Copenhagen and decarbonising the power sector

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Agenda

- Decarbonising power generation
- A detailed look at CCS
- Copenhagen – the sequel

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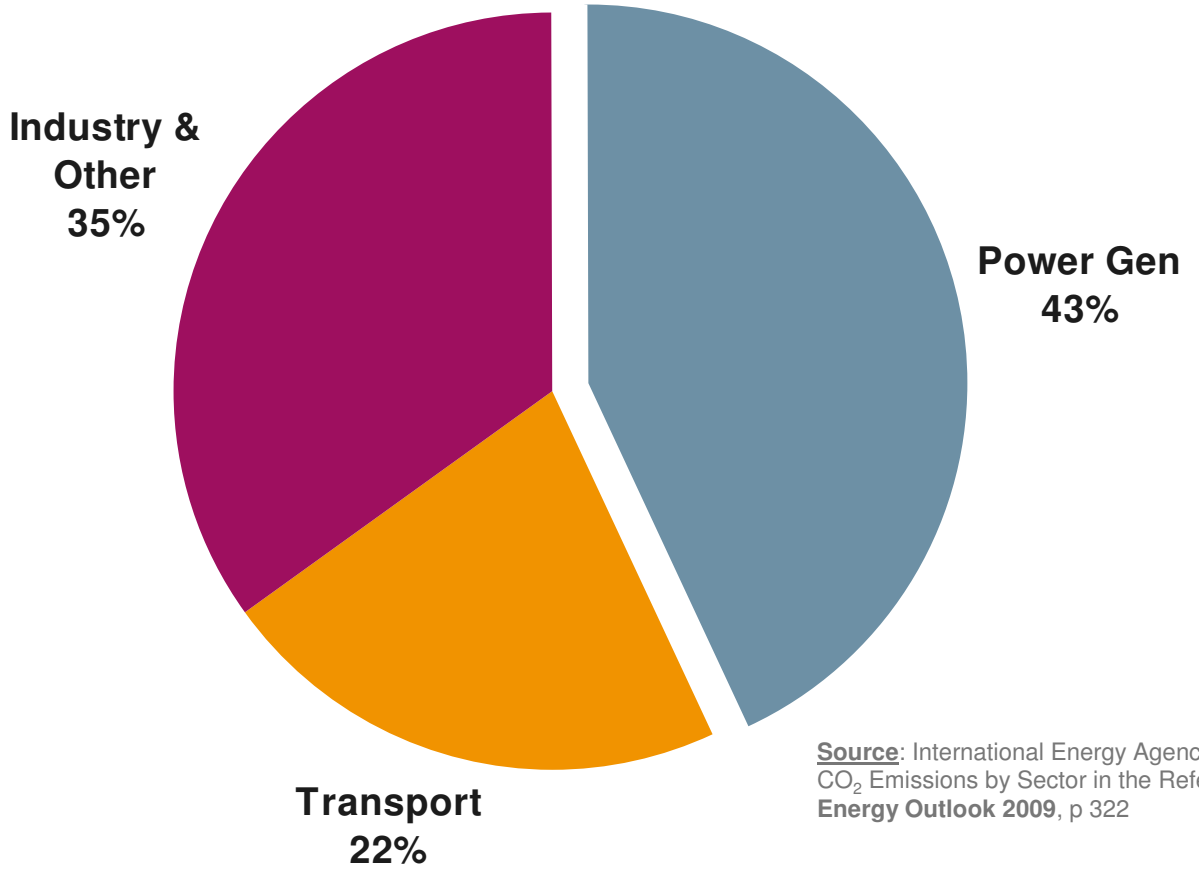
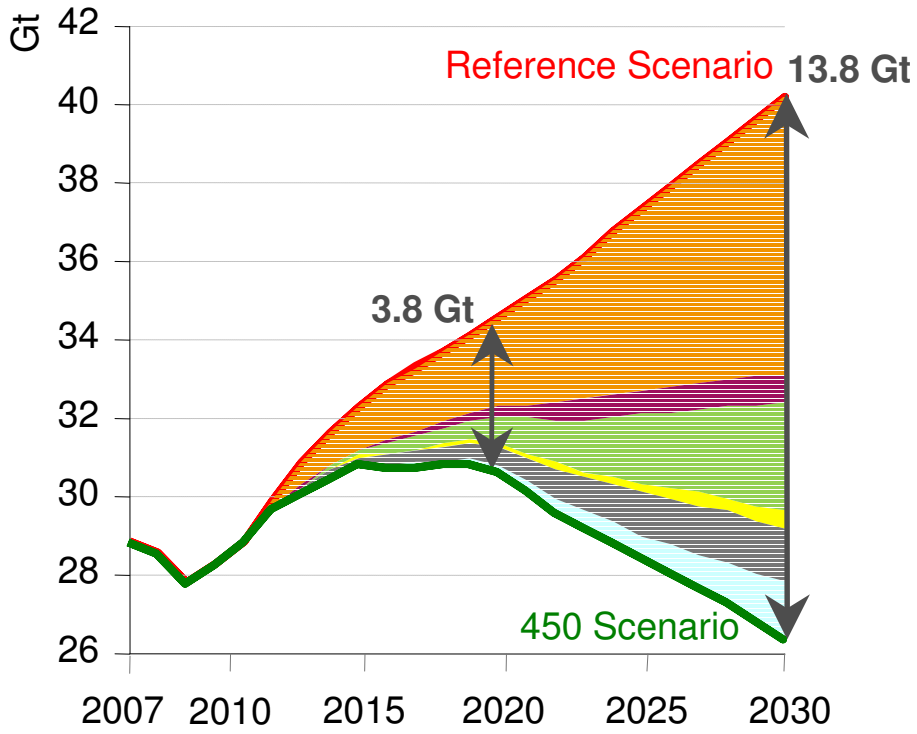
CO_2 global emissions by sector



Source: International Energy Agency, "World Energy-Related CO_2 Emissions by Sector in the Reference Scenario," **World Energy Outlook 2009**, p 322

Power generation is the main CO_2 contributor

World abatement of energy-related CO2 emissions

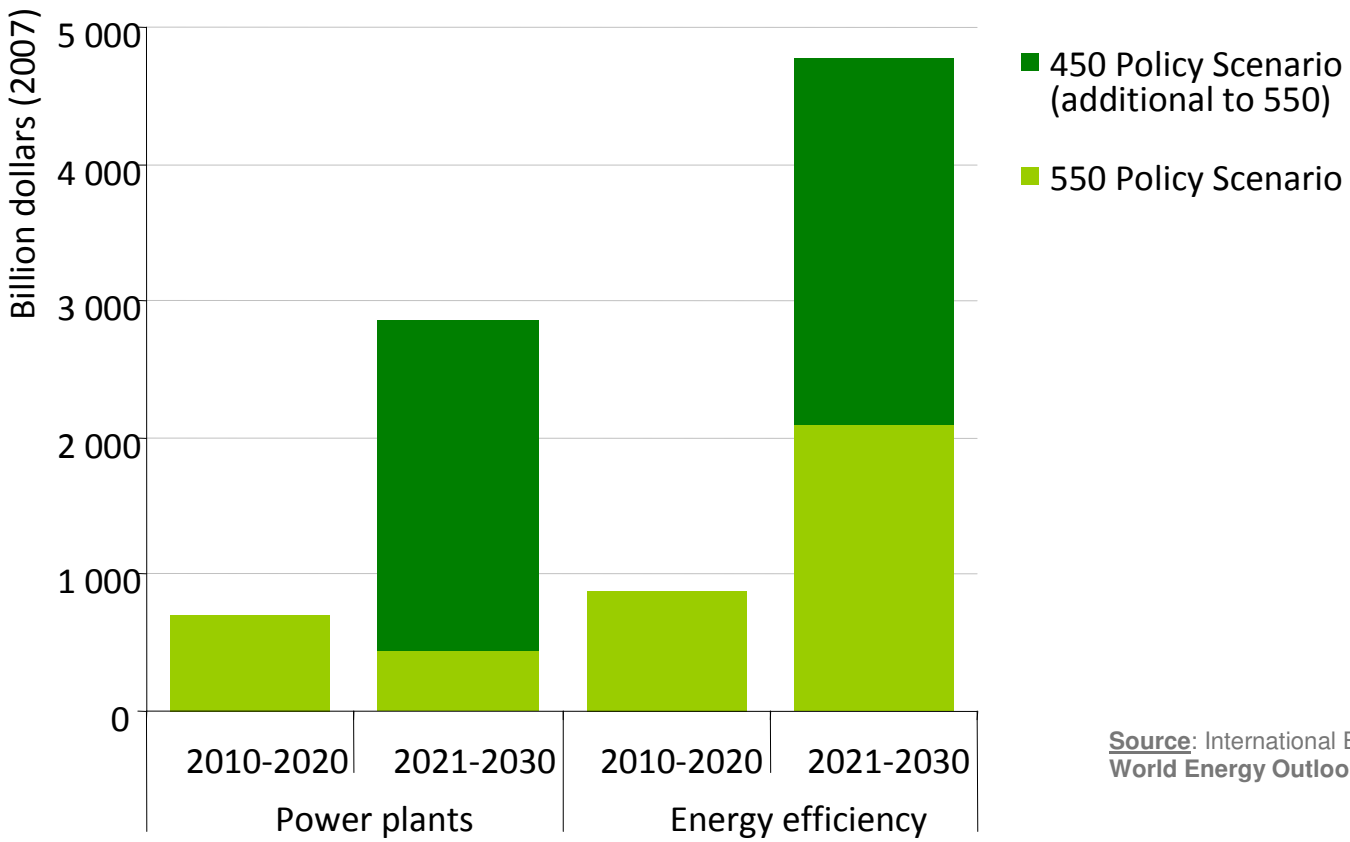


Share of abatement %

	2020	2030
Efficiency	65	57
1. End-use	*59*	*52*
2. Power plants	*6*	*5*
Renewables	18	20
Biofuels	1	3
Nuclear	13	10
CCS	3	10

Source: International Energy Agency, "World abatement of energy-related CO2 emissions in the 450 Scenario," **World Energy Outlook 2009**

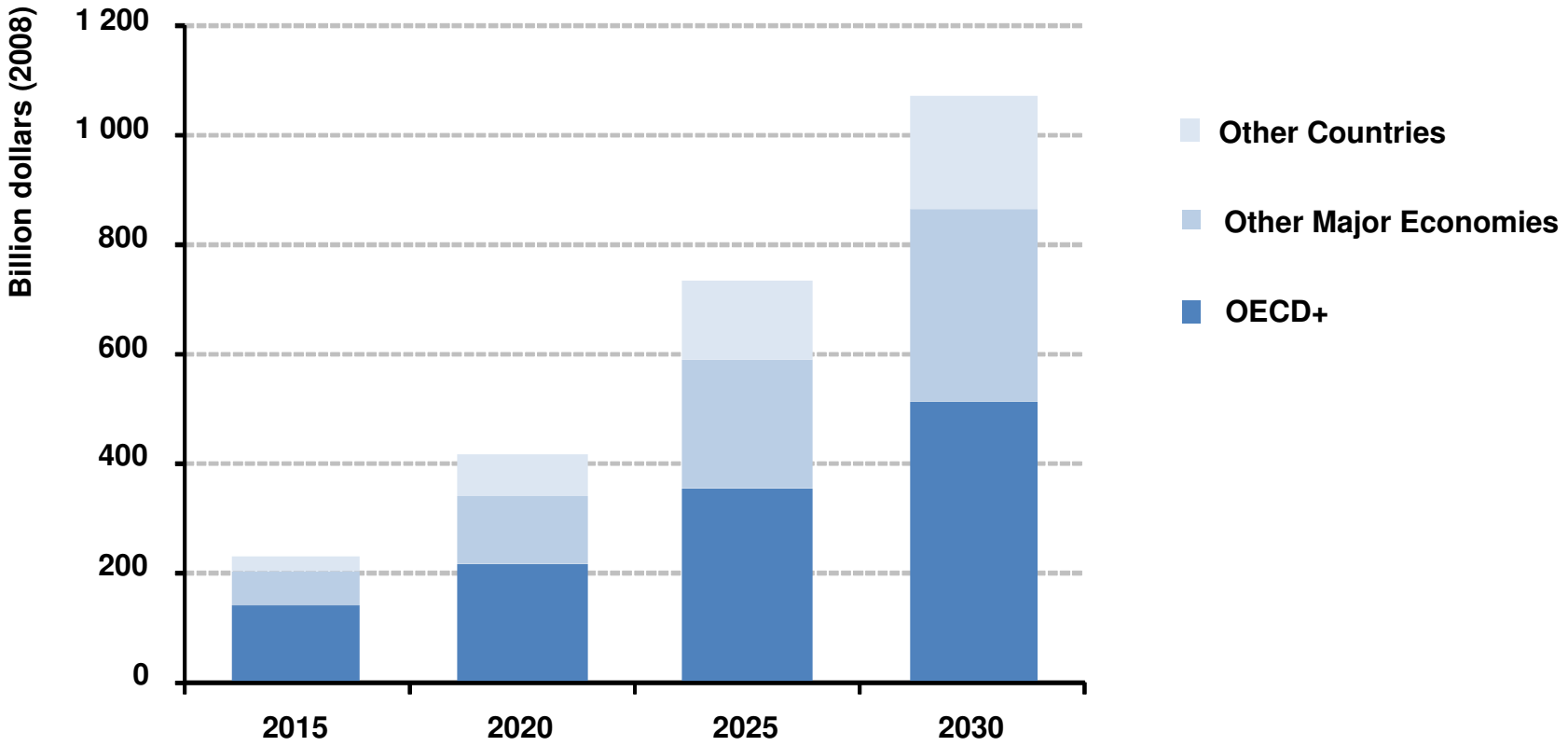
Additional investments in the climate-policy scenarios versus the Reference Scenario



Source: International Energy Agency, **World Energy Outlook 2008**

Power-sector investment in the last decade of the Outlook period in the 450 Policy Scenario is almost double that in the Reference Scenario

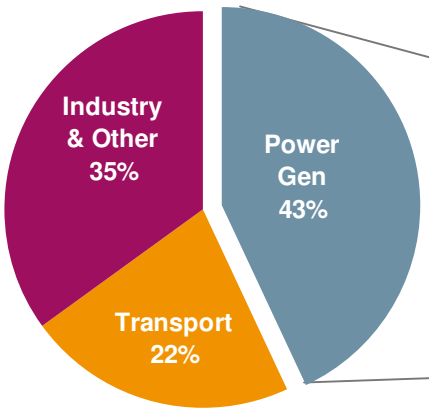
Additional investments in the 450 versus the Reference scenario



Source: International Energy Agency, "Additional energy investment in the 450 Scenario relative to the Reference Scenario," **World Energy Outlook 2009**

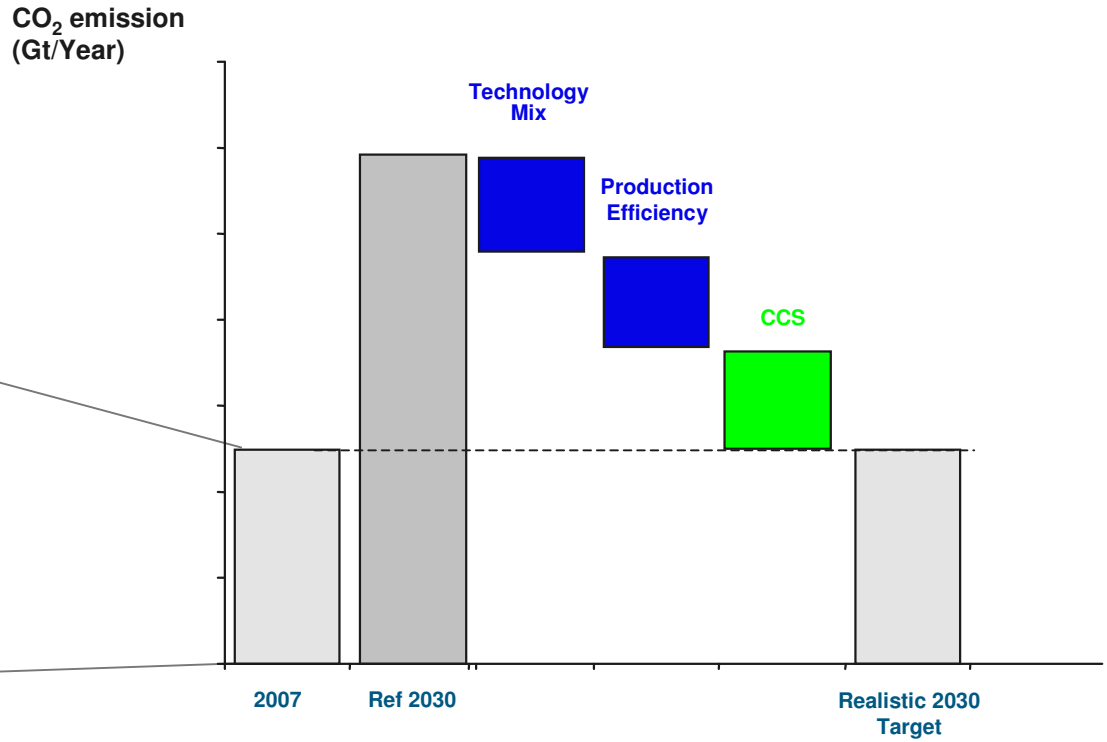
CO_2 emissions by energy use

CO_2 global emissions per Sector



Source: International Energy Agency, "World Energy-Related CO_2 Emissions by Sector in the Reference Scenario," **World Energy Outlook 2009,** p.322

Power sector-related CO_2 emissions



Source: Alstom Power analysis

Alstom's Three Pillar Approach

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- **Technology Mix**
  - Nuclear ✓
  - Renewables ✓
- **Production Efficiency**
  - Fuel Preparation/Retrofit ✓
  - New generation plants ✓
  - Energy management ✓
- **Carbon Capture and Storage** ✓

Source: Power Systems analysis

Our solutions:
Technologies adapted to all energy sources

Gas

Coal

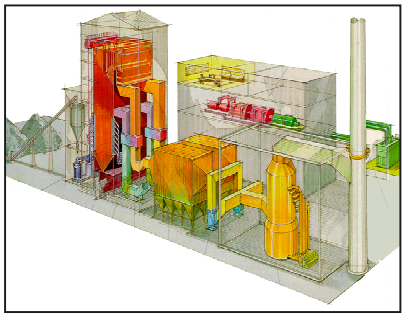
Oil

Hydro

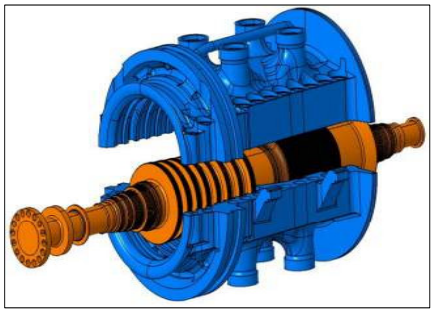
Nuclear (Conv. Island)

Wind

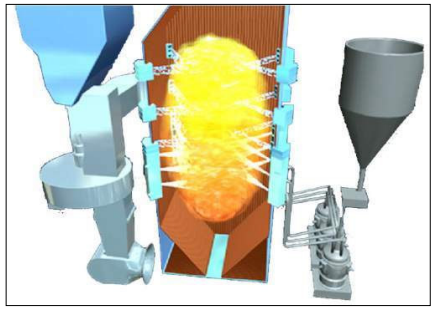
Production efficiency: retrofit



Plant Optimisation:
-5% CO_2



Turbine retrofit:
-5% CO_2

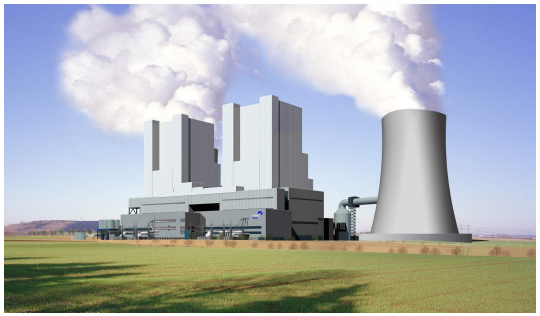


Boiler retrofit:
-3% CO_2

Retrofit can avoid up to 13% CO2

60% of CO2 emitted in 2030 will come from existing plants

Production efficiency: new plants



	Coal	Gas
↗ Efficiency	30% to 50%	40% to 60%
↘ CO_2 emissions	40%	33%

60% of the 2030 plants still to be built

Generation efficiency in Europe

- Retrofit/repower existing plant
- BAT on new plant
  + some other changes

→ > 20% of EU ETS reductions required by 2020

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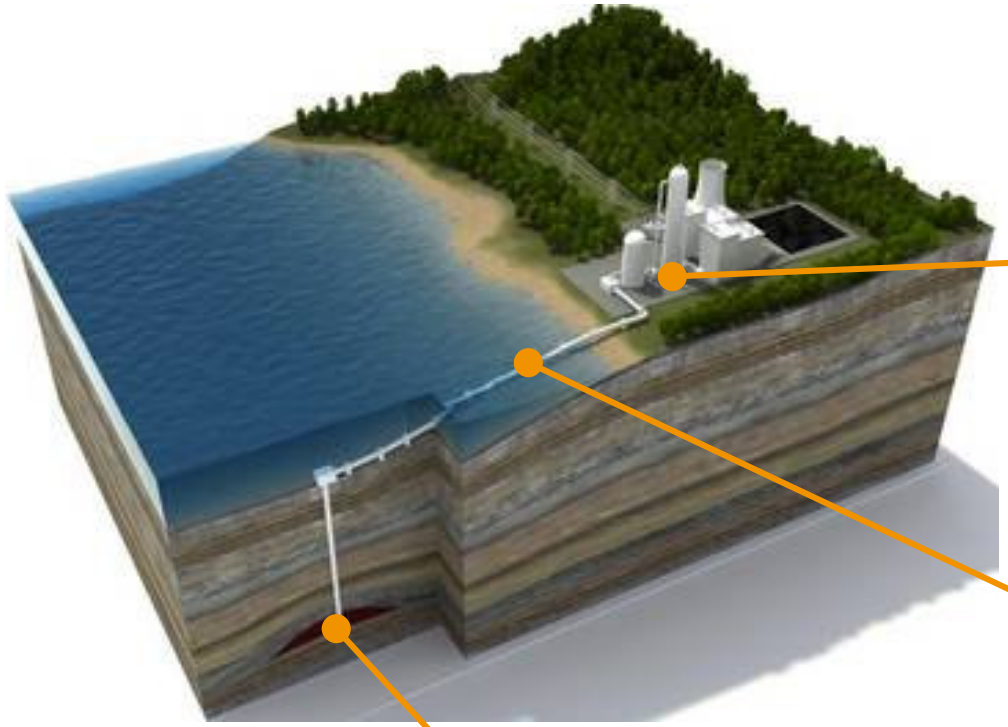
Carbon Capture and Storage
In a nutshell



Capture
Power plants

Transport
Pipelines
Ships

Storage
Depleted Oil and Gas fields
Enhanced Oil/Gas Recovery
Saline Aquifers

Carbon Capture and Storage
CO2 Capture Solutions Choices

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Power Plant with CO2 capture

Post-combustion

(New + retrofit)

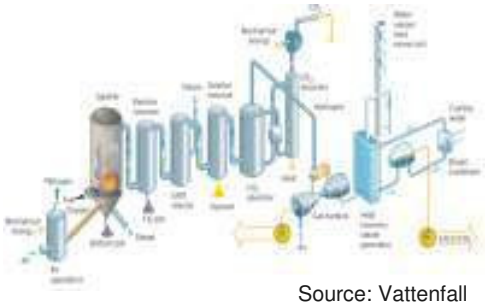
Oxy-combustion

(New + retrofit)

Solutions developed by Alstom

Pre-combustion

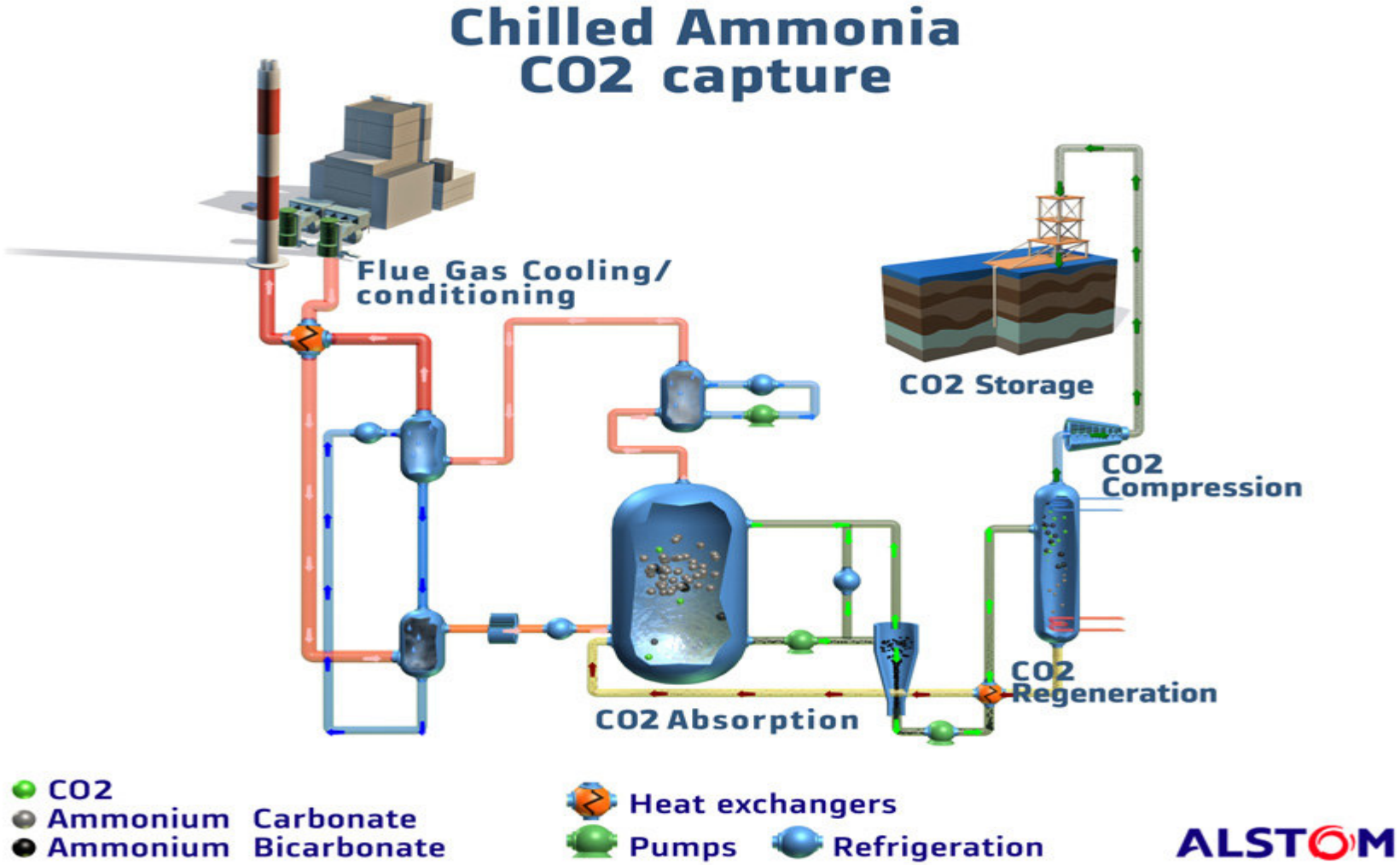
(New only)



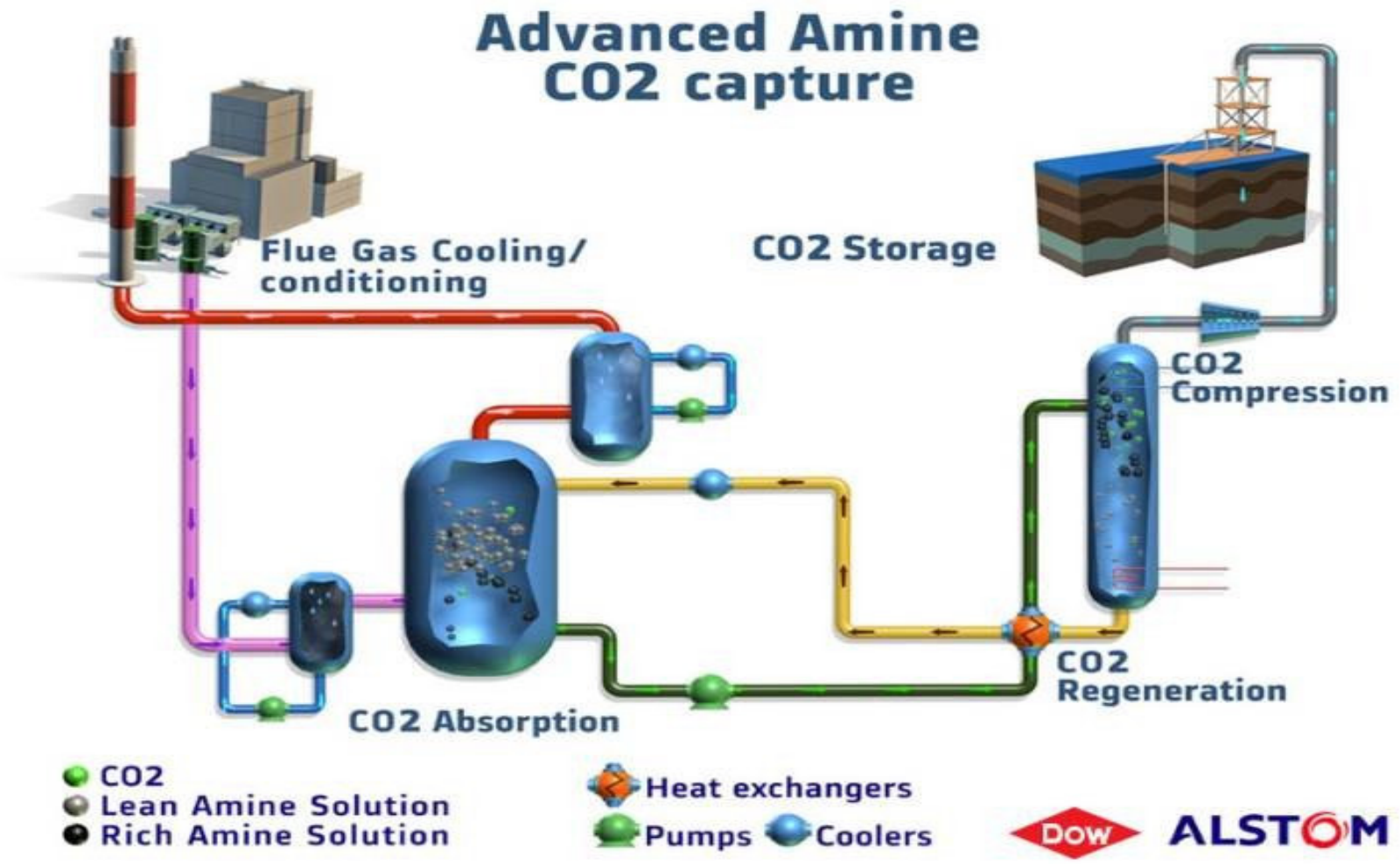
Source: Vattenfall

CCS must be also applied to the installed base

Post Combustion - Chilled Ammonia Process

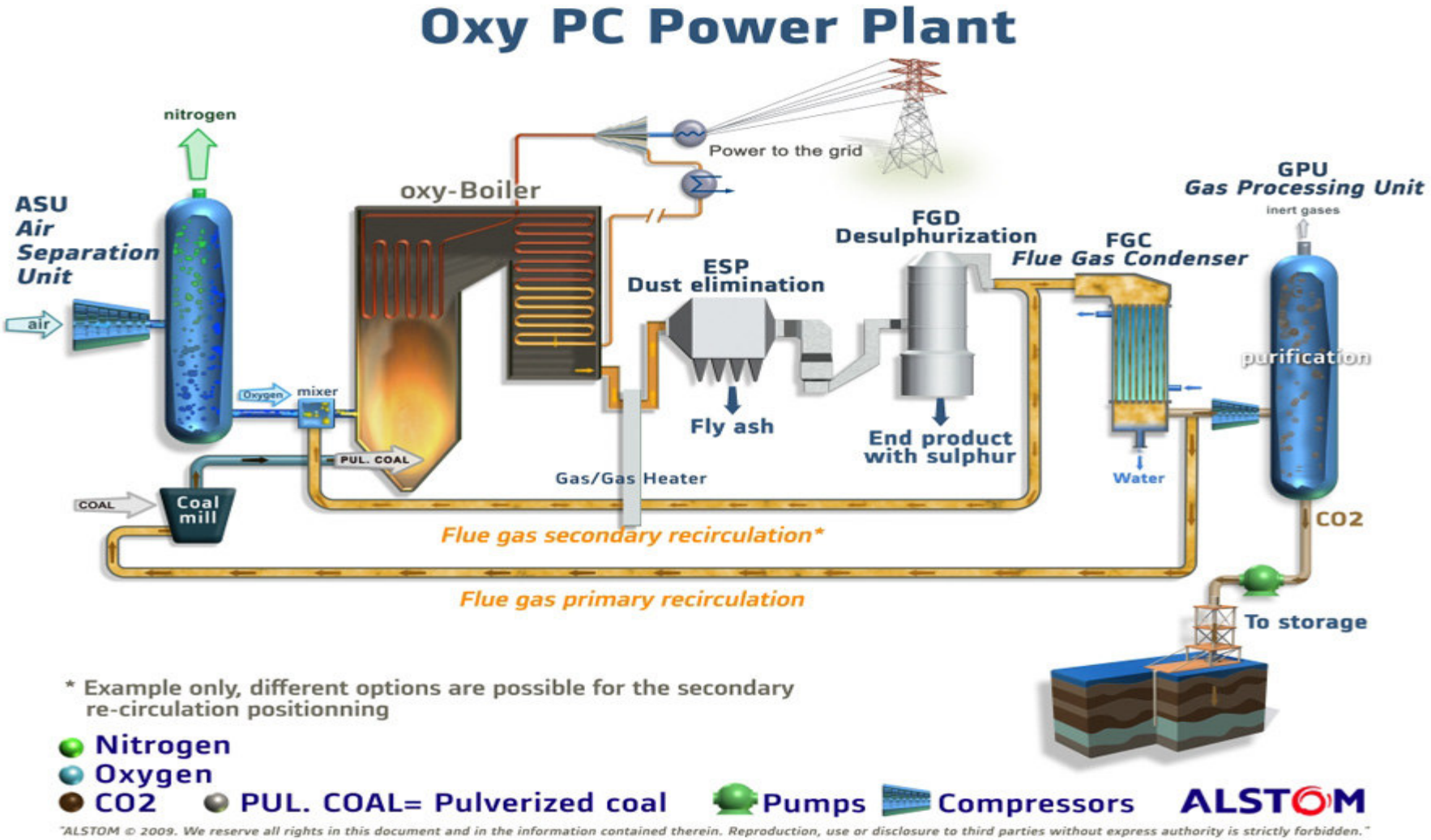


Post-Combustion
Advanced Amine: Process description

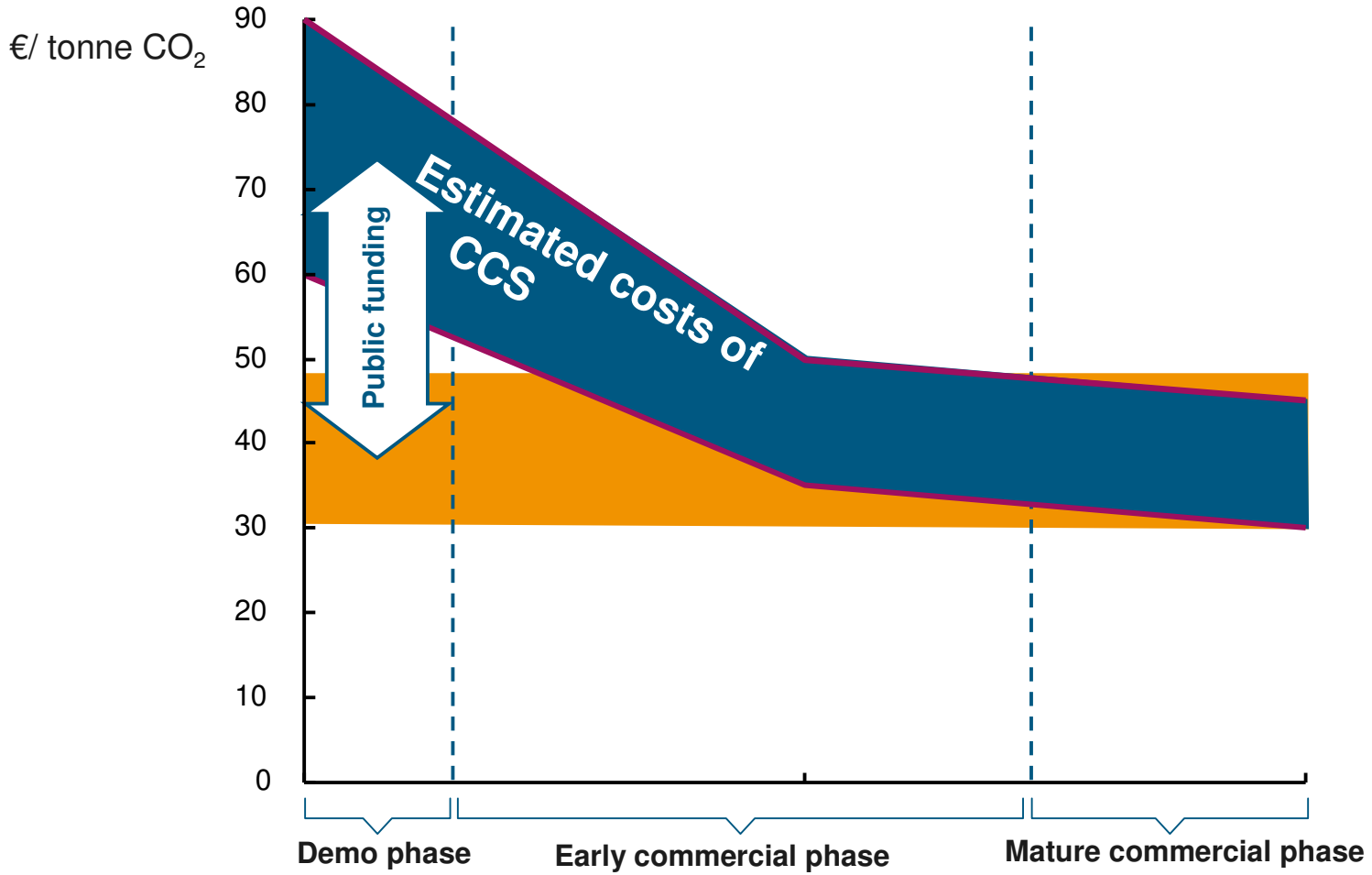


Amine – Commercial Scale
After implementation

Oxy Combustion
Process description



Economics of Carbon Capture and Storage



Source: McKinsey & Company "CCS – assessing the economics" for the cost numbers; policy implications drawn by ZEP

Large scale demonstration

Public funding starting to emerge:

- EU – 300m EUAs + €1.25 billion EU economic recovery plan (€6-8bn)
- Canada - $2bn for 3-5 projects in Alberta
- Australia - 500m AUD for clean coal
- US - $3.4bn for coal-related fossil energy programmes (inc CCS) in American Recovery & Reinvestment Act
- GCCSI – 100m AUD p.a. for CCS facilitation

EU starting to define a tendering process for two funding streams

	Recovery Plan	300m EU ETS Allowances
Total Money available	€1bn	€3bn at current carbon price €7.2bn at projected 2013 price
How much will each project get ?	€180m max	Up to a maximum of 50% of total costs
Which projects ?	6 selected; in UK, Netherlands, Germany, Poland, Italy & Spain	Top-ups for Recovery Plan 6 A further 6 projects ?
Who selects the projects ?	European Commission.	EU Member States put forward short-lists; Commission and EIB select.
Bids to be submitted	July 2009	September 2010 (we hope)
Projects to be selected	December 2009	December 2010 (we hope)
Cash to projects	Cash awarded Jan-Mar 2010	Allowances auctioned and monetised from 2011 (we hope)
Constraints on when we spend the money ?	Money must be committed (i.e. contracts signed) by December 2010	None

Alstom activity on 12 major demonstrations
As of December 2009

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Operating

Vattenfall Schwarze Pumpe
Germany - 30 MWth
Oxy - Lignite

AEP Mountaineer
USA - 58 MWth
Chilled Ammonia - Coal

EoN Karlshamn
Sweden - 5 MWth
Chilled Ammonia - Fuel

Total Lacq
France - 30 MWth
Oxy - Gas

Dow Chemical Co.
USA, West Virginia
Advanced Amines - Coal

Alstom BSF Windsor
US - 15 MWth
Oxy - Coals

Coming

PGE Belchatow
Poland – 260 MWe
Adv. Amines - Lignite

Vattenfall Jänschwalde
Germany - 250 MWe
Oxy - Lignite

Statoil Mongstad
Norway - 40 MWth
Chilled Ammonia - Gas

Transalta
Canada - >200 MWe
Chilled Ammonia - Coal

Archer Daniels Midland
USA, Illinois
Advanced Amines - Coal

AEP Mountaineer
USA – 235MWe
Chilled Ammonia - Coal

Selected for receiving EEPR funding

Selected by Alberta and Federal Canadian funding

Selected by US DOE to receive CCPI Round 3 funding

Clean Power Today!
Carbon Capture and Storage (CCS)

Chilled Ammonia
Demonstration facility at TransAlta Keephills 3

TransAlta **Project Pioneer**

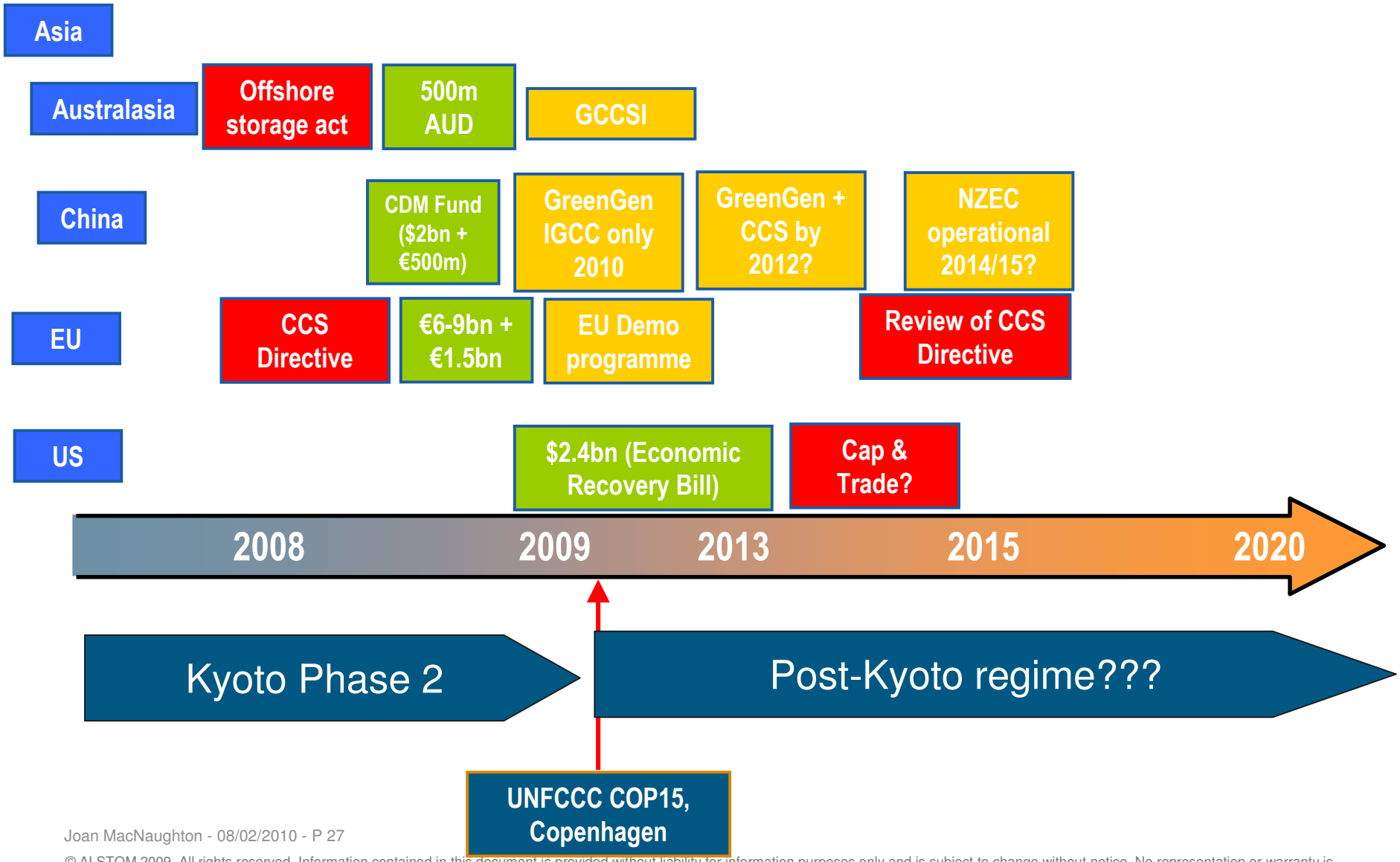
Location of Project Pioneer

Validation Plant Program

- New coal-fired unit Keephills 3
  - Scheduled to come on line in 2011
- CCS project selected by Alberta CCS fund and the Canada Clean Energy Fund and ecoENERGY Technology Initiative
- Designed to capture 1 million t CO_2/year
- CCS Project schedule:
  - Engineering to start in 2010
  - Operational in 2015

Selected by Alberta/Canada funding program

Race to the first CCS large-scale demonstration



CCS also needs a policy framework

- Funding for large scale demos
- Global – linked cap & trade systems (EU, US, Australia)
- Regional – strategic plan for transport, storage
- National –
  - Regulation of CO_2 storage, including liabilities
  - Regulatory framework – foundation for a commercial offering
- National/Local –
  - Public acceptability

EU Directive on the Geological Storage of CO2

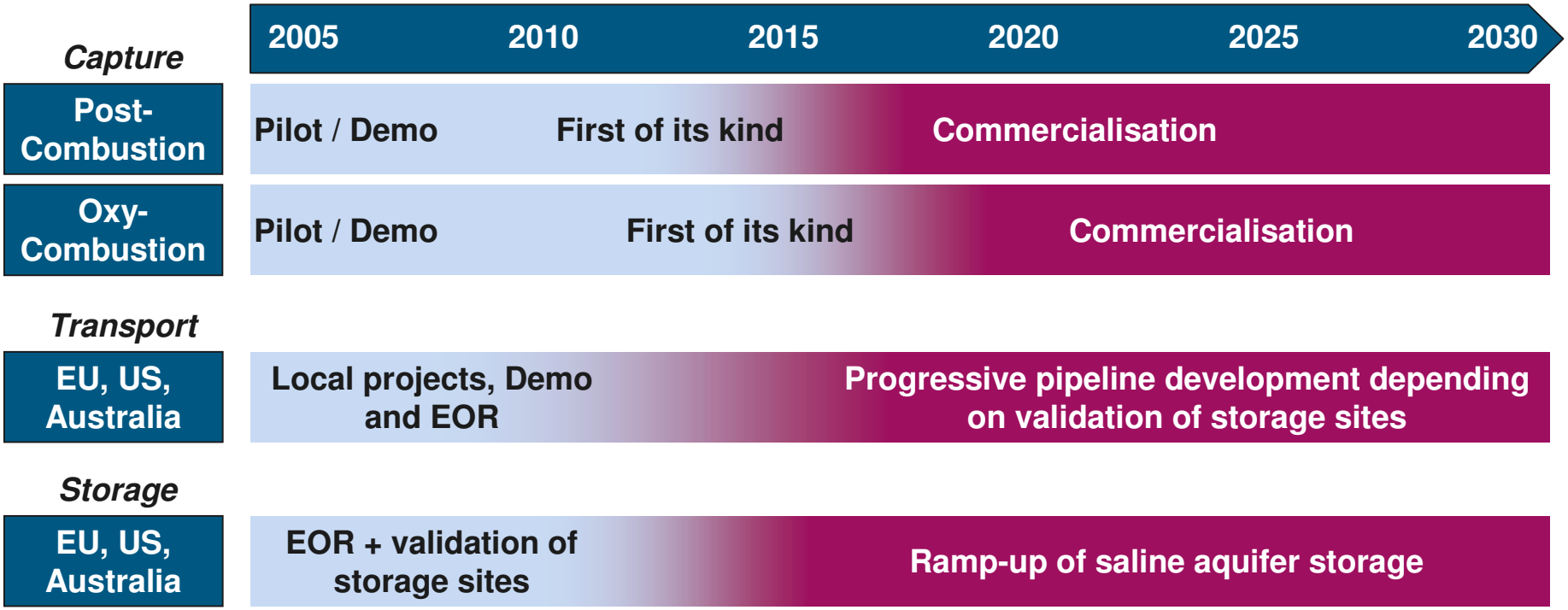
- Legal framework for CO2 transport and storage
- New plant – assessment of “CCS readiness”
- Review 2015

Commercial model for CCS

Across the value chain:

- Ownership of CO_2
- Operating responsibilities
- Asset ownership
- Liabilities/risk sharing
- Revenue sharing
- Exit model
- Transport access model (3rd party or exclusive)
- Knowledge sharing and IP

Carbon Capture and Storage
The Roadmap



CCS can be commercial in 2015

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The Copenhagen Accord

The Accord did not deliver:

- **Binding emission targets for 2020 and 2050** consistent with 2° C
- Progress towards global development of **carbon markets**
- Reform of **Clean Development Mechanism**.

The Copenhagen Accord

The Accord delivers :

- **Temperature**: max 2° C globally
- **Cuts in developed countries' emissions**
- **Voluntary action by developing countries**
- **Finance for developing countries**: "fast track" $30bn for 2010-12; and $100bn a year by 2020.
- **Stronger international efforts on technology development**, through a 'technology mechanism'.

The Copenhagen Accord

Not yet clear:

- **status of the Accord** – 'noted' by the COP, but not an official UN document
- whether countries will **register pledges** made pre-COP – some were conditional
- where the promised **financial resources** will come from
- how the Accord will **mesh with the Kyoto Protocol**
- whether the **limited verification rules** in the Accord for developing countries will really satisfy the others.

Copenhagen – is the glass half-full or half-empty?

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Carbon markets

- No greater buy-in from developing countries
- US legislative outlook
- EU – little prospect of 30% target
- Carbon pricing – EUAs down 10%
- No progress on market linked reforms (e.g. sectoral crediting)

Copenhagen – is the glass half-full or half-empty?

- Credibility of UNFCCC in question
- General confidence in processes ditto
- Role of US and China – not “G2”
- Emergence of BASIC countries
- Sidelining of EU and Japan
- Developing countries’ spectacular “own goal”

Conclusion (1)

- Welcome that world leaders **accept climate science & need to act**
- Welcome an Accord that, for **first time, engages all major economies** in keeping temperature rise below 2 degrees centigrade.
- **But the Accord as it stands is not enough**. The aggregated developed country cuts – at best - are around 17%, not the 25-40% required.
- **We need a legally binding agreement** to signal clearly to business that transition to a low carbon economy is fully underway.
- Without this, it will take longer to **unlock all of the potential investment** that will be focused on the transition.
- Cutting carbon is clearly still the **smart business objective**.
- Copenhagen hasn't changed that – but it was a **missed opportunity** to provide a considerably stronger platform on which business could build the low carbon economy.

Conclusion (2)

- Decarbonising power is central to tackling climate change
- Tackling climate change more difficult post-Copenhagen – as regards process and substance
- Watch this space – Copenhagen Accord, UNFCCC meetings, MEF, G8/20, BASIC,…..

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