# Update on Carbon Dioxide Capture and Storage in the Global Climate Scene

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IEAGHG

Midwest Carbon Sequestration Science Conference, Champaign

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## Who are we?

Our internationally recognised name is the IEA Greenhouse Gas R&D Programme (IEAGHG). We are a Technology Collaboration Programme (TCP) and are a part of the International Energy Agency's (IEA's) Energy Technology Network.

## Disclaimer

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TOTAL

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INSTITUTO DE INVESTIGACIONES ELECTRICAS

Evaluating technology options to mitigate greenhouse gas emissions

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DOOSAN Doosan Babcock

equinor

BR PETROBRAS

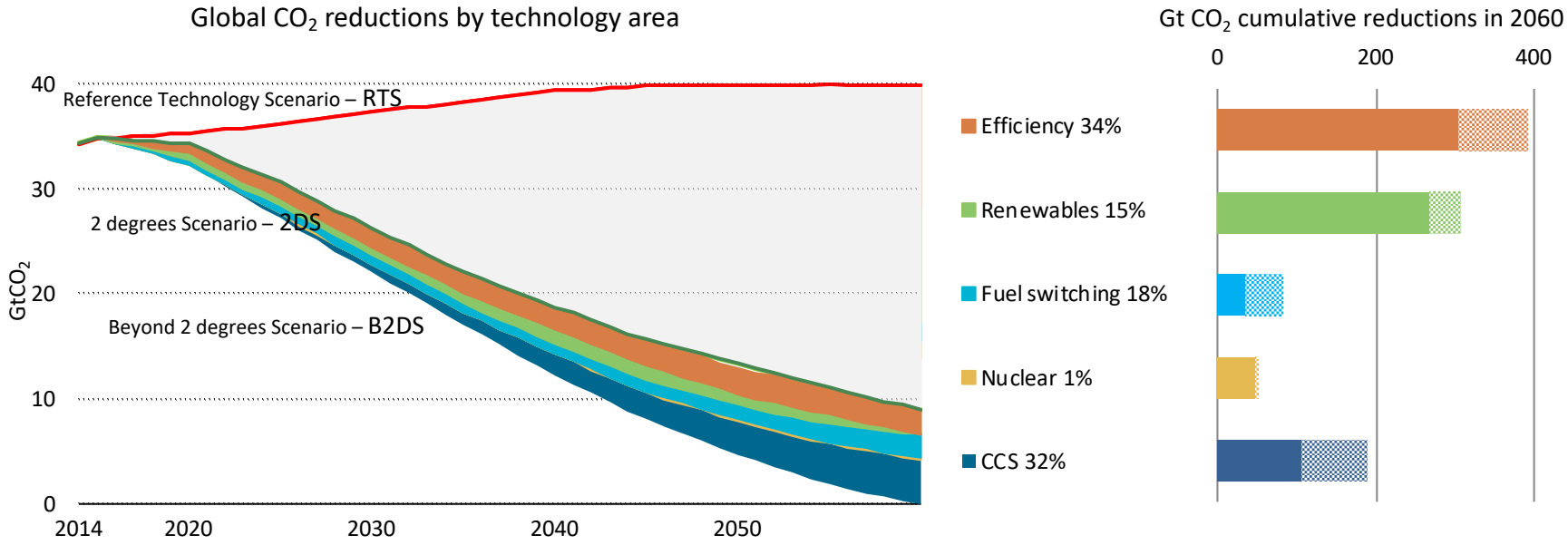
جامعة خليفة Khalifa University

JGC

RWE The energy to lead

# IEA (ETP2017) CCS plays a leading role in the energy transformation

Technology area contribution to global cumulative $CO_2$ reductions




**Pushing energy technology to achieve carbon neutrality by 2060 could meet the mid-point of the range of ambitions expressed in Paris**

# Global Update on CCUS - Policy

- CCUS Initiative launched under Clean Energy Ministerial (CEM)
  - Ministerial launch in Copenhagen, May 2018
- The objectives are to include CCUS in the technologies being considered by CEM, to create a sustained platform for private sector, governments and investment to engage, to facilitate investment, and to disseminate best practices in CCUS policy, regulatory and investment.
- Member countries are Norway, Saudi Arabia, USA, UK, and Japan, UAE, China, Canada, Mexico, and South Africa
- Meeting of the CCUS Initiative at the CEM Ministerial meeting, Vancouver, 27 May 2019. A CCUS Focus Event on the 29 May

- Mission Innovation's Carbon Capture Challenge report issued
  - Ministerial launch in Malmo, Sweden, May 2018
  - 30 Priority Research Directions for advancing the performance and reducing the costs of CCUS, focussing on low TRL
  - Next workshop 20 June 2019, Trondheim (TCCS-10)

# International CCUS Summit

- **UK Gov and IEA, Edinburgh UK, 28 Nov 2018**
- Global energy leaders (CEO of oil companies and Ministers) met to "drive new momentum in CCUS technologies"
- *Accelerating investment in a critical climate solution*
- *CCUS technologies will play a critical role in meeting globally agreed climate targets while supporting industrial competitiveness and economic growth.*
- *New business models (inc hubs and clusters), supportive policies and global partnerships can deliver a rapid scale-up of CCUS investment.*
- *Identify and develop "bankable" $CO_2$ storage: In many regions further assessment work is required to convert theoretical storage capacity into "bankable" storage, where capacity, injectivity and containment are well understood. Regional and interregional collaboration and partnerships are playing an important role in the identification and development of $CO_2$ storage facilities globally and need to be increased.*

# Japan and G20

- Japan to host G20: Summit 28-29 June 2019 in Osaka, and Energy and Environment Ministerial 15-16 June 2019 in Karuizawa
- Would like a CCUS initiative agreed for G20
- Roundtable workshop Feb 13th-14th in Washington DC organised by RITE/METI and C2ES to discuss ideas and best practice in CCUS : Policy; Finance; International Collaboration
- Proposals:
  - Highlighting importance and benefits of CCUS
  - Integrating CCUS into action plans
  - Promoting carbon recycling
  - Other recommendations: engaging finance institutions; ratification of expert amendment of London Protocol; support for CSLF; CCUS side events at G20

# Global Update on CCUS - Policy

- Country developments
  - USA enhanced 45Q
  - Norway – FEED on industrial CCS for cement and WtE
  - UK CCUS Cost Challenge Task Force report
  - Japan/Australia/Norway/UK – Hydrogen value chains with CCS

# Paris Agreement Update on CCS

**Nationally Determined Contributions (NDCs)**

- 187 Nationally Determined Contributions submitted ahead of COP-21 - 10 included CCS as a mitigation activity, these countries covered a signification proportion of the world's emissions.
- Should be noted that these NDCs were short-term focussed in being 5 years duration and only to 2025 or 2030.
- To be updated every 5 years and represent a progression

**Low GHG emission development strategies**

- Longer-term, the Paris Agreement invited Parties to communicate 'long term low GHG emission development strategies' to the mid-century.
- **Eleven** countries have submitted these, and **eight** of which contain CCS as a mitigation activity, particularly for industrial emissions (USA, Canada, Germany, Mexico, France, Czech Republic, UK, and Ukraine)(Jan 2019).

# COP24

COP24·KATOWICE 2018
UNITED NATIONS CLIMATE CHANGE CONFERENCE

United Nations
Framework Convention on
Climate Change

**2-14 December 2018, Katowice, Poland**

- To complete "Paris Agreement Work Programme" - set of issues that create shared guidance and framework for parties to implement the Paris Agreement.
- Most of key issues were agreed in the '***Katowice Climate Package***' aka 'Paris Rulebook' , including:
  - the mitigation section of nationally-determined contributions (NDCs);
  - common timeframes for countries to submit and/or update their NDCs
  - the transparency framework of action and support;
  - Technology Framework;
  - global stocktake;
  - information on future finance provided by developed countries.
- But not
  - Cooperative approaches, including new market mechanism (Article 6)

# UNFCCC Technology Framework

Guiding framework to stimulate development and transfer of climate technologies (mitigation and adaptation) to developing countries – including using Climate Technology Centre and Network (CTCN)

- Overall, technology neutral, and encourages use of existing international RD&D initiatives ie

  *III Key Themes*

  *A. Innovation*

  *(8b) sharing information on international RD&D partnerships*

  *(8e) promoting collaboration with international technology RD&D partnerships and initiatives*

  *(8f) supporting joint country activities*

  *(8g) identify ways to increase developing country participation in collaborative RD&D.*

  *D. Collaboration*

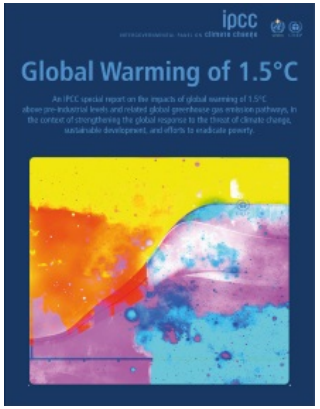
  *(20d) enhanced collaboration with relevant international organisations including academic and scientific.*

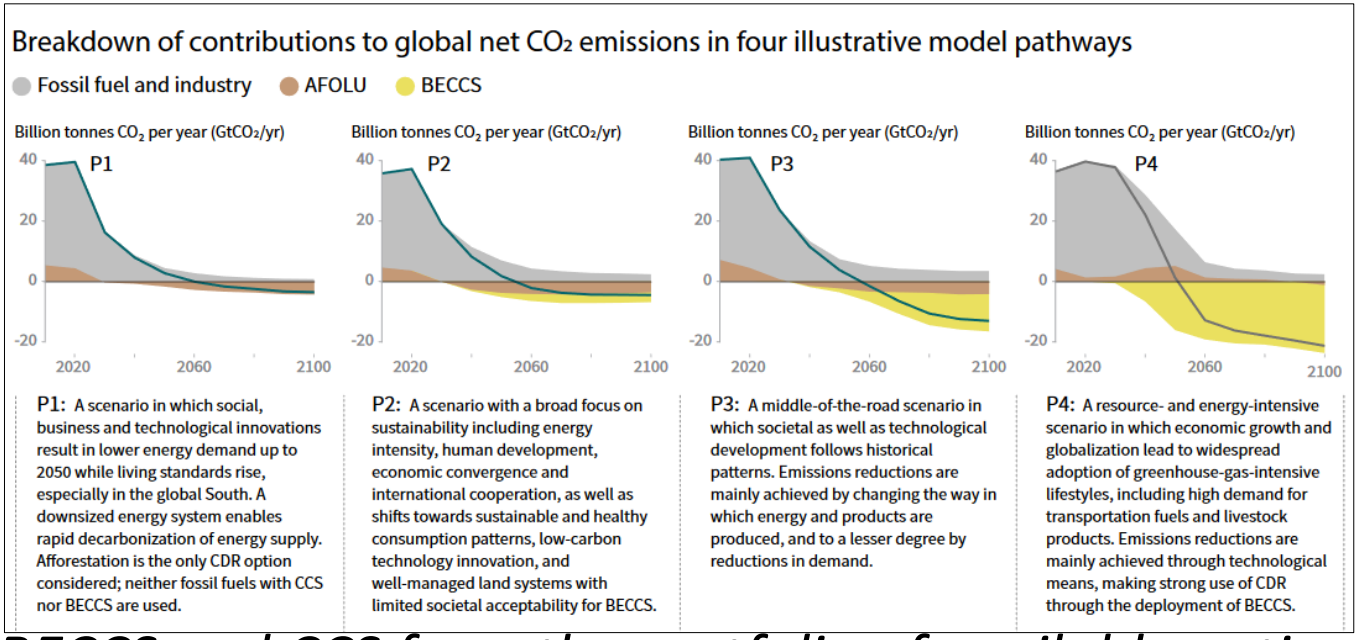
(UNFCCC Proposal by President 15/12/18 pages 58-62)

# IPCC 1.5 Special Report

- Impacts and pathways to achieving 1.5C by 2100, in context of increasing global response, sustainable development and poverty (IPCC Oct 2018)

Fig SPM.3b




- *"Removing BECCS and CCS from the portfolio of available options significantly raises mitigation costs."* (Chp 4.3)

  - https://www.ipcc.ch/report/sr15/

# Scenarios in SR1.5

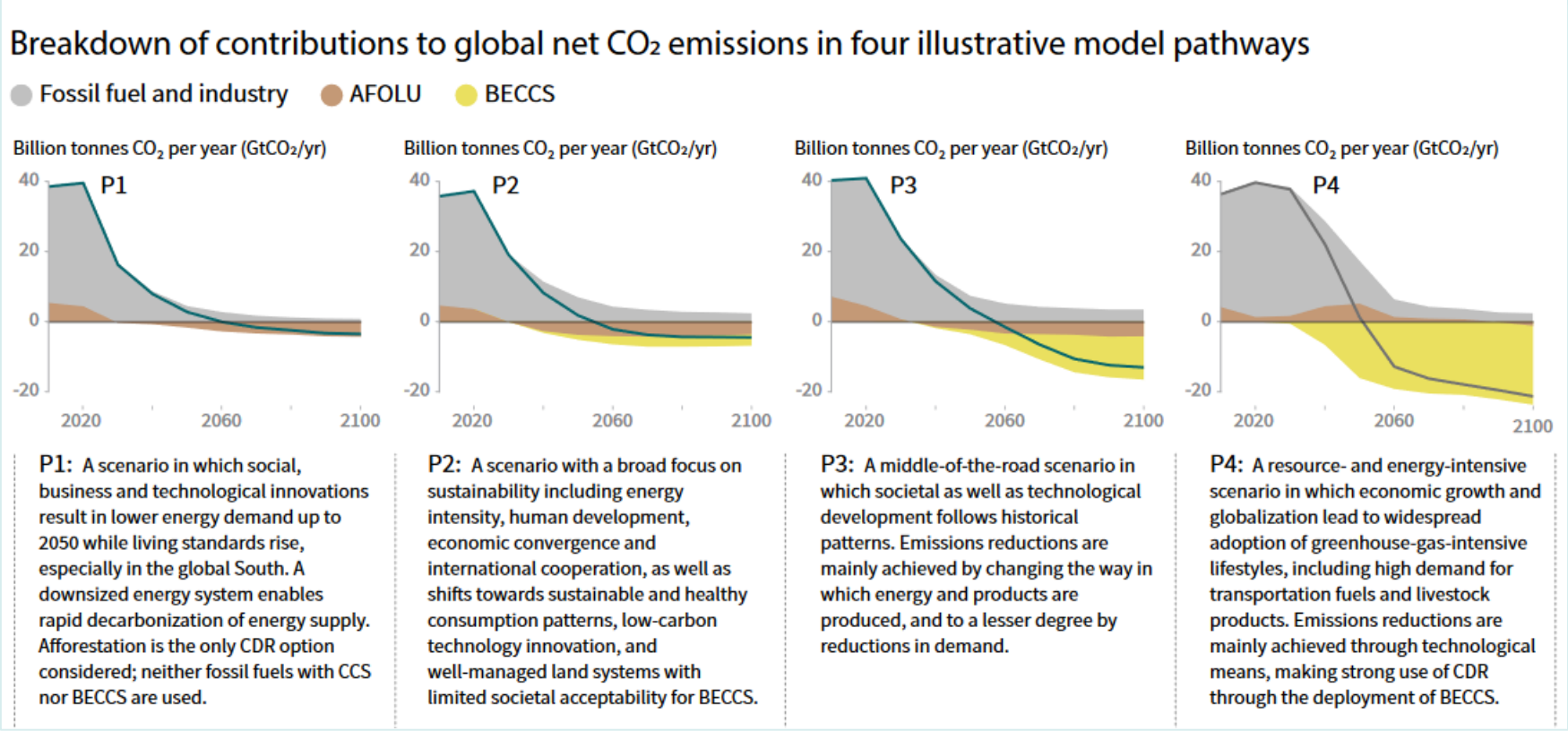
| Global indicators | P1 | P2 | P3 | P4 | Interquartile range |
|---|---|---|---|---|---|
| Pathway classification | No or low overshoot | No or low overshoot | No or low overshoot | High overshoot | No or low overshoot |
| $CO_2$ emission change in 2030 (% rel to 2010) | -58 | -47 | -41 | 4 | (-59,-40) |
| ↳ in 2050 (% rel to 2010) | -93 | -95 | -91 | -97 | (-104,-91) |
| Kyoto-GHG emissions* in 2030 (% rel to 2010) | -50 | -49 | -35 | -2 | (-55,-38) |
| ↳ in 2050 (% rel to 2010) | -82 | -89 | -78 | -80 | (-93,-81) |
| Final energy demand** in 2030 (% rel to 2010) | -15 | -5 | 17 | 39 | (-12, 7) |
| ↳ in 2050 (% rel to 2010) | -32 | 2 | 21 | 44 | (-11, 22) |
| Renewable share in electricity in 2030 (%) | 60 | 58 | 48 | 25 | (47, 65) |
| ↳ in 2050 (%) | 77 | 81 | 63 | 70 | (69, 87) |
| Primary energy from coal in 2030 (% rel to 2010) | -78 | -61 | -75 | -59 | (-78, -59) |
| ↳ in 2050 (% rel to 2010) | -97 | -77 | -73 | -97 | (-95, -74) |
| from oil in 2030 (% rel to 2010) | -37 | -13 | -3 | 86 | (-34,3) |
| ↳ in 2050 (% rel to 2010) | -87 | -50 | -81 | -32 | (-78,-31) |
| from gas in 2030 (% rel to 2010) | -25 | -20 | 33 | 37 | (-26,21) |
| ↳ in 2050 (% rel to 2010) | -74 | -53 | 21 | -48 | (-56,6) |
| from nuclear in 2030 (% rel to 2010) | 59 | 83 | 98 | 106 | (44,102) |
| ↳ in 2050 (% rel to 2010) | 150 | 98 | 501 | 468 | (91,190) |
| from biomass in 2030 (% rel to 2010) | -11 | 0 | 36 | -1 | (29,80) |
| ↳ in 2050 (% rel to 2010) | -16 | 49 | 121 | 418 | (123,261) |
| from non-biomass renewables in 2030 (% rel to 2010) | 430 | 470 | 315 | 110 | (243,438) |
| ↳ in 2050 (% rel to 2010) | 832 | 1327 | 878 | 1137 | (575,1300) |
| Cumulative CCS until 2100 ($GtCO_2$) | 0 | 348 | 687 | 1218 | (550, 1017) |
| ↳ of which BECCS ($GtCO_2$) | 0 | 151 | 414 | 1191 | (364, 662) |
| Land area of bioenergy crops in 2050 (million hectare) | 22 | 93 | 283 | 724 | (151, 320) |
| Agricultural $CH_4$ emissions in 2030 (% rel to 2010) | -24 | -48 | 1 | 14 | (-30,-11) |
| in 2050 (% rel to 2010) | -33 | -69 | -23 | 2 | (-46,-23) |
| Agricultural $N_2O$ emissions in 2030 (% rel to 2010) | 5 | -26 | 15 | 3 | (-21,4) |
| in 2050 (% rel to 2010) | 6 | -26 | 0 | 39 | (-26,1) |

*NOTE: Indicators have been selected to show global trends identified by the Chapter 2 assessment. National and sectoral characteristics can differ substantially from the global trends shown above.*

** Kyoto-gas emissions are based on SAR GWP-100*
*** Changes in energy demand are associated with improvements in energy efficiency and behaviour change*

Source: IPCC Special Report on Global Warming of 1.5°C

# IPCC 1.5 Special Report

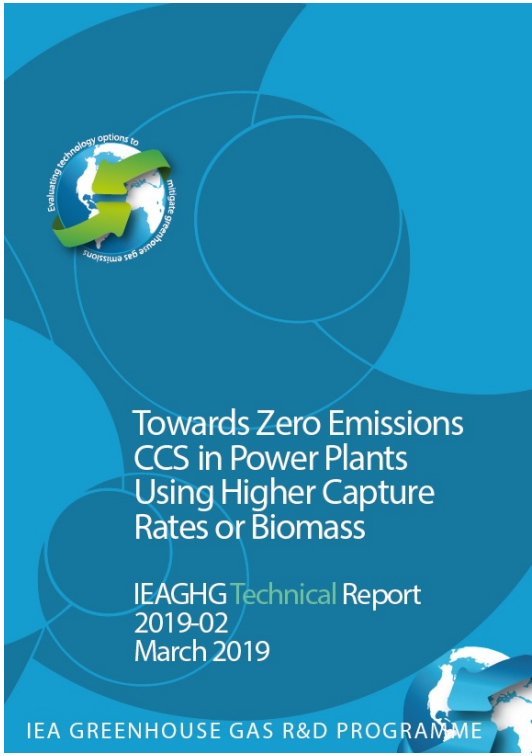



- **IEAGHG Note: IAMs typically assume Capture rate of 90% - this is a limiting factor for CCS deployment from IAMs later this century.**
  - https://www.ipcc.ch/report/sr15/

# Towards Zero Emissions IEAGHG study

- CSIRO contractor
- All three $CO_2$ capture routes are adaptable to increase in capture rates
- Most $CO_2$-capture technologies allow for higher capture rates than 90%
- Indirect emissions are dominant at high (99%) $CO_2$ capture rates
- Biomass co-combustion with 90% $CO_2$ capture provides zero emissions
- Techno-economic assessments for amine-based PCC indicate only minor cost increases ~ **7% for 99% capture**

➢ Need to ensure this is input to modelling community for IPCC AR6



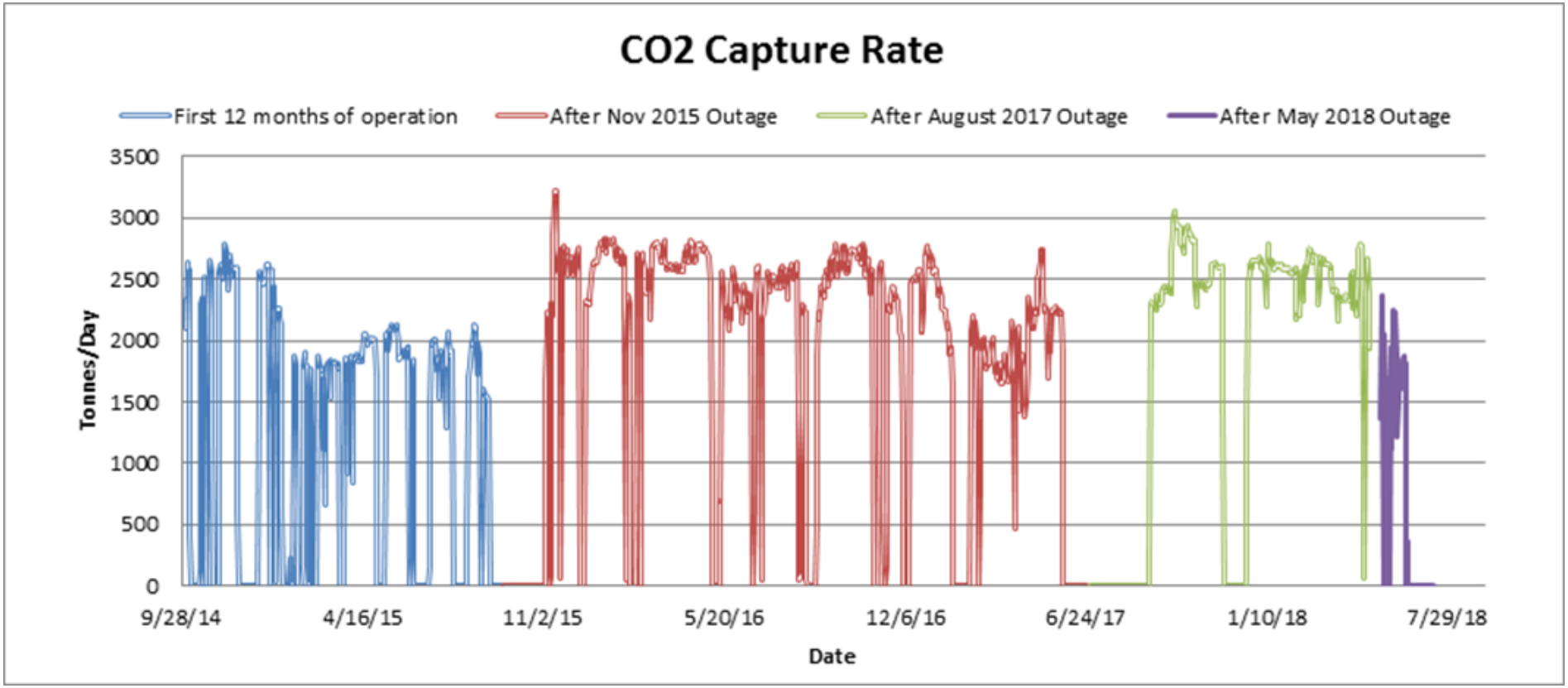
# 2014 Worlds first integrated coal fired power plant with CCS

- **SaskPower's Boundary Dam Coal PS, Saskatchewan, Canada**
- 110MWe Retrofit
- Shell/Cansolv Post combustion capture technology.
- EOR, and storage at Aquistore
- Started operation October 2014
- 2016 - International CCS Knowledge Centre


INTERNATIONAL CCS KNOWLEDGE CENTRE

# Reliable Performance of Capture Island Since 2017 Outage

INTERNATIONAL CCS KNOWLEDGE CENTRE



## Introduction: *The Shand CCS Feasibility Study* *(Corwyn Bruce GHGT-14)*

- The Shand CCS Feasibility Study was undertaken to evaluate the economics of a CCS retrofit and life extension on what was believed to be the most favorable host coal fired power plant in SaskPower's fleet.
- Collaboration between Mitsubishi Heavy Industries (MHI), Mitsubishi Hitachi Power Systems (MHPS), SaskPower and The International CCS Knowledge Centre (Knowledge Centre).

*Figure 1. 3D model of the proposed Shand CCS facility*

***Table 1. Division of Labour by Scope of Work***

| MHI/MHPS Scope | Stantec/Knowledge Centre Scope |
|---|---|
| • $SO_2$ Capture System | • Steam Supply to Battery Limit |
| • $CO_2$ Capture System | • Feed-heating Modifications |
| • $CO_2$ Compressor | • Condensate Preheating |
| • Turbine Modifications | • Deaerator Replacement |
| | • Flue Gas Supply |
| | • Flue Gas Cooler |
| | • Hybrid Heat Rejection System |
| | • Waste Disposal |

## Conclusions: *The Shand CCS Feasibility Study*

- A second generation CCS facility on coal is in sight
- Capital costs have been reduced by 67%
- Calculated cost of capture would be $45US/tonne of CO2
- Capture rate can reach up to 97% with reduced load (i.e. integrates well with renewable electricity)
- Novel optimizations and lessons learned have de-risked aspects of CCS
- Emissions are significantly lower than Canadian regulations
- Carbon Neutral Coal Power is Possible

- IPCC 1.5 *“Removing BECCS and CCS from the portfolio of available options significantly raises mitigation costs”*

- IPCC and IEA climate change mitigation scenarios need BECCS, and IBDP and Illinois Industrial CCS Project prove the technology at scale

# Thank You

# Any questions?

www.ieaghg.org