


Technology Collaboration Programme  
by IEA



# An International Update on CCUS from IEAGHG


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DOE-NETL 2020 Integrated Project Review Meeting  
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[www.ieaghg.org](http://www.ieaghg.org)

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Technology Collaboration Programme  
by IEA



## 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

The IEA Greenhouse Gas R&D Programme (IEAGHG) is organised under the auspices of the International Energy Agency (IEA) but is functionally and legally autonomous. Views, findings and publications of the IEA Greenhouse Gas R&D Programme do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.

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# UNFCCC Paris Agreement



## NDCs

- 187 Nationally Determined Contributions submitted ahead of COP-21 - 10 included CCS as a mitigation activity, these countries covered a significant proportion of the world's emissions.
- These NDCs are short-term focussed in being 5 years duration. Have to be updated every 5 years and represent progression.
- Have to be updated in 2020. 6 have submitted, 1 includes CCS (as of 02/04/20)

## 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.
- So far, **17** countries have submitted these, and **12** of which contain CCS as a mitigation activity, particularly for industrial emissions (USA, Canada, Germany, Mexico, France, Czech Republic, UK, Ukraine, Japan, Portugal, Slovak Republic, Singapore).

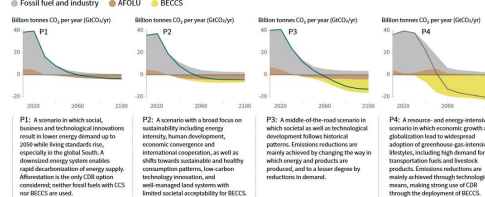
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# IPCC 1.5 Special Report 2018



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

Breakdown of contributions to global net CO<sub>2</sub> emissions in four illustrative model pathways



- **“Removing BECCS and CCS from the portfolio of available options significantly raises mitigation costs.”** (Chp 4.3)
- IEAGHG Note: IAMs typically assume Capture rate of 90% - this is a limiting factor for CCS deployment from IAMs later this century. Can be increased to 99% cost increase only 3-8%. See IEAGHG Report 2019-02.

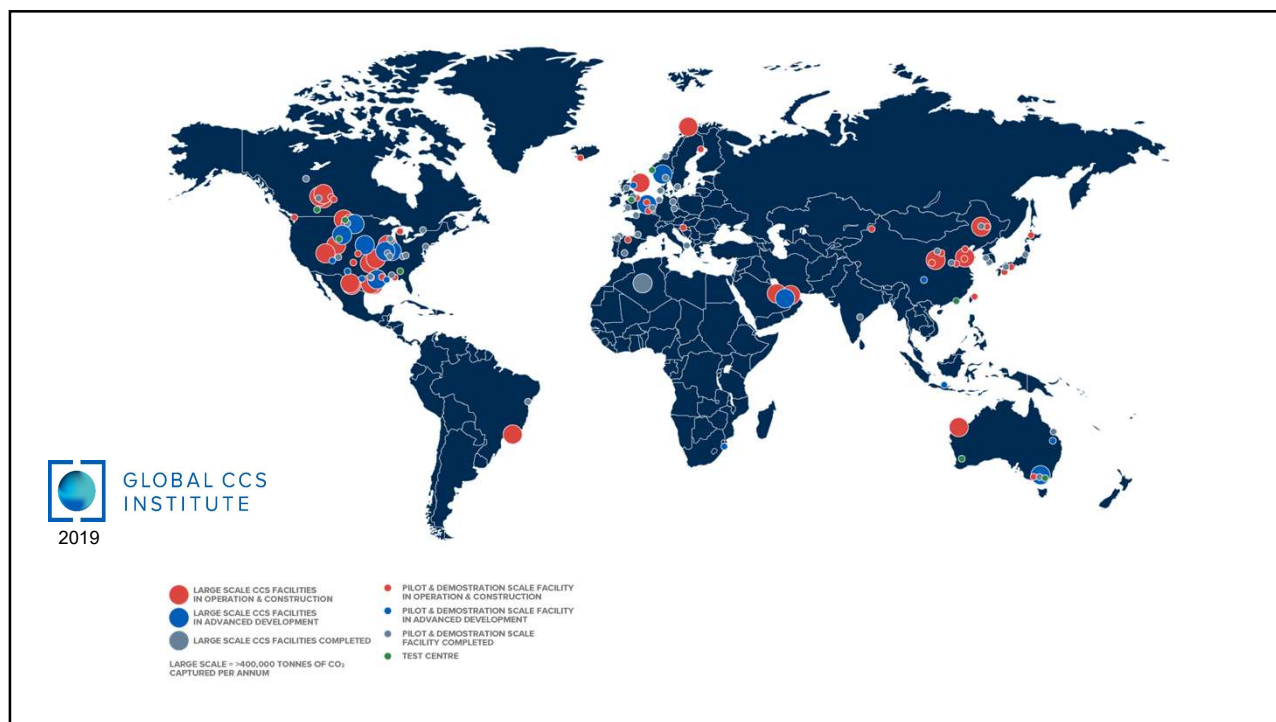
• <https://www.ipcc.ch/report/sr15/>

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## Large-scale CCS Facilities Globally Proving the Technologies work



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## Tomakomai, Japan



- Capture from hydrogen production unit in existing refinery
- Injection started spring 2016, rate ~100kt pa
- Onshore wells, deviated 3600m to offshore storage at 1200m
- Act for the Prevention of Marine Pollution and Maritime Disasters (amended 2007 to reflect London Protocol amendment). Permit issued by Min Env Mar 2016
- MMV plan included Marine Environmental Survey:- Regular (annual); Precautionary; Contingency
- Achieved target of 300kt in November 2019. Injection ceased, MMV continues.



Tip Meckel BEG

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## 2019 - Gorgon CO<sub>2</sub> Injection Project



- Largest commercial-scale injection project
- Operated by Chevron, off the coast of Western Australia
- CO<sub>2</sub> from Gorgon and Jansz-lo gas fields
  - Separated from natural gas stream prior to processing
- Injection into Dupuy Formation (2km beneath Barrow Island)



Chevron Australia Pty Ltd

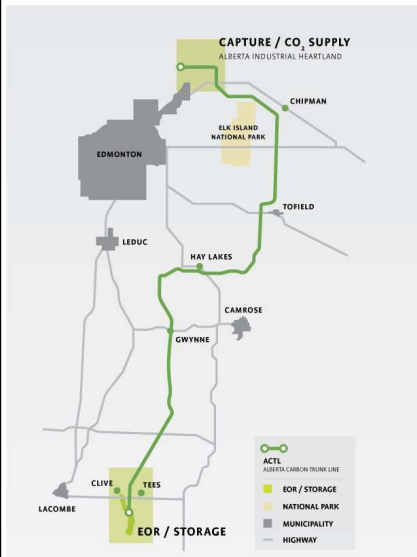
Image c/o <https://www.dmp.wa.gov.au/Petroleum/Gorgon-CO2-injection-project-1600.aspx>

- 3.4–4 million tonnes CO<sub>2</sub> /yr to be injected
- Expected 100 Mt total will be injected over project lifetime (40 yrs)

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## 2020 - Alberta Carbon Trunk Line (ACTL)



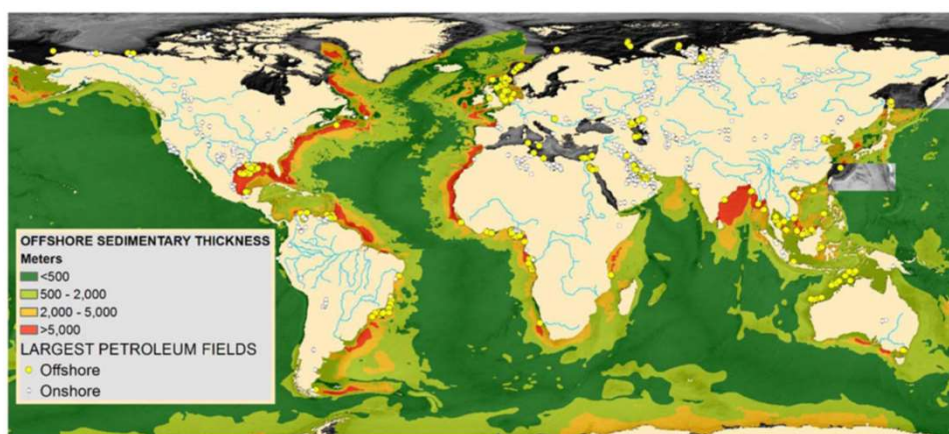
Images courtesy of [www.actl.ca](http://www.actl.ca)

- World's newest integrated, large-scale CCUS system
- Central Alberta, Canada
- Consortium of partners & government support
- 240km pipeline
- Captures industrial CO<sub>2</sub> & delivers to mature oil & gas reservoirs for EOR & permanent storage
- CO<sub>2</sub> sources:
  - Sturgeon Refinery
  - Redwater Fertilizer Facility
- Fully operational in June 2020
- 1.8 Mt CO<sub>2</sub> /yr expected to be stored in Phase 1
- At full capacity, 14.6 Mt of CO<sub>2</sub> /yr can be transported



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## Offshore Storage Potential



Ringrose and Meckel, Nature 2019

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## Countries looking at Offshore CCS



Parker Medford, BEG, 2020

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## 4<sup>th</sup> Offshore Workshop



- Bergen, February 2020
- STEMM-CCS project, University of Bergen, UT BEG and GCCC and IEAGHG



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## London Convention and Protocol



- Marine Treaty - Global agreement regulating disposal of wastes and other matter at sea
- Convention 1972 (87 countries)
- Protocol 1996 – ratified March 2006 (51 countries as of Oct 2019)
- Annual Meeting of the Contracted Parties. Annual meeting of Scientific Group.
- How it works: Prohibition on dumping of all wastes, except for those listed in Annex 1, which need to be permitted under conditions in Annex 2.
- Annex 1: dredged material; sewage sludge; fish waste; vessels and platforms; inert, inorganic geological material; organic material of natural origin; bulky items primarily comprising unarmful materials, from small islands with no access to waste disposal options

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## London Convention and Protocol and CCS



- Prohibited some CCS project configurations
- CO2 Geological Storage Assessed by LC Scientific Group 2005/6
- 2006 - Risk Assessment Framework for CO2
- **To allow prohibited CCS configurations – Protocol amendment adopted at 28th Consultative Meeting (LP1), 2 Nov 2006** - came into force 10 Feb 2007 to allow disposal in geological formations
- CO2 Specific Guidelines (2007) – provide the environmental protection

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## London Protocol Amendment



Allowed to dispose of "CO<sub>2</sub> streams from CO<sub>2</sub> capture processes for sequestration"

"Carbon dioxide streams may only be considered for dumping, if:

- 1 disposal is into a sub-seabed geological formation; and
- 2 they consist **overwhelmingly** of carbon dioxide. They may contain incidental associated substances derived from the source material and the capture and sequestration processes used; and
- 3 no wastes or other matter are added for the purpose of disposing of those wastes or other matter."

LC 28/15 (6 Dec 2006) Annex 6

- Acceptable concentrations of incidental associated substances should be related to their potential impacts on the integrity of the storage sites and relevant transport infrastructure and the risk they may pose to human health and the marine environment.

LC/SG 30/14 (Jul 2007) Annex 3.

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## London Protocol Transboundary



London Protocol Article 6

"EXPORT OF WASTES OR OTHER MATTER

*Contracting Parties shall not allow the export of wastes or other matter to other countries for dumping or incineration at sea."*

- Prohibits transboundary transport of CO<sub>2</sub> for geological storage
- 2009 LP4 (30 Oct) - Amendment to allow CO<sub>2</sub> for storage was adopted by vote.
- Article 6, new para 2: 'Export of CO<sub>2</sub> for disposal in accordance with Annex 1 may occur, provided an agreement or arrangement has been entered into by countries concerned'
- Agreement shall include: permitting responsibilities; for export to non-LP Parties provisions equivalent to LP's for issuing permits.
- **To come into force needs ratification by two thirds all Parties**
- Transboundary movement of CO<sub>2</sub> streams after injection is not export in the sense of article 6, of the London Protocol.

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## London Protocol CO<sub>2</sub> Export



- LC41 and LP14 meeting at IMO London, 7<sup>th</sup>-11<sup>th</sup> October 2019
- **Ratification of the London Protocol's 2009 CO<sub>2</sub> export amendment** Needs two thirds of the then 51 Parties to the London Protocol to ratify for it to come into force (ie 34).
- Only Norway, UK, Netherlands, Iran, Finland and Estonia ratified to date (6)
- **Norway and Netherlands proposal to LP14 for "Provisional Application" of export amendment (joined by UK).** Drawing on IEA report 2011 (IEAGHG input). Drafting Group formed at LP14.
- IEAGHG supported with Information Paper 2019-IP11, and evidence-base in plenary with paper LC41/INF3
- **Success! – Resolution for Provisional Application was adopted 11 Oct 2019**



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## London Protocol Allows CO<sub>2</sub> Export for CCS



- This means that countries can now legally export and import CO<sub>2</sub> for offshore geological storage
- Environmental protection is in place. The guidance documents for permitting offshore storage and for export agreements were revised/finalised for transboundary activities in 2012 (CO<sub>2</sub> Specific Guidelines) and 2013 (Agreements and Arrangements).

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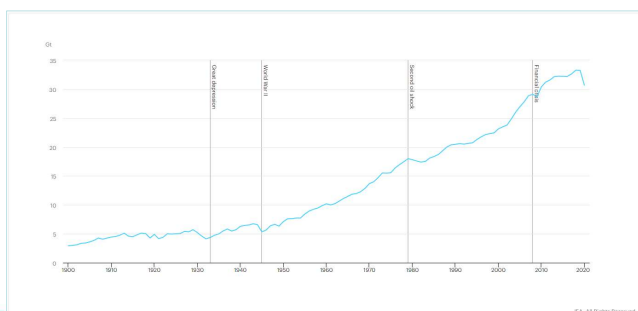
## Northern Lights: a nucleus for further growth



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## COVID-19

- Severe human health and economic disruption globally
- CO2 emissions drop: –
  - 5% lower in Q1 cf Q1 2019
  - Forecast is 8% lower for 2020, largest ever reduction, 6x larger than 2009



(IEA Global Energy Review 2020)

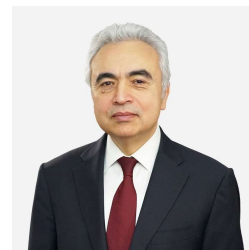
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## COVID Recovery and CCUS



- Dr Fatih Birol, Executive Director IEA
- *Governments are drawing up stimulus plans in an effort to counter the economic damage from the coronavirus. These stimulus packages offer an excellent opportunity to ensure that the essential task of building a secure and sustainable energy future doesn't get lost amid the flurry of immediate priorities.*
- *Large-scale investment to boost the development, deployment and integration of clean energy technologies – such as [solar](#), [wind](#), [hydrogen](#), [batteries](#) and [carbon capture \(CCUS\)](#) – should be a central part of governments' plans because it will bring the twin benefits of stimulating economies and accelerating clean energy transitions.*

Dr Fatih Birol 14 March IEA Commentary



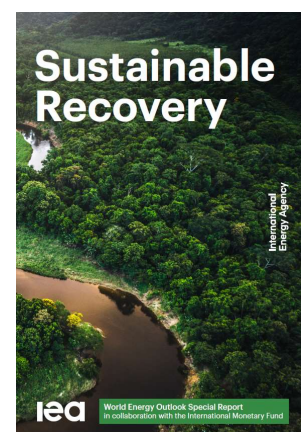
- US American Reinvestment and Recovery Act of 2009 - supported Petra Nova, ADM Industrial, and Port Arthur CCS Integrated projects

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## IEA Sustainable Recovery Plan (WEO)



- Published in collaboration with the International Monetary Fund in June 2020 to inform COVID economic responses
- Shows how governments have a unique opportunity to boost economic growth, create millions of new jobs and put global greenhouse gas emissions into structural decline
- Sectors: electricity; transport; industry; buildings; fuels and strategic opportunities in technology innovation:- hydrogen; batteries; CCUS (has CCUS-dedicated section).
- *"Carbon capture, utilisation and storage technologies have an important role to play in the development of sustainable and resilient energy systems"*
  - Noting that CCUS infrastructure is capital intensive
  - Job creation, and job retention in key sectors including oil & gas

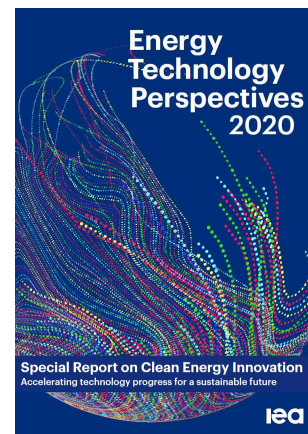


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## IEA Clean Energy Innovation (ETP)



- July 2020
- Uses IEA's Sustainable Development Scenario (net zero by 2070) and a new Faster Innovation Case (net zero by 2050)
- 4 critical technologies:
  - Electrification of end-use sectors – transport, industry heating
  - CCUS and BECCS/DAC – technology ready for early adoption
  - Hydrogen and hydrogen-derived fuels
  - Bioenergy and biofuels
- Five key principles to fast-track clean energy innovation:
  - Prioritise, track and adjust.
  - Raise public R&D and market-led innovation.
  - Address all links in the value chain.
  - Build enabling infrastructure..
  - Work globally for regional success. Share best practices.



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## IEA Greenhouse Gas R&D Programme (IEAGHG)



- A collaborative international research programme founded in 1991
- Aim: To provide information on the role that technology can play in reducing greenhouse gas emissions from use of fossil fuels and biomass in power and industrial systems.
- Focus is on Carbon Dioxide Capture and Storage (CCS)
- Producing information that is:
  - ✓ Objective, trustworthy, independent
  - ✓ Policy relevant but NOT policy prescriptive
  - ✓ Reviewed by external Expert Reviewers

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# IEAGHG



- Flagship activities:
- **Technical Studies** >330 reports published on all aspects of CCS
- **International Research Networks**
  - Risk Management – Meeting postponed to 2021  
Webinar in Fall 2020
  - Monitoring – Webinar on 12 August 2020
  - Modelling
  - Environmental Research
  - High Temperature Solid Looping
  - Costs
- **GHGT conferences** –
- GHGT-14, Melbourne, Australia, Oct 2018 – papers published on SSRN
- **PCCC conferences**
- PCCC6, UK, date tbc Fall 2021



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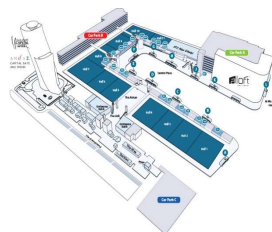


## ghgt-15

**Postponed to  
15<sup>th</sup> to 21<sup>st</sup> March 2021**



**Hosted by Khalifa University**  
**Abu Dhabi, UAE**



- Deadline to submit an abstract – 8<sup>th</sup> January 2020 – 770 abstracts
- Early Bird registration opens October 2020
- Draft Technical programme announced online May 2020
- Visit <https://ghgt.info/> for all conference information

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# IEAGHG



Other activities include:

- International CCS Summer Schools: 636 alumni, 58 countries
- **2020 in Bandung, Indonesia, hosted by ITB**
- **Postponed to 11–17 July 2021**
- **CCS Course online for ASEAN students**



- Peer reviews, eg US DOE, US EPA; CO2CRC
- Collaborations with IEA, CSLF, CCSA, International CCS Knowledge Centre, EU ZEP, GCCC, and many others

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International  
Energy Agency

Input to WPPF



IEAGHG  
Technical reports  
to CSLF  
Technical Group



United Nations  
Framework Convention on  
Climate Change

CCS Side Events at COP20, COP21,  
COP22, COP23, COP24, **COP25**



**ipcc**  
INTERGOVERNMENTAL PANEL ON  
climate change

Expert  
Reviewers,  
Accredited  
Observer



ISO Technical Committee  
on CCS, TC-265  
4 draft standards, 2  
technical reports  
**IEAGHG input**



London Convention:  
Regular updates on CCS:  
**ROAD permit assessment,**  
**Offshore workshops**  
**CO<sub>2</sub> Export**



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## IEAGHG Recent Reports (1)



Title	Contractor	Report number	Published
Integrated Greenhouse Gas Accounting Guidelines for Carbon Dioxide Capture, Utilisation and Geological Storage		2019-TR03	14/11/2019
CO2StCap (Cutting Cost of CO <sub>2</sub> Capture in Process Industry)		2019-TR02	18/11/2019
Further Assessment of CO <sub>2</sub> Capture Technologies for the Power Sector and the Potential to Reduce Costs	CSIRO	2019-09	5/03/2020
Guide to Front End Engineering Design Studies for Selected CO <sub>2</sub> Capture and Storage Projects		2019-TR01	16/09/2019
The Monitoring Network and Environmental Research Network combined meeting 20 <sup>th</sup> – 22 <sup>nd</sup> August 2019.		2020-02	26/03/20
Fault workshop 23 <sup>rd</sup> August 2019		2020-03	26/03/20
Hydrogen Production with CCS Workshop – 6 November 2019		2020-TR01	12/02/2020
Monitoring and Modelling of CO <sub>2</sub> Storage: The Potential for Improving the Cost-Benefit Ratio of Reducing Risk	Battelle	2020-01	20/02/2020

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## IEAGHG Recent Reports (2)



Title	Contractor	Report number	Published
4 <sup>th</sup> International Workshop on Offshore CCS		2020-TR-2	4/2020
PCCC5 Summary			2020
The Clean Refinery and the Role of Electricity Generation	Wood	2020-04	5/2020
Value of Emerging and Enabling Technologies in Reducing Costs, Risks & Timescales for CCS	Element Energy	2020-05	7/2020
Update techno-economic benchmarks for fossil fuel-fired power plants with CO <sub>2</sub> capture	Wood	2020-07	7/2020
The Status and Challenges of CO <sub>2</sub> Shipping Infrastructures	Element Energy	2020-10	7/2020

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# IEAGHG Webinars



- **Reducing Water Usage in Coal and Gas Fired Power Plants with CCS**
- Monica Garcia, IEAGHG, Regina Sander and Paul Feron, CSIRO Energy
- 25th June 2020
- **Launching CO<sub>2</sub> DataShare – a digital portal for making CO<sub>2</sub> storage data available**
- Grethe Tangen and Odd Andersen, SINTEF Digital, Philip Ringrose and Anne-Kari Furre, Equinor
- 27th February 2020
- **COP-25 Summary Highlights**
- Arthur Lee, Chevron
- 14th January 2020
- <https://ieaghg.org/publications/webinars>

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