent months. The decline in projects in continental Europe contributed almost exclusively to a reduction to 60 in the number of large-scale CCS projects worldwide monitored by the Institute as of February 2014, compared to 65 in the October 2013 report (Figures 1 and 2).

FIGURE 1 Large-scale CCS projects by project lifecycle and year

FIGURE 2 Large-scale CCS projects by project lifecycle stage and region/country as of February 2014



	Identify	Evaluate	Define	Execute	Operate	**Total**
United States	0	4	6	2	7	**19**
Europe	1	4	4	0	2	**11**
China	6	2	4	0	0	**12**
Canada	0	1	1	4	1	**7**
Australia	0	3	0	1	0	**4**
Middle East	0	1	0	2	0	**3**
Other Asia	1	1	0	0	0	**2**
South America	0	0	0	0	1	**1**
Africa	0	0	0	0	1	**1**
Total	**8**	**16**	**15**	**9**	**12**	**60**

In recent months there have been a number of important national and regional policy, legal and regulatory developments, with emphasis on CO_2 emissions standards and targets.

- The US Environmental Protection Agency (EPA) recently released proposals dealing with power plant CO_2 emissions and geologic carbon storage.
- The UK Energy Act received Royal Assent and became law in December 2013 – critical parts impacting CCS include the establishment of emissions performance standards and the eligibility of CCS projects for Contract for Difference (CfD) payments.
- The EC in January 2014 proposed a new package of measures aimed at addressing climate and energy targets to 2030, including a 40% EU-wide reduction target for greenhouse gas emissions (below 1990 levels). Also in January 2014 the European Parliament adopted by vote a report released by Member of the European Parliament (MEP) Chris Davies on *Developing and applying carbon capture and storage technology in Europe*.
- At the provincial level, the Government of Alberta issued a final draft of the *Alberta Regulatory Framework Assessment (RFA)* report in August 2013, which evaluated Alberta's CCS regulatory regime and global best practice.

On the international stage, the 19th Session of the Conference of the Parties (COP 19) to the United Nations Framework Convention on Climate Change (UNFCCC) was held in Warsaw, Poland in November 2013. COP 19 saw the formal adoption of the modalities and procedures for the Climate Technology Centre and Network (CTCN) Advisory Board, signalling not only the full operationalisation of the CTCN, but also of the Technology Mechanism. The Technology Mechanism provides the platform for relevant policy and implementation initiatives to be supported.

This is a 'landmark' achievement for the UNFCCC given that the Technology Mechanism was only established in late 2010, and essentially means that the CTCN is open to receive country-driven technology requests for assistance – including for CCS activities – from developing country Nationally Designated Entities.

These climate talks did not explicitly consider CCS specific issues. CCS will, however, be formally considered again in 2016 in respect to the adoption of procedures to manage two outstanding CCS Clean Development Mechanism (CDM) issues, including the transboundary movement of CO_2 and whether to further 'tax' CCS projects under the CDM with the establishment of a global reserve of CDM credits. Many other issues were discussed in Warsaw that are of high relevance to CCS developments, including the nature of mitigation commitments, deep decarbonisation transition pathways, finance, established and new market mechanisms and frameworks, and nationally appropriate mitigation actions.

Future decisions on these matters could influence national policy settings that, in turn, can affect CCS developments.

Key project observations

- There are a number of positive project developments in North America:
  - The Boundary Dam Integrated Carbon Capture and Sequestration Demonstration Project is expected to be in operation in the first half of 2014 while the Kemper County IGCC Project is expected to be in operation before the end of the year.
  - The US Department of Energy (DOE) has approved formal funding for the Lake Charles CCS Project (US$264.1 million) and for the FutureGen 2.0 Oxy-Combustion Project (approximately US$1 billion) under a cooperative agreement with the respective project proponents.
- The Emirates Steel Industries (ESI) CCS project has progressed to the 'Execute' stage after the joint venture between Masdar and the Abu Dhabi National Oil Company (ADNOC) awarded an engineering, procurement and construction (EPC) contract to the Dodsal Group.
- In China, the Yanchang Integrated Carbon Capture and Storage Demonstration Project has progressed to the 'Define' stage after the project proponents approved construction of compression and dehydration facilities for 360,000 tonnes of CO_2 per annum.
- Twenty of the 27 projects in operation, under construction or likely to make a final investment decision during 2014 (74%) use or intend to use captured CO_2 for enhanced oil recovery (CO_2-EOR) purposes (Figure 3).
- CO_2-EOR can provide added impetus for a number of first mover projects. The approach is most evident in regions of mature oil extraction such as North America, the Middle East and China, where market opportunities to utilise CO_2 as a commodity with value are strongest (Figures 3 and 6).
- In the UK, the Department of Energy and Climate Change (DECC) has awarded funding from its CCS Commercialisation Programme to the White Rose CCS Project to support FEED studies, thereby advancing the project to the 'Define' stage of planning. Discussions between the Programme's other 'preferred bidder', the Peterhead Gas CCS Project, and the UK Government to support FEED studies are at an advanced stage.
- In continental Europe, four projects have been cancelled or put on hold since the production of *The Global Status of CCS: 2013* report:
  - The OXYCFB 300 Compostilla Project in Spain and the Porto Tolle Project in Italy, both of which were at the 'Define' stage, and
  - The Getica CCS Demonstration Project in Romania and the Full-scale CO_2 Capture Mongstad (CCM) Project in Norway, both of which were at the 'Evaluate' stage.
- The number of large-scale CCS projects in continental Europe has fallen sharply from 14 in 2011 to just five in February 2014. Two of these are operating CCS projects in the gas processing industry sector (the Snøhvit and Sleipner CO_2 injection projects in Norway) leaving only three projects in the planning stage – the most advanced being the ROAD project in the Netherlands (Figure 4).
- In Europe as a whole (including the UK), planned CCS projects, mostly in the power sector, are not anticipated to begin operation until the 2018-20 period (Figure 6).
- Supporting European projects into operation is particularly important in broadening the successful demonstration of large-scale carbon capture in power and industrial applications in combination with geologic/non-EOR storage options (Figure 6).

While large-scale injection and geologic storage of CO_2 in deep saline formations has been safely performed for more than 15 years (and in oil and gas reservoirs for decades), the majority of perceived risk in CCS projects is often associated with storage. It is essential that a broad program that validates various geologic storage options is implemented. Successful large-scale projects are also vital to improve community understanding of CCS as an environmentally friendly technology and reinforce the important role of CCS in reducing global CO_2 emissions.

FIGURE 3 Large-scale CCS projects proceeding to the 'Operate' and 'Execute' stages since 2011 by storage type

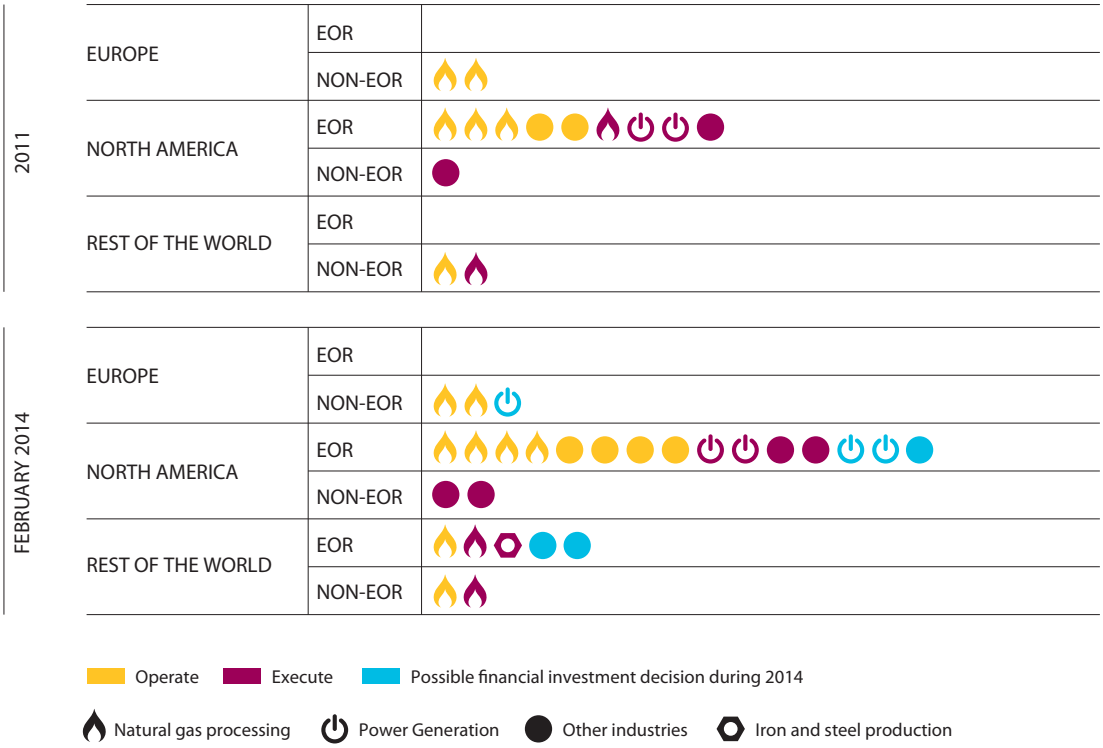


FIGURE 4 Large-scale CCS projects in key markets by project lifecycle

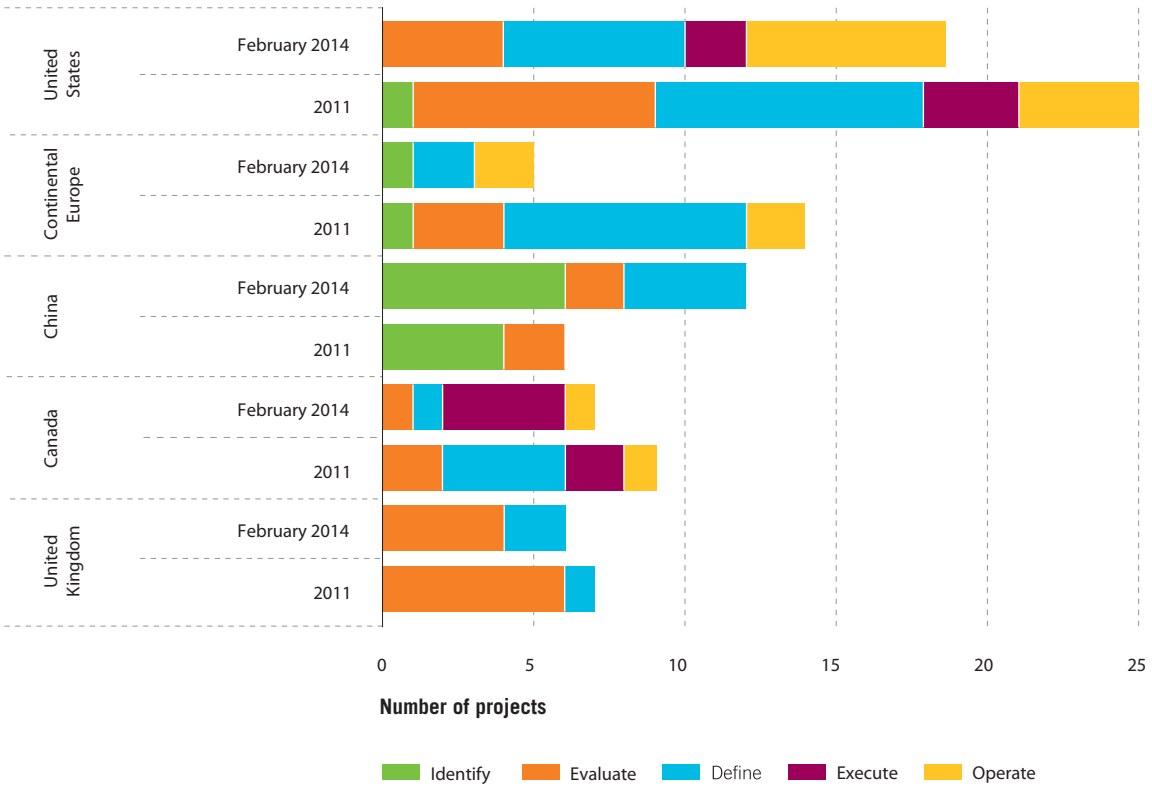


FIGURE 5 Number of large-scale CCS projects and mass of CO_2 captured by actual and expected year of operation as of February 2014

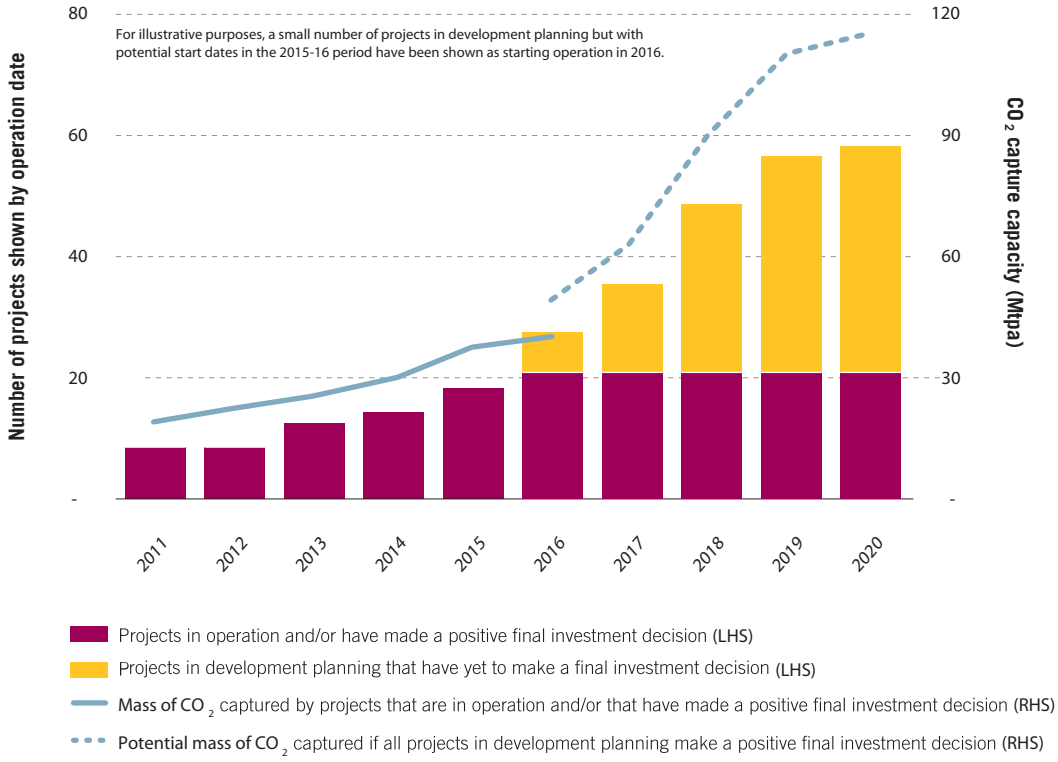
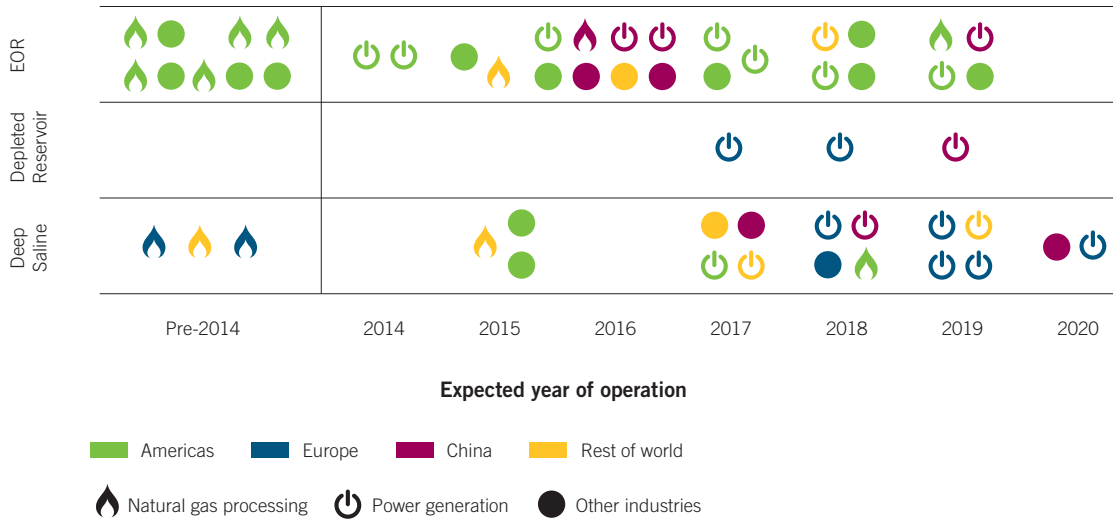


FIGURE 6 **Expected start date for large-scale CCS projects by industry sector, storage type and region as of February 2014**



MAJOR REGIONAL DEVELOPMENTS

THE AMERICAS

TWO POWER PROJECTS ARE APPROACHING OPERATION

The world's first large-scale CCS project in the power sector is expected to be operational in the first half of 2014. Testing and verification activities are presently underway on the new capture plant at the Boundary Dam Integrated Carbon Capture and Sequestration Demonstration Project. The application of capture facilities will reduce CO_2 emissions from a rebuilt (coal-fired) Production Unit 3 at the Boundary Dam power station by up to 90% and, when fully operational, capture one million tonnes of CO_2 per annum. The CO_2 captured from Production Unit 3 will be used primarily for EOR at the Weyburn Oil Unit and will supplement the existing CO_2 supply to the Weyburn–Midale fields that is captured and delivered from the Great Plains Synfuels plant, a coal gasification facility in North Dakota. Any CO_2 from the project that is not used in EOR will be injected into a nearby deep saline formation through the Aquistore project – an important research project into onshore CO_2 storage.

The Kemper County IGCC Project in Mississippi is now expected to be operational in the second half of 2014. The 582 megawatt (MW) project will use Transport Integrated Gasification (TRIG™) technology (a coal-gasification method designed for lower rank coals) developed by Southern Company and KBR in conjunction with the US DOE. The plant will capture 65% of total CO_2 emissions, or approximately 3.5 million tonnes per annum. In October 2013, construction of the 96 kilometre/60 mile CO_2 pipeline was completed and the CO_2 will be transported for use in CO_2-EOR operations. By-product sales, including CO_2, are expected to generate approximately US$50 million to US$100 million annually. The project proponent (Southern Company) received US$270 million in US DOE funding under the Clean Coal Power Initiative (CCPI).

The Illinois Industrial CCS Project has also progressed significantly through its construction activities. This project involves the compression/dehydration of CO_2 already separated in a corn-to-ethanol plant and its storage in a deep saline aquifer adjacent to the producing plant. The Illinois Industrial CCS Project will integrate its facilities with the existing 1,000 tonnes of CO_2 per day facility under the Illinois Basin-Decatur Project (IBDP) to achieve a total CO_2 injection capacity of 3,000 tonnes per day or approximately one million tonnes per annum of CO_2. Construction of the surface facilities and the two monitoring wells has been completed. Receipt from the EPA of a Class VI injection well permit is anticipated for the third quarter of 2014. After receipt of the permit, drilling of the injection well is expected to take five months, suggesting the project could be operational in the first quarter of 2015.

TWO LARGE-SCALE PROJECTS FORMALLY SECURE US DOE FUNDING

In December 2013 the US DOE issued its Record of Decision to provide cost-share funding to Leucadia Energy for its Lake Charles CCS Project under the DOE's Industrial Carbon Capture Sequestration (ICCS) Program. The DOE action would provide US$261.4 million of the estimated total cost of the Lake Charles CCS Project of around US$436 million, through a cooperative agreement with Leucadia Energy. The Lake Charles CCS Project in Louisiana is at an advanced stage of development planning and may transition to the 'Execute', or construction, stage within the first half of 2014. The proposed Lake Charles gasification facility would convert petroleum coke into synthetic gas, which would be further processed to produce methanol, hydrogen gas and sulphuric acid. The Lake Charles CCS Project would be designed to capture 4.6 million tonnes of CO_2 per annum, averaged over the life of the facility. The captured CO_2 would be transported through an existing pipeline to the West Hastings oil field near Houston, Texas, for use in EOR operations.

In January 2014 the US DOE issued its Record of Decision to provide financial assistance to the FutureGen Industrial Alliance. The DOE action would provide approximately US$1 billion in cost share for its FutureGen 2.0 Project, largely through the American Recovery and Reinvestment Act (ARRA) and other funding through cooperative agreements with the Alliance. The estimated total project cost is US$1.68 billion. Key aspects of the FutureGen 2.0 Project include the capture of approximately 1.1 million tonnes of CO_2 during steady-state operations of a repowered electricity generating unit (with oxy-combustion technology) at the Meredosia Energy Center in Illinois.

The captured CO_2 would be transported approximately 48 kilometres/30 miles through a new pipeline to an injection well that would inject the CO_2 into the Mount Simon formation to a depth of approximately 1,220 metres/4,000 feet below ground level. To progress to construction both a state permit for CO_2 storage and the FutureGen Industrial Alliance share of the financing is needed.

ONE PROJECT CANCELLED

The Kentucky NewGas Project in Muhlenberg County, Kentucky, has been cancelled. The planned coal gasification facility with CCS would have produced synthetic natural gas with a pre-combustion CO_2 capture rate of about five million tonnes per annum. The project developer, Peabody Energy, officially advised the Commonwealth of Kentucky in the middle of 2013 that it had ceased further development work on the project.

INDUSTRIAL CCS PROJECT 'CLUSTERS' MAY BE SIGNIFICANT

Several EOR operators in the US utilise CO_2 from multiple industrial sources that individually are below the CO_2 capture volume thresholds for identification of a large-scale CCS project. When aggregated, these projects could be considered a 'cluster' that meets or exceeds these volume thresholds. For example, Chaparral Energy operates several CO_2 pipeline systems (such as Panhandle and Velma) that transport CO_2 from multiple sources (including fertiliser and ethanol plants) to EOR fields in Texas and Oklahoma. As a 'cluster' they aggregate to almost two million tonnes of CO_2 per year injected. The Institute will report on these 'cluster' projects and their effect on the overall inventory of CO_2 captured and stored as greater detail becomes available.

US EPA NEW SOURCE PERFORMANCE STANDARDS (NSPS)

On 8 January 2014 the EPA published its proposed NSPS rule that sets limits on CO_2 from new coal and natural gas-fired power plants. The EPA is also developing a proposal to limit CO_2 emissions from existing power plants; the proposed rule is expected in June 2014, followed by the final rule in June 2015.

The NSPS sets emissions limits based on the EPA's assessment of best available technologies. As part of its determination, EPA took into account whether:

1. CCS is technically feasible
2. CCS costs are 'reasonable'
3. further technology development could be achieved, and
4. the amount of emission reductions that CCS would achieve.

The EPA concluded that partial CCS for coal units, about 40% CO_2 capture, is technically 'feasible' and is thereby 'adequately demonstrated' and its cost is 'reasonable' under the statute. In contrast, the EPA determined that CCS for natural gas fired units has not yet been adequately demonstrated and that including partial CCS would add costs to natural gas plants that would be 'unreasonable'.

To comply with the proposed standard, new large natural gas generating units (~ 100 megawatts of electrical output or larger) could emit no more than 1,000 pounds of CO_2 per megawatt-hour (MWh), which can be achieved with combined cycle technology. Smaller natural gas units would need to achieve 1,100 pounds CO_2/MWh.

Coal plants, including the higher efficiency ultra-supercritical boilers and IGCC units, have two alternative compliance options, both of which would require CCS. One option requires coal plants to begin using CCS soon after start-up to achieve a 12-month average emission rate of 1,100 pounds CO_2/MWh. Alternately, CCS could be used within seven years of start-up to achieve a seven-year average emission rate of 1,000-1,050 pounds CO_2/MWh (requiring about 40% CO_2 capture). This longer compliance period was intended to encourage CCS technology advances and allow for more start-up time.

Compliance with the standard is only based on tonnes of CO_2 captured and the EPA has emphasised that the proposal does not involve regulation of any downstream recipients of captured CO_2. However, captured CO_2 must be transported to a storage site that complies with reporting obligations under the EPA's GHG Reporting Rule, Subpart RR, which requires storage site owners or operators to submit a monitoring, reporting and verification (MRV) plan to the EPA for review and approval. Geologic storage sites permitted for long term storage under the EPA's Underground Injections Control (UIC) Program Class VI regulations already must report under Subpart RR.

As the EPA explains in its NSPS proposal, the practical impact would be that owners and operators of projects injecting CO_2 that are permitted under UIC Class II for EOR operations, and receive CO_2 captured from power plants to meet the proposed NSPS, will also be required to submit, and receive approval from the EPA for an MRV plan and report under Subpart RR.

The question remains as to whether the EPA's proposed NSPS will have any significant impact on emissions. Under the present circumstances in the US such as low electricity demand growth, cheap natural gas, and the pressures and costs associated with other regulatory compliance requirements for coal plants, it appears unlikely that any new coal plants would be built over the next several years even without the proposed NSPS. Between now and 2018, the US Energy Information Administration (EIA) forecasts only four potential coal plants compared to more than 200 natural gas plants. As the EPA's NSPS regulatory action alone may not be sufficient to drive CCS deployment, at least on coal, it follows that additional policy action would be needed to further advance the technology and put in place the incentives and regulatory frameworks necessary to attract private sector investments.

Legal challenges to the proposed NSPS are anticipated with a key issue relating to whether the EPA can lawfully determine that partial CCS is 'adequately demonstrated' and can therefore be selected as a best system of emission reduction under section 111 of the Clean Air Act. The EPA will hold public hearings on the proposed rule, and comments are due by 10 March 2014. It is widely expected that the EPA will publish its final rule no later than 1 June 2014.

US EPA GUIDANCE ON TRANSITIONING FROM CLASS II TO CLASS VI WELLS

In December 2013 the EPA released draft guidance for comment on transitioning Class II wells for oil and gas operations, including EOR, to Class VI wells for geologic carbon storage. According to the draft, owners or operators of Class II wells that inject CO_2 for the primary purpose of long-term storage would be required to apply for and obtain Class VI well permits if the UIC program director determines there is increased risk to underground sources of drinking water. If a determination is made that a Class VI permit is needed, a number of requirements must be fulfilled, both at the time of re-permitting and during future operations, including:

- well construction and operation
- geologic storage site testing and monitoring
- post-injection site care and emergency, and
- remedial response.

The EPA will accept comment on the draft guidance until 1 March 2014.

US EPA EXEMPTS CLASS VI CO_2 INJECTION FROM RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) HAZARDOUS WASTE REGULATIONS

In December 2013, the EPA conditionally excluded CO_2 captured from power plants and industrial sources and injected into UIC Class VI wells from RCRA hazardous waste regulation in a pre-publication version of the rule. The EPA has determined that CO_2 injected into Class VI wells does not present a substantial risk to human health or the environment and should be exempted from the regulation.

ALBERTA GOVERNMENT RELEASES REGULATORY FRAMEWORK ASSESSMENT (RFA) REPORT

In August 2013, the Alberta Government released a final draft of the RFA report, which concluded a two-year process of evaluating the current regulatory regime for CCS in Alberta, as well as considering the best practice approaches adopted in other jurisdictions around the world. The process resulted in over 70 conclusions and recommendations and sought to *ensure the highest levels of protection for public safety and the environment* in the creation of a regulatory model.

The publication of the final draft report in August 2013 was followed by a period of consultation to allow the public to provide feedback. This consultation period concluded in October 2013 and a summary of the feedback received will be published by Alberta Energy in due course.

EUROPE, MIDDLE EAST AND AFRICA

United Kingdom

There have been a number of encouraging developments for CCS in the UK recently, with important amendments passed on energy policy and progress in the UK CCS Commercialisation Programme.

UK ENERGY ACT 2013

On 18 December 2013, the *UK Energy Act 2013* received Royal Assent and became law in the UK. The Act provides the legislative framework aimed at supporting the wide-scale electricity market reforms and investments being made in the UK to replace ageing energy infrastructure. There are two critical parts of the Act influencing CCS deployment in the UK.

The first is the establishment of an Emissions Performance Standard (EPS) which enforces the UK policy that no new coal-fired power plant should be approved unless equipped with CCS technology. Operators of all new fossil fuel plants in the UK will have to operate within an annual emission limit, equivalent to 450 g of CO_2 per kilowatt hour (kWh) of electricity for a plant operating at base-load. The limit is around half the level expected of a new coal-fired plant when operating unabated but above the level of a modern combined cycle gas-fired power plant, which operate at below 400 g per kWh. The *UK Energy Act 2013* also provides three-year exemptions from the emissions limit duty for operators developing CCS projects. The CCS exemptions are available until the end of 2027 and commence for three years from the start of operation of the CCS system.

The second is the eligibility of CCS projects for a Contract for Difference (CfD). CfDs are long term contracts that provide a stable revenue stream for developers of eligible low-carbon electricity generation. Generation using CCS is explicitly included within this category under the 2013 Act. Each CfD has a set 'strike price' (a price per unit of electricity generated) which is set at the level determined to be necessary to support the particular technologies or projects supported by the scheme. The strike price for UK CCS projects will be determined initially on a case-by-case basis, with a progressive move to competitive allocation in line with the development of the technology.

UK CCS COMMERCIALISATION PROGRAMME – MAKING STEADY PROGRESS

In addition to the longer-term funding support and incentive mechanisms being built into the UK Electricity Market Reforms, including the EPS and CfDs, the UK Government established the UK CCS Commercialisation Programme which made GBP1 billion capital funding available for first mover CCS projects through a competition process. In March 2013, the Peterhead Gas CCS Project in Aberdeenshire, Scotland and the White Rose CCS Project in Yorkshire, England, were selected as the two 'preferred bidders' in the competition, allowing both projects to negotiate for funding to produce detailed FEED studies of their projects.

The White Rose CCS Project integrates an oxyfuel combustion capture facility into a new super efficient coal-fired power station, capturing approximately two million tonnes per annum of CO_2. This will link into the planned development of a CO_2 transportation and storage infrastructure (the 'Yorkshire/Humber CCS Trunkline') which would have capacity for additional CCS projects in the area. Storage will be in a deep saline aquifer beneath the Southern North Sea, approximately 65 kilometres/40 miles offshore. In addition to the UK Competition funding, the White Rose CCS Project is the only CCS Project to have been supported to apply for funding through the second call of the EU's NER300 Programme.

The Peterhead Gas CCS project plans to retrofit a carbon capture plant onto an existing gas-fired power station to capture around one million tonnes of CO_2 per annum. The CO_2 would be stored approximately 100 kilometres/160 miles offshore in the depleted Goldeneye gas reservoir.

On 9 December 2013, the UK Government announced that a FEED contract had been successfully agreed with the White Rose CCS Project, moving the project from the 'Evaluate' to the 'Define' stage of the project lifecycle. Negotiations with the Peterhead Gas CCS Project are nearing completion – an announcement is expected in the near future. Once FEED is complete both of these projects could be eligible for further capital and operational support through a CfD.

FINAL INVESTMENT DECISION ENABLING PROGRAM

Beyond the CCS Competition, the UK Government is also discussing support for additional early projects through its Final Investment Decision Enabling program. Any such support will be limited to issuing a CfD, and funding will not be available to support development or capital costs.

ADDITIONAL FUNDING TO DEVELOP INDUSTRIAL CCS

In December 2013, the UK Prime Minister announced funding for the Tees Valley City Deal, a regeneration initiative in north-east England which provides additional funding for a feasibility study on industrial CCS in the region. The initiative, led by the Local Enterprise Partnership – Tees Valley Unlimited – aims to establish the Tees Valley area as an industrial CCS hub.

VISION FOR CCS

Latest modelling from the UK's Electricity Market Reform Delivery Plan published in December 2013 expects up to 13 gigawatts of CCS could be deployed in the UK by 2030. The UK Government has stated a vision of three phases in the development of CCS in the UK. Their GBP1 billion Commercialisation Programme represents the first phase and they anticipate a second phase could come forward in parallel to, as well as subsequent to those projects – before a third phase of cost competitive projects in the 2020s.

Continental Europe

Developments have been mostly negative on the European continent where a number of projects have been either cancelled or put on hold. Of the six CCS projects (from Germany, the UK, Italy, the Netherlands, Poland and Spain) that were initially supported under the European Energy Programme for Recovery (EEPR), two remain active (as large-scale CCS projects). These are the Don Valley Power Project in the UK and the ROAD Project in the Netherlands. The ROAD Project is the most advanced project in Europe and is ready to adopt a final investment decision if additional funding can be secured.

Overall, there are now five large-scale CCS projects in continental Europe compared to 14 in 2011. Excluding the two operating gas processing projects in Norway, only three large-scale CCS projects remain in development planning. Despite earlier high expectations, no new large-scale CCS projects have entered the construction stage in continental Europe in well over a decade.

FOUR PROJECTS CANCELLED OR PUT ON HOLD

Two EEPR supported projects have been cancelled.

- In August 2013, the Porto Tolle CCS Project, which aimed to capture one million tonnes of CO_2 per annum from an existing power plant, was cancelled due to delays in project delivery after the decision of the Italian State Council to annul the environmental permit for the Porto Tolle power plant and difficulties in achieving closure for the financial structure of the project.
- The OXYCFB 300 Compostilla Project, which intended to capture around one million tonnes of CO_2 per annum from a new build power plant, completed the work that it had committed to carry out under the terms of its EEPR grant by October 2013 and subsequently took a decision not to proceed to full-scale demonstration.

The project proponents for Porto Tolle (Enel S.p.A.) and Compostilla (Endesa Generación SA and CIUDEN) will continue with the pilot initiatives that were created to support the large-scale project proposals – a capture facility in Brindisi in the case of Porto Tolle and the capture and storage (Hontomin) pilots for Compostilla. These pilots will produce valuable data to help support the wider development of CCS in Europe.

Two non-EEPR supported projects have been cancelled or put on hold.

- In September 2013, the Norwegian Government announced that the full-scale carbon capture project at Mongstad (CCM), which intended to capture approximately one million tonnes of CO_2 per annum from an existing power plant, was cancelled. Subsequently, the Government reiterated its support for CCS as an important technology in the efforts being made to reduce carbon emissions from industry and from power production.
- The Getica CCS Demonstration Project in Romania, which intended to capture over one million tonnes of CO_2 per annum from an existing power plant, has been put on hold as the project sponsors seek funding to enable the work to progress towards the capture FEED and storage appraisal phases.

EC PROPOSES CLIMATE TARGETS OUT TO 2030

In January 2014, the EC proposed a new package of measures aimed at addressing climate and energy targets out to 2030, which sets more stringent greenhouse gas reduction targets but moves away from national targets for renewable energy production. Building upon commitments found in the existing 2020 package; the new framework seeks to ensure that the EU meets its 2050 greenhouse gas emission reduction objectives, as well as continues its efforts towards developing a low-carbon economy. The framework introduces a number of targets to apply beyond 2020 and out to 2030, including a 40% EU-wide reduction target for greenhouse gas emissions (below 1990 levels) and an aim to increase the share of renewable energy at European level to at least 27% of energy consumption.

The Communication also makes reference to a number of 'key complementary policies', which include carbon capture and storage. In addition to re-stating the continued significance of the technology in Europe, the document highlights that it 'may be the only option available to reduce direct emission from industrial processes at the large scale needed in the longer term'. An increase in research and development and commercial demonstration are envisaged by the EC, as central to achieving the technology's deployment within the 2030 timeframe.

MEP CHRIS DAVIES PRESENTS A REPORT ON CCS IN EUROPE

In January 2014, the European Parliament passed a report advocating for the future of CCS technology called *Developing and applying carbon capture and storage technology in Europe*. The report was passed by a vote of 524 to 141 with 25 abstentions. Presented by MEP Chris Davies, the report called for urgent parliamentary support for CCS technology.

It highlights a number of factors which he suggests will likely prove critical in encouraging the widespread deployment of the technology and calls on the EC to undertake activities in a number of key areas. Several issues in particular are highlighted in the report, including the need for the EC and Member States to 'raise ambitions' for the technology and the strengthening of regulation and funding support.

TRANSPOSITION OF THE CCS DIRECTIVE

In November 2013, as part of its monthly infringements package, the EC provided further detail of European Member States' transposition of the Directive into national laws. In a 'Reasoned Opinion', which constitutes the second stage of the official infringements procedure, the EC requested six member states (Austria, Cyprus, Hungary, Ireland, Sweden and Slovenia) adopt the necessary measures to fully transpose the requirements of the Directive and formally comply with EU law. Failure to adopt the necessary provisions and fulfil this requirement, may lead to the EC referring the Member State concerned to the European Court of Justice.

In addition to issuing this Opinion, the EC also formally closed infringement proceedings against several other Member States, following their communication of transposition measures. Transposition cases are now closed in relation to Belgium, Bulgaria, the Czech Republic, Germany, Estonia, Greece, Finland, Luxembourg, Latvia and the UK. The EC is now conducting an assessment of transposition of the Directive into Polish law which was made through an amendment to the Geological and Mining Bill adopted in September.

In March 2013 the EC launched a Consultative Communication on the future of CCS in Europe, which considered the status of CCS in the EU and the barriers which have impacted its deployment to date. In addition to this analysis, the Communication also welcomed stakeholder views on a range of opportunities for promoting CCS demonstration and wider deployment.

The EC has now published a summary and analysis of the stakeholder responses it received to the Communication. The stakeholder responses highlight several conclusions, including widespread and continued support for the existing EU CCS demonstration program and a desire to ensure CCS is included in the EU's 2030 energy and climate policy framework.

Middle East and Africa – world's first large-scale CCS iron and steel project

The world's first iron and steel project to apply CCS at large scale has moved into the 'Execute' phase in the United Arab Emirates (UAE). The ESI CCS Project involves the capture of approximately 0.8 million tonnes of CO_2 per annum from the direct reduced iron (DRI) process used at the Emirates Steel plant in Abu Dhabi and its transportation to the ADNOC-operated Rumaitha oil field for the purpose of EOR. The project will be managed by a joint venture between ADNOC, the UAE's state-owned oil company, and Masdar, a wholly-owned subsidiary of the Abu Dhabi Government-owned Mubadala Development Company.

In November 2013, ADNOC and Masdar formalised a joint venture agreement and awarded the Dodsal Group with a Dh450 million (US$122.5 million) EPC contract to build the CO_2 dehydration and compression facility at the Emirates Steel factory and the 45 kilometre/27 mile pipeline to Rumaitha. Injection of CO_2 is planned for 2016.

ASIA PACIFIC

China

China continues to lead the Asia Pacific region in making steady progress with moving projects through the lifecycle stages.

Approval has been given for a key capture component of the Yanchang Integrated Carbon Capture and Storage Demonstration Project, which in total intends to capture more than 0.4 million tonnes of CO_2 per annum from a coal-to-chemicals facility located in Yulin City, Shaanxi Province. Other capture components are in development planning, as is pipeline infrastructure development, and as a result the overall project status is advanced from 'Evaluate' to 'Define'.

The Sinopec Qilu Petrochemical CCS Project, which intends to capture approximately 0.5 million tonnes of CO_2 per annum from a coal gasification facility in Zibo City, Shandong Province, has completed FEED studies and is awaiting approval to proceed to execution from Sinopec.

Both of these (advanced) CCS projects will utilise the captured CO_2 in EOR operations. For the Yanchang coal-to-chemicals project the primary storage sites are at the Jingbian, Wuqi, and Dingbian oil fields, south-west of Yulin City. Carbon dioxide from the Sinopec petrochemical project would be injected into the Shengli oil field in Dongying, Shandong Province.

The Institute currently records 12 large-scale CCS projects in China, double the number of projects in 2011 (six). Additional large-scale projects are being confirmed so this number could increase further in the near-term.

Australia

In Australia, the Gorgon Carbon Dioxide Injection Project has commenced its multi-year injection well drilling campaign. A purpose-built drilling rig began drilling the first CO_2 injection well on Barrow Island in September 2013. Nine wells are expected to be directionally drilled at three drill centres to inject reservoir CO_2 into the Dupuy Formation.

INTERNATIONAL COLLABORATION

Successful large-scale CCS projects in the power sector and additional industrial applications are essential to gain valuable design, construction and operational experience. The knowledge or 'learning' from demonstrating CCS technology in new applications at different sites and different settings is critical for reducing costs and strengthening investor and stakeholder confidence.

Coordinated international collaboration and knowledge sharing platforms can be effective mechanisms to leverage the learnings from project experiences and research and development to accelerate CCS technology deployment.

A vibrant research and development effort across CCS – and especially capture – technologies complements the present project pipeline and will play an important role in the longer term deployment of CCS technology. Recent initiatives in CCS research and development include the US DOE's award of US$84 million across 18 innovative, next generation advanced carbon capture research projects and the EC's first call for proposals under the framework program for research and innovation Horizon 2020. These examples are not exhaustive as significant research and development activities are also taking place in many other parts of the world.

Linking this research effort with the new International CCS Test Centre Network's programs could help accelerate the global CCS research effort. The International CCS Test Centre Network was launched in late 2013 and is currently comprised of eight member organisations with test facilities, including the National Carbon Capture Center (operated by Southern Company in Wilsonville, Alabama, the US) and the Technology Centre Mongstad (TCM) CCS test facility (Mongstad, Norway).

Participants are operating a capture facility connected to a coal or gas fired power plant or an industrial plant, with the aim of providing performance results to inform technology decisions. The network participants are willing to share non-confidential knowledge and jointly work together to solve joint problems. The mission of the network is to accelerate carbon capture technology development by sharing lessons learnt between the world's leading test centres. This mission will be achieved primarily by sharing knowledge internally to a network of experts.

The network focuses on topics such as:

- good practices in health, safety and the environment
- establishing recognised laboratory methods for sampling and analysis
- lessons learned in measurement, monitoring and instrumentation, and
- defining standard methods necessary and proper key performance indicators, such as energy consumption per tonne of CO_2 captured.

Effective knowledge sharing will be delivered through structured meetings and events, targeted dissemination of information and the use of digital capabilities.

The Global CCS Institute provides secretariat services for the network which includes meeting facilitation, providing digital infrastructure for information sharing and basic analysis from key meetings. TCM will Chair the network through 2015.

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