The 27th Annual
INTERNATIONAL PITTSBURGH
COAL CONFERENCE

Plenary Lecture: International Issues

Realities & Constraints of Coal from Energy and Environmental Perspectives

Professor Ekrem EKINCI

President, Isık University

October 11 – 14, 2010

1972-1976 PhD dissociation of hydrogen molecules to atoms

A novel electricity generation

I. & II. oil crisis and embargo

Time to do research on coal

Never appropriate response but interest renewed without fail

FBC of low grade Turkish fossil fuels

Liquefaction and pyrolysis of lignites, oil shales and asphaltites

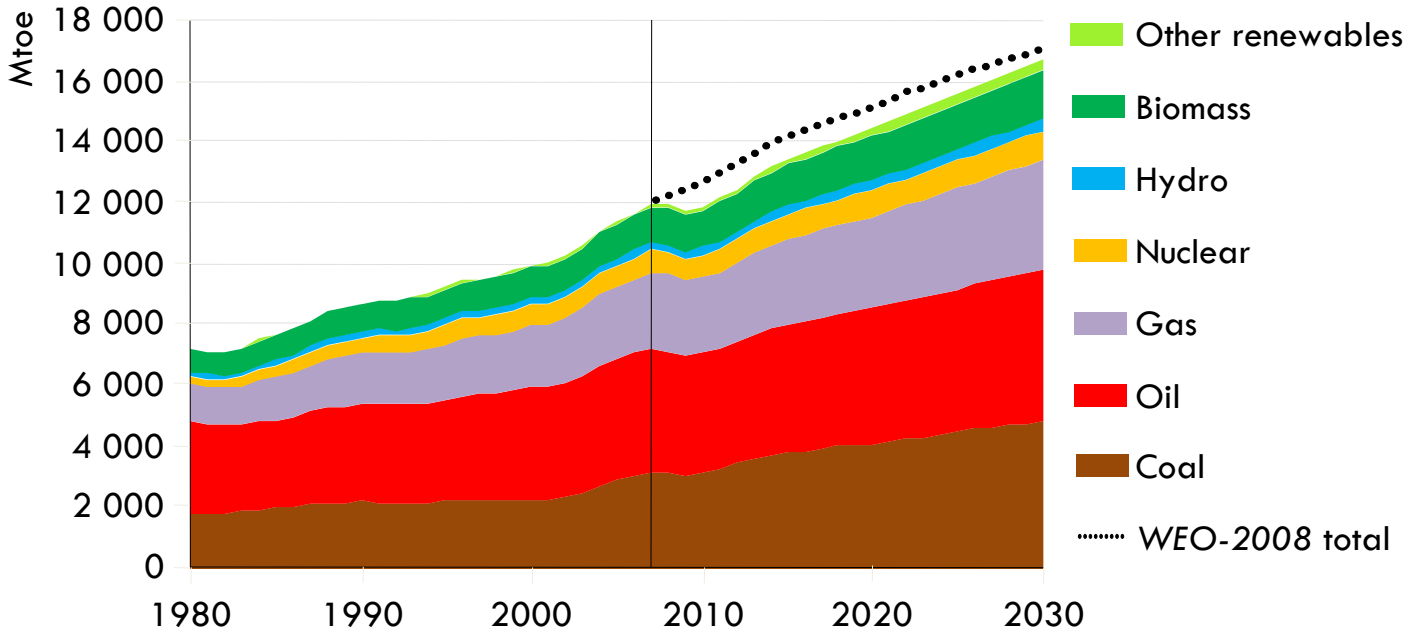
Carbon materials

Transportation , urbanisation, industrialisation,
population growth,emerging mega economics
Increasing energy utilisation & demand
Increasing compliance to environmental regulations

Interphase between sustainability & catastrophe
Nothing like the dilemnas before (climatic episodes)

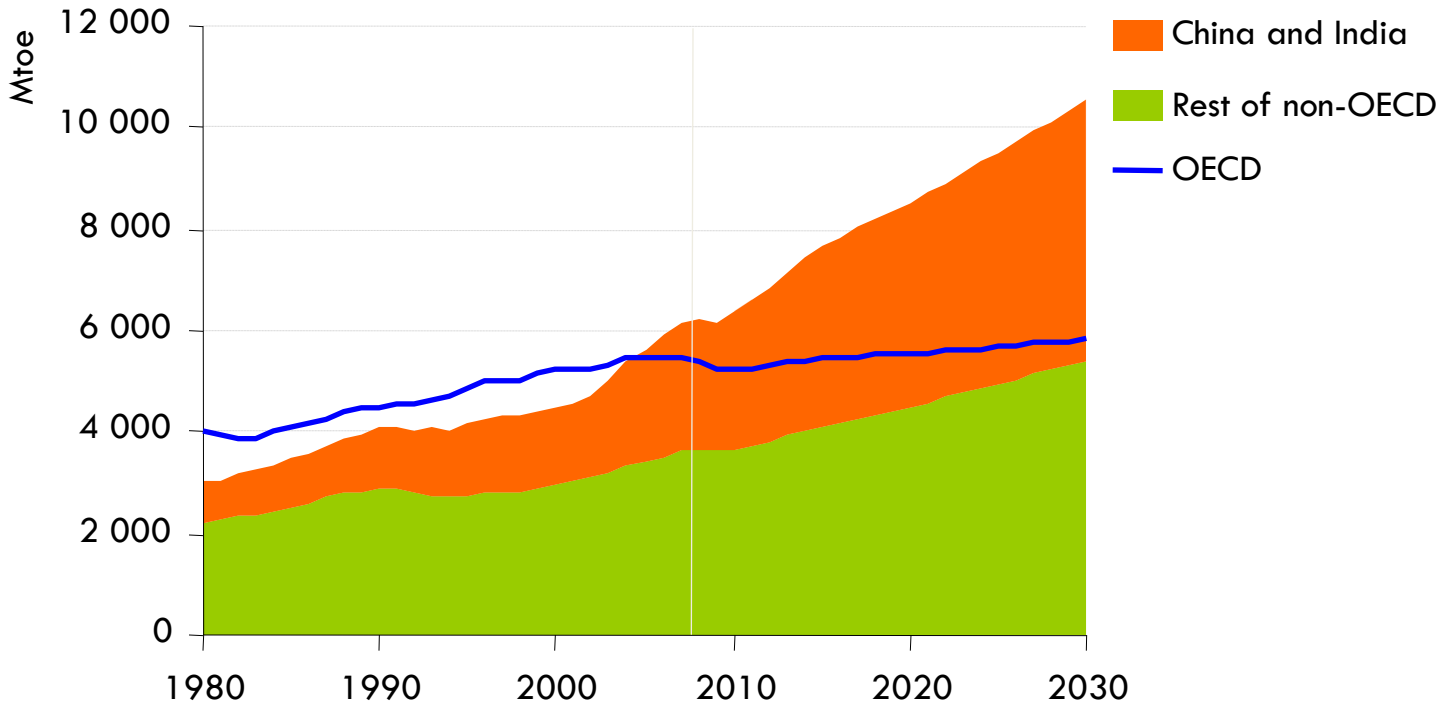
Where are we going in terms of energy, particularly coal?
IEA data, special thanks to Fatih Birol
What is the role of coal in addressing GLOBAL WARMING?

World primary energy demand by fuel in the Reference Scenario



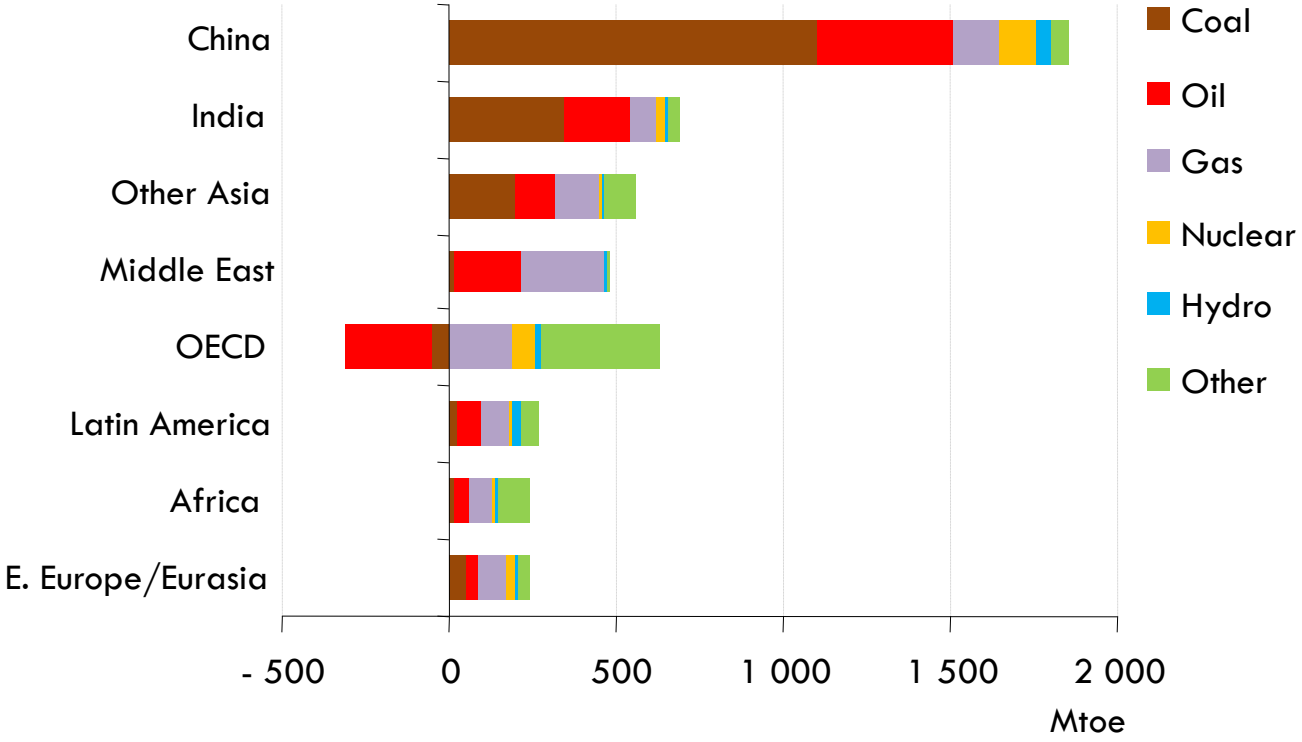
Global demand grows by 40% between 2007 and 2030, with coal use rising most in absolute terms, IEA

World primary energy demand in the Reference Scenario



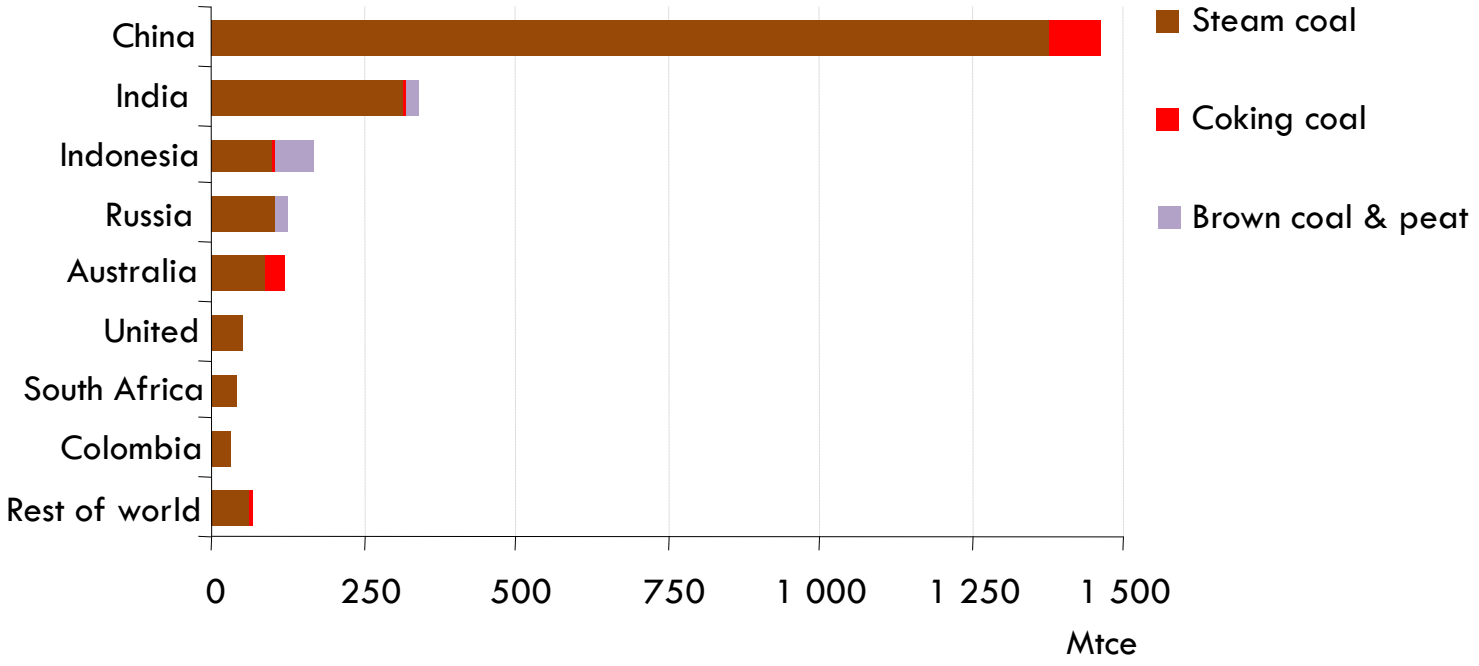
Non-OECD countries account for 93% of the increase in global demand between 2007 & 2030, driven largely by China & India (IEA)

Change in primary energy demand by fuel in the Reference Scenario, 2007-2030



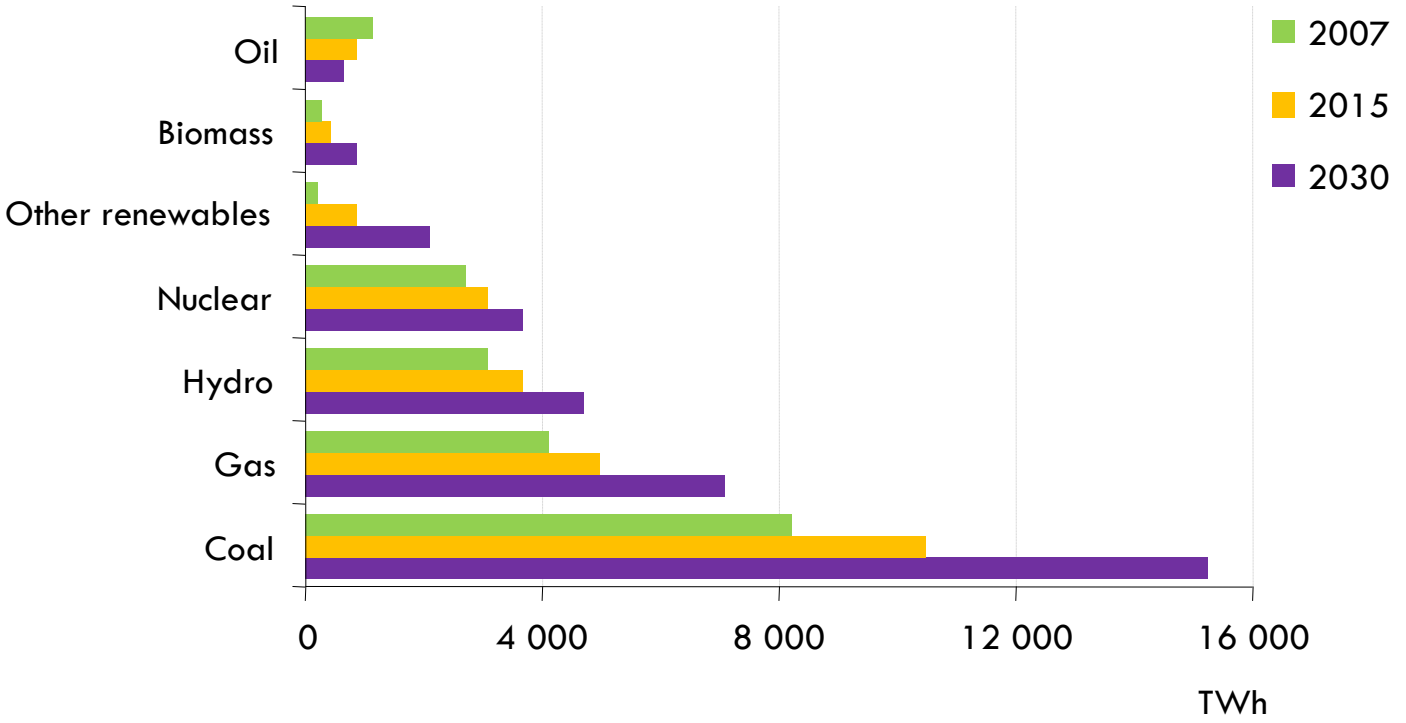
The increase in China's demand for energy – for coal in particular – dwarfs that of all other countries & regions (IEA)

Change in coal production by type & region in the Reference Scenario, 2007-2030



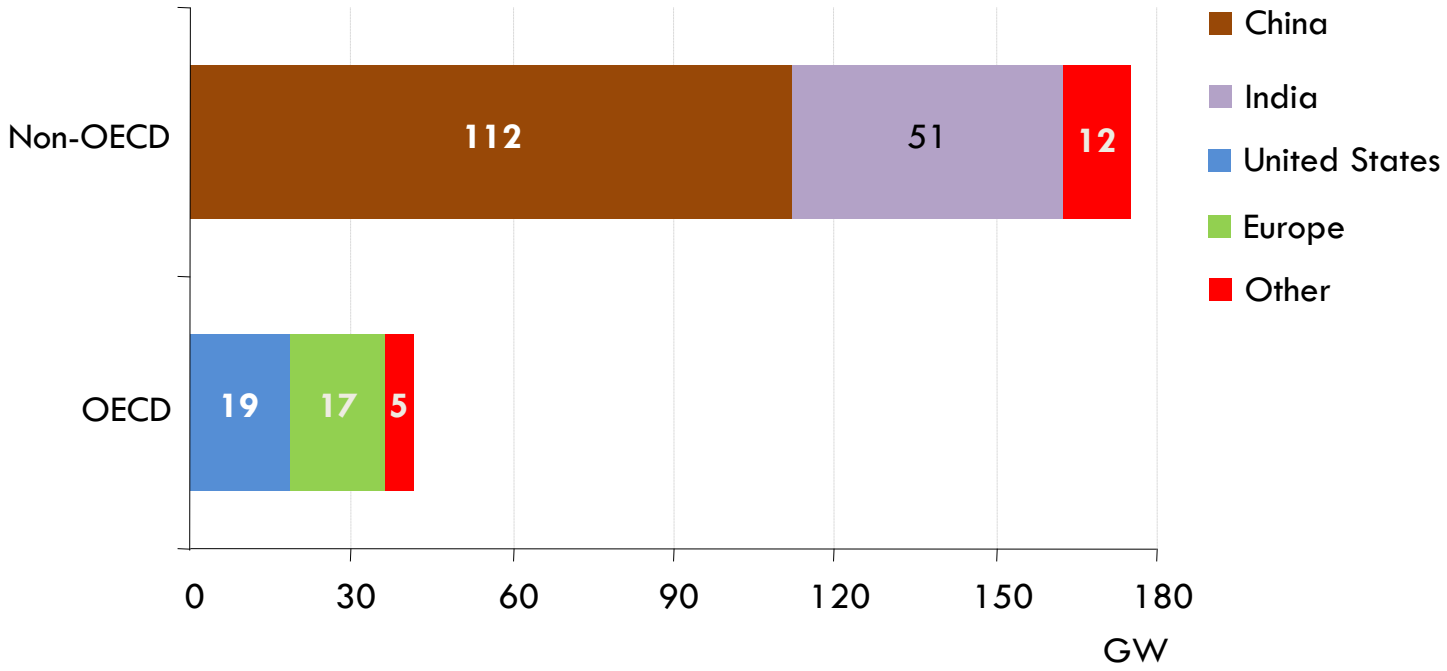
Over 60% of the growth in coal output in 2007-2030 is projected to come from China, as it strives to satisfy a near-doubling of domestic demand (IEA)

World electricity generation by fuel in the Reference Scenario



Power generation based on all types of energy except oil is projected to grow, with the biggest increases in absolute terms coming from coal- and gas-fired capacity (IEA)

Coal-fired power-generation capacity under construction by country



The bulk of coal-fired capacity currently being built is in non-OECD countries – more than half of the world total in China alone (IEA)

Implications of the energy trends in the Reference Scenario, IEA

- Current energy trends are patently unsustainable — *environmentally, economically & socially*
- Rising CO_2 emissions imply an inevitable rise in global greenhouse-gas concentration & potentially catastrophic climate change
- Increasing oil & gas imports & prices threaten to exacerbate energy insecurity
- Current energy trends in the least-developed regions would leave millions dependent on traditional fuels & lacking access to electricity

Australia, Canada, China, India, Japan, South Korea, USA, administration support group

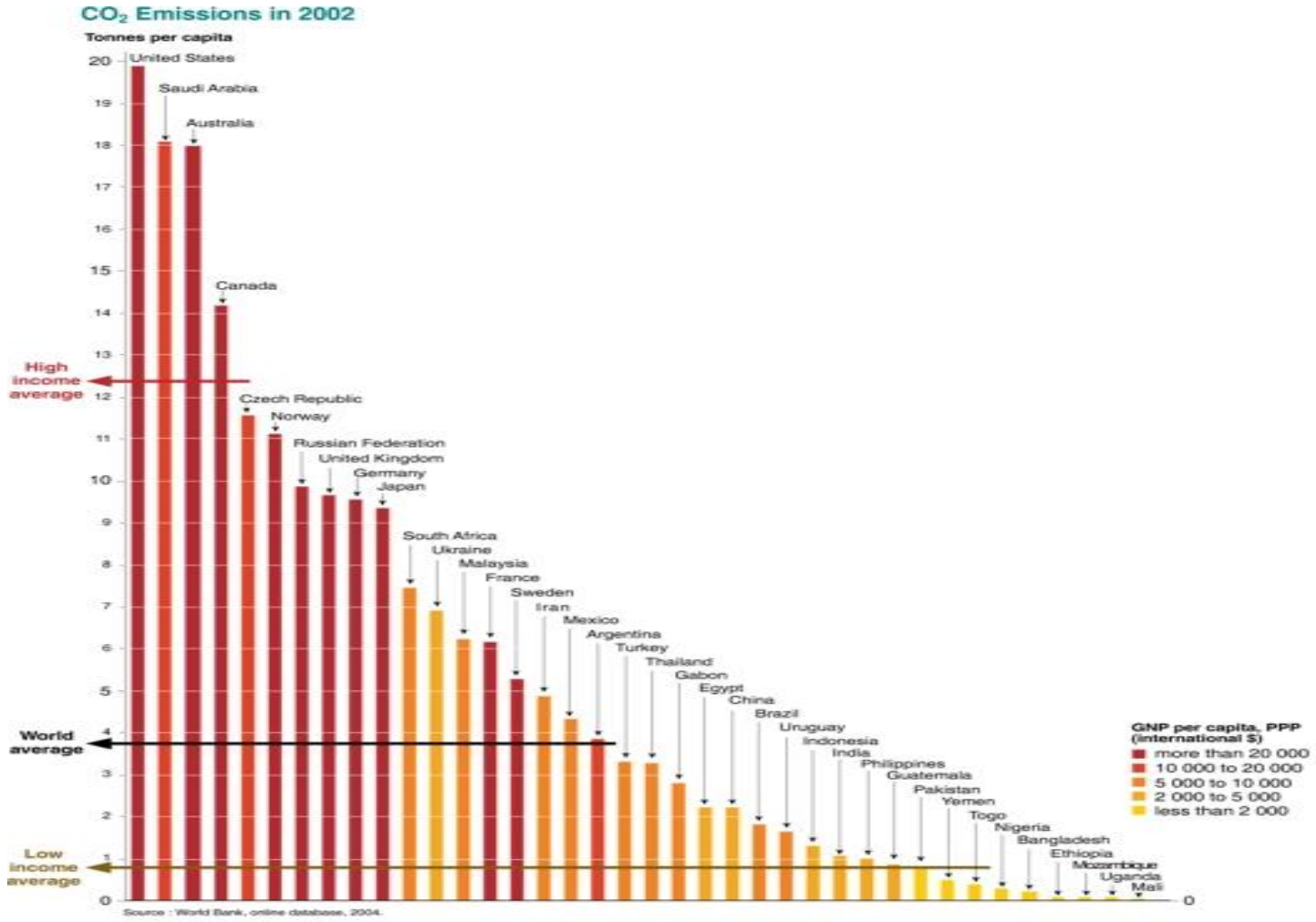
Yearly average atmospheric T increase scenario 2˚C

Population increase + energy demand

If business as usual, equilibrium warming range 1990 to 2100, EPA

low	2.3 ˚C
best guess	4.8 ˚C
high	10.1 ˚C

2.5 ˚C warming, a monumental challenge


CO_2 Emissions in 2002
Tonnes per capita
United States
Saudi Arabia
Australia
Canada
Czech Republic
Norway
Russian Federation
United Kingdom
Germany
Japan
South Africa
Ukraine
Malaysia
France
Sweden
Iran
Mexico
Argentina
Turkey
Thailand
Gabon
Egypt
China
Brazil
Uruguay
Indonesia
India
Philippines
Guatemala
Pakistan
Yemen
Togo
Nigeria
Bangladesh
Ethiopia
Mozambique
Uganda
Mali
High income average
World average
Low income average
GNP per capita, PPP (international $)
more than 20 000
10 000 to 20 000
5 000 to 10 000
2 000 to 5 000
less than 2 000
Source : World Bank, online database, 2004.

Debating a clean coal future, Toni Johnson
www.cfr.org/publications/....

Most vexing question for policy makers regarding responsibility of climate change is therefore, What swift action is needed to mitigate climate change?

Biggest responsibility lays on
China & USA (60%) and India & later whoever else
Coal and petroleum communities have direct responsibility to find solutions to reduce harmful effects

450 Scenario is low-carbon energy technologies and energy efficiency programme to avoid severe climate change by 2030

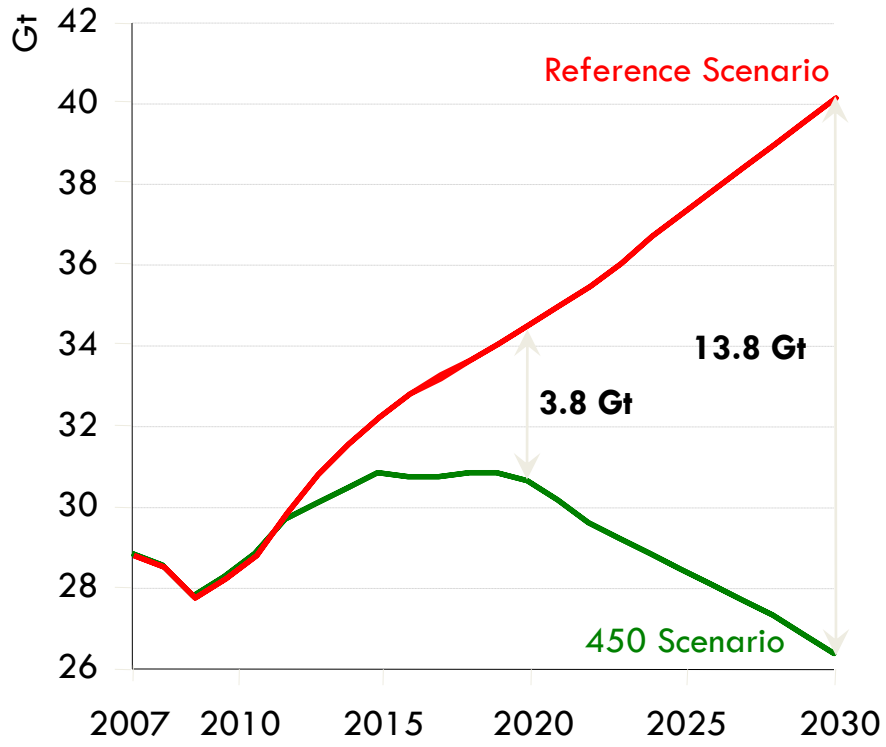
Expected to improve economics, health and energy-security

Cumulative incremental investment of $10.5 trillion is needed compared to reference scenario

Agreement on instruments, incentives and financing of investments in non-OECD countries is still not clear

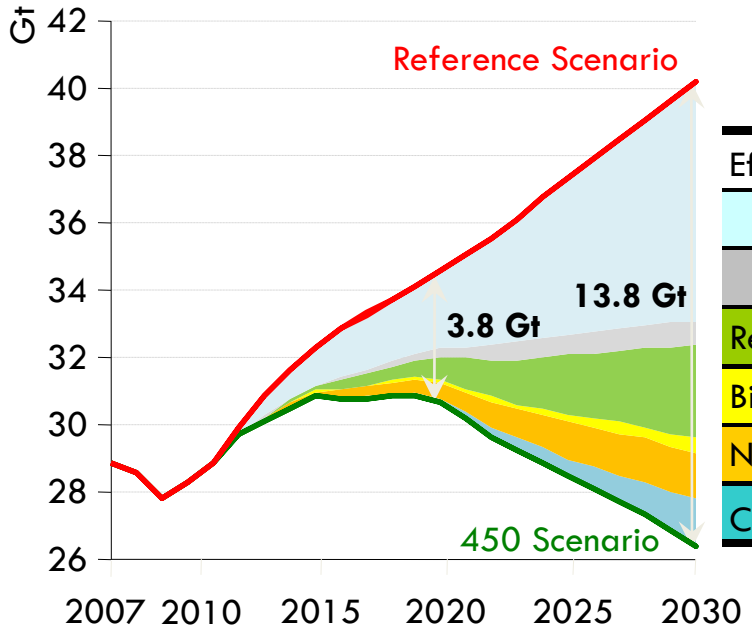
In 450 Scenario in OECD countries carbon price reaches $50 pt of CO2 in 2020 and $110 in 2030

Energy-related CO_2 emissions by scenario



In the 450 Scenario, emissions peak before 2020 at 30.9 Gt, falling to 26.4 Gt by 2030 – almost 14 Gt lower than in the Reference Scenario (IEA)

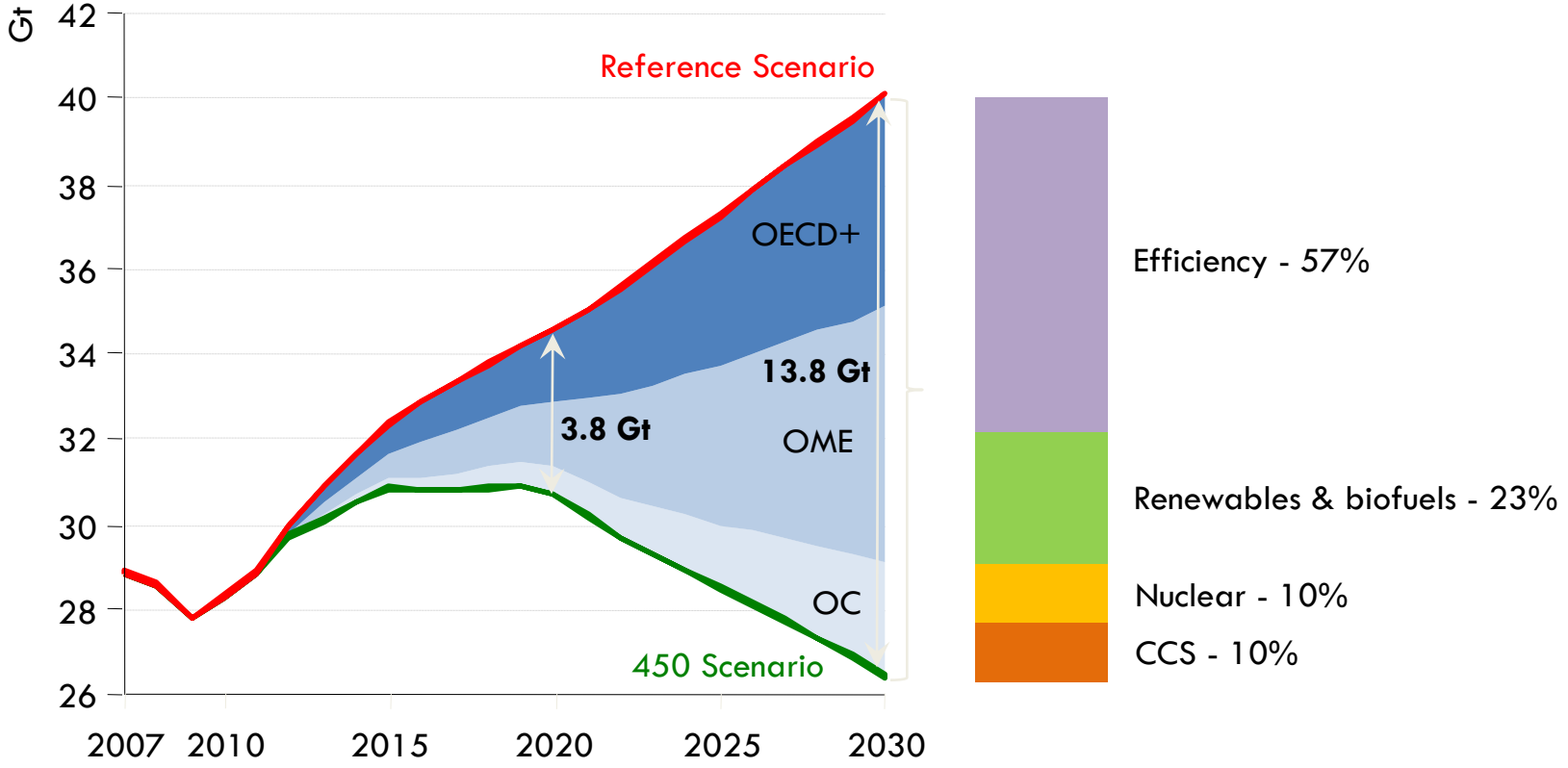
World abatement of energy-related CO_2 emissions in the 450 Scenario



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

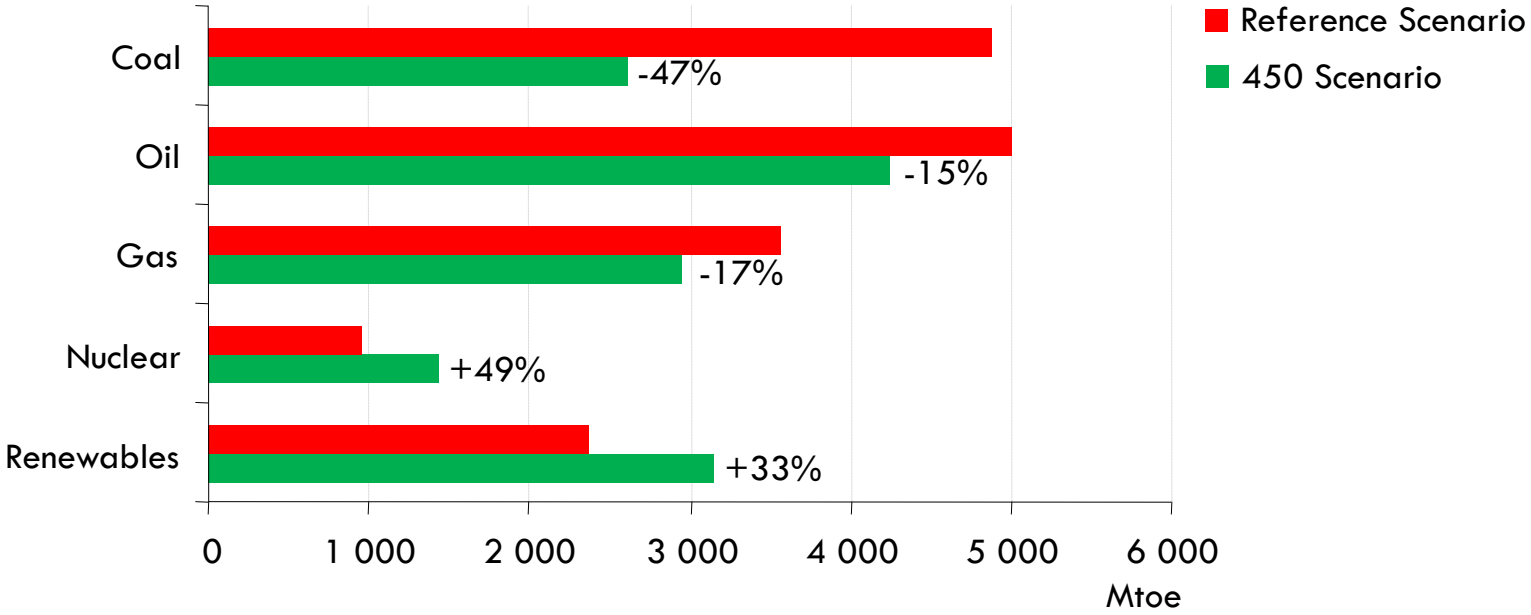
Efficiency measures account for two-thirds of the 3.8 Gt of abatement in 2020, with renewables contributing close to one-fifth (IEA)

World abatement of energy-related CO_2 emissions in the 450 Scenario



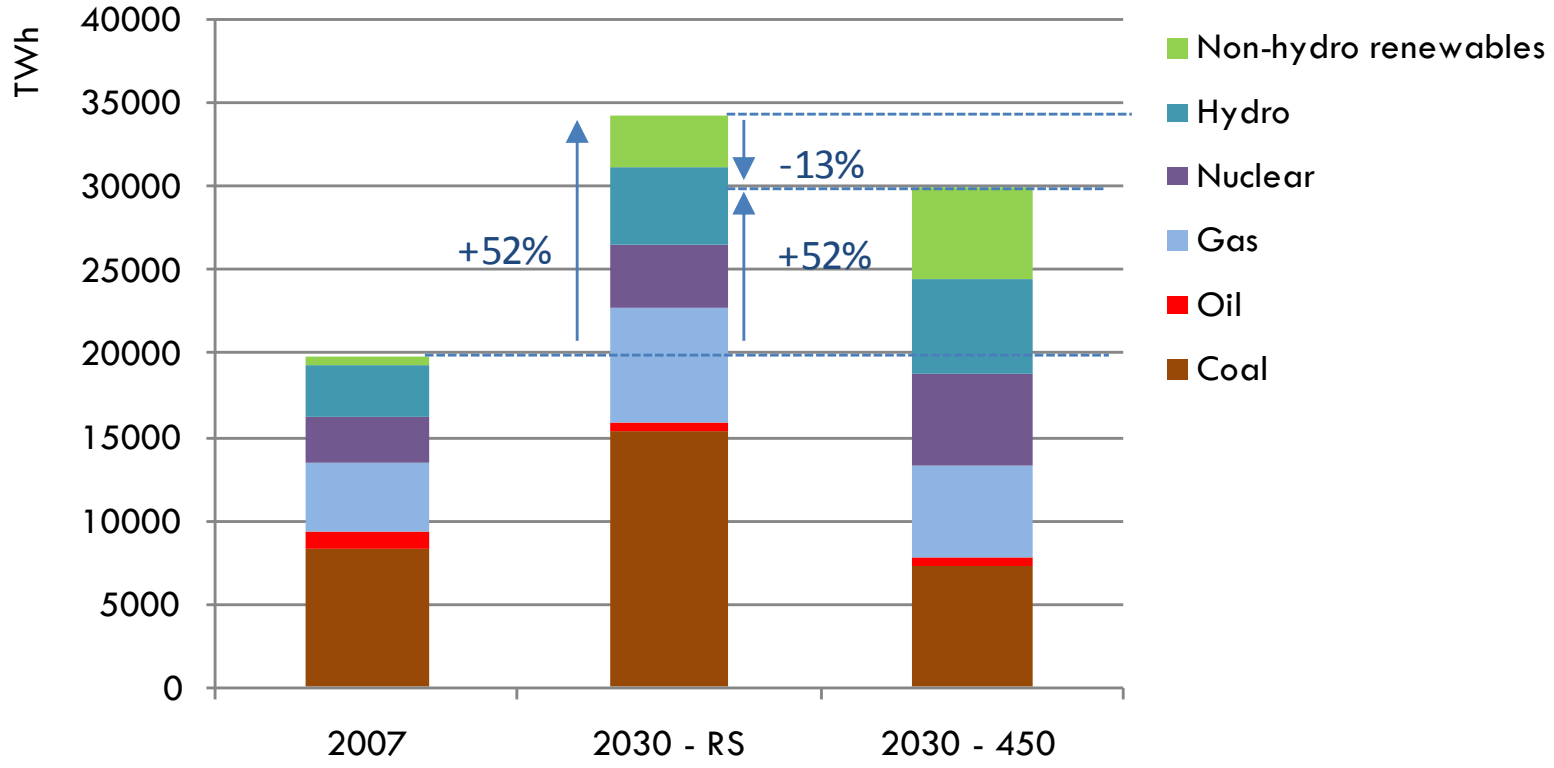
Efficiency measures comprise two-thirds of the abatement in 2020, and 57% in 2030. Renewables contribute around one-fifth of the total emissions reduction. (IEA)

World primary energy demand by fuel & scenario in 2030



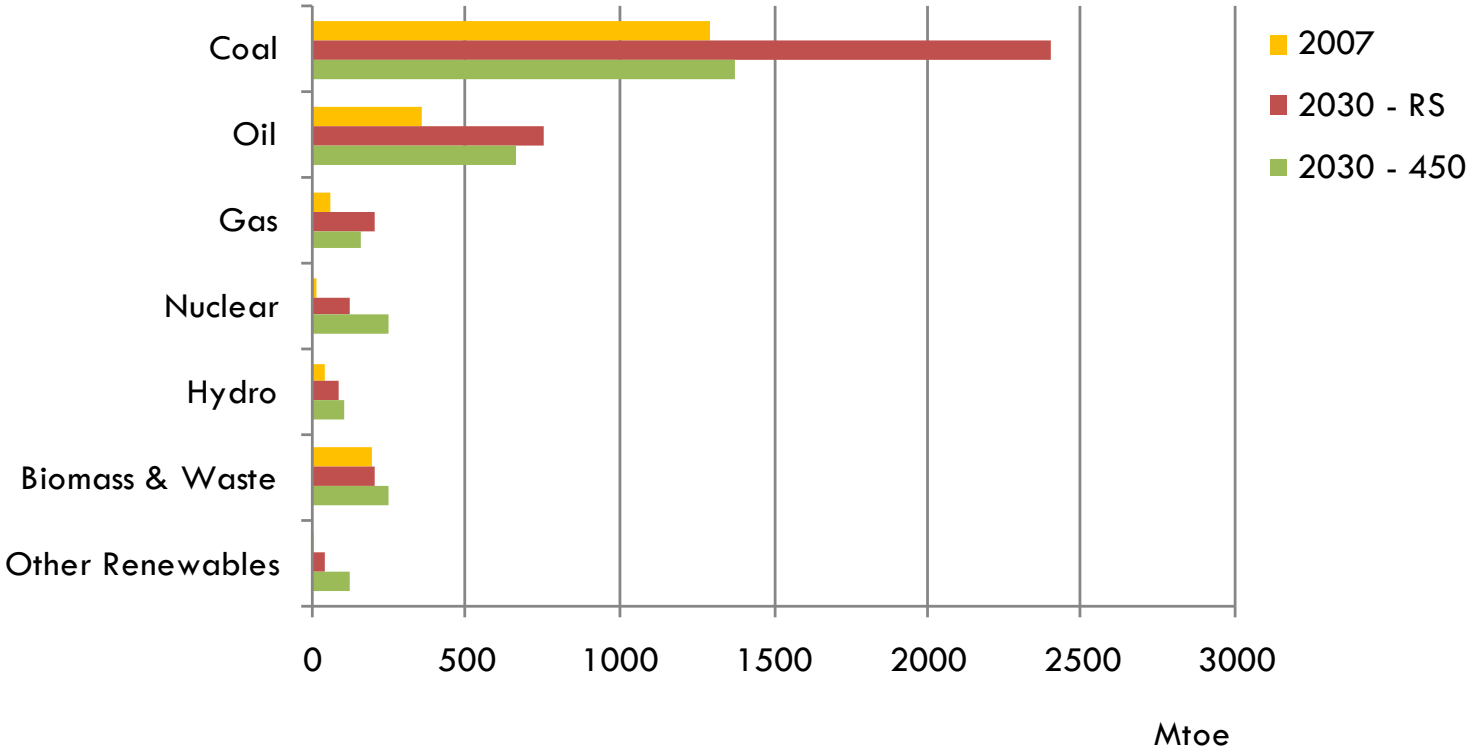
The share of fossil fuels in total primary energy demand in the 450 Scenario declines from 81% today to 68% in 2030, with gas remaining at close to today's levels of 20% (IEA)

World electricity generation by fuel & scenario



Among the fossil fuels, coal use falls the most in power generation in the 450 Scenario, partially offset by stronger growth in nuclear power & renewables-based technologies (IEA)

Primary energy demand in China by fuel & scenario



Coal use barely rises above 2007 levels by 2030 in the 450 Scenario – a huge reduction on the Reference Scenario – thanks to electricity savings & switching to low-carbon technologies (IEA)

Is there a chance of success?
Has there been any example?
Kofi Annan, Montreal Protocol (MP), “May be the most successful international agreement so far’’
Turkey was one of the last signing countries of Kyoto Protocol not exactly the real solution
But one of the most successful countries in the execution of the Montreal Protocol
A sound material basis for the problem
Similar approach

Past accomplishments for coal sector
1970 – 2007

Electricity : +187 %
Emissions : - 84%

USA presidential candidates
80% 60%

Cap and trade a market-based approach to control pollution by providing economic incentive for achieving reductions in emissions of pollutants

A central authority sets a limit or *cap* on emissions

Limit or cap is allocated or sold to firms as right to emit or discharge a specific volume of the specified pollutant

Permits cannot exceed the cap, limiting total emissions to a specified level

Firms that need to increase their emission permits must buy them from those who require fewer permits

Coal versus Natural Gas

Albo, etal, Environmental sustainability assessment of clean coal combustion compared to natural gas combustion: carbon footprint, VII Eur. Cong. of Chem. Eng. Prague, 2010
Conducted using I Chem E sustainability matrix and social environmental and economic aspects,
atmospheric, aquatic and land impacts

electricity production primary footprint for 1 Kw
1261 g CO_2 for hard coal and 536 g CO_2 for natural gas

Carbon capture & storage, new technologies, efficiency
Efficiency paradigm shift to higher temperature and new materials and combustion technologies, generation and transportation
Important since carbon capture and storage may reduce energy efficiency by as much as 40%
Energy conservation especially for new energy users worldwide funds

Driving force for proven technologies is not strong enough
Environmentally coal needs to catch up with gas
Alternative energy sources enjoying favouritism
Closing up the price difference will end coal's role as main energy source
Chemicals from coal, ash, etc. integration where possible
If not anticipated, coal will be known as the villain, culprit and bad boy of the pack
We do need to clean our back yard

It is getting harder to harness energy from coal
There is no sensible scenario where coal can be neglected
Capture technologies up to 95% is at least a decade away from deployment
So let us use the coming one or two decades to make coal the energy supplier of the future
International cooperation and colossal funding most needed

C footprint – Global, trading system
Water footprint – Local, no trading system
LONG TERM RESPONSIBILITY & LONG TERM COST
Waste water treatment/Petroleum based industrial culture mix and treat
Refining and defining role to coal and oil shale industries must go through petroleum culture

Environmental Footprint of Energy Production: Process Engineering Challenges, **P. A. Tanguy** (Total SA, FR), VII Eur. Cong. of Chem. Eng. Prague, 2010

INNO Energy: 11 countries, 10 Research Institutes and 14 Universities

Coal sector bad guys in the block
UK integrated efforts
100 km 3.2 lt gasoline 5 years

Concluding Remarks

- International cooperation is key issue
- Current level of policy agreement on cap and trade is a starting point but needs to follow with realistic and solid policies
- Major technological advances needed, CCS
- Coordinated approach between coal and petroleum and other related sectors essential
- Huge amount of funds needs to be raised

- Future price of fossil fuels must address cost of research, R&D and investment expenses for control of greenhouse gases
- For international success, previous agreements should be considered

  Ozone Depleting Substances Control, Montreal Treaty

Acknowledgments

Special thanks to:

Fatih Birol of EIA

Professors H. Atakül, M.F. Yardım and H. Okutan and other students who produce work on Turkish coals

Prof. K.D. Bartle of Leeds University and

Prof. Alec Gaines who inspired me in coal research

TKI (S.Anaç)

Prof. Güven Önal who put in a tremendous amount of work to bring the prestigious International Pittsburgh Coal Conference to Istanbul