



World Energy Outlook and the World Energy Model

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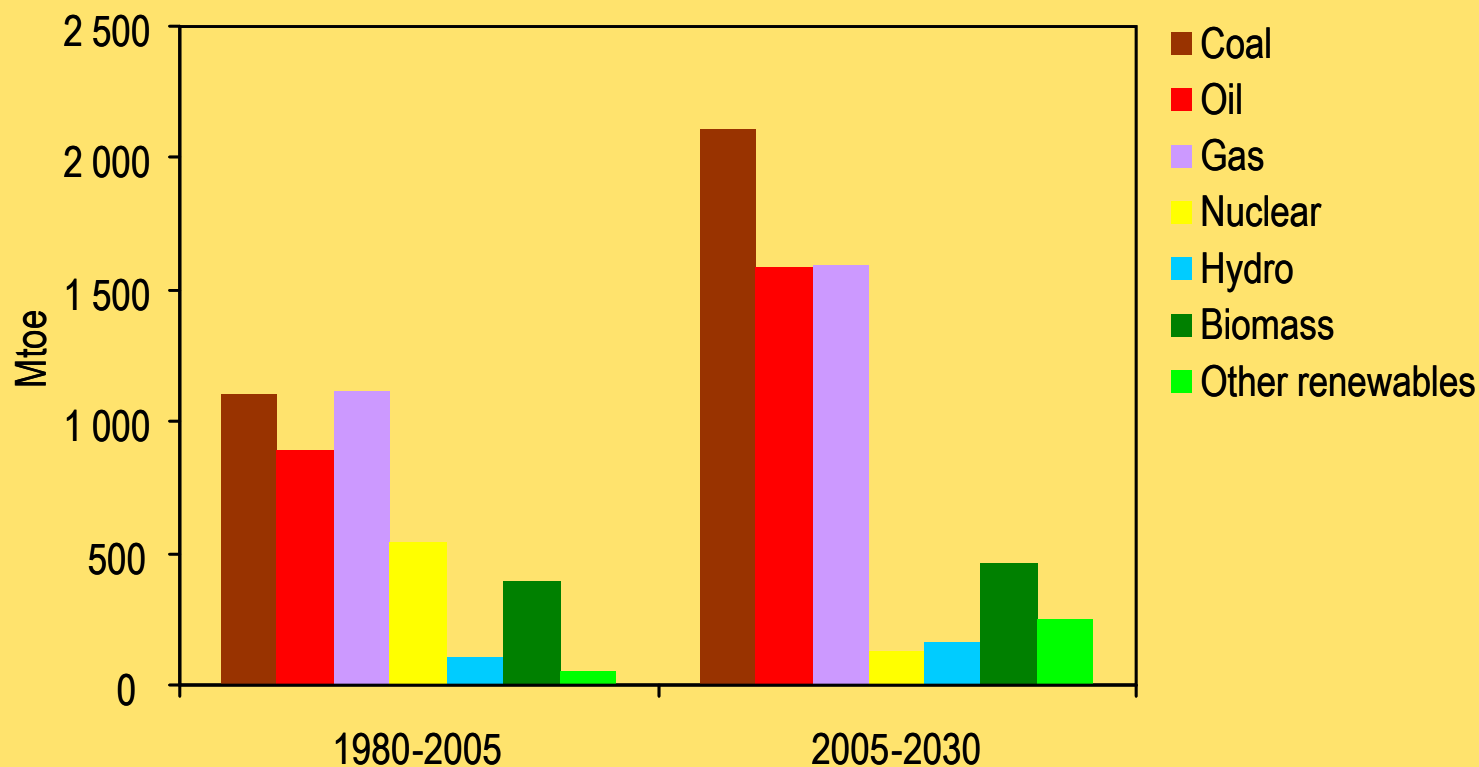
IEW 30 June- 2 July 2008, IEA, Paris



Key Lessons from WEO-2007



Reference Scenario: Increase in World Primary Energy Demand



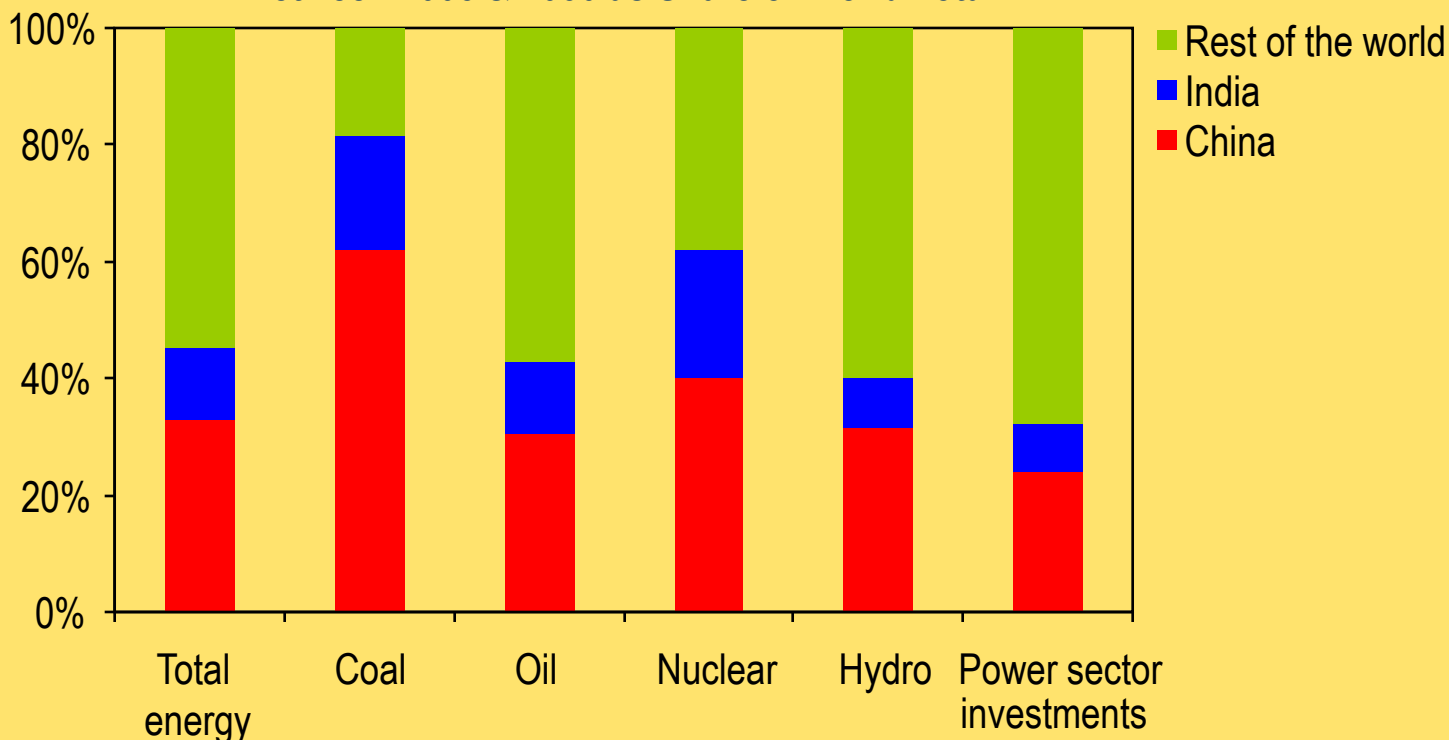
Global demand grows by more than half over the next quarter of a century, with coal use rising most in absolute terms

The Emerging Giants of World Energy

WORLD ENERGY OUTLOOK 2007

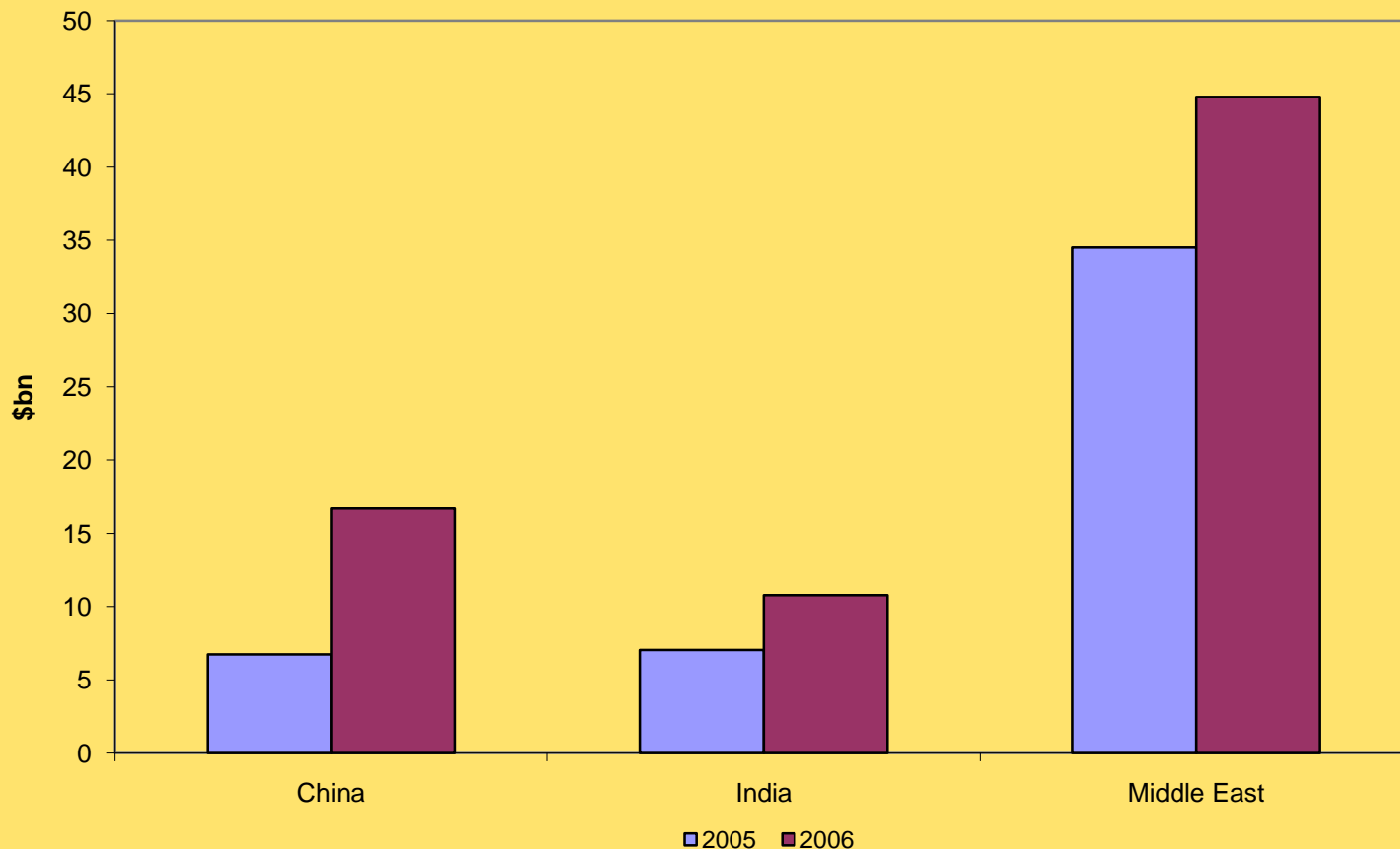
China and India Insights

Increase in Primary Energy Demand & Investment Between 2005 & 2030 as Share of World Total



China & India will contribute more than 40% of the increase in global energy demand to 2030 on current trends

Subsidies to Oil Products, 2005-2006



Increase in international oil prices is not passed to consumers in countries where bulk of oil demand is generated



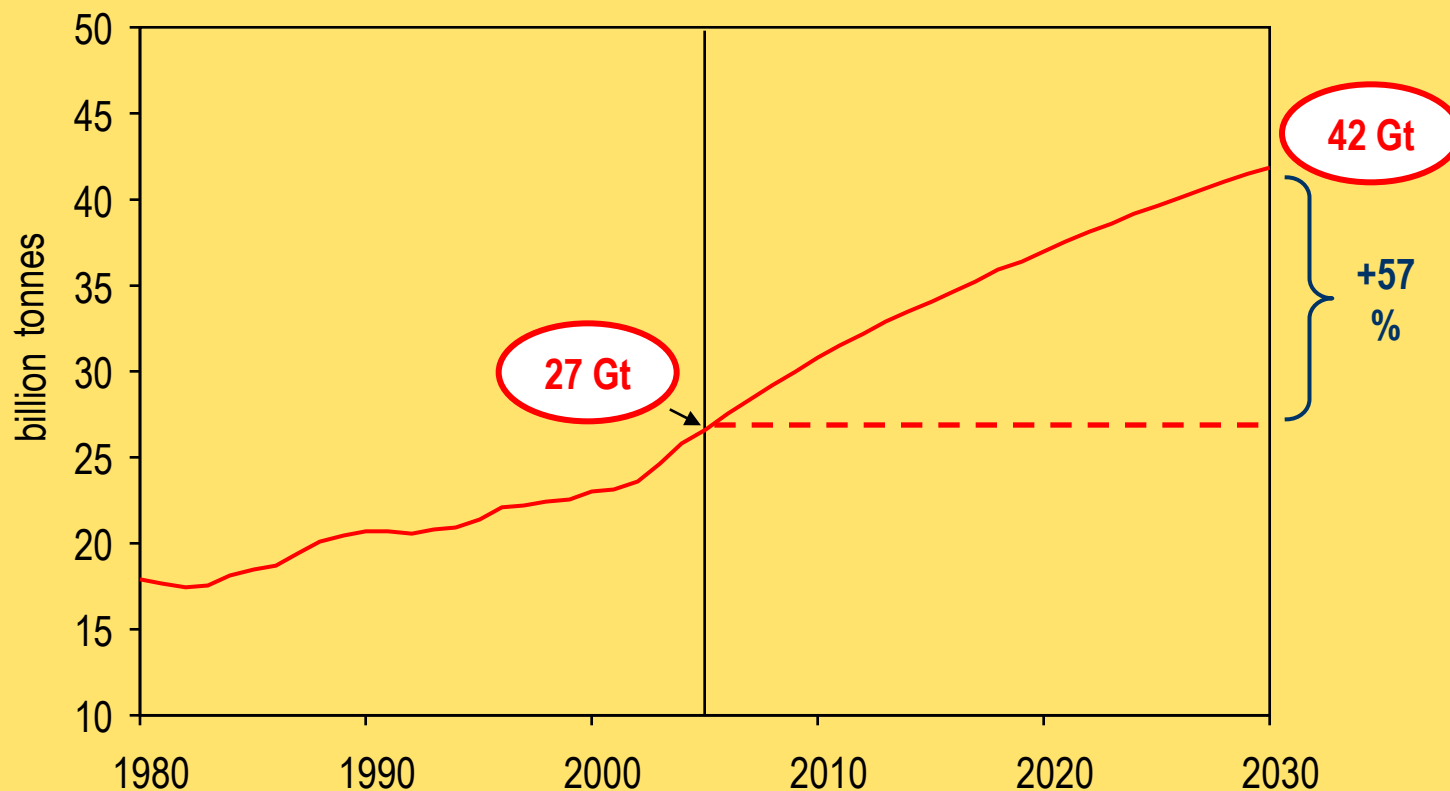
Global Oil Supply Prospects to 2015

- Oil supply/demand balance is set to remain tight
- In total, 37.5 mb/d of gross capacity additions needed in 2006-2015
 - *13.6 mb/d to meet demand & rest to replace decline in existing fields*
- OPEC & non-OPEC producers have announced plans to add 25 mb/d through to 2015
- Thus, a further 12.5 mb/d of gross capacity would need to be added or demand growth curbed

Global CO₂ Emissions and Climate Change

WORLD
ENERGY
OUTLOOK
2007

China
and India
Insights



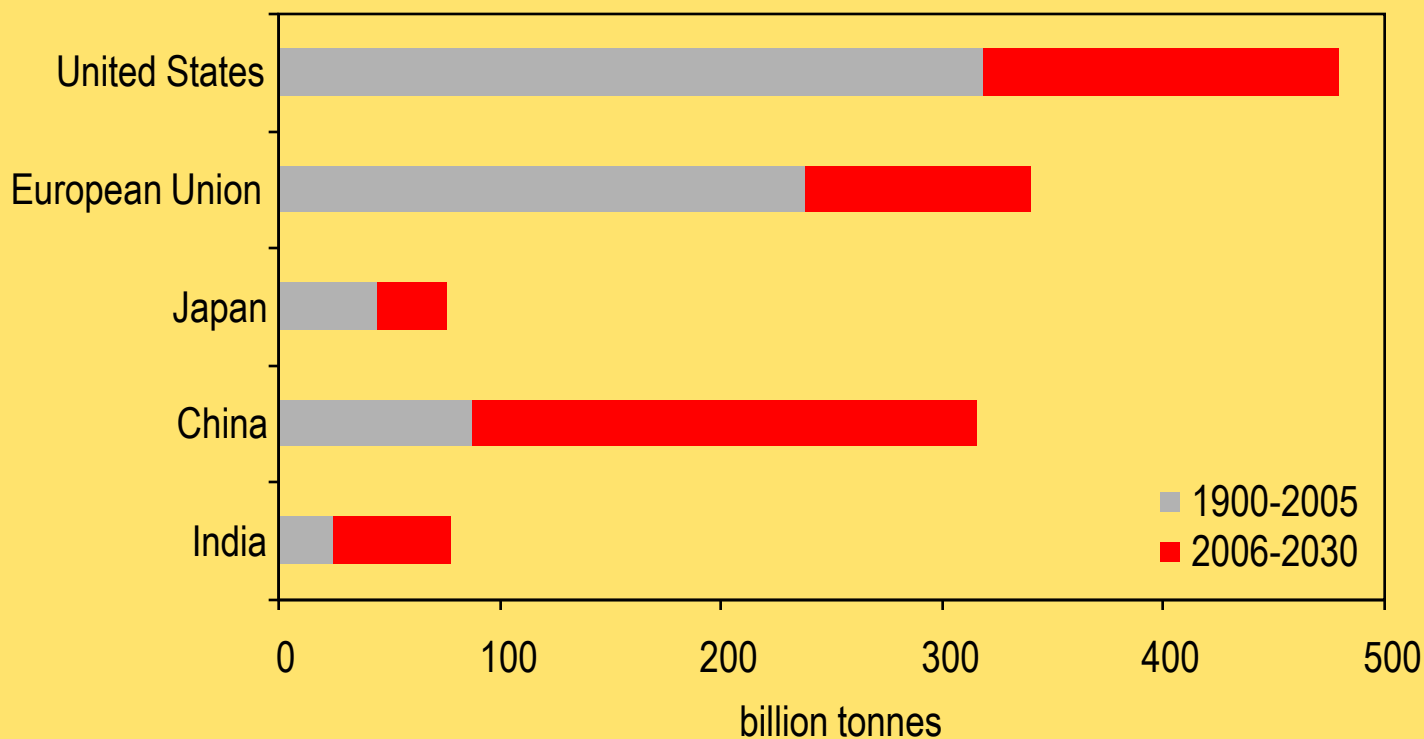
Global CO₂ emissions rise to 42 gigatonnes in 2030, 57% above current levels and double the 1990 level

China & India in Global CO₂ Emissions

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Insights

Cumulative Energy-Related CO₂ Emissions



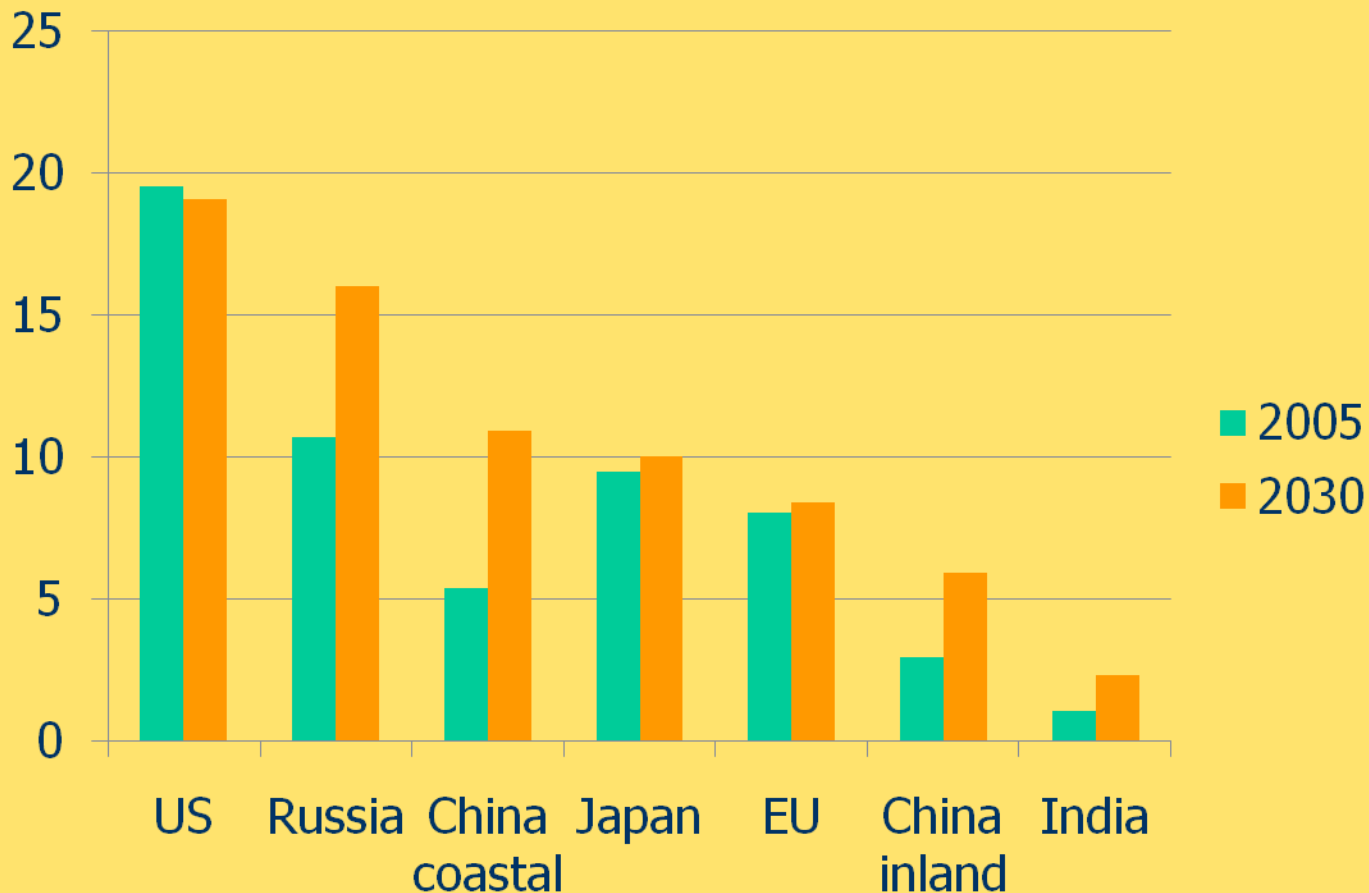
Around 60% of the global increase in emissions in 2005-2030 comes from China & India

World's Top Six CO₂ Emitters

	2005		2015		2030	
	Gt	rank	Gt	rank	Gt	rank
US	5.8	1	6.4	2	6.9	2
China	5.1	2	8.6	1	11.4	1
EU	3.9	3	4.0	3	4.2	3
Russia	1.5	4	1.8	5	2.0	5
Japan	1.2	5	1.3	6	1.2	6
India	1.1	6	1.8	4	3.3	4

China becomes the largest emitter in 2007 & India the 4th largest by 2015

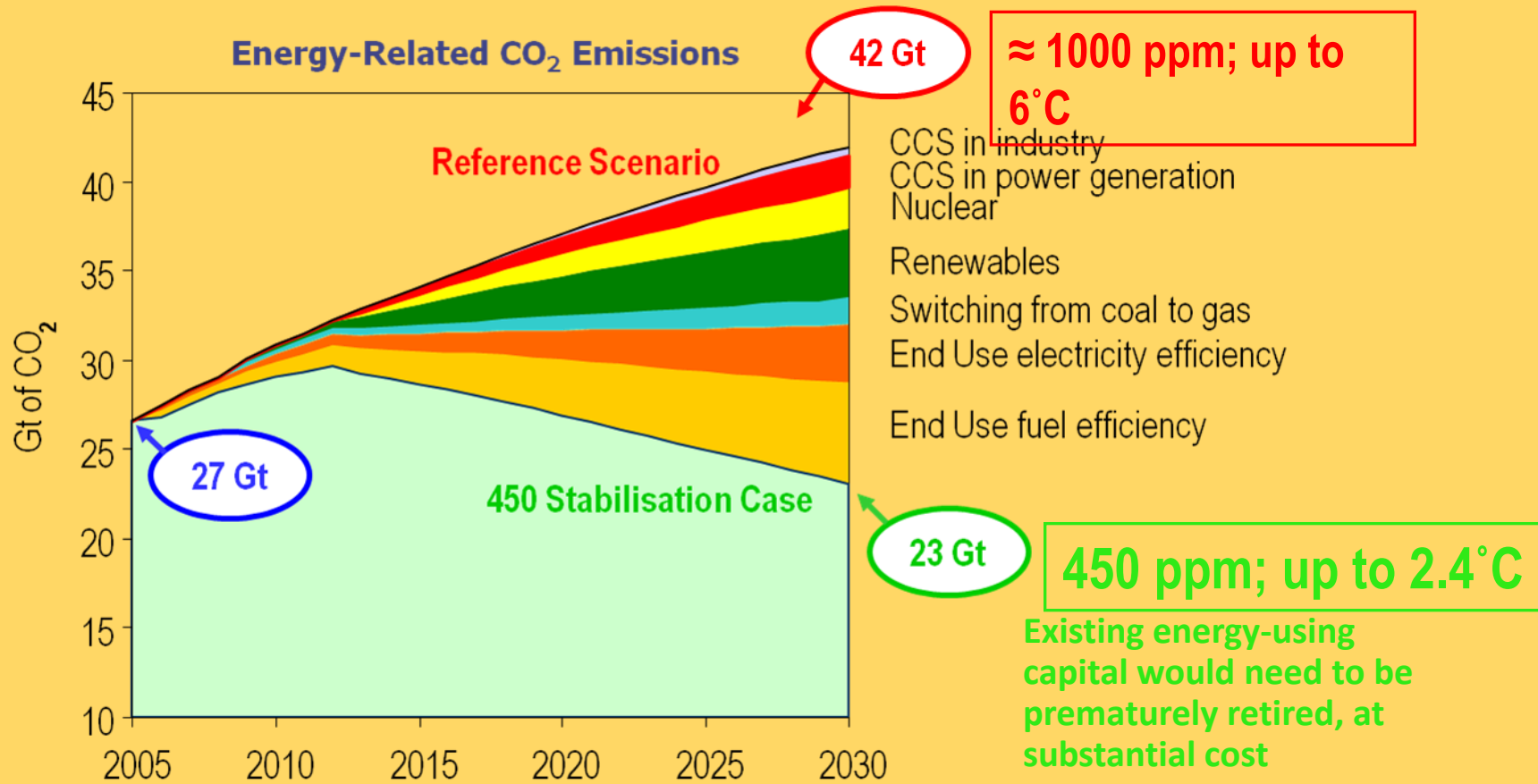
The Per-Capita Dimension



In 2030 a Chinese living in Coastal area will emit as a Japanese, and more than a European - but twice as much a Chinese living in inland China

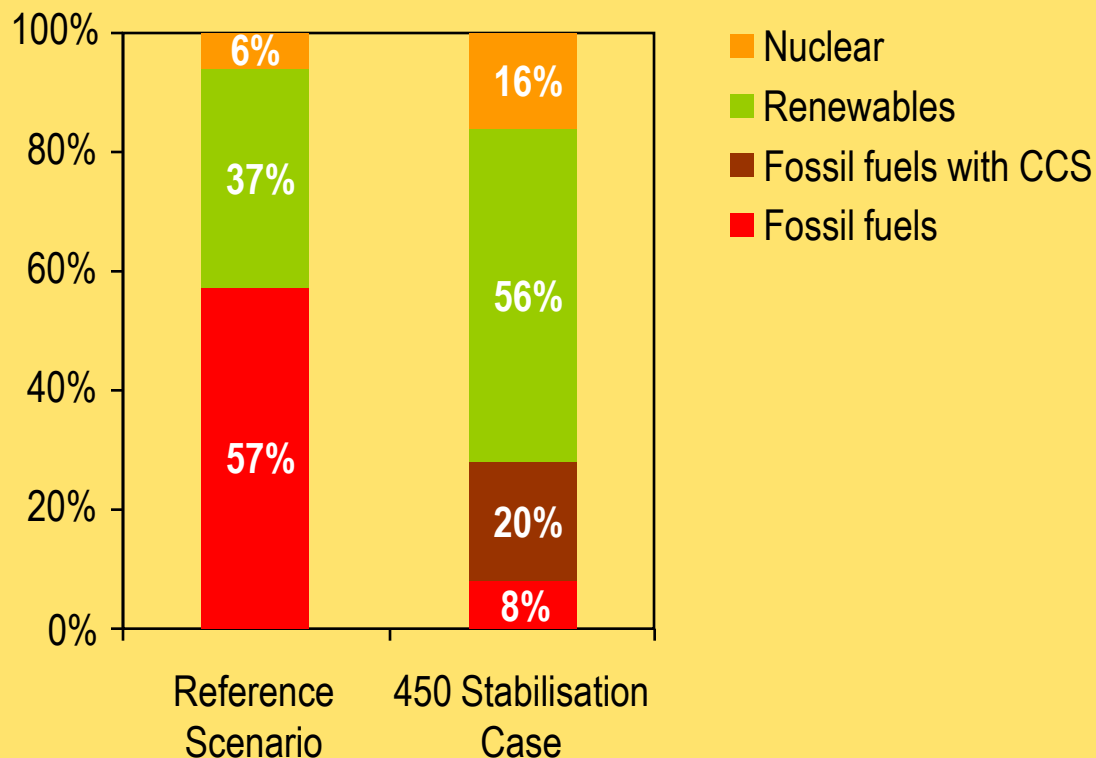
World Energy Outlook 2007 findings: Reference Scenario and 450 Stabilisation Case

World
Energy
Outlook
2008



By 2030, emissions are reduced to around 23 Gt in the 450 case, a reduction of 19 Gt compared with the Reference Scenario

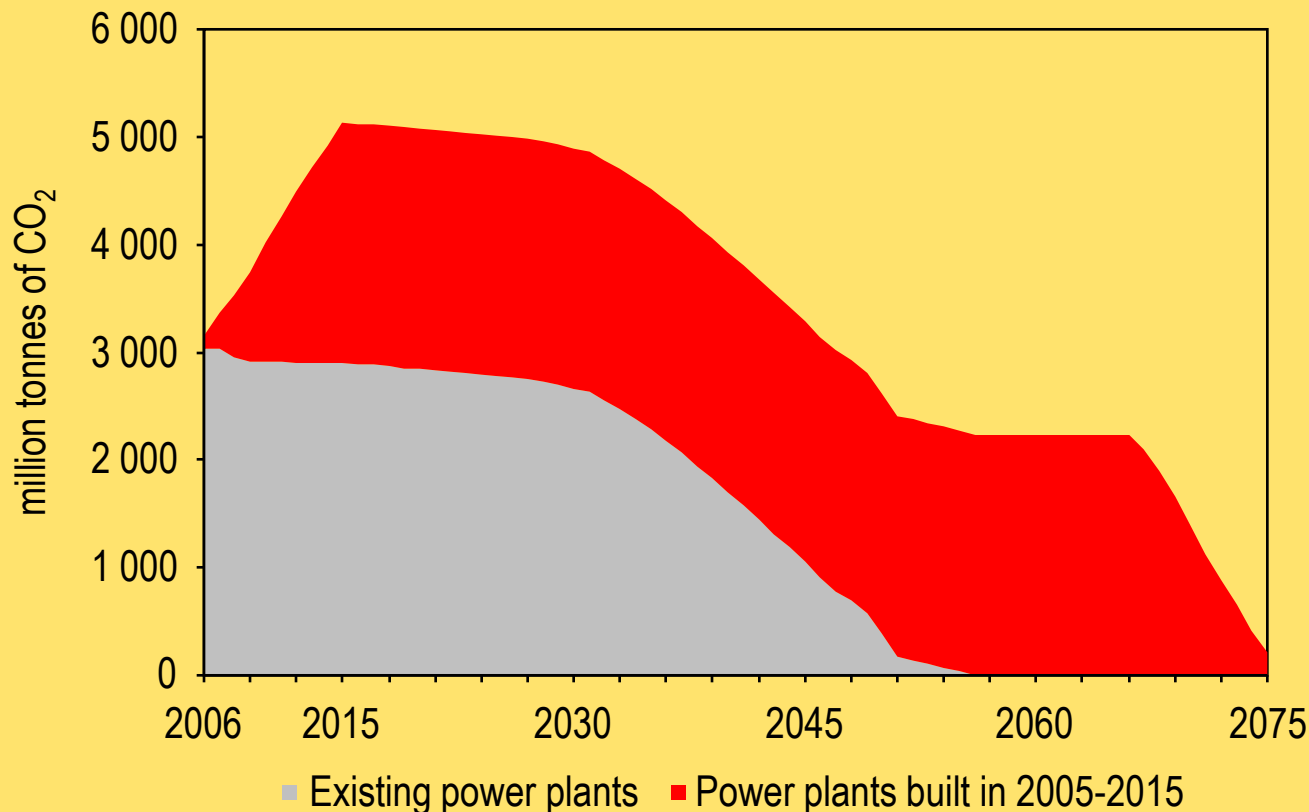
450 Stabilisation Case: Share of Cumulative Power-Generation Investment by Technology, 2006-2030



The power generation investment are \$7.5 trillion (and \$1 trillion for early retirement) – an increase of more than 30% compared to RS

Challenges to reach 450

CO₂ Emissions from Coal-Fired Power Stations built prior to 2015 in China & India

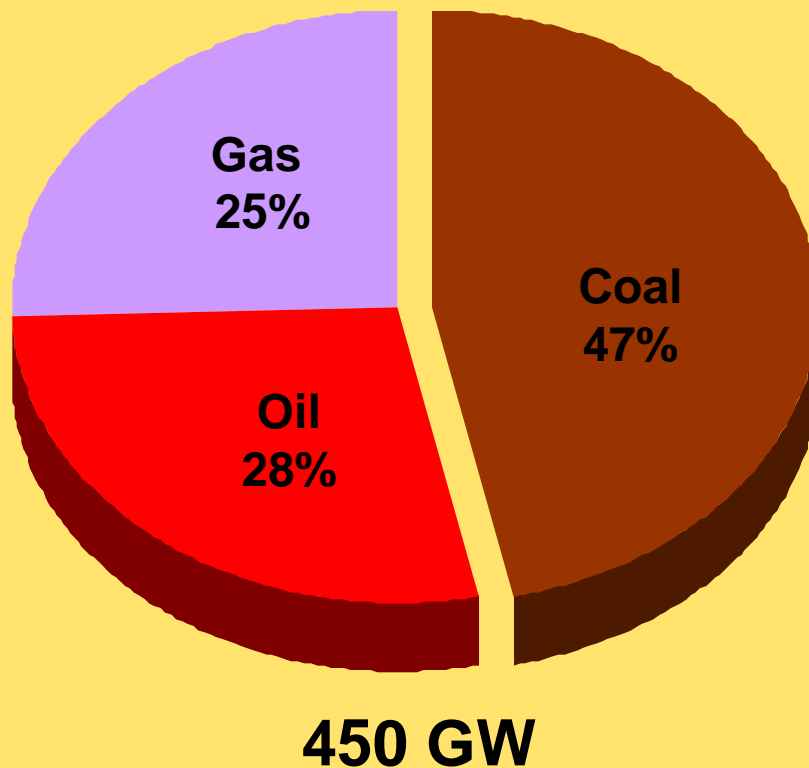


Capacity additions in the next decade will lock-in technology & largely determine emissions through 2050 & beyond



....And opportunities

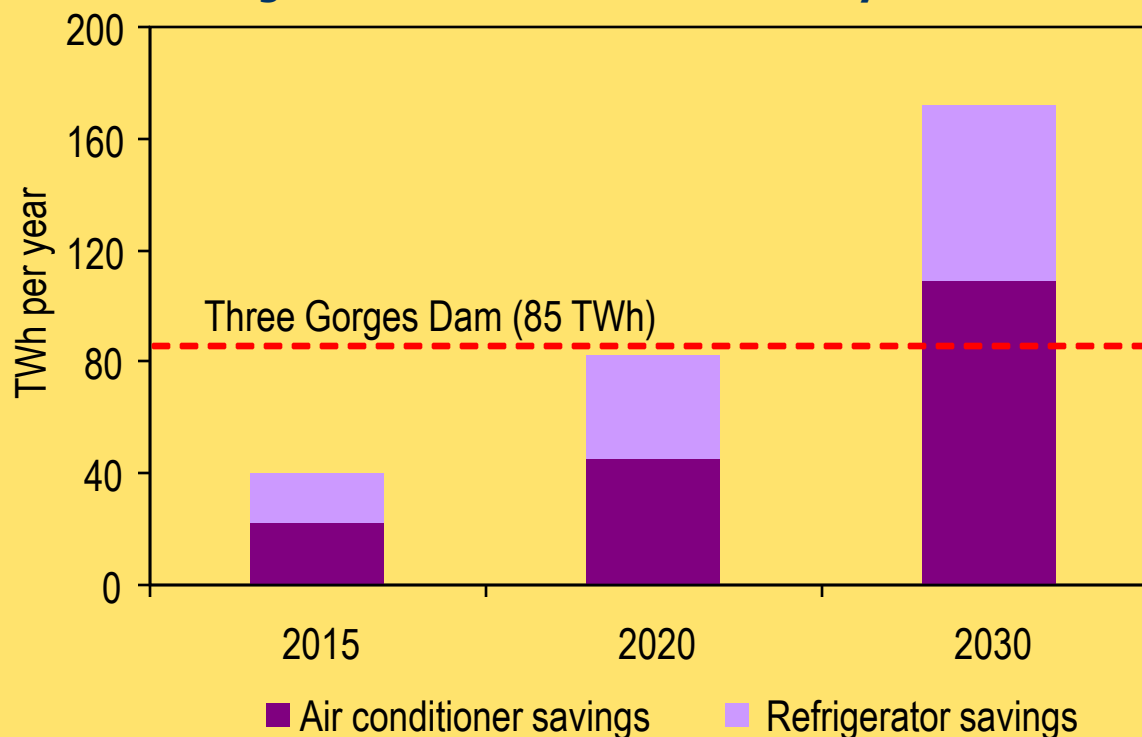
OECD Power Plant Retirements



Between 2012 and 2022, some 450 GW of generation capacity will be retired in the OECD – over 1/3 in Europe

Effectiveness of Policies to Promote Energy Efficiency in China

Electricity Savings from More Efficient Air Conditioners & Refrigerators in the Alternative Policy Scenario



Tougher efficiency standards for air conditioners & refrigerators alone would save the need to build a Three Gorges Dam by 2020

A world map is shown in the background, rendered in a dark blue color. The map is overlaid with a grid of thin, light-colored lines. The background has a color gradient from dark blue at the bottom to bright yellow at the top. The title text is centered horizontally across the middle of the map.

What are we busy with - WEO-2008



World Energy Outlook 2008: Outline

World
Energy
Outlook
2008

- **New set of projections to 2030, based on enhanced modelling capability, for**
 - > Reference Scenario
- **In-depth analysis and modelling of headline issues**
 - > Oil and gas supply prospects
 - > Post-2012 climate change policy scenarios
 - > Energy poverty in resource-rich Sub-Saharan African countries
- **Enhanced modelling capability**
 - > World Energy Model updated and improved
 - > Integration with general equilibrium model to analyse energy links with global economy
 - > Oil supply model greatly improved

Oil & Gas Supply Prospects

- **Assess prospects for global crude oil & natural gas production**
 - > *Impact of geology & adequacy of investment in new capacity*
- **Detailed field-by-field analysis of trends & prospects for production & decline rates at 400+ largest fields**
- **Bottom-up analysis of upstream cost and investment (by field & project)**
- **Review of reserves & resources**
- **Analysis of structural trends in the upstream industry, including relationships between national & international companies**

● Environmental impacts of Reference Scenario

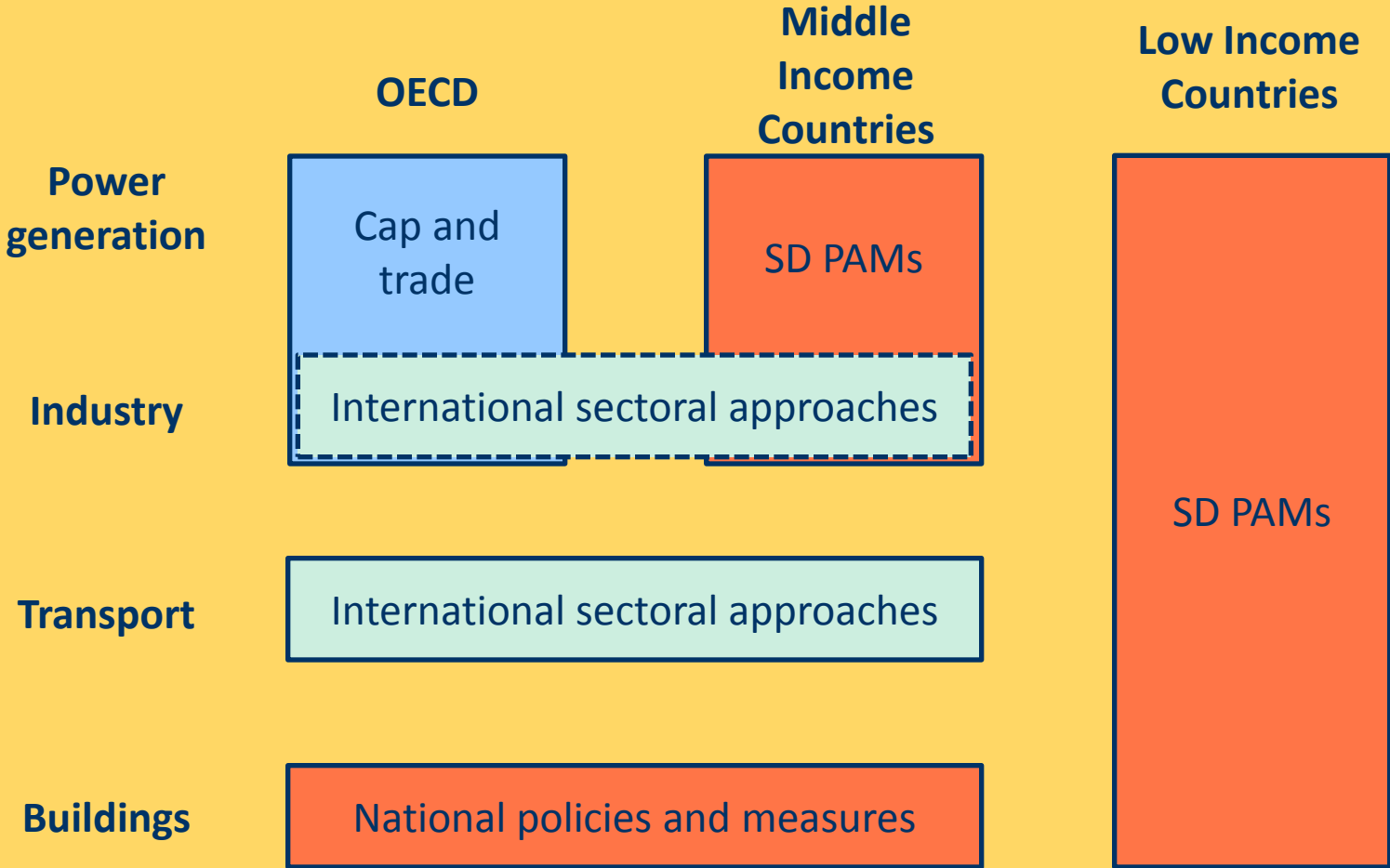
- > CO₂ and other greenhouse gases – emissions and concentrations
- > Trends by sector and by fuel
- > Breakdown by region/countries

● Analysis of post-2012 climate change issues

- > Quantitative analysis of “hybrid” frameworks, combining
 - Cap and trade
 - Sectoral approaches
 - SD PAMs
- > Implications for energy sector investment, consumer spending, technology deployment and transfer
- > Analysis of co-benefits
 - Energy security
 - Local pollution
- > 450 and 550 CO₂-equivalent trajectories
- > Analysis to 2020/2030, set in a longer-term context

● Focus on cities

Hybrid scenario



A world map is shown in the background, rendered in a color gradient from blue to red. A grid of lines is overlaid on the map. The text is centered over the map.

WEM – a continuous update and learning



World Energy Model



- **Partial equilibrium model that allows scenario analysis**
 - **Detailed sectoral and regional energy demand balances**
 - **Regional supply of all fuels and trade matrixes**
 - **CO2 emissions from fuel combustion**
 - **Investment need in the supply and end-use technologies**

- **Time horizon to 2030, with annual data – complete update every year (i.e. next year last data point will be 2006)**

- **Regional resolution: 21 regional models (of which 9 country models, including US, China, India, Japan, Russia, Brazil...)**

- **Technology-rich model**

World Energy Model – 2008 updates

- **New challenges, new updates:**
 - **Coupling with a General Equilibrium Model to capture macroeconomic feedback (i.e. uncertainties on future economic growth) – WEM-ECO**
http://www.worldenergyoutlook.org/docs/weo2007/WEM-ECO_Description.pdf
 - **More detailed oil supply model, that gives price feedback**
 - **More detailed demand-side analysis - example of transport but also industries, residential, services, refineries, CTL/GTL etc.**
 - **More detailed power generation modules (nuclear and renewables are endogenous, CHP, CCS)**
 - **Detailed analysis of end-use prices and subsidies**
 - **Detailed survey of investment trends in energy industries**
 - **Ensure consistency with short term demand projections (OMR) and long term technology trends (ETP)**



- **Co-operation with**
 - **Technical University of Vienna – renewables technologies**
 - **Argonne Lab – demand side efficiency investment**
 - **EPA – GHGs emissions other than CO2 energy**
 - **CIREN – general equilibrium model**
 - **IIASA – estimate of local pollutants**
 - **IFP – field by field analysis**
 - **A number of industry for technology and investment data**

World Energy Model 2008:

A glimpse of new oil supply model

- **A disaggregated bottom up approach analysing more than 400 fields**
- **Determination of marginal production cost, inform price path, feedback to demand model**
- **Field by field analysis considering:**
 - **Currently producing fields**
 - *Production profile determined by analysis of standard profiles (over 3000 fields analysed, by size and onshore/offshore)*
 - **Fields to be developed**
 - *Criteria: NPV of future cash flow*
 - **Fields yet to be found and developed**
 - *Discoveries function of exploration efforts*

World Energy Model 2008: A glimpse of the Transport Module

Vehicle Stock

S shaped Gompertz function
of GDP/cap:

$$V_t = ye^{ae^{bGDP_t}}$$

Road Technologies:

LDV Gasoline
LDV Hybrid Gasoline
LDV Diesel
LDV Hybrid Diesel
LDV Fuel Cells
Plug-in Hybrid Diesel
Electric Vehicle
Natural Gas Vehicle
LDV Biofuels
HDV Biofuels
Truck Diesel
Truck Gasoline
Bus Diesel
Bus Gasoline
2-wheelers
3-wheelers



Vehicle Efficiencies:
ETP 2008

Road Transport

All Fuels:

Coal
Oil - Gasoline
Oil - Diesel
Oil - Jet Fuel
Natural Gas
Electricity
Biofuels

All Other Modes:

Aviation
Rail
Pipeline
Navigation
Other Non-Specified



Total Transport

Travel estimate
 $RT_i = F(GDP, prices)$

More detailed technology split for road transport sub-model