CARBON CAPTURE AND STORAGE

International Energy Agency

CCS in a Global Climate Change Context

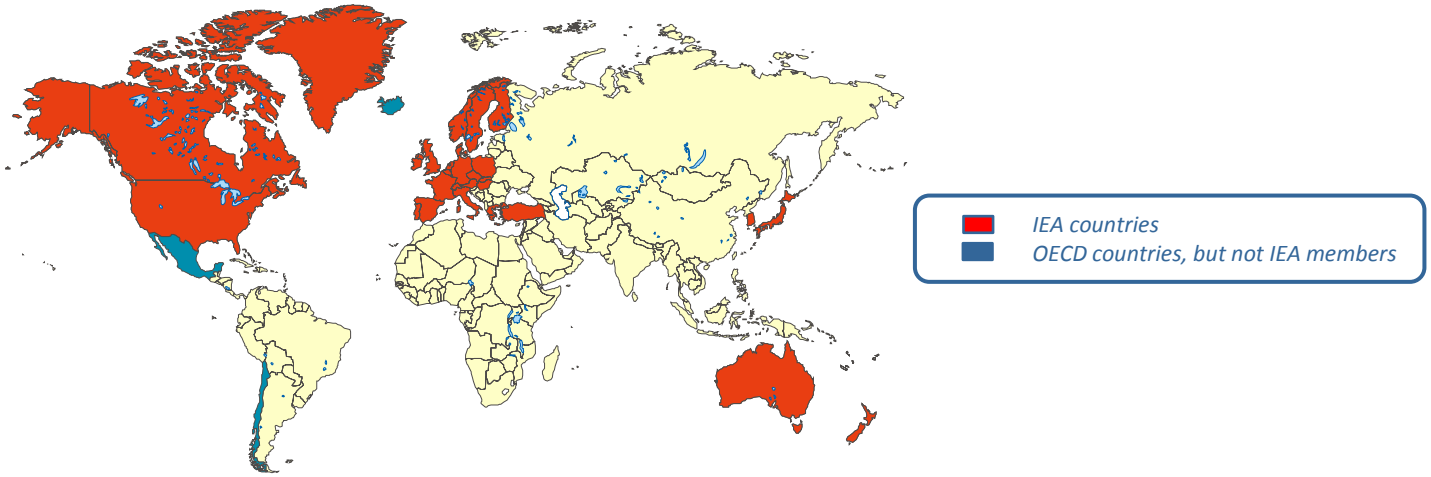
IEA-SENER Joint Workshop
Mexico City March 7

Dennis Best
Programme Officer

Global Energy Dialogue
International Energy Agency

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INTERNATIONAL ENERGY AGENCY



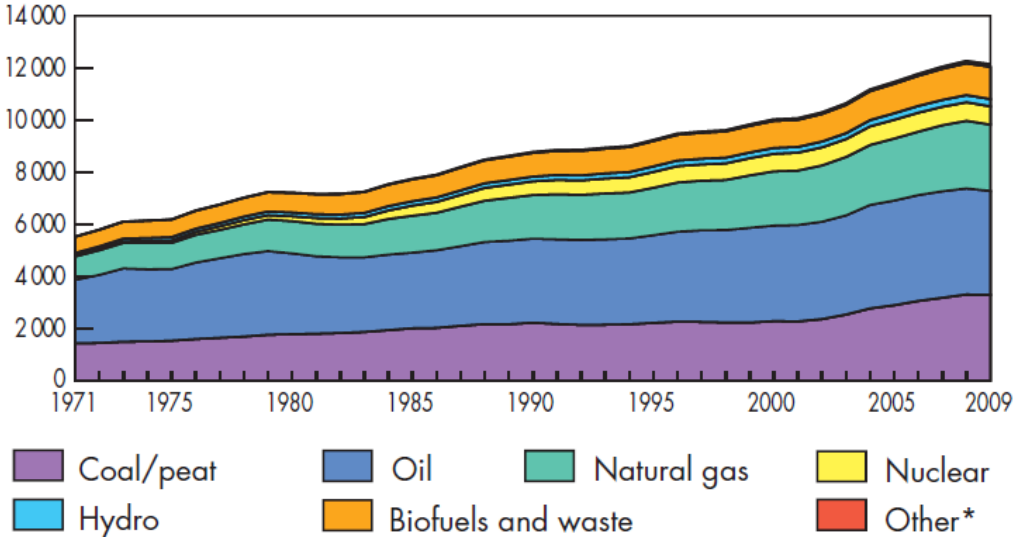
- Inter-governmental body founded in 1973, currently 28 Member Countries
- Policy advice and energy security coordination
- Whole energy policy spectrum and all energy technologies
- Flagship publications include WEO and ETP
- Host to more than 40 technology-specific networks ("Implementing Agreements" 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

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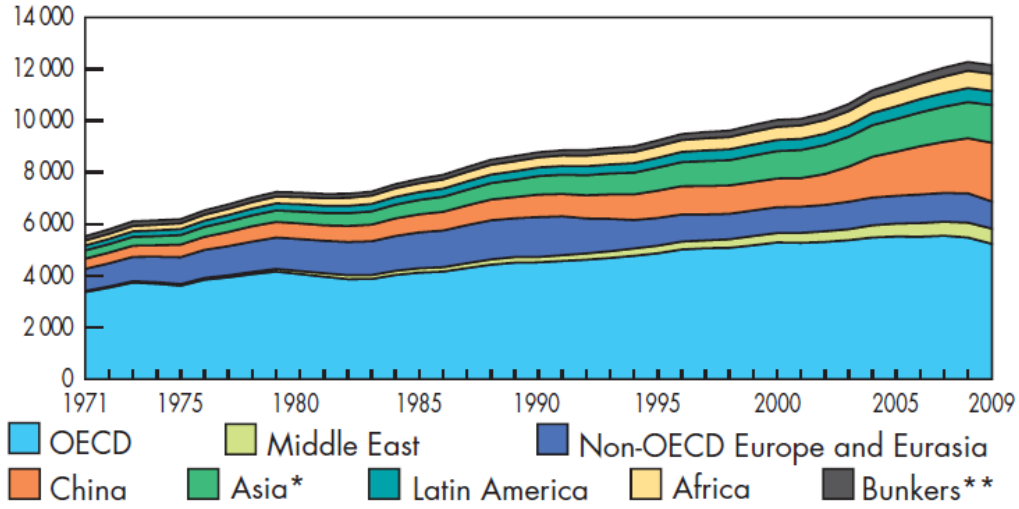
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ENERGY DEMAND x2 IN 40 YEARS



- From 6000 Mtoe to 12 000 Mtoe
- 75% of the increase is from fossil fuels



- Moderate increase in OECD world
- Rapid demand growth outside OECD

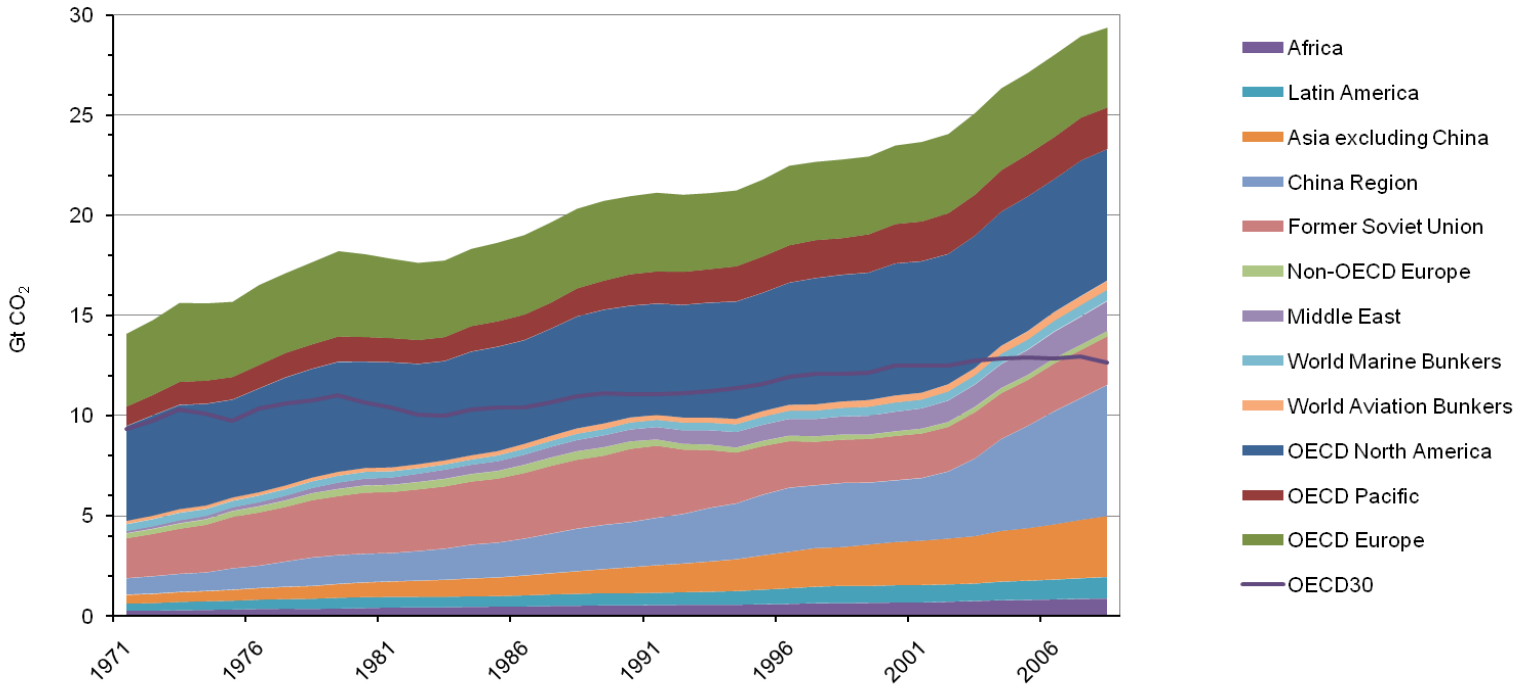
Source: IEA statistics

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GLOBAL CO_2 EMISSIONS DOUBLED

- Global energy-related CO_2 emissions have more than doubled in past 40 years, from 14Gt to 30Gt
- Until very recently, majority of emissions in OECD countries
- Since 2005, non-OECD countries emit more than OECD
- Current CO_2 concentration in atmosphere roughly 390ppm



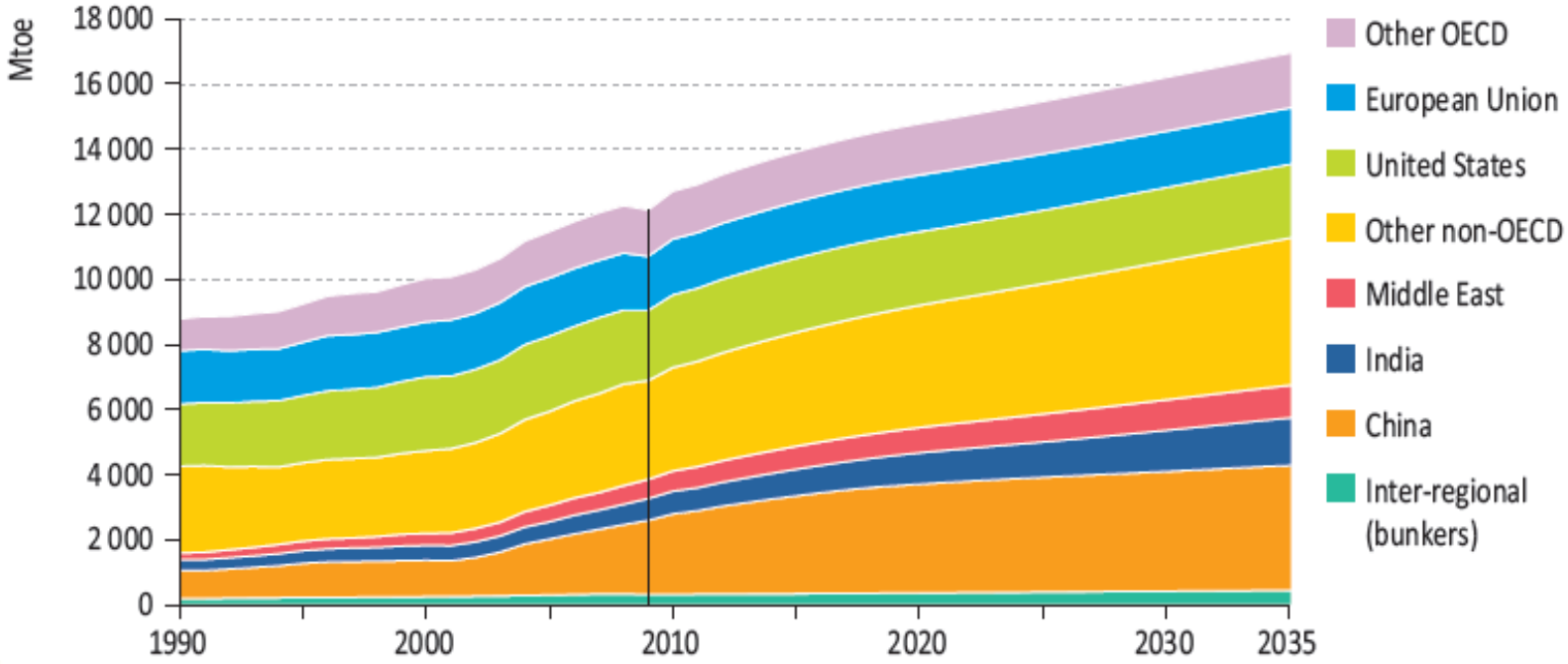
Source: IEA statistics

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ENERGY DEMAND CONTINUES TO GROW

- Energy demand +40% by 2035 (12000 → 17000 Mtoe)
- OECD demand stagnates



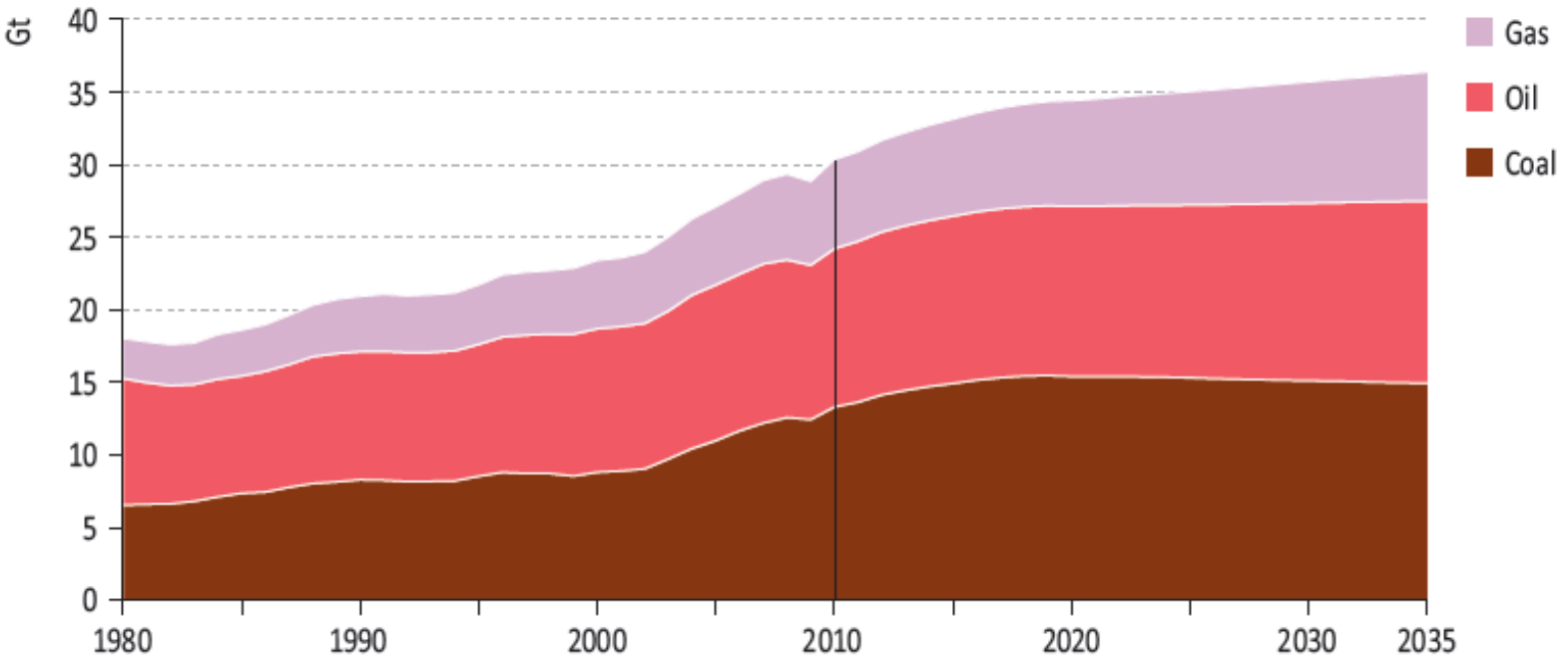
Source: "New Policies Scenario", IEA World Energy Outlook 2011

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CO_2 EMISSIONS CONTINUE TO GROW

- Energy-related CO_2 emissions 36 Gt by 2035
- Gas-related CO_2 emissions grow fastest (1,5%pa), followed by coal (0,5%pa)
- 650ppm CO_2-eq pathway



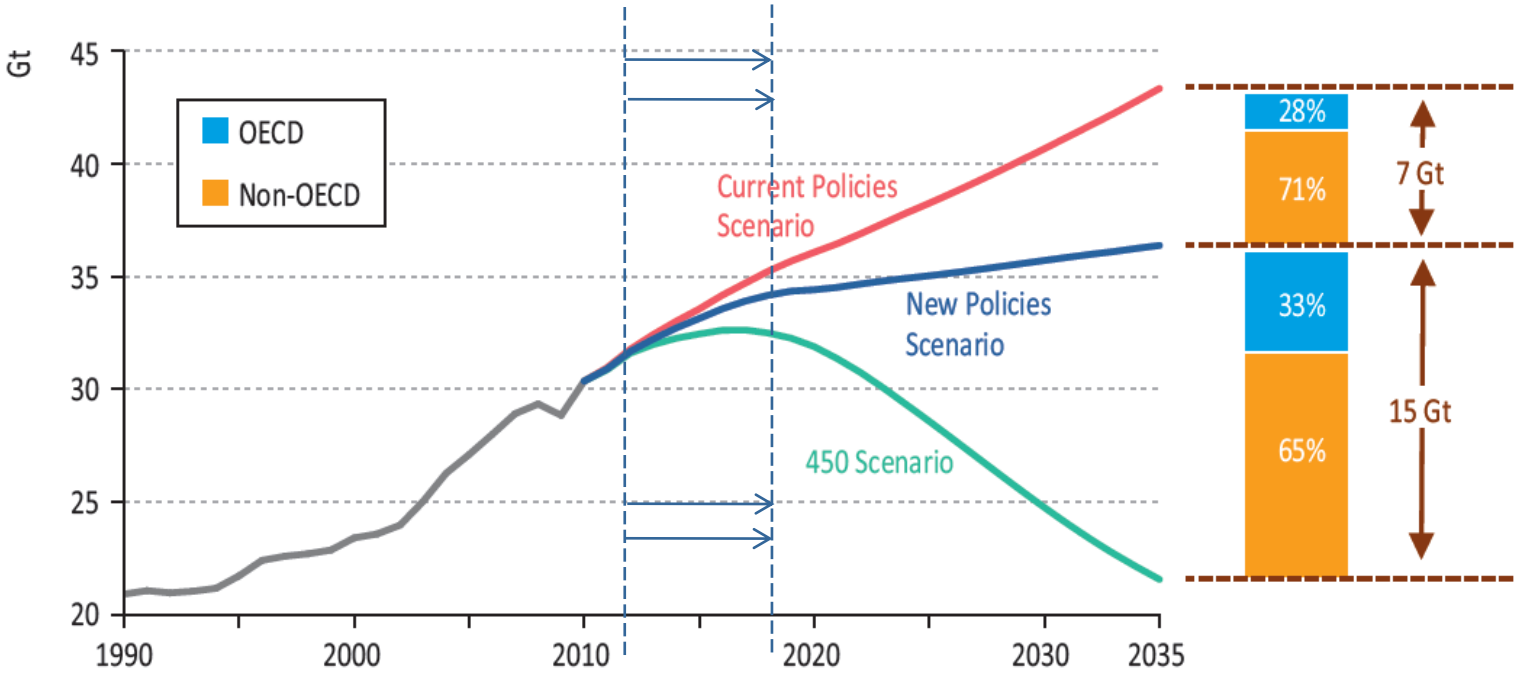
Source: "New Policies Scenario", IEA World Energy Outlook 2011

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TOWARDS SUSTAINABLE FUTURE

- Current policies or "reference scenarios" unsustainable
- Scientific evidence and policy ambitions now often target "450ppm scenarios" (50-50 chance to keep temperature increase at ≤2°C)
- Critical period NOW to establish policy and develop technology



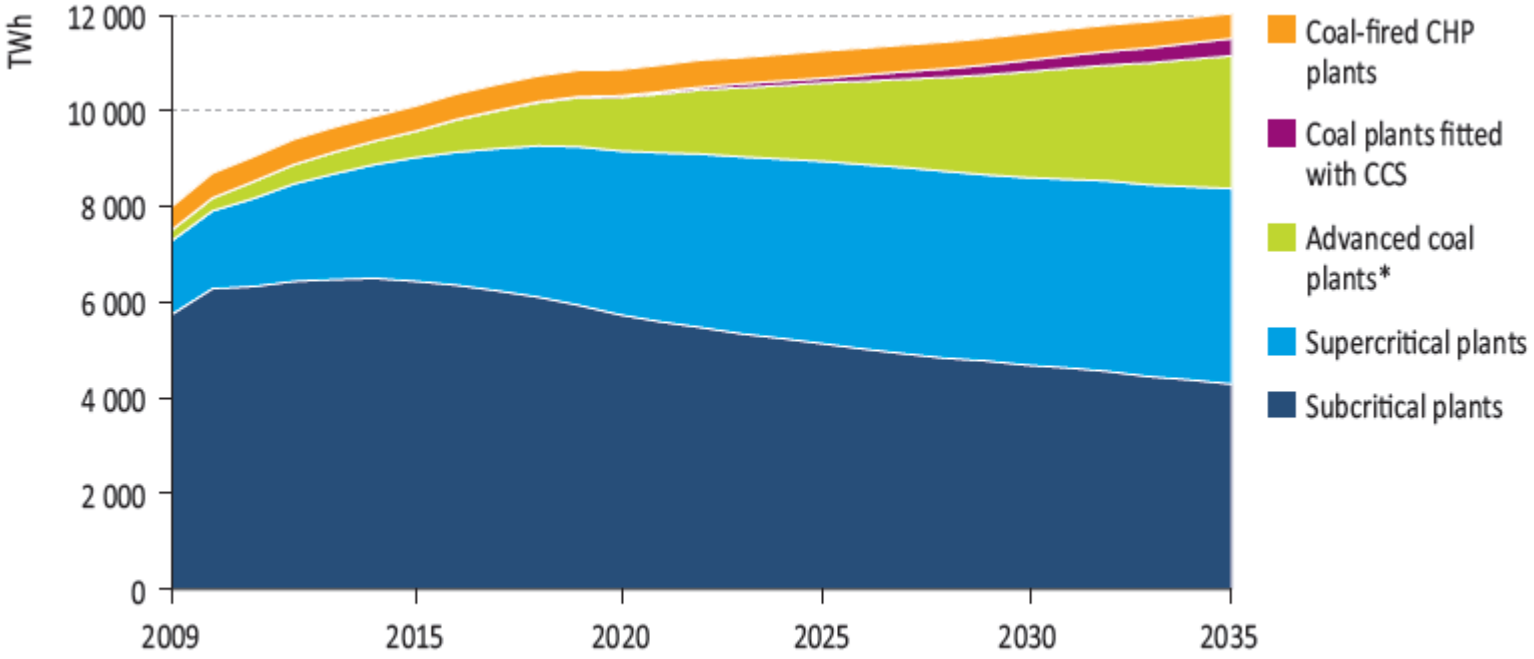
Source: "New Policies Scenario", IEA World Energy Outlook 2011

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CARBON CAPTURE & STORAGE: LIMITED ROLE WITH KNOWN POLICIES...

- Only 65GW of CCS-equipped coal-fired power capacity by 2035
- Share of CCS in coal-fired power remains at 3% in 2035 (and only 1% of total power generation)
- No gas-CCS



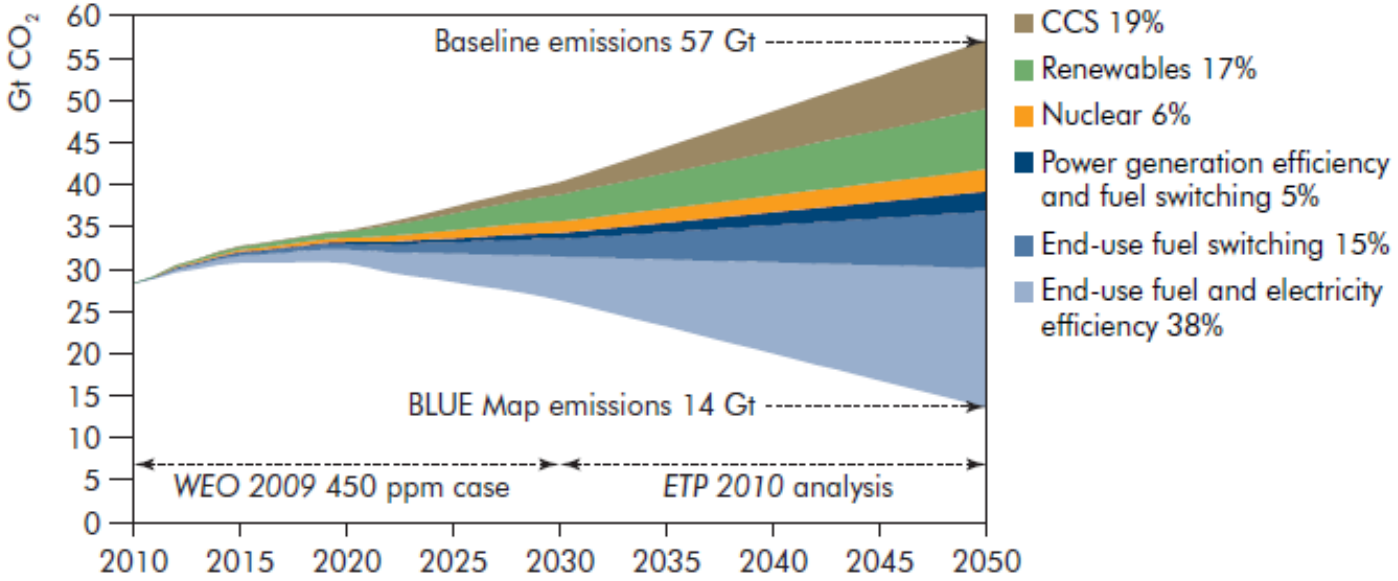
*Advanced coal plants include ultra-supercritical and IGCC plants.

Source: "New Policies Scenario", IEA World Energy Outlook 2011

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… BUT CRITICAL IN "450" SCENARIOS



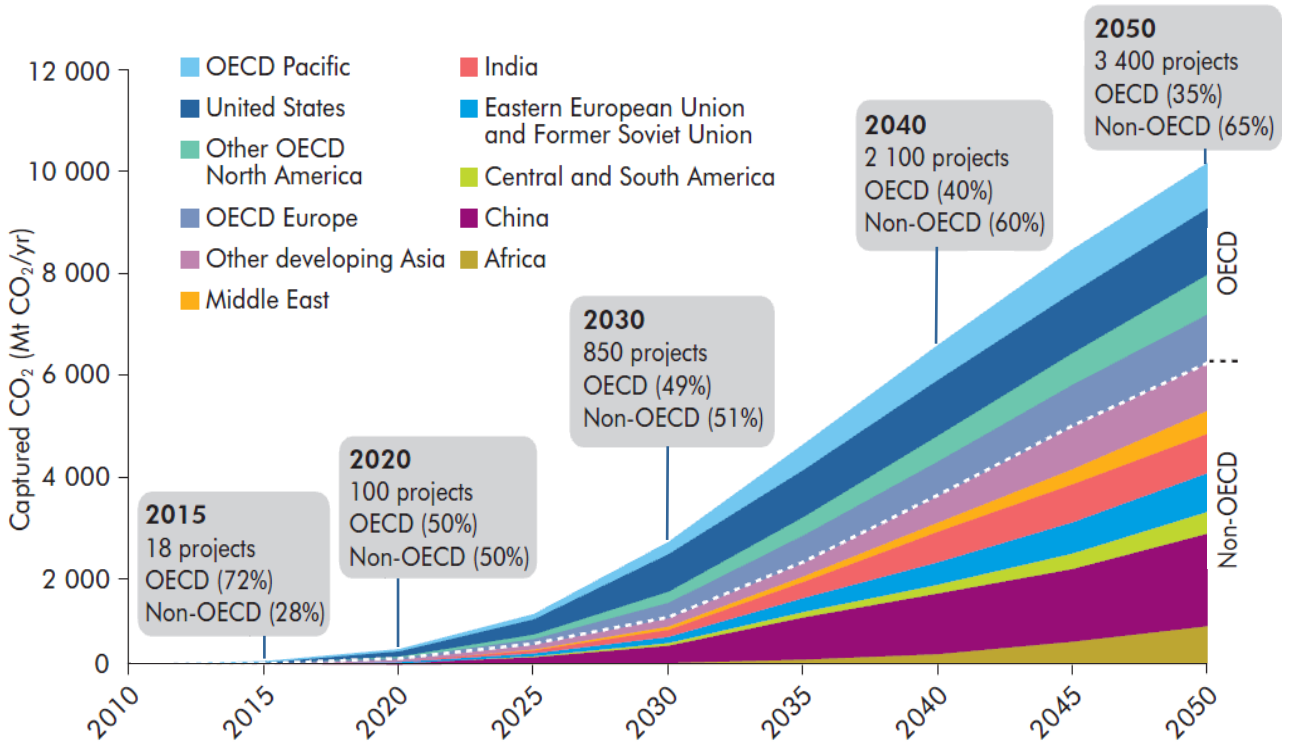
- IEA analysis assigns critical role for CCS in a least-cost pathway to reaching 450ppm scenario
- Role of CCS increases after 2030 → contributes 1/6 of total needed reductions against baseline 2010-2050
- 450ppm achievable without CCS, but at higher cost
- Stronger reliance globally on gas replacing coal is alone not enough to stabilise emissions

ENERGY TECHNOLOGY PERSPECTIVES 2010

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THE POTENTIAL OF CCS?

- 3000+ projects across the globe
- 3000+ across industries: CCS not only about coal-fired power
- 150Gt CO_2 captured and stored



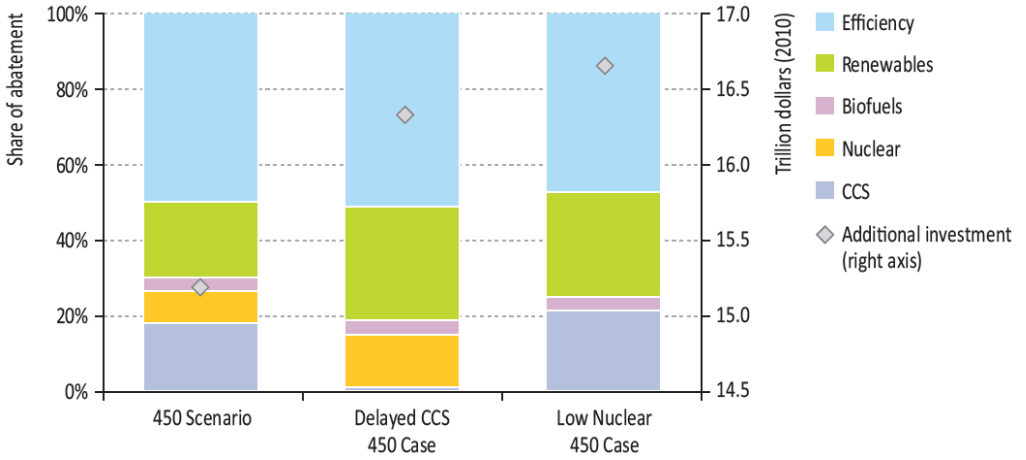
Technology Roadmap
Carbon capture and storage

ENERGY TECHNOLOGY PERSPECTIVES 2010

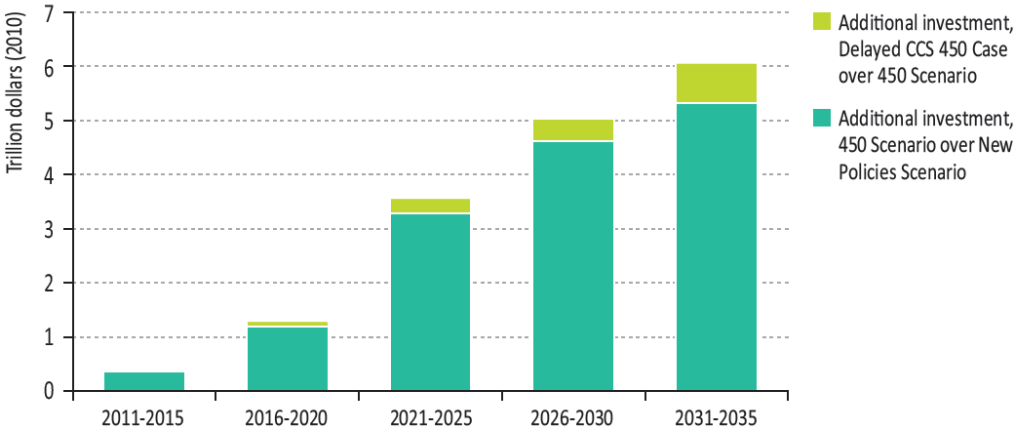
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IF CCS IS DELAYED UNTIL 2030...



- Abatement shifts to renewables and nuclear
- A further energy efficiency boost will be increasingly challenging



- Cost increase: 1.14 trn USD additional investment

Source: IEA World Energy Outlook 2011

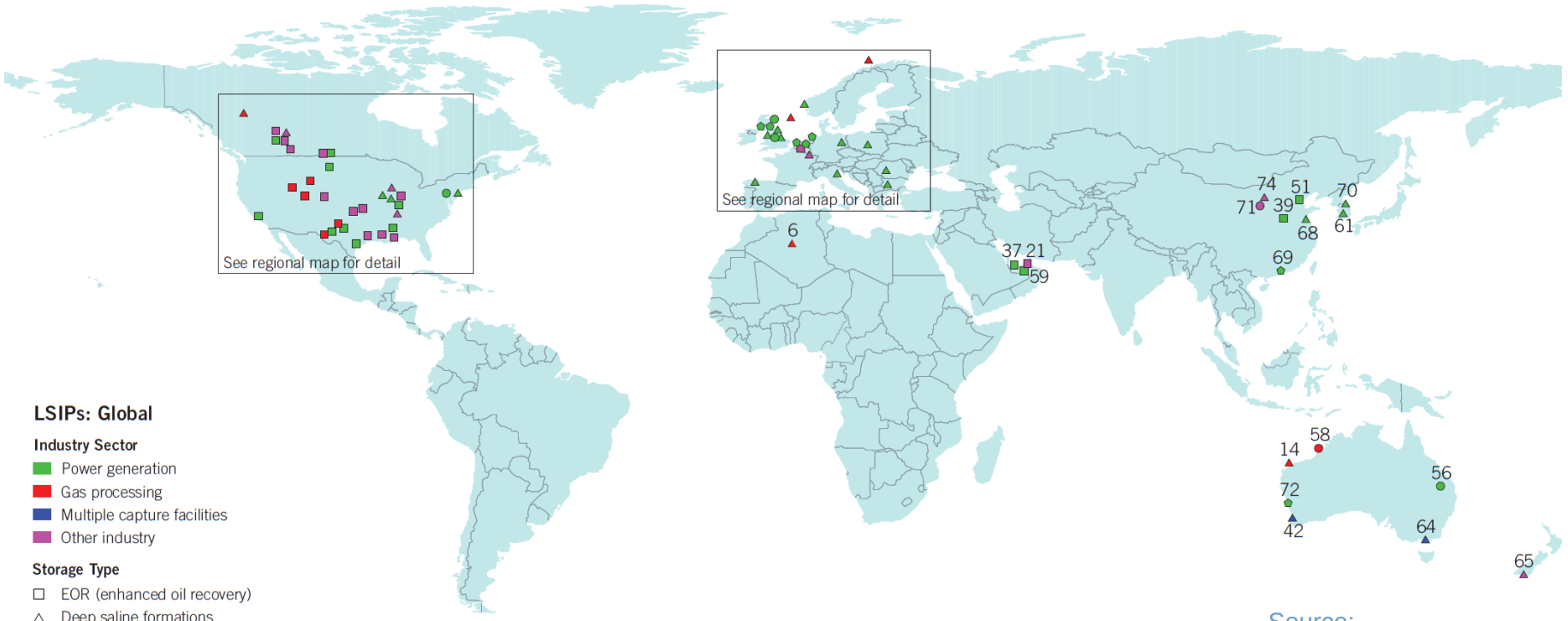
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… PLANNED Projects

Over 60 integrated large-scale projects in various stages of development

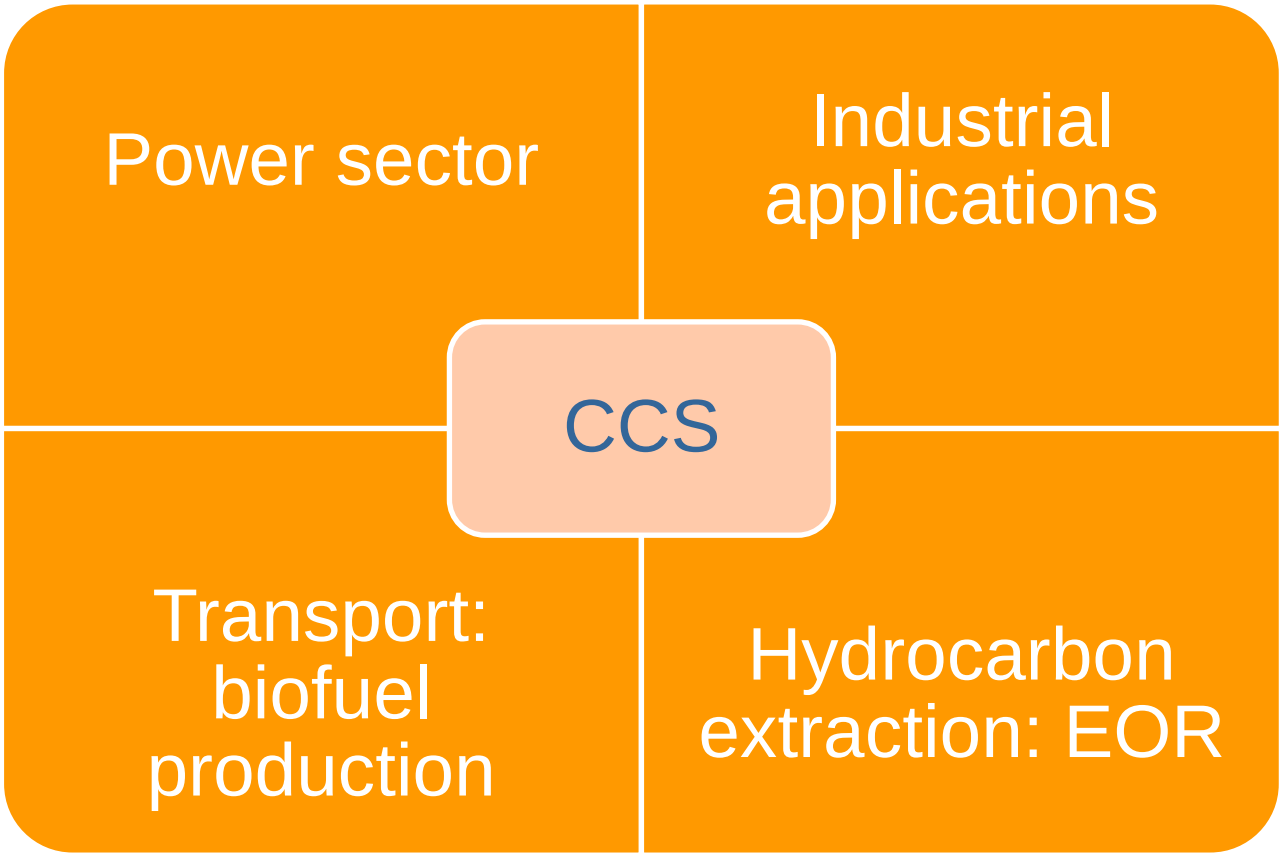


Source:

GLOBAL CCS INSTITUTE

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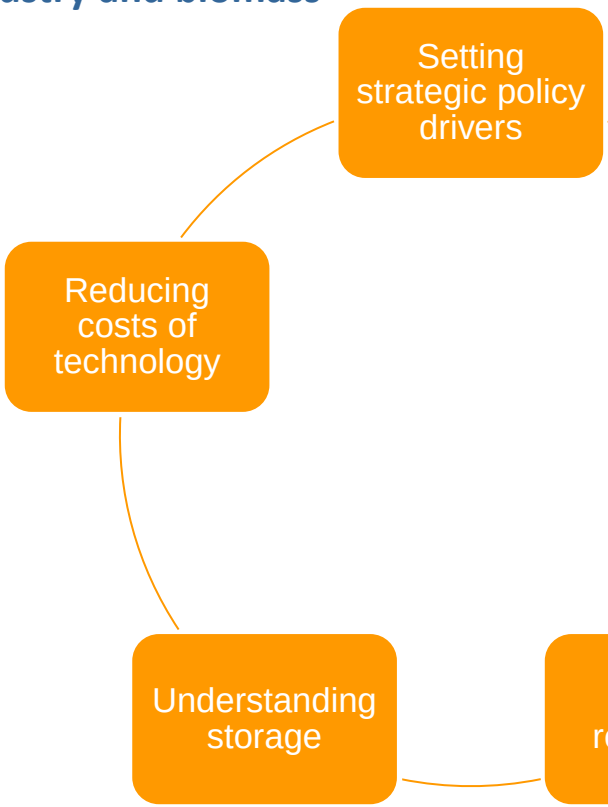
CCS CUTS ACROSS VARIOUS SECTORS



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CHALLENGES REMAIN FOR CCS

- Firm decisions to address climate change
- Understanding of CCS and recognition of its role
- CCS in industry and biomass



- CAPEX, OPEX
- Market dynamics, incl. impact of cheap gas
- Industrial deployment bottlenecks
- Infrastructure planning and coordination

- Existing public support 23 bn USD globally
- Need to mobilise 5 trillion USD 2010-2050
- OECD – non-OECD
- Incentive policy pathways

- Knowledge on storage capacity
- Time required for storage site development
- Long-term liability
- Public acceptance

- OECD vs. non-OECD countries
- International legal issues e.g. London Protocol and OSPAR

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SUMMING UP

- Global energy demand and emissions continue to grow
- Role of CCS is important in any ambitious scenario: it has potential to deal with 1/6 of needed emission reductions by 2050
- This potential WON'T be realised if the world does not adopt policies towards 450ppm type outcomes
- This potential MAY be realised, if ambitious policy and incentives exist… and other challenges are solved

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Thank you!

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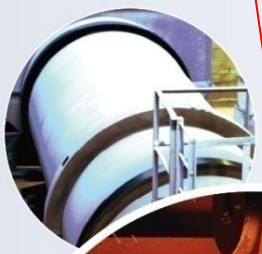
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Backup slides

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Launched 19 September in Beijing







Technology Roadmap

Carbon Capture and Storage in Industrial Applications

International Energy Agency

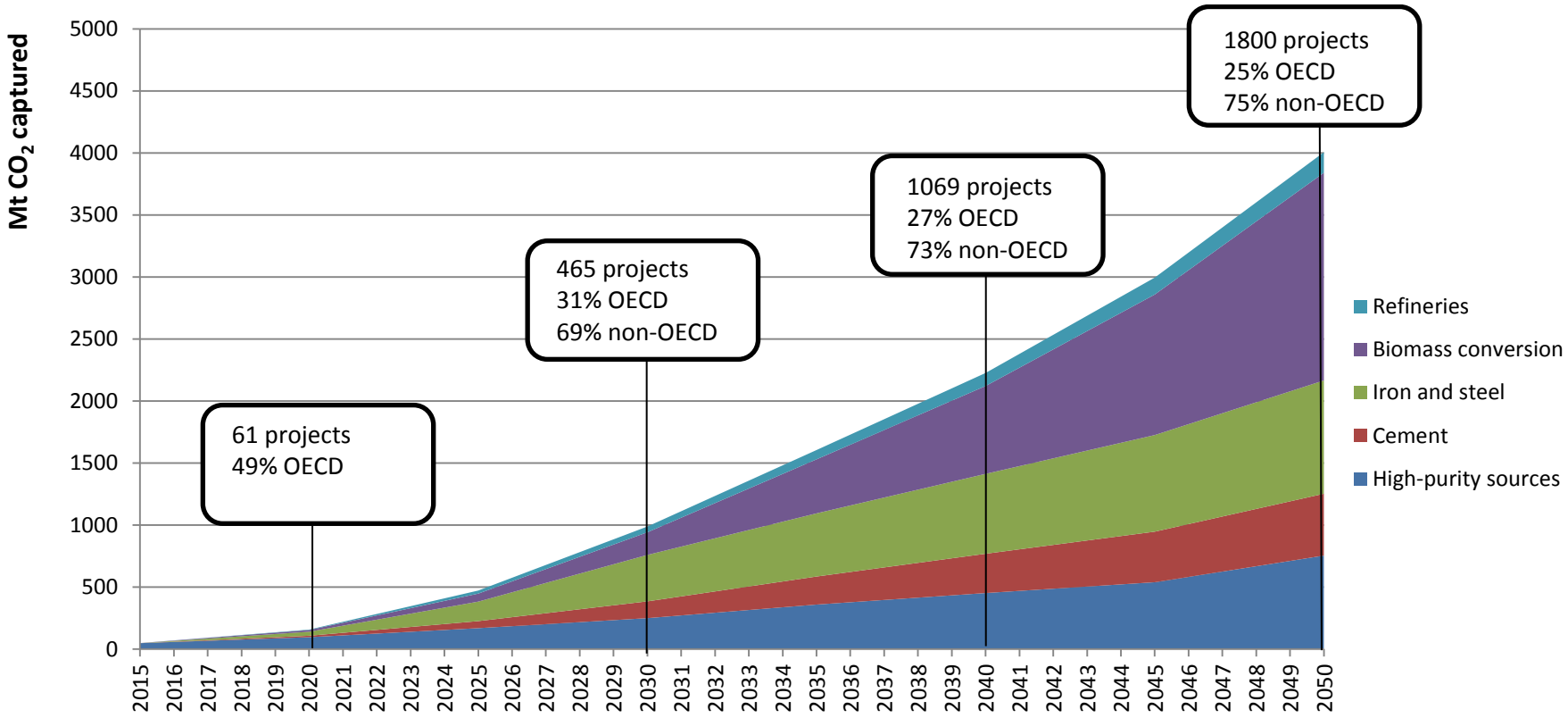
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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ROLE OF CCS IN THE FIVE COVERED SECTORS CAN BE VERY SIGNIFICANT:

→ CCS could cut emissions by 4Gt in 2050

→ 9% of the global required emission reductions in 2050

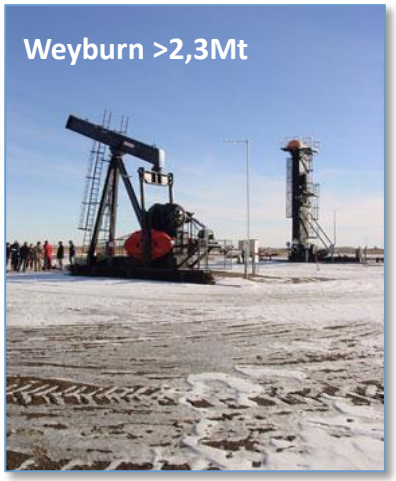


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CO_2 IS CAPTURED AND STORED AS WE SPEAK…











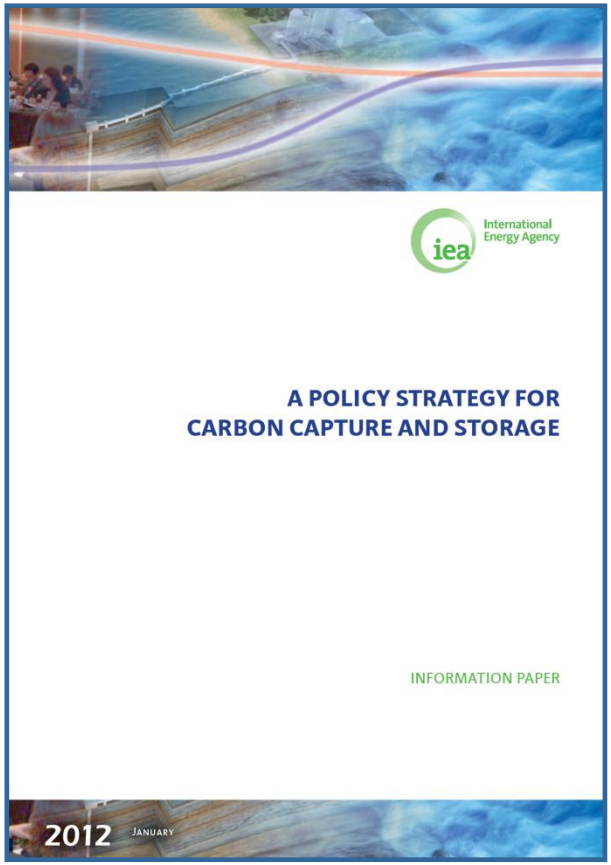
- Five to eight (5-8) integrated large-scale projects are currently storing >5Mt CO2 per year;
- Another six (6) projects under construction
- Several smaller-scale pilot installations across the globe
- Applied R&D by government, industry and research community
- Academic research into capture, transport and storage technologies and related sciences

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NEW REPORT: "A Policy Strategy for CCS"



- Policy objectives will evolve over time
- Incentive policy to match policy objectives and suit level of technical maturity
- Interactions between incentive mechanisms
- Long-term strategy and "policy gateways"

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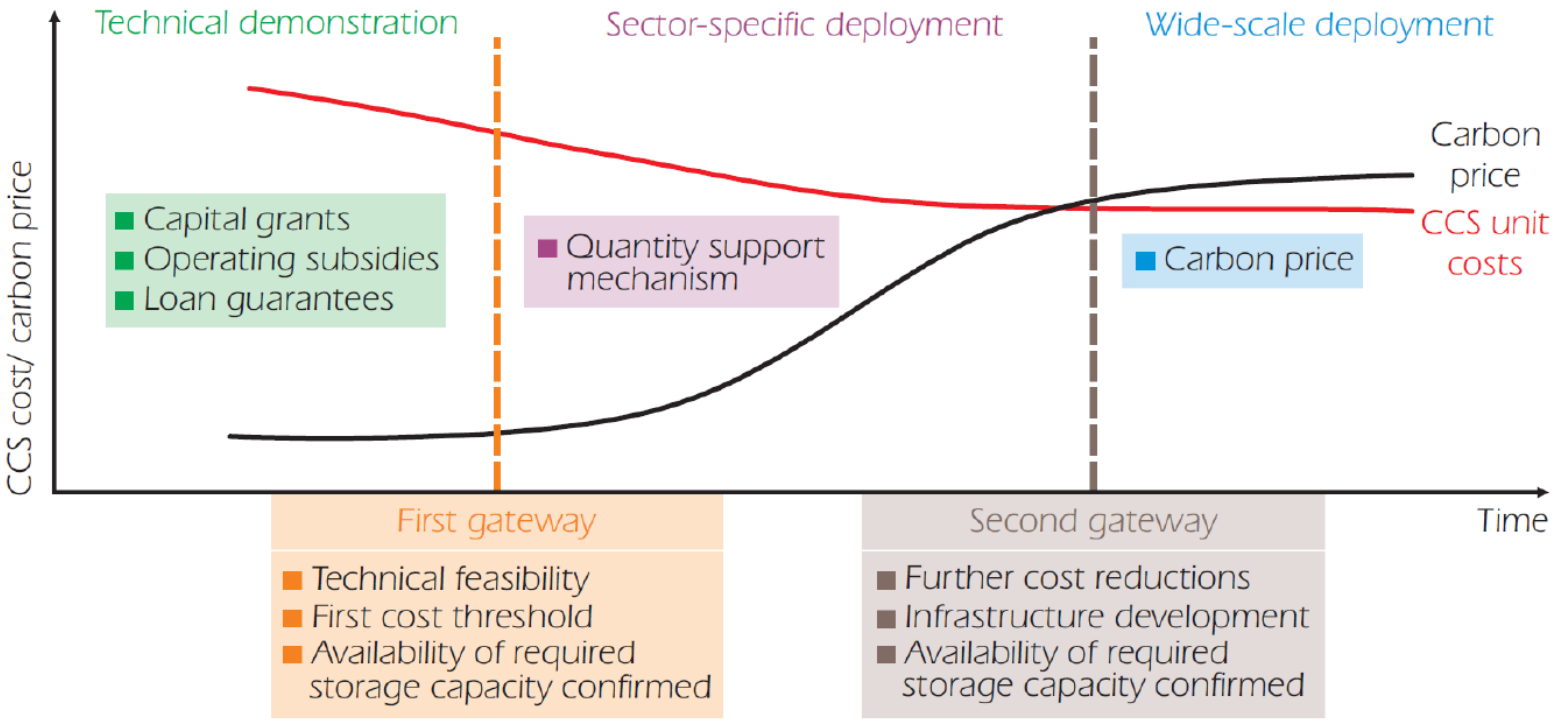
POLICIES TO ADDRESS DIFFERENT OBJECTIVES

Reducing emissions	Technology learning	Access to capital markets
Cap and trade	Capital grant	Co-investment equity
Carbon tax	Production subsidy	Provision of debt
Baseline and credit	Investment tax credit	Credit guarantees
Feebate	Production tax credit	Insurance products
Emissions performance standard	Feed-in tariff	
CO2 purchase contract	Premium feed-in tariff	
	Portfolio standard	

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POLICY ARCHITECTURE AND GATEWAYS



Long-term policy architecture can enhance credibility and effectiveness

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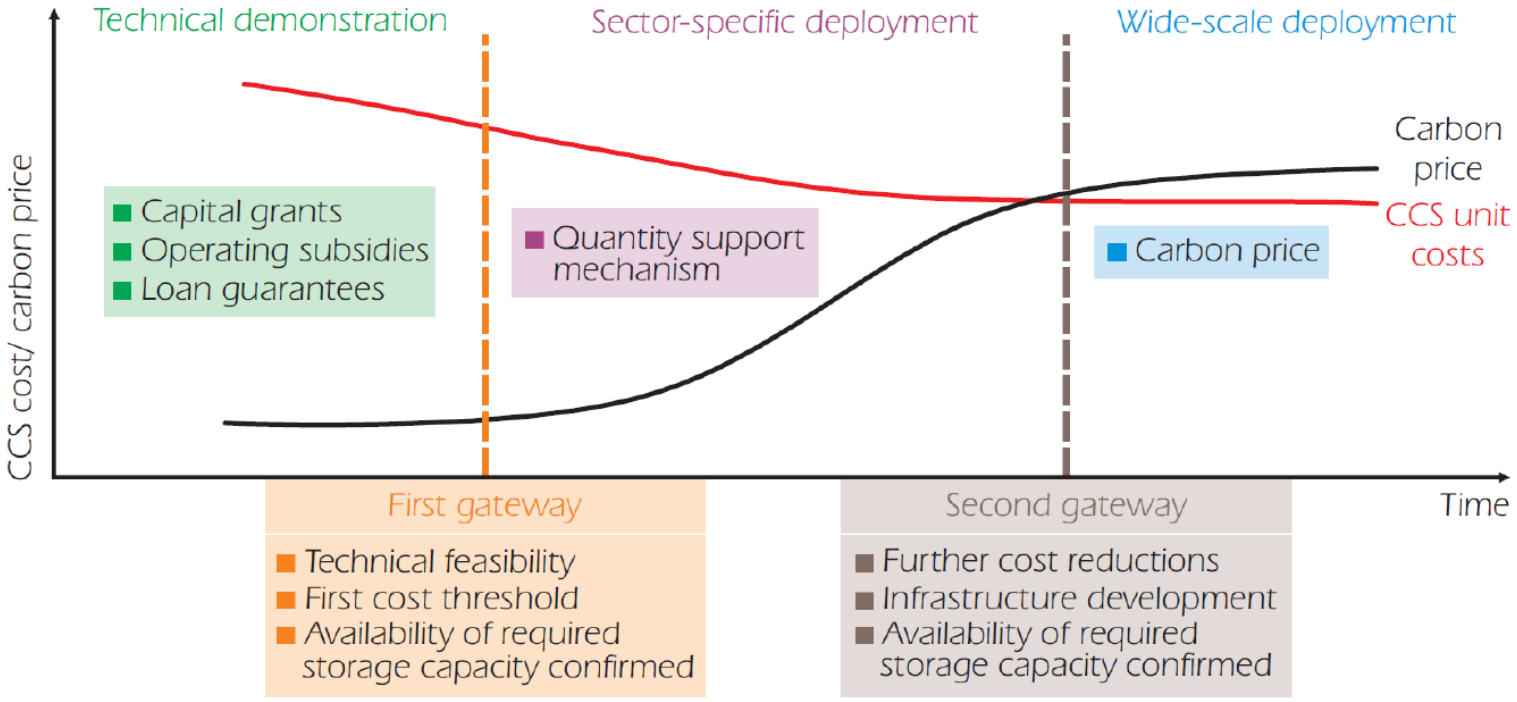
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EXAMPLES OF CURRENT INCENTIVE POLICIES

US: Demo funding
EU: NER300, EEPR
AUS: Flagship pr.
UK: CCS competition
NO: Mongstad
Etc..

UK: 2011 Electricity Market Reform

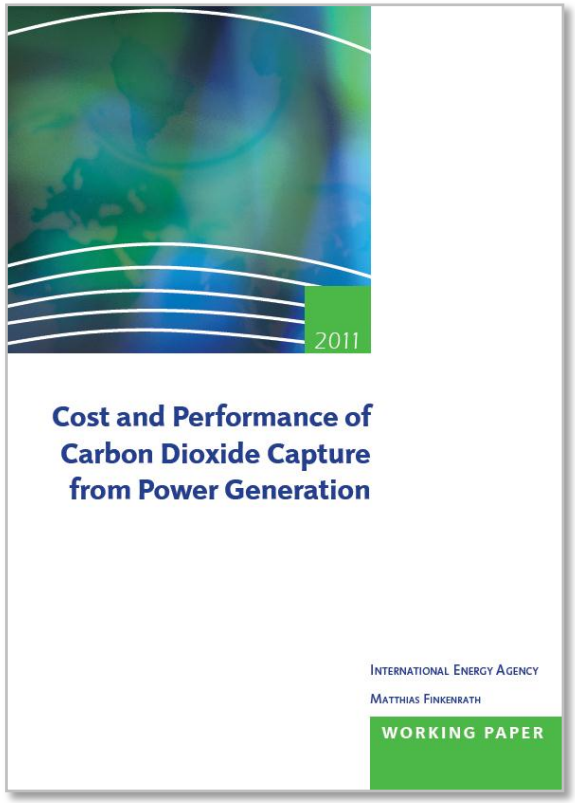
NO: Carbon tax
US: EOR projects



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Cost of CCS in power generation



Re-evaluated engineering study data of various institutions

- *Carnegie Mellon University*
- *China-UK Near Zero Emissions Coal Initiative*
- *CO_2 Capture Project*
- *Electric Power Research Institute*
- *Global CCS Institute*
- *Greenhouse Gas Implementing Agreement*
- *National Energy Technology Laboratory*
- *Massachusetts Institute of Technology*

→ **Cost and performance estimates for more than 50 capture installations across all capture routes**

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EARLY COMMERCIAL PLANTS

Summary of results (OECD countries)

Fuel	Coal *(similar for all capture routes; relative to a pulverized coal baseline)*	Natural gas *(post-combustion)*
Efficiency penalty	10 %-points	8 %-points
Capital costs	3 800 USD/kW (74% increase)	1 700 USD/kW (82% increase)
Cost of CO_2 avoided	55 USD/tCO_2	80 USD/tCO_2

Notes: Averages figures for OECD countries shown (costs in China estimated to be about half), capital costs are overnight costs

Not yet included (since site-specific):

CO_2 transport & storage cost and performance impact

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CONCLUSIONS FROM REPORT

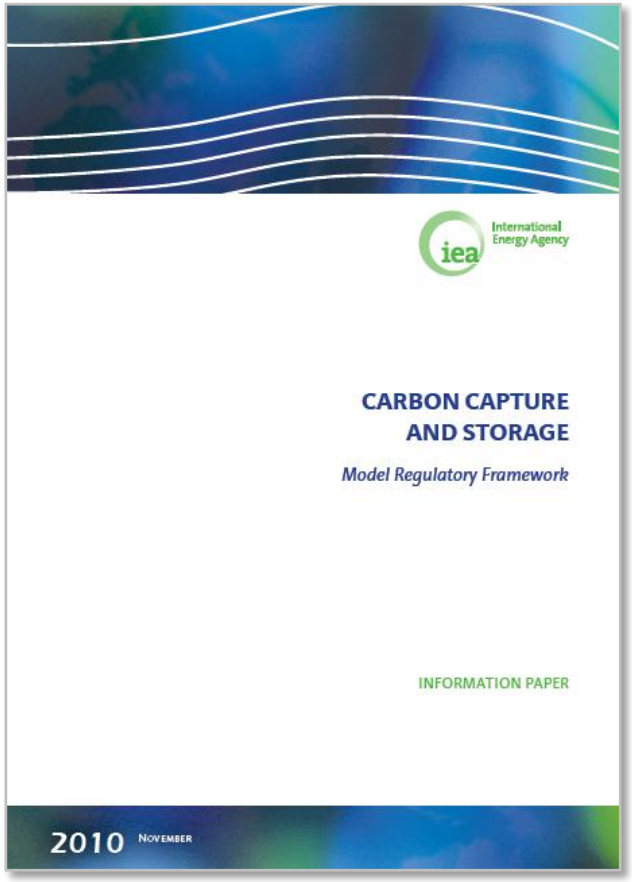
- **No single technology outperforms** alternative routes **for coal-fired power generation**
- **Variability** between and **uncertainty** of costs remains **significant**
- **Harmonisation** of costing methodologies and formats of reporting data is desirable in order to increase transparency
- **Suggested additional analysis**
  - Quantifying differences between generic cost estimates and project- and site-specific costs of CO_2 capture projects
  - bioenergy with CCS (BECCS)
  - applications in non-OECD countries

Free download of study on IEA and OECD homepages
Contact: matthias.finkenrath@iea.org

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IEA CCS Regulatory Work



- 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

Key CCS a regulatory issues

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	