20 Years of Carbon Capture and Storage

Accelerating Future Deployment

International Energy Agency

Secure Sustainable Together

CCS in a 2°C pathway: Retrofitting CCS in China

CCUS Conference

Beijing, 26 April 2017

Tristan Stanley

CCS in a 2°C pathway

Presentation outline:

1. CCS in the context of the global energy transition: the 2°C pathway

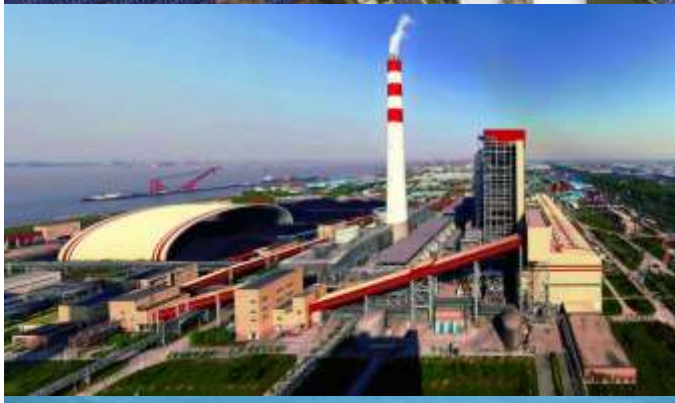
2. Retrofitting CCS in China

3. What's next?

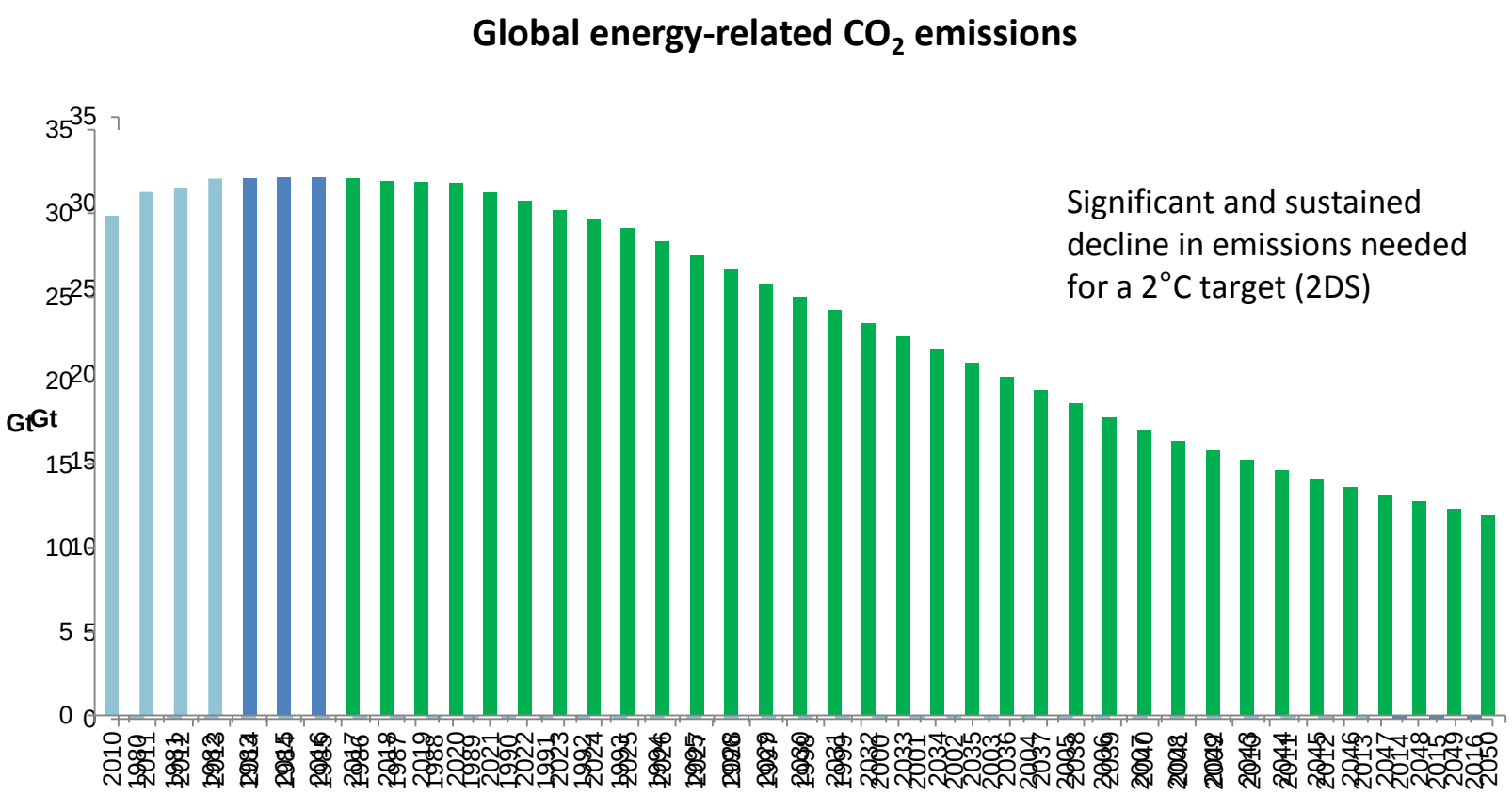
http://www.iea.org/topics/ccs/

The energy transformation has begun

- The globally installed capacity of renewable energy has overtaken coal-fired power generation
- In 2016, global investment in renewable energy outstripped coal, gas and oil
- China and the USA play a major role:
  - In China:
    - Increased share of renewables, nuclear and natural gas in the power sector
    - Switch from coal to gas in industry and buildings
  - In the USA:
    - Coal demand decline by 11% in 2016
    - Electricity generation from natural gas now higher than coal for the first time

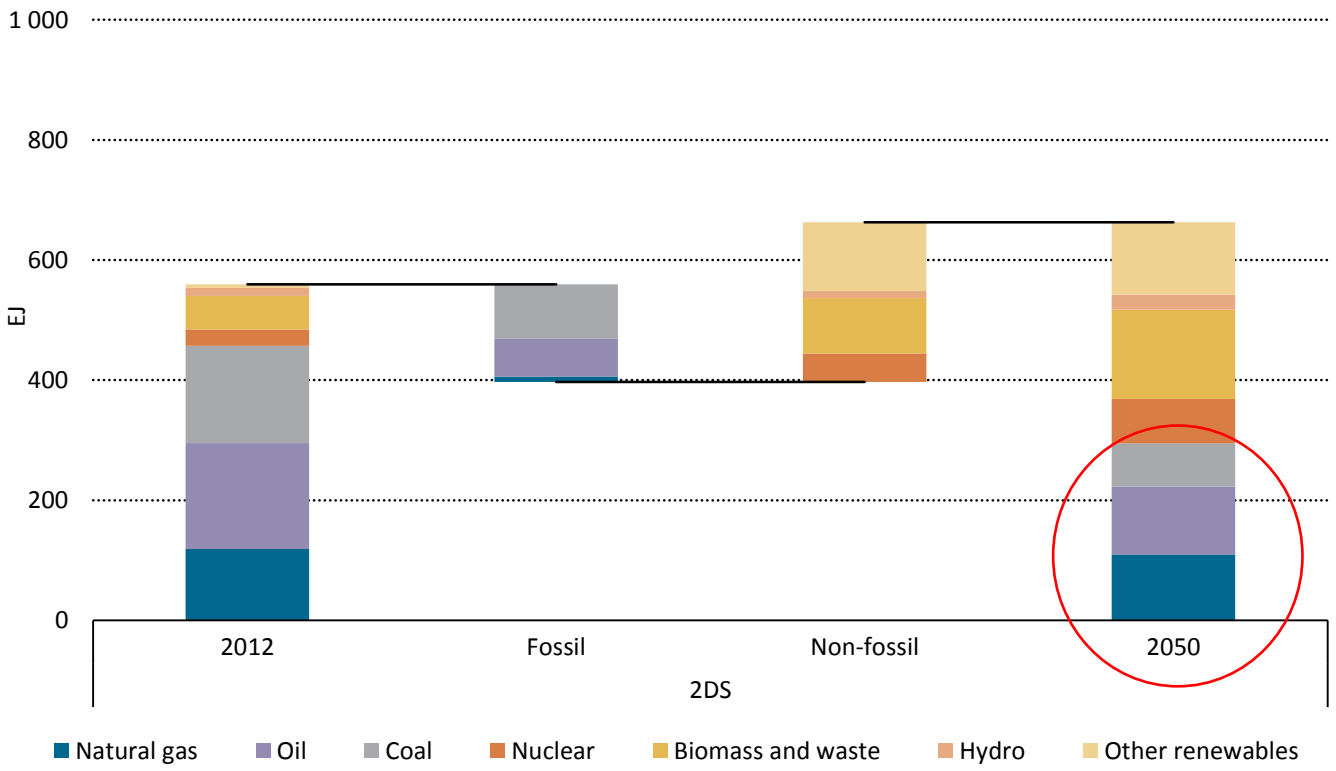


Global energy emissions – peaked?



Three consecutive years of stable emissions alongside global GDP growth

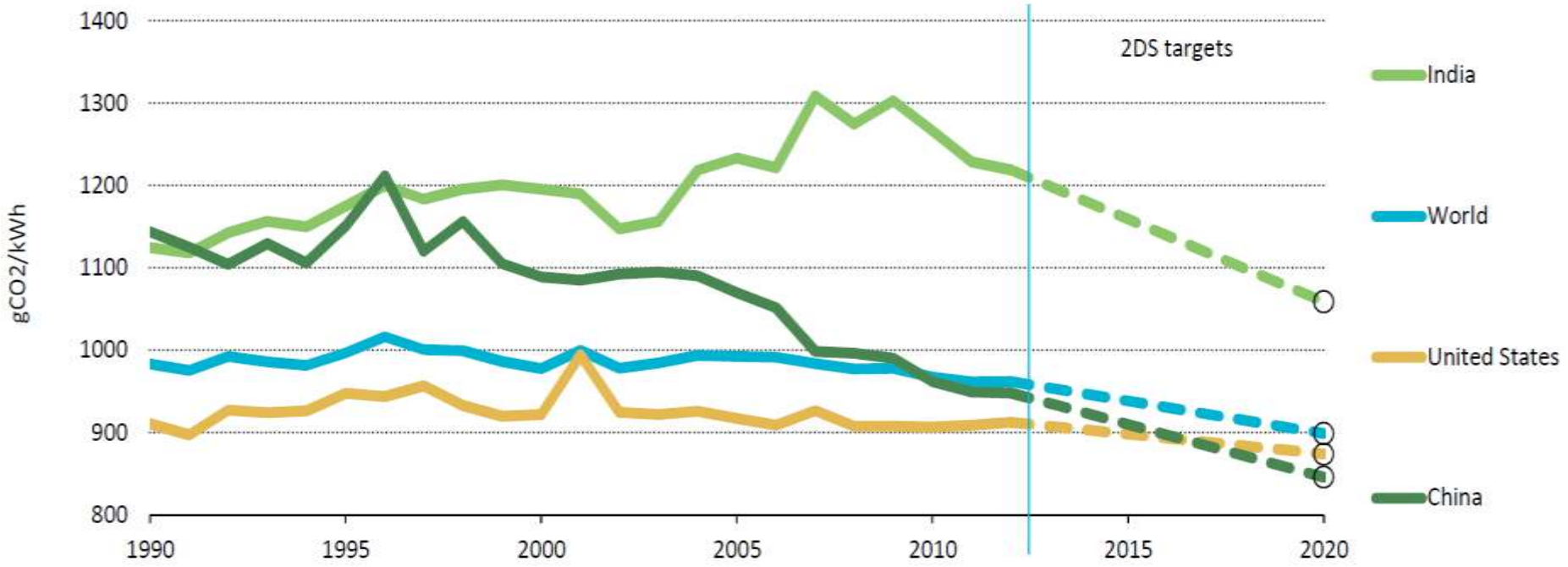
Fossil fuels remain an important part of the energy mix, even in a 2°C world



*Fossil fuels use is reduced but still has a **44% share in 2050 in the 2DS.** CCS is essential to reduce emissions from this future use.*

The use of fossil fuels is gradually more efficient

Carbon intensity of coal-fired power generation

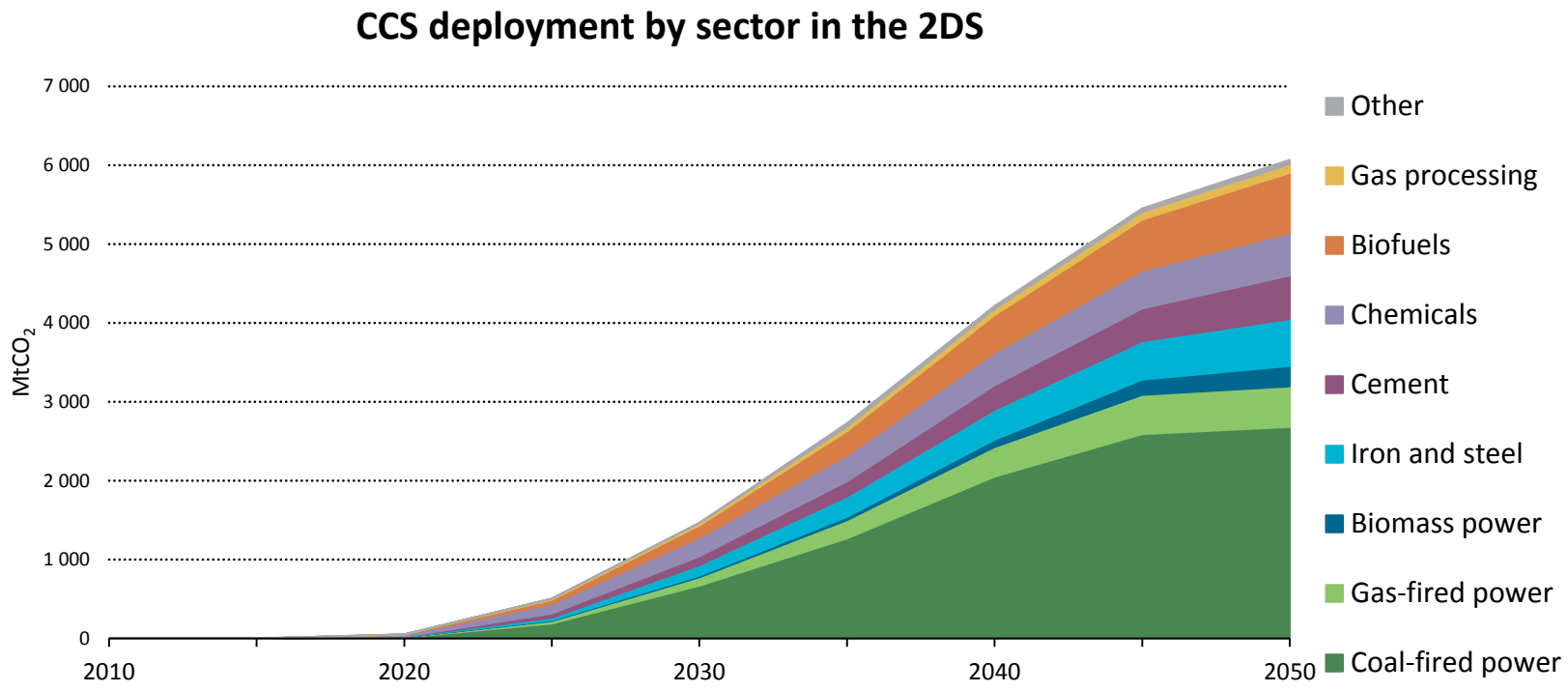


The emissions intensity of Chinese coal fired power is declining…

However CCS will be needed ultimately to reach 2DS emissions intensities

ETP 2014, 2015

94 $GtCO_2$ captured and stored in 2DS



- From 50Mt in 2020 to 6Gt in 2050
- A total of 94Gt captured and stored through 2050
  - 52Gt → 55% power
  - 29Gt → 31% process industries
  - 13Gt → 14% gas processing and biofuel production

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What kind of potential exists to retrofit CCS on China's existing coal-fired power fleet?

Analysis partners:

China Electricity Council (CEC)
Chinese Academy of Sciences (CAS)
International Energy Agency (IEA)

Facilitated by:

Administrative Centre for China's Agenda 21 (ACCA21)

Key criteria for assessment

A. SUITABILITY CRITERIA

- Access to storage
- Unit age
- Unit size
- Load factor
- Local policy and strategic factors

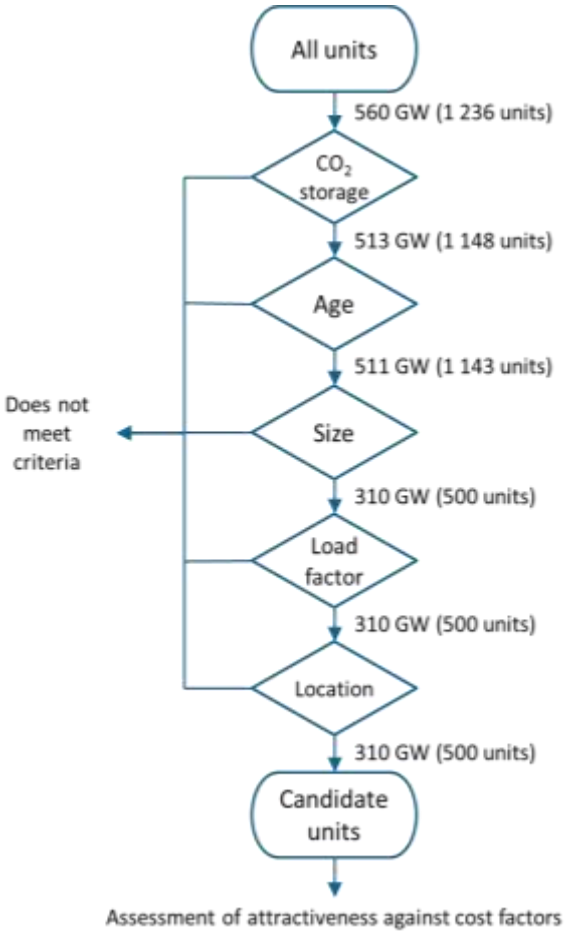
“WHAT IS POSSIBLE?”

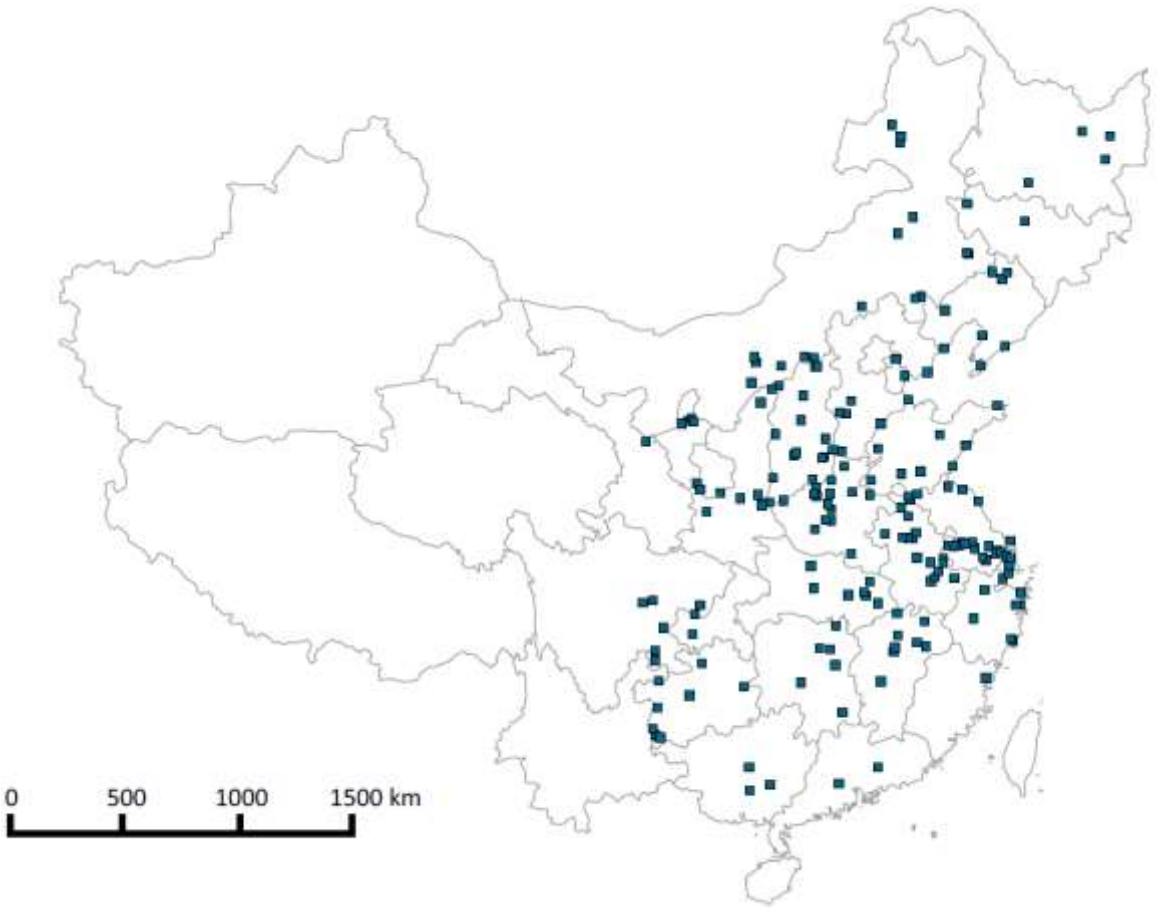
B. COST FACTORS

- Transport and storage cost
- Age, size and load factor
- Efficiency and steam cycle design
- Cooling type
- Pollution controls

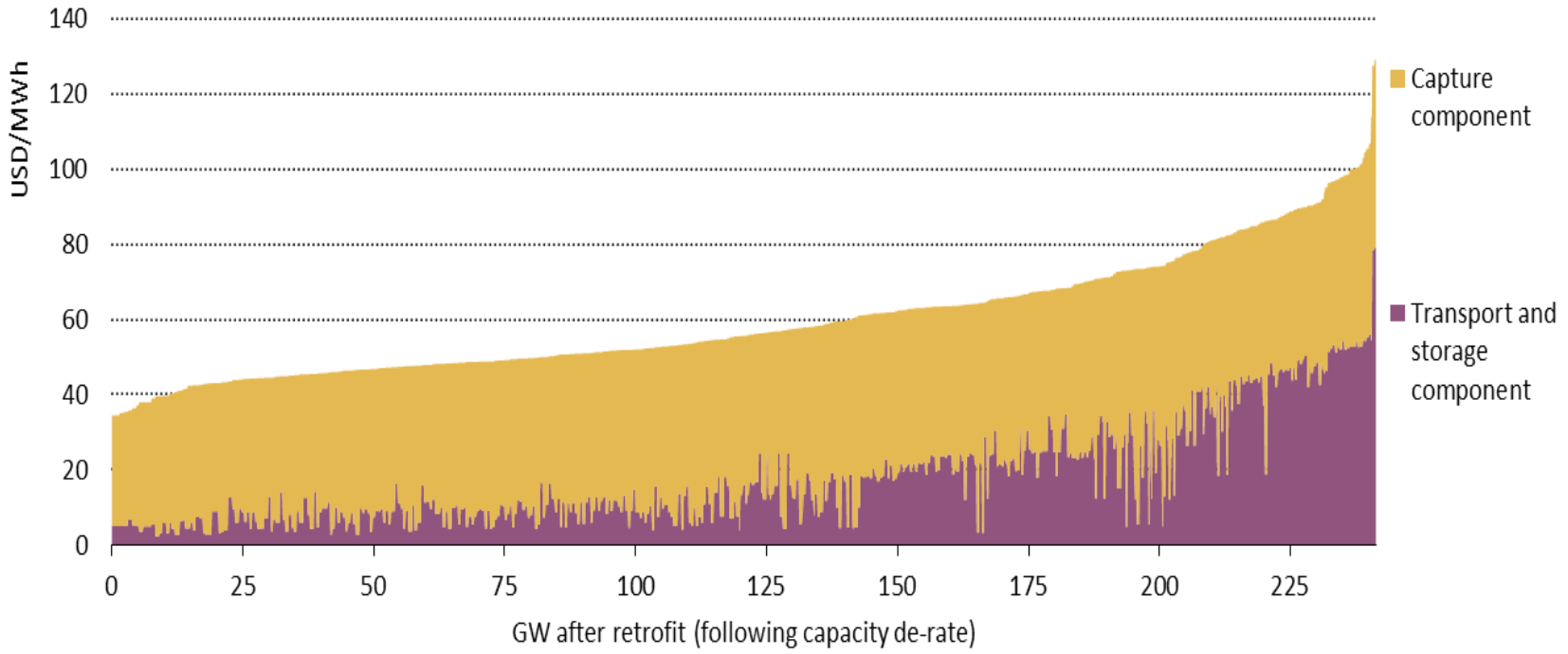
“AT WHAT COST?”

310GW of plant suitable for retrofit





There is significant potential for CCS retrofitting in China



- 100+GW could be retrofitted for 200RMB/MWh additional power generation cost and 200GW at 300RMB/MWh
- Proximity to storage has a large impact on the cost

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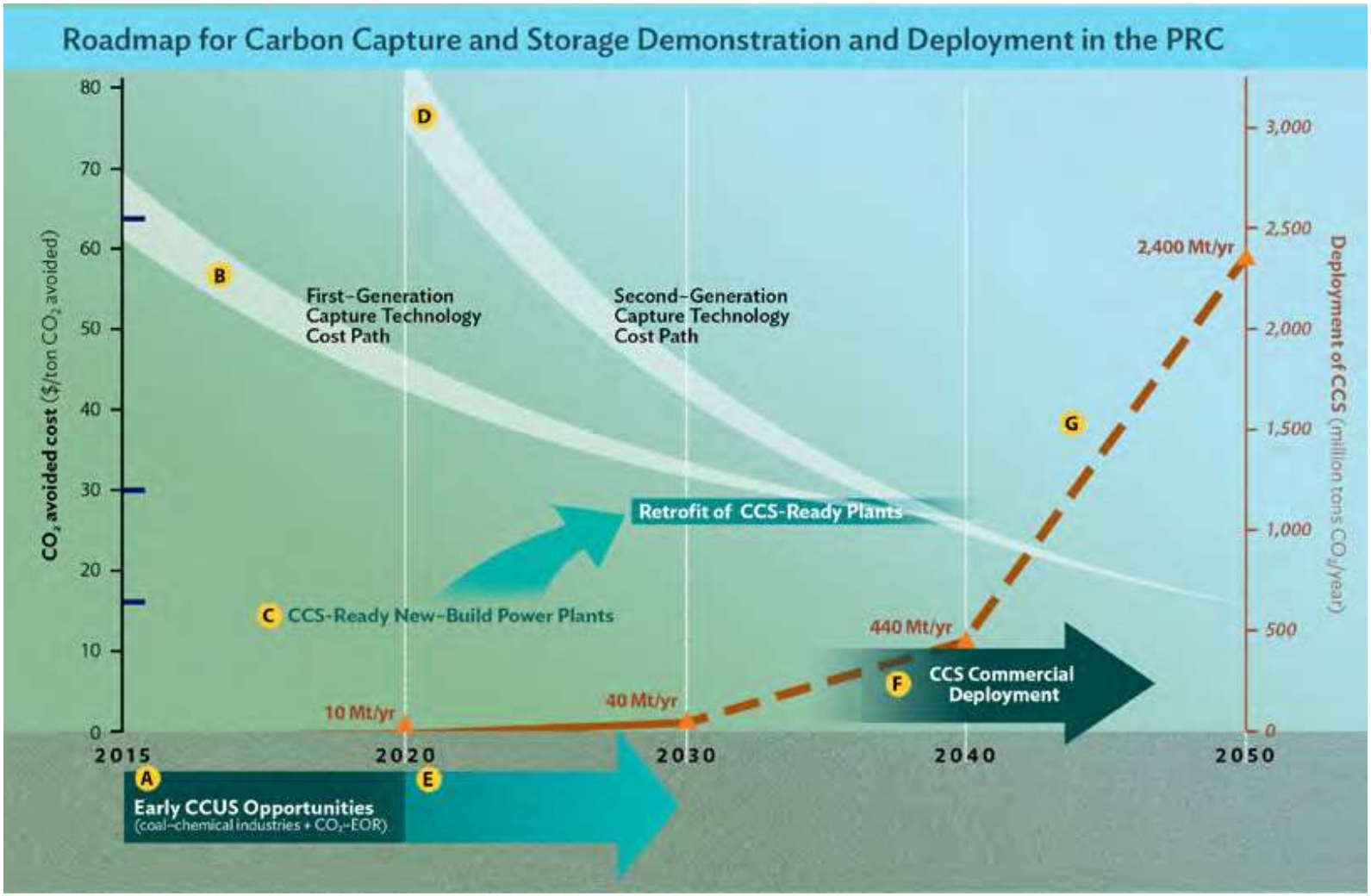
An ambitious roadmap for deployment



Source: Asian Development Bank, Roadmap for Carbon Capture and Storage Demonstration and Deployment in the People's Republic of China

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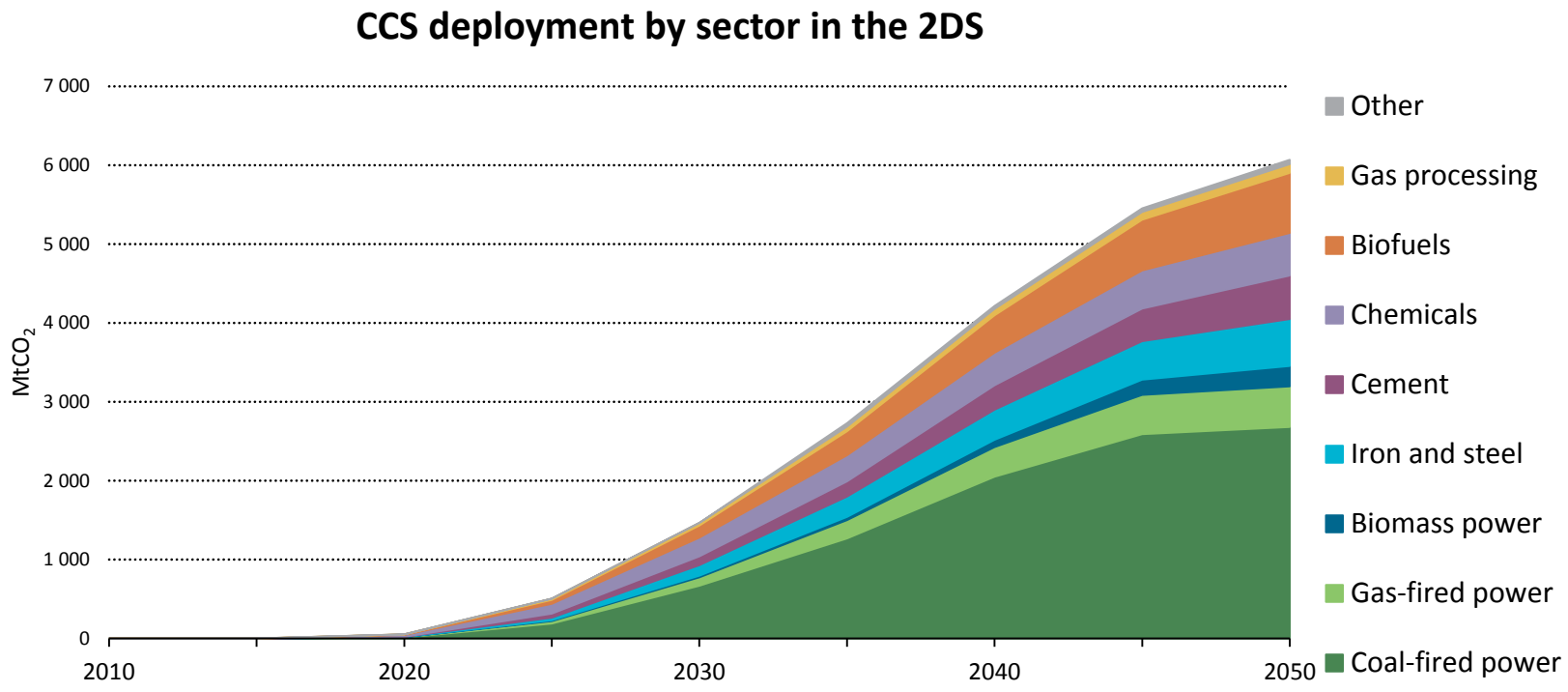

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Thank you for your attention!

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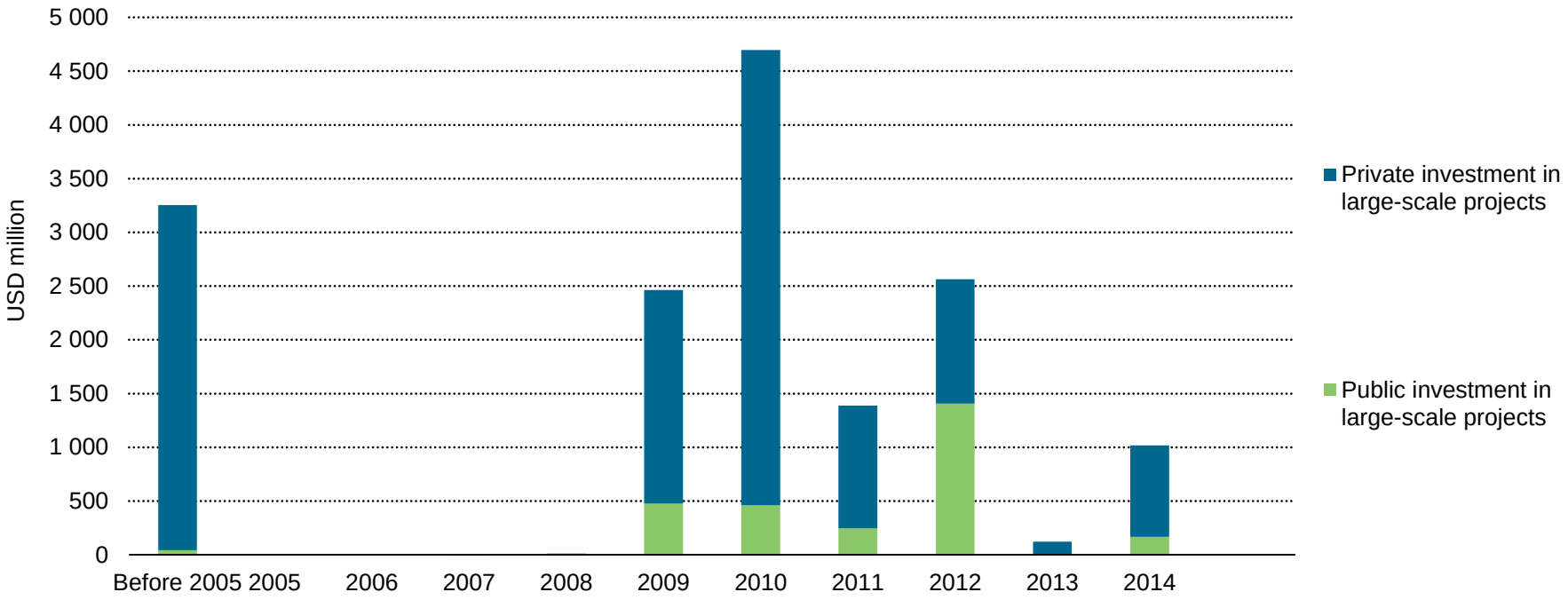
Investment in CCS projects



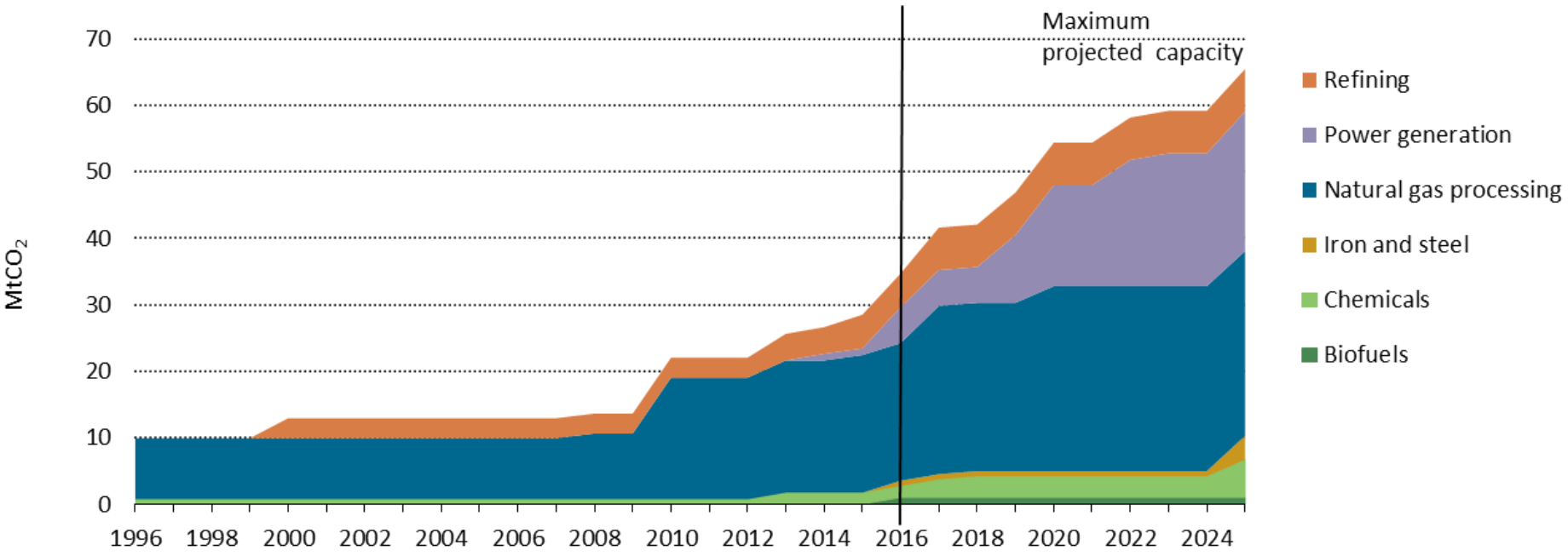
- Around USD 30 billion in public funding announcements were made between 2007-2010 – corresponding to a peak in CCS investment decisions
- 80% of capital investment has been from private sources

Energy Technology Perspectives 2017

- Three key scenarios
  - Reference Technology Scenario (RTS)
  - 2-degree scenario (2DS)
  - Beyond 2 degrees scenario (B2DS)
- Transformation
- Role of CCS

CCS is not “on track” for a 2°C future

- CCS has moved forward – but is far from meeting its potential according to the 2DS
  - If all projects known today were to proceed, the maximum capture rate would be less than 70 $MtCO_2$

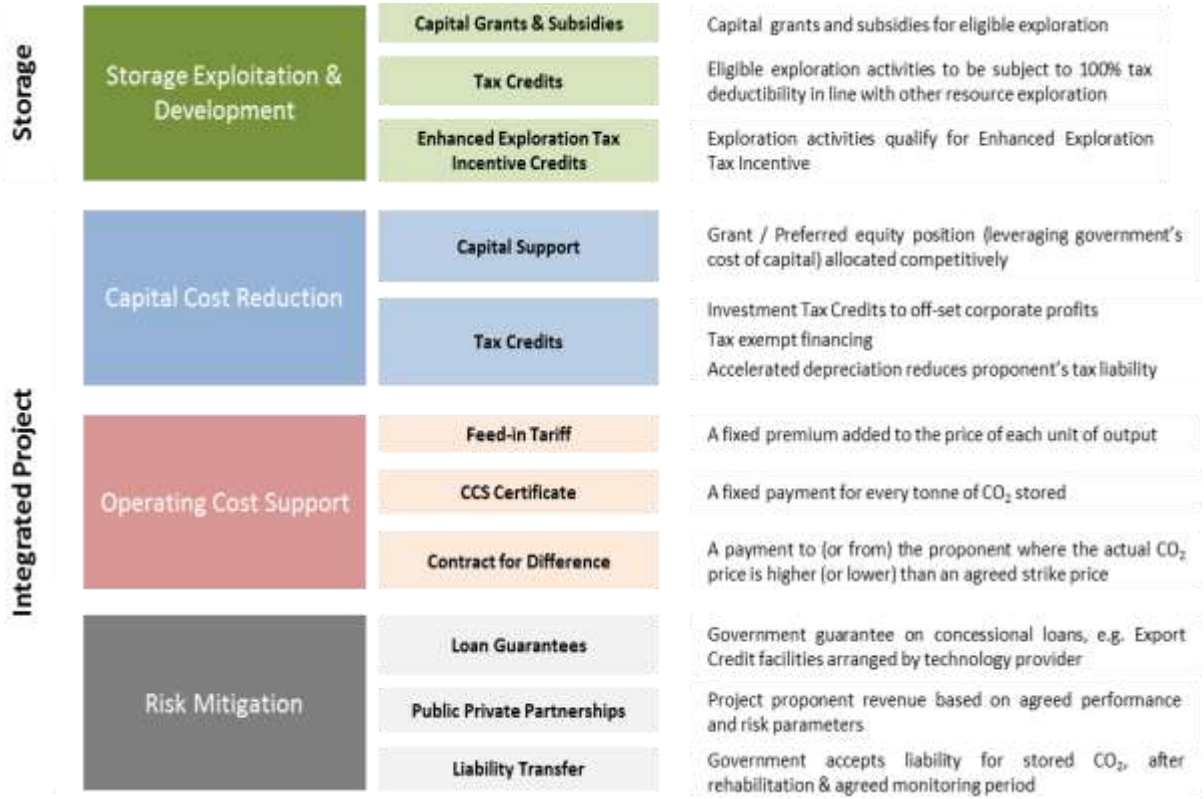


Capture potential of the project pipeline, by sector. Data source: GCCSI

Delivering faster CCS progress

1. TARGETED DEPLOYMENT INCENTIVES

- CCS does not advance without targeted support
- Capital and operational incentives
- Grants, tax incentives, feed-in tariffs, CO_2 purchase contracts etc. etc.



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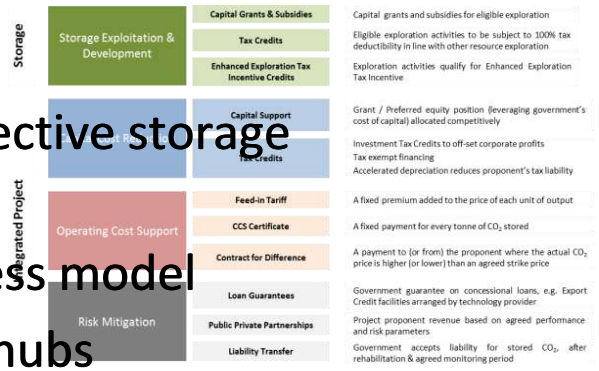
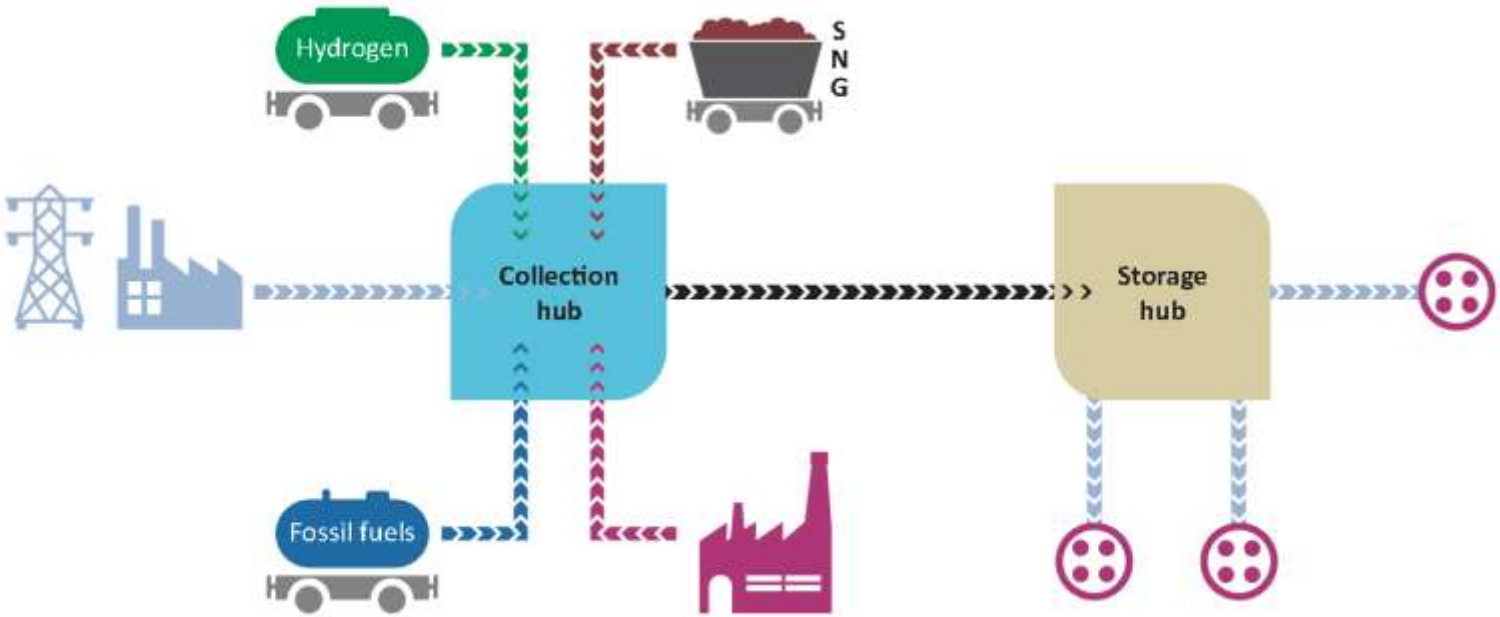
2. INFRASTRUCTURE APPROACH

- Prioritised development of prospective storage areas and sites
- Publicly led storage business model
- Decoupling of CCS chain through hubs





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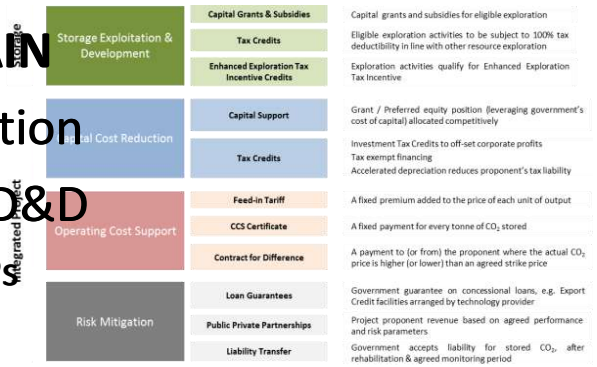
3. SUPPORT INNOVATION CHAIN

- Moving beyond first generation
- Co-ordinated Technology RD&D
- Mission Innovation, TCPs, PPPs



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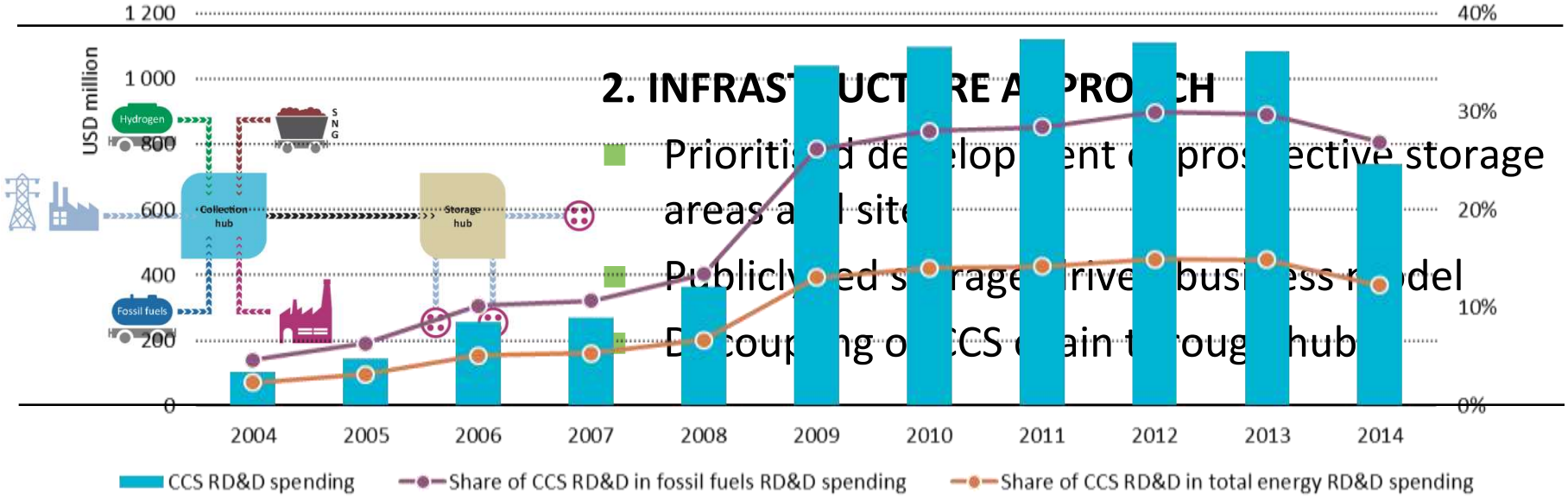
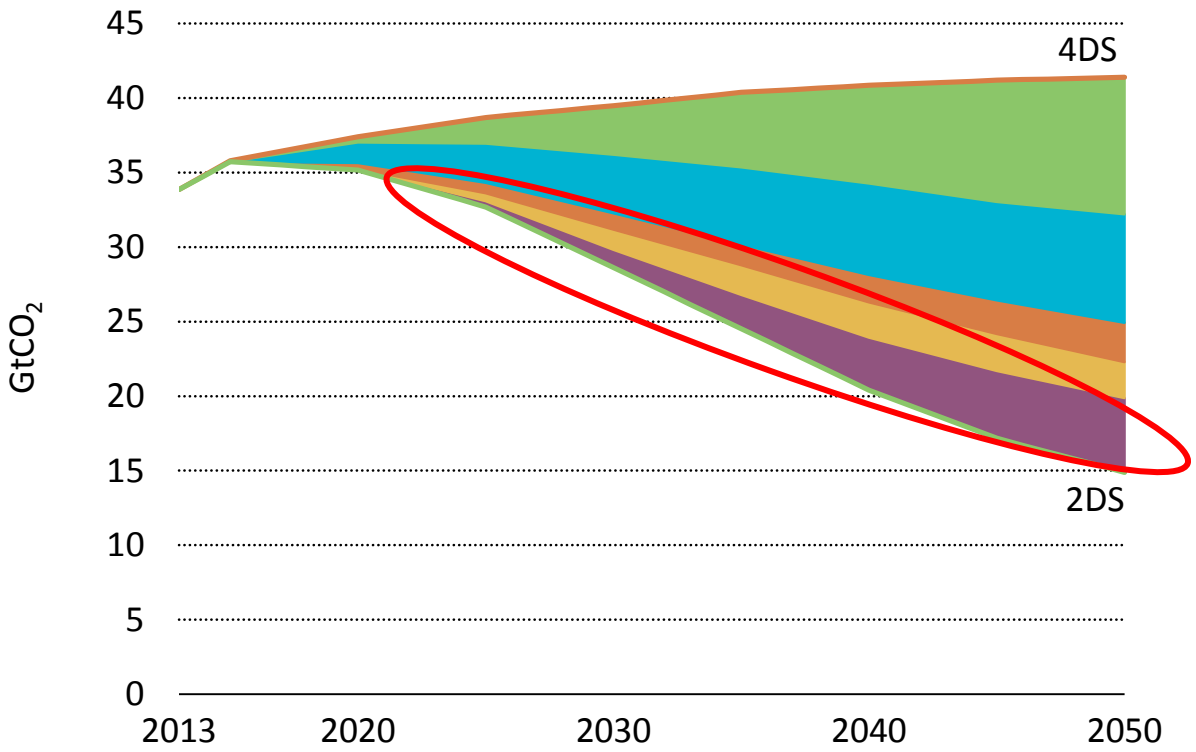


Summary / conclusions

- **20 years of CCS has delivered significant progress**
  - Technologies have been proven in many applications
  - The pace of deployment has been too slow but reflects limited support and incentives
  - EOR has been – and will continue to be – an important driver for investment
- **The Paris Agreement has increased the need for CCS**
  - CCS will be essential in delivering a 2°C and well-below 2°C target
  - Greater emphasis on BECCS and negative emissions
  - Future emissions reductions are dependent on CCS investment today
- **Policy support and new approaches could drive faster progress**
  - CO_2 storage development must be prioritised; government leadership critical
  - Moving from a single-project focus to an infrastructure approach
  - Ensuring EOR contributes to verifiable emissions reductions
  - Strategies for CCS retrofitting of existing infrastructure

A portfolio of technologies is needed to meet a 2°C target

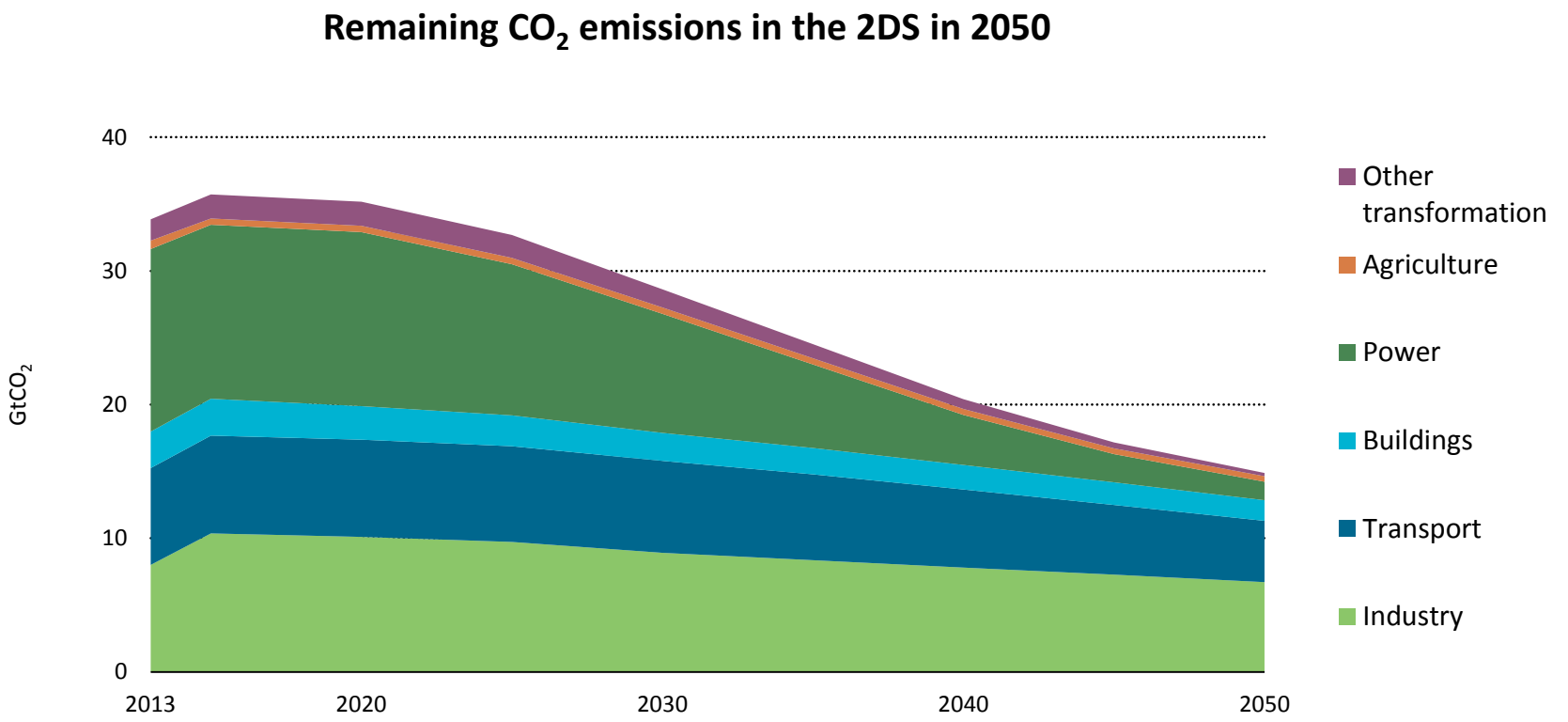
Contribution of technology area to global cumulative CO_2 reductions



CCS delivers 15% of the emissions reductions in the shift from a 4°C pathway to 2°C

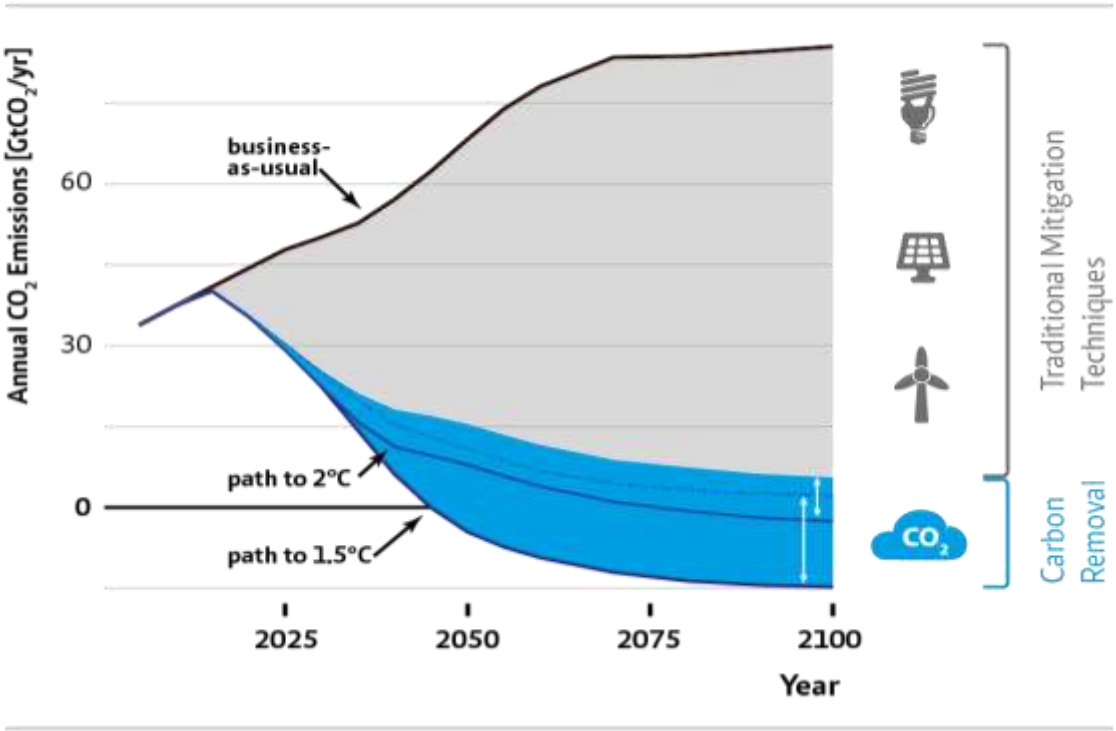
Source: IEA Energy Technology Perspectives, 2DS

Shifting to “well below”: Targeting remaining emissions in the 2DS



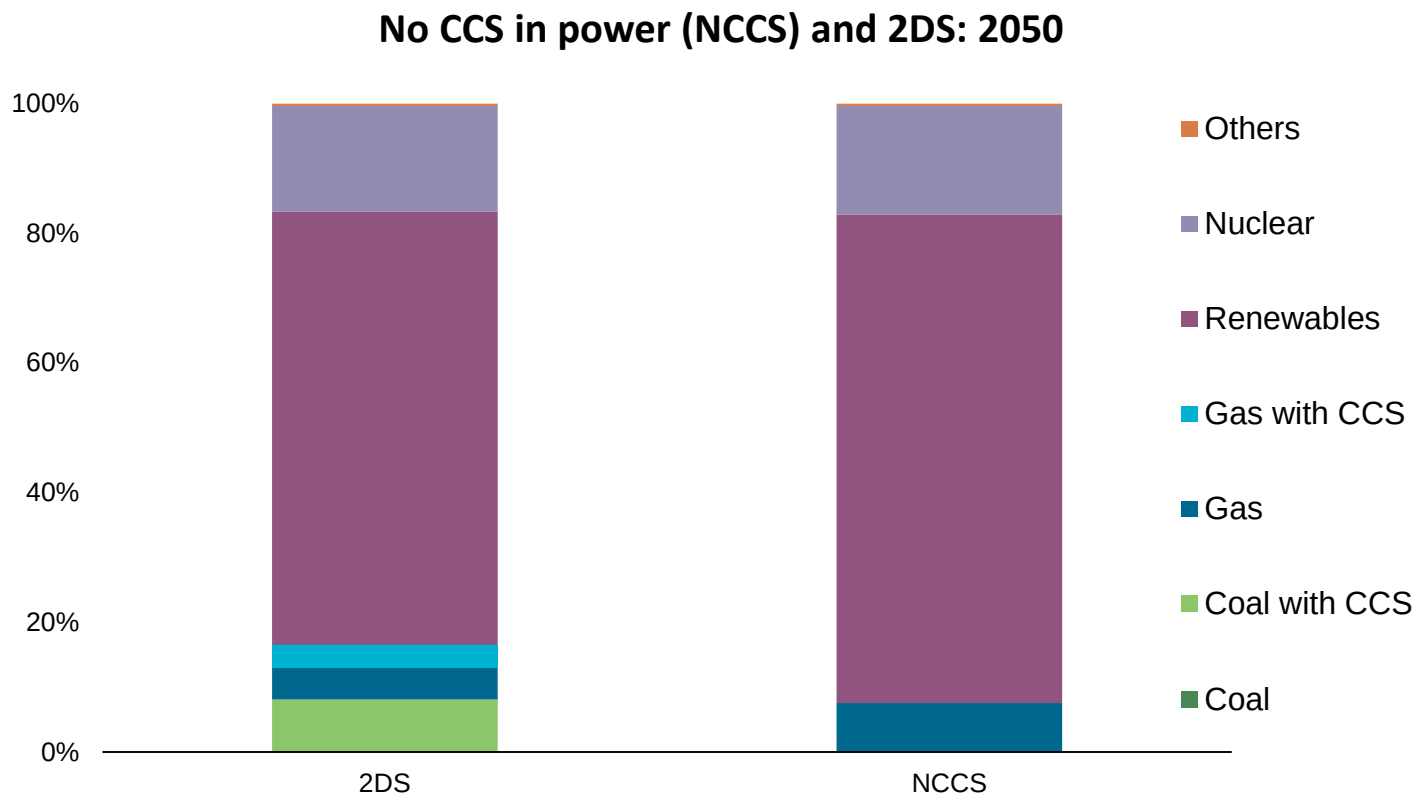
- Industry the largest source of emissions in 2050 (45%); accounts for 33% of aggregate emissions to 2050
- Power sector virtually decarbonised by 2050; but is the second-largest source of cumulative emissions in the period to 2050 (29%)

Beyond net zero emissions



ADM's Illinois Industrial CCS Project: the first large-scale BECCS project

Understanding the value of CCS - What happens if no CCS in power?



- 850 GW of fossil-CCS capacity replaced by 1 900 GW of renewable capacity.
- *At least* an additional USD 3.5 trillion in generation capacity investment will be required; but even greater challenges result.
- Coal-fired power eliminated by 2050.

The Sleipner CCS project: 20 years of successful operation

- Commenced operation in 1996
- World's first dedicated storage project at commercial scale
- Almost 17 Mt of CO_2 permanently stored

Two decades of significant progress

- 16 large-scale projects operating
  - Portfolio is becoming more diverse, including coal-fired power generation, oil sand upgrading and steel manufacture
- New projects advancing
  - 6 more projects in construction, most due to commence in next 12-18 months
  - China leads the next wave of projects, with 8 in early development
- Technology is now proven in many applications; widespread deployment can deliver further cost reductions

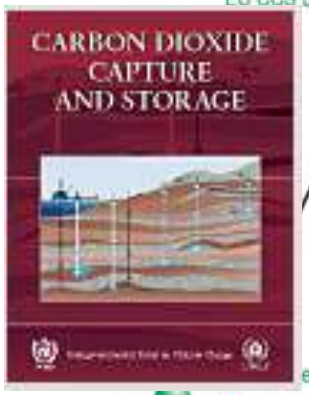

Scotford Upgrader (Source: Shell)


Al Reyadah (Source: The National)


Parish – Petra Nova (Source: NRG)


Gorgon (Source: Chevron)

Policy support has fluctuated



o CCS exceeds USD 30 billion

n Copenhagen postpones global climate change mitigation plans

ecial Report on CCS

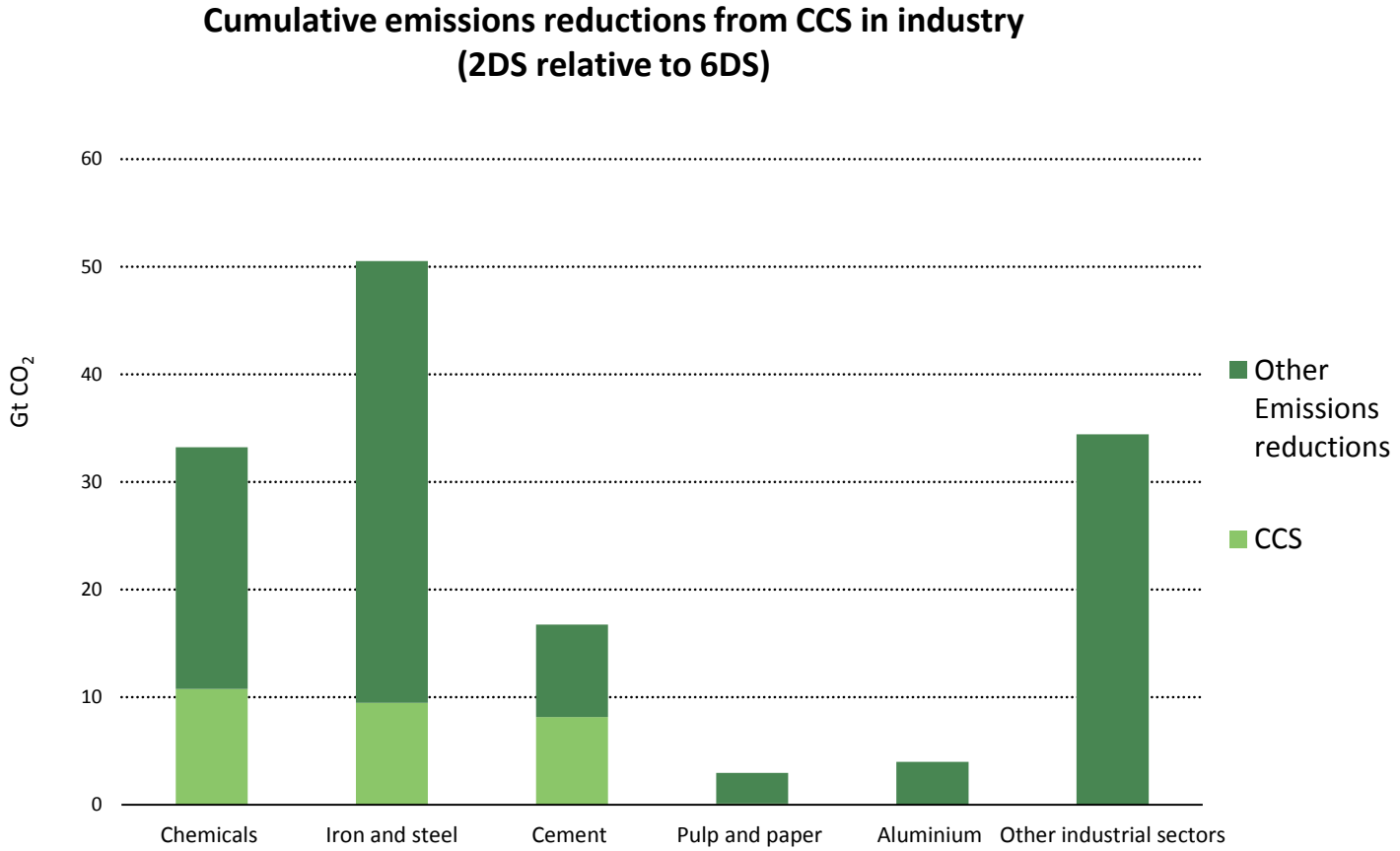
Inaugural CSLF Ministerial meeting

Sleipner becomes first large-scale CCS project with dedicated storage

1996 2003 2005 2008 2009 2010 2011 2012 2015 2016

Source: IEA (2016), *20 years of CCS: Accelerating Future Deployment*.
Adapted from SBC Energy Institute (2016), *Low Carbon Energy Technologies Fact Book Update: Carbon Capture and Storage at a Crossroads*.

Understanding the value of CCS - What happens if no CCS in industry?



- CCS delivers 20% of the total CO_2 emissions reductions in industry
- The role of CCS grows over time
- Limited alternatives to 29 Gt of cumulative emissions captured from industry in the period to 2050: burden may shift to other sectors.

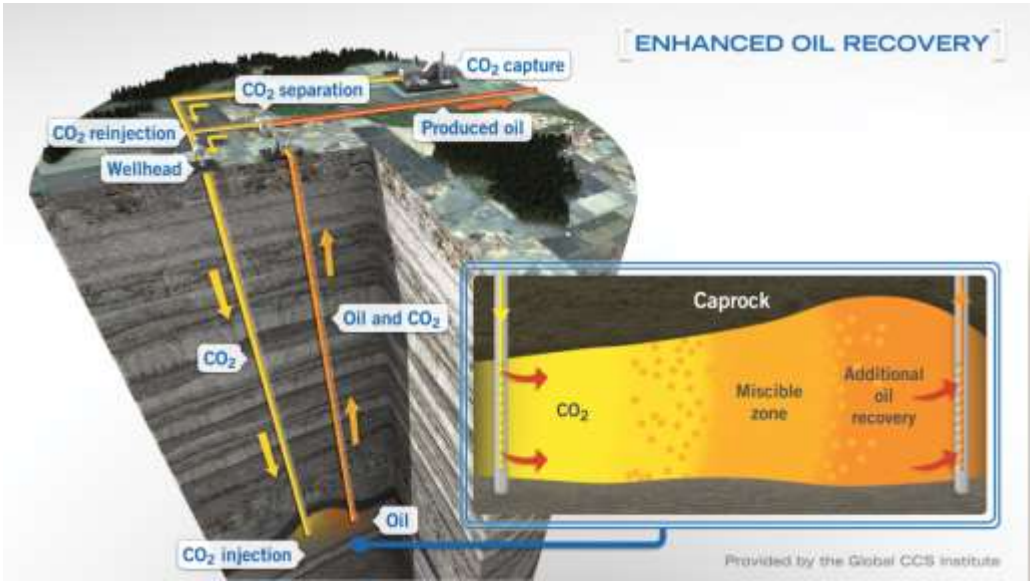
Implementing Paris: "Well below 2°C"

- "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;"

- "… Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions … so as to achieve a balance between anthropogenic emissions by sources and removals by sinks … in the second half of this century …"

Enhanced oil recovery (EOR) driving CCS investment

- EOR opportunities have been important for CCS investment:
  - CO_2 has been injected for EOR since the 1970's in the USA
  - 12 of the 16 large-scale projects operating are associated with EOR
    - Most are in North America; 2 projects recently commissioned in Saudi Arabia and United Arab Emirates.
- EOR provides the single largest source of CO_2 utilisation globally



Key lessons from past 20 years

1. Significant progress despite limited support
2. Long-term commitment and stability in policy frameworks is critical
3. Early opportunities for CCS deployment exist, but must be cultivated
4. No CCS without the "S": CO_2 storage must come first
5. The role of CCS goes well beyond a "clean coal technology"
6. Many more projects are needed
7. Community engagement is essential