



INTERNATIONAL ENERGY AGENCY



# *Fossil Fuels and Carbon Capture and Storage*

## IAEA Scientific Forum 2009

15-16 September, Vienna

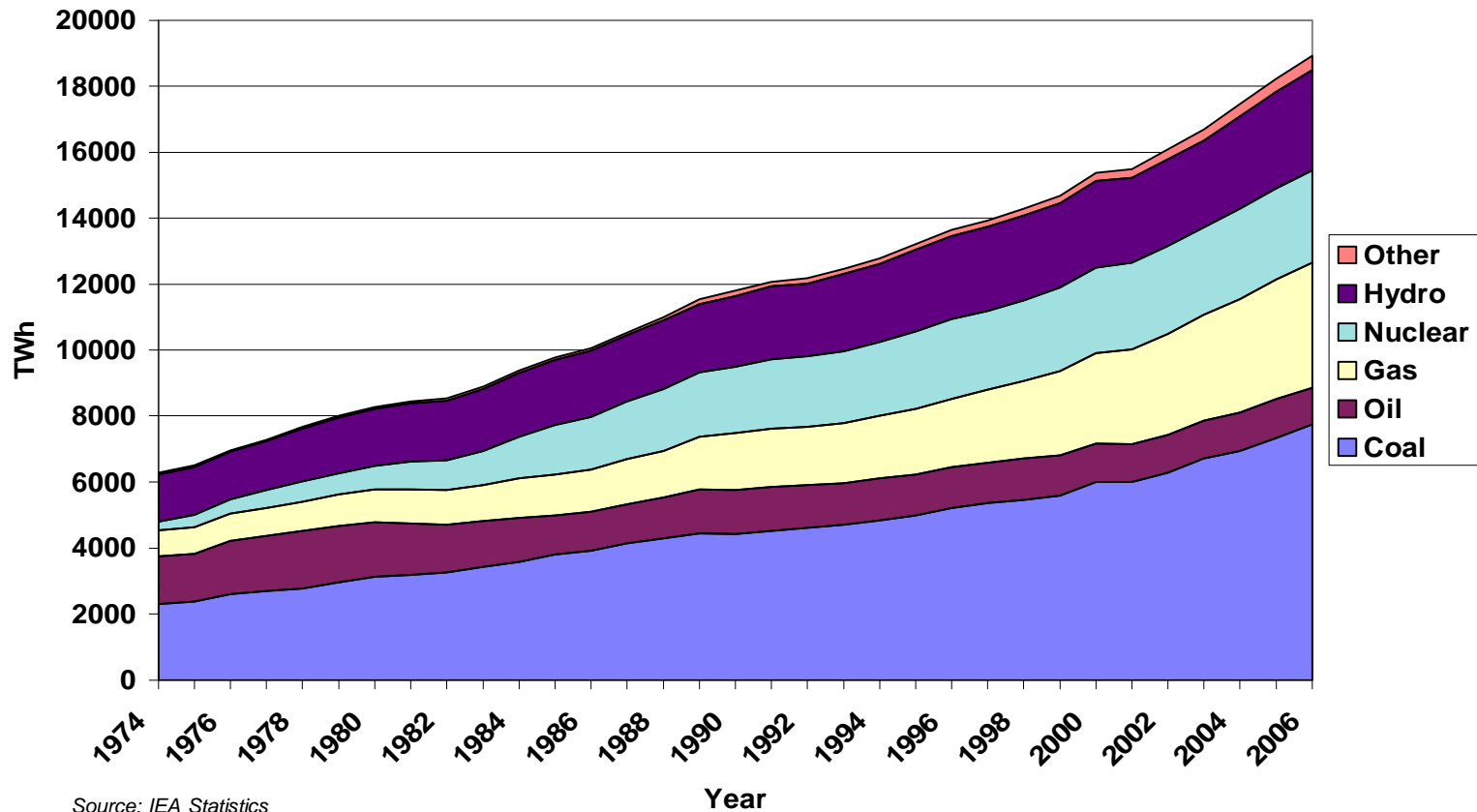
Keith Burnard  
*International Energy Agency*

# Overview

## Carbon capture and storage (CCS)

1. Cleaner fossil fuels/cleaner coal technologies?
2. Why CCS?
3. What is CCS?
4. What are the challenges?
5. What benefits for developing countries?

# Role of coal in power generation

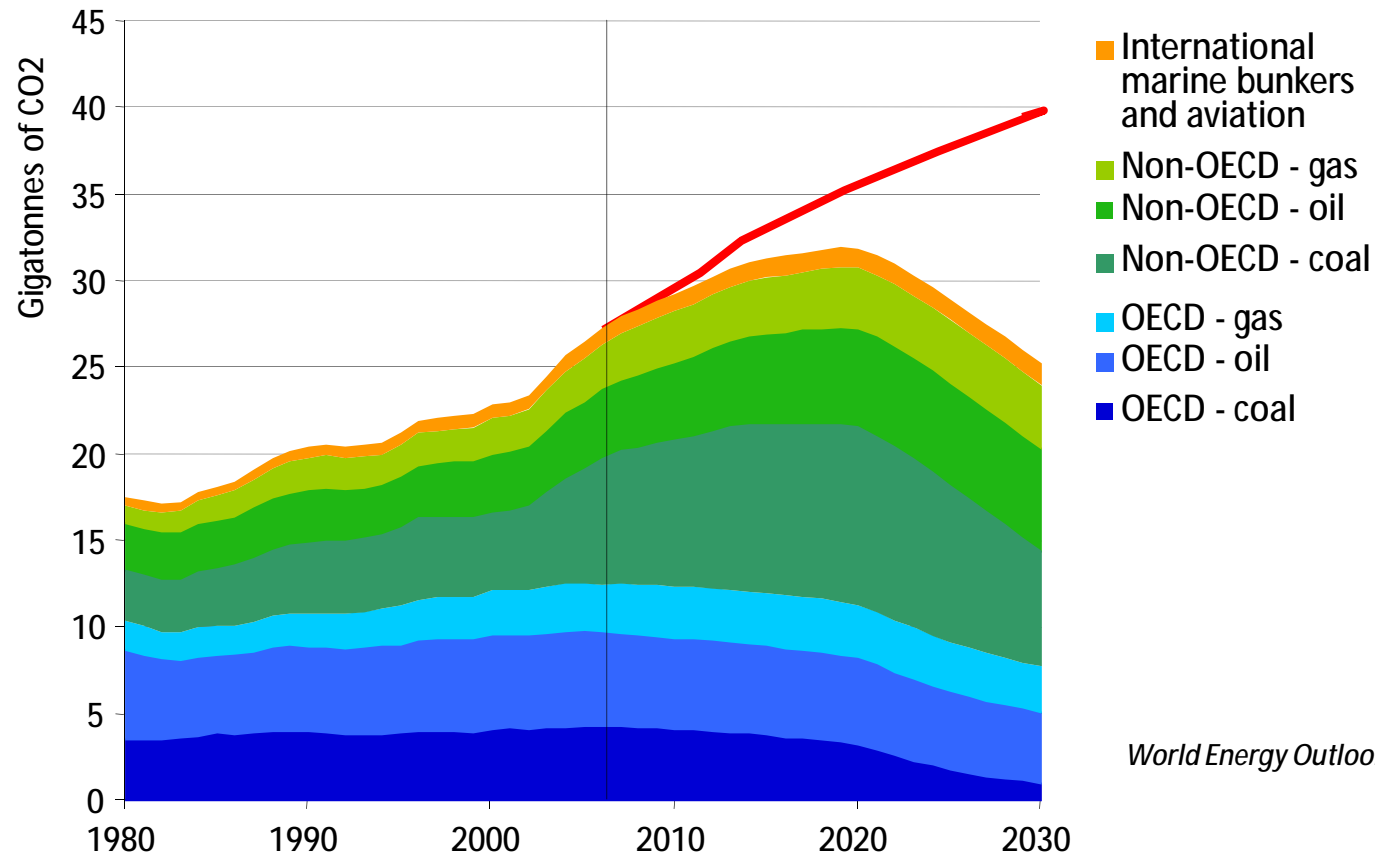


Source: IEA Statistics

*The coal demand for power generation has increased steadily over the past 30 years and its share in world power generation has reached around 40%.*



# Energy-related CO<sub>2</sub> emissions in the IEA's 450 Policy Scenario

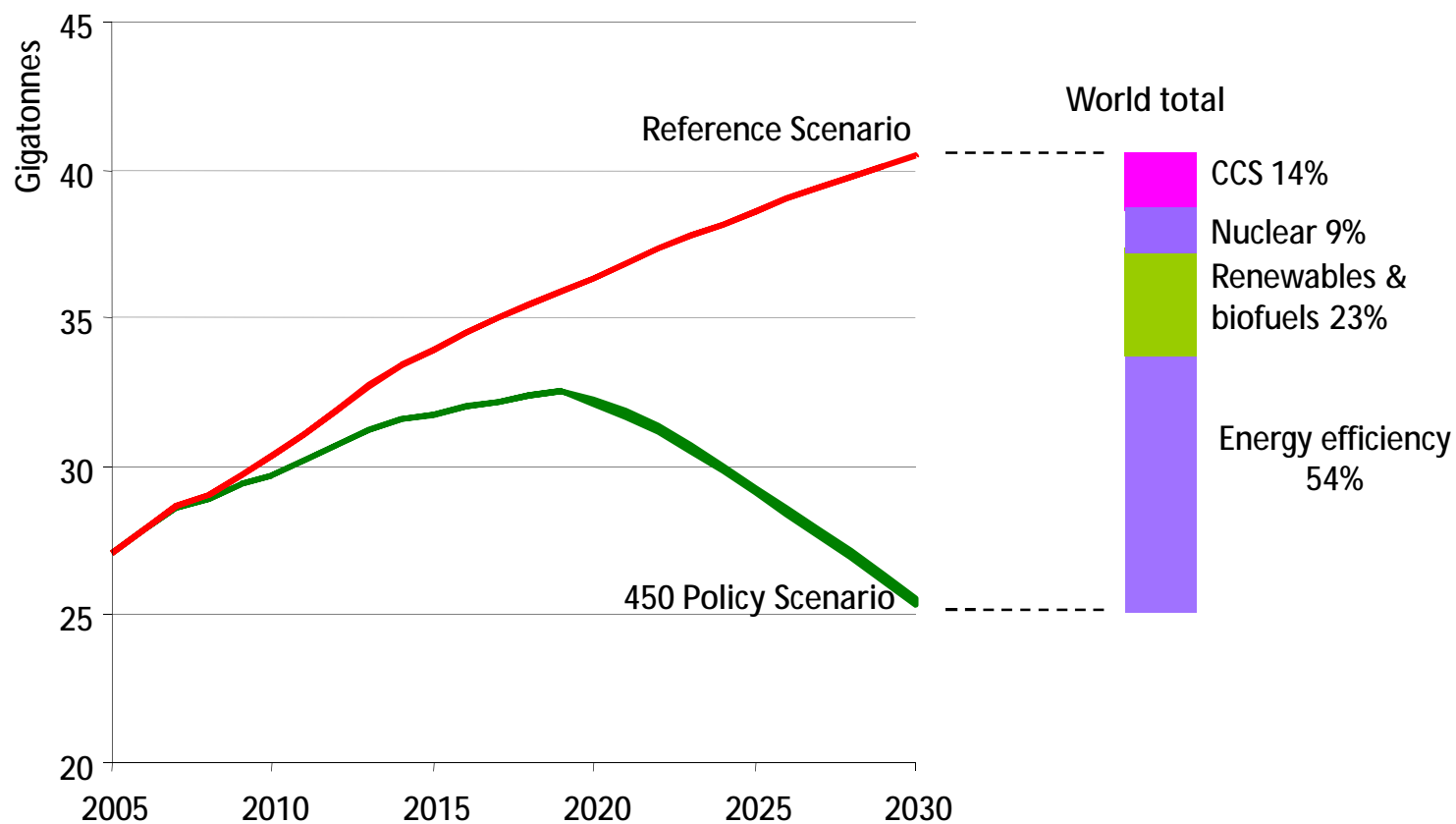


World Energy Outlook 2008, IEA

*In the 450 Policy Scenario emissions peak around 2020, and then decline by more than 1/3 to reach 26 Gt in 2030.*

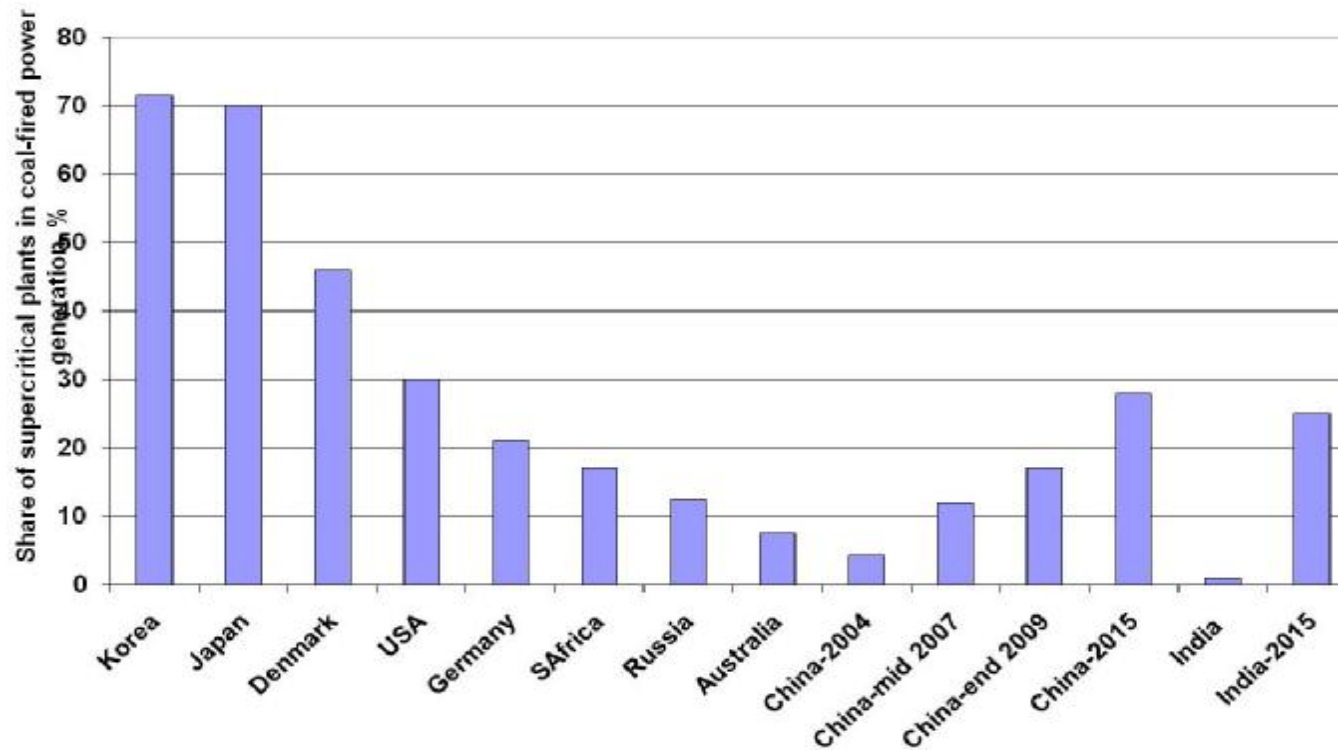
[Coal share of CO<sub>2</sub> emissions from power generation (2006) = ~73%]

# Reductions in energy-related CO<sub>2</sub> in the 450 Policy Scenario



# Improving plant efficiency is important and .....

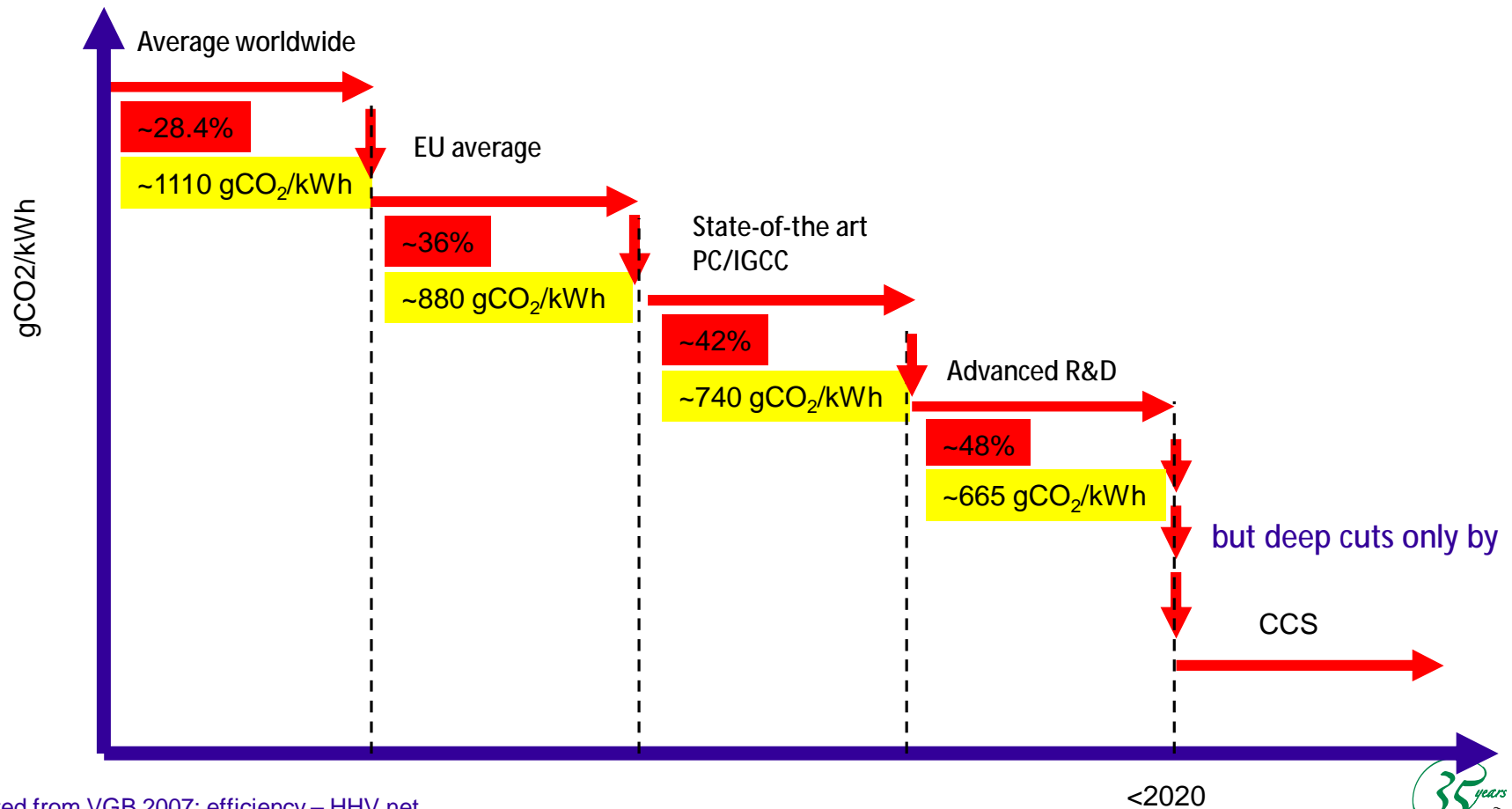
..... average efficiency is improving



Source: IEA Clean Coal Centre, China Electricity Council and Ministry of Power, India



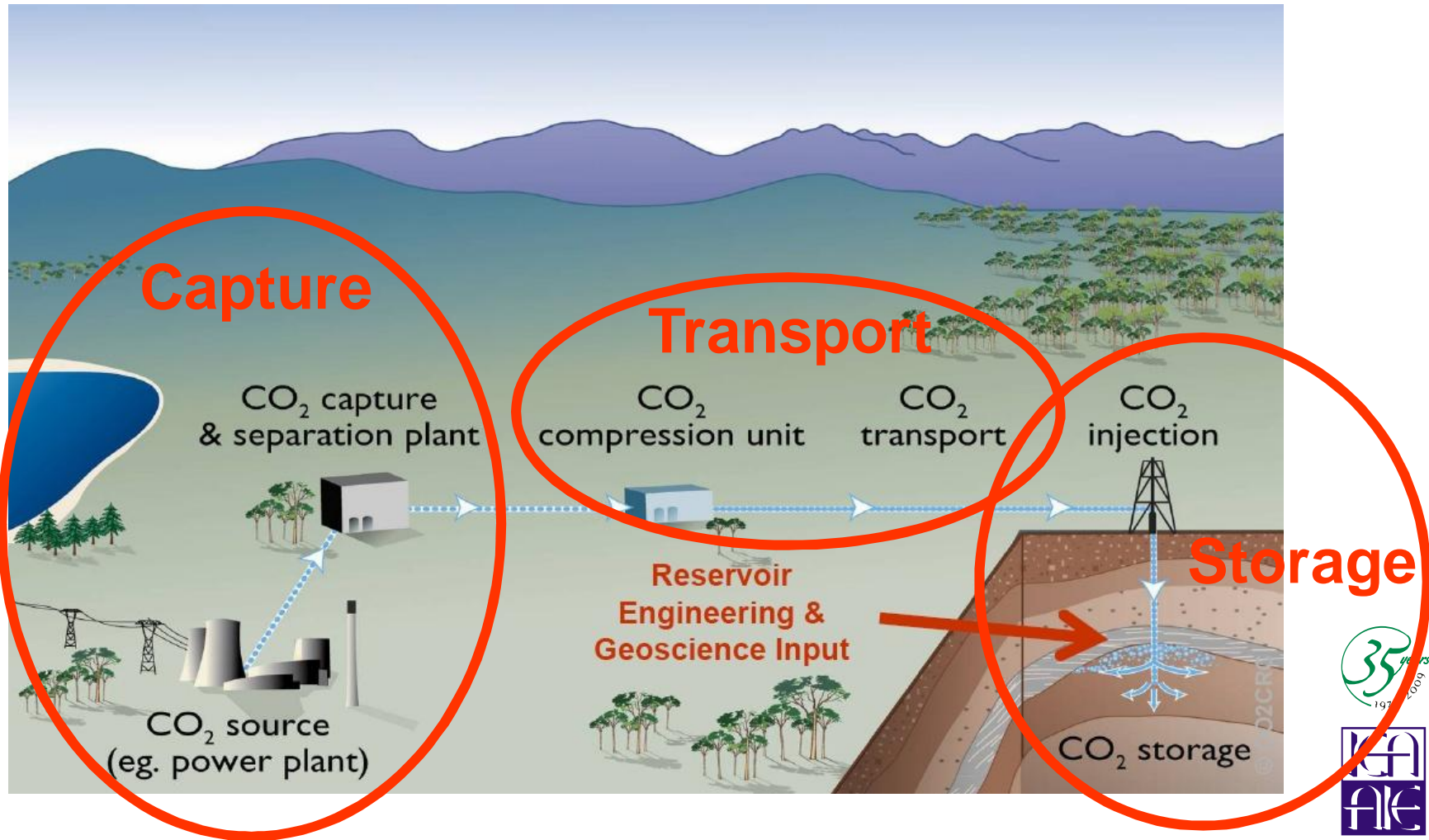
# CO<sub>2</sub> emission reduction by key technologies



adapted from VGB 2007; efficiency – HHV<sub>net</sub>

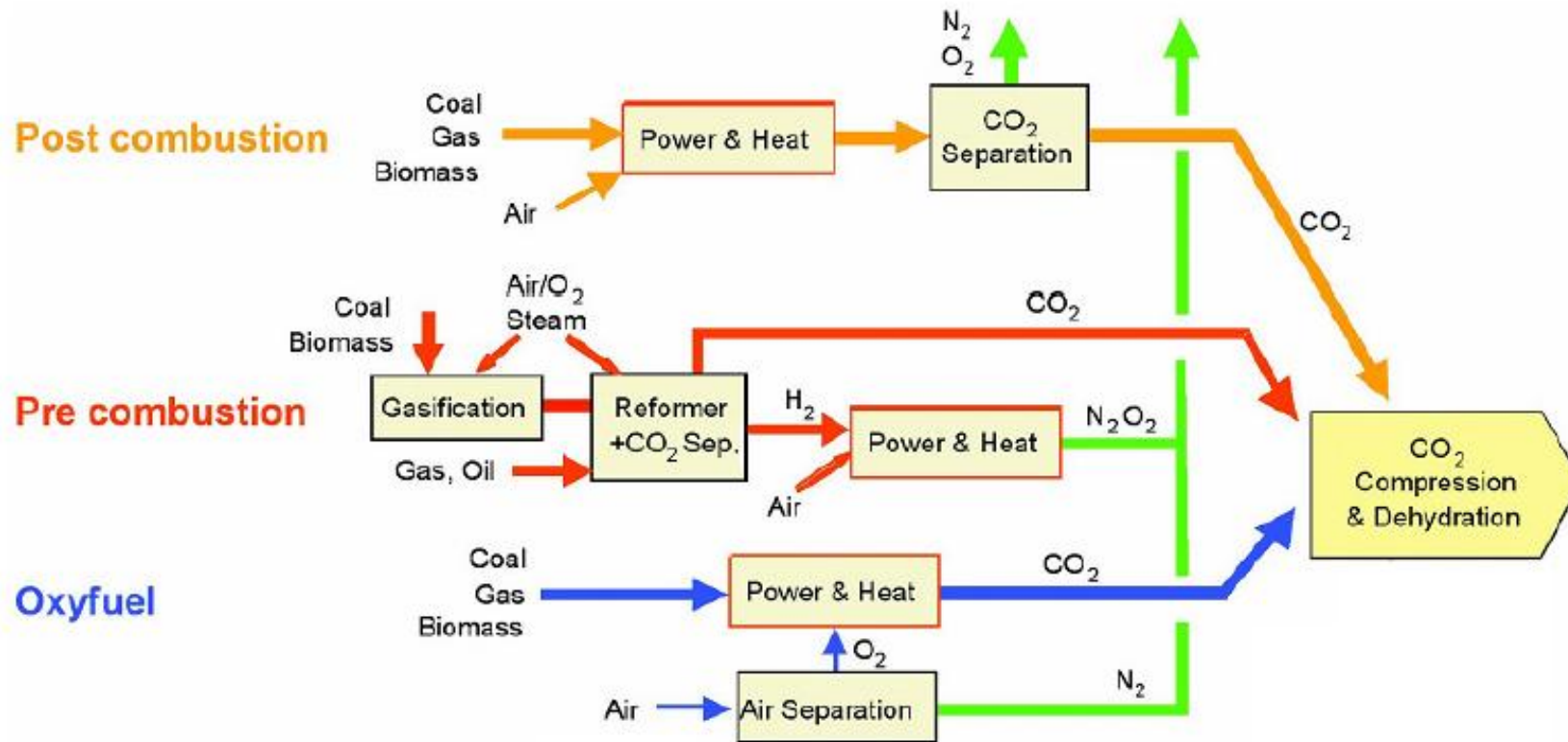
*Energy efficiency makes a big impact but deep cuts of CO<sub>2</sub> emission can be achieved only by deploying carbon capture and storage (CCS)*

# Carbon capture and storage





# CO<sub>2</sub> capture processes



# Vattenfall's 30 MW<sub>th</sub> Oxyfuel carbon capture unit



# CCS: not just for coal

## Power sector

- Coal\*
- Gas
- Biomass

} c. 53% (2050)\*\*

## Industry and upstream sectors

- Biomass syngas
- Iron and steel
- Cement
- Gas processing
- Natural gas syngas
- Chemicals
- Pulp and paper

} c. 47% (2050)\*\*

\* Coal share of CO<sub>2</sub> emissions from power generation (2006) = ~75%

\*\* From IEA CCS Roadmap to be launched at CSLF Ministerial meeting in October 2009

# CCS: the challenges I

## 1. Technology maturity

- Capture
  - Applied for several decades in industry and at scale
- Transport
  - Well over 3000km CO<sub>2</sub> pipeline in the USA
- Storage
  - Currently more than 8.5Mt/a CO<sub>2</sub> stored

**BUT:**

*As yet, no large-scale power plant with fully integrated CCS*

# CCS: the challenges II

## 2. Deployment

Date	No. projects	
2010	20 (launched)	G8 Leaders recommendation
2030	850	Forthcoming IEA CCS Roadmap*
2050	3400	Forthcoming IEA CCS Roadmap*

**BUT**

***Present status: Five (5) large-scale CCS plants in operation***

- ***2 in N America***
- ***2 in Europe***
- ***1 in Africa***

# Operational large and medium-scale CCS projects



1) Projects were, or had been operational before December 31<sup>st</sup> 2008  
 2) Large-scale projects capture and/or store more than 500,000tCO<sub>2</sub> per year  
 3) Medium-scale projects capture and/or store and monitor more than 10,000tCO<sub>2</sub> per year

# CCS: the challenges III

## 3. Cost and efficiency penalty

- Currently estimated 30-60% additional cost if adding CCS to a coal-fired power plant
- Currently estimated 8-10 %-points reduction in efficiency of coal-fired power plant resulting from addition of CCS

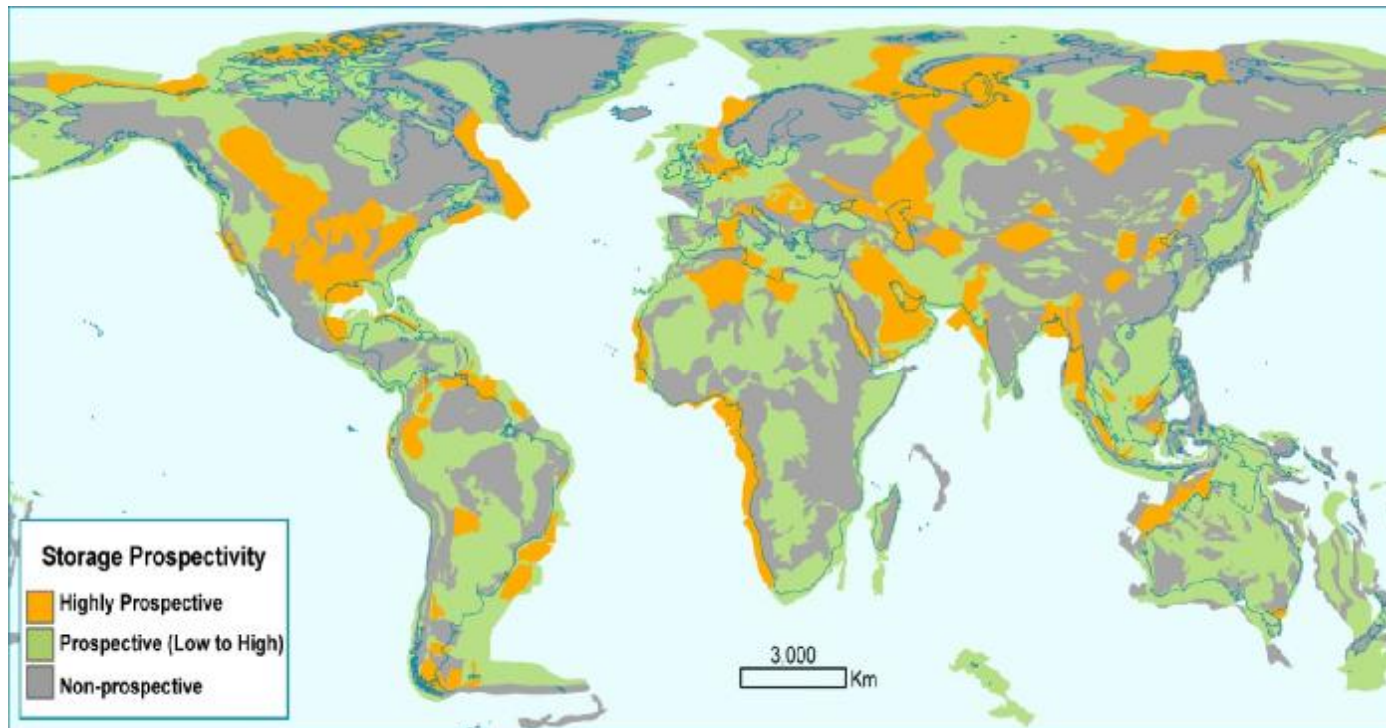
### Important:

*High costs and efficiency penalty must be addressed continuously but, of course, improvements based on experience from design, construction and operation of early demonstration plants will be essential.*



# CCS: the challenges IV

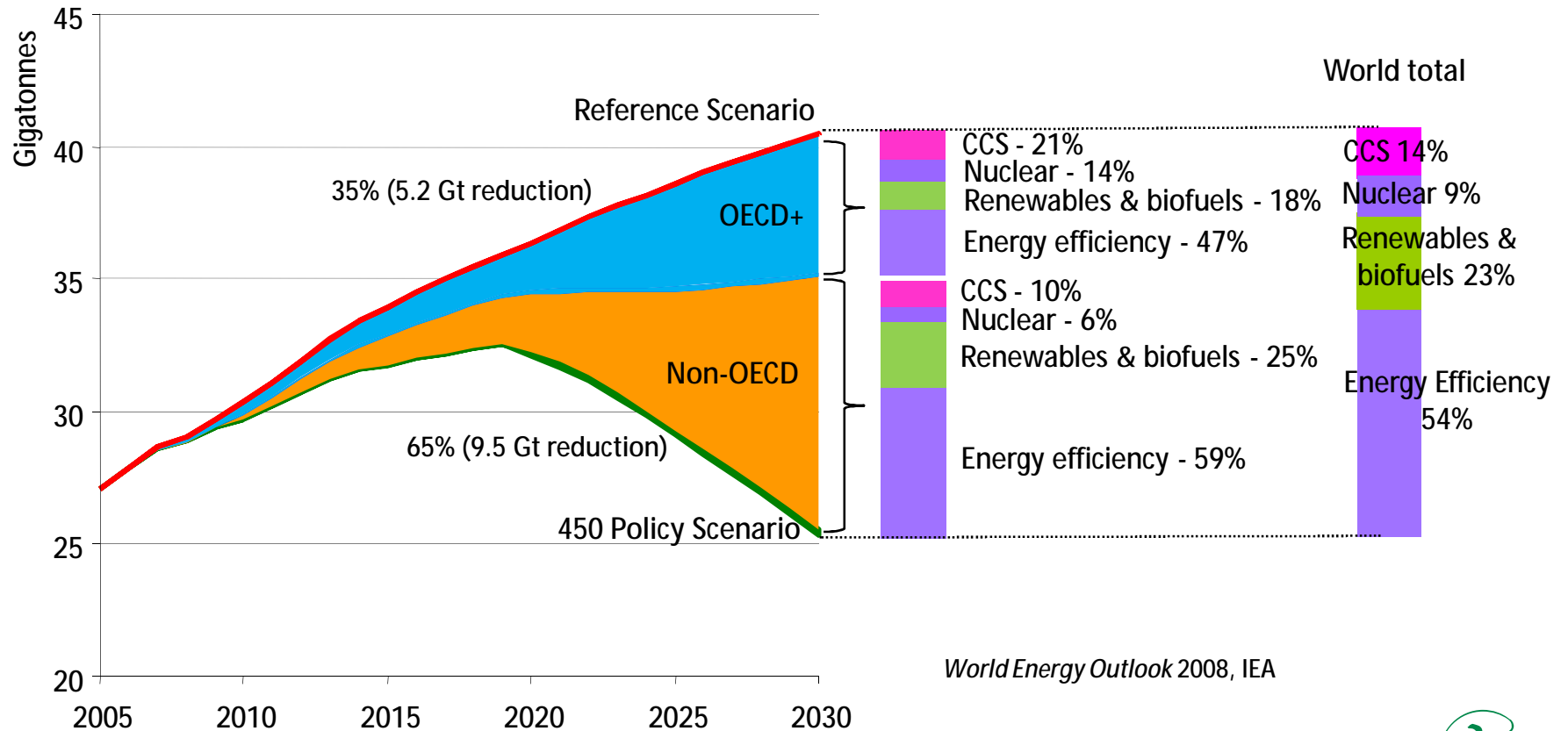
## 5. CO2 storage



Source: Bradshaw, J. and Dance, T. (2004): "Mapping geological storage prospectivity of CO2 for the world's sedimentary basins and regional source to sink matching," in (E.S. Rubin, D.W. Keith and C.F. Gilboy eds.), GHGT-7, Proc. Seventh International Conference on Greenhouse Gas Control Technologies, Vancouver, B.C., Canada, September 5-9, 2004.



# Reductions in energy-related CO2 in the 450 Policy Scenario



World Energy Outlook 2008, IEA

- *OECD and non-OECD countries must both work towards reducing CO2 emissions*
- *Energy efficiency is the largest contributor. Renewables, nuclear and CCS also play key roles.*



# China's 1<sup>st</sup> post-combustion CO<sub>2</sub> capture pilot plant

## Design parameters:

- Flue gas flow to unit  
2000-3000 Nm<sup>3</sup>/h
- Steam consumption  
3 GJ/tonne CO<sub>2</sub>
- CO<sub>2</sub> captured  
3000 tonnes/year
- Solvent consumption  
< 1.35 kg/tonne CO<sub>2</sub>



# Benefits of cleaner fossil technology and CCS for development

## High efficient, cleaner fossil technology

- | Stretches reserves
- | Reduces burden on infrastructure
- | Lower local pollution and GHG emissions

## ..... and with CCS

- | Coal and a low-carbon economy need not be incompatible
- | Maintaining fossil fuels in the energy mix increases energy security
- | The extent of potential CCS deployment at a given location will be dependent on
  - u Carbon price
  - u Fossil resource endowment/use
  - u Suitable storage sites
  - u Non-fossil energy alternatives

# IEA work on CCS



**Thank you!**

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