

Carbon Capture and Storage: Potential, Progress and Challenges

15.3.2011

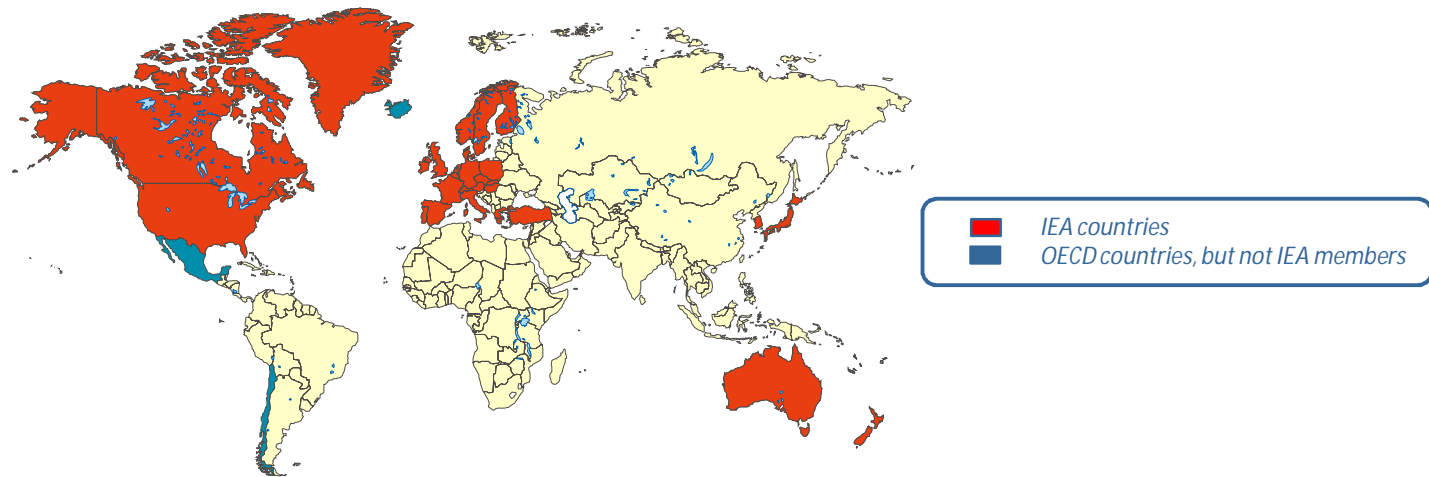
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International Energy Agency



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International Energy Agency



- Inter-governmental body founded in 1973, currently 28 Member Countries
- Policy advice and energy security coordination
- Whole energy policy spectrum and all energy technologies
- Flagship publications include WEO and ETP
- Host to more than 40 technology-specific networks ("Implementing Agreements" or "IAs")
 - Operated independently with their own membership and financing
 - Includes GHG IA
- Active in CCS since 2000; dedicated CCS unit created in 2010
 - Provides policy advice
 - Supports broader IEA cross-technology analysis



CONTENTS

1. Role of CCS
2. Current status of development
3. Challenges for deployment

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1. Capture of CO₂ from large point sources

Trucks, ships, pipelines

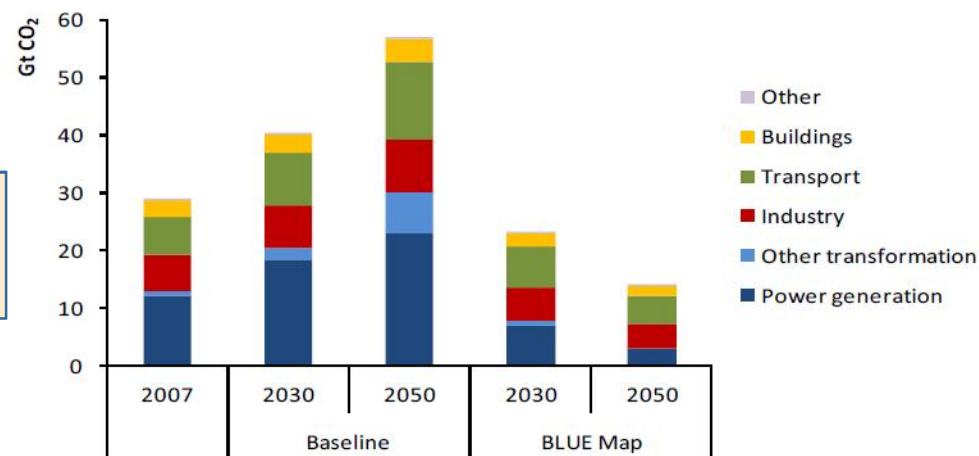


Depleted oil and gas fields, saline aquifers, EOR, ECBMR etc.

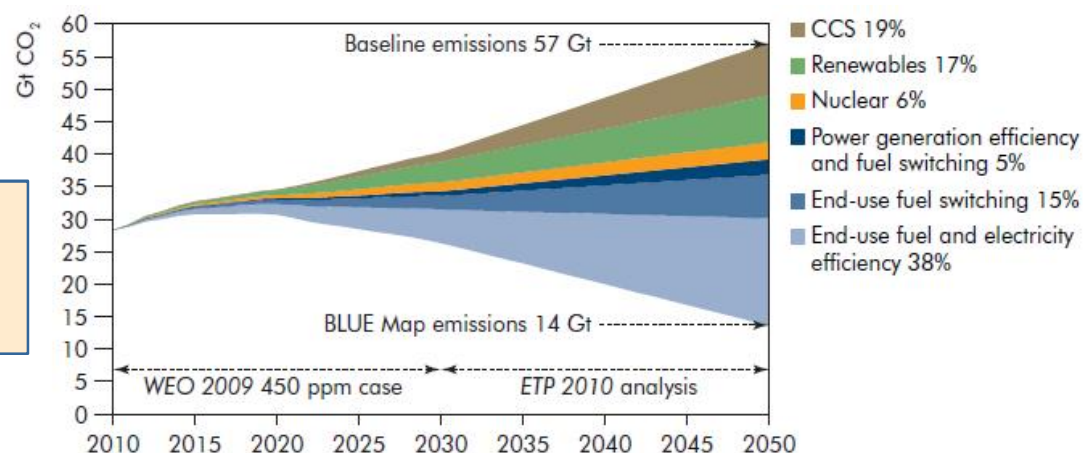


TOWARDS 450ppm: CCS PART-SOLUTION

1. CO₂ emissions from energy must be halved



2. CCS plays a significant role in the low-carbon mix



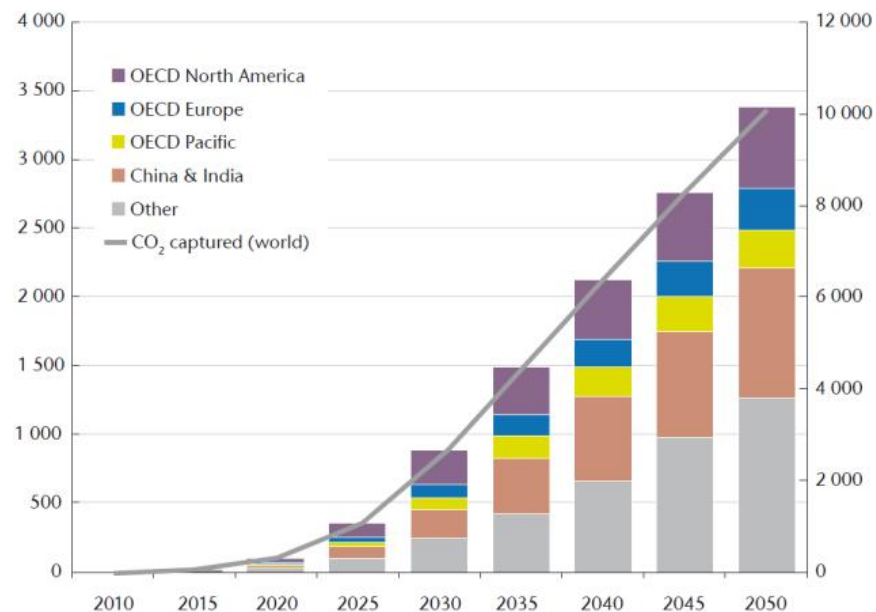


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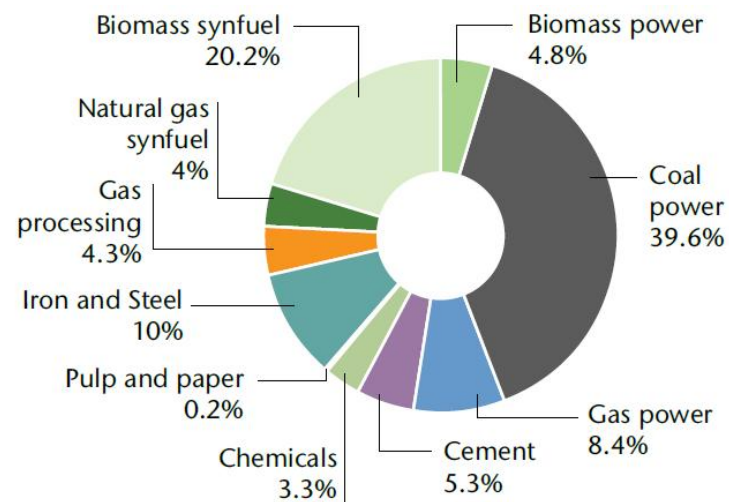
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TOWARDS 450ppm: CCS PART-SOLUTION

3. Deployment is very challenging



4. ... And CCS is not only about power



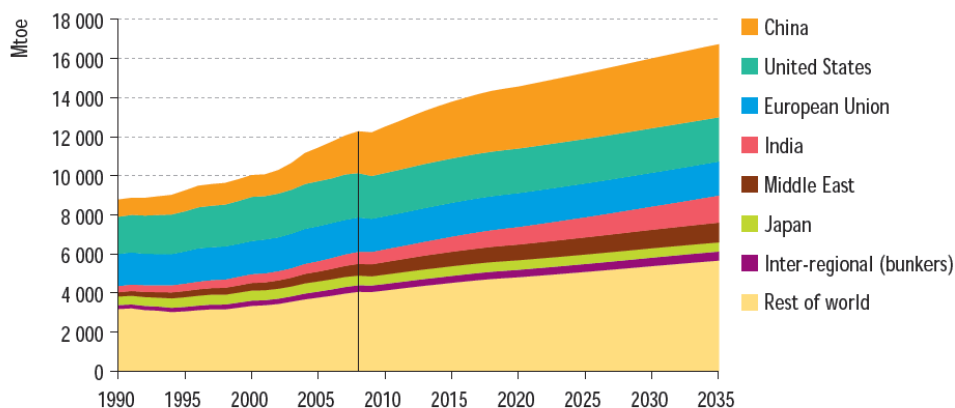


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NEW POLICIES: ENERGY & EMISSIONS GROWTH CONTINUES*

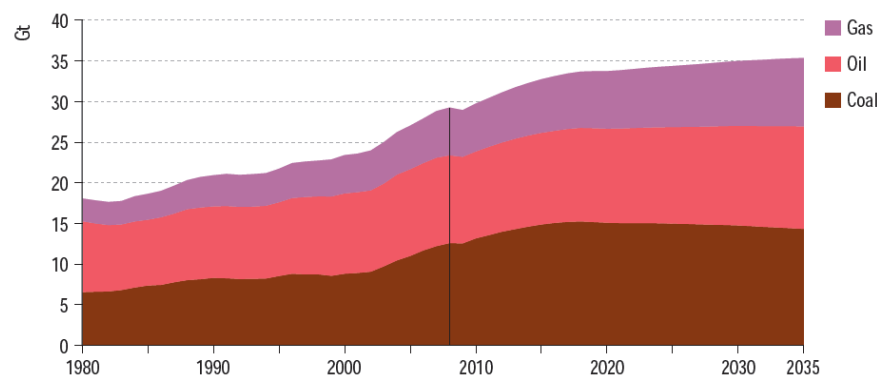
Figure 2.5 • World primary energy demand by region
in the New Policies Scenario



2008-2035

- Energy demand +35%
- China: 35% of global incremental demand
- OECD demand stagnates

Figure 2.13 • World energy-related CO₂ emissions by fuel
in the New Policies Scenario



- Energy-related CO₂ emissions 35 Gt by 2035
- Growth from non-OECD countries
- 650ppm pathway

* "New Policies Scenario", IEA World Energy Outlook 2010

World Energy Outlook
2010



CO₂ IS CAPTURED AND STORED AS WE SPEAK...



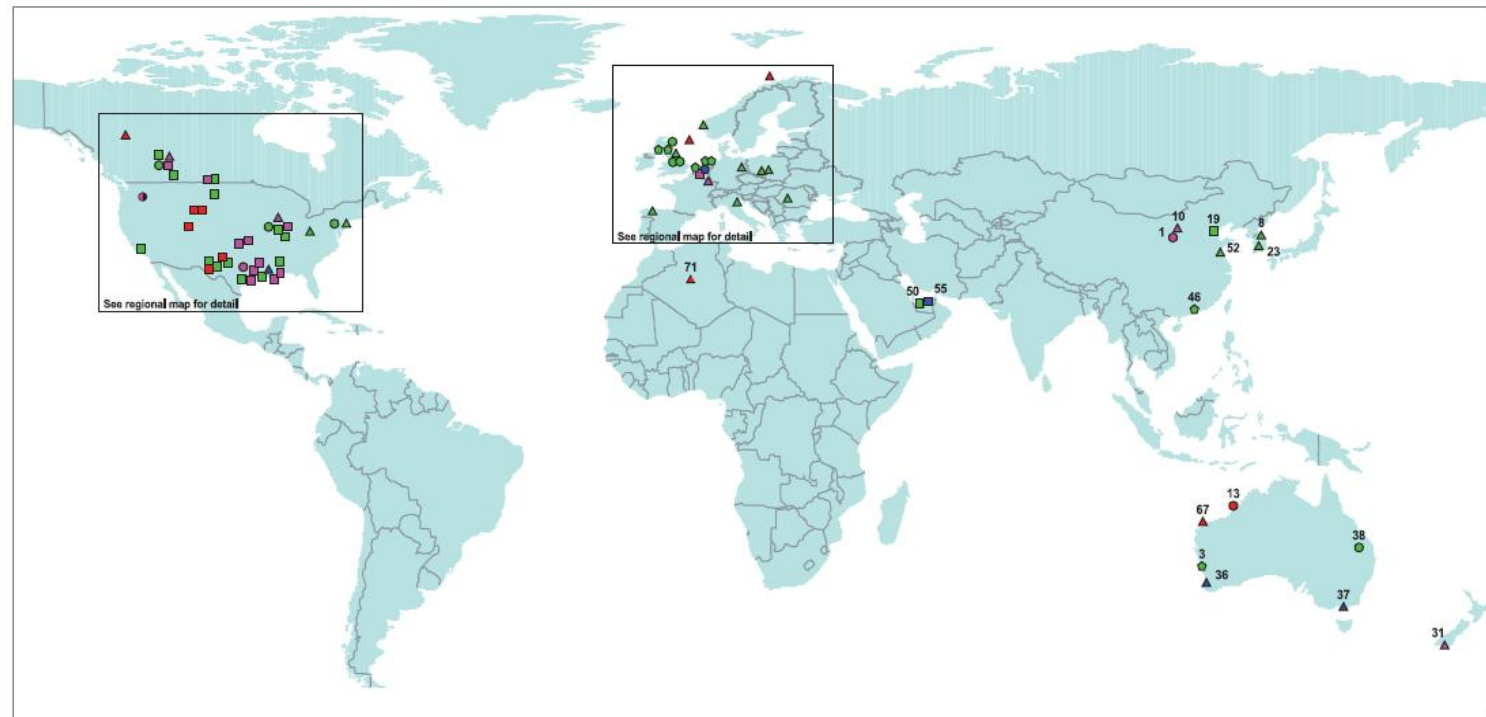
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*Five large-scale projects are
currently storing >5Mt CO₂ per year*



... AND MORE IS PLANNED

70+ integrated large-scale projects in various stages of development



LSIPs: Global
Industry sector
■ Power generation
■ Gas processing
■ Multiple capture facilities
■ Other industry

Storage type
□ EOR (Enhanced oil recovery)
△ Deep saline formations
○ Depleted oil and gas reservoirs
● Deep basalt formations
○ Various/not specified

Source:



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So, we know CCS has enormous potential, technologies exist and projects are being advanced...

...but what are the challenges going forward?



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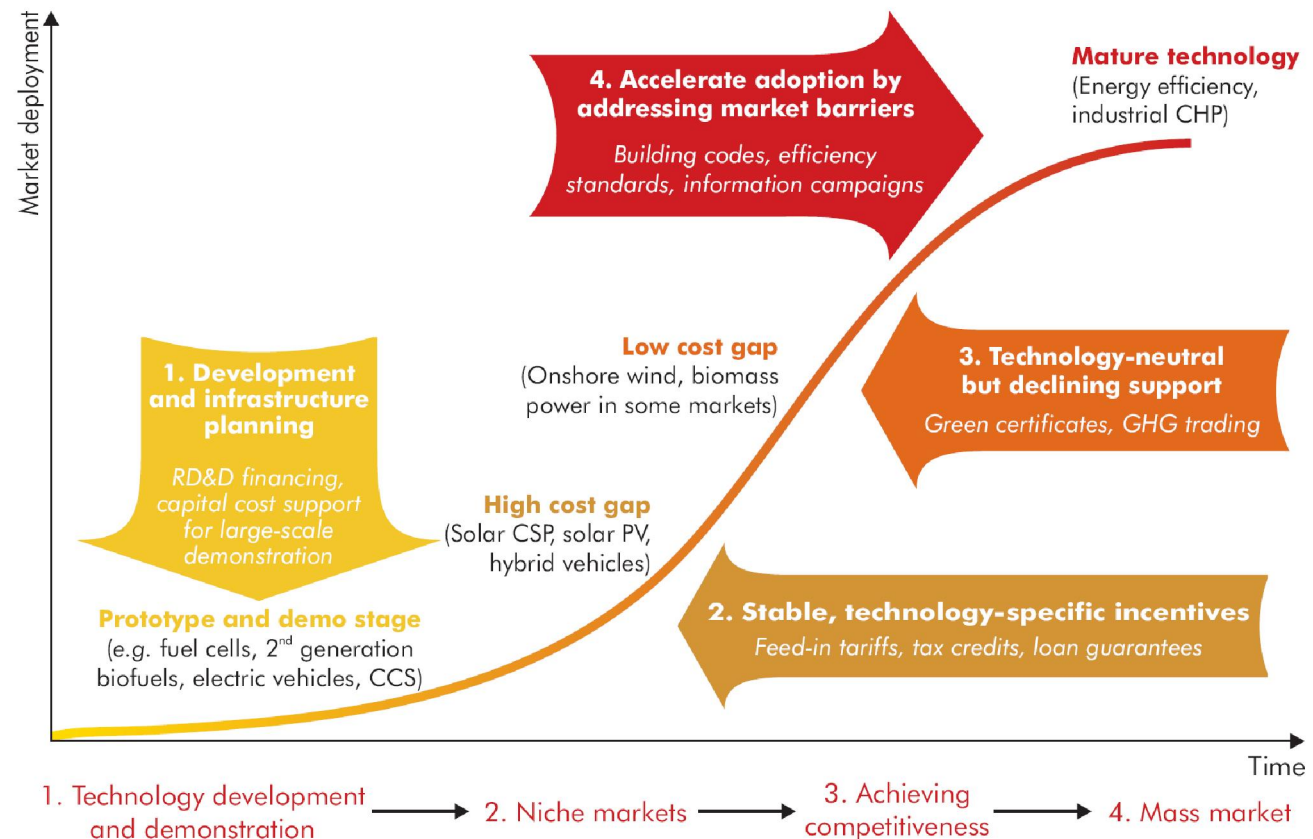
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Challenge I: SETTING STRATEGIC POLICY DRIVERS & DIRECTION

- Making firm decisions required to address climate change
- Improving understanding of CCS and its role within the broader technology portfolio
- Recognition of the role of CCS
- More attention on industrial CCS applications

Challenge II: CREATING INCENTIVES (1)

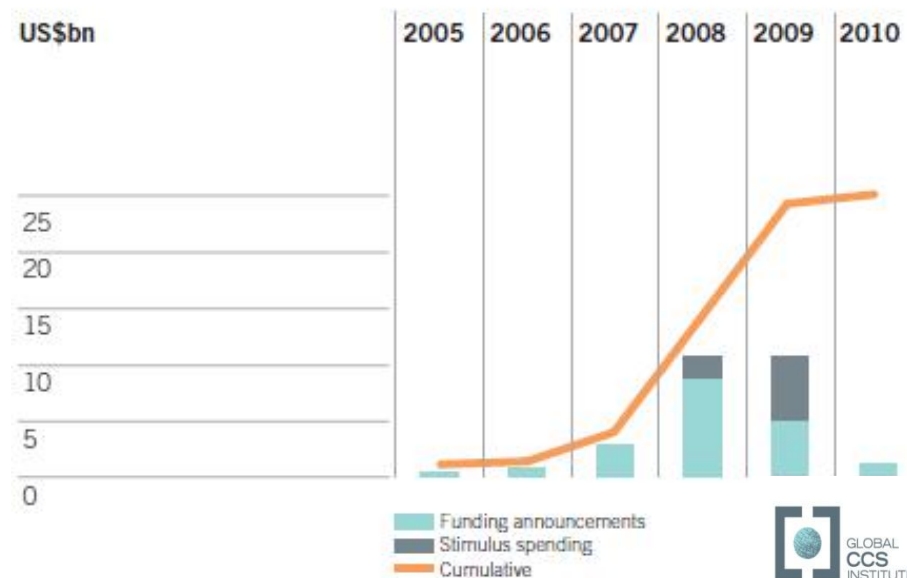
- Time dimension: R&D → Demonstration → Deployment
- Geographic dimension: OECD vs. non-OECD world



CREATING INCENTIVES (2)

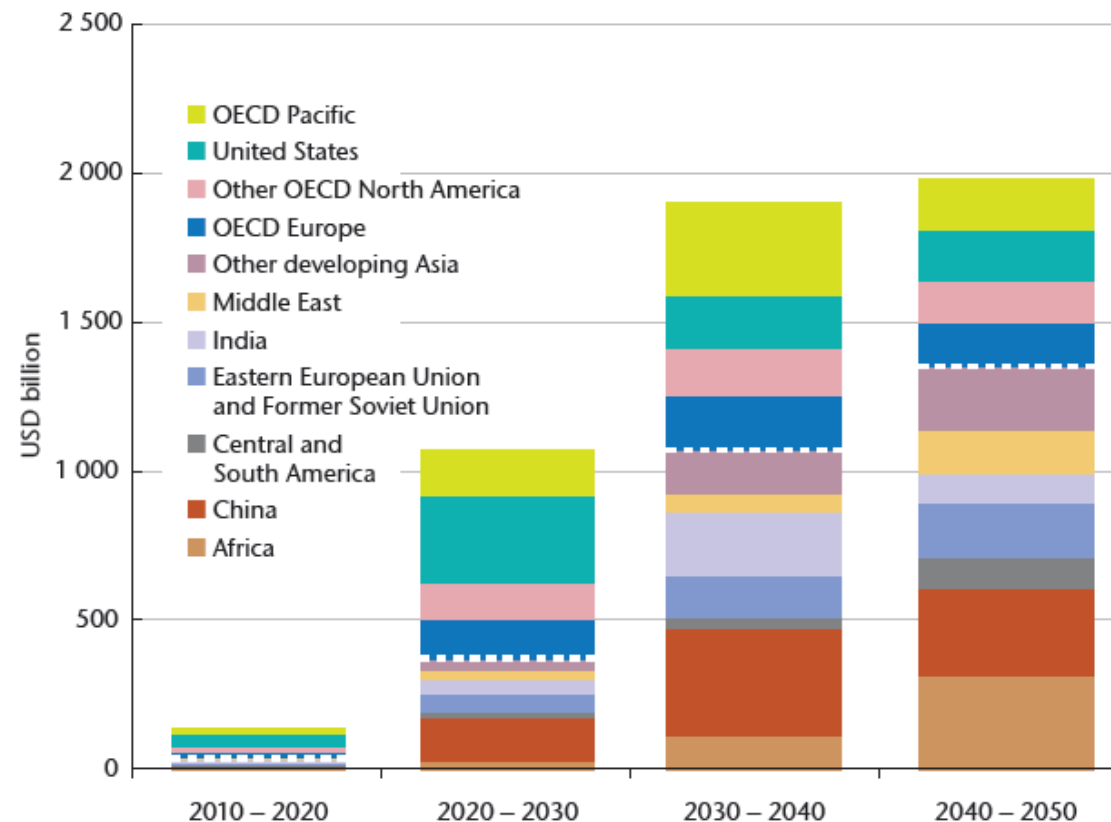
- Short-term: accelerating financing by industry and governments for large-scale demonstration
- Various “one-off” government schemes for 20-40 large-scale demo plant across the globe, worth ~USD 25 bn:
 - Direct subsidy
 - CO₂-price linked schemes
 - Fiscal measures etc.

Figure 6 Government CCS funding initiatives from 2005 to 2010⁶



CREATING INCENTIVES (3)

- Long-term: mobilising 2500 bn USD investment in capture plant, transport and storage between 2010-2050 for deployment
- Carbon pricing, feed-in tariffs, subsidies etc. etc.



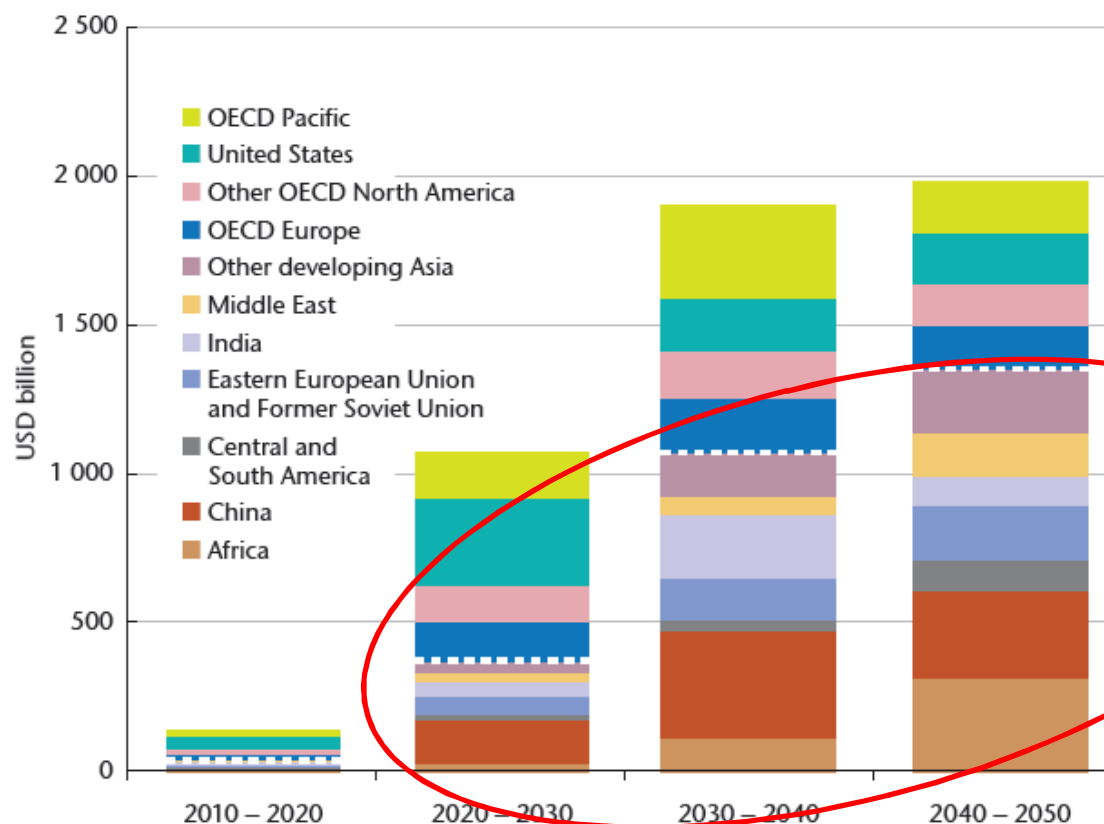


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CREATING INCENTIVES (4)

- 1400 bn USD investment in non-OECD countries 2010-2050
- Creating incentive mechanisms in non-OECD countries
 - Carbon pricing
 - CDM
 - multilateral climate funds (WB etc.)
 - UNFCCC "Technology Mechanism", etc.





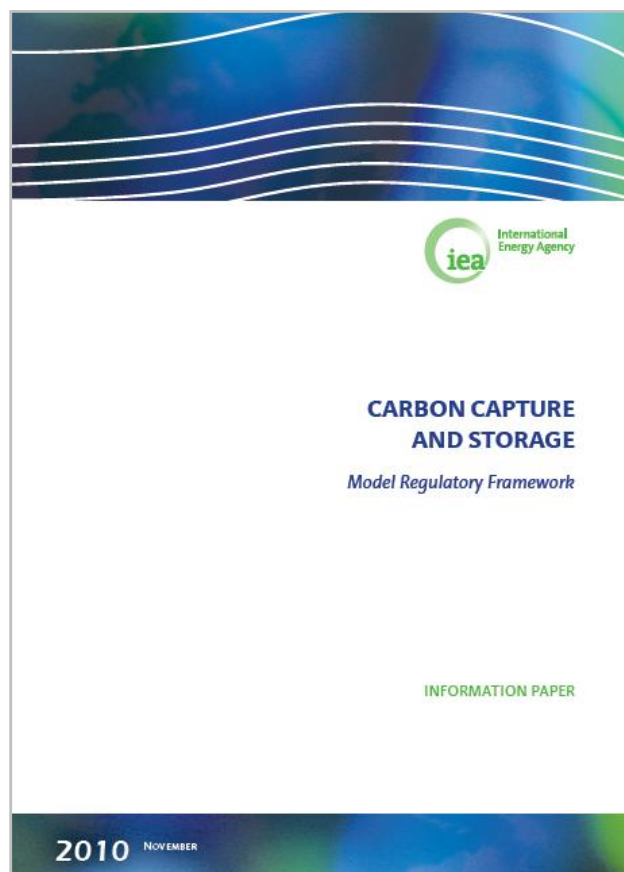
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Challenge III: COMPLETING REGULATION

- Many OECD countries have implemented, or are implementing, legal & regulatory frameworks
 - Safety & environmental effectiveness
 - Long-term liability
 - Ensuring public engagement
- Completing frameworks in many parts of the world, especially in key non-OECD countries
- Dealing with outstanding international legal issues e.g. ratification of the London Protocol and OSPAR amendments

IEA Model CCS Regulatory Framework 2010



- Regulatory development process
- Capture, transport and storage
- 29 key issues
- 4 categories
 - A. Broad regulatory issues
 - B. Existing regulatory issues
 - C. CCS-specific regulatory issues
 - D. Emerging CCS regulatory issues

29 issues that require a regulatory framework...

Classification of CO ₂	Engaging the public in decision-making	Corrective measures and remediation measures
Property rights	CO ₂ capture	Liability during the project period
Competition with other users and preferential rights issue	CO ₂ transportation	Authorisation for storage site closure
Transboundary movement of CO ₂	Scope of framework and prohibitions	Liability during the post-closure period
International laws on protection of the marine environment	Definitions and terminology applicable to regulating CO ₂ storage	Financial contributions to post-closure stewardship
Incentivising CCS as part of climate change mitigation strategies	Authorisation of storage site exploration activities	Sharing knowledge and experience through the demonstration phase
Protecting human health	Regulating site selection and characterisation activities	CCS Ready
Composition of the CO ₂ stream	Authorisation of storage activities	Using CCS for biomass-based sources
The role of environmental impact assessment	Project inspections	Understanding enhanced hydrocarbon recovery with CCS
Third-party access to storage site and transportation infrastructure	Monitoring, reporting and verification requirements	

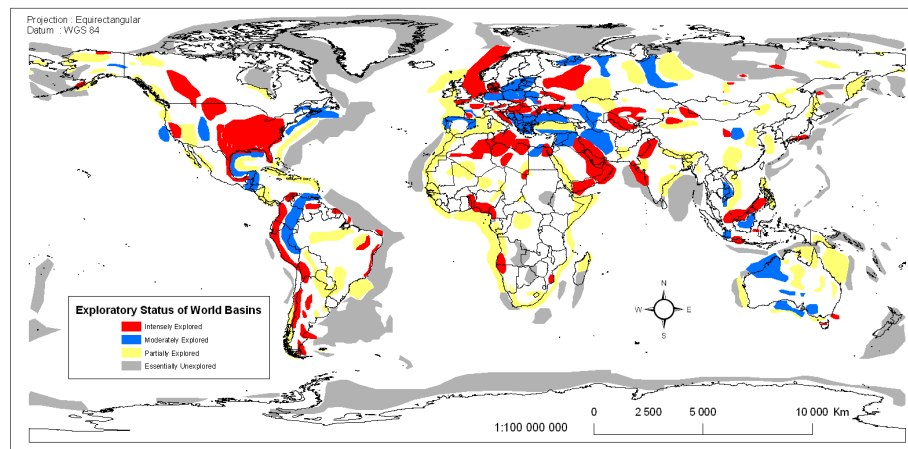


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Challenge IV: ENHANCE UNDERSTANDING of CO₂ STORAGE

- Developing common methodology to estimate storage capacity
- Improving data on global/regional/national storage capacities
- Clarifying responsibilities for long-term liability
- Alleviating public concerns



IEA GHG, GCCSI



Challenge V: IMPROVING TECHNOLOGY & INFRASTRUCTURE

- Reducing capital and operating cost
 - Understanding differences in costs across technologies & regions
 - Analysing potential for cost reduction by learning
- Understanding industrial and other deployment bottlenecks
- Accelerating progress in pipeline infrastructure planning and coordination



Vattenfall



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CAPTURE COST & PERFORMANCE STUDY

Summary

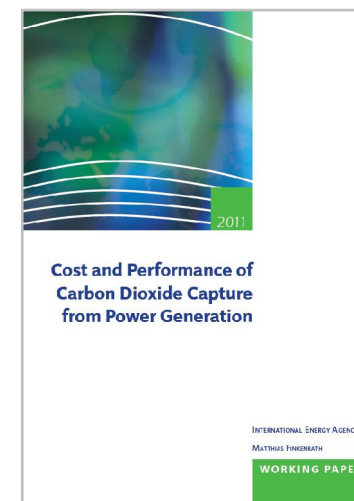
- Cost and performance trends for CO₂ capture from power generation based on major engineering studies
- Re-evaluation of capital cost and cost of electricity for early commercial plants in the OECD and China
- Discussion of site-specific costs, learning rates and cost sensitivities; storage and transportation not included

Conclusions & recommendations

- Average results (power plant with capture & compression; OECD):

Fuel (<i>capture route</i>)	Coal (<i>pre-, post-, oxy-combustion</i>)	Natural gas (<i>post-comb.</i>)
Efficiency penalty (%-pts.)	10 (<i>pre-combustion vs. IGCC: 8</i>)	8
Overnight costs (USD/kW)	3 800 (<i>74% increase vs. PC reference</i>)	1 700 (<i>82% increase</i>)
Cost of CO ₂ avoided (USD/tCO ₂)	55 (<i>vs. PC reference</i>)	80

- Costs in China estimated to be about half for most cases
- Further harmonisation of costing methodologies is needed
- Broader assessments for non-OECD countries required





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CONCLUSION: "ARE WE STILL IN THE STARTING BLOCKS?"

No, because we have technology, and
regulation starting to emerge

Yes, because we lack drivers and
incentives for large-scale deployment

Moving forward:

Policy decisions, cooperation,
risk-sharing and risk-taking



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Thank you!

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