IPCC Outreach Event on AR4 Working Group III

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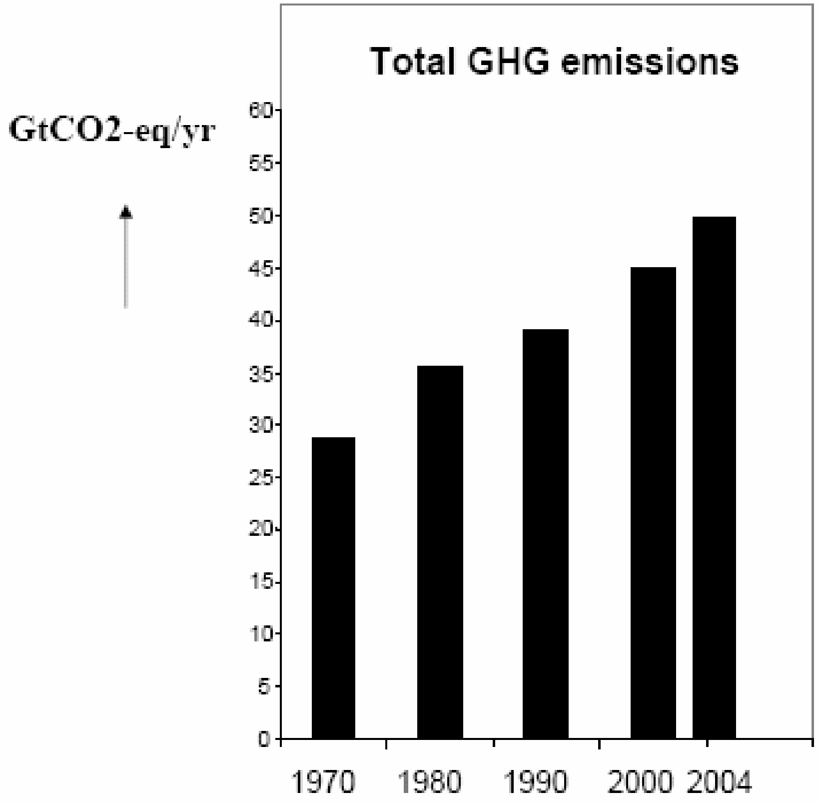
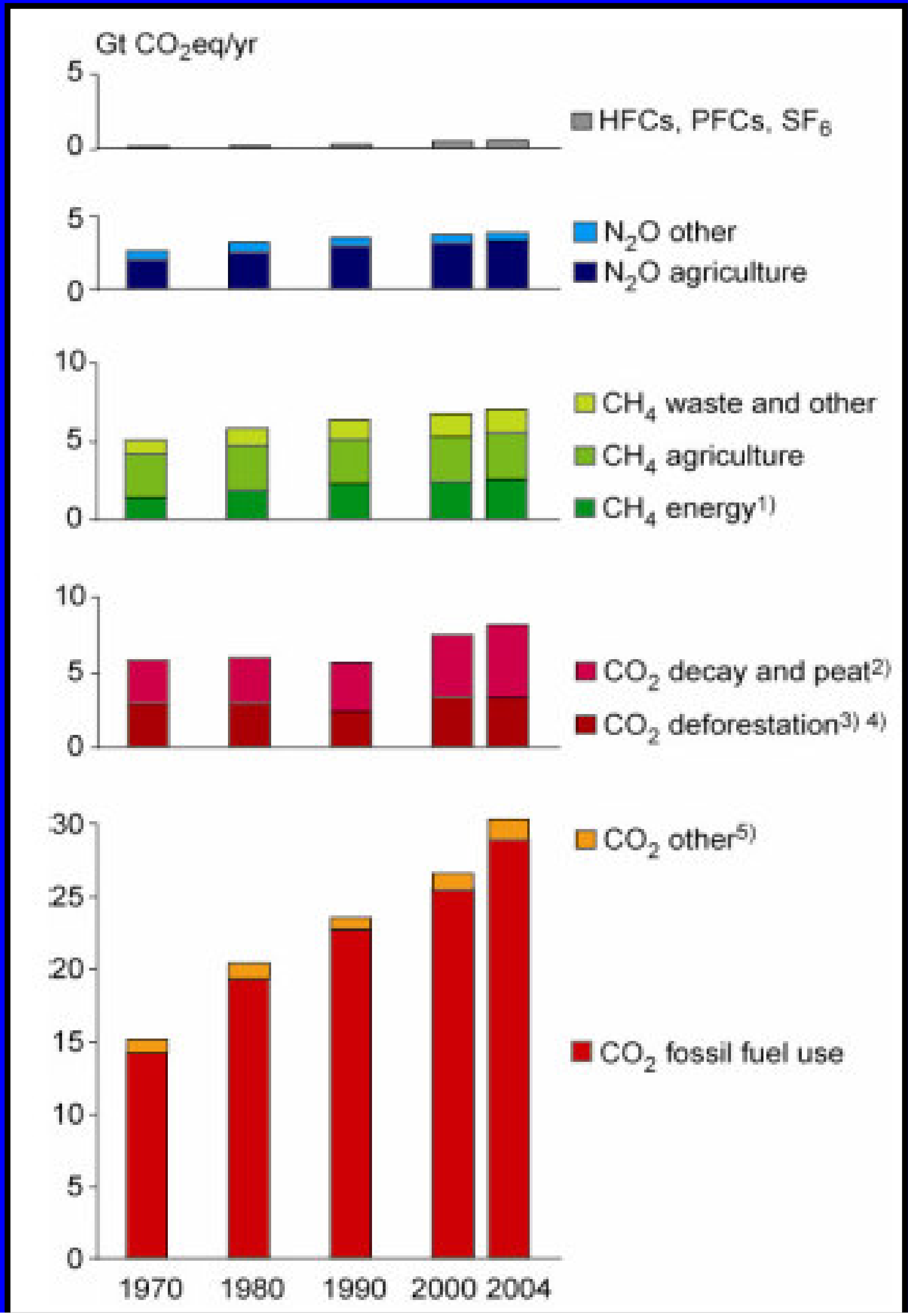
Between 1970 and 2004 global greenhouse gas emissions have increased by 70 %



AR4 – WG3

Carbon dioxide is the largest contributor

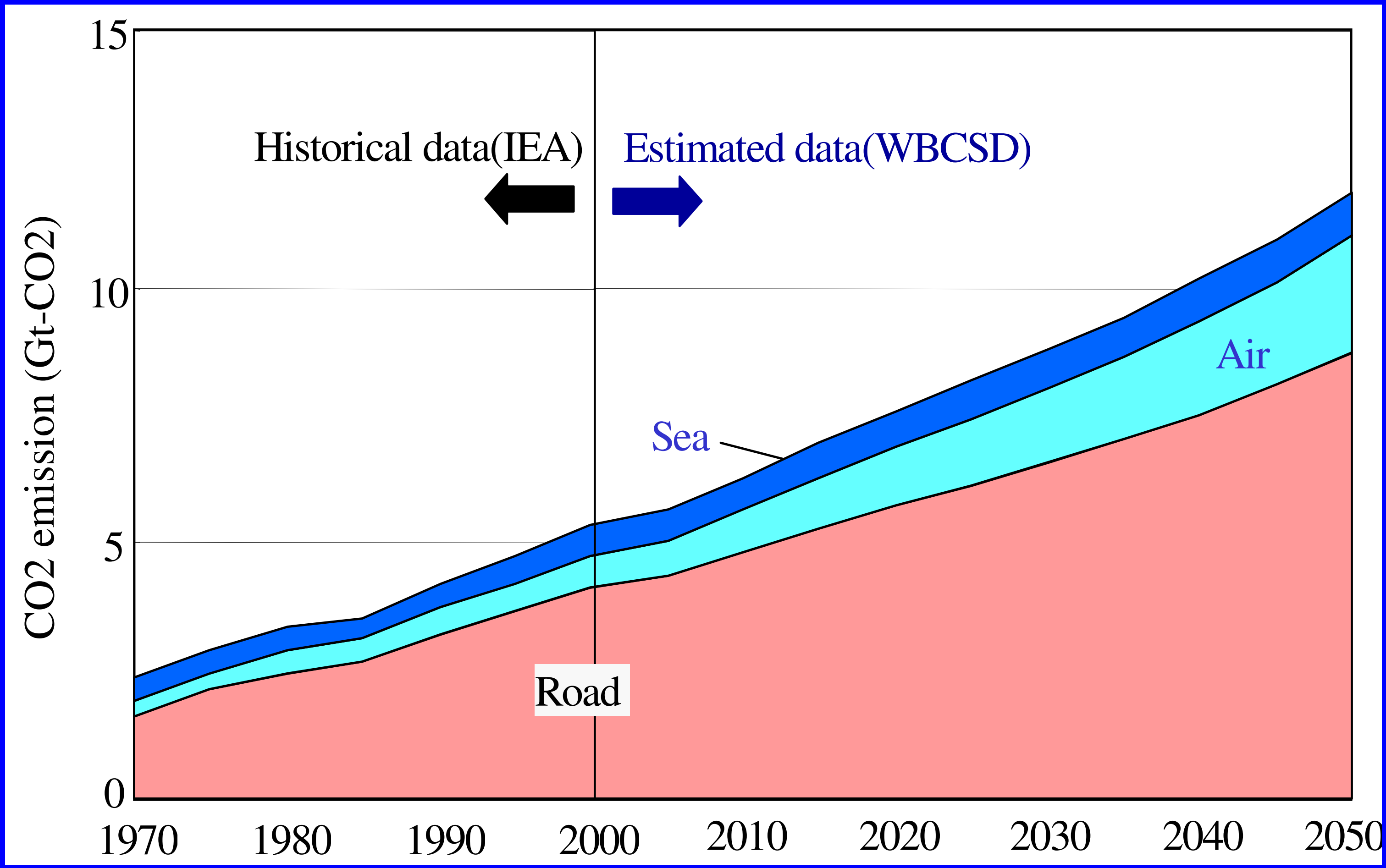


Source: *WG3 – Bangkok, 2007*

GHG in Transport Sector

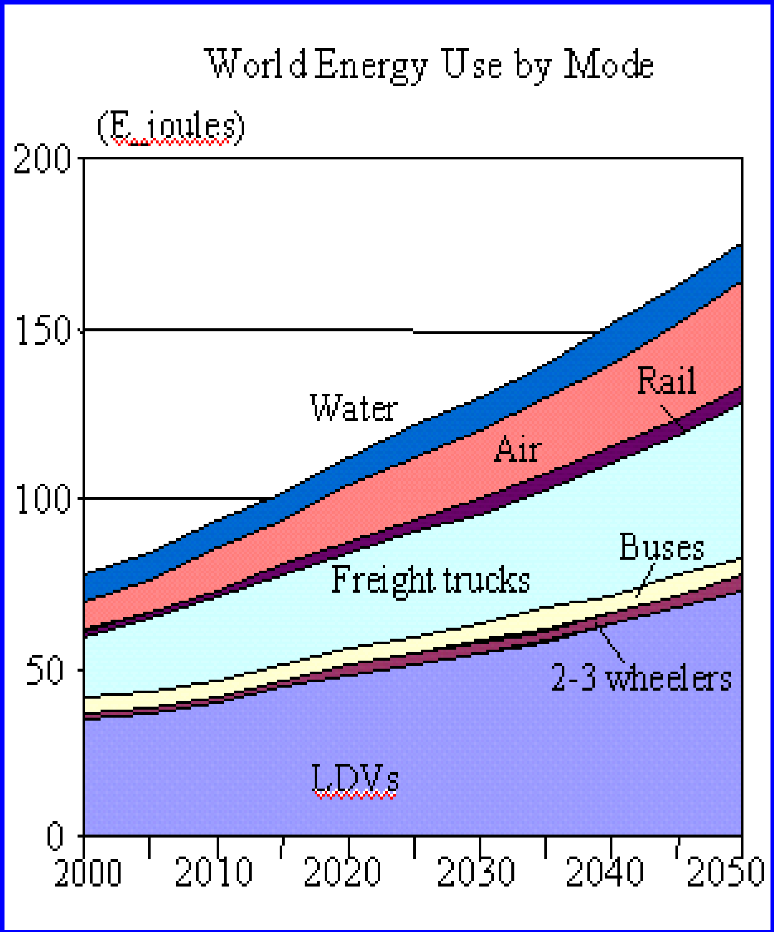
- Since motorized transport relies on oil for virtually all its fuel and accounts for almost half of world oil consumption, the transport sector faces a challenging future, given its dependence on oil.
- Transport activity will continue to increase in the future as economy grows. The majority of the world's population still does not have access to personal vehicles and many do not have access to any form of motorized transport. However, this situation is rapidly changing.
- In 2004, the transport sector produced 6.3 GtCO_2 emissions (23% of world energy-related CO_2 emissions) and its growth rate is highest among the end-user sectors.
- Road transport currently accounts for 74% of total transport CO_2 emissions.

Historical and Estimated Data on CO_2 Emissions by Mode of Transport, 1970 – 2050



Source: *IEA(2005) and WBCSD (2004b).*

Energy Consumption Forecast by Mode

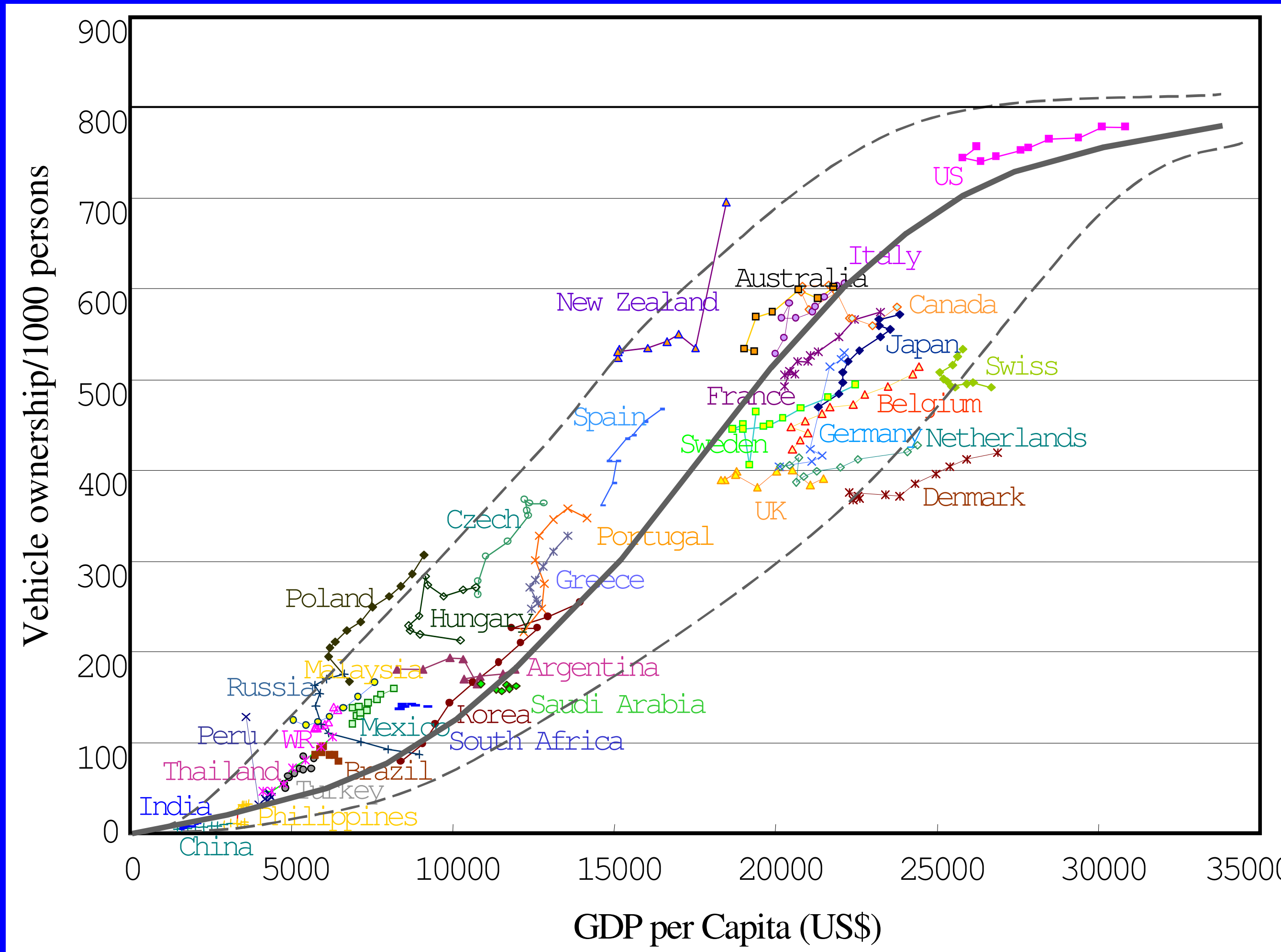


Source: *WBCSD, 2004a.*

World Transport Energy Use in 2000, by Mode

Mode	Energy use (EJ)	Share (%)
Light-duty vehicles (LDVs)	34.2	44.5
2-wheelers	1.2	1.6
Heavy freight trucks	12.48	16.2
Medium freight trucks	6.77	8.8
Buses	4.76	6.2
Rail	1.19	1.5
Air	8.95	11.6
Shipping	7.32	9.5
Total	76.87	100

Source: WBCSD, 2004b.



Note: *plotted years vary by country depending on data availability.*

Data source: *World Bank, 2004.*

Unless there is a major shift away from current patterns of energy use, world transport energy use is projected to increase at the rate of about 2% per year, with the highest rates of growth in the emerging economies, and total transport energy use and carbon emissions is projected to be about 80% higher than current levels by 2030.

Mitigation Options for Transport: Technologies and Policies and Measures

1. Reducing Load (lightweight material/aerodynamic improvements)
2. Improving drive train efficiency (hybrids)
3. Alternative Fuels (biofuels/natural gas/hydrogen/ electric)
4. Modal Shift (public transport/NMT/ecodriving)
5. Land use and transport planning
6. Taxation and Pricing
7. Fuel Economy Standards
8. Transport Demand Management

Non Technological Options

- Road transport efficiency may increase by to 20% through the use of strategies such as load factor increase (either the member of passenger or tons carried), adequate driving, efficient maintenance, tire efficienty, traffic manegement and go on.

Efficiency in Transport Sector

	Load Factor (average occupancy)	CO_2- equivalent emissions per passenger-km (full energy cycle)
Car (gasoline)	2.5	130-170
Car (diesel)	2.5	85-120
Car (natural gas)	2.5	100-135
Car (electric)[1)]	2.0	30-100
Scooter (two-stroke)	1.5	60-90
Scooter (four-stroke)	1.5	40-60
Minibus (gasoline)	12.0	50-70
Minibus (diesel)	12.0	40-60
Bus (diesel)	40.0	20-30
Bus (natural gas)	40.0	25-35
Bus (hydrogen fuel cell)[2)]	40.0	15-25
Rail Transit[3)]	75% full	20-50

Note: All numbers in this table are estimates and approximations, and are best treated as illustrative.

1) Ranges are due largely to varying mixes of carbon and non-carbon energy sources (ranging from about 20–80% coal), and also the assumption that the battery electric vehicle will tend to be somewhat smaller than conventional cars.

2) Hydrogen is assumed to be made from natural gas.

3) Assumes heavy urban rail technology ('Metro') powered by electricity generated from a mix of coal, natural gas, and hydropower, with high passenger use (75% of seats filled on average).

Source: Sperling and Salon, 2002).

GHG and Energy Potential Reduction due to Taxation Measures

Tax/pricing measure	***Potential energy/ GHG savings or transport improvements)***	***Reference***
Optimal Road Pricing based on congestion charging (London UK)	*20% reduction CO_2, as a result of a 18% reduction of traffic*	*Transport for London (2005).*
Congestion Pricing of the Namsan Tunnels (Seoul S Korea)	*34% reduction of peak passenger traffic volume* *Traffic flow from 20 to 30km/hr*	*World Bank (2002)*
Fuel Pricing and Taxation	*15–20% for vehicle operators*	*Martin et al (1995)*
Area Licensing Scheme (Singapore)	*1.043GJ/day energy savings* *Vehicular traffic reduced by 50%* *Private traffic reduced by 75%* *Travel speed increased 20 to 33 km/hr*	*FWA (2002)*
Urban gasoline tax (Canada)	*1.4 Mton by 2010* *2.6 Mton by 2020*	*Transportation in Canada; www.tc.gc.ca/pol/en/Report/anre1999/tc9905be.htm*
Congestion charge trial in Stockholm (2005–2006)	*13% reduction of CO_2*	*http://www.stockholmsforsoket.se/templates/page.aspx?id=2453*

CO_2 Potential Reduction in Latin American Cities

Transport Measure	*GHG Reduction Potential %*	*Cost per tCO_2 (US$)*
BRT mode share increases from 0-5%	***3.9***	***66***
BRT mode share increases from 0-10%	***8.6***	***59***
Walking share increase from 20-25%	***6.9***	***17***
Bike share increases from 0 to 5%	***3.9***	***15***
Bike mode share increases from 1-10%	***8.4***	***14***
Package (BRT, Pedestrian upgrades, cycle ways)	***25.1***	***30***

Source: Wright and Fulton (2005).

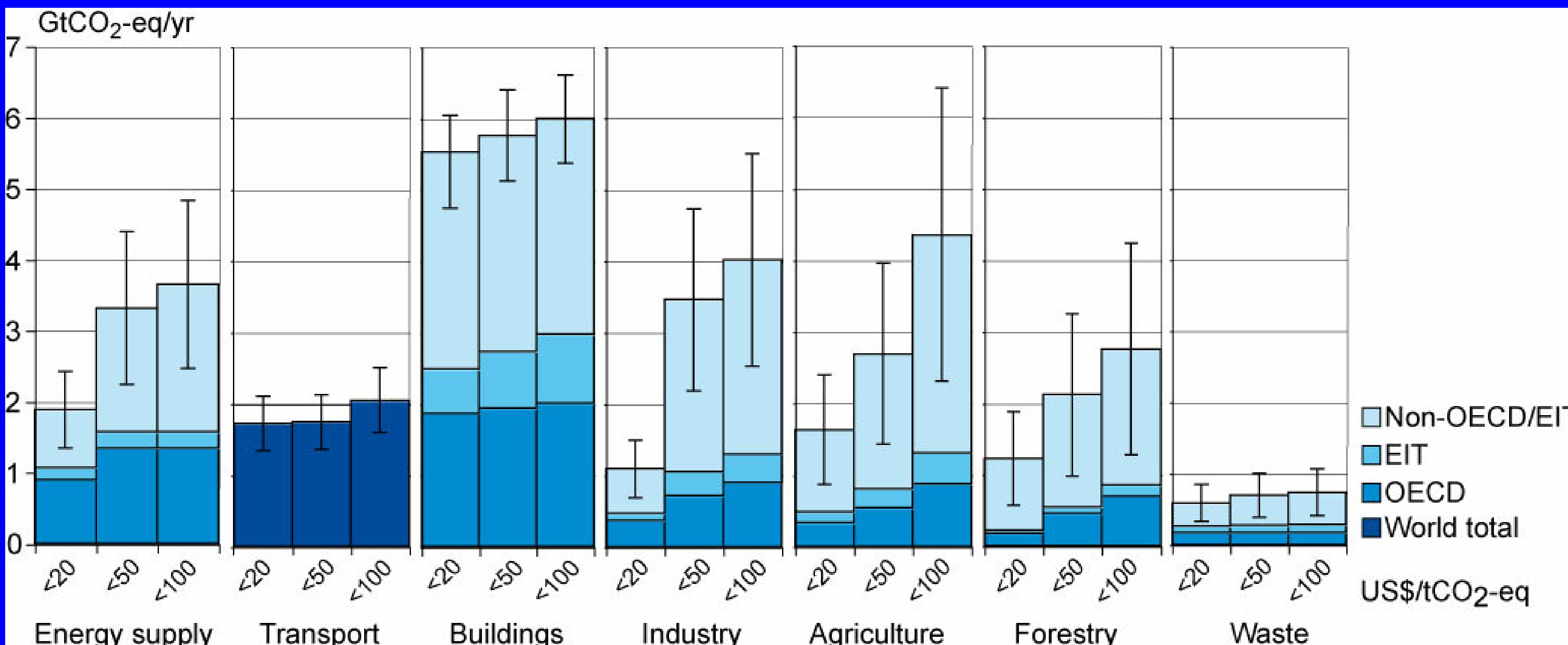
AR4 – WG3

How can emissions be reduced?

Sector	(Selected) Key mitigation technologies and practices currently commercially available.
Energy Supply	efficiency; fuel switching; nuclear power; renewable (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; early applications of CO2 Capture and Storage
Transport	More fuel efficient vehicles; hybrid vehicles; biofuels; modal shifts from road transport to rail and public transport systems; cycling, walking; land-use planning
Buildings	Efficient lighting; efficient appliances and airco; improved insulation ; solar heating and cooling; alternatives for fluorinated gases in insulation and aplliances

Source: ***WG3** – Bangkok, 2007*

All sectors and regions have the potential to contribute (2030 World)



Note: estimates do not include non-technical options, such as lifestyle changes and behaviour pattern.

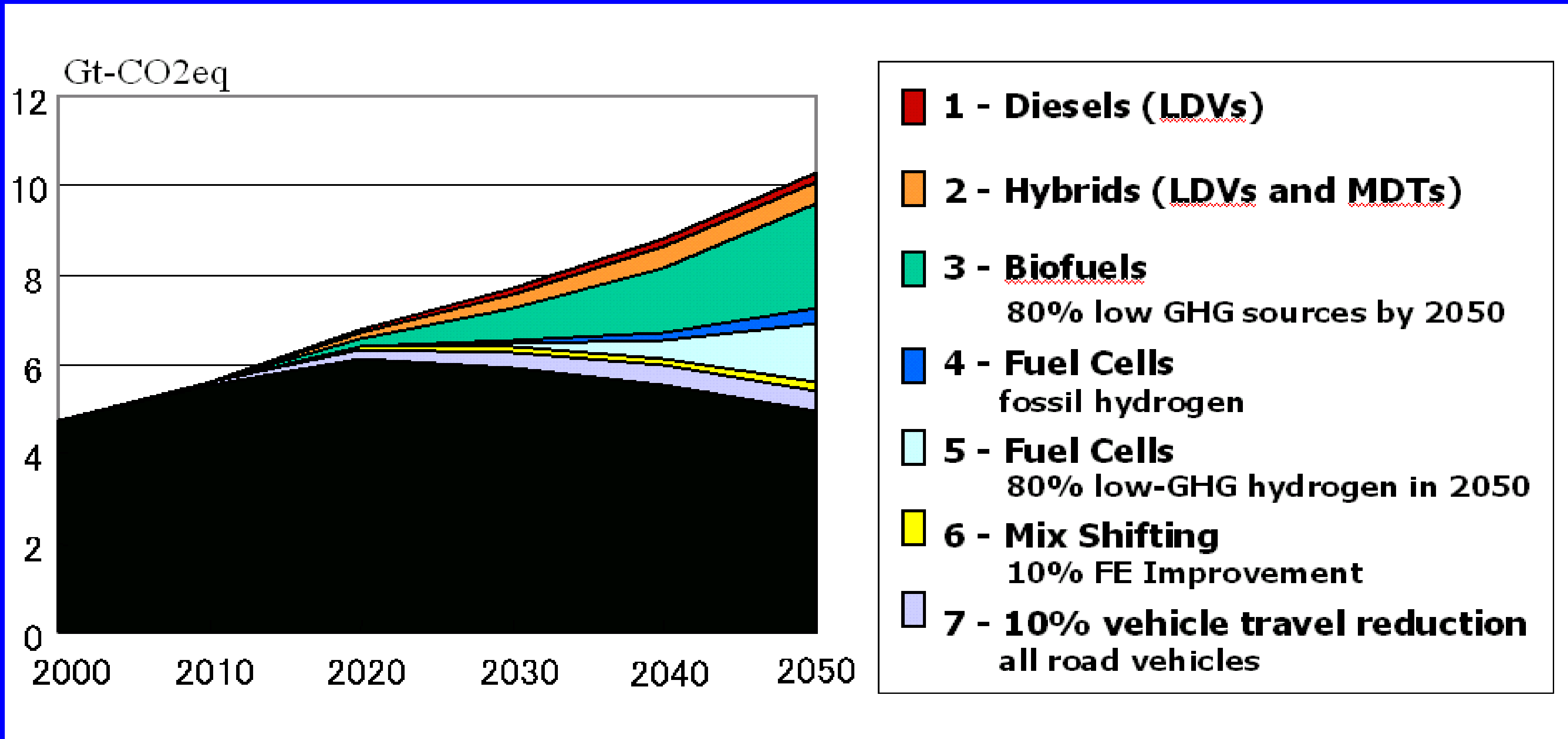
Selected Policies, measures and instruments that have shown to be environmentally effective- Transport

- Mandatory fuel economy and CO_2 standards: Partial coverage of vehicle fleet must limit effectiveness
- Taxes on vehicle purchase, registration, use and motor fuels, road and parking pricing :Effectiveness may drop with higher incomes
- Influence mobility needs through land use regulations, and infrastructure planning : Particularly appropriate for countries that are building up their systems
- Investment in attractive public transport facilities and non-motorised forms of transport : Particularly appropriate for countries that are building up their systems.

The growth of transportation emissions is among the highest of all end-use sectors. Mitigation options are faced with many barriers

- Improved vehicle efficiency measures to a large extent have net negative costs due to fuel savings (at least for light-duty vehicles), but the market potential is much lower than the economic potential due to the influence of other consumer considerations. Market forces alone, including fuel costs, are therefore not expected to lead to significant emission reductions.
- Biofuels as gasoline and diesel fuel additives/substitutes are projected to grow to 3% of total transport fuel in the baseline in 2030. For carbon prices of US$25/tCO2eq this could increase to about 10%, which includes only a small contribution by biofuels from cellulosic biomass.
- Public transport systems and non-motorised transport offer opportunities for greenhouse gas mitigation, depending on local conditions.
- Realising emissions reductions in the transport sector will often be a co-benefit of addressing traffic congestion, air quality and energy security.

The effect of a scenario postulating the market penetration of all technologies



Biofuel Potential

- For 2030 IEA (2006a) reports mitigation potentials for bioethanol between 500–1200 $MtCO_2$, with possibly up to 100–300 $MtCO_2$ of that for ligno-cellulosic ethanol (or some other bio-liquid). The long-term potential for ligno-cellulosic fuels beyond 2030 is even greater. For biodiesel, it reports mitigation potential between 100–300 $MtCO_2$.

- The GHG reduction potential of biofuels, especially with cellulosic materials, is very large but uncertain. IEA estimated the total mitigation potential of biofuels in the transport sector in 2050 to range from 1800 to 2300 $MtCO_2$ at 25 US$/$tCO_2$-eq. based on scenarios with a respective replacement of 13 and 25% of transport energy demand by biofuels (IEA, 2006a).

Biofuel Potential

The biofuel potential is limited by:

• The amount of available agricultural land (and in case of competing uses for that land) for traditional and dedicated energy crops;

• The quantity of economically recoverable agricultural and silvicultural waste streams;

• The availability of proven and cost-effective conversion technology.

Another barrier to increasing the potential is that the production of biofuels on a massive scale may require deforestation and the release of soil

Final Remarks

Transport energy and GHG emissions will grow rapidly, especially in the developing world.

- **Energy and emissions GHG growth: 1-2%/yr in developed world, 3-5%/yr in developing world….India is projected to grow at nearly 5%/yr**
- **96% of transport energy comes from oil-based fuels**
- **Road vehicles account for three quarters of the total**

- **By 2030, transport GHG emissions will grow by *80%* compared to 2002 if current trends continue.**

Final Remarks

Longer-term, hydrogen fuel cells, plug-in hybrids and advanced biofuels are promising but all require major advances, esp. in reducing costs.

- **Benefits depend on details of the full fuel cycle – how the hydrogen is produced, how the electricity is generated.**
- **With current biofuels, ethanol from sugar cane has strongest emission reduction; ethanol from corn has modest reductions, potential for food/fuel conflicts**
- **Biofuels from cellulosic materials appear most promising, but require substantial R&D progress**
- **Strong R&D support is crucial for hydrogen fuel cells and batteries for plug-in hybrids**

Final Remarks

Freight transport is often ignored in analyses, but it's 35% of transport emissions and growing fast!

- **Continuing shift to faster, more energy-intensive modes**
- **Freight trucks now dominate energy use and GHG emissions; air is small but growing fast**
- **Technology improvement is crucial: hybridization for urban delivery vehicles, improved diesels for all, better aerodynamics for highway trucks**
- **Improved logistics and multi-modal deliveries – combination of overcoming institutional barriers, computerizing networks**

Conclusion

- **Transport = 23% of world energy-related GHG emissions & growing faster than other end-use sectors …….so must be a critical part of mitigation strategy**
- **Emissions growth is slowing in developed world, but rapid motorization in developing nations is driving worldwide growth in emissions**
- **Advanced vehicle technology, low carbon fuels, urban planning, shifting to more efficient modes, and appropriate pricing all have crucial roles to play in mitigation.**
- **"Best" strategy will depend on local conditions.**