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CO_2 Reductions in Transport: What's Hot and Not

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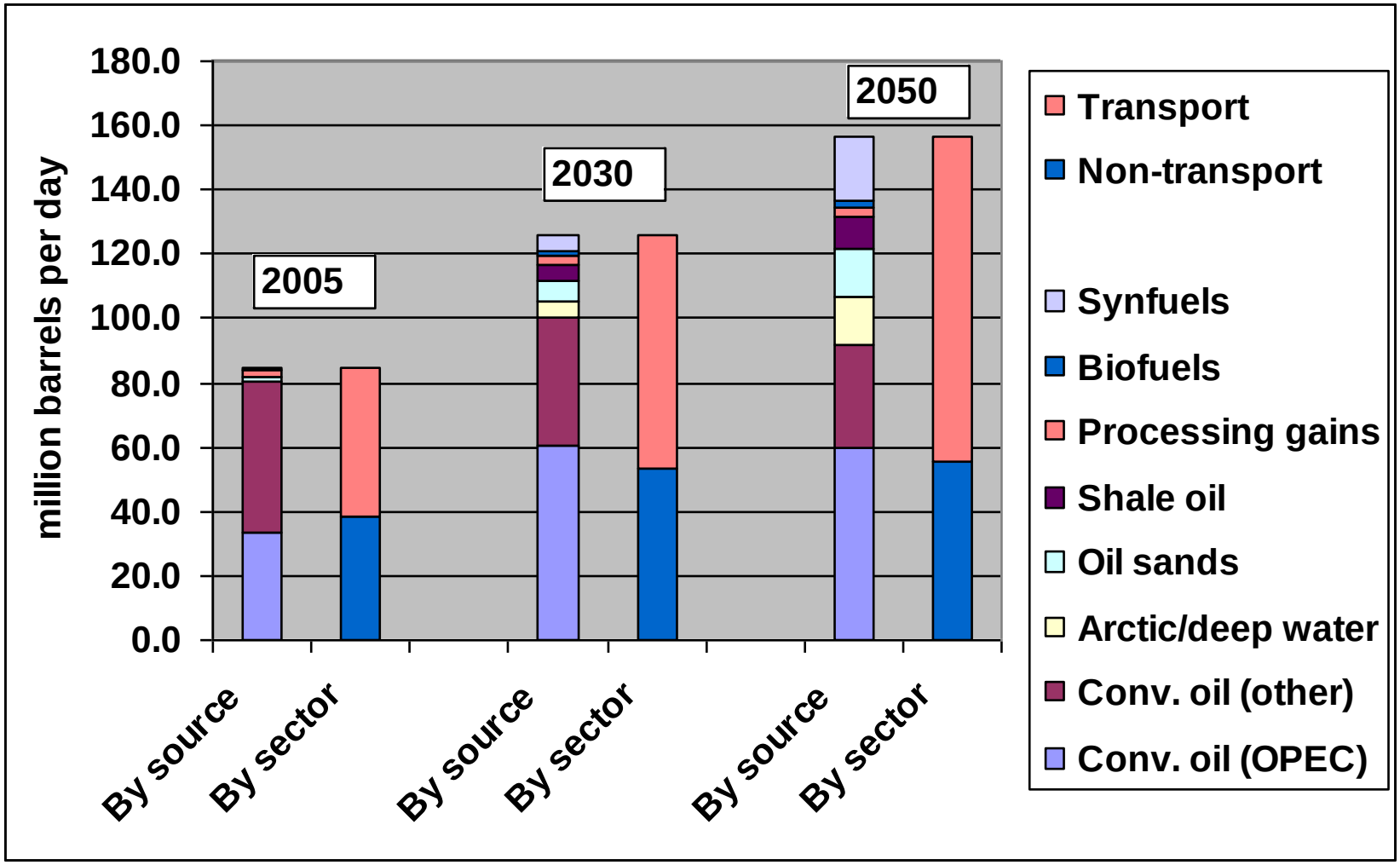
www.iea.org

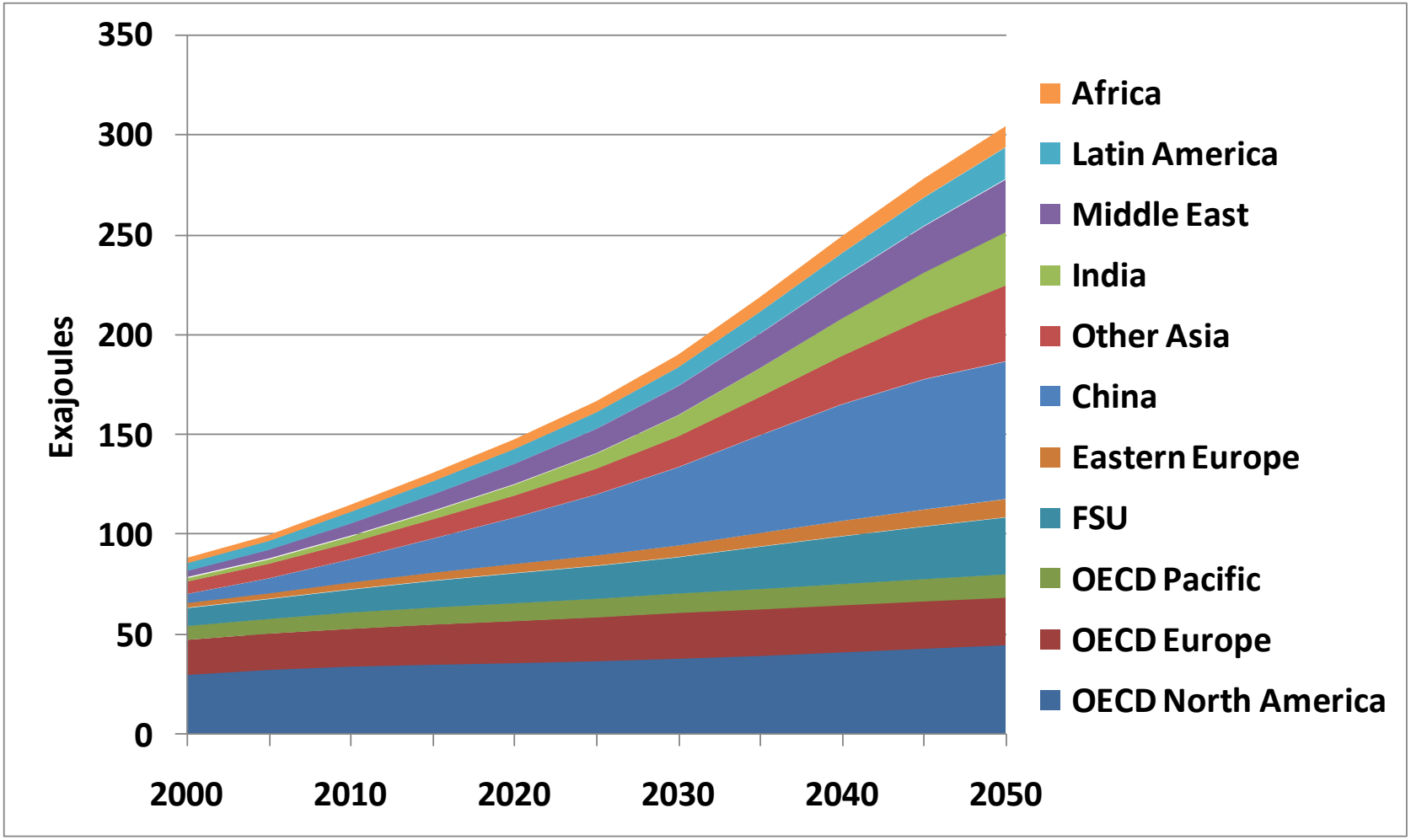
IEA Energy Technology Perspectives 2008
Baseline: Liquid Fuels to 2050



IEA ETP 2008

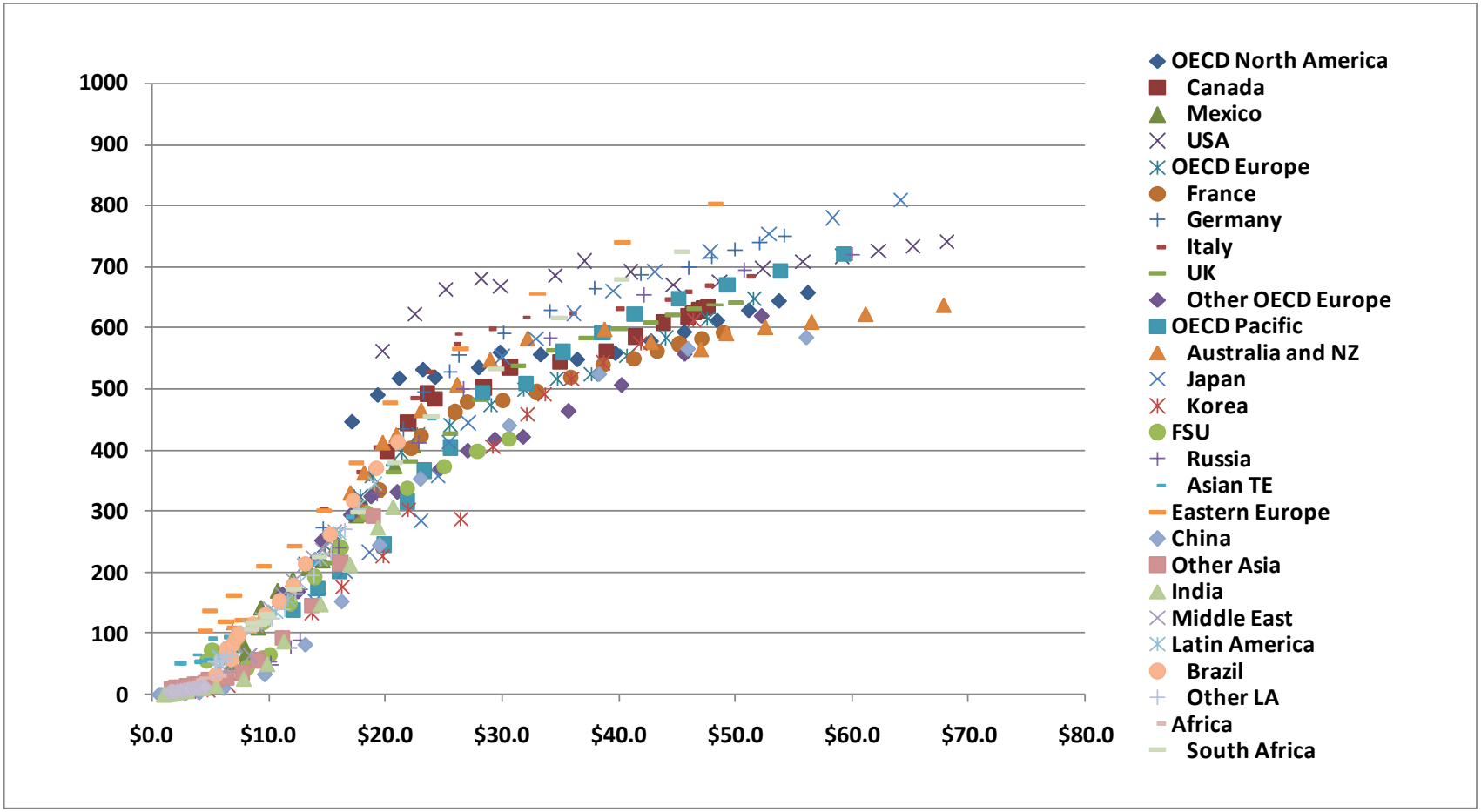
Baseline Transport Energy Demand Projection

About a tripling world-wide, 2005-2050



ETP vehicle ownership projections

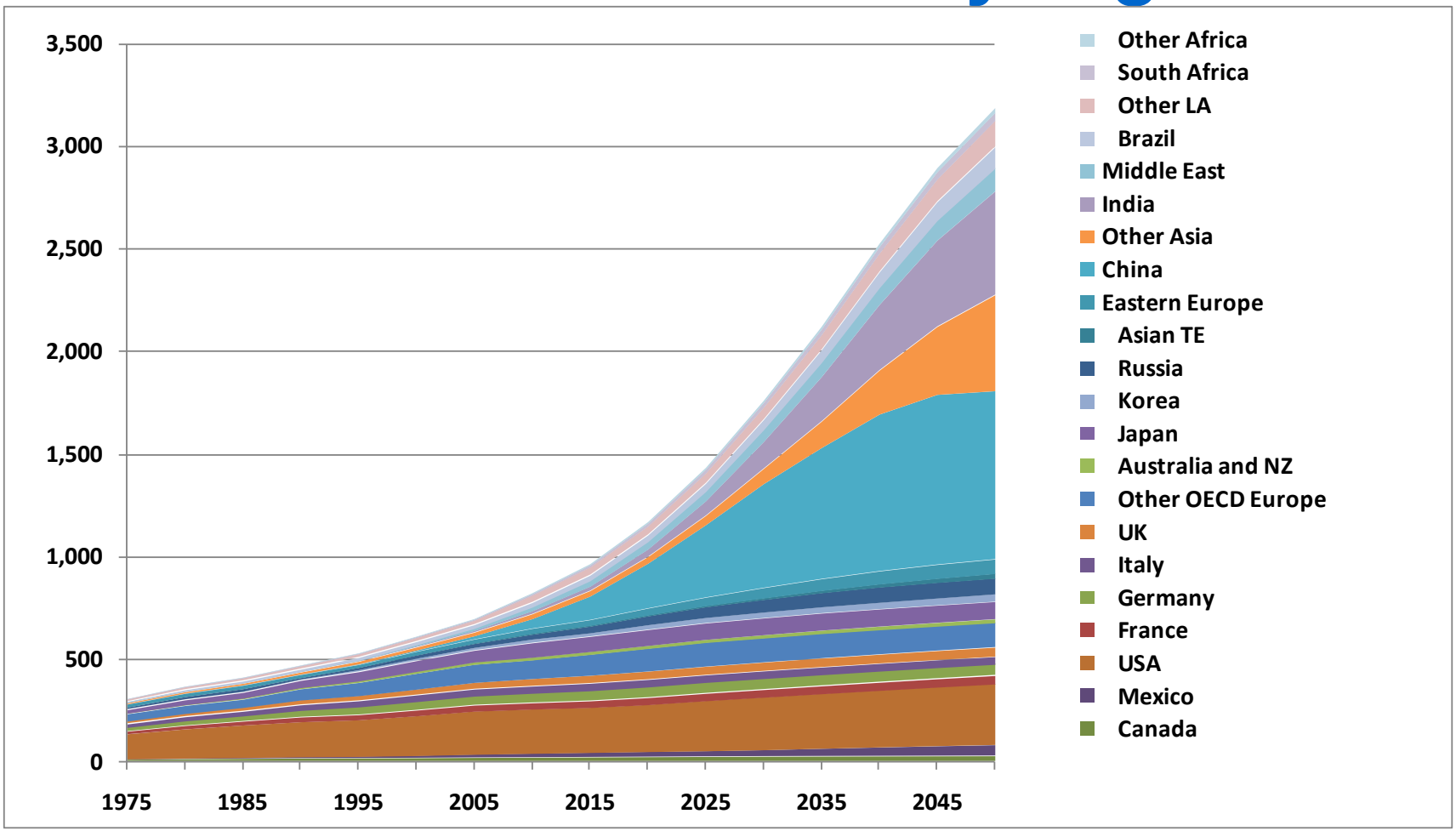
Cars per 1000 as a function of GDP/cap



*Based on a scenario where ownership/income relationships in non-OECD countries track those in OECD countries; Income growth based on OECD/WB projections

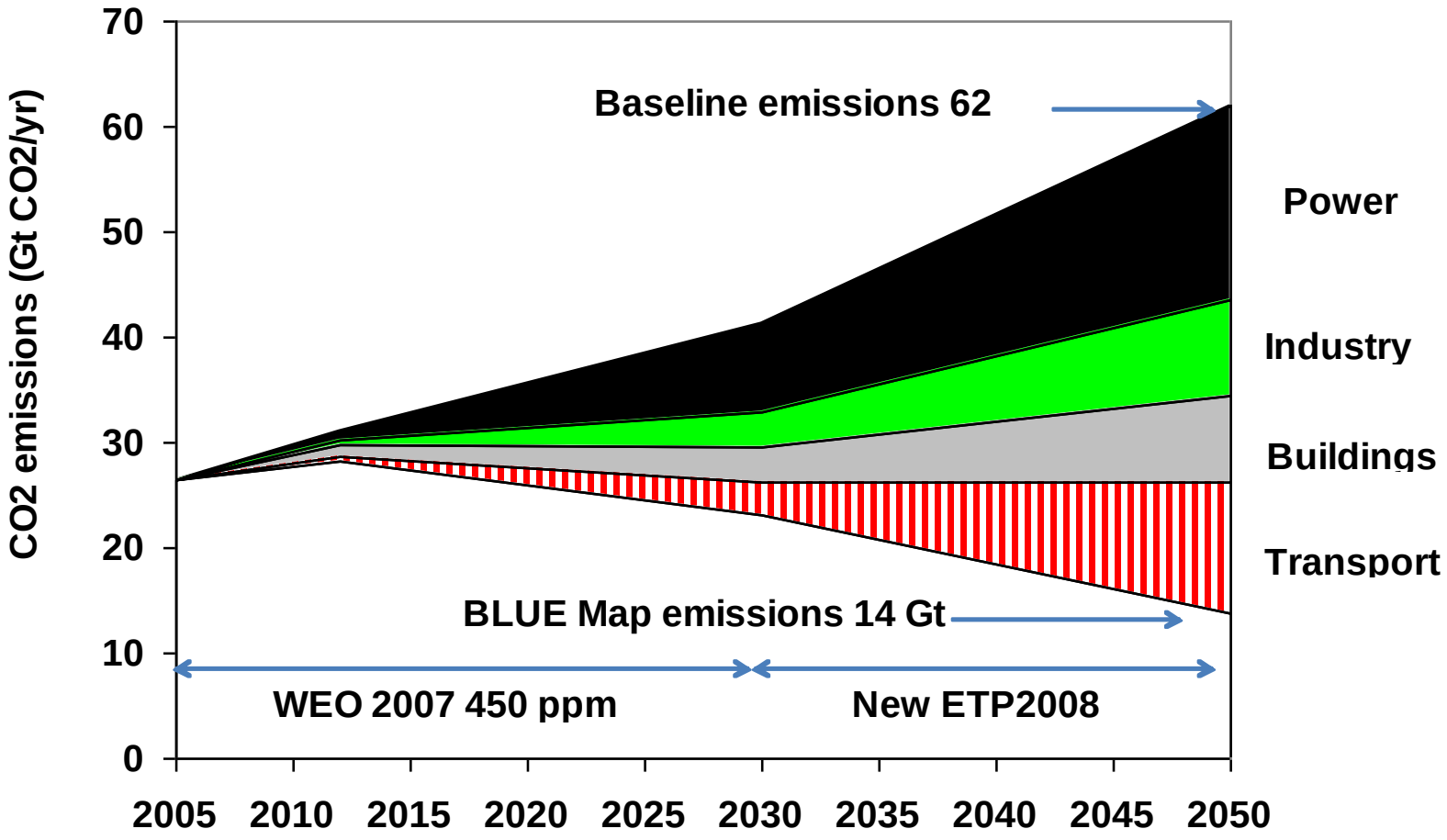
ETP vehicle ownership projections

Total car stocks by region



2. IPCC: we need a global 50% CO2 cut by 2050

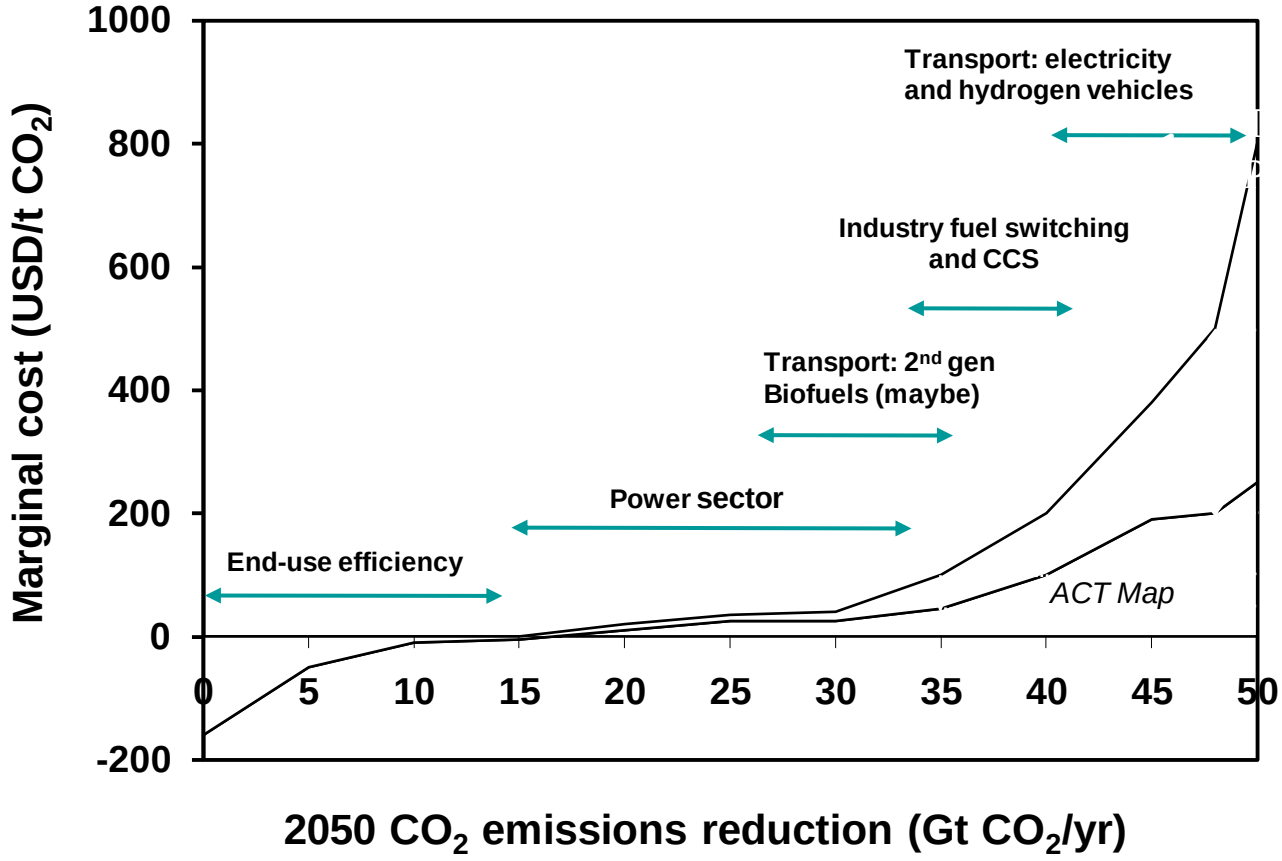
IEA ETP 2008: Where CO2 reductions come from



ETP Transport Scenarios

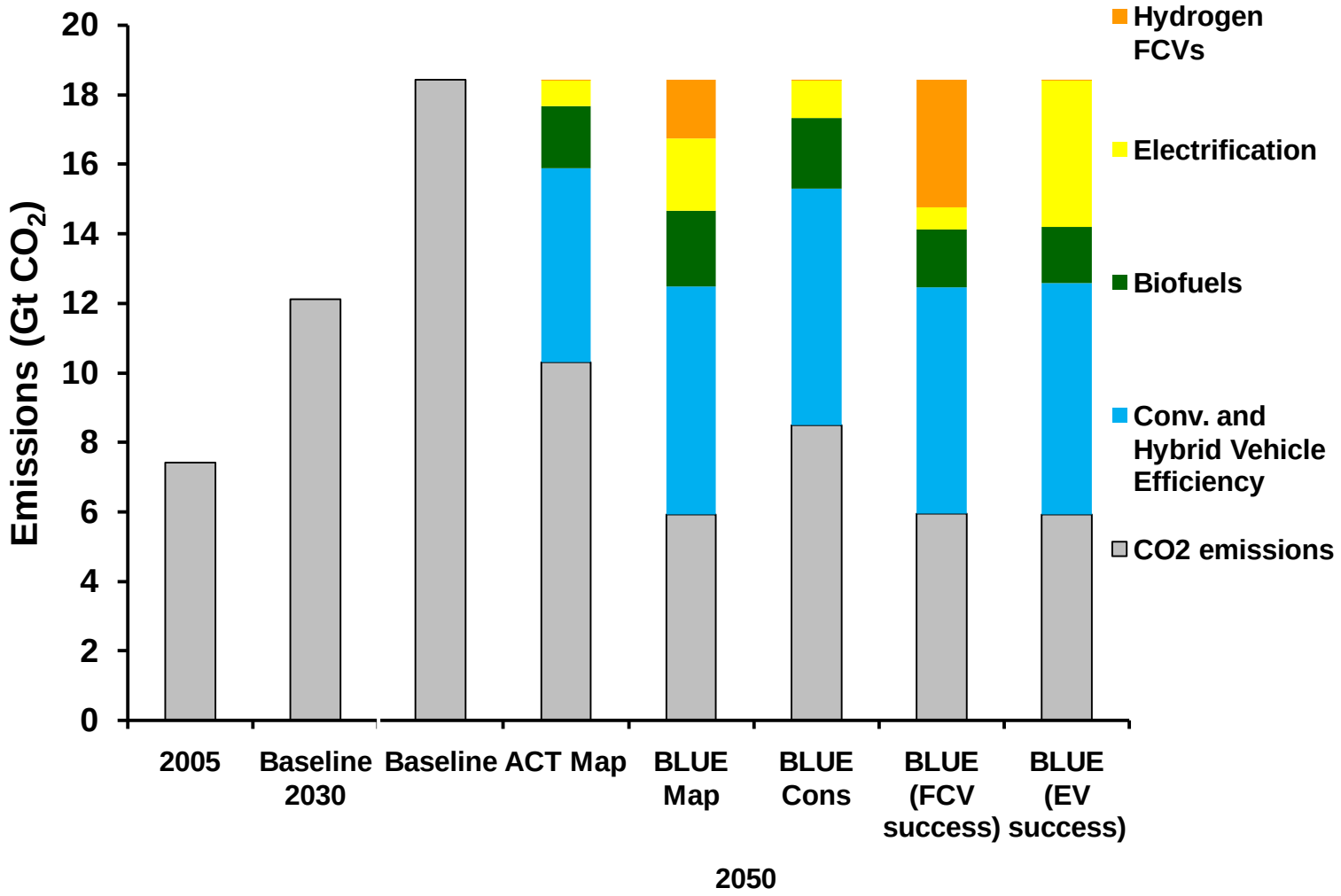
- Baseline: business as usual through 2050
- ACT: measures costing up to USD50/tonne; stabilization of CO_2
  - Efficiency measures dominate
- BLUE: measures costing up to USD200-500; reduction of global CO_2 to below 2005 levels with downward trend
  - BLUE Map: mix of biofuels, fuel cell vehicles (FCVs), and electric vehicles (EVs) for cars and light trucks in 2050
  - BLUE Conservative: no FCVs or EVs (only plug-ins)
  - BLUE FCV Success: FCVs dominate by 2050
  - BLUE EV Success: EVs dominate by 2050

ETP BLUE Map - 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

ETP Scenarios: Transport WTW CO2 Emissions



ETP and Modal Shift

- ETP does not include travel behaviour changes, except some modal shift:
  - Passenger – hold transit shares to 60% rather than drop to 30% by 2030, via strong BRT and NMT investments
  - Passenger – high-speed rail investments sufficient to induce a shift of 5% of highway trips and 10% of air trips to rail in 2030
  - Freight – rail investments sufficient to cut trucking over 750km by 25% in 2030
- Net effect is a 20% reduction in car travel, 10% reduction in truck travel compared to baseline case in 2030
  - The problem is that travel increases 4-6 fold in baseline

"Other" Transport Modes
Half of total demand

- Electricity and H2 are difficult fuels for trucks, ships, aircraft
- The best we could do for ETP:
  - Air – 15% efficiency improvement over baseline (30% in baseline) by 2050
    - 30% biofuel (BTL) by 2050
  - Shipping – 30% efficiency improvement by 2050; 30% biofuels by 2050
  - Trucks, buses – 30-50% efficiency improvement by 2050
    - Same biofuels share as for LDVs
    - Medium trucks – 50% fuel cell/EV by 2050

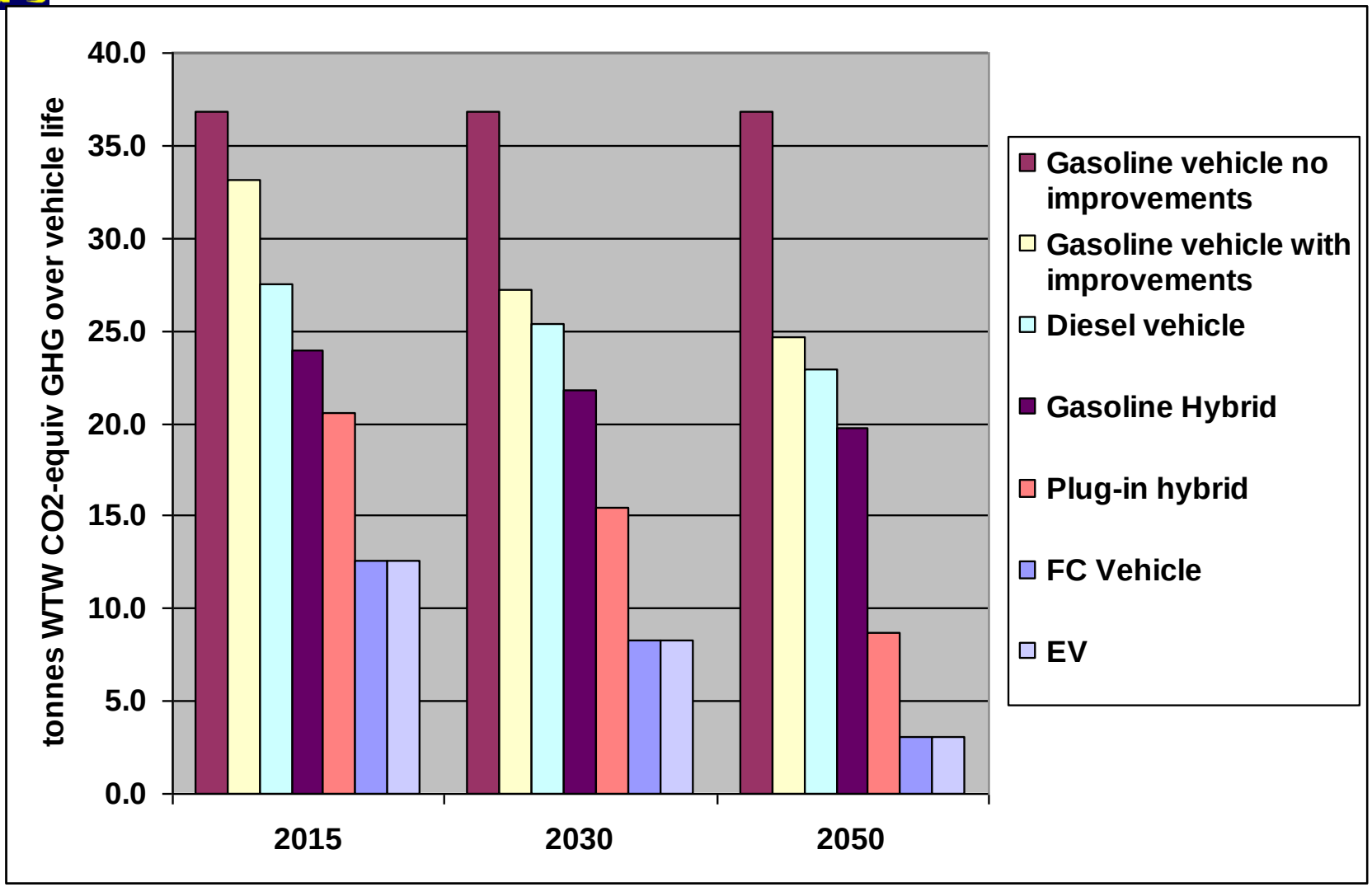
How LDVs can achieve large oil use and CO2 emissions reductions

- **Efficiency improvement generally is our cheapest and most important near-term option**
  - **CO2 from vehicles can be cut by 50% at low cost**
- **Electric vehicles emerging as a near-term option**
  - **Plug-in hybrids and urban EVs are likely first steps**
- **Biofuels could be important, but only if produced sustainably and really deliver life-cycle GHG reductions – big questions**
  - **Need to move to 2nd gen produced from low GHG (low impact LUC) feedstocks**
- **Hydrogen fuel-cell vehicles are an important long-term option, but will take time**
  - **Even if we can get FCV costs down, infrastructure will be a long-term challenge**

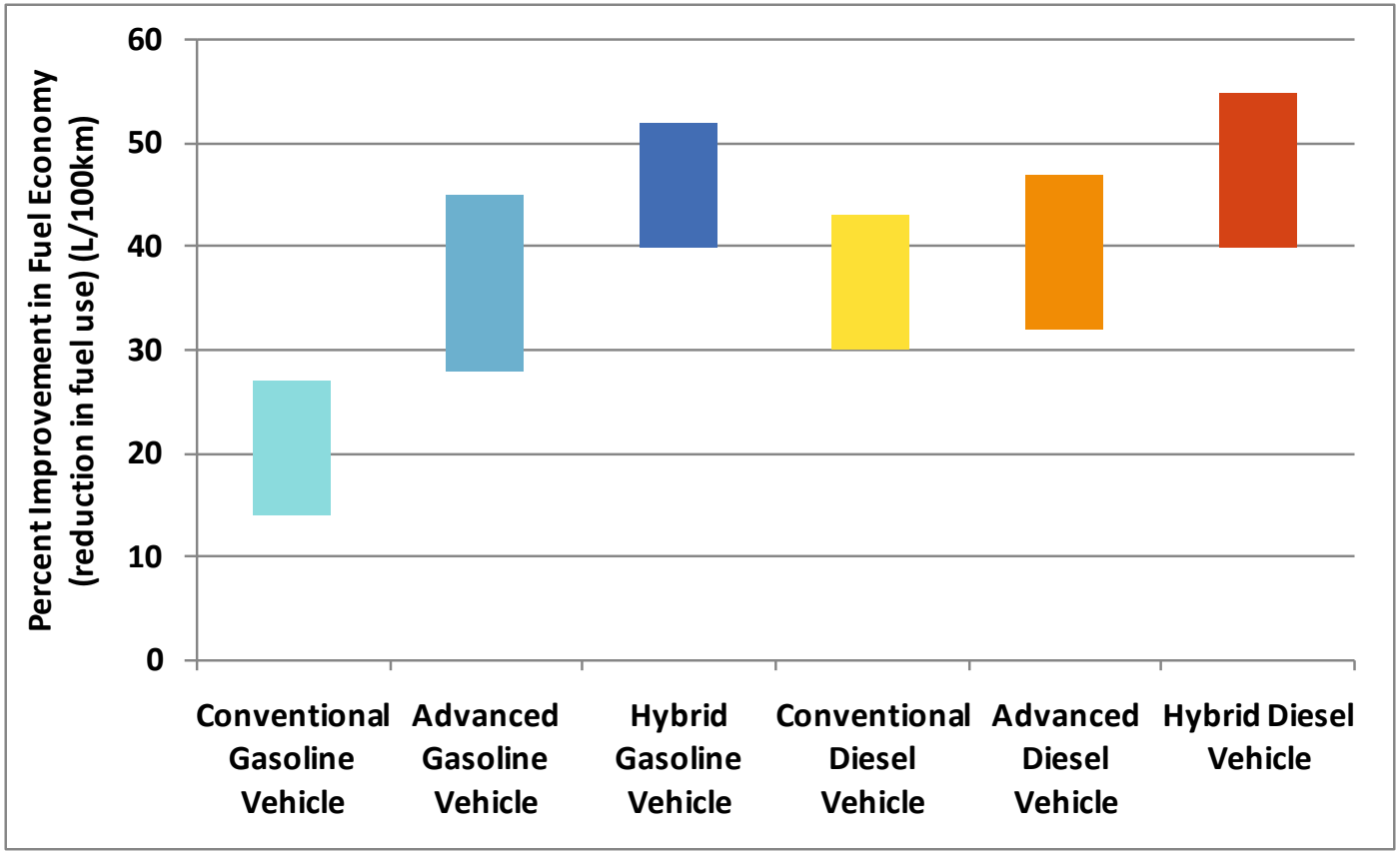
ETP 2008: Low Cost Transport Option

- New LDVs can become 50% more efficient by 2030
  - In some countries, progress toward this 50% target has already begun
    - This is, very roughly, moving from 8 L/100 km to 4. EU is already well below 8.
    - Some individual vehicles, like Prius are there already
  - Involves maximum use of available technology, including hybrids
  - Important to constrain increases in vehicle size, weight and power
  - Plug-in hybrids may play a significant role if battery costs come down further

GHG over vehicle life
(well-to-wheel CO2-equiv, preliminary)



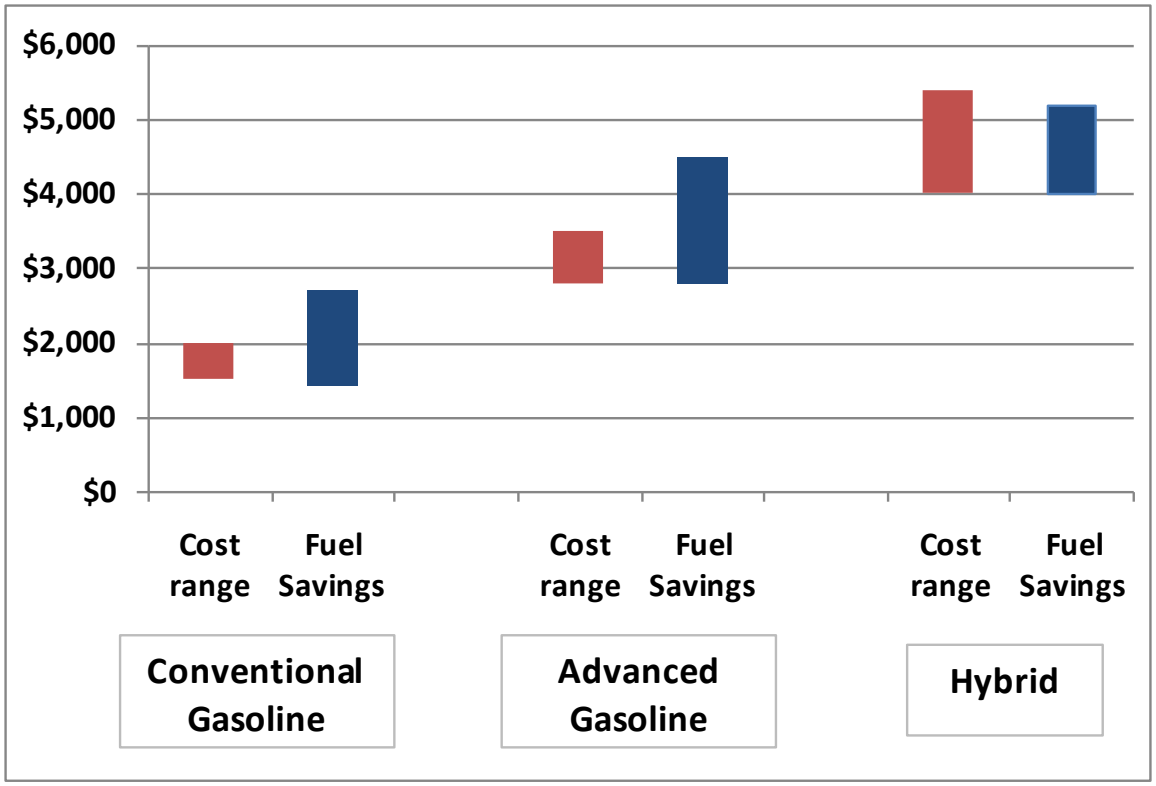
IEA Estimates: FE improvement potential in OECD Countries



- Based on an analysis of technology potential and current market penetrations for engines, drive-trains, components, weight reduction and aerodynamic improvements

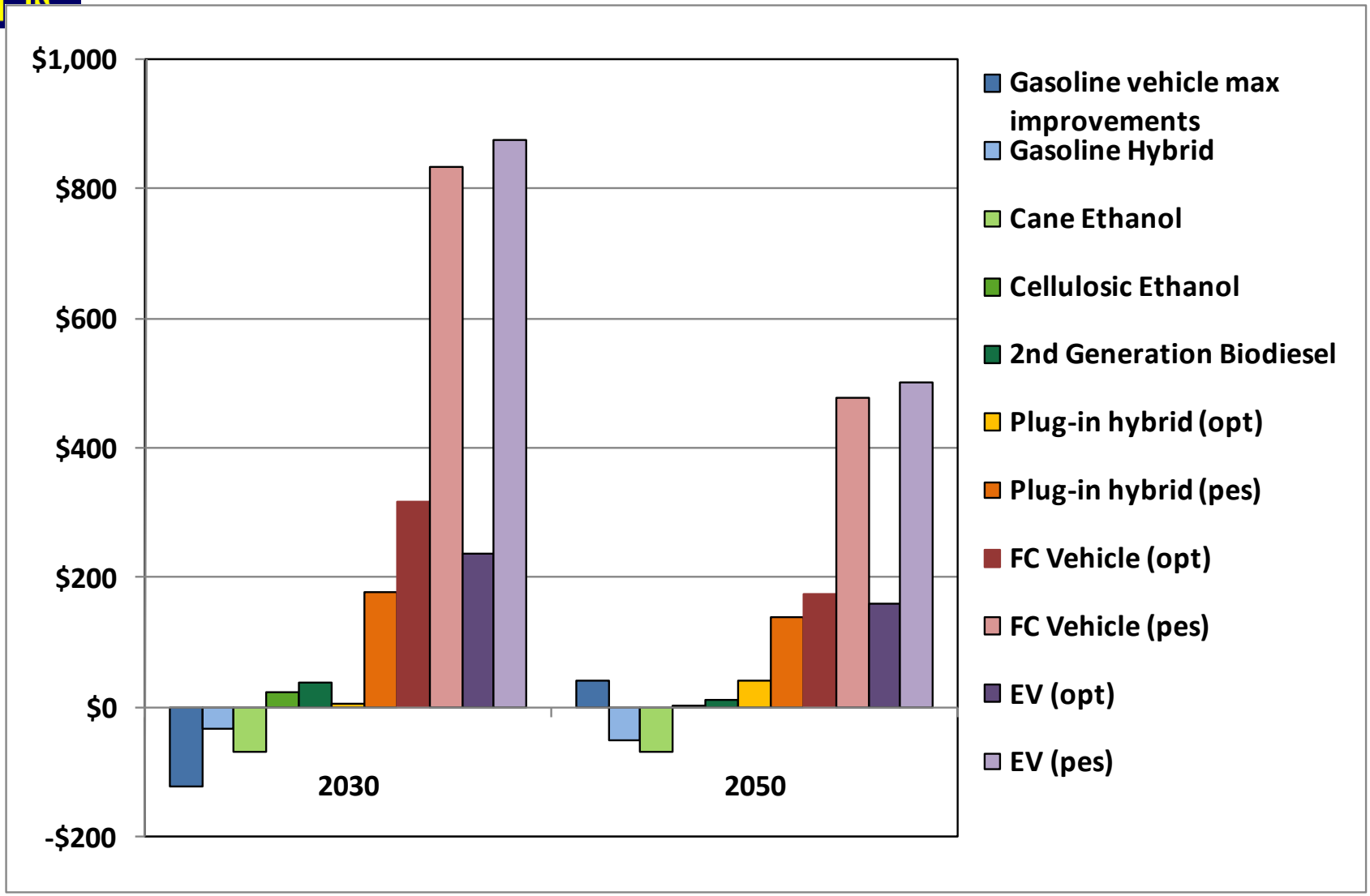
IEA Fuel Economy Estimates:

Range of Technology Costs and Fuel Savings per Vehicle



- The fuel savings values in this figure can be obtained from the FE improvement estimates in previous figure and either of the following assumptions: a) fuel saved over 200k km of driving, oil at $60/bbl, no tax; or b) fuel saved over 100k km of driving, $100/bbl, $0.25/litre fuel tax.

LDV Alternative Vehicles and Fuels
Cost per tonne CO2, 2030 and 2050



Plug in Hybrids – a promising transition technology

- Offers a small amount of EV range at relatively low battery cost
  - Minimizes range issue for EVs
- Not zero emissions unless liquid fuel is zero-emission biofuel
- Unclear whether customers will go for small electric range
  - Optimal tradeoff between range and cost?
- A “Range extender” hybrid for an otherwise pure EV is not a bad approach
  - Will be closer to zero emissions, but need more batteries

Projected Plug-in Battery Costs

Plug-in vehicle battery capacity	Vehicle driving range on batteries (km)	Battery storage needed (kWh)	Vehicle battery cost (USD)		Percent of average daily driving on batteries
			Current (USD 1 000/kWh)	Future (USD 300/kWh)	
Low	20 km	5	5 000	1 500	20-40%
Medium	50 km	12.5	12 500	3 750	40-60%
High	80 km	20	20 000	6 000	60-80%

Based on recent estimates of EV battery cost, efficiency, and daily driving profiles; percertage of daily driving for a given range will be higher in some countries (like Japan) than others (like US).

Pure Electric Vehicles

- Performance issues are being overcome
- Range and battery costs are the key questions
  - These can be traded off – what is optimal?
  - Depends on consumer tastes and on recharging infrastructure
- Night-time recharging, yes – but to maximize range and mobility benefits, will need to be day/night
  - This will affect generation mix and CO_2 impacts
- Challenge will be finding right balance and reaching the early adopters

H2 Fuel Cell Vehicles

- Still substantial technical hurdles
  - E.g. on-board energy storage, FC system reliability
- Costs are still a major concern
- Infrastructure and “chicken-or-egg” problems
  - Government investments will need to be very large, highly coordinated around the world
- H2 supply systems are uncertain

Biomass use in ETP

- Biomass currently provides around 190 Mtoe (8 EJ)/yr of commercial heat and power and 40 Mtoe (1.7 EJ)/yr of liquid transport fuels.
  - Traditional biomass accounts for over a further 800 Mtoe (35 EJ) /yr.
- In BLUE Map scenario biomass will increase to around 3600 Mtoe (150 EJ)/yr in 2050.
  - This will require 15 000 Mt biomass with half from crop and forest residues and the rest from purpose grown energy crops (estimated at about 4% of global agricultural area)
  - About 40% (1400 Mtoe/yr) will be used for **transport fuels** (at 50% efficiency, this gives 700 Mtoe or about 35ej of final fuel)
  - 700 Mtoe /yr to produce 2 450 TWh of electricity, and the rest used for bio-chemicals, heating and cooking.

Biofuels Use in BLUE Map
26% of Transport Fuel Use in 2050

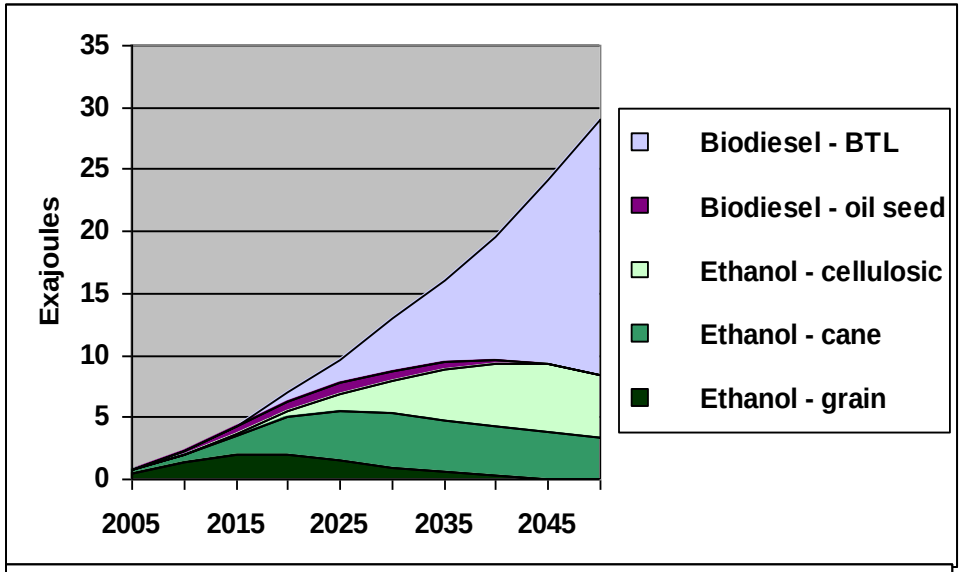
Biofuel demand by fuel/feedstock type…

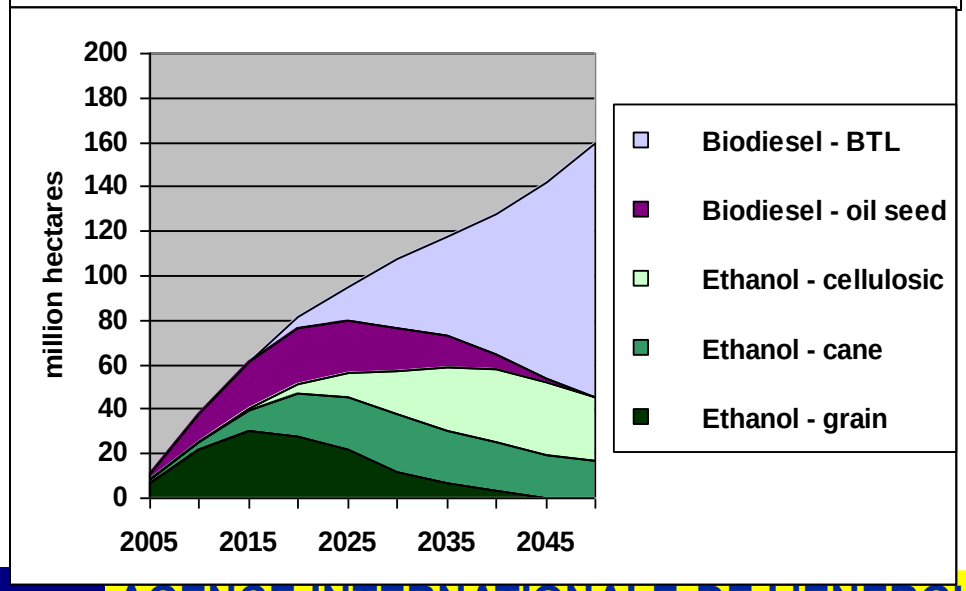
BTL diesel dominates after 2030 due to demand in truck/air/shipping sectors

Estimated land requirements if all fuels come from crop feedstocks

About 160 million hectares in 2050 (3% of world agricultural area)

2nd generation crops and cane much more land efficient





Conclusions

- There are some “hot” options – low cost, high CO2 reduction
  - Efficiency and modal shift potential burn the brightest
- It appears reasonable to target a 50% reduction in vehicle energy intensity, on average around the world by 2030
  - Strong policies around the world will be needed
- EVs are warming up – but cost and infrastructure are major hurdles
- Biofuels are a slow burn – how do we manage the global agricultural sector to maximize sustainability and GHG reduction?