INTERNATIONAL ENERGY AGENCY

Energy Futures and Air Travel

ICAO Workshop on Aviation and Alternative Fuels
10 February 2009

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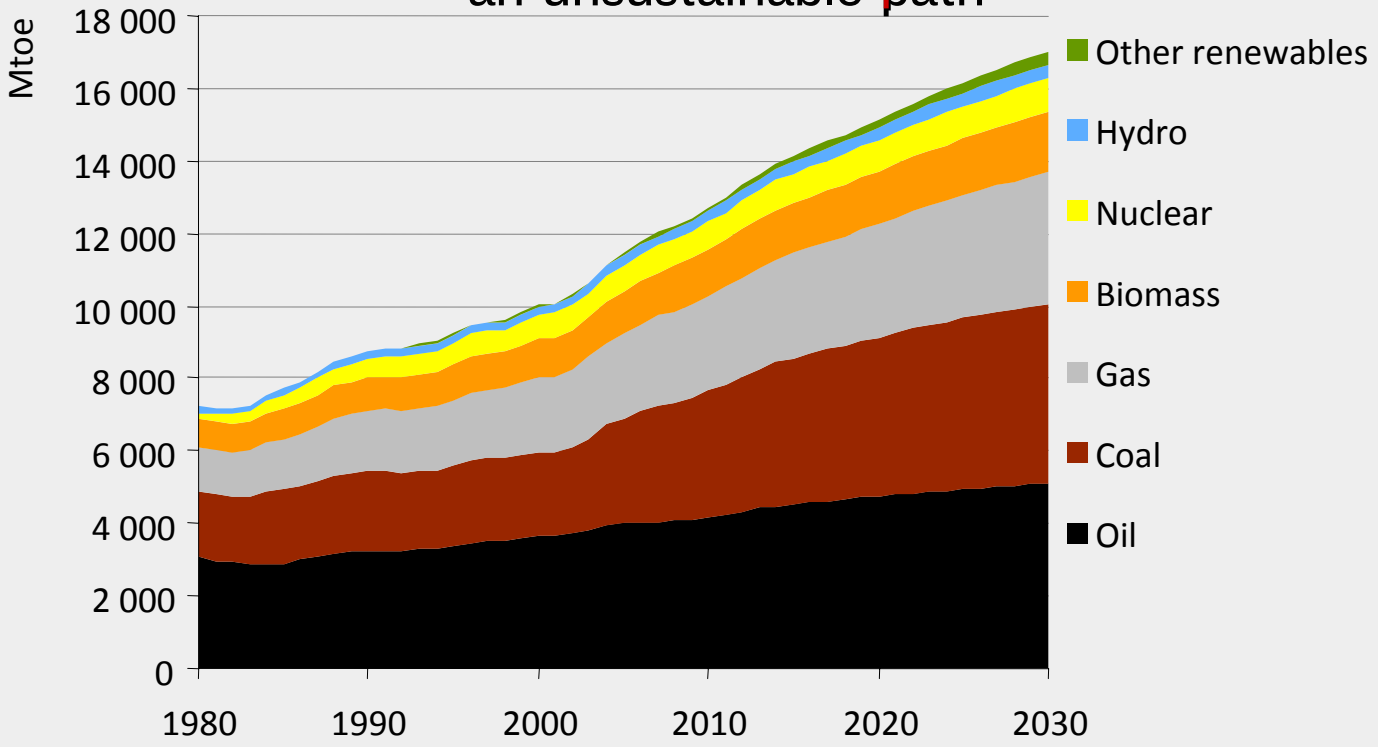
International Energy Agency

Where are we headed? World Energy Outlook 2008

World Energy Outlook 2008

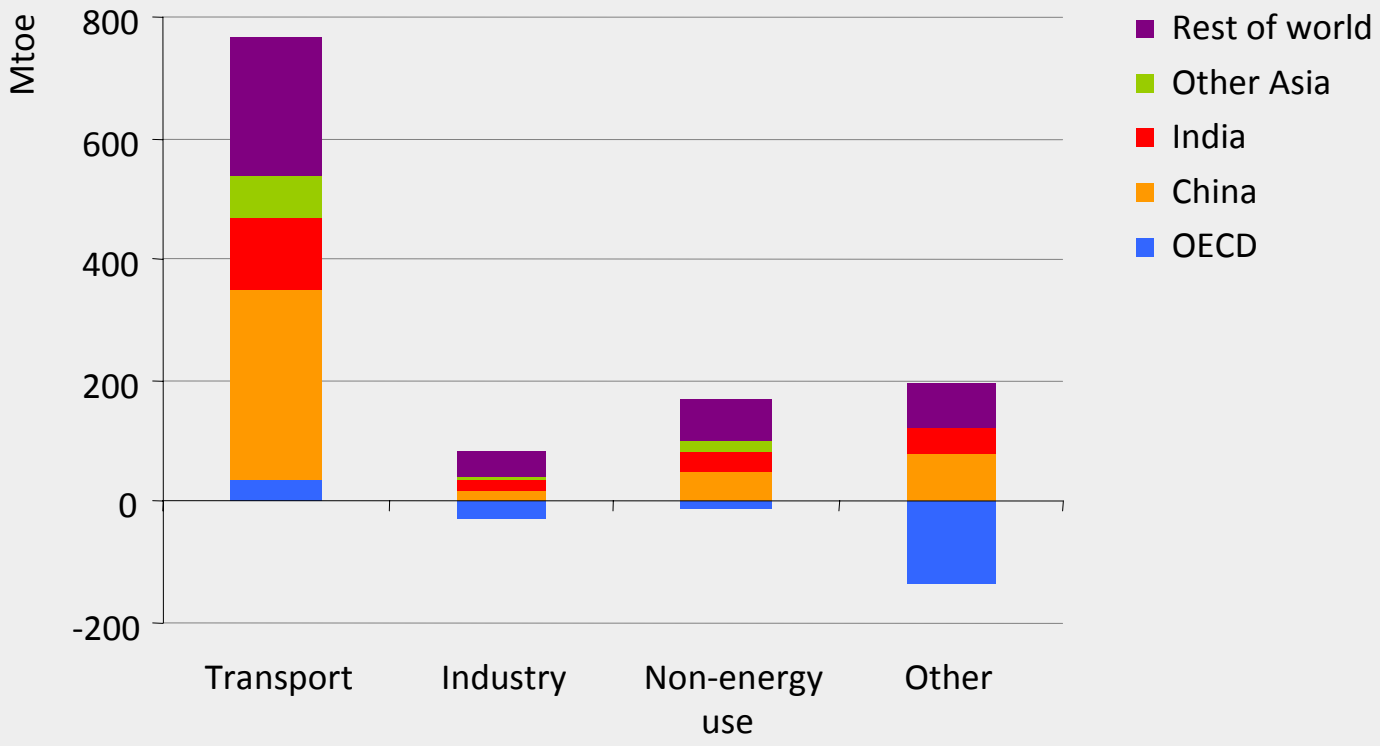
World primary energy demand in the Reference Scenario: an unsustainable path



World energy demand expands by 45% between now and 2030 – an average rate of increase of 1.6% per year – with coal accounting for more than a third of the overall rise

WEO 2008 Reference Scenario: Incremental oil demand, 2006-2030

World Energy Outlook 2008



Around three-quarters of the projected increase in oil demand comes from transportation

Oil-import dependence in the Reference Scenario

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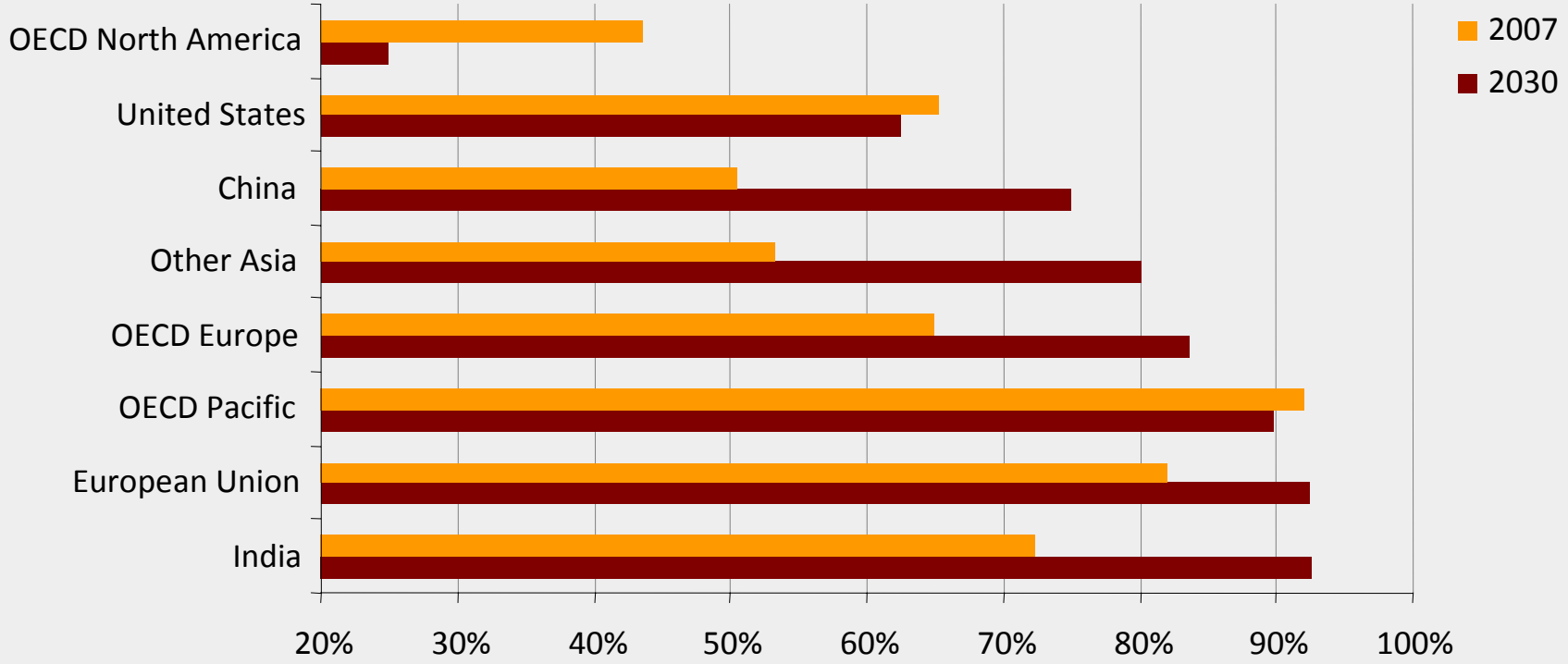

OECD Europe & Asia become even more dependent on oil imports, but import dependence drops in North America & OECD Pacific

World oil production by source in the Reference Scenario

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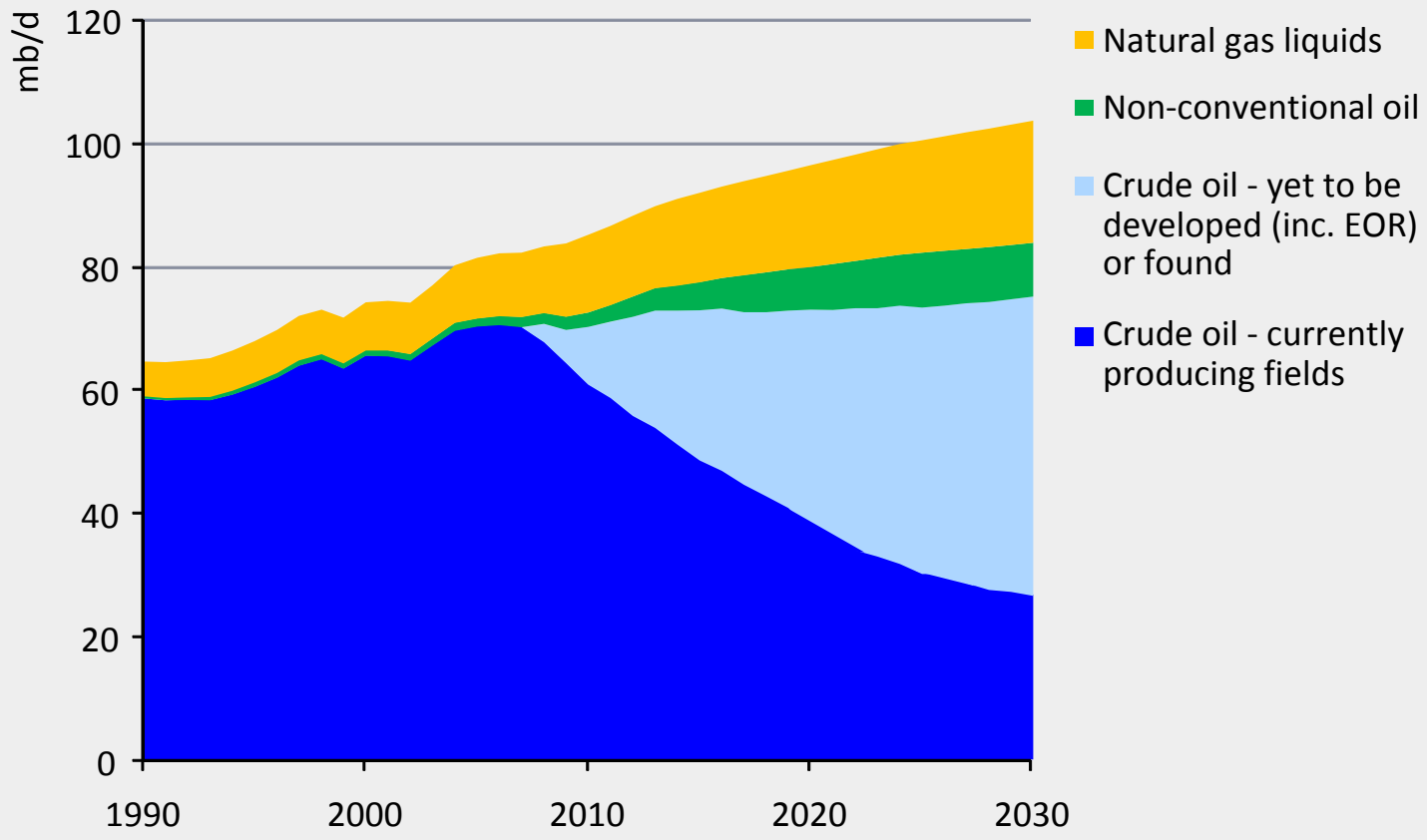

64 mb/d of gross capacity needs to be installed between 2007 & 2030 – six times the current capacity of Saudi Arabia – to meet demand growth & offset decline

Energy-related CO_2 emissions in the Reference Scenario

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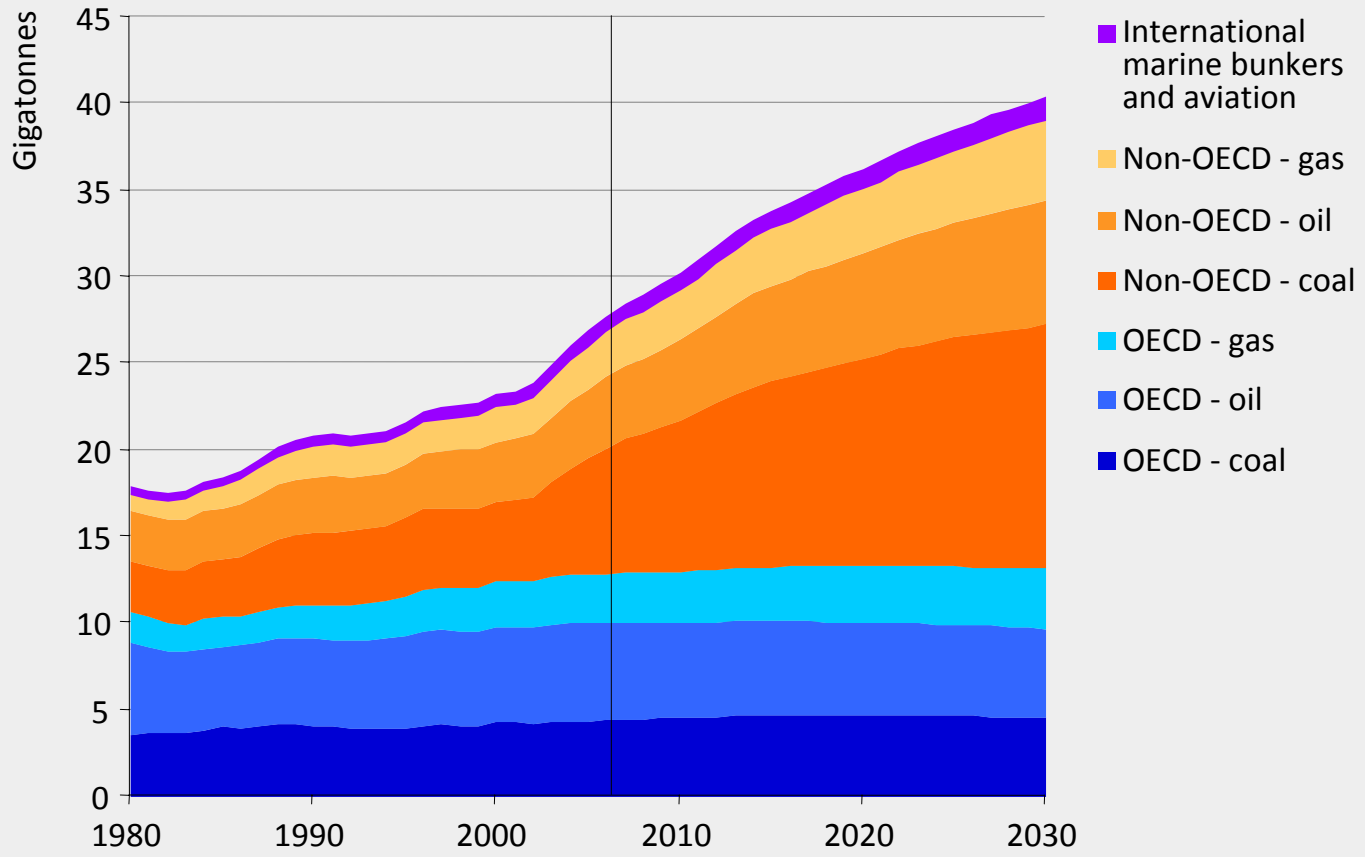
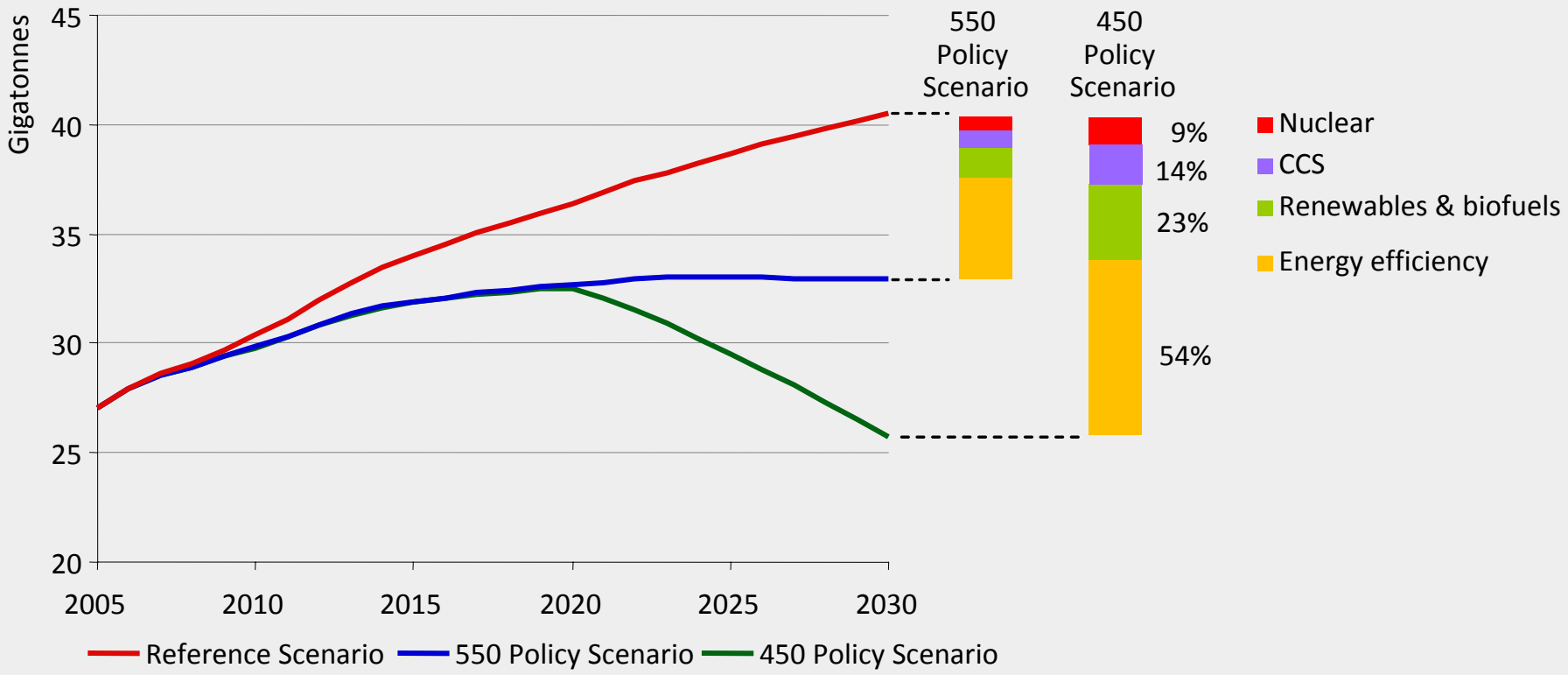


97% of the projected increase in emissions between now & 2030 comes from non-OECD countries – three-quarters from China, India & the Middle East alone

WEO 2008 scenarios for CO_2 emissions pathways to 2030

World Energy Outlook 2008



While technological progress is needed to achieve some emissions reductions, efficiency gains and deployment of existing low-carbon energy accounts for most of the savings

IEA's Long-term View: Energy Technology Perspectives 2008

- A Low CO_2 world to 2050: what it looks like and how to get there
  - A study primarily about the role of technology
  - Achieving IPCC CO_2 emission targets
    - Transport does not have to achieve zero emissions, but it would clearly help.
  - Identifying short and medium term technology and policy needs
- Scenario analysis – three main scenarios:
  - Baseline WEO2007 Reference Scenario, extended to 2050
  - Global stabilization by 2050 (ACT – up to USD50/tonne)
  - Global 50% reduction by 2050 (BLUE – up to USD200/tonne)

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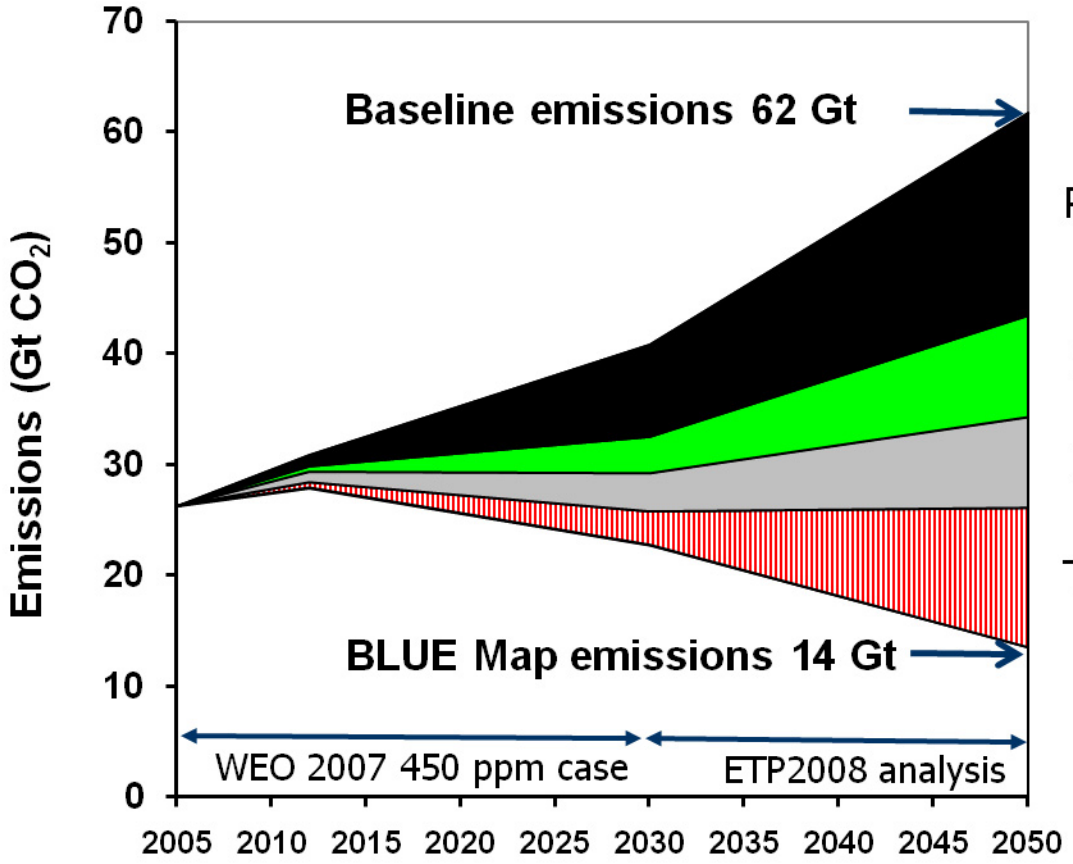
Sector Contributions



Power sector (38%)

Industry (19%)

Buildings (17%)

Transport (26%)

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Scenarios & Strategies to 2050

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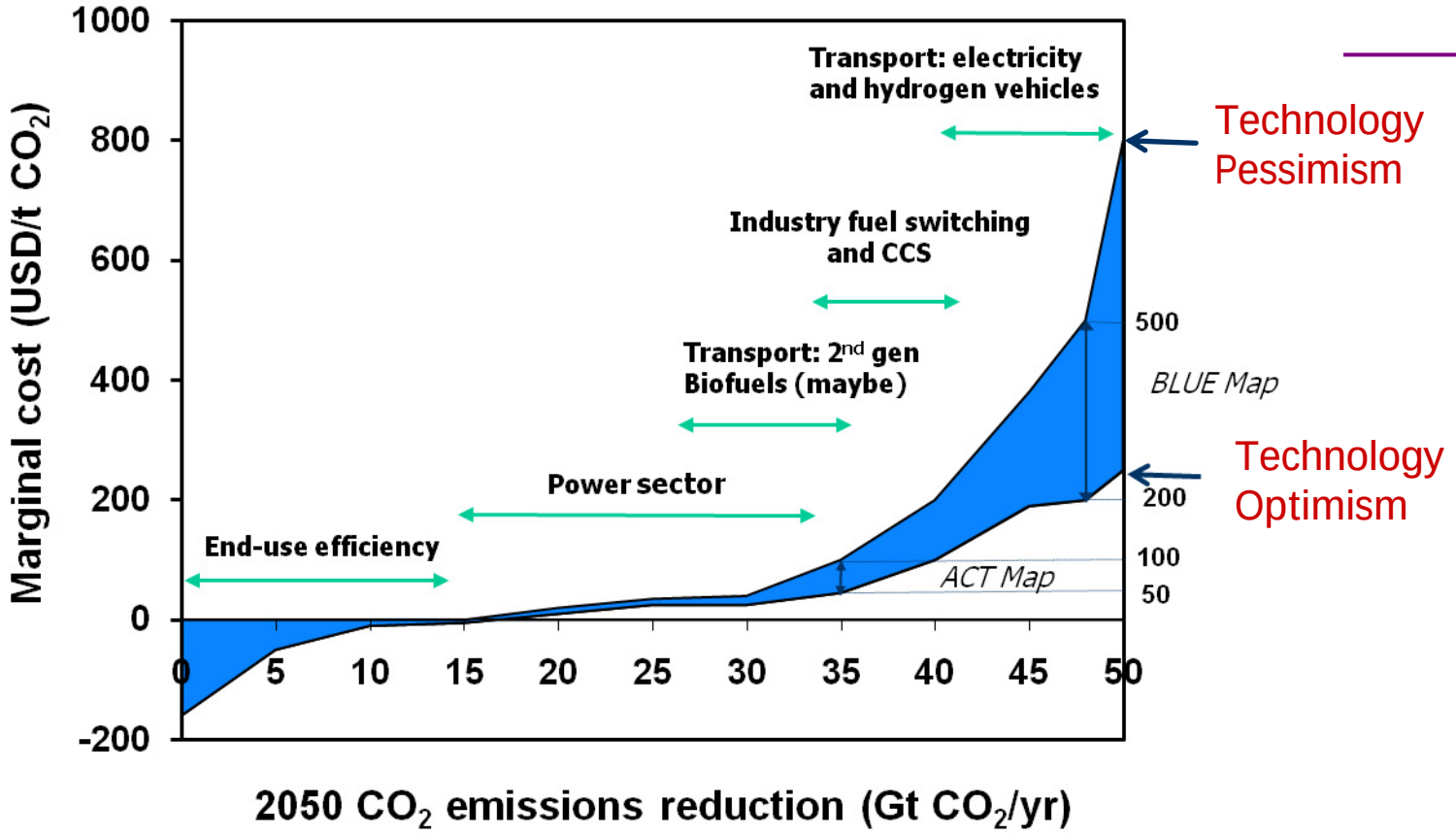
A New Energy Revolution ?



To bring emissions back to current levels by 2050 options with a cost up to USD 50/t are needed. Reducing emissions by 50 % would require options with a cost up to USD 200/t, possibly even up to USD 500/t CO_2

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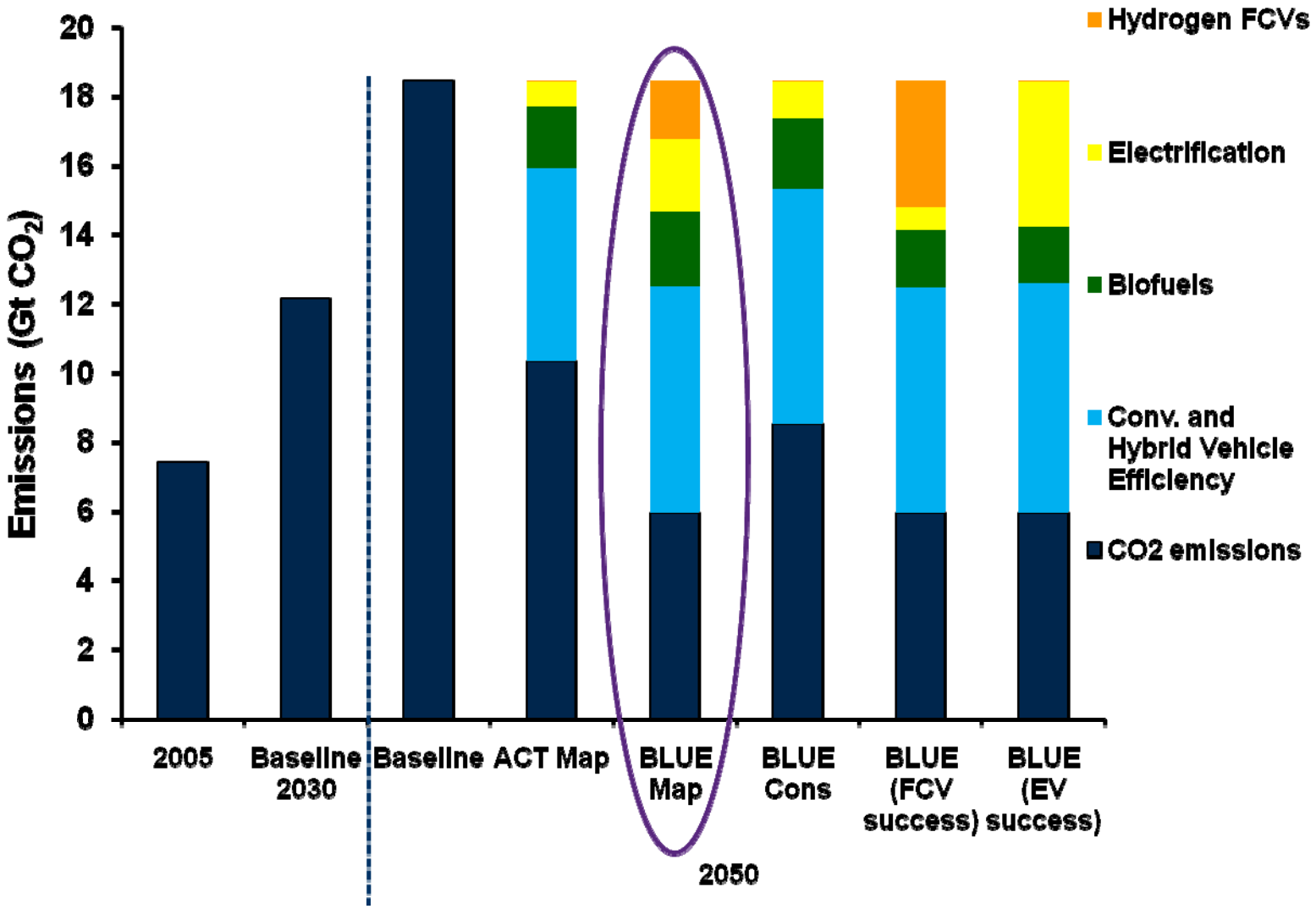
Transport GHG Emissions

(well-to-wheels CO_2-equivalent emissions)



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ETP Blue
Light-duty Vehicles (cars, SUVs)

- LDVs 50% more efficient by 2030
  - Hybrids dominate by 2030, plug-in hybrids dominate by 2050
- Electric and / or H2 Fuel Cell Vehicles play a major role after 2030
- Biofuels reach up to 12% of total liquid fuel share by 2030, mostly 2nd gen, mostly diesel
  - Rising to 26% by 2050 (20-fold increase compared to 2007)
  - LDVs may not be the best application

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Other Transport Modes
Half of total demand

- **Air**
  - **15% efficiency improvement over baseline (30% in baseline) by 2050**
  - **Some logistic improvements**
  - **30% biofuels (BTL fuel) by 2050**
- **Shipping**
  - **30% efficiency improvement by 2050;**
  - **30% biofuels (heavy fuel oil substitutes) by 2050**
- **Trucks, buses**
  - **30-50% efficiency improvement by 2050**
  - **Same biofuels share as for LDVs**
- **Lots of biofuels in these modes – and it probably won't be ethanol!**

Alternative Fuels for Aviation

- **Alternative fuels derived from coal or natural gas are certainly suitable for aviation and can provide energy security benefits, but are not low CO_2 fuels.**
  - **CTL (and GTL) economics are currently better than for biofuels.**
- **Current commercial bio-fuels (FAME from bio-oils, ethanol) appear not very attractive for a "drop in" bio-jet fuel**
  - **Compatibility issues, high cost.**
- **Hydrotreating of vegetable oils is more interesting than conventional FAME for fuel blends: better fuel quality, some CO_2 bonus, possibly better economics, but it shares the feedstock cost penalty.**
- **"Biomass-to-liquids (with F-T) is a potential fuel for a route to very low CO_2 aviation and offers the benefits of synthetic kerosene with a significant CO_2 bonus, but currently economics look rather difficult. Technology not fully ready: no large-scale BTL plant exists in the World today**
  - **Harvesting biomass is a major challenge and land-use change impacts on CO2 are a major question**
- **"Third generation" biofuels (e.g. algae) – under development – cost, potential scale are key challenges**

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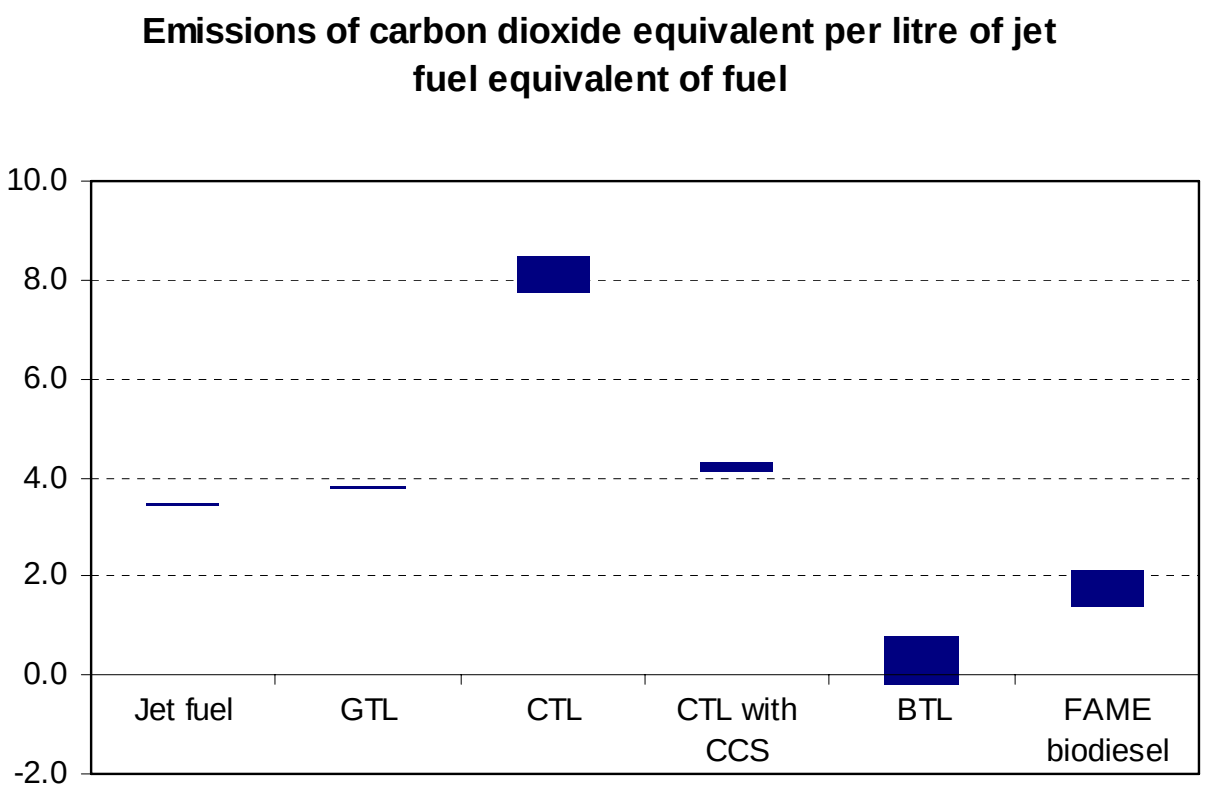
Aviation Fuels - GHG emission characteristics



Source: synthesis of IEA and ANL data

- Only biomass-derived fuels deliver significant GHG reductions
  - BTL (biomass-to-liquids) offers "greener" promises than conventional FAME biodiesel

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Summary & Conclusions

- **Current energy trends are unsustainable — environmentally AND economically**
  - **Oil will remain the leading transport energy source but...**
  - **The era of cheap oil will soon be over, though price volatility will remain**
- **To avoid "abrupt and irreversible" climate change we need a major decarbonisation of the world's energy system**
  - **Copenhagen must deliver a credible post-2012 climate regime**
  - **Limiting temperature rise to 2°C will require significant emission reductions in all sectors and regions**
  - **New fuels in aviation can play an important role – but only certain fuels deliver large CO2 reductions.**

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