Technology Collaboration Programme
by iea

The Global Scene for CCS

Tim Dixon

IEAGHG

International Knowledge-Sharing Symposium
University of Trinidad and Tobago and
University of West Indies
29 October 2019

ieaghg

Who are we?

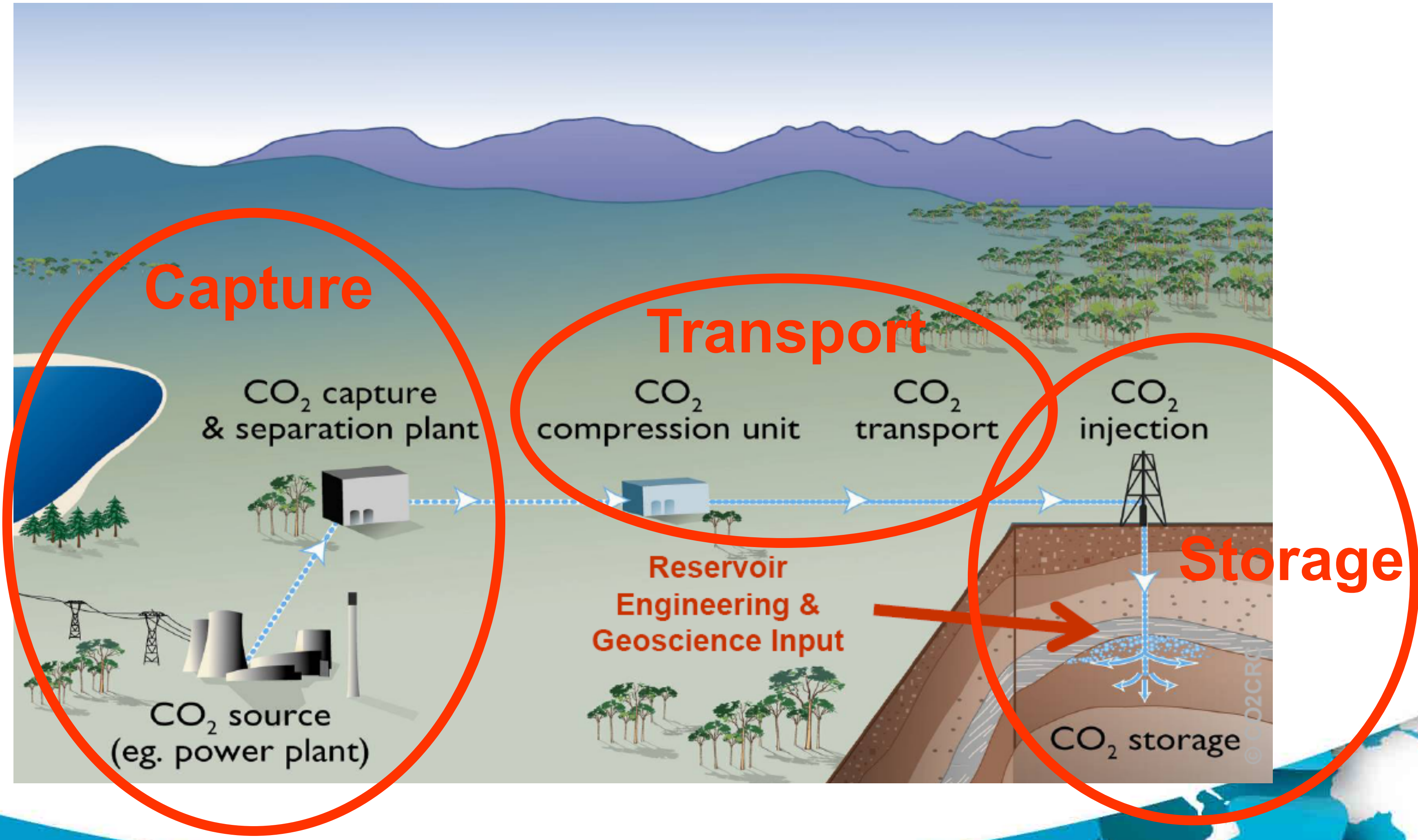
Our internationally recognised name is the IEA Greenhouse Gas R&D Programme (IEAGHG). We are a Technology Collaboration Programme (TCP) and are a part of the International Energy Agency's (IEA's) Energy Technology Network.

Disclaimer

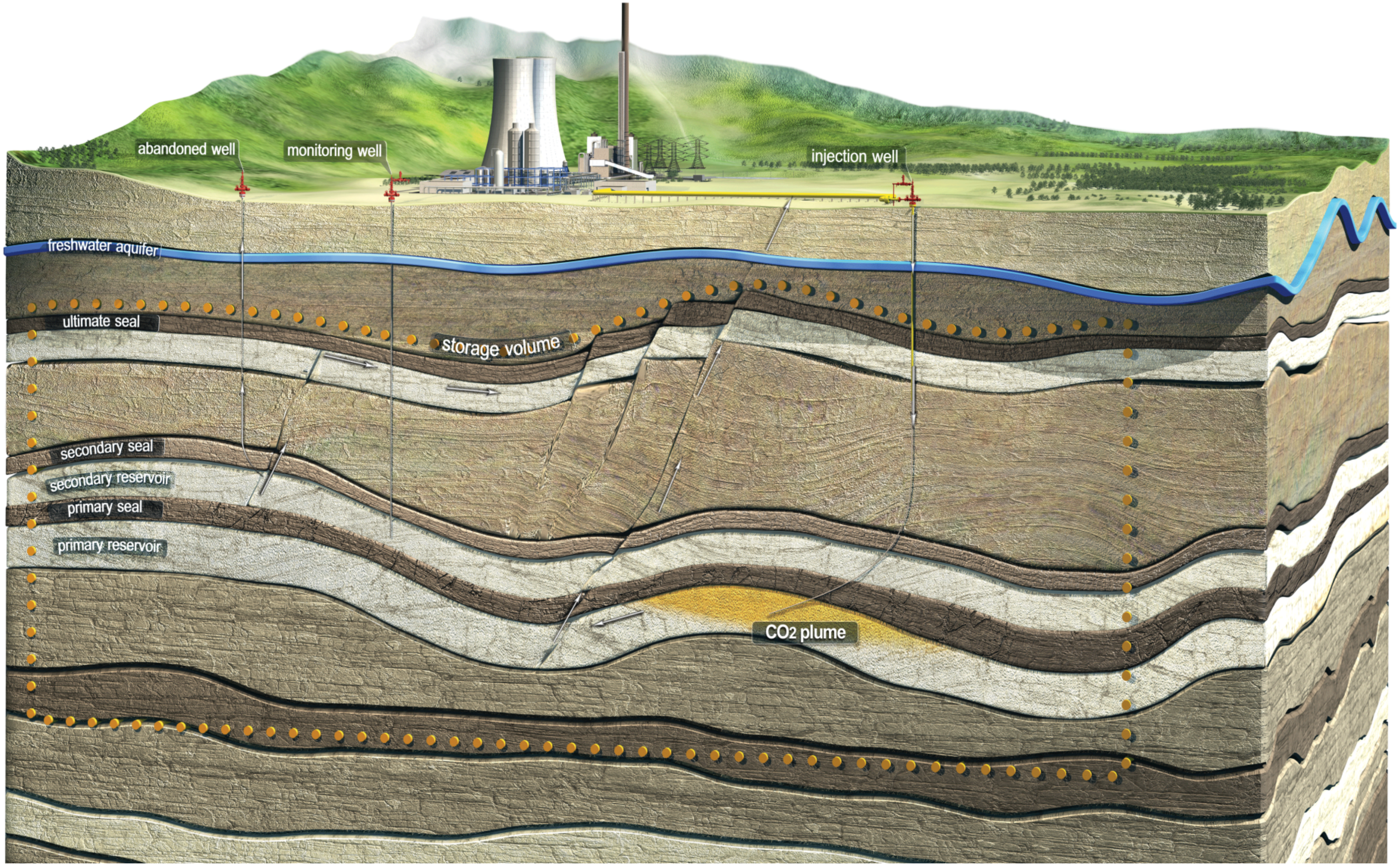
The IEA Greenhouse Gas R&D Programme (IEAGHG) is organised under the auspices of the International Energy Agency (IEA) but is functionally and legally autonomous. Views, findings and publications of the IEA Greenhouse Gas R&D Programme do not necessarily represent the views or policies of the IEA Secretariat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

IEAGHG Members

What is CO_2 Capture and Storage (CCS) ?



What is CCS?



Source: DNV

Why CCS ?

IPCC Fifth Assessment Report Synthesis Report

2nd November 2014
Copenhagen

INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

Key Messages

→ Human influence on the climate system is clear

→ The more we disrupt our climate, the more we risk severe, pervasive and irreversible impacts

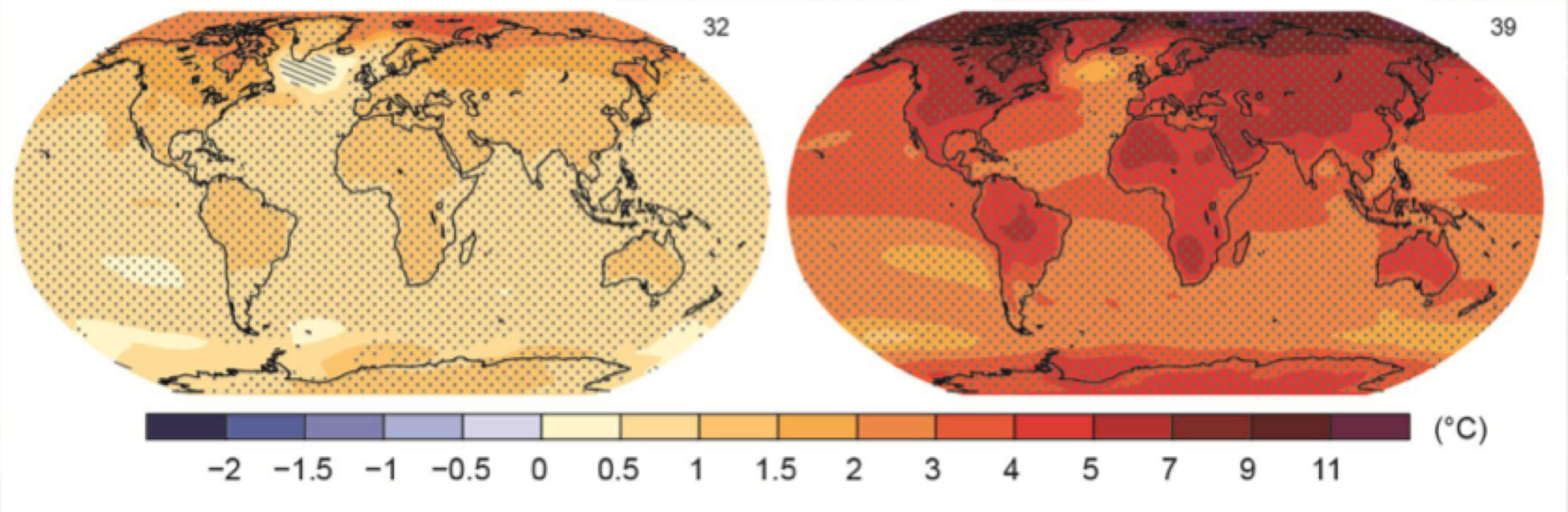
→ We have the means to limit climate change and build a more prosperous, sustainable future

AR5 WGI SPM, AR5 WGII SPM, AR5 WGIII SPM

The Choices We Make Will Create Different Outcomes

With substantial mitigation

Without additional mitigation

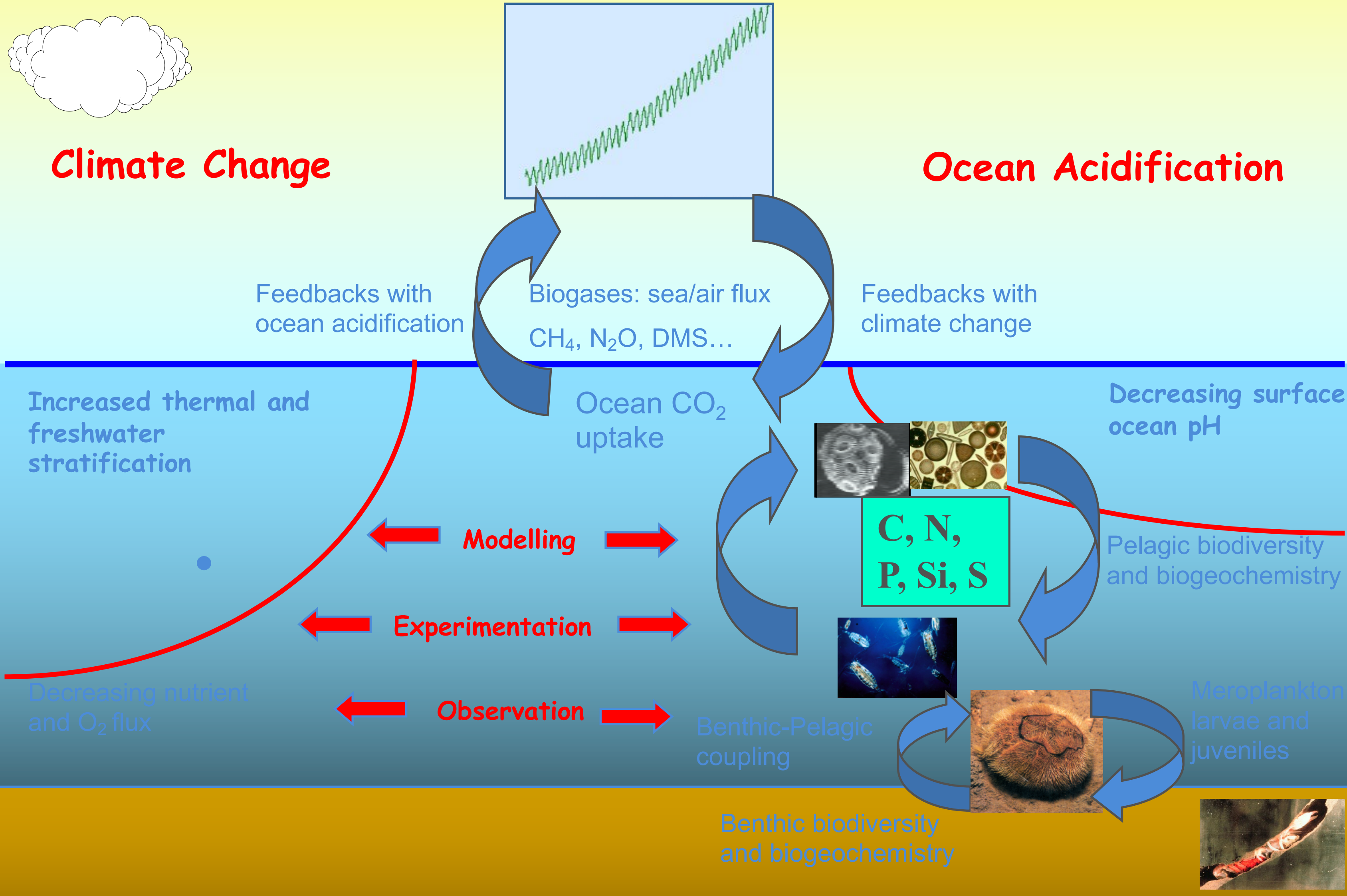


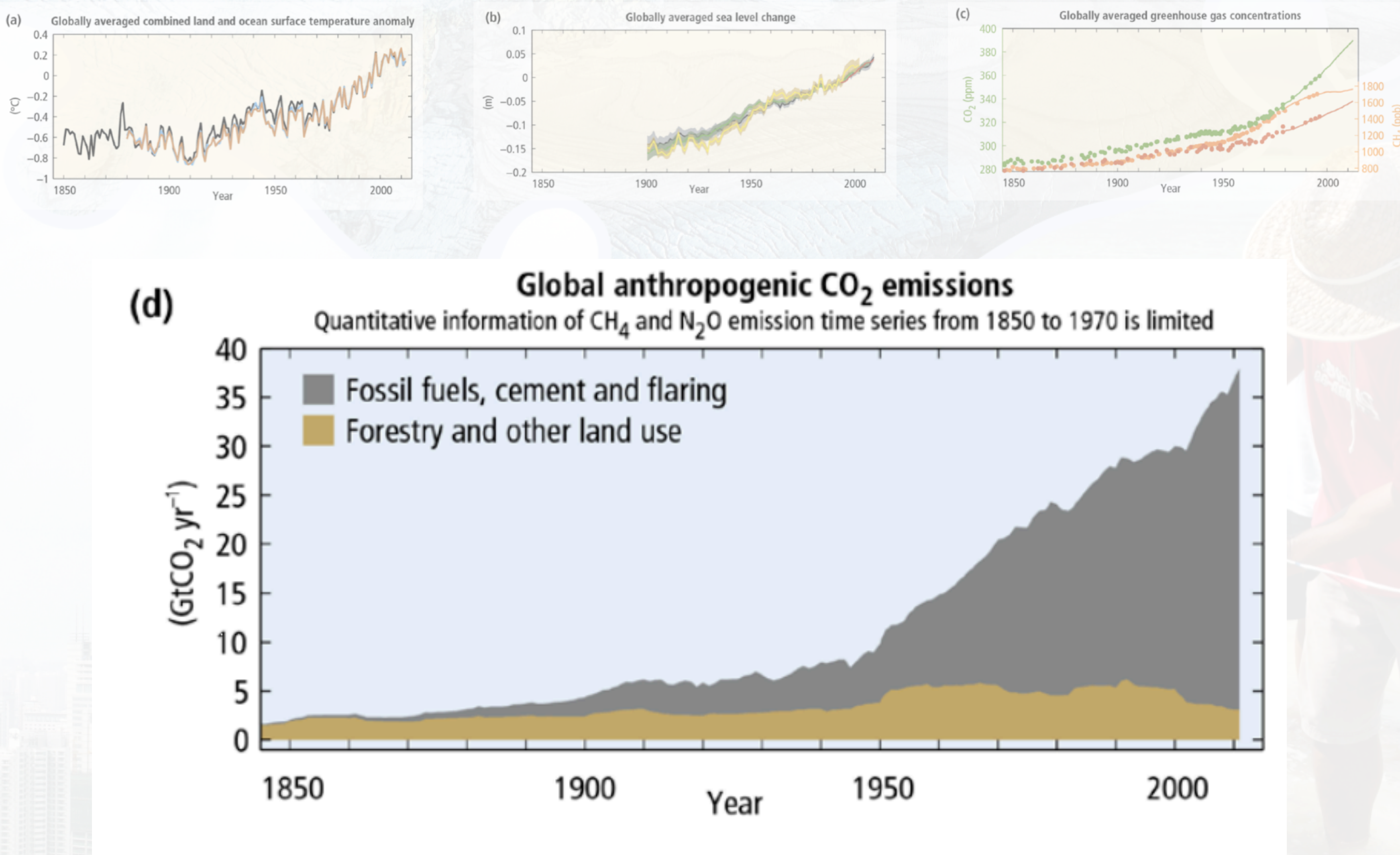
Change in average surface temperature (1986–2005 to 2081–2100)

AR5 WGI SPM

PML: Impacts and Feedbacks in a High CO_2 World?

Synergistic Effects




(a)
Globally averaged combined land and ocean surface temperature anomaly
(°C)
Year
(b)
Globally averaged sea level change
(m)
Year
(c)
Globally averaged greenhouse gas concentrations
CO_2 (ppm)
CH_4 (ppb)
Year
(d)
Global anthropogenic CO_2 emissions
Quantitative information of CH_4 and N_2O emission time series from 1850 to 1970 is limited
Fossil fuels, cement and flaring
Forestry and other land use
($GtCO_2\ yr^{-1}$)
Year

AR5 SYR SPM

Sources of emissions

Energy production remains the primary driver of GHG emissions

2010 GHG emissions

AR5 WGIII SPM

Mitigation Measures

More efficient use of energy

Greater use of low-carbon and no-carbon energy

- Many of these technologies exist today

Improved carbon sinks

- Reduced deforestation and improved forest management and planting of new forests
- Bio-energy with carbon capture and storage

Lifestyle and behavioural changes

AR5 WGIII SPM

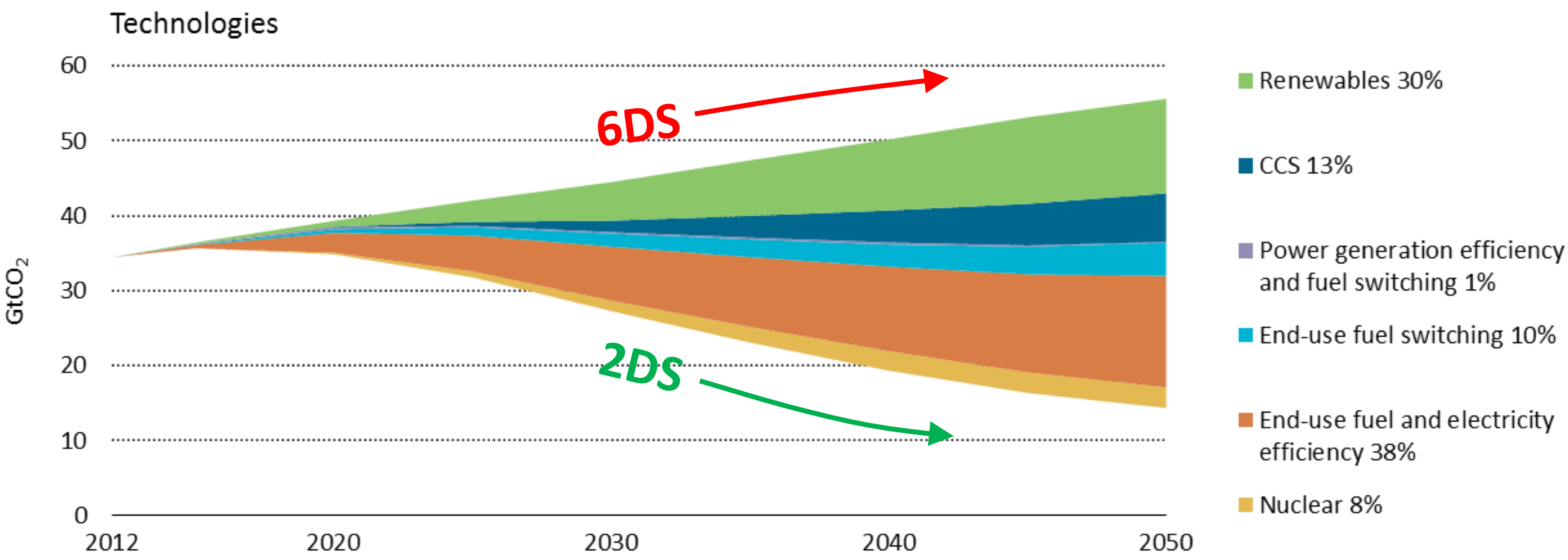
IPCC AR5 – Role of different low-carbon energy technologies

Mitigation cost increases in scenarios with limited availability of technologies [d] *[% increase in total discounted* [e] *mitigation costs (2015–2100) relative to default technology assumptions]*				
2100 concentrations (ppm CO_2-eq)	no CCS	nuclear phase out	limited solar/wind	limited bioenergy
450 (430 to 480)	138% (29 to 297%) 4	7% (4 to 18%) 8	6% (2 to 29%) 8	64% (44 to 78%) 8

IPCC AR5 SYR from Table 3.2 (2014)

A portfolio of technologies is required to get from here to there

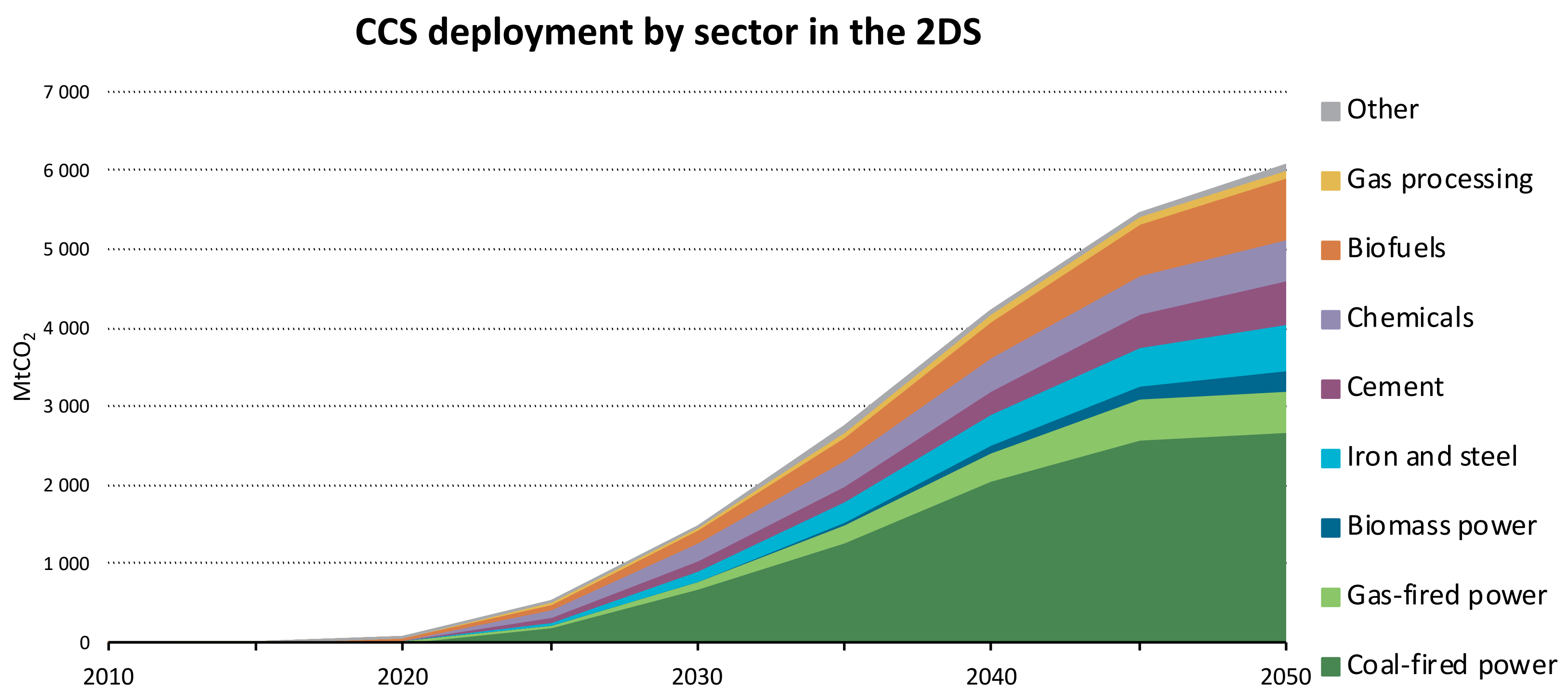
ETP 2015



Percentages represent cumulative contributions to emissions reduction relative to 6DS

International Energy Agency
Secure • Sustainable • Together

IEA: 94Gt CO_2 captured and stored in 2DS



- From 50Mt in 2020 to 6Gt in 2050
- A total of 94Gt captured and stored through 2050
  - 52Gt → 56% power
  - 29Gt → 31% process industries
  - 13Gt → 14% gas processing and biofuel production

COP-21 – Paris Agreement

- **Article 2 – ‘Objectives’**
- Purpose of the agreement is limit warming to “well below” 2.0 C (by 2100) and pursue 1.5C
  - To be delivered by the pledges in Articles 3 and 4 - via (Intended) Nationally Determined Contributions (NDCs)
- Increasing adaptation
- Ensuring finance
- Continues principle of “common but differentiated responsibilities and respective capabilities, in the light of different national circumstances”

ETP 2017
The role of CCS in achieving global climate ambitions

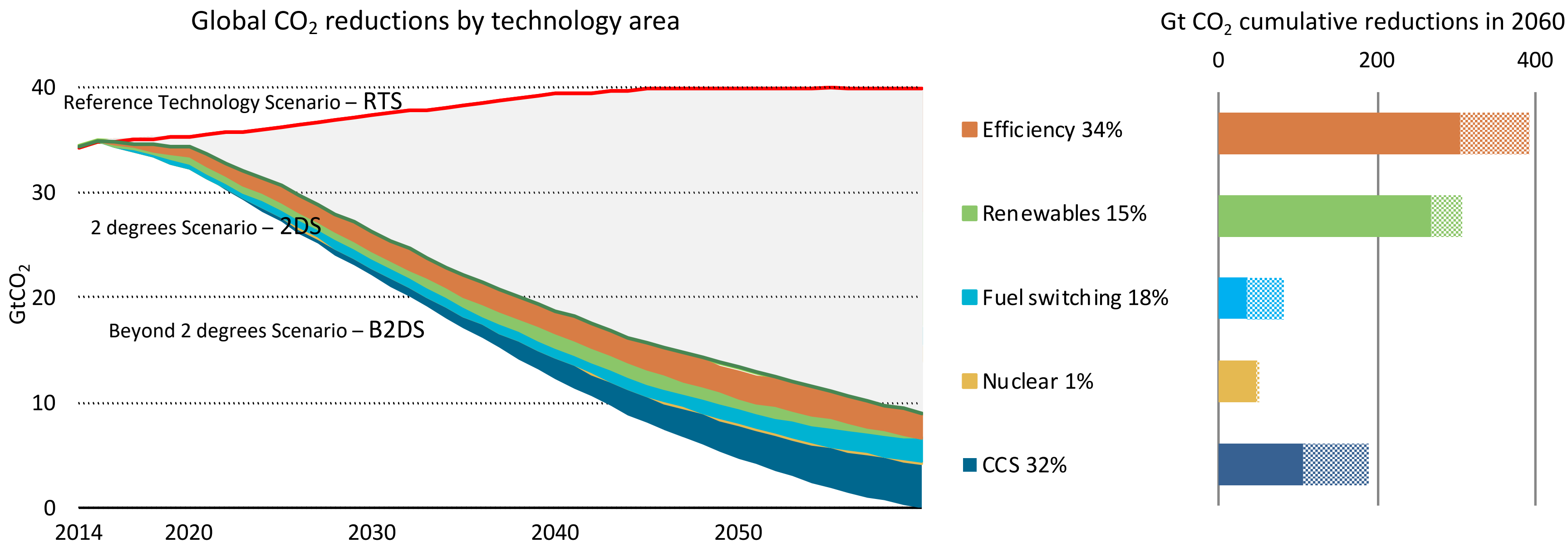
Samantha McCulloch

June 2017

IEA

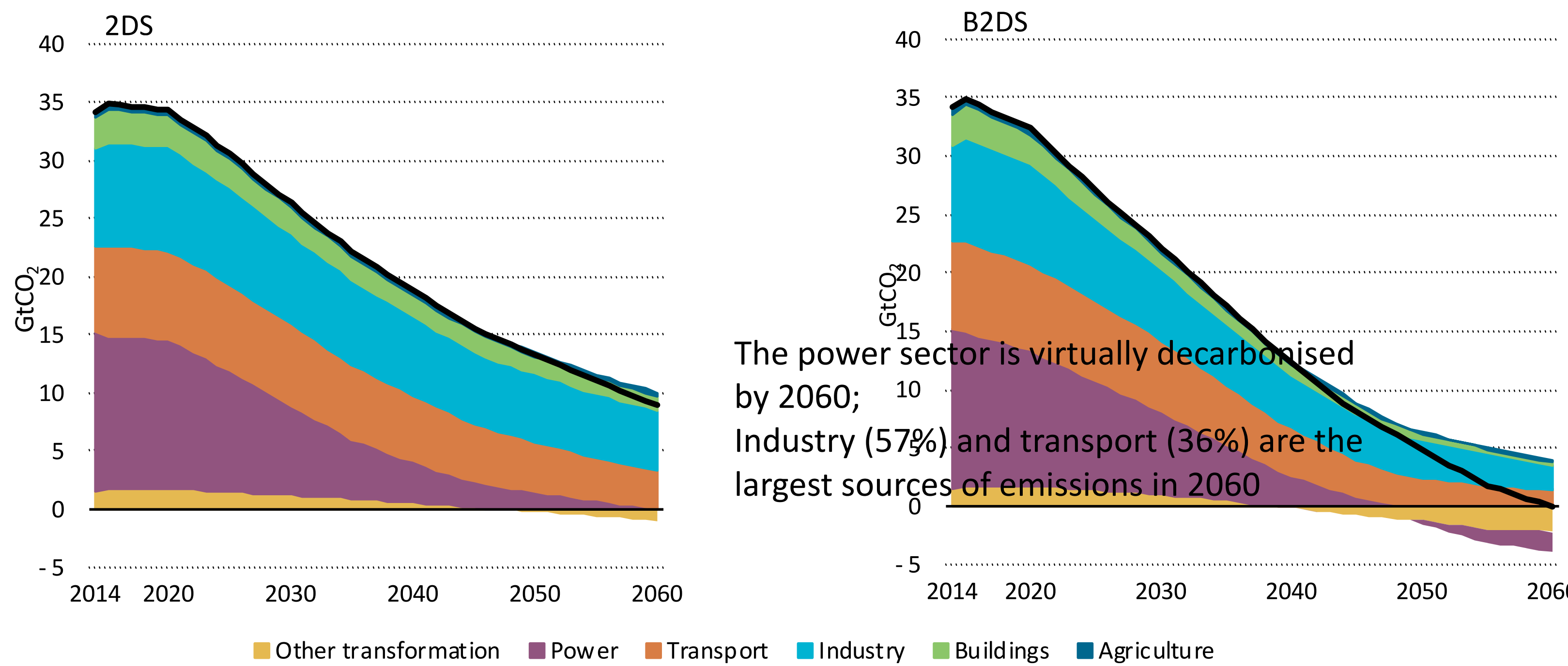
CCS plays a leading role in the energy transformation

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

Remaining CO_2 emissions in the 2DS and B2DS



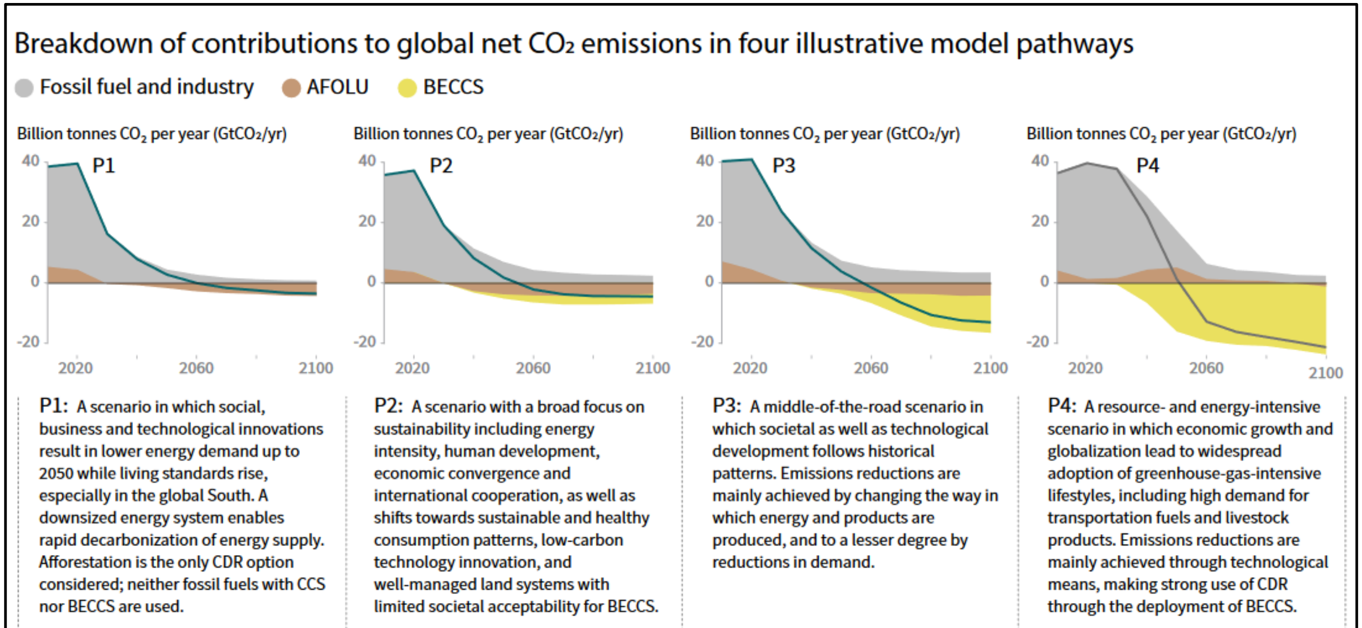
The power sector is virtually decarbonised by 2060;
Industry (57%) and transport (36%) are the largest sources of emissions in 2060

The remaining CO_2 emissions in industry and power must be targeted for the B2DS
Negative emissions are necessary to achieve net-zero emissions in 2060

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

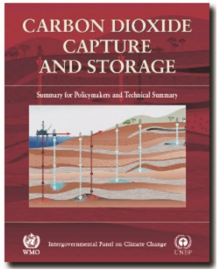


- *"Removing BECCS and CCS from the portfolio of available options significantly raises mitigation costs."* (Chp 4.3)

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

CCS in UNFCCC

- **2005 - IPCC SR on CCS**



- 2005– 2011 CCS in CDM?

- 2011 – CCS CDM Abu Dhabi workshop
- **2011 - COP-17 CCS in CDM**

- 2014 - ADP TEM on CCS – project focussed
- 2014 - COP-20 – CCS projects Side Event
- 2015 - COP-21 – CCS projects Side Event
- 2016 – COP-22 – CCS in Africa Side Event
- 2017 – COP-23 – CCS, Oceans and SIDS

COP24 CCS Side-event

Can CCS decarbonise industry in developed and developing countries?

Organised by University of Texas and IEAGHG, with CCSA, International CCS Knowledge Centre, Bellona

- Chair and CCS introduction – Tim Dixon IEAGHG
- IPCC 1.5 - Scene-setting – IPCC Vice-chair Thelma Krug
- CCS for Industry Panel: Facilitator – Jonas Helseth, Bellona and EU ZEP
- CCS and Cement Industry - Manuela Ojan, Heidelberg Cement
- Cement, Poland, learnings from BD3. - Mike Monea ICKC
- ‘A Just Transition for Industry’ – Brian Kohler, IndustriALL
- Role of CCS in net zero emissions for industry – tbc EU ZEP
- CCS for Developing Countries Panel: Facilitator – Katherine Romanak
- Demonstrating storage/Assistance for developing countries – Katherine Romanak BEG UT
- Trinidad and Tobago’s perspective – Professor Andrew Jupiter, Uni of the West Indies
- Sustainable Development Goals and CCS – Tim Dixon IEAGHG
- Outcomes of the Global CCUS Summit and UK’s support to emerging economies – UK FCO Minister Mark Field MP

➢ 150 attendees and IISD coverage

L-R: **Thelma Krug**, IPCC Vice-Chair; **Tim Dixon**, IEAGHG; **Jonas Helseth**, Bellona and ZEP; **Manuela Ojan**, HeidelbergCement; **Mike Monea**, ICKC; **Brian Kohler**, IndustriALL; **David Jupiter**, University of the West Indies; **Katherine Romanak**, UT

Jonas Helseth, Bellona and ZEP

Mike Monea, ICKC

David Jupiter, University of the West Indies

Katherine Romanak, University of Texas

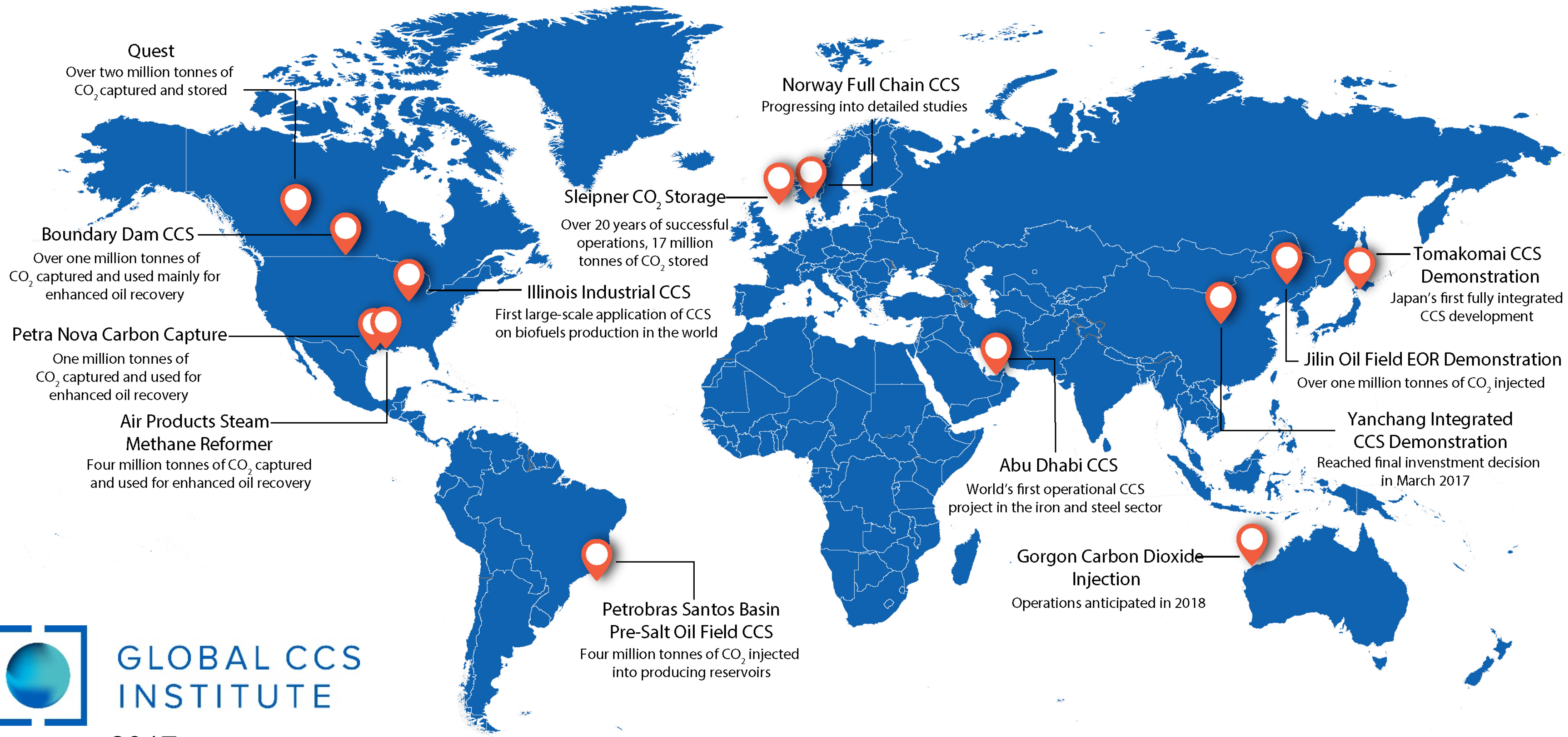
Mark Field, UK

A participant takes a photo during the event

Mark Field, United Kingdom

Photos and captions courtesy of IISD
http://enb.iisd.org/climate/cop24/enbots/6dec.html

Key CCS Facility Developments Globally



GLOBAL CCS INSTITUTE

2017

Commercial-scale Application of CCS (to 2010)

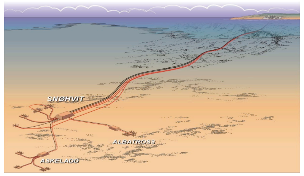
Sleipner
1Mt/y CO_2

Weyburn
2.5 Mt/y CO_2

In-Salah
1.2 Mt/y CO_2

Snohvit
0.7Mt/y CO_2

350km overland pipeline

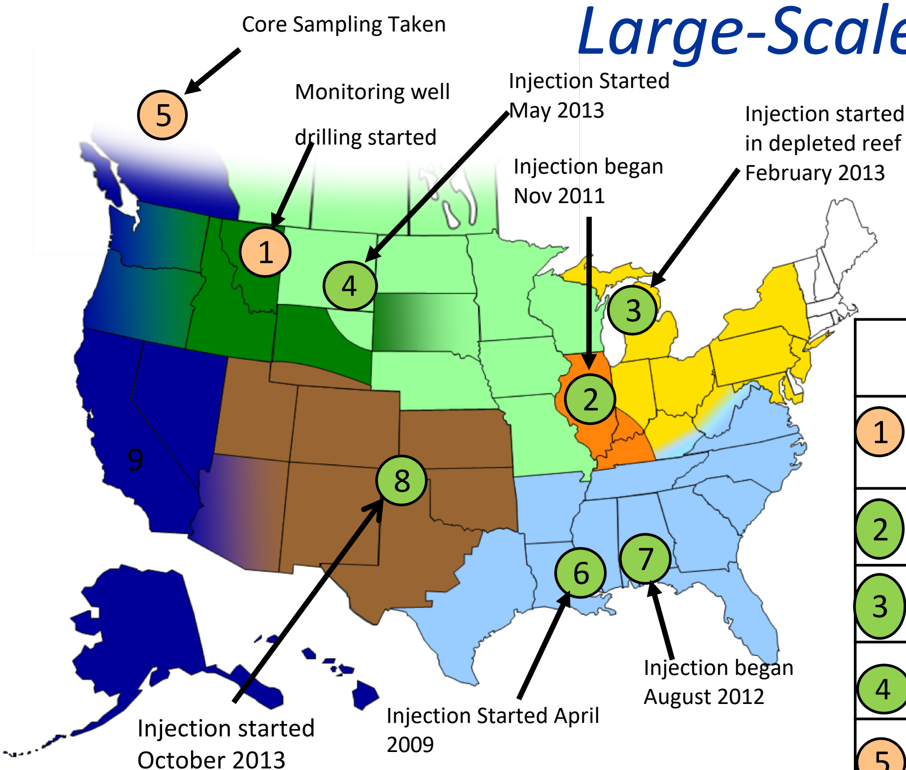


160km sub sea pipeline

1996 1998 **2000** 2002 **2004** 2006 **2008** 2010 2012 2014 2016 2018

RCSP Phase III: Development Phase

Large-Scale Geologic Tests



Injection Ongoing

Injection Scheduled 2013-2015

Note: Some locations presented on map may differ from final injection location

- ✓ *Large-volume tests*
- ✓ *Four Partnerships currently injecting CO_2*
- ✓ *Remaining injections scheduled 2013-2015*

	Partnership	Field Project – Geologic Formation	Metric Tons Injected to Date
1	Big Sky	Kevin Dome- Duperow Formation	0
2	MGSC	Illinois Basin Decatur- Mt. Simon Sandstone	> 850,000
3	MRCSP	Michigan Basin - Niagaran Reef	> 234,000
4	PCOR	Bell Creek - Muddy Sandstone	> 741,000
5		Fort Nelson - Sulfur Point Formation	0
6	SECARB	Early Test (Cranfield Field) - Tuscaloosa Formation	> 4,300,000
7		Anthropogenic Test (Citronelle Field) – Paluxy Formation	> 100,000
8	SWP	Farnsworth Unit - Morrow Formation	> 102,000
	WESTCARB	Regional Characterization	

Courtesy NETL 2014

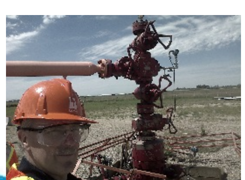
2013 Port Arthur Project

- H_2 Plant – SMR operated by Air Products
  - Consists of 2 Trains of SMR

- Retrofit capture VSA
- Operational 2013
- 1mt CO_2 pa to EOR

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

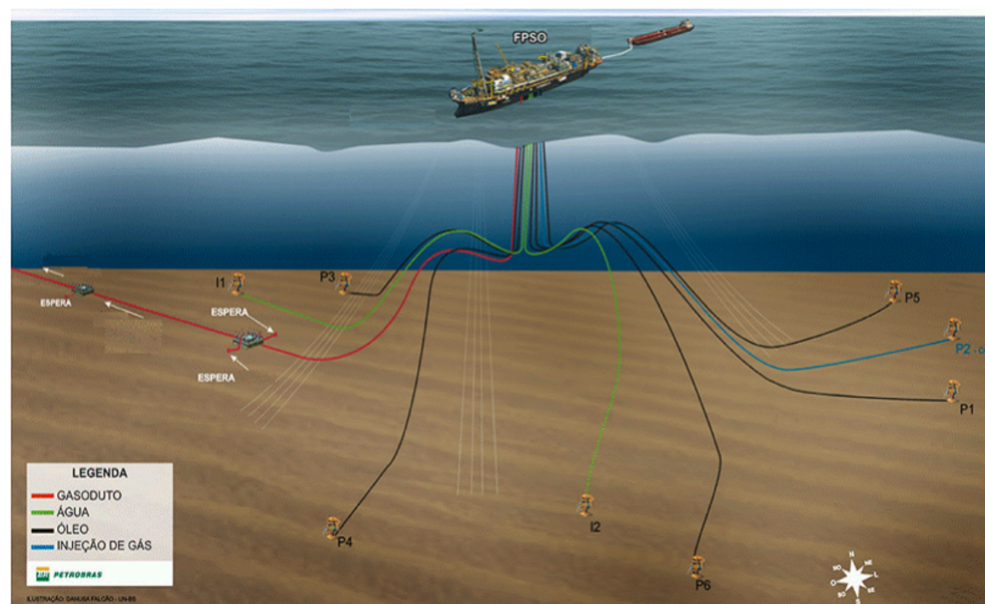
2015

Quest, Shell, Canada

H_2 Refining
1Mt CO2 pa to DSF storage

Lula, Petrobras, Brazil

Offshore gas separation and
CO2-EOR
FPSO
Deep: 2000m water depth,
3000m beneath seabed



2017

Petra Nova,

NRG Parish, USA

- Refit of existing coal fired unit
- Operational Jan 2017
- MHI amine based PCC technology
- 250 MW slip stream, 90% capture
- 1.6Mt pa CO_2 for EOR

ADM's Illinois Industrial CCS Project

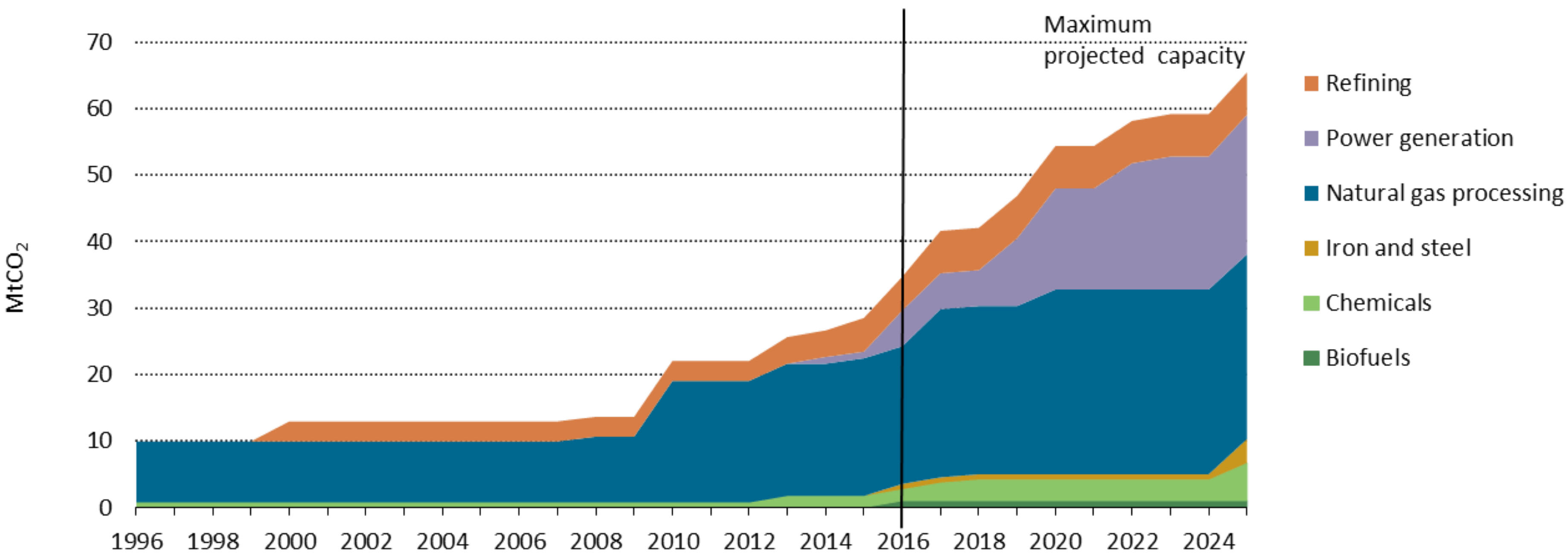
- 1Mt pa CO_2 to DSF
- Operational April 2017
- Bioethanol = BioCCS

Other New Developments

- Norway
  - Developing towards 2 industry projects - WtE, Cement
  - Ship - hub - pipeline - Offshore Storage
- Gulf States
  - Uthmaniyah CO2-EOR Demonstration Project, Saudi Aramco
  - The Abu Dhabi CCS Project
    - CO_2 capture capacity of 0.8 Mt pa,
    - the world's first iron and steel project
- Australia – Gorgon project
- Japan - Tomakomai

IEA: CCS is not "on track"

- CCS has moved forward – but is far from being consistent with a 2°C pathway
  - If all projects known today were to proceed, the maximum capture rate would be less than 70 $MtCO_2$



Capture potential of the project pipeline, by sector. Data source: GCCSI

IEA: Accelerating future progress

- Stable policies, including financial support, are urgently needed.
- CO_2 storage development critical
- New approaches and a re-focusing of efforts can also promote faster deployment:
  - Greater emphasis on CCS retrofitting
  - Cultivating early opportunities for BECCS
  - Developing markets for "clean products"
  - Moving from conventional enhanced oil recovery (EOR) practices to "EOR+" for verifiable CO_2 storage
  - Disaggregating the CCS value chain to enable new business models to emerge

"Deployment of CCS will not be optional in implementing the Paris Agreement"

Dr Fatih Birol, Executive Director, International Energy Agency 2016

Scott Kelly 2016

Thank You

Any questions?

www.ieaghg.org