Carbon Capture and Storage: A necessary clean energy option

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Carbon Sequestration Leadership Forum Ministerial meeting
4 November 2015 – Riyadh, Saudi Arabia

Carbon capture and storage is necessary,

is moving forward,

but needs more steam!

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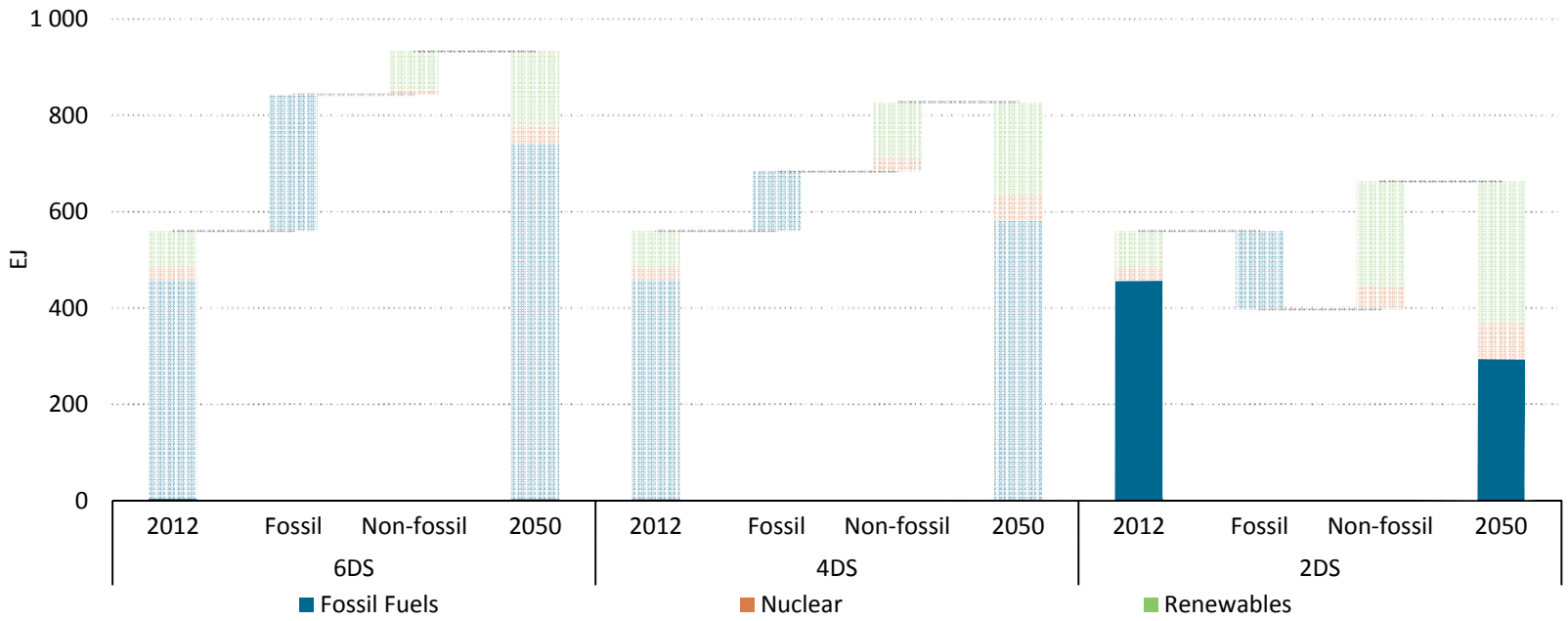
Ambitious energy transformation - fossil fuels retain a strong role



*Role of fossil fuels diminishes, but still has a **44% share in 2050** in IEA 2DS*

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CCS is essential for meeting a 2°C target

- Energy system models (including several used by IPCC) indicate that CCS is essential, and needed to keep mitigation costs to acceptable levels.
- CCS is the only way to sufficiently reduce emissions intensity from certain industrial sectors and enable "negative emissions".
- CO_2 emissions from natural gas up by 30% in the last ten years, while coal has been the fastest-growing source of primary energy for the past five years. **We cannot rely on strategies that assume fossil fuels are rapidly eliminated.**

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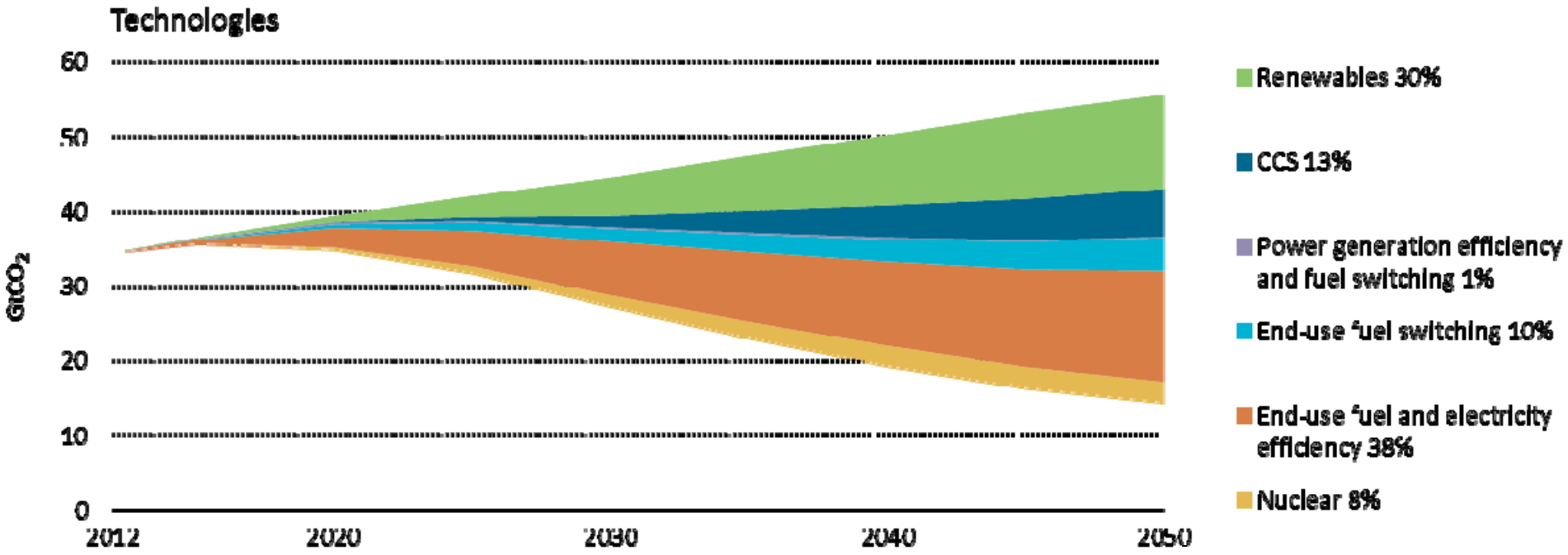
From 6DS to 2DS requires a portfolio of technologies and policies



Percentage numbers represent cumulative contributions to emissions reduction relative to 6DS

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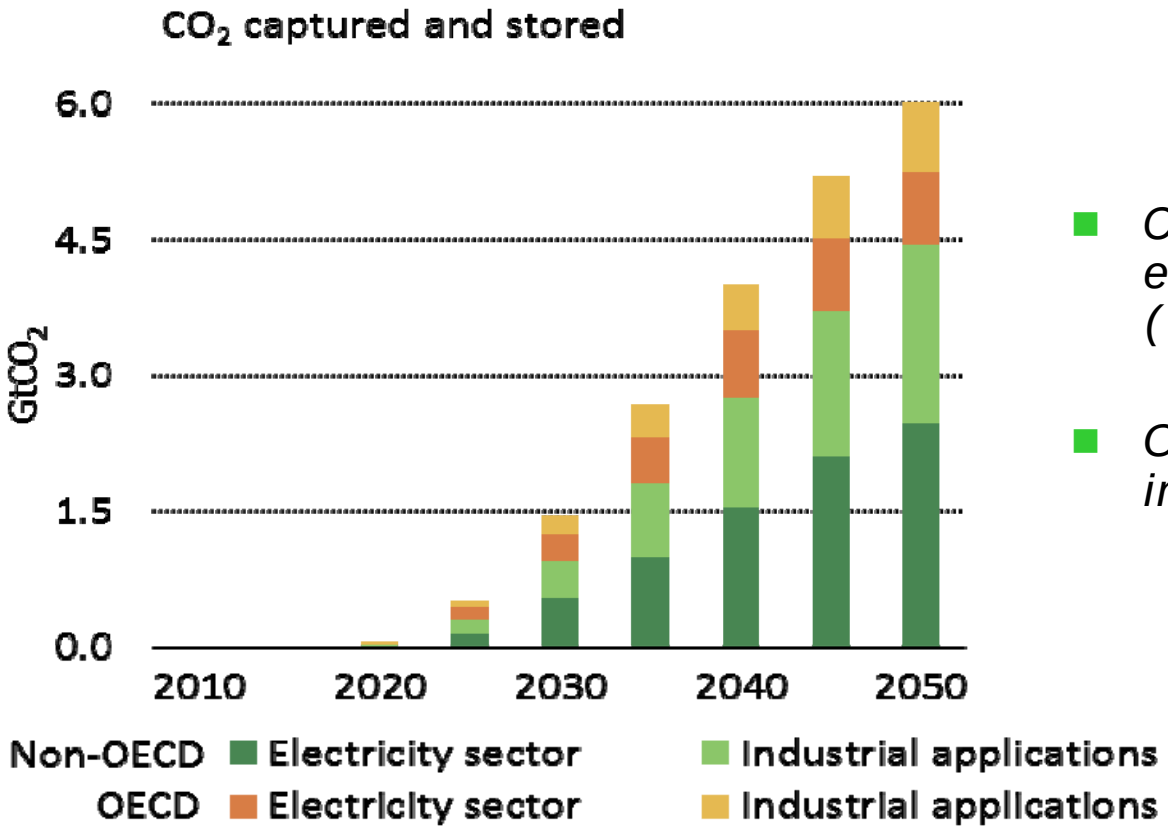
CCS in the 2DS



- *CCS is important in both electricity and industry ("50-50").*
- *Over ⅔ of CO_2 captured is in non-OECD countries.*

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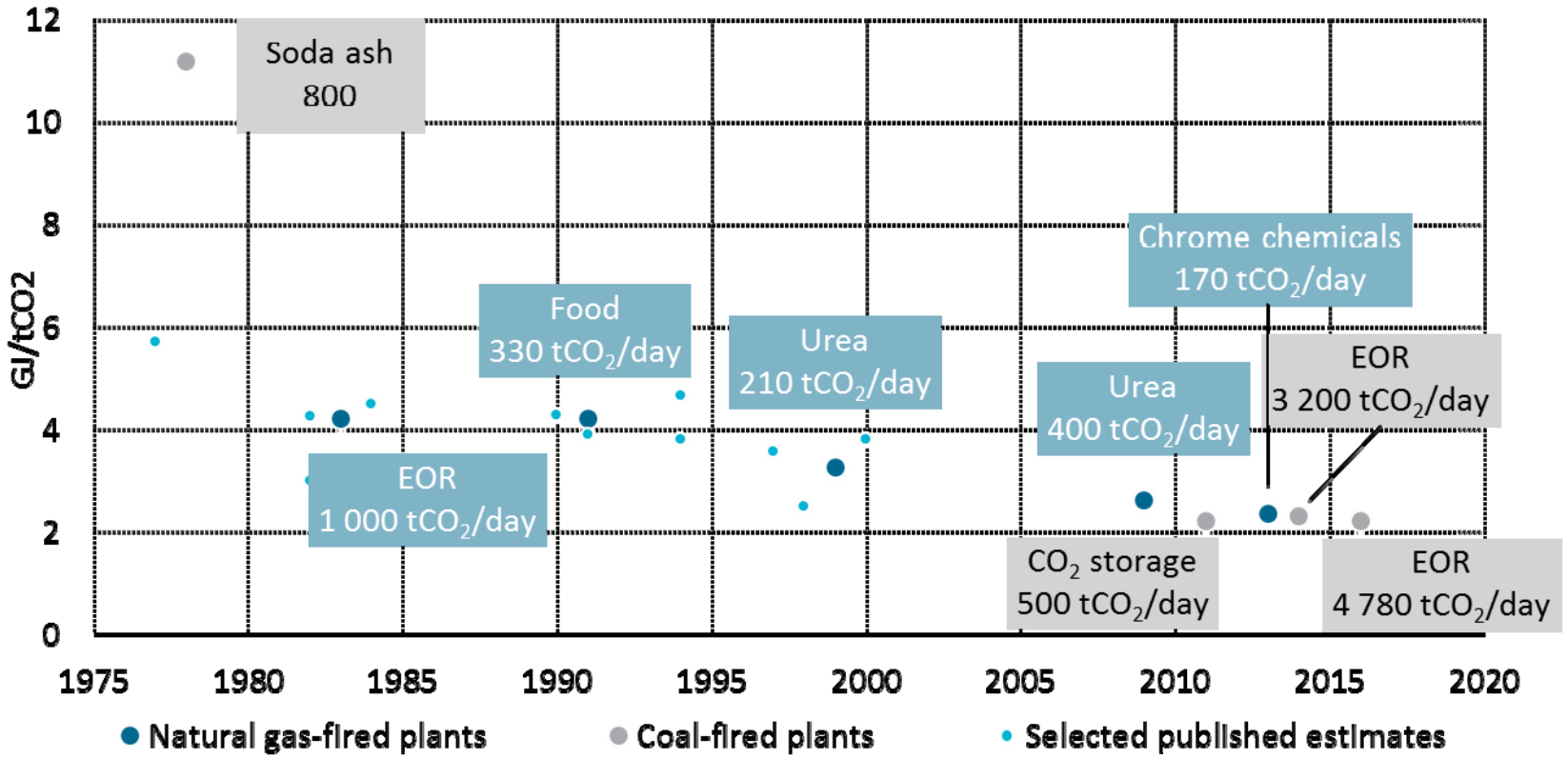
Technology has come a long way



Rochelle, G. (2014) Presentation at GHGT-12 conference; Yeh, S. and E. Rubin (2012) *Energy Economics*, Vol. 34/3

The energy requirement to separate a tonne of CO_2 has been reduced by 50% over the past 25 years.

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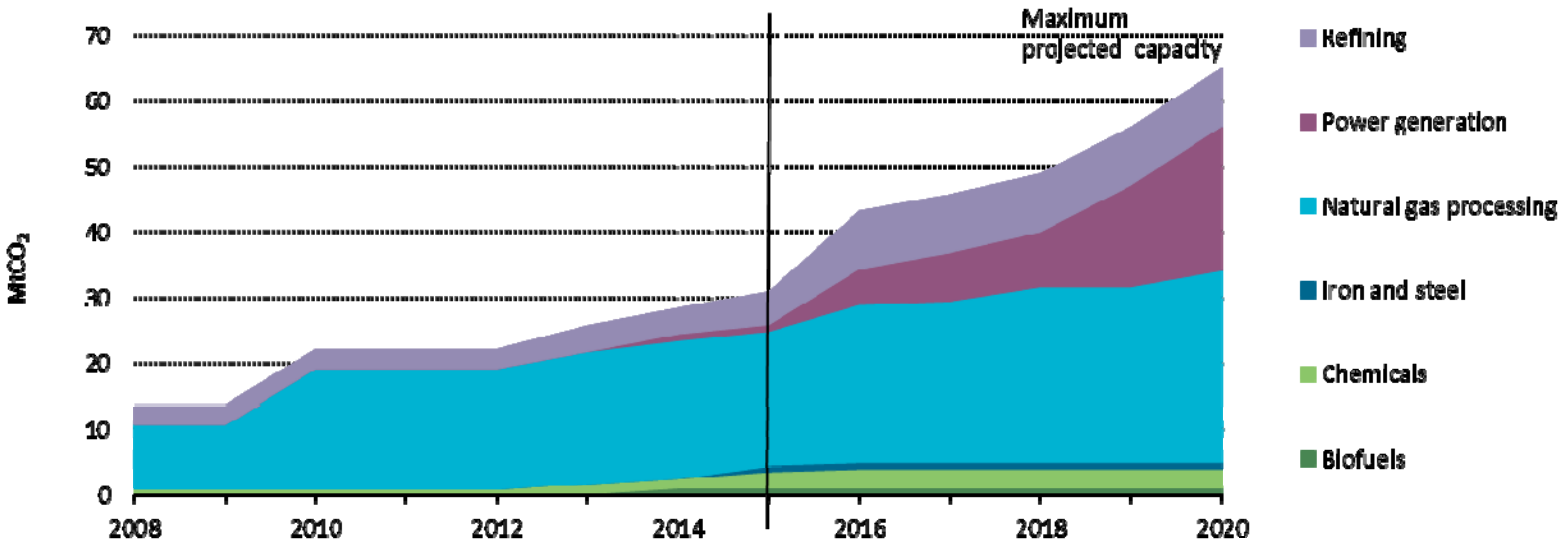
Projects keep advancing – but slowly

60

MILLION TONNES OF CO_2 STORED WITH MONITORING TO DATE



The maximum capture capacity from all projects in the pipeline is 65 $MtCO_2$ a year – The 2DS calls for 500 $MtCO_2$ a year to be stored by 2025.

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Early opportunities: where is CCS succeeding, and why?


Sleipner
(Source: Statoil)

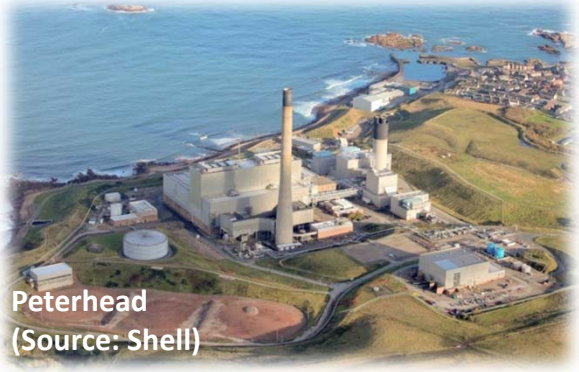

Great Plains Synfuels
(Source: Dakota Gasification)


Boundary Dam
(Source: SaskPower)


Kemper
(Source: IEA)


Decatur
(Source: US DOE)

Port Arthur
(Source: Air Products)


Peterhead
(Source: Shell)


Gorgon (Source: Chevron)


Scotford Upgrader
(Source: Shell)

What has worked - Criteria for positive FID for existing projects

Common success factors:

1. Certainty of fossil fuel value: Clear opportunity for continued use or export of local fossil fuel resources.	**2. Understood local geology**: Suitable geology for CO_2 storage and available expertise.
3. Market opportunity beyond technology demonstration: Low expectation of near-term competition (e.g. regulated tariffs etc.)	**4. Low-risk political and social environment**: Including a predictable regulatory framework for CO_2 storage.

Plus one or more of the following criteria:

- Dependable **revenue stream** for CO_2 sales, for example for EOR
- Strong **government financial support** for the development of CCS
- Explicit national **emissions reduction policy** that includes reductions via CCS
- Manageable impact on profit **margins** (e.g. low-cost producer, or can pass on costs)
- **Strategic benefits** (e.g. a boost to reputation or an advantage from being first)

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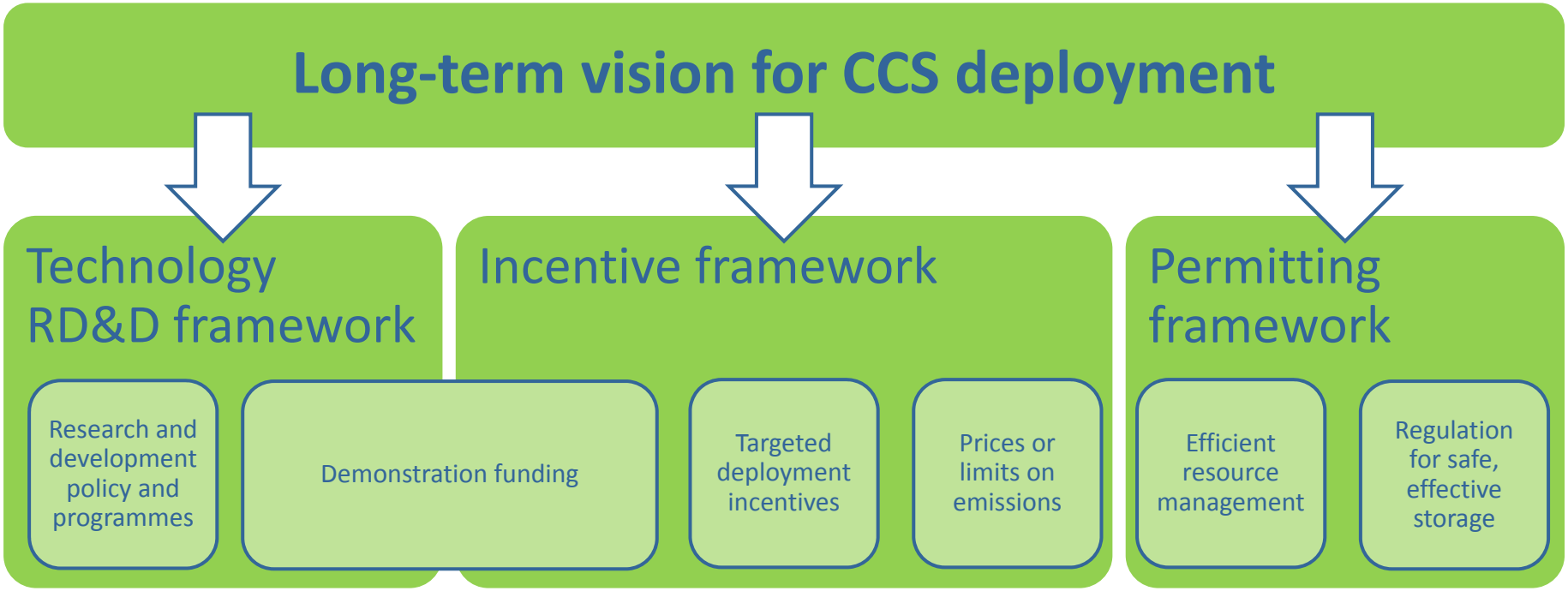
IEA seven key actions to advance CCS

Lead stakeholder	Actions
Government	Introduce financial support mechanisms for demonstration and early deployment of CCS to drive private financing of projects.
Government	Implement policies that encourage storage exploration, characterisation, and development for CCS projects.
Government	Develop national laws and regulations as well as provisions for multilateral finance that effectively require new-build, base-load, fossil-fuel power generation capacity to be CCS-ready.
Industry	Prove capture systems at pilot scale in industrial pilot applications where CO_2 capture has not yet been demonstrated.
Government	Significantly increase efforts to improve understanding among the public and stakeholders of CCS technology and the importance of its deployment.
Industry/R&D	Reduce the cost of electricity from power plants equipped with capture through continued technology development and use of highest possible efficiency power generation cycles.
Government	Encourage efficient development of CO_2 transport infrastructure by anticipating locations of future demand centres and future volumes of CO_2.

Creating policy & incentives: critical



Lead governments must rethink the policy frameworks in place – CCS to be driven to markets much like other low-carbon energy.

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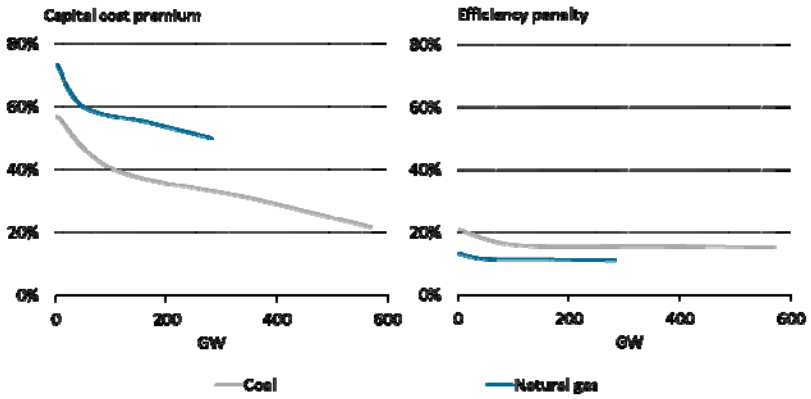
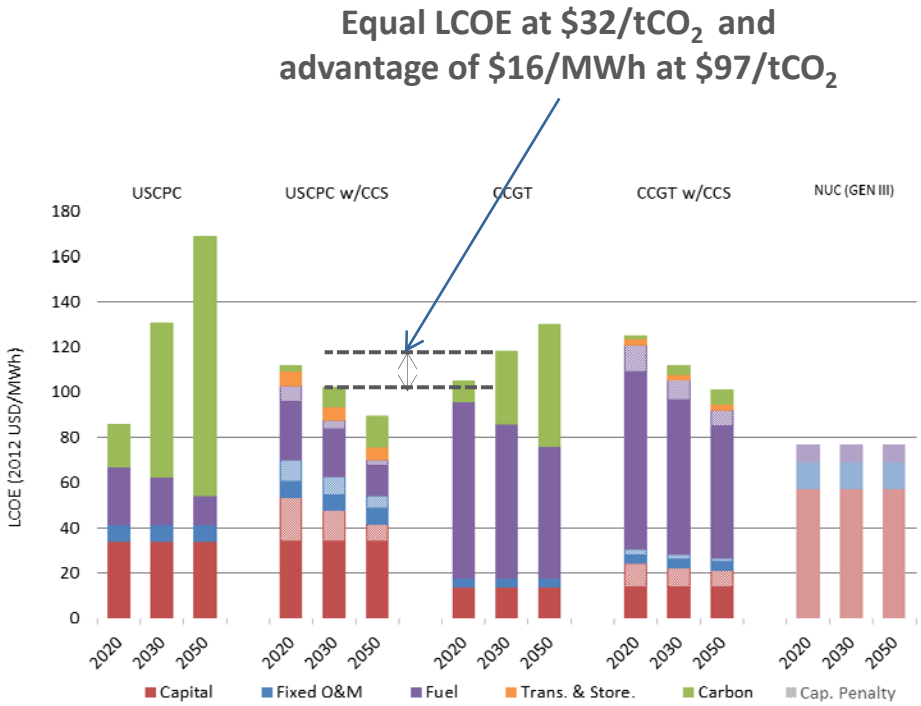
CCS can be competitive with cost reductions

As the installed capacity of CCS-equipped power plants grows, the efficiency penalty and capital cost premium fall



Case Japan: Post-2030 USCPC with CCS is lower cost than CCGT and even CCGT with CCS.



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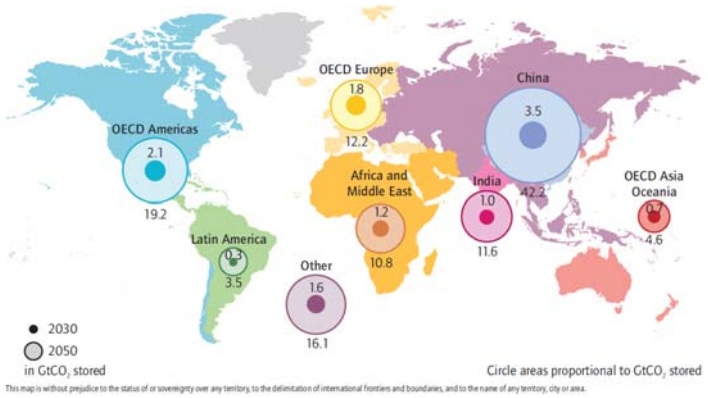
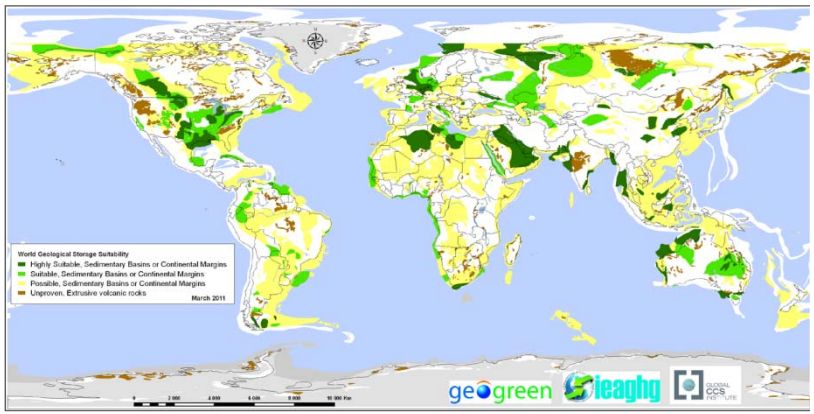
Develop CO_2 transport networks and storage as strategic assets

Significant storage requirements globally



Abundant suitable geologic <u>formations</u>



…but it can take up to 10 years to qualify a greenfield storage <u>site</u>!

- Identify potential storage on national/regional level
- Incentivise up-front storage site exploration for projects
- Invest in CO_2 transport networks
- Ensure safeguards: enact laws and regulations to ensure long-term containment
- Ensure that EOR activity is monitored

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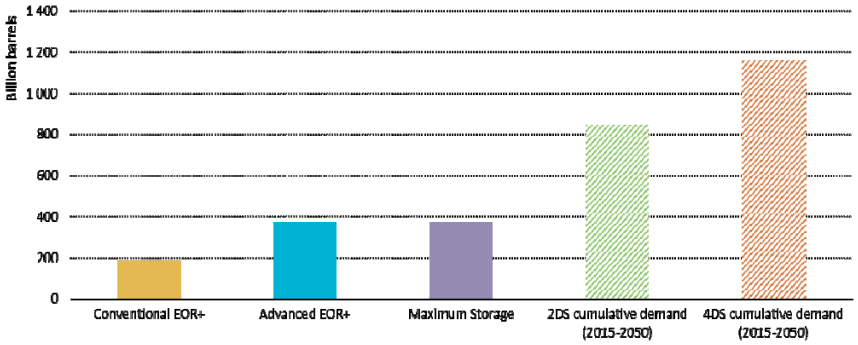
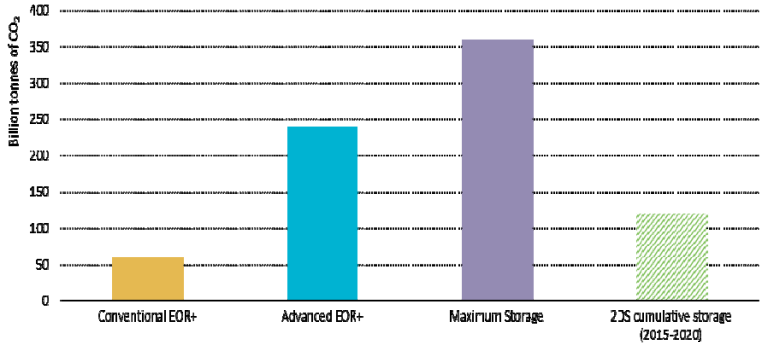
“EOR+”: creating a win-win for business and climate

Significant additional oil production potential…



… and CO_2 storage potential



- *EOR+ requires additional activities compared with today’s EOR.*
- *Additional activities in operation and monitoring increase cost, but can make economic sense if EOR+ operator is paid to store CO_2.*
- *On LCA basis, EOR+ operations can also be beneficial to the climate.*

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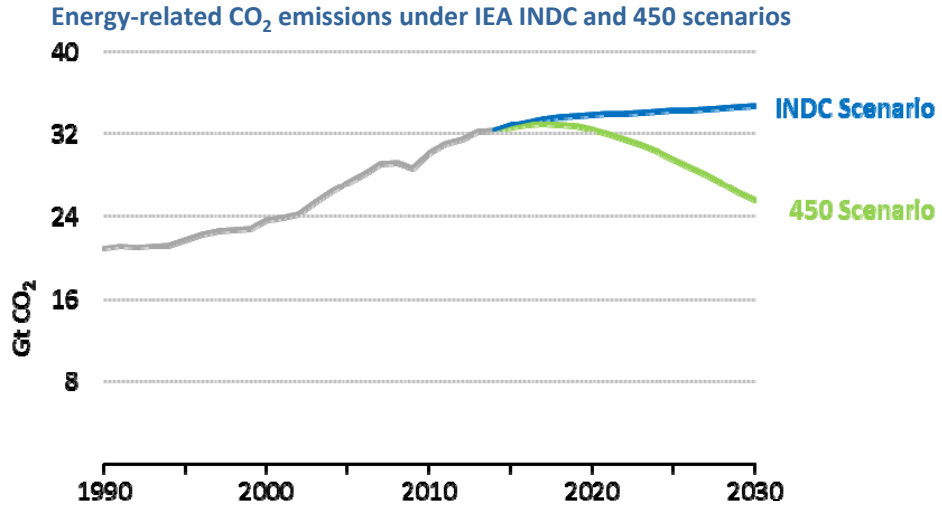
Energy & climate change – COP21

- A major milestone in efforts to combat climate change is fast approaching – COP21 in Paris in December 2015
- Momentum is building:
  - Historic US-China joint announcement; EU 2030 targets agreed etc.
  - 128 INDCs submitted, covering 150+ countries and 90% of energy-related green-house gases
  - Energy-sector CO_2 emissions slow down significantly if INDCs implemented



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CCS in UNFCCC – COP21

- Individual technologies are unlikely to feature in the text of the agreement reached in Paris – but the **UNFCCC processes can still make a big difference for CCS**
  - Individual **INDCs** may identify CCS as a part of their mitigation pathway
  - Funding for CCS can be available under the **Green Climate Fund** (is a dedicated window possible?)
  - Other mechanisms may help build capacity, e.g. the **TEM** can support CCS by creating enabling conditions

Thank you.

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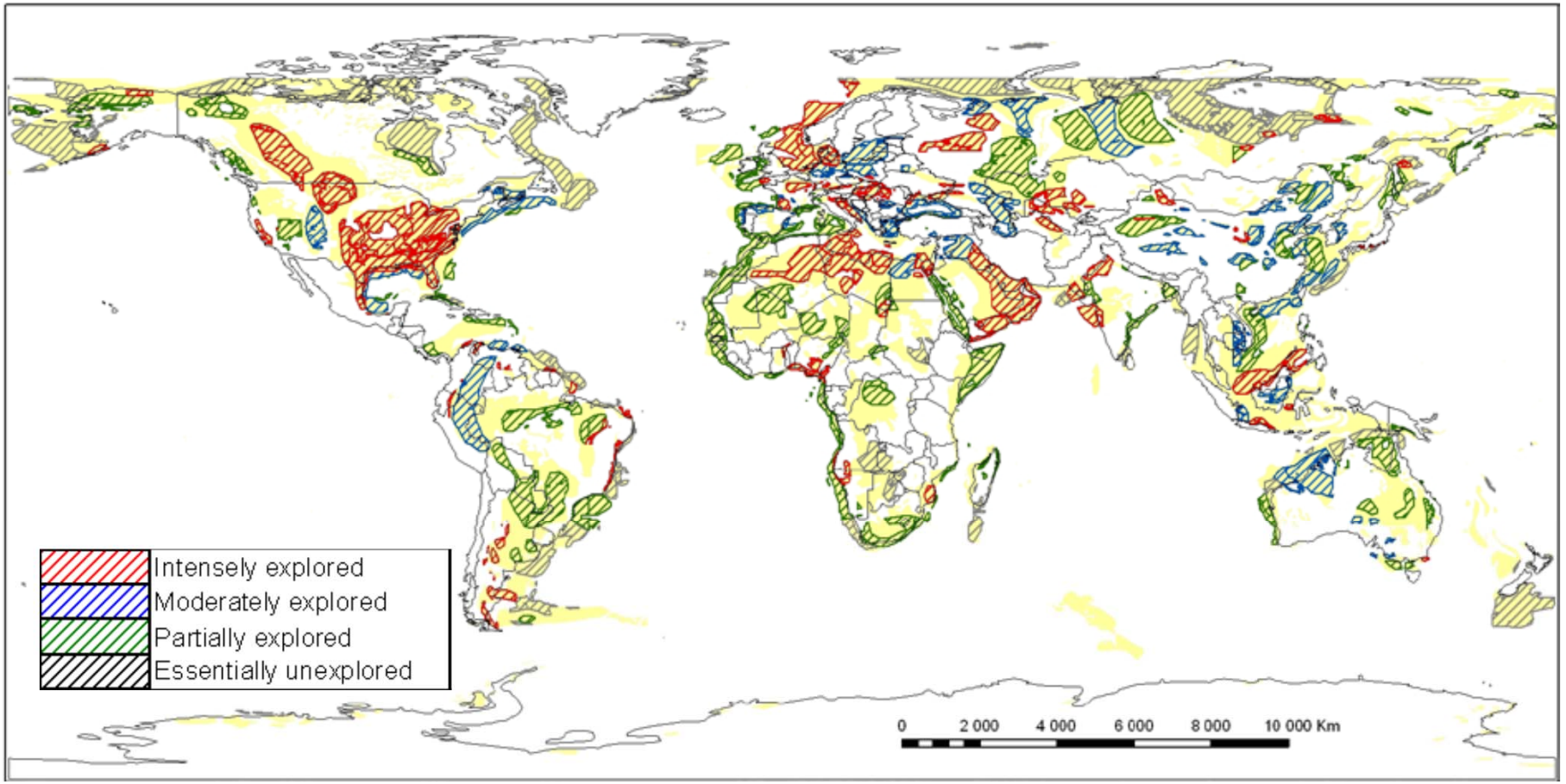
Exploratory status of world basins - 2011



IEAGHG, "Global Storage Resource Gap Analysis for Policy Makers", 2011/10, September, 2011

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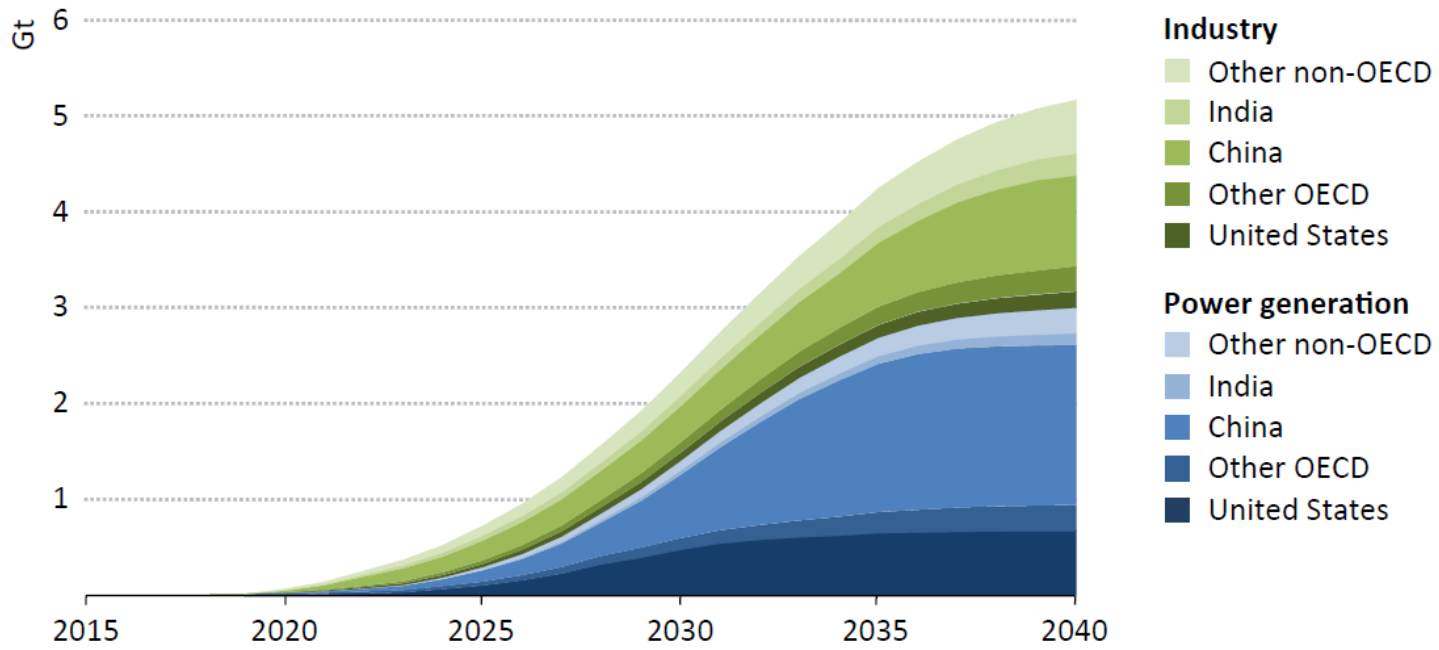
TS1

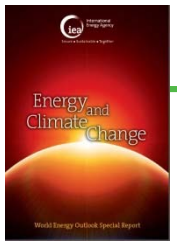
CCS in the 450 Scenario: An ambitious deployment pathway

Figure 4.4 ▻ CO_2 captured in the 450 Scenario by sector and region



5Gt captured by 2040

Over 6Gt by 2050 (ETP 2DS)



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Slide 23

TS1 This is a useful figure, however the following slides go into depth on the 2DS which could create confusion - especially given its a short presentation which doesn't allow for explaining the differences.

STANLEY Tristan, IEA/SPT/EED/CCS, 10/9/2015

How do we move forward?

1. In both 450 Scenario and the 2DS, 5 - 6 GtCO2/yr are captured and stored by 2050 in all sectors

2. CCS deployment has begun in “sweet spots”

3. “Learning-by-doing” is now also under way for CCS in power generation

How do we move forward?

4. **The cost gap needs to be closed by determined, parallel action in technology development and market creation**

5. **Improving and using post-combustion technologies is of particular importance**

6. **Innovation and robust regulation will help CO_2 storage remain a minor cost component of CCS**

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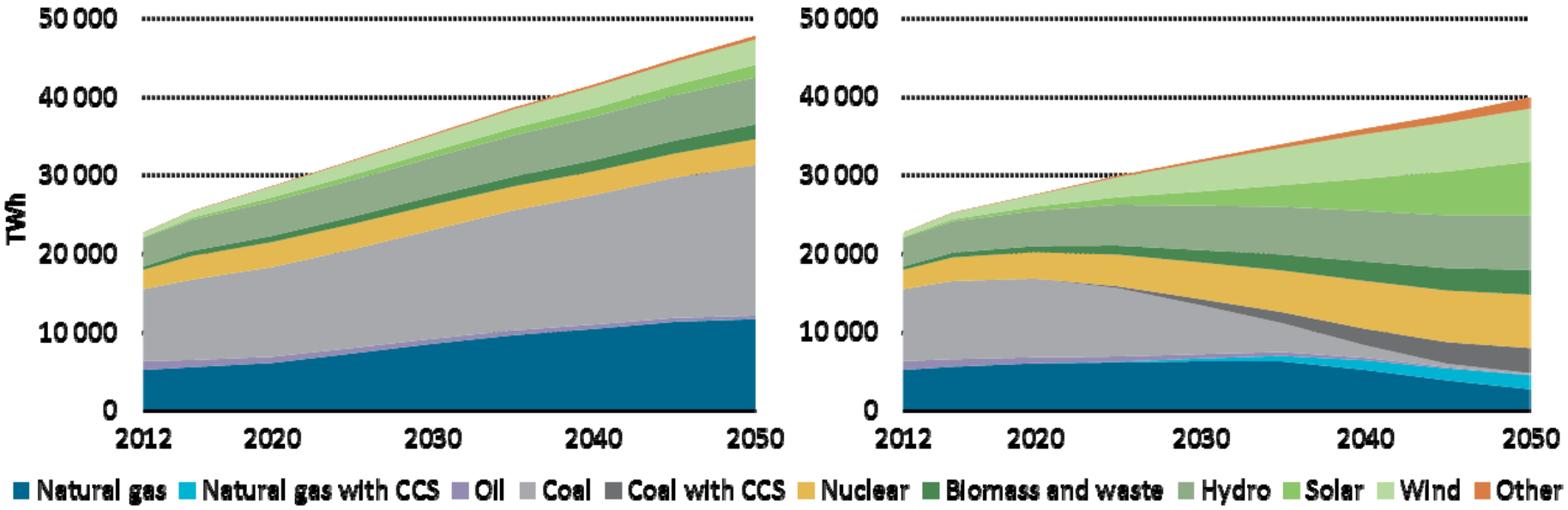
2DS - Fossil fuel electricity generation declines



By 2050 in the 2DS, fossil fuels in electricity generation declines to 20%, with ***CCS being applied to 63% of fossil fuel generation***

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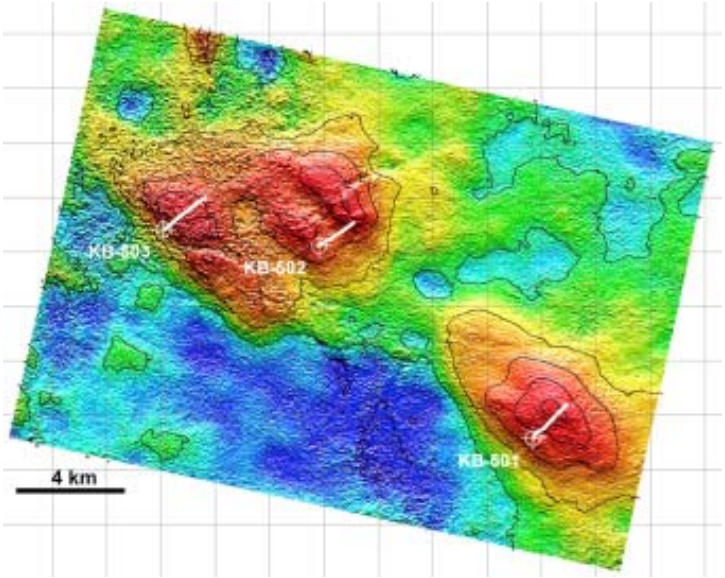
Monitoring is critical for confirming the storage of CO_2

- Developed new and refined MMV techniques
- Through experience – better understand which tools work where
- Better understand what can and needs to be monitored

Surface displacement at In Salah



Charles Jenkins, Andy Chadwick, Susan D. Hovorka, international Journal of Greenhouse Gas Control, Volume 40, 2015, 312–349, http://dx.doi.org/10.1016/j.ijggc.2015.05.009

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