



# CCUS Status and New Developments.

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BIXPO 2017

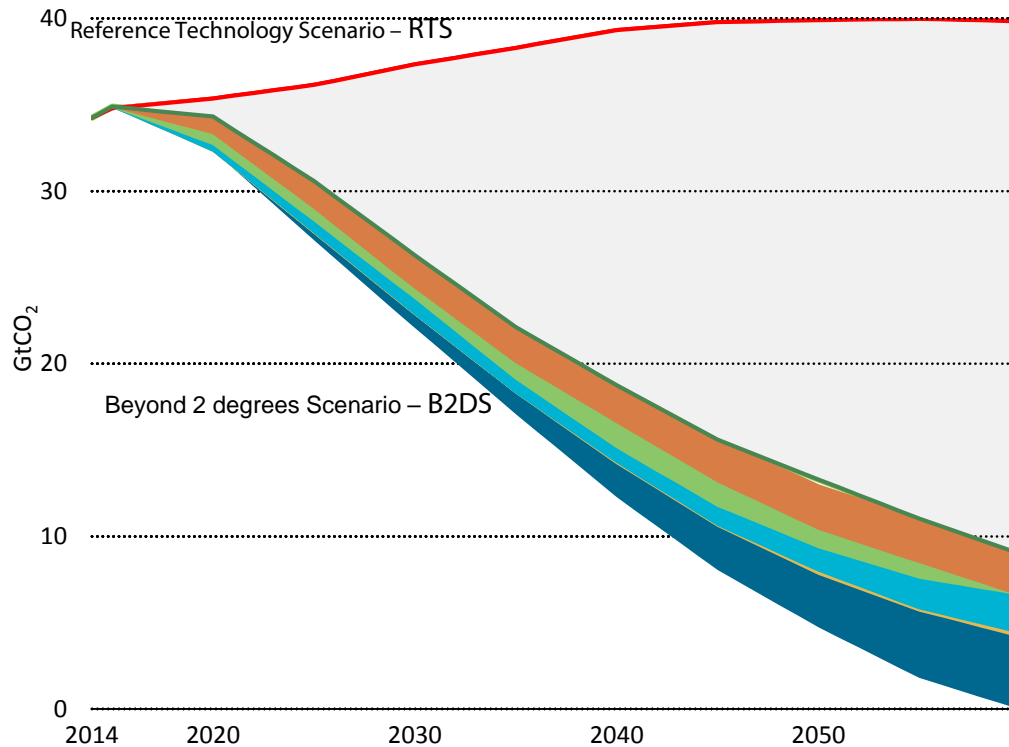
KDJ Convention Center, Gangju, Korea)

1-3 November 2017

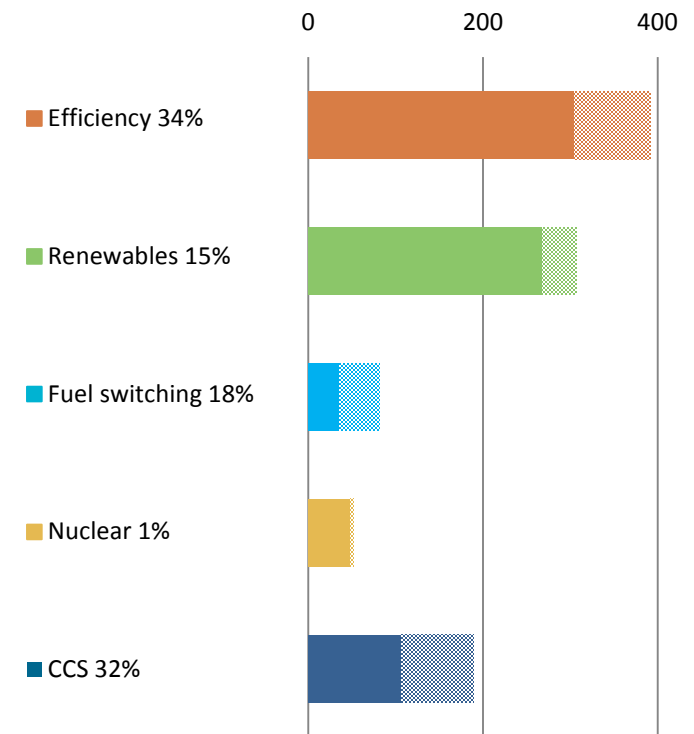
# CCUS a Key Climate Mitigation Option



Global CO<sub>2</sub> reductions by technology area



Gt CO<sub>2</sub> cumulative reductions in 2060



Source: IEA ETP 2017

# Current status of CCUS



- CCUS technology is proven and in use around the world.
- 21 large-scale CCUS projects in operation or under construction globally - CO<sub>2</sub> capture capacity of 40 Mtpa.
- 6 projects in construction as of March 2017
  - 3 projects to be operational in 2017 & 3 in 2018
  - CO<sub>2</sub> capture capacity of ~ 8 Mtpa.
- 11 more large-scale CCUS projects are in earlier stages of planning
  - CO<sub>2</sub> capture capacity of ~21 Mtpa.

Source: Global CCS Institute

<http://hub.globalccsinstitute.com/sites/default/files/publications/201158/global-status-ccs-2016-summary-report.pdf>

# Worldwide distribution



Source: Global CCS Institute, 2016, "The Global Status of CCS 2016 – Summary Report"

# Significant milestones passed



- Sleipner project, 20 years of continuous operation in 2016
  - 16Mt CO<sub>2</sub> stored and monitored
- Sleipner and Snohvit projects were re-permitted by Norwegian Government under EC CCS Directive in 2016
  - Conforms with requirements of London Convention for undersea storage.
  - Demonstrates that the CCUS-specific regulations are workable and achievable by projects and regulators

# Significant milestones (2)



## Boundary Dam 3, Canada (2015)

- Power sector, 120MWe retrofit
- Cansolv Amine technology
- 1.6 Mt CO<sub>2</sub> Captured
- 100,000 tonnes stored in DSF
- Rest sent for CO<sub>2</sub>-EOR



## Air Products, Texas USA (2014)

- Hydrogen refining
- Vacuum Swing Absorption
- Over 4 Mt CO<sub>2</sub> Captured
- Existing pipeline for CO<sub>2</sub>-EOR



## Quest, Canada(2015)

- Hydrogen refining
- Cansolv amine based technology
- Over 2.6 Mt CO<sub>2</sub> Captured
- 80km pipeline for storage in a DSF



# New CCUS Projects



## Emirates Steel Project, UAE

- Started November 2016
- DRI steel plant with Amine capture
- Compression and pipeline added
- 800,000 tonnes CO<sub>2</sub> for CO<sub>2</sub>-EOR

## Petra Nova project, USA

- Started in January 2017
- Kansai-Mitsubishi amine capture
- Capture rate 1.4 Mtpa,
- CO<sub>2</sub> sold for CO<sub>2</sub>-EOR

## Illinois Industrial Carbon Capture project, USA (BioCCS)

- Started in April 2017
- 1Mt CO<sub>2</sub>/y bioethanol plant
- Dehydrated, compressed, and stored in a deep saline formation.

## Tomakomai, Japan

- Started April 2016
- Test CCUS in Japanese conditions  
100,000 t/y for 2 yrs into DSF



# Learnings



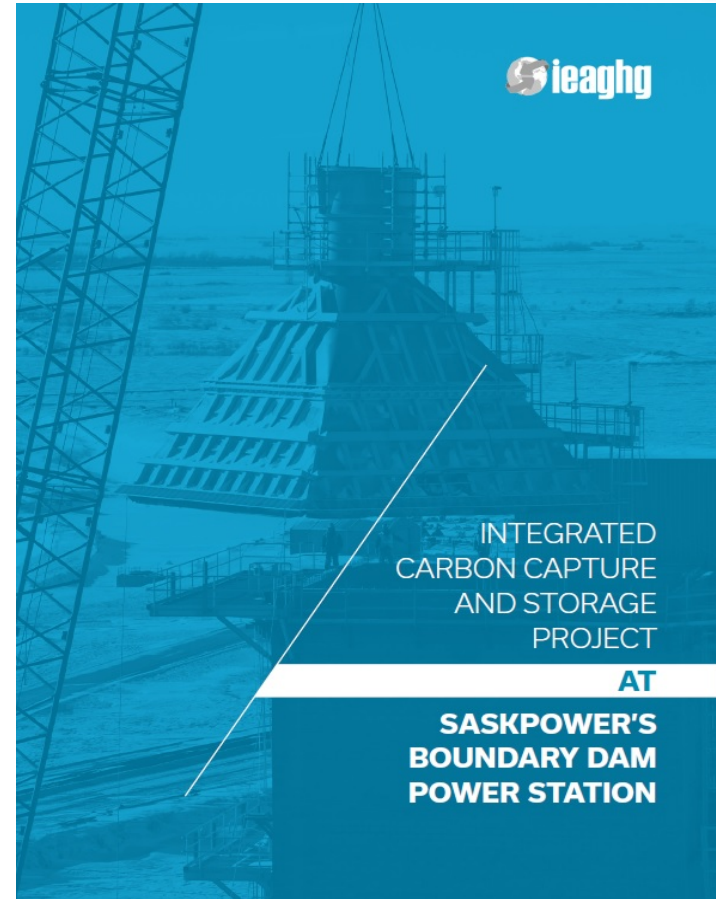
- **Boundary Dam 3** and **Petra Nova** are PC boiler retrofits with Amine Scrubbing technology
  - Both capture units built on schedule and to cost
    - Cost over runs at BD3 due to existing boiler retrofit
  - Both projects could be built again at lower cost
    - 30%CAPEX, 20% OPEX
- **Kemper**
  - Capture plant built to schedule and cost
  - Cost overruns/delays in other plant areas
- **Air Products**
  - Vacuum Swing Absorption technology preferred to amines
    - Reduced energy consumption and improved project economics
    - 27,000:1 technology scale up successfully achieved
- **Quest** on shore injection better than expected
  - Ahead of schedule on tonnes CO<sub>2</sub> injected.
  - Modular construction design reduces cost for future projects



# Learnings Captured & Shared



- Boundary Dam 3, first years learnings reported
- International CCS Knowledge Centre
  - Preparing 3 years learnings report from BD3
- IEAGHG now developing reports on learnings from :
  - Air Products CCUS project
  - Quest CCUS project
  - Available early 2017



[http://ieaghg.org/docs/General\\_Docs/Reports/2015-06.pdf](http://ieaghg.org/docs/General_Docs/Reports/2015-06.pdf)

# Other Developments



## **Osaki Cool Gen Project, Japan- April 2017**

- Operated by J-Power, J-Power is a 166MW IGCC demonstration project
- CO<sub>2</sub> capture slipstream test using physical absorption technology in late 2018/19.

## **Yangchang Petroleum, China**

- Physical adsorption from Coal to gas plant
- 800,000 t CO<sub>2</sub>/y, to be used for CO<sub>2</sub>-EOR
- Operation planned late 2018/2019

## **Gorgon, Western Australia**

- Offshore- gas processing, using amine technology to capture 3.5Mt/y CO<sub>2</sub>
- Injection into deep saline formations
- Starts operation late 2017

## **Kemper Project, USA**

- Cancelled in June 2017 – costs overruns/delays

## **ROAD project, Netherlands**

- Project developers pulled out in July 2017 – uncertainty over Government policy



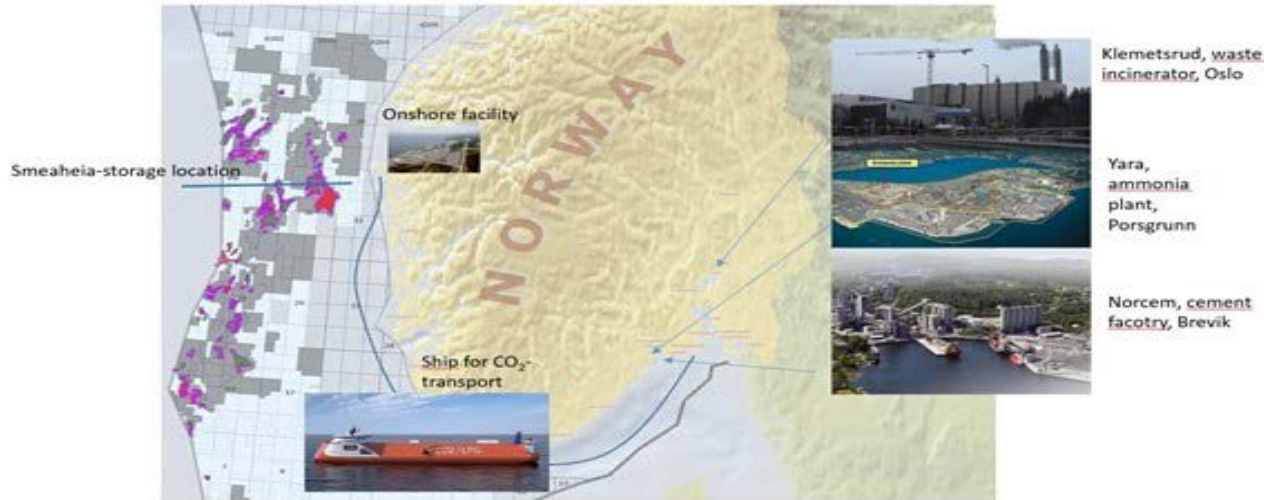
# CCUS in Europe

- First commercial CCUS project
  - Sleipner in 1996
- First CCUS regulations drafted
  - EC CCS Directive issued in 2009
- 6 CCUS projects supported under EC EPPR programme,
  - All closed
- 1 CCS project supported under NER 300
  - UK CCS competition closed – White Rose Project ended
- EU Zero Emissions Platform (ZEP) still pressing for EC for CCS
  - CCUS important for industry/regional development
  - Use of EU infrastructure funds to build CO<sub>2</sub> pipeline network
- European Trading Scheme – €7.45 (18/10/17)

# New CCUS Initiatives in Europe



- Norway
  - FEED studies underway for CCUS projects:



- Timeline:
  - FEED contracts end Autumn 2018
  - Investment Decision –Spring 2019
  - Full scale project in 2020.

# Netherlands



- ROAD project closed by power companies in June 2017
- July 2017, Statoil, Vattenfall & Gasunie sign an MoU to evaluate converting a gas power plant in the Netherlands into a H<sub>2</sub> powered plant.
  - The CO<sub>2</sub> emission reduction is 4 MT CO<sub>2</sub>/y
- In October 2017, the Dutch Government announced a new Climate and Energy Plan
- 49 per cent reduction in CO<sub>2</sub> emissions by 2030.
  - A reduction of more than 56 million tonnes of CO<sub>2</sub> per annum by 2030.
  - CCS will deliver at least 20 million tonnes in CO<sub>2</sub> emissions reductions every year by 2030.
  - CCS in industry, electricity sectors (bioCCS) and waste incineration
  - New fund - 4 billion euros annually.

# United Kingdom



- CCS completion closed in late 2015 without agreement for a demonstration project.
- ACORN project funded under EU ERA NET Programme for feasibility study
  - CO<sub>2</sub> capture from St Fergus gas terminal (gateway to North Sea)
  - CO<sub>2</sub> stored offshore using existing pipeline infrastructure
- October 2017, UK Government announces Clean Energy Growth Programme
  - CCS seen as a vital part of the solution
  - A new Ministerial CCUS Council, will be formed
  - As will a new CCS Cost Challenge Task Force.

# Jubial City CCU Project



- SABIC CCU project uses the captured CO<sub>2</sub> to produce methanol and urea.
  - First commercial application of Linde post combustion capture technology
  - First capture unit on an ethylene glycol plant.
  - At 500, 000Mt CO<sub>2</sub> pa it was the biggest commercial capture unit.
  - Business model CAPEX/OPEX recovered through sale of Products



# Other CCU demonstrations



- SAGA City, Japan – waste incineration facility
- Toshiba amine technology, 10tpd CO<sub>2</sub>
- Carbon Clean Solutions
- 10MWe power plant in India
- Novel amine technology





# The CCU Paradigm



- Carbon Capture and Utilisation (CCU) options are not mitigation options
  - No permeant storage – not a mitigation option
    - Classic non-mitigation examples – Methanol and Urea production
- But CCU can help CCUS deployment by
  - Demonstrating different capture technology at scale **X**
  - Introducing new capture vendors **✓**
  - Infrastructure development, i.e. pipelines **X**

# Summary



- CCUS a more significant climate mitigation option in B2DS
- Significant progress has been made on CCUS demonstration project deployment
- 21 CCUS projects now operating worldwide storing 40MtCO<sub>2</sub>/yr
  - Most required Government support
  - Some industry projects are commercial without
- Early projects have identified cost reductions for next build plants
  - Learning by doing helps drive down costs
- CCU can contribute to capture technology rollout
  - But it is NOT a mitigation option
- Developments in Europe could lead to CCUS deployment



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