



CCS Post Paris

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US Energy Association

“Membership Briefing”

Tuesday, September 27th

Washington, DC , USA



Introduction

- A walk through of IEAGHG
 - Who we are
 - What we do
- A climate change perspective
- COP21 activities, outcomes and next steps
- IEAGHG focus Post COP21

IEA Greenhouse Gas R&D



Part of the IEA ETN since 1991



35 Members from 18 countries plus OPEC, EU and CIAB

What We Are:



Members set strategic direction and technical programme



Universally recognised as independent technical organisation

Current membership



ieaghg



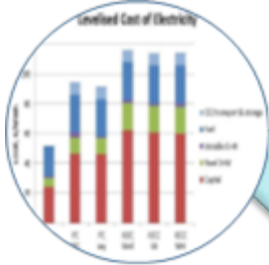
Partner Organisations:



What do we do?



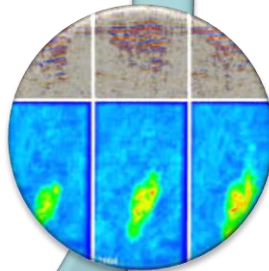
Our Core Activities Are:



Assess Mitigation Options –
Focus our R&D CCS



Facilitate technology
implementation



Facilitate international
co-operation

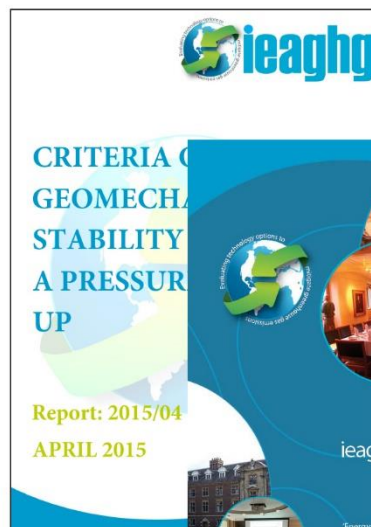


Disseminate our results as widely
as possible



Technical assessments

- Cover full scope of CCS development
- Peer reviewed before release
- Technical only not policy prescriptive
- >250 reports published to date
- Referenced by; IEA, Governments, industry & academia
- Annual overview book produced





International Energy Agency



Regular briefing on CCS status



Input to ETP/WEO
Input to WPF
Indirect Input to IEA Ministerial



Joint reports on CCS Costs & Industry CCS



Technical reports to CSLF Technical Group



ISO Technical Committee on CCS, TC-265



United Nations Framework Convention on Climate Change

Side Events on CCS Projects at COP20 and COP21

Int'l research networks



- Storage networks
 - Environmental impacts of CO₂ storage
 - Modelling
 - Monitoring
 - Risk management
- Capture networks
 - Oxyfuel combustion
 - Post combustion
 - High temperature solid looping cycles
- Cross Cutting
 - Social research
 - CCS Costs
 - LCA start up in November 2015



Dissemination



Information Papers

- Notes on technical developments & broader GHG issues

Webinars

Recordings are available:

www.ieaghg.org

Web site: www.ieaghg.org

Social media:

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IEA Greenhouse Gas R&D Programme

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Blog

New Secretary of State speaks at CCSA Presidents Reception 2015

Written by Sian Twinning on 26 June 2015. Posted in [General](#)



A large number of the great and the good from the UK's CCS world gathered for the annual CCSA President's Reception on the 24 June at the House of Lords, hosted by their Honorary President Lord Oxburgh. This followed on from the CCSA's AGM. The highlight of the reception was the guest speaker was Amber Rudd, the new Secretary of State for Energy and Climate Change. I think this was her first CCS-related event in her new position. She gave a speech that recognised the importance of CCS in dealing with climate change, the UK's expertise and capabilities in this area, mentioning of course the two UK demonstration projects as well as the government's support for feasibility work at Teesside and for R&D. The two UK projects are expected to reach final investment decisions in late 2015, with the government's decision on support in early 2016. Amber Rudd began by offering her 'personal commitment' to commercialising CCS in the UK and concluded by emphasising the need to balance longer-term considerations around the cost of decarbonisation with short-term costs to consumers. Pleasingly, she invited questions afterwards, which covered uncertainty issues for the industry and timings. Overall, the new Secretary of State provided much to discuss among the gathering of 220.

search...

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- [CO₂ capture](#)
- [Policy and legal](#)
- [Communications](#)

ExCo Members

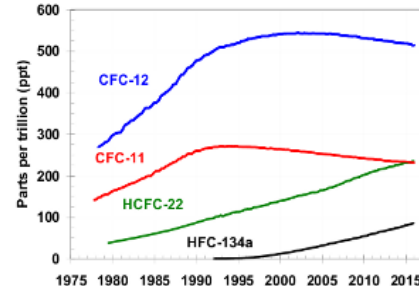
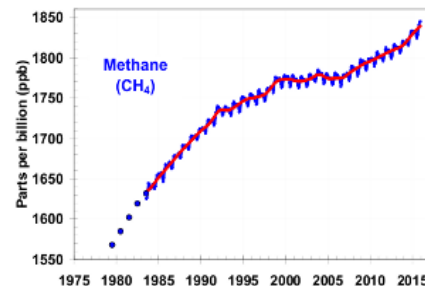
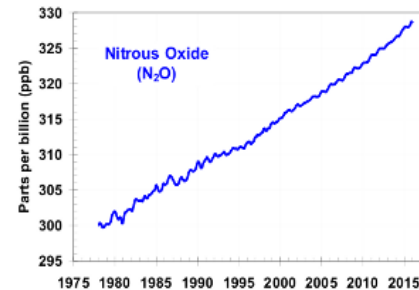
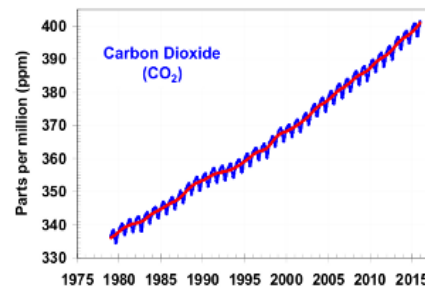
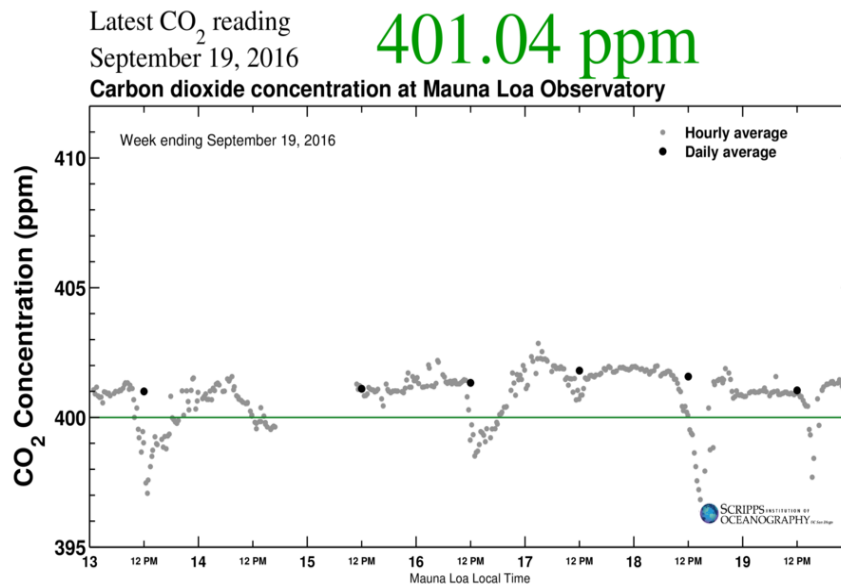
[Click here for Executive Committee](#)

Greenhouse Gas Emissions



- IPCC 5th Assessment Report – SPM

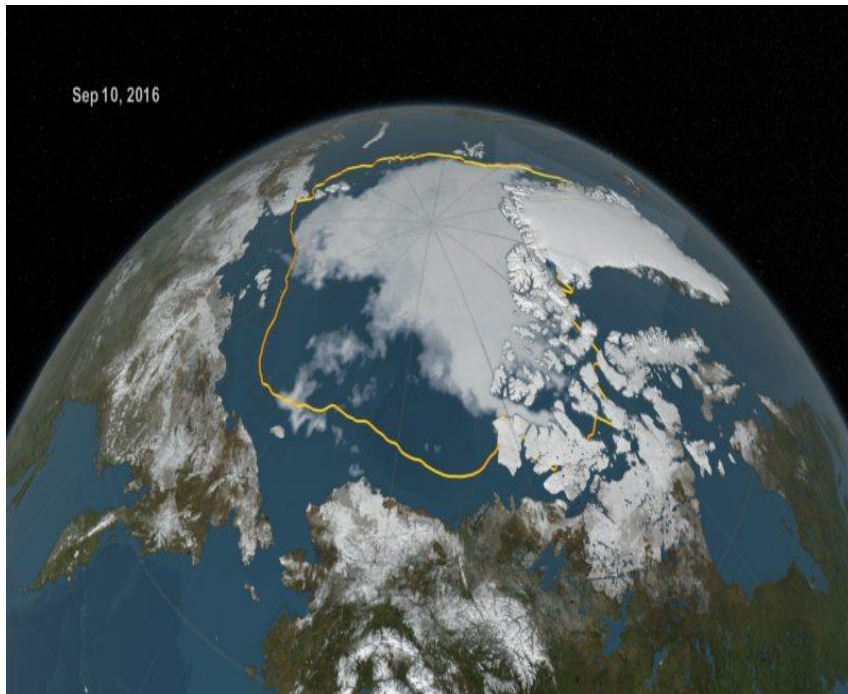
The atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years. Carbon dioxide concentrations have increased by 40% since pre-industrial times, primarily from fossil fuel emissions and secondarily from net land use change emissions. The ocean has absorbed about 30% of the emitted anthropogenic carbon dioxide, causing ocean acidification



Current Climate Status



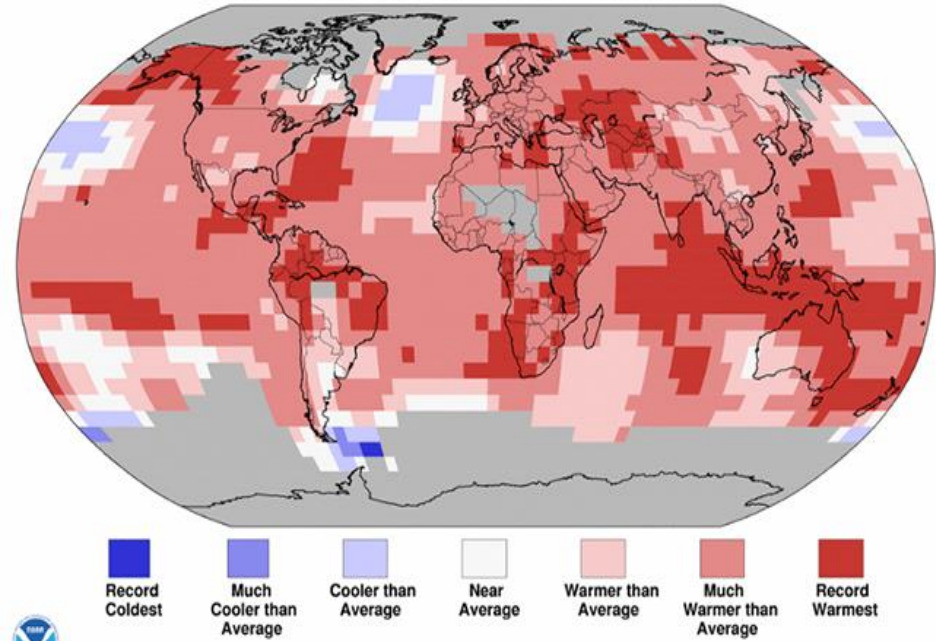
Arctic Sea Ice Extent at lowest ever level



Source: <http://earthsky.org/earth/arctic-sea-ice-2nd-lowest-on-record>

August 2016 Global Temperatures Set 16th Straight Monthly Record

Land & Ocean Temperature Percentiles Jan–Aug 2016
NOAA's National Centers for Environmental Information
Data Source: GHCN–M version 3.3.0 & ERSST version 4.0.0



Fri Sep 16 09:45:33 EDT 2016

Source: <http://www.ncdc.noaa.gov/sotc/global/201608>



Key Outcomes

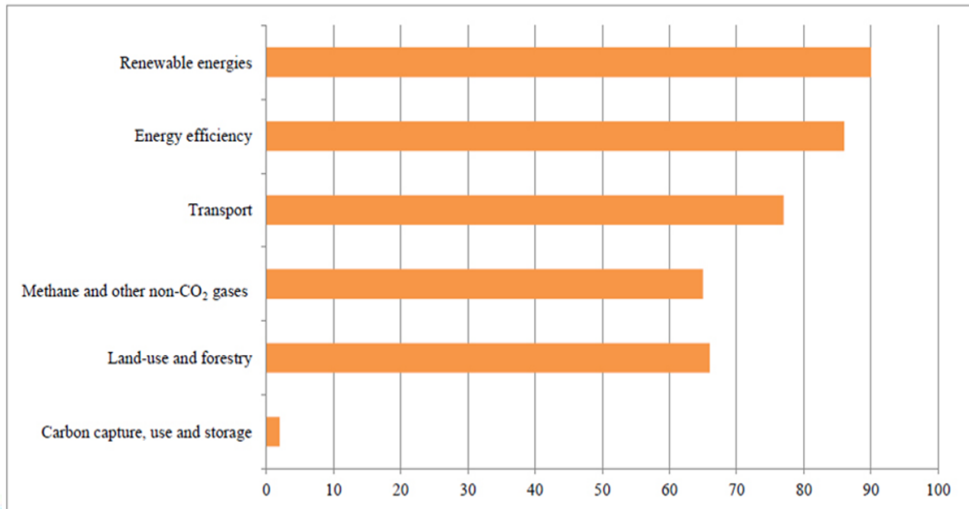
- Paris Accord agreed by 181 Countries
 - A truly “Global” agreement unlike the Kyoto Agreement
 - USA not a party to Kyoto
- Below 2⁰C target, sets a new tougher goal
 - “Green” NGO’s – total phase out of fossil fuels !!!
- Status of ratification
 - 62 countries (need 55 countries)
 - 49.3% of global emissions (need 55%)
 - 16 countries to ratify by end of 2016
 - EU October 2016 ???

Intended Nationally Determined Contributions (INDCs)



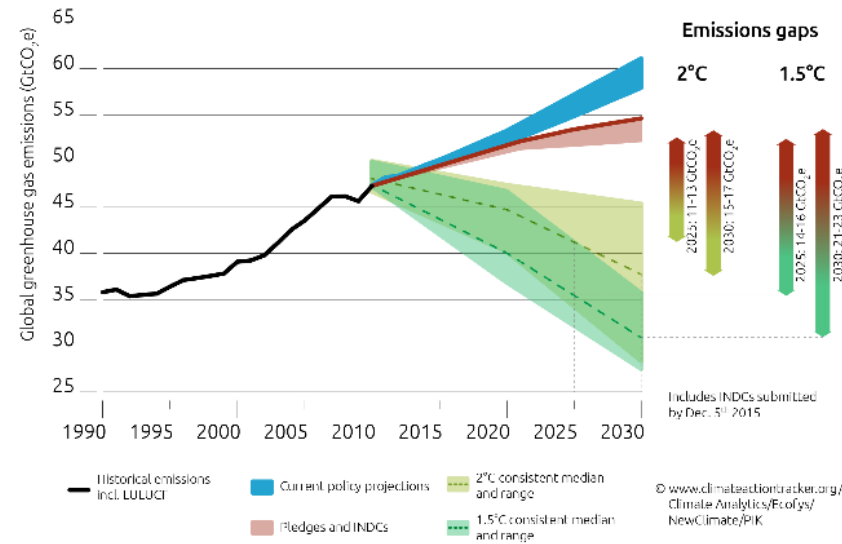
- 187 INDCs submitted
- 94% global emissions
- New trajectory to ~ 2.70C
- ~ 3.6C from existing policies

Priority areas for implementation highlighted in the intended nationally determined contributions



CAT Emissions Gaps

7th December 2015



Climate Action Tracker

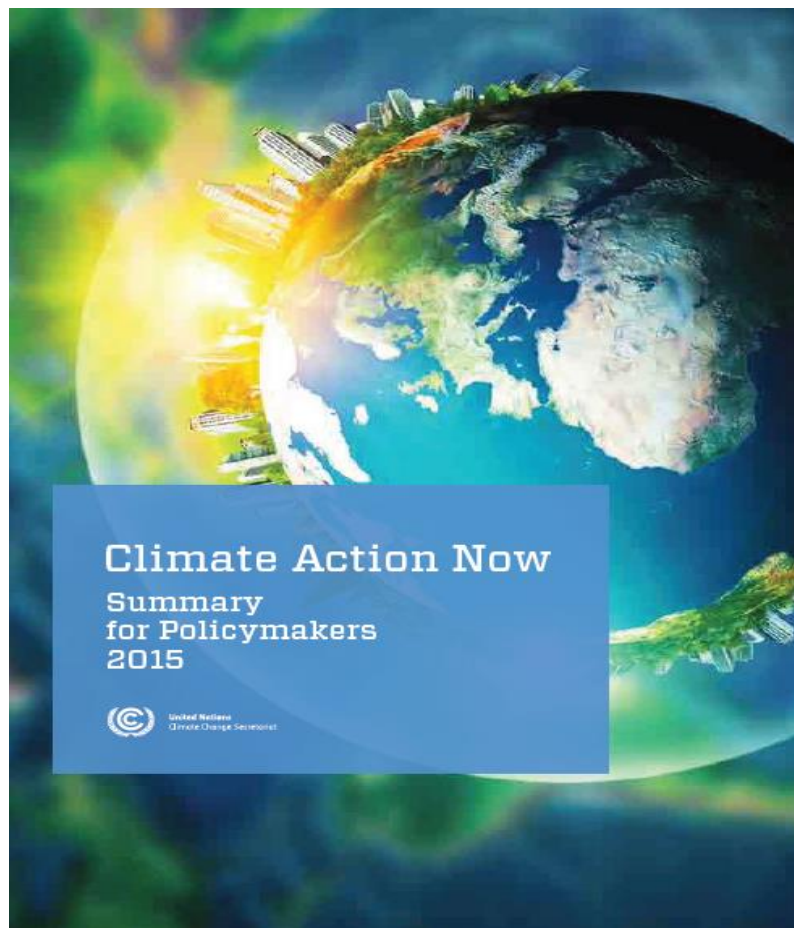
<http://climateactiontracker.org/global/173/CAT-Emissions-Gaps.html>

CCS underplayed in INDC's?



- CCS directly mentioned in 10 INDCs
 - Bahrain, Canada, China, Egypt, Iran, Norway, Malawi, Saudi Arabia, Egypt, South Africa & UAE
 - EU – represents 28 countries
- USA, main climate action was Clean Power Act
 - Includes CCS
- Cumulative emissions from these countries 22Gt CO₂ in 2013
 - World total 35.7Gt – energy production and cement
 - Covers 62% of total emissions in 2013

Climate Action Now, A Summary for Policy Makers 2015



- Key messages for policymakers;
- Brief overview of state of play of climate change;
- Actions to realize significant mitigation potential in the areas of:
 - Renewable energy,
 - Energy efficiency,
 - CCUS,
 - Non-CO₂ greenhouse gases (GHGs)
 - land use.
- International organisations that can help.
- Use the information so Parties can:
 - Increase their pre-2020 ambition,
 - Further reduce the emissions gap to limit global warming to 2°C,
 - Lay the foundation for post-2020 action.

<http://climateaction2020.unfccc.int/media/1173/21789-spm-unfccc-lowres.pdf>

CCUS in Climate Action Now



Priority thematic areas

**CARBON
CAPTURE, USE
AND STORAGE**

- Project financing
 - Boundary Dam 3
 - UK Competition
- Frameworks and Directives
 - EC Directive
 - Korean CCS Roadmap
- Carbon Pricing
 - Norway Carbon Tax
- Information Sources
 - CSLF
 - IEAGHG
 - GCCSI

IEAGHG et al Side-event



Carbon Capture and Storage (CCS): Achievements and Opportunities for Developing Country Involvement, 1st December 2015



Messaging,

- Statoil: 19 years of injection & monitoring at Sleipner
- SaskPower: Boundary Dam 3 achievements
- CO2GeoNet: CO₂ storage projects in Europe

Outcomes



- 200 attendees
- Many from Developing Countries
- Reported at:
www.ieaghg.org &
<http://www.iisd.ca/climate/cop21/enbots/1dec.html#event-6>
- Generated a lot of discussion and attendance at booth in “Blue Zone”

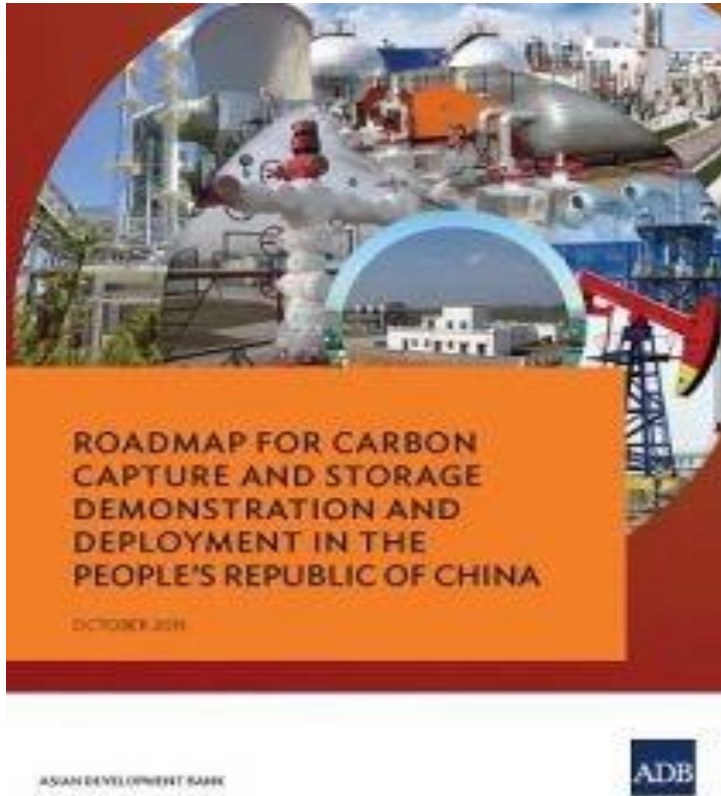


'Mission Innovation' launch

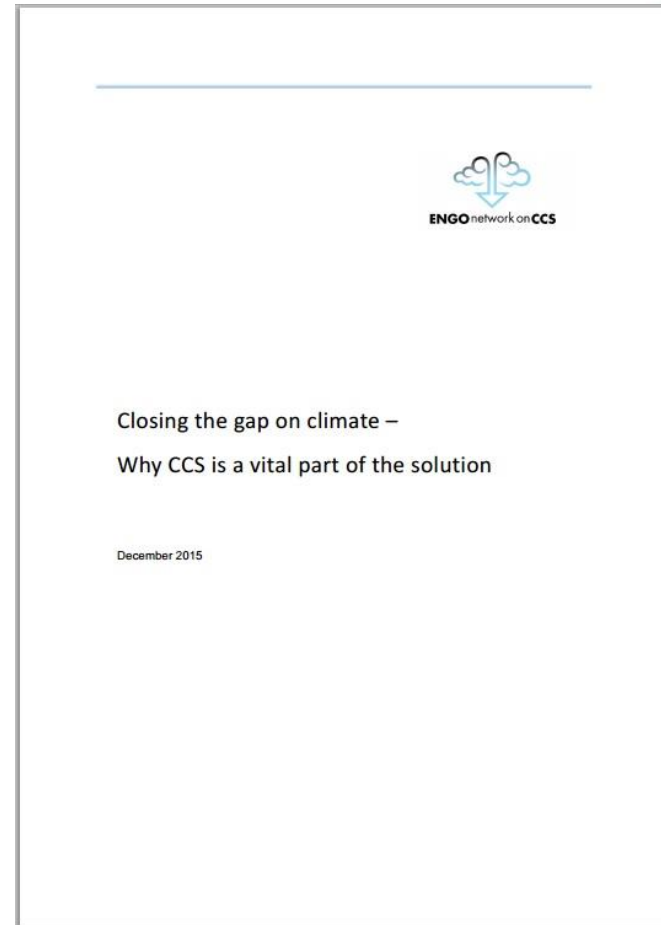


- 20 countries will seek to double governmental and/or state-directed clean energy R&D investment over five years
- *"Accelerating the Clean Energy Revolution"*
- Aims to reinvigorate and accelerate global clean energy innovation with the objective to make clean energy widely affordable (for climate challenge, affordable and reliable energy for everyone, and energy security)
- also *Breakthrough Energy Coalition* - 28 investors from 10 of these countries make a commitment to invest in early-stage technology development.

Associated Activities



<http://www.adb.org/sites/default/files/publication/175347/roadmap-ccs-prc.pdf>



http://www.engonetwork.org/eng_o_perspectives_on_ccs_digital_version.pdf

What happens next?







- 181 Countries signed Paris Accord on 22 April 2016
- To enter into force it has to be ratified by 55 countries that represent 55% of global emissions
 - September 2016 – 29 nations had ratified
- INDC's become NDC's
 - Not legally binding, no enforcement action and no “naming and shaming”
- Stocktake of NDC commitments in 2018, then updated every 5 years
- IPCC Special Report in 2018 on Below 2⁰C needs

CCS critical to getting to 2°C



IPCC AR5 SYR from Table 3.2 (2014)

Mitigation cost increases in scenarios with limited availability of technologies ^d				
<i>[% increase in total discounted ^e mitigation costs (2015–2100) relative to default technology assumptions]</i>				
2100 concentrations (ppm CO ₂ -eq)	no CCS	nuclear phase out	limited solar/wind	limited bioenergy
450 (430 to 480)	138% (29 to 297%) 	7% (4 to 18%) 	6% (2 to 29%) 	64% (44 to 78%) 

Going to <2°C will need:

- Concerted action on Low C technology deployment
 - Mission Innovation launch at COP21
 - Including CCS post 2030

Study on Unburnable Carbon and CCS



Contractor: SGI at Imperial College UK



- CCS enables access to significant quantities of CO₂ from fossil fuels in a 2°C world
- The impact of CCS on unburnable carbon is significant, starting from 2030/2040 and becoming more apparent by 2100
- The global carbon budget erodes quickly
 - Imperative for prompt action on CCS
- Cost assumptions do not limit CCS uptake in IAM's
- But there are other factors that limit CCS uptake in IAM's
 - Hypothesis: residual emissions
- Global CO₂ storage capacity is large and well above known fossil fuel reserves
- Pressure and brine management will likely induce higher costs



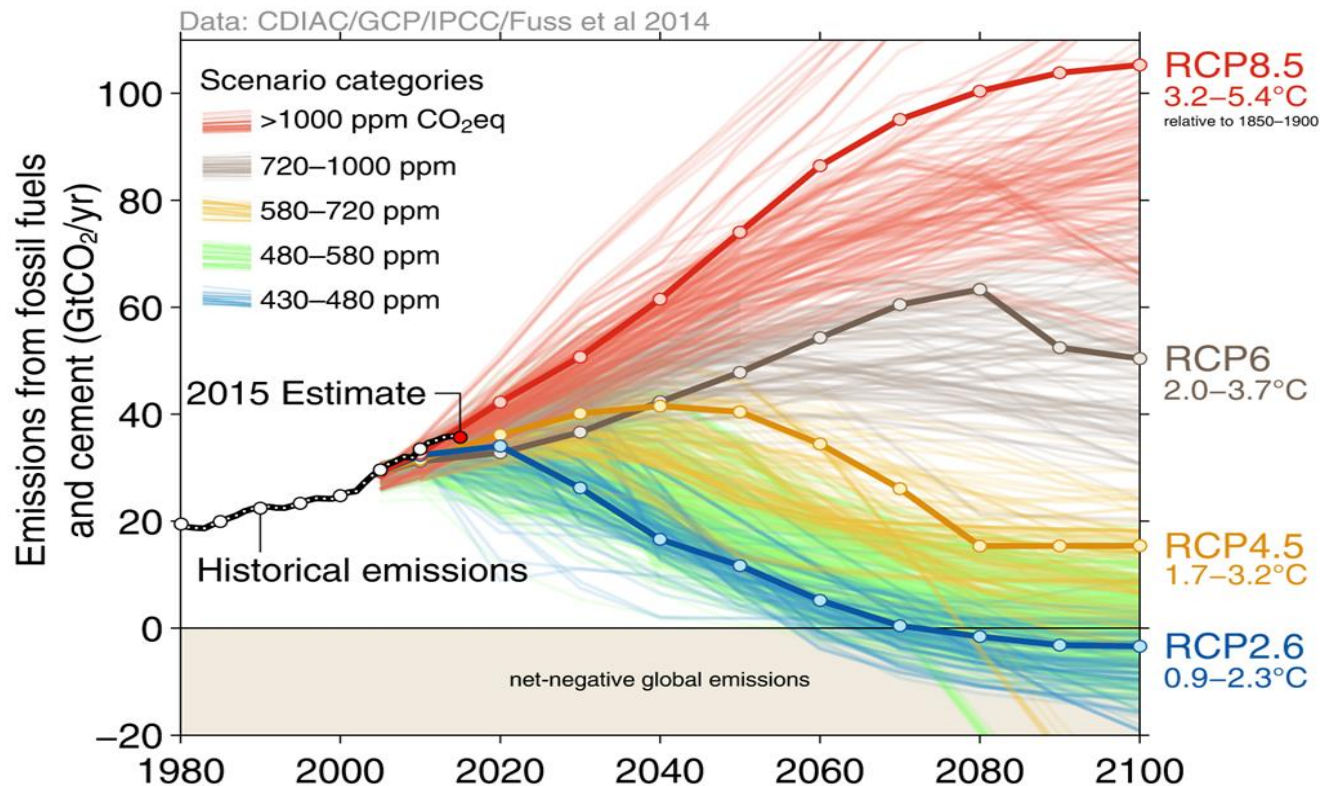
Residual Emissions

- Current capture systems take us to 85-90% capture
 - 10 to 25% of emissions remain
 - Problem under $>2^{\circ}\text{C}$ scenario
- Need to increase capture percentage without occurring additional cost
 - Technically feasible to increase capture rates
 - Combination of capture and biomass firing
 - “negative emissions”
 - Oxy fired cycles can achieve high capture rates
 - But trade off on impurity levels

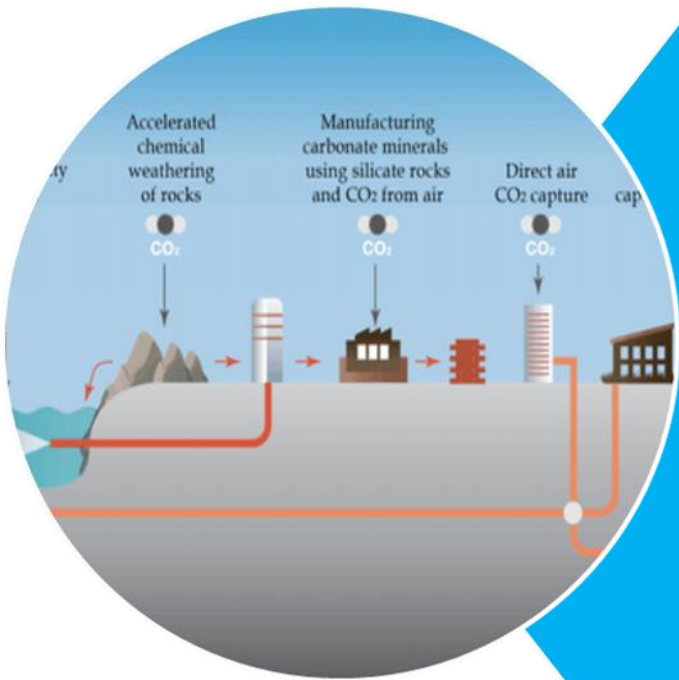
Negative Emissions



- Already an expectation that NET'S will be needed after 2030



NET options



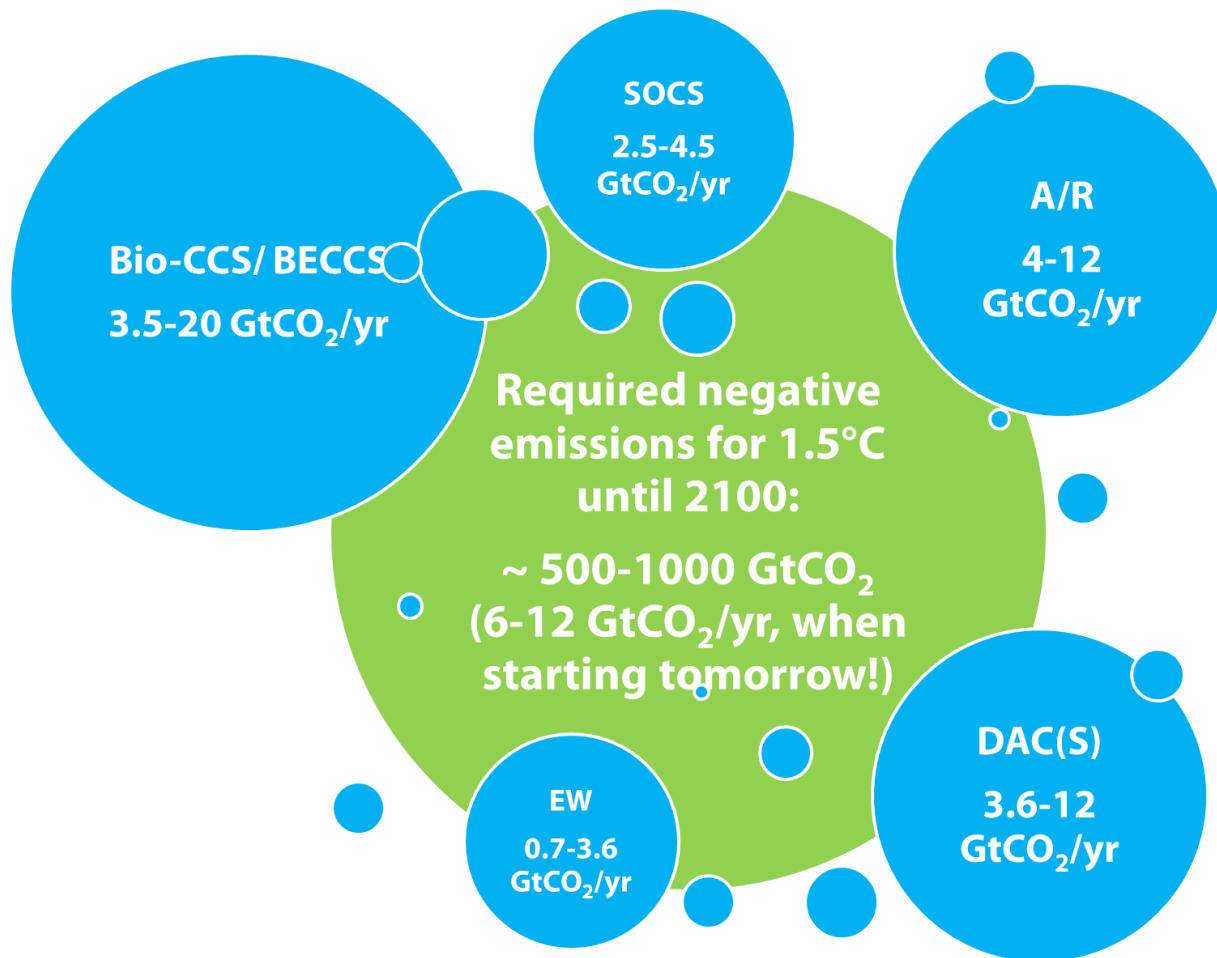
NETs (negative emission technologies)

- **Bio-CCS/BECCS (bioenergy with CCS)** – using biomass that has previously taken up CO_2 during growth to produce power/heat/fuels, then capturing and storing the emitted CO_2
- **A/R (afforestation/reforestation)** – planting trees where previously (a) there were none or (b) they have been cut down
- **DAC(S) (direct air CCS)** – capturing CO_2 directly from air
- **EW/MC (enhanced weathering/mineral carbonation)** – spreading pulverised rock on land/water to take up CO_2 and form bicarbonate
- **SOCS (soil organic carbon sequestration)** – storing CO_2 in soil through advanced farming methods, restoration and land creation
- **Biochar** – adding burnt/torrefied biomass to soil for long term storage
- **Ocean fertilisation** – adding Fe or N to accelerate CO_2 uptake by microorganisms for photosynthesis
- **Cloud/ocean treatment** – (a) using alkalis to wash CO_2 out of the atmosphere, (b) using lime to absorb CO_2 from the oceans

Bio-CCS/BECCS status



- Many studies conclude: Bio-CCS, incl. its CCS components, technically feasible as of today (TRL 3-7) (except microalgal biomass)
- Perceived „double benefit“: heat/power + negative emissions → would be less so for fuels due to release of CO₂ during combustion
- 5 operating Bio-CCS projects: 0.1-1 MtCO₂/yr (all ethanol based, 3 for EOR, 4 in US, 1 rather Bio-CCU), several more underway
- GHG accounting: only 2006 IPCC GLs, CDM/JI, Ca LCFS and EU RED/FQD cover Bio-CCS
- Plenty of research on public perception of CCS but very limited and contradictory on Bio-CCS
- Bio-CCS generally has lower profile than Fossil-CCS
- Main drivers/barriers for Bio-CCS:
 - CO₂/NG price, infrastructure/clusters, sustainable feedstocks, public perception



Most important NET trade-offs

Impact on soil	Energy demand
Impact on albedo	Water demand
Costs	Land demand



Downward Pressure on Costs



- Costs of some renewable technologies have reduced
 - Mass production of panels etc.,
- CCS must be cost competitive
 - LCOE standard comparative measure of CCS
 - Is it a way to compare costs off different technologies?
- LCOE ignores “system costs” therefore not a good way to compare different costs
- Especially in grids with high influx of variable renewable energy

Valuing the Flexibility of CCS



- Electricity grids are now more complex with varying degrees of RE input
- CCS power plants will need to be flexible to meet effects of VRE's on grid
- New study indicates:
 - Integrated flexible CCS and RE systems can have a low carbon intensity and have low system costs
 - The higher the degree of VRE the lower the utilisation rates of flexi CCS becomes
 - Economic disadvantage for investors
 - Requires policy action to implement

Summary



- Historic agreement reached in Paris at COP21
 - Commitment to take the world to below 2⁰C temperature rise
 - Represents a considerable challenge with current rate of CO₂ emissions rise – now 401ppm
- CCS had highest profile yet at COP21
 - More interest from Developing Countries
- Next 6 years critical to set process in motion
 - CCS critical to reach 2⁰C
 - Even more important now and “negative emission” options - BioCCS

Summary



- CCS was profiled quite highly at COP21 as a mitigation option
- INDC's reflect early action – don't include CCUS significantly
- Move now to “below 2⁰C” will require increased mitigation activity after 2020/2030
 - **CCS will then need to play a big role**
- Ensuing conflict:
 - NGO's see new goal as option to phase out fossil fuels (“coal”)
 - CCS seen as coal option – need new narrative, gas and bio important
- CCS will become key for industry to mitigate CO₂



Thank you, any Questions?

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