



Sustainable Low Emissions Coal for our Grandchildren?

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**2010 International Pittsburgh Coal Conference
October 2010**



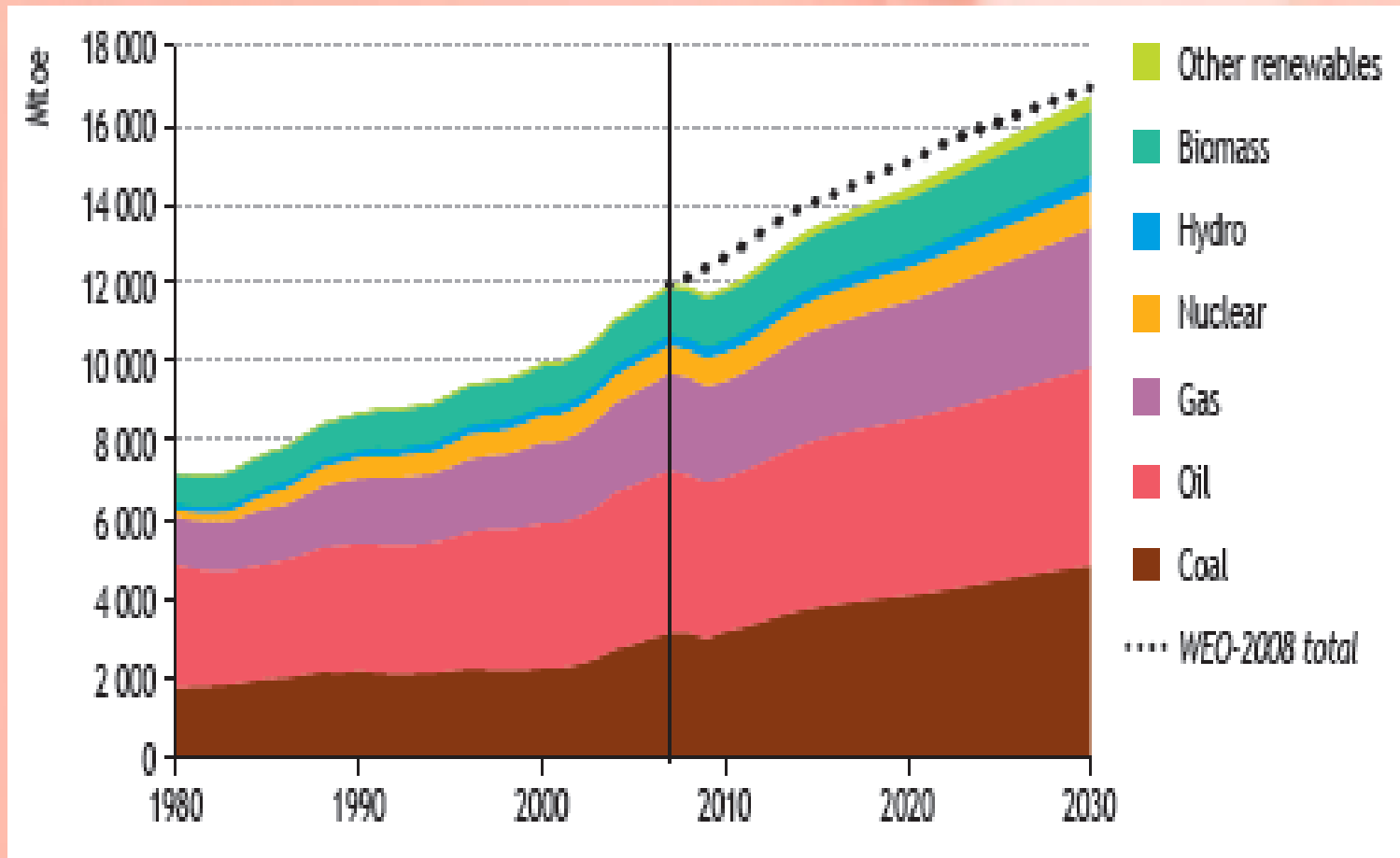


* To be decided

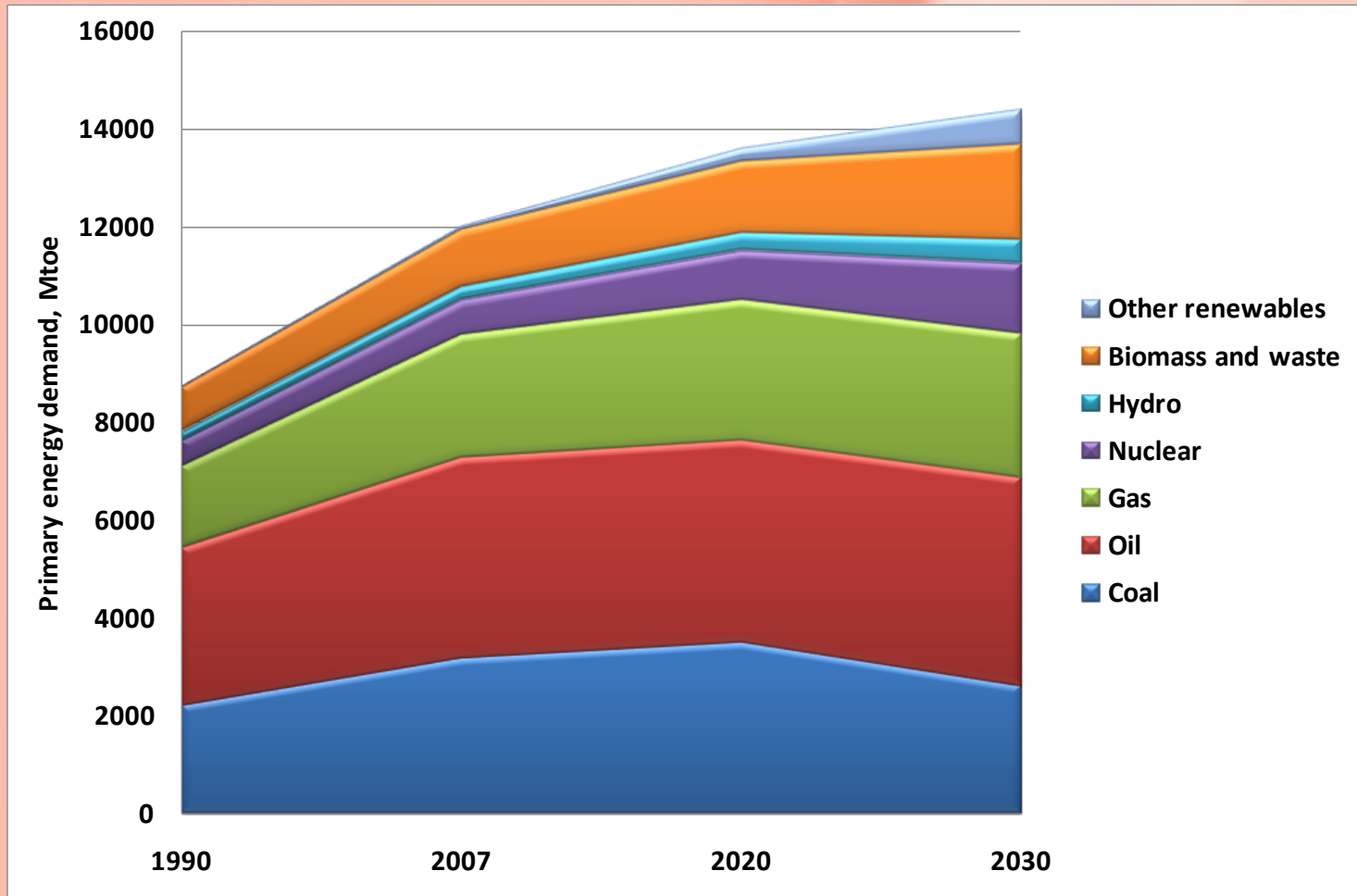
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- **The long term CCS roadmap for sustainable use of fossil fuels**
- **State of the Art in coal fired power plant**
- **Up grading and replacing old coal fired power plant**
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World primary energy demand in the Reference Scenario: WEO 2009



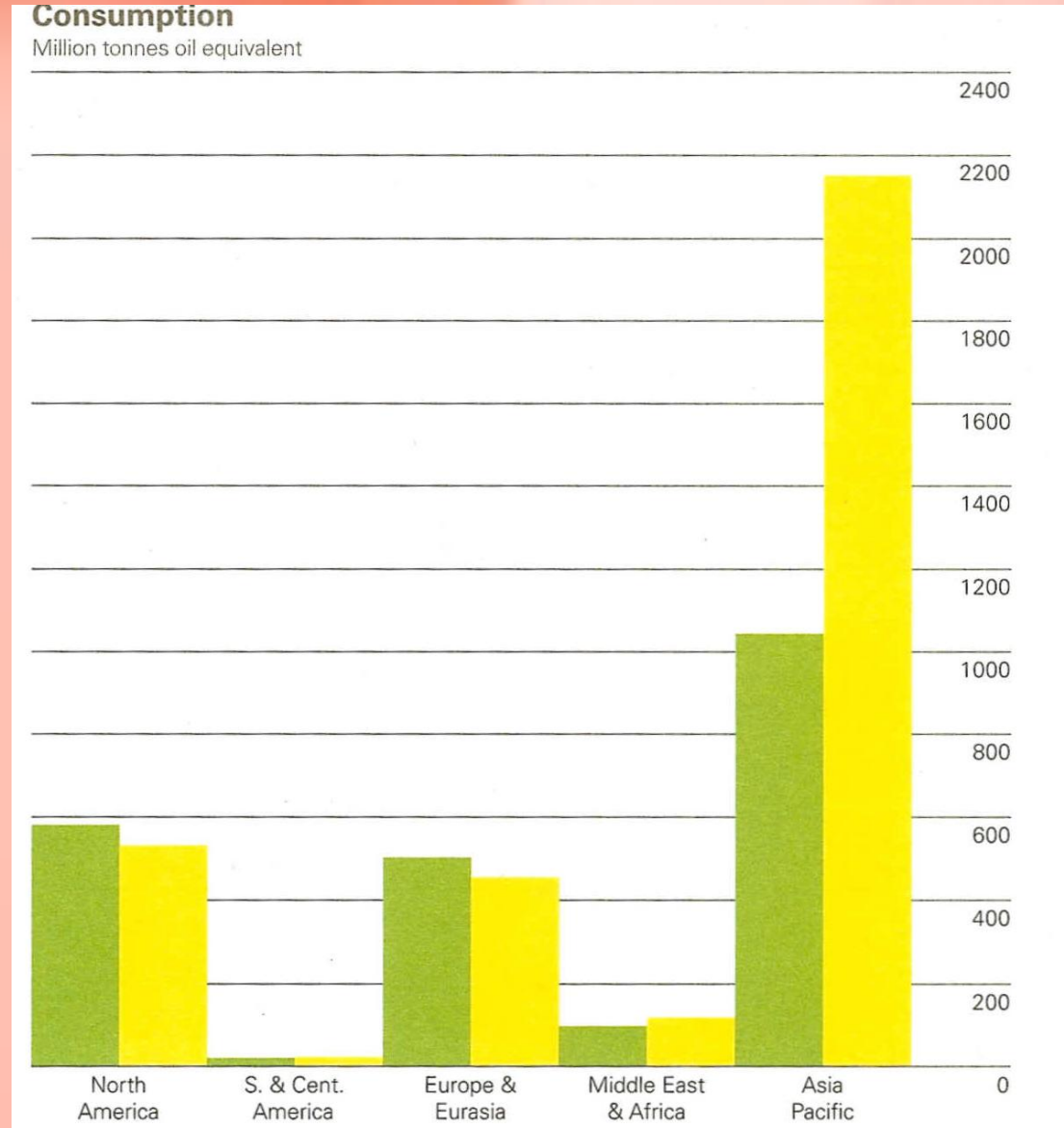
World primary energy demand under the 450 Scenario, Mtoe (WEO, 2009)



Coal Consumption 1999 and 2009

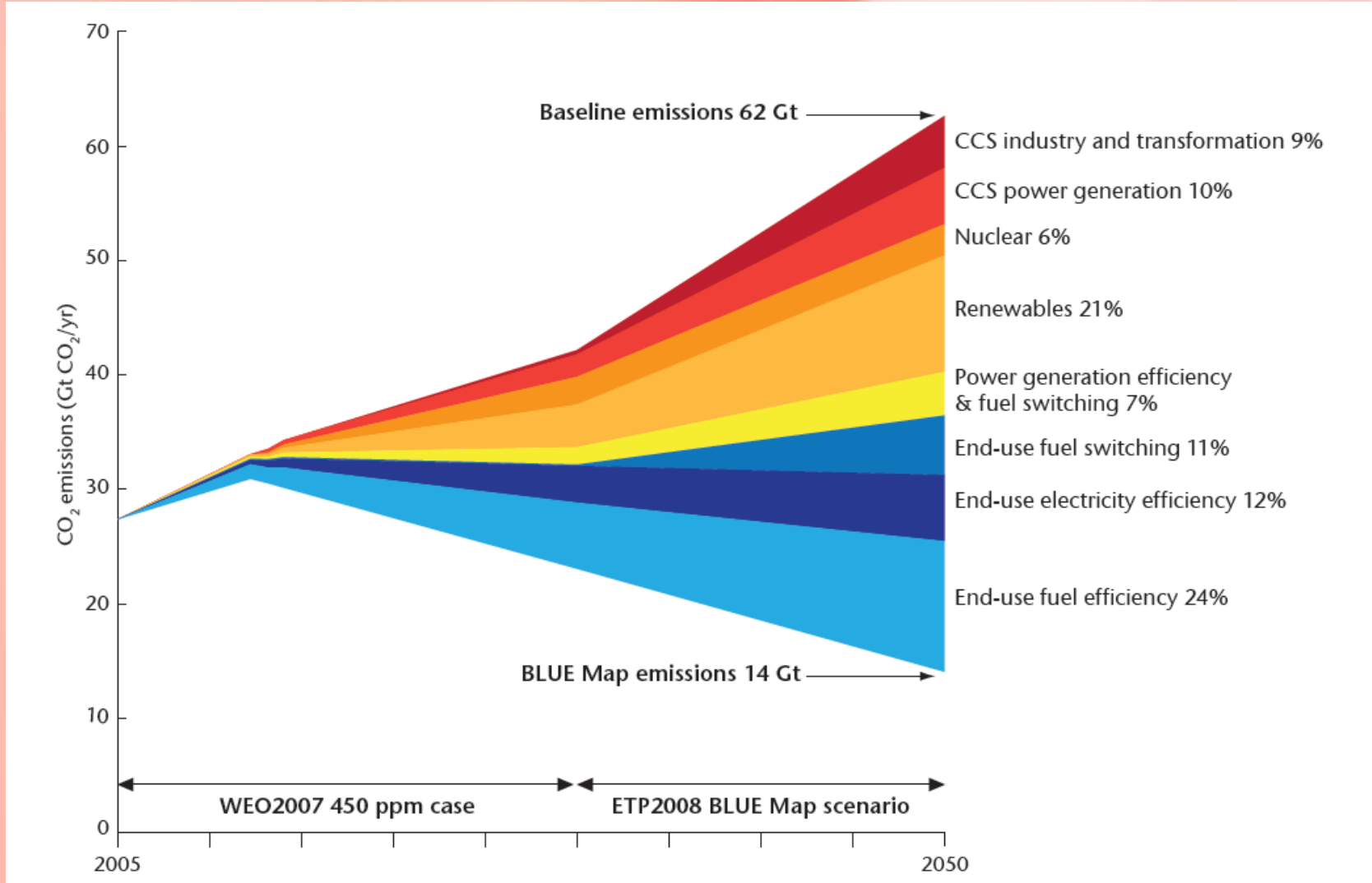
“World Coal Consumption was essentially flat in 2009, the weakest year since 1999. For the first time since 2002 coal was not the fastest growing fuel in the world. The OECD and Former Soviet Union experienced the steepest declines on record, while growth elsewhere was nearly average, largely due to the above average growth in China which accounted for 46.9% of global consumption”

Source: BP Statistical Review of World Energy, June 2010

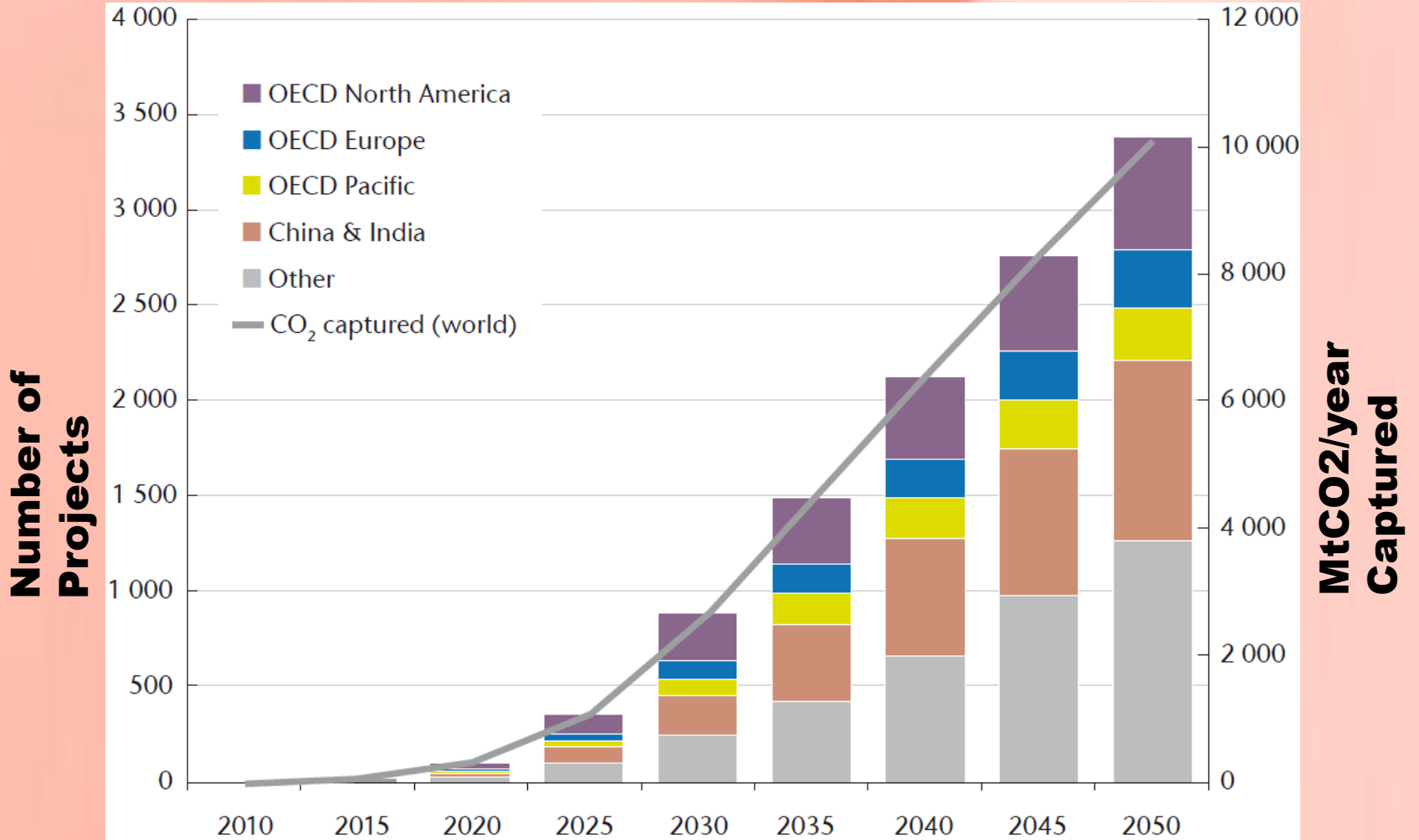


TOP DOWN CCS ROADMAP

The ETP BLUE Map Scenario



CCS deployment in the BLUE Map Scenario

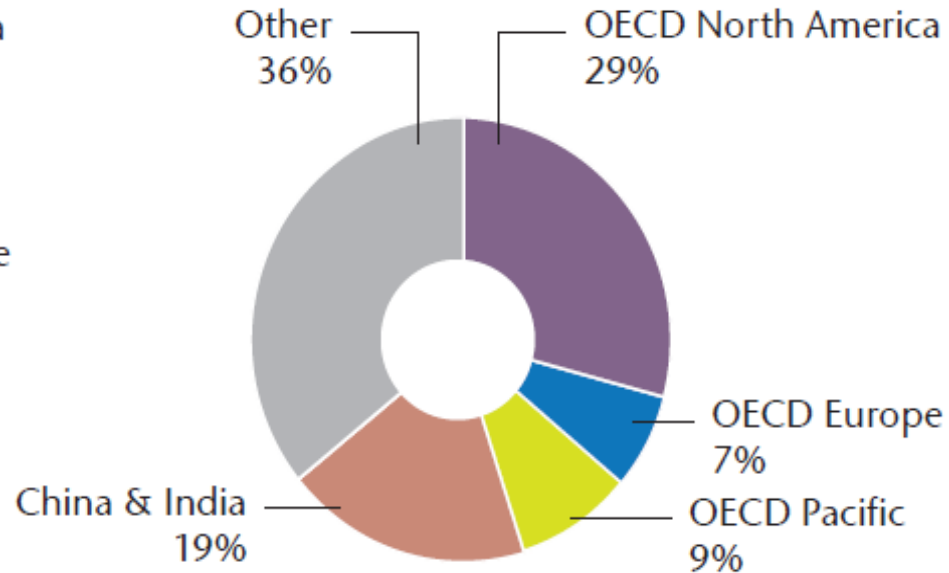
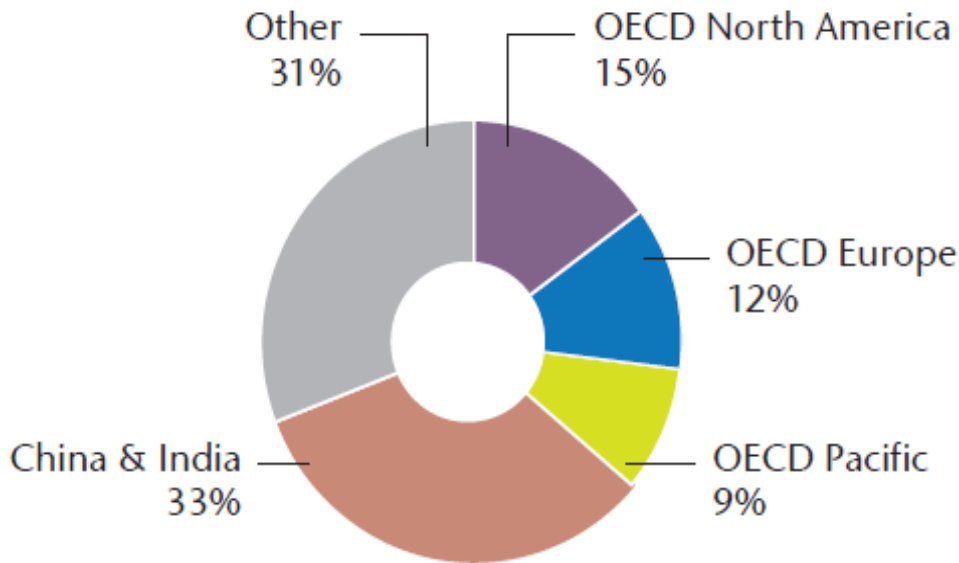


There is an ambitious growth path for CCS from 2010 to 2050

A Global Challenge

Power generation on 5.5 Gt CO₂ captured 2050

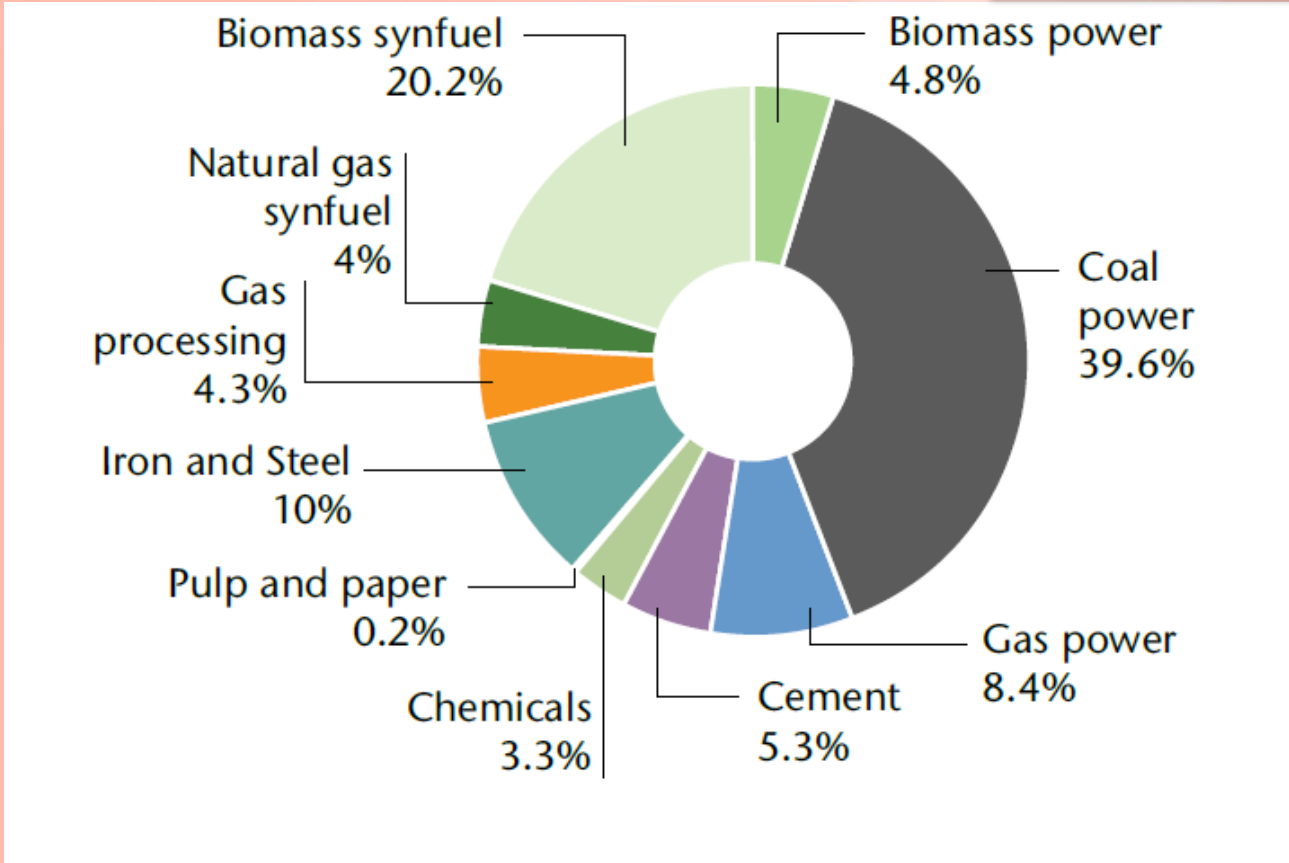
Industry & Upstream 4.5 Gt CO₂ captured 2050



CCS will be required in all regions of the world in power, industry and upstream

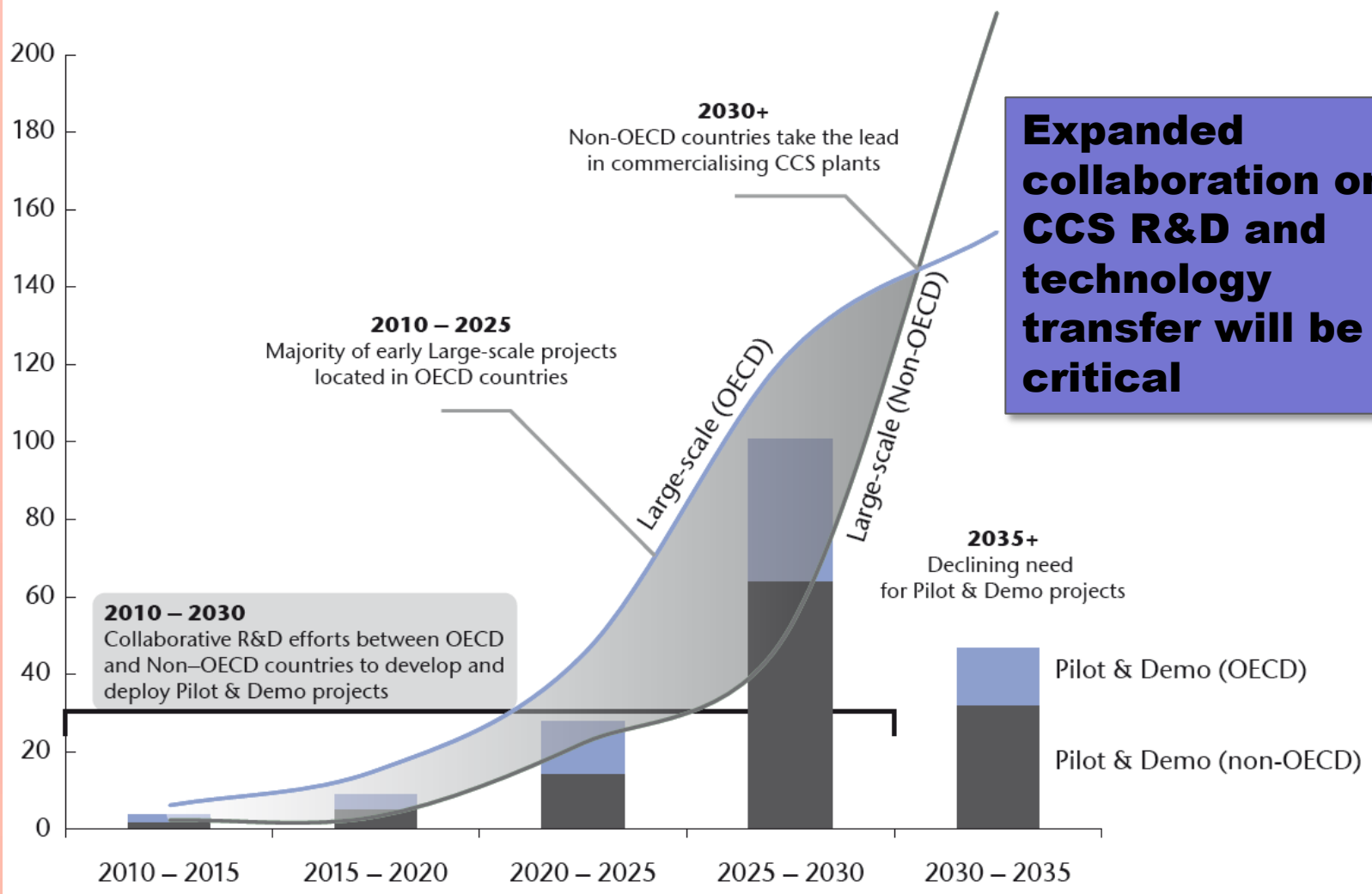
CCS is not just a “clean coal”

Coal power only makes up around 40% of stored emissions in 2050



Demonstration to Commercial

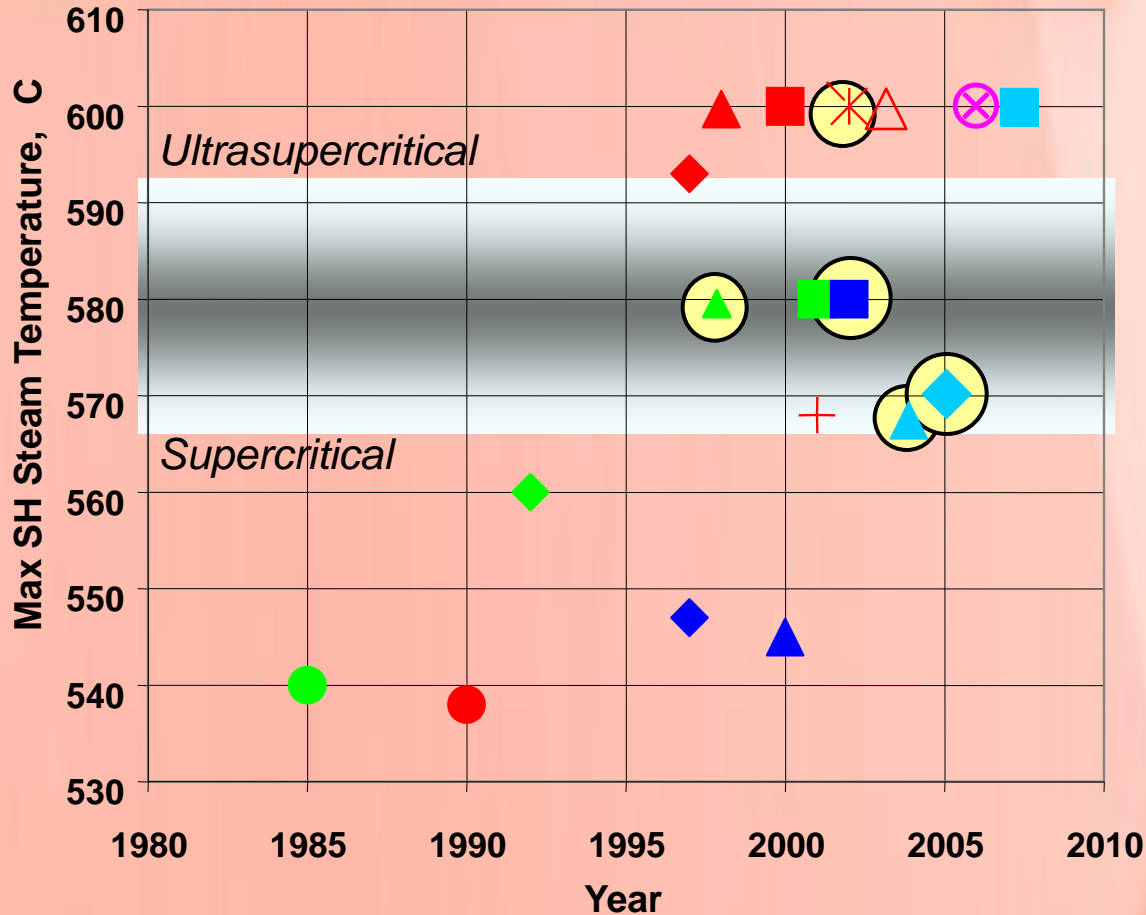
New build projects



Coal Fired Power Plant – State of the Art

Recent Plant State-of-the-Art Conditions

○ G8 Case study plants



- Studstrup (DK) 540/540
- Maatsura 1 (J) 538/566
- ◆ Esbjerg (DK) 560/560
- ◆ Schwarze Pumpe (D) 547/565
- ◆ Maatsura 2 (J) 593/593
- ▲ Haramachi 2 (J) 600/600
- ▲ Nordjylland (DK) 580/580/580
- ▲ Boxberg (D) 545/581
- Tachibanawan 1 (J) 600/610
- Avedore (DK) 580/600
- Niederaussem (D) 580/600
- + Hekinan (J) 568/593
- * Isogo (J) 600/610
- ▲ Yunghung 566/576
- ◆ Genesee 3 580/570
- △ Hitachinaka (J) 600/600
- ⊗ Torrevaldaliga (I) 600/610
- Huyan (China)

Isogo New Unit 1, Japan



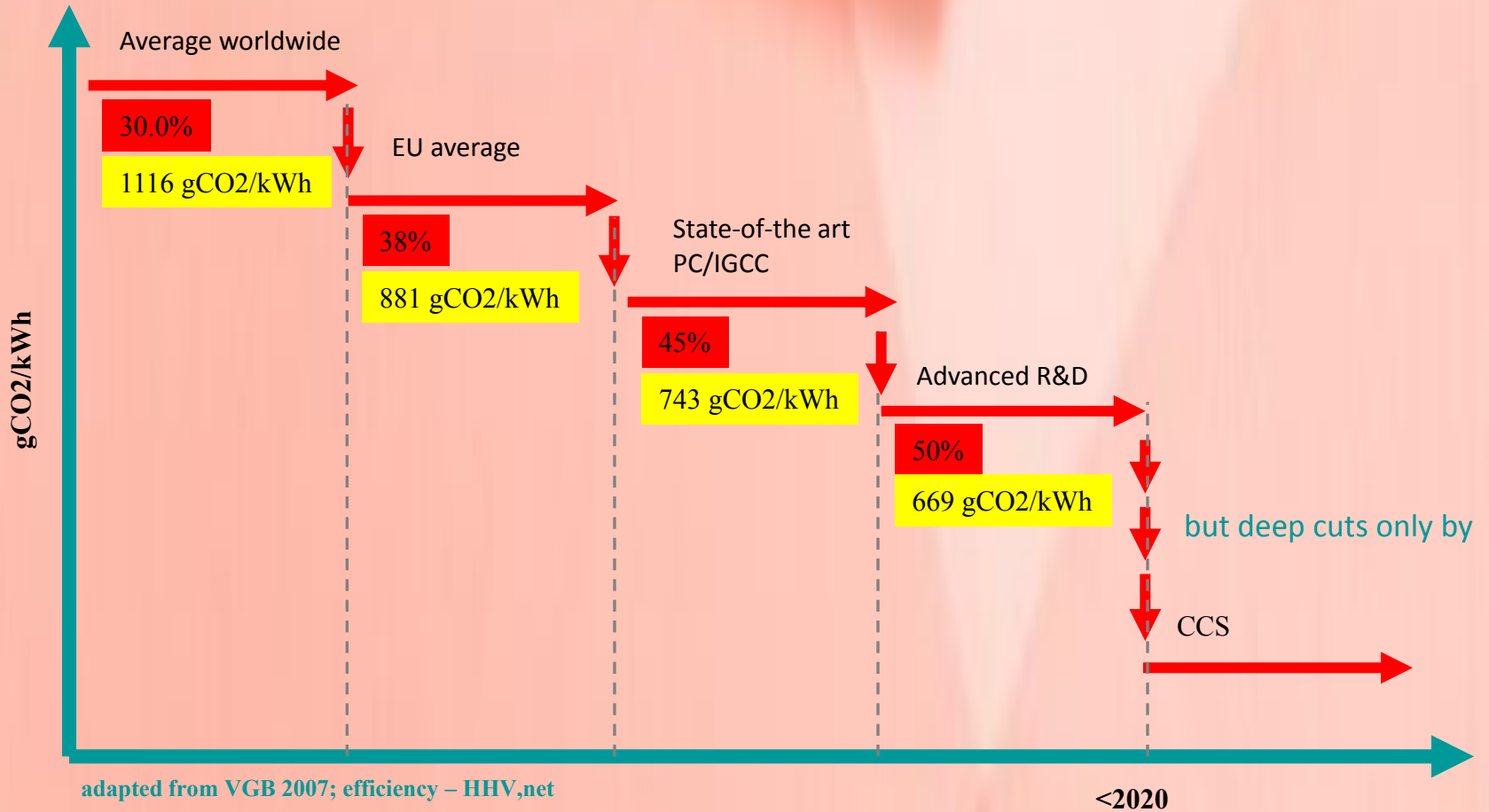
USC, tower boiler, opposed wall firing, int bitum and Japanese coals, warm sea water

- **Near zero conventional emissions (NO_x 20 mg/m^3 , sulphur oxides 6 mg/m^3 , particulates 1 mg/m^3 , at 6% O_2 , dry); full waste utilisation**
- **Highest steam conditions: 25.0 MPa/600°C/610°C at turbine: ASME CC 2328 steels in S/H; P122 for main steam pipework**
- **Operating net efficiency >42% LHV/40.6% HHV**
- **Efficiency tempered slightly by 21°C CW, fewer FW heating stages**
- **Dry regenerable activated coke FGD (ReACT)**
- **NO_x abatement Combustion measures and SCR**
- **Particulates removal ESP**
- **Isogo New Unit 2 will use ReACT specifically for multi-pollutant control, including mercury**

Huaneng Yuhuan 4x 1000MWe USC coal fired power plant



CO2 emission reduction pathways



Energy Efficiency makes big change but deep cuts of CO2 emission can be done only by Carbon Capture and Storage (CCS)

Potential for CO₂ emissions reductions by adopting state of the art

- **Coal-fired power and CHP plants worldwide account for ~25% of total CO₂ production**
- **Replacement potential - ~300 GW**
- **Upgrade potential - up to 200 GW**
- **Replacement or upgrade of some units under progress or already planned**
- **Globally 1.35 - 1.7 billion ton/annum of CO₂ reduction possible by moving to current state of the art pc-plants – about 5% of global anthropogenic emissions**

China - Latest old plant closure announcements

China to reduce emissions, save coal by closing old power stations

BEIJING, May 21, 2010 -- Xinhua

China's energy watchdog, the National Energy Administration, signed agreements with 26 provincial governments Friday to close at least 10 million kilowatts of outdated coal-fuelled power capacity before October this year. The agreement means **China will close 70 million kilowatts of small-scale, outdated thermal power station capacity in the Eleventh Five-Year Plan period from 2006 to 2010. If achieved on time, the plan will save 81 million tonnes of coal annually, or 2.6 percent of the coal used in 2005; eliminate 1.4 million tonnes of sulfur dioxide emissions, or 5.5 percent of 2005 levels; and cut carbon dioxide emissions by 164 million tonnes, about 3.2 percent of 2005 levels.**

Status of CCS

Post Combustion Capture by Coal Power Investment

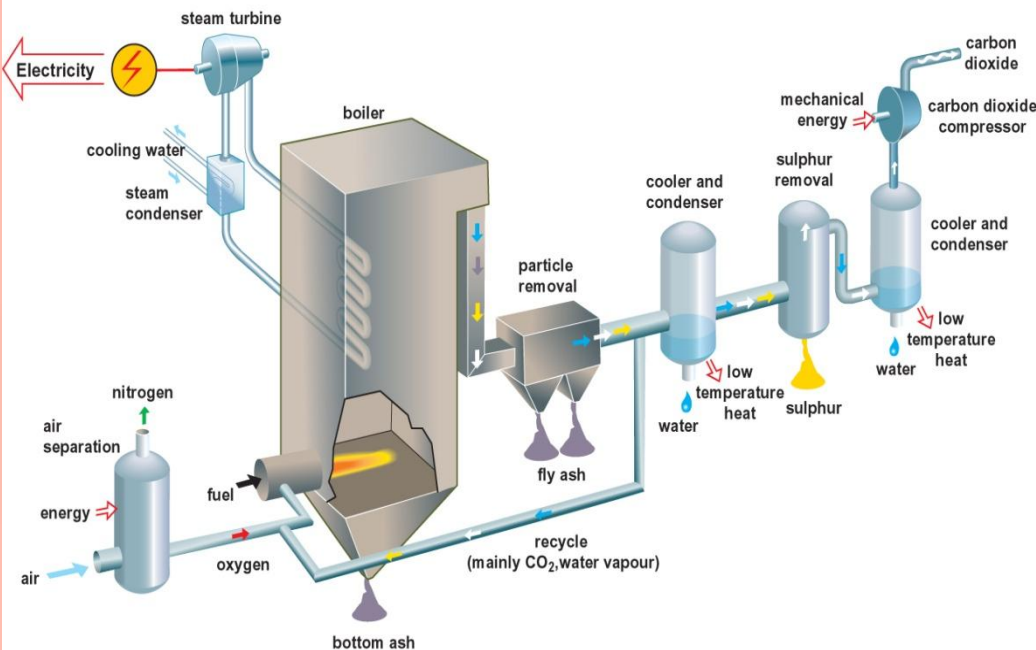


At Chongqing Hechuan Shuanghuai 2x300MWe Power Plant . First operated in January 2010. Annual CO₂ capture capacity is 100000tonnes. This unit is part of a range of test units assessing various environmental control systems, including SO₂, mercury and NO_x.

Vattenfall Oxy Fuel Technology (Courtesy Vattenfall)

**The size of the plant is about 30 MWth
Operational since late 2008
Located at Schwarze Pumpe in Germany
Trials with lignite and hard coals**

O₂/CO₂ recycle (oxyfuel) combustion capture



250MWe IGCC under construction at Tianjin

(Phase 1 of the Greengem project)



CCS activities using low rank coals - Projects and proposals

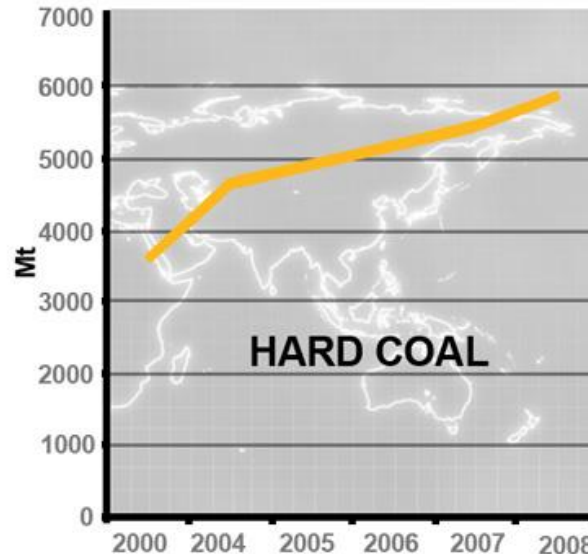
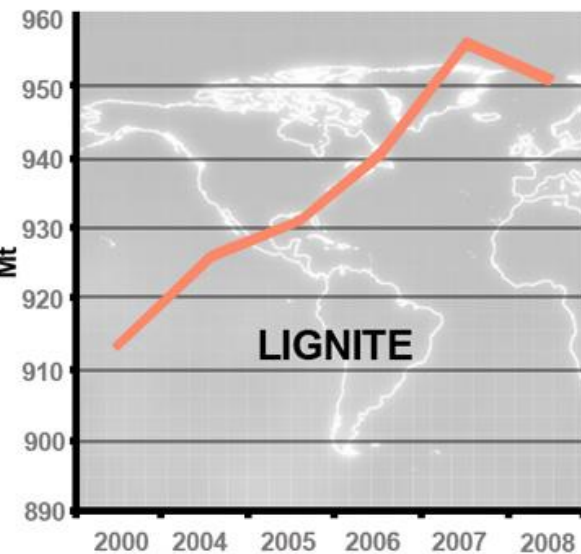
Developer	Location	Fuel
Post-combustion capture		
International Power	Hazelwood, Australia	Lignite
International Power, Loy Yang Power, CO2CRC	Loy Yang	Lignite
Dakota Gasification	North Dakota, USA	Lignite
SaskPower	Poplar River, Canada	Lignite
CEZ	Ledvice, Czech Republic	Lignite
CEZ	Hodonin, Czech Republic	Lignite
RWE and others	Niederaussem, Germany	Lignite
PGE	Belchatow, Poland	Lignite
PCOR	Montana/Dakota, USA	Lignite
Basin Electric, Powerspan	Antelope Valley, USA	Lignite
NRG, Powerspan	WA Parish, Texas, USA	Subbit
Tenaska	Sweetwater, Texas, USA	Lignite
We Energies, Alstom	Pleasant Prairie, USA	Subbit
Oxy-fuel combustion		
Vattenfall	Schwarze Pumpe, Germany	Lignite, bit. coals
Vattenfall	Jaanschwalde, Germany	Lignite
KOSEP, KEPRI	Youngdong, South Korea	Subbit
B&W, Air Liquide	Barberton, USA	Lignite, subbit, bit. coals

Developer	Location	Fuel
Gasification + CCS		
Perdman, Samsung	Collie, Western Australia	Subbit
Sherritt International	Alberta, Canada	Subbit
IGCC + CCS		
Monash Energy and others (on hold)	Latrobe Valley, Australia	Lignite
TET	Maritsa, Bulgaria	Lignite
na	Low Energy Lignite Project	Lignite
EPCOR (on hold)	Genesee, Canada	Subbit
RWE and others (on hold)	Huerth, Germany	Lignite
ATI Sulcis	Sardinia, Italy	Subbit blends
ELCOGAS	Puertollano, Spain	Subbit-petcoke
FutureGen	Mattoon, USA	Subbit + bit. coals
Excelsior Energy	Mesaba, USA	Subbit + bit. coals
Mississippi Power, Southern Co.	Kemper County, USA	Lignite
Summit Power - NowGen	Odessa, USA	Subbit
Texas Energy/Luminant	Texas, USA	Subbit + lignite
Wallula Resource Recovery	Wallula, USA	Subbit

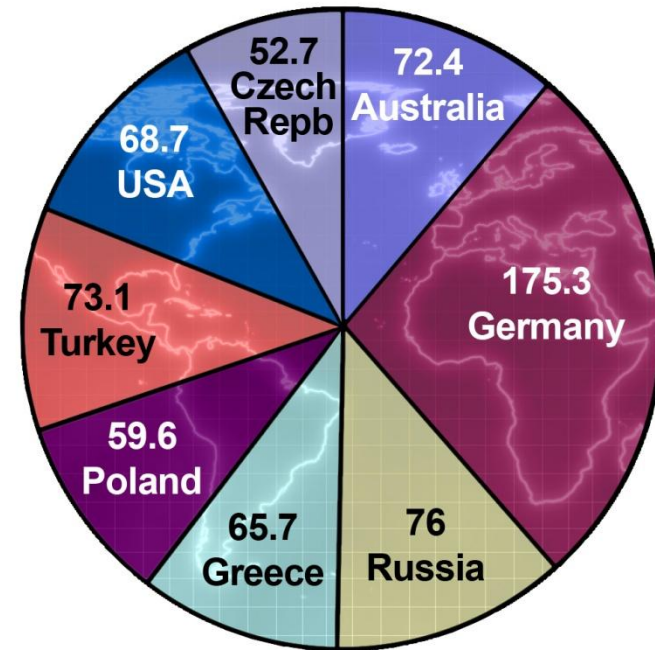
World Lignite Production

- Deposits widespread
- 14 countries produce >20 Mt/y
- More than 20 other smaller producers
- Total global Lignite output 951 Mt (2008)

Lignite and hard coal production (2000-08)



Bigger lignite Producers (Mt/y)



CCS Barriers and Hurdles

Barriers and Hurdles are primarily non-technical

- **Real Political will – global agreement lacking**
- **Regulation**
- **Finance**
- **Social acceptability of Transport Routes and Storage**

CONCLUSIONS

- **Even if ambitious targets for achieving 450ppmCO₂ are achieved, the world will still be using very substantial amounts of coal**
- **Coal use will be increasingly in developing countries where pressures to maintain economic growth and increase living standards could take precedence.**
- **Decarbonising power and industrial use requires thousands of projects, will cost around several trillion \$ and will encompass, coal and gas fired power, large industrial use of fossil fuels and after 2030 be very dependent on actions in non-OECD countries**
- **Immediate action is required for sustainability and much of it to address non-technical issues**



THE END

Thank you for Listening

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