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International Energy Agency

Improvement of Energy Efficiency in the Transport Field: Outline of IEA's Mobility Model and BLUE Map Scenario

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The IEA Energy Technology Perspectives calls for CO_2 cuts to 50% below 2007 levels by 2050

- To achieve this, we need a global energy technology revolution to meet climate change and energy security challenges.
- A key part of this will be a revolution in transport to new technology vehicles and new fuels
- Some early signs of progress, but much more needs to be done.
  - How fast can we ramp up sales new vehicles such as EVs and PHEVs
  - What infrastructures will be needed, by when?
  - What policies are needed?
  - What is the role of national governments, municipal governments, electric utilities, auto makers and others?

Key Transport steps to achieve BLUE Map outcomes

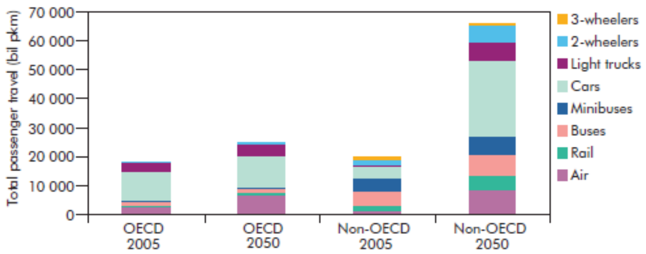
- **BLUE Map – *technology* solutions**
  - 50% reduction in conventional new PLDV (car, SUV) fuel intensity by 2050
  - 30-50% reduction in energy intensity for bus/truck/rail/ships/aircraft by 2050
  - Strong uptake of advanced technology vehicles and Fuels
    - Plug-in Hybrids [PHEVs], starting in 2010-2015
    - Battery electric vehicles [BEVs], starting in 2010-2015
    - Fuel cell vehicles [FCVs], starting in 2025
    - Advanced, low-GHG Biofuels reach 12% of transport fuel use by 2030, 25% by 2050

- **BLUE Shifts – *travel* solutions**
  - 25% lower level of car and air travel in 2050 compared to Baseline
  - Up to 2x travel by rail, 1.5x bus (such as Bus Rapid Transit systems)
  - Lower travel demand due to better land use planning, road pricing, telematic substitution

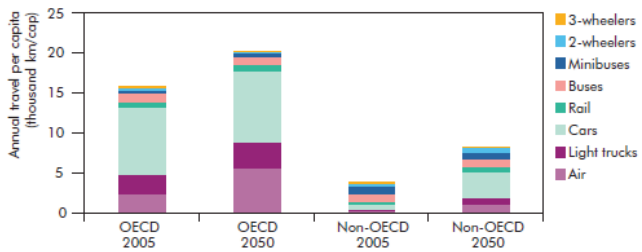
IEA travel projection: land passenger travel by mode and region, Baseline scenario

Non-OECD/OSCE is where the growth happens, though from a far lower base per capita than OECD/OSCE

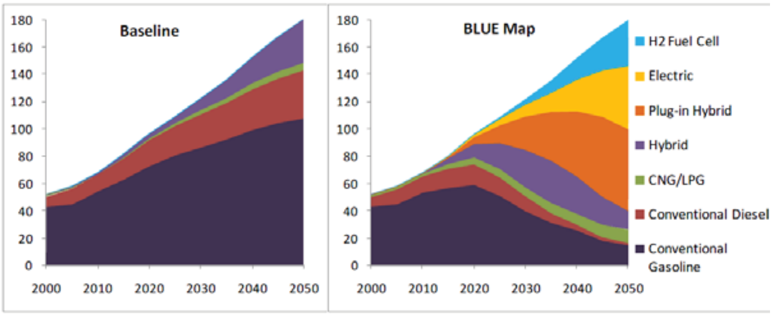
Total



Per capita



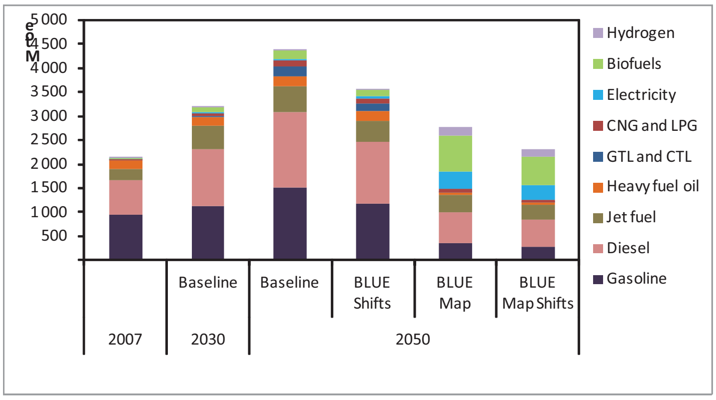
Passenger LDV sales by technology type and scenario: BLUE Map will be VERY challenging



In the ETP Baseline, sales are mainly conventional vehicles through 2050; hybrids reach about 20% of sales

In BLUE Map, strong penetration of hybrids by 2015, PHEVs and EVs by 2020, FCVs after 2025. By 2050, plug-in vehicles account for more than two-thirds of all sales.

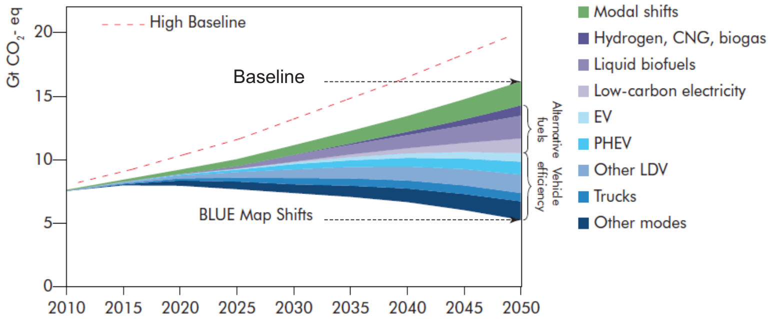
Transport Energy Use by ETP Scenario



- Global transport energy use in Baseline doubles by 2050
- BLUE Shifts achieves a 20% reduction in 2050; BLUE Map achieves 40%, BLUE Map/Shifts achieves nearly 50%
- Nearly 50% of energy is low-CO_2 renewable in 2050

Transport GHG emission wedges

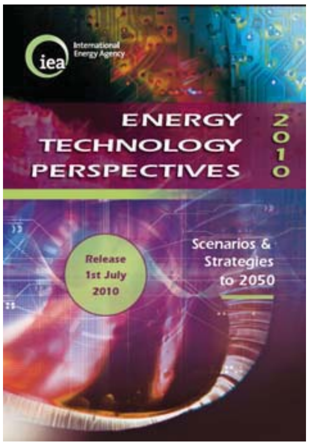
(well-to-wheel CO_2-eq)



Worldwide, GHGs increase from 7 to over 16 Gt in the Baseline in 2050 and to over 19 Gt in the High Baseline. The combination of technology changes and modal shift yields a reduction to about 5 Gt in BLUE Map/Shifts. (Shifting yields bigger reductions than shown here if the technology targets in BLUE Map are not achieved.)

Conclusions for OSCE

- **Without strong policy interventions, oil use and related CO_2 emissions worldwide could double by 2050**
  - **Most growth will be in the developing world, though per-capita CO2 starts much lower than in OECD or OSCE countries**
- **We can change this picture dramatically and cut transport CO2 below current levels via a combination of**
  - **Strong efficiency improvements, rapid uptake of advanced technologies, and strong adoption of alternative fuels**
    - **New LDV fuel economy could reach 4 L/100 km, 90 g/km CO_2 by 2030, probably sooner in most OSCE countries**
    - **Strong uptake of EVs will result in 2-3% stock share by 2020 but could reach 15% by 2030, 50% by 2050**
  - **Modal shifts via smart growth and strong investments in state-of-art transit and bus systems**
    - **Shifting 25% of future car and air travel to other modes (with some cuts from smart growth, telematics, etc) would cut energy use 20%**



Thank You

www.iea.org/techno/etp/index.asp

Backup Slides

Projected electric and plug-in hybrid vehicle sales through 2020, based on national targets

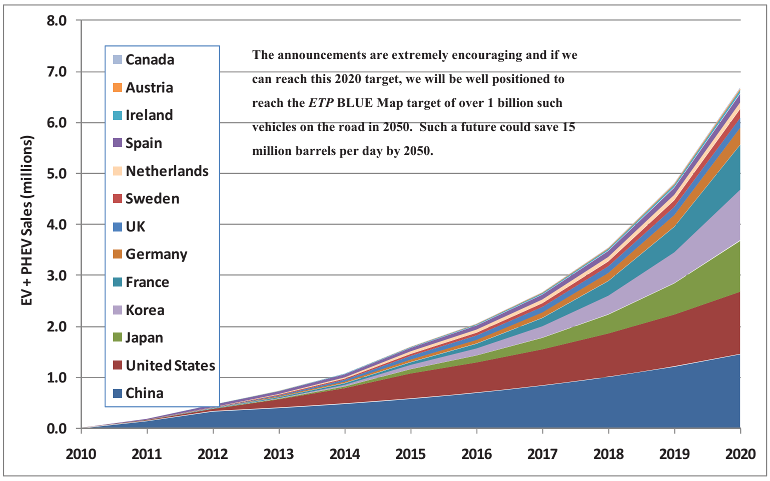


Figure based on announced national sales and stock targets, with assumed 20% annual sales growth after target is met, if target is before 2020 (e.g. China's target is for end of 2011).

EV / PHEV sales could reach nearly seven million by 2020

What is MoMo?

- It is a spreadsheet model of global transport, energy use, emissions, safety, and materials use
  - Analysis of a multiple set of scenarios, projections to 2050
  - Based on hypotheses on GDP and population growth, fuel economies, costs, travel demand, vehicle and fuel market shares
- World divided in 11 regions, plus a good number of specific countries (for road modes only, being extended to other modes)
  - USA, Canada, Mexico, Brazil, France, Germany, Italy, UK, Japan, Korea, China, India
  - The model is suitable for handling regional and global issues
- It contains a large amount of information (data) on technologies and fuel pathways
  - Full evaluation of the life cycle GHG emissions
  - Cost estimates for new light duty vehicles
  - Estimates for fuels costs and taxes
  - Section on material requirements for LDV manufacturing
- It is based on the "ASIF" framework:

  Activity (passenger travel) * Structure (travel by mode, load factors) * Energy Intensity = Fuel use

Analytical capabilities (1)

- For LDVs and trucks, Tracking of
  - A stock model has been developed for LDVs
  - Activity, intensity, energy use
  - GHG emissions (on a WTW, a TTW basis)
  - Pollutant emissions (CO, VOCs, PM, lead and NO_x)
  - Fuel and vehicle costs (only for LDVs)
- For buses, 2/3 wheelers, we track stock, tkm, stock efficiency, energy use and emissions
- For rail and air, total travel activity (in pkm or tkm), stock efficiency, energy use and emissions is tracked
- For shipping, so far just energy use and emissions
- Material requirements and emissions have been integrated in the model
  - Analysis of future vehicle sales (e.g. fuel cells) and how they impact materials requirements (e.g. precious metals, Li) is possible
  - Full life-cycle analysis for GHG emissions from LDVs (including manufacturing);
  - Tailpipe emissions of various pollutants

Analytical capabilities (2)

- Increasingly versatile model
  - Suitable for simple “what-if analysis” to understand changing trends given the variation of one or more variables
    - Analysis of hypotheses on vehicle fuel economies and fuel shares
    - Learning incorporated in the model, given initial and “asymptotic” technology prices
  - Suitable for analysis based on inputs relative to economic growth, population growth and the variation of fuel prices
    - Travel and vehicle ownership affected
    - Prices module being improved to account for the variation of the main feedstock prices given changes in the oil price
  - Full "back-casting“ possible
    - The model is fully transparent, all calculations can be tracked back
    - No black box effect
    - Inevitable limitations, being progressively overcome to help the model user and to improve the quality of the results

Coverage of transport modes

- 2-3 wheelers
- Light duty vehicles
  - Spark ignition (SI) ICEs
  - Compression ignition (CI) ICEs
  - SI hybrid ICEs (including plug-ins)
  - CI hybrid ICEs (including plug-ins)
  - Hydrogen ICE hybrids (including plug-ins)
  - Fuel cell vehicles
  - Electric vehicles
- Heavy and duty vehicles
  - Passenger
    - Minibuses
    - Buses
  - Freight
    - Medium freight trucks
    - Heavy freight trucks
- Rail
  - Passenger
  - Freight
- Air
- Water transport
  - National
  - International

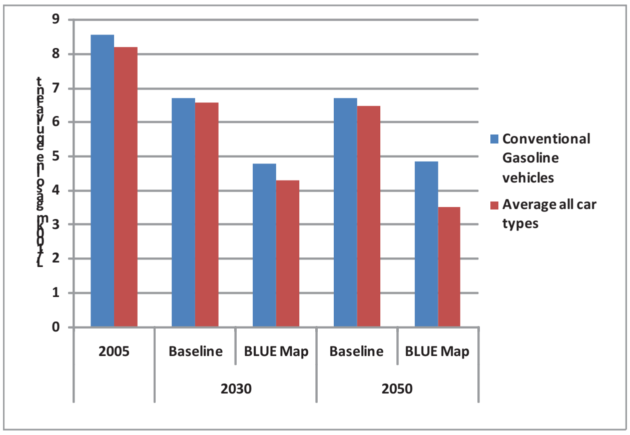
Coverage of fuel pathways

- Liquid petroleum fuels
  - Gasoline
  - Diesel (high- and low-sulphur)
- Biofuels
  - Ethanol
    - Grain, sugar cane, advanced technologies (lignocellulose)
  - Biodiesel
    - Conventional (fatty acid methyl esters, FAME or biodiesel obtained from hydrogenation of vegetable oil in refineries), advanced processes (BTL, fast pyrolysis, hydrothermal upgrade)
- Synthetic fuels
    - GTL and CTL
- CNG/LPG
    - CNG, LPG, biogas
- Electricity
    - Separately for EVs and PHEVs; by generation mix, by region
- Hydrogen
    - from natural gas, with and without CO_2 sequestration
    - from electricity, point of use electrolysis, with and without CO_2 sequestration
    - from biomass gasification
    - advanced low GHG hydrogen production

Costs of Baseline and BLUE Map, 2010-2050

- **If EV and fuel cell vehicle costs drop as anticipated, by 2050 the transport BLUE Map scenario should be achievable at a *marginal cost* below USD 200/tonne CO2.**
- **During the transition costs will be higher, but costs will drop as volumes become higher so early high unit costs may not be that significant in the long run.**
- **On *average* between 2010 and 2050, BLUE Map may not be much more expensive, or possibly cheaper, than the Baseline.**
  - **In the Baseline, the total (undiscounted) cost of vehicles of all types between 2010 and 2050 is about USD 230 trillion, with another 150 trillion cost for fuel.**
  - **In BLUE Map, vehicle costs rise by an additional 22 trillion but fuel costs (at USD 120/bbl) drop by 20 trillion.**
  - **However, if the price of oil in BLUE drops, more savings accrue. For example, if the price drops to USD 60/bbl, the additional savings is USD 30 trillion.**

Passenger Light-duty vehicle fuel economy



•Passenger light-duty vehicle (PLDV) fuel economy improves slowly in the Baseline (no extension of existing standards assumed).
•It improves much more in BLUE Map with maximum uptake of available incremental technologies; achieves about a 50% reduction in new LDV energy intensity by 2030, and an additional 20% by 2050.

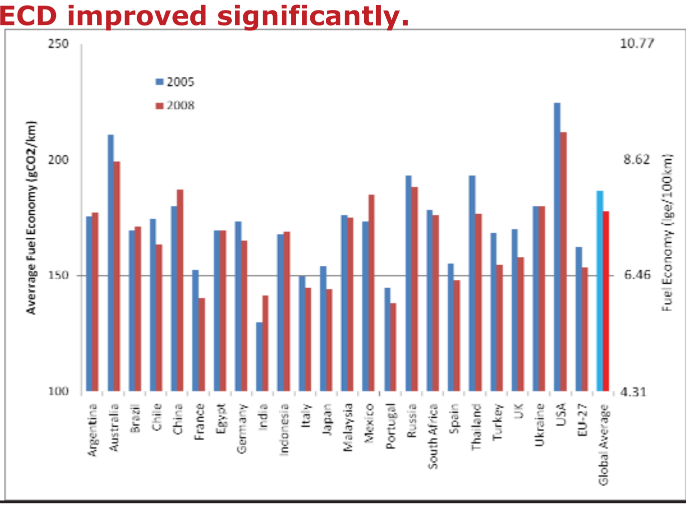
Results

The global average was about 8 L/100km in 2005. It improved to below 7.7 in 2008. But the rate of change was well less than that needed to hit GFEI targets.

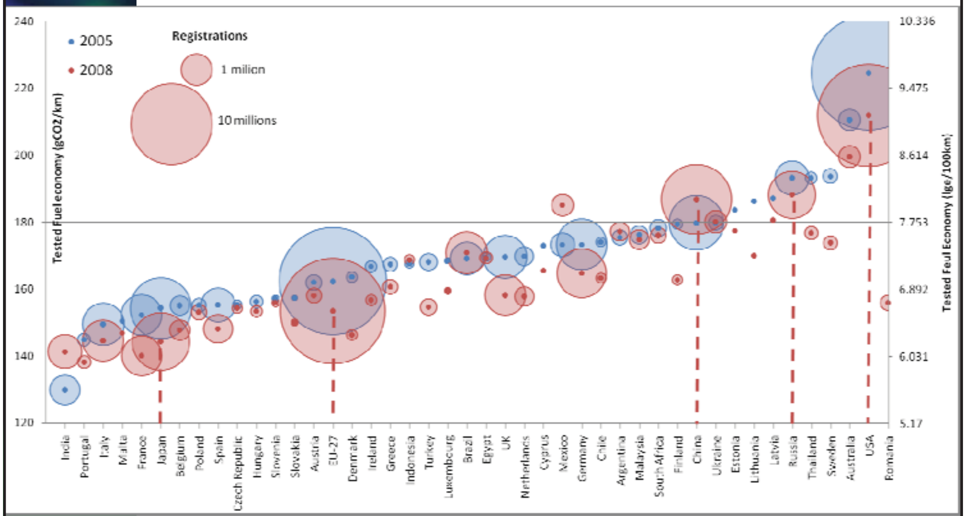
		2005	2008	Annual Change 2005-2008
Fuel Economy (lge/100km)	Global Average	8.04	7.65	-1.6%
	GFEI Objective	8.04	4.02	-2.7%
		2005	2030	Required Annual Change 2005-2030

Results by country

There's a wide range of averages across the studied countries. Non-OECD countries have a lower (better) average than OECD, but improved less (or not at all) between 2005-2008 whereas OECD improved significantly.



Shown another way



Breaking out FE by region and vehicle class is revealing…

Biggest change is for large LDVs in OECD