IRF Environment Policy Statement

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Outline of IEA Mobility Model and Modal (BLUE) Shift Scenario

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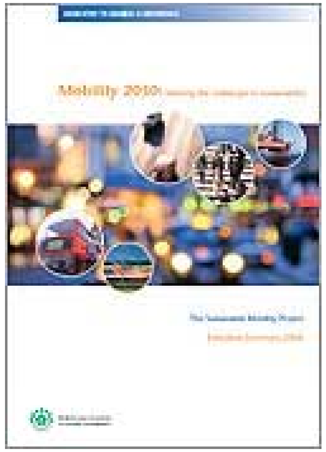
www.iea.org

Project development



2003

WBCSD project and SMP model

- **First Generation Model available on the SMP website**
- **SMP model used for the Mobility 2030 report**
  - **scenarios exploring energy use, CO_2 and pollutant emissions, safety and materials use**

2004-2005

SMP model developed further into the first version of the **MoMo model**

- MoMo data used for the IEA ETP analysis and ETP 2006

2006-2008

Second phase of model development

- Deeper analysis of vehicle technology potential (incl. PHEVs)
- Elasticities of travel with respect to income and prices
- Significant amount of historical data integrated in the model
- Development of ETP 2008 scenarios

2008-2011

Third phase of model development

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

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**

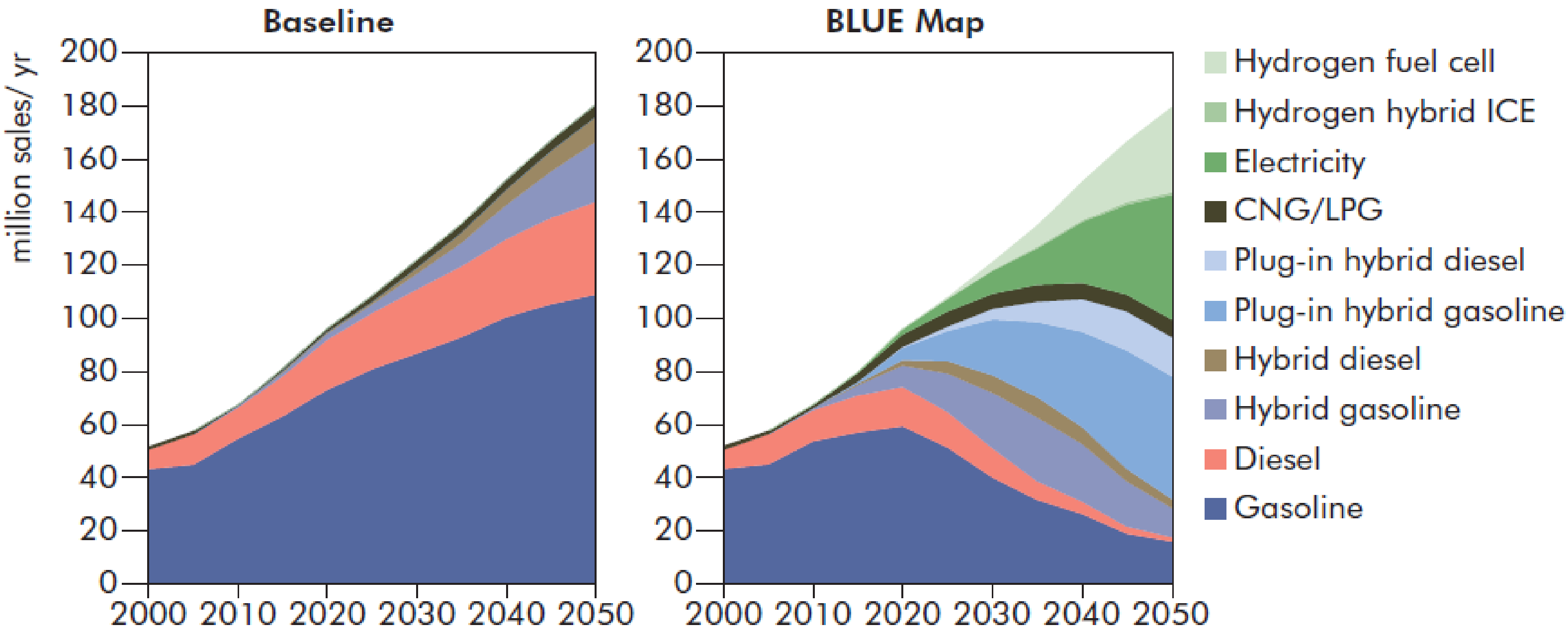
- **Some early signs of progress, but much more needs to be done.**
  - **How fast can we ramp up sales new vehicles such as EVs and PHEVs**
  - **What infrastructures will be needed, by when?**
  - **What policies are needed?**
  - **What is the role of national governments, municipal governments, electric 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**

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



- *In the Baseline, sales are mainly conventional gasoline and diesel 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 half of all sales.*
- *Fuel economy target: 50% reduction in new fuel economy by 2030.*
- *Role of biofuels for remaining ICEs*

Modal Shift: Objectives

- Simulate modal shift
  - Keeping pkm constant versus baseline
  - Split travel by type (conceptual issue, as well as data availability)
    - Urban / Non-urban
- Historical data gathering
  - Data collection underway
  - Smoothing trends
  - Consistency with MoMo global mode shares
- Vehicle ownership/operating costs
  - Purchase
  - Fuel cost
  - O&M
- Infrastructure costs
  - Construction cost
  - O&M

Vehicle Infrastructure

- Database build-up
  - Road, IRF : 3 road types
  - Rail, UIC : 5 rail types urban, intercity, high speed
  - Bus, ITDP: BRT
  - Airports, ICAO
- Indicators:
  - Road density
  - Road length per vehicle
    - ↳Infrastructure requirements by mode, by region

Shift effects on Infrastructure

- How to deal with reduced cars traffic activity in Shift case? Also, urban vs. non-urban split?
  - Less road?
  - Less lanes on motorways?
  - Less congested roads (more road per car)?

- How to deal with frequency, bottlenecks for mass transportation
  - Does relying on national average indicators enough?
  - What do we do about bottlenecks/saturation effects?

Bus Rapid Transit Potential

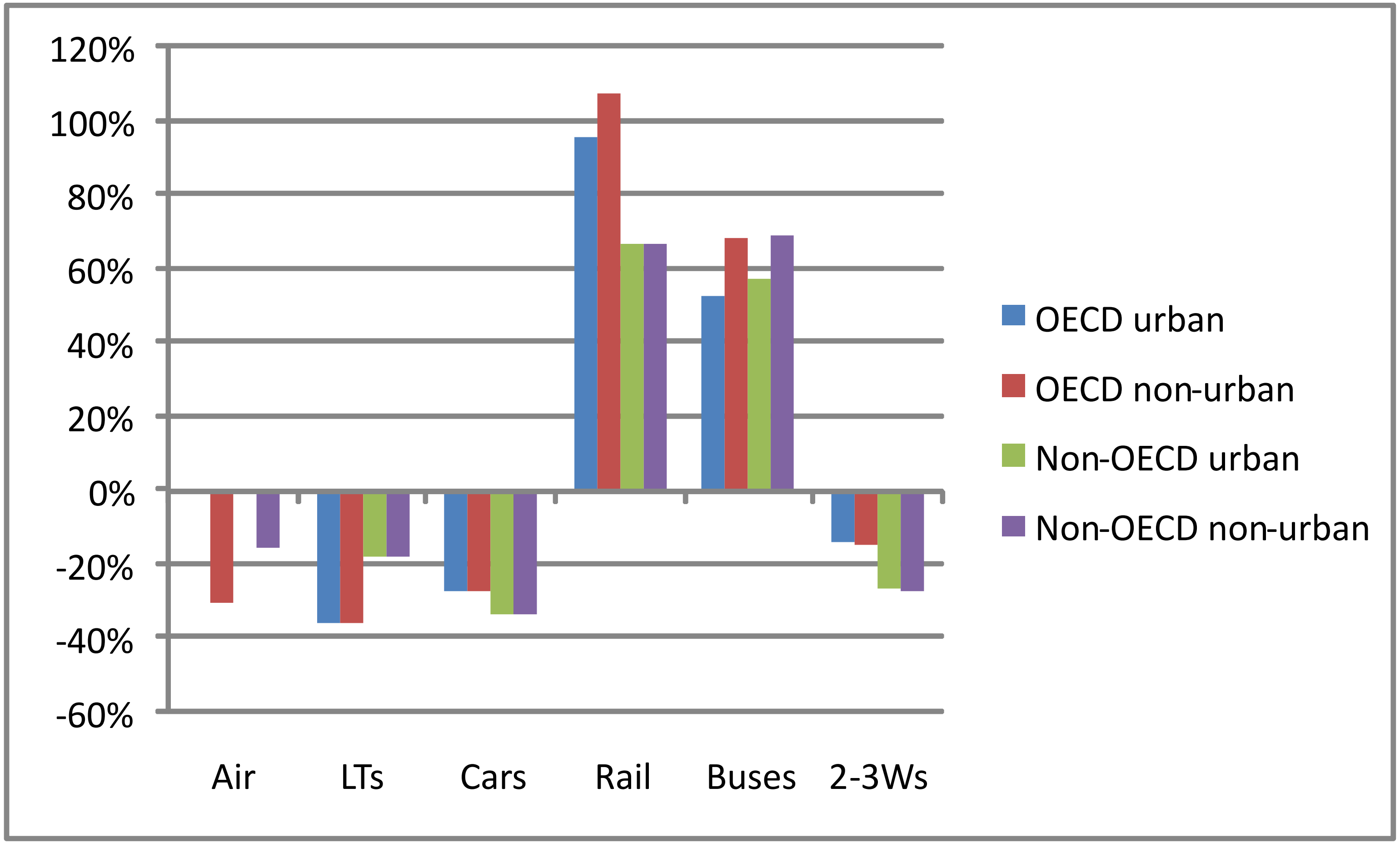
Streetsblog.org

- **BLUE Shifts – BRT systems database**
  - **From Curitiba's 1972 system, to today's 100+ around the world**
  - **Developing world potential (vs. light rail and metro)**
  - **Trying to find regional averages for $/km (tricky)**
  - **Initial results:**
    - **Longitudinal analysis shows increasing costs over time**
    - **Systems exist across various population densities (Rouen 63 vs. Taipei 25,000)**
- **Totals**
  - **Moving 10 million people per day**
  - **1,600 km of road**
  - **Thought exercise: [very] back of the envelope calculation ->**

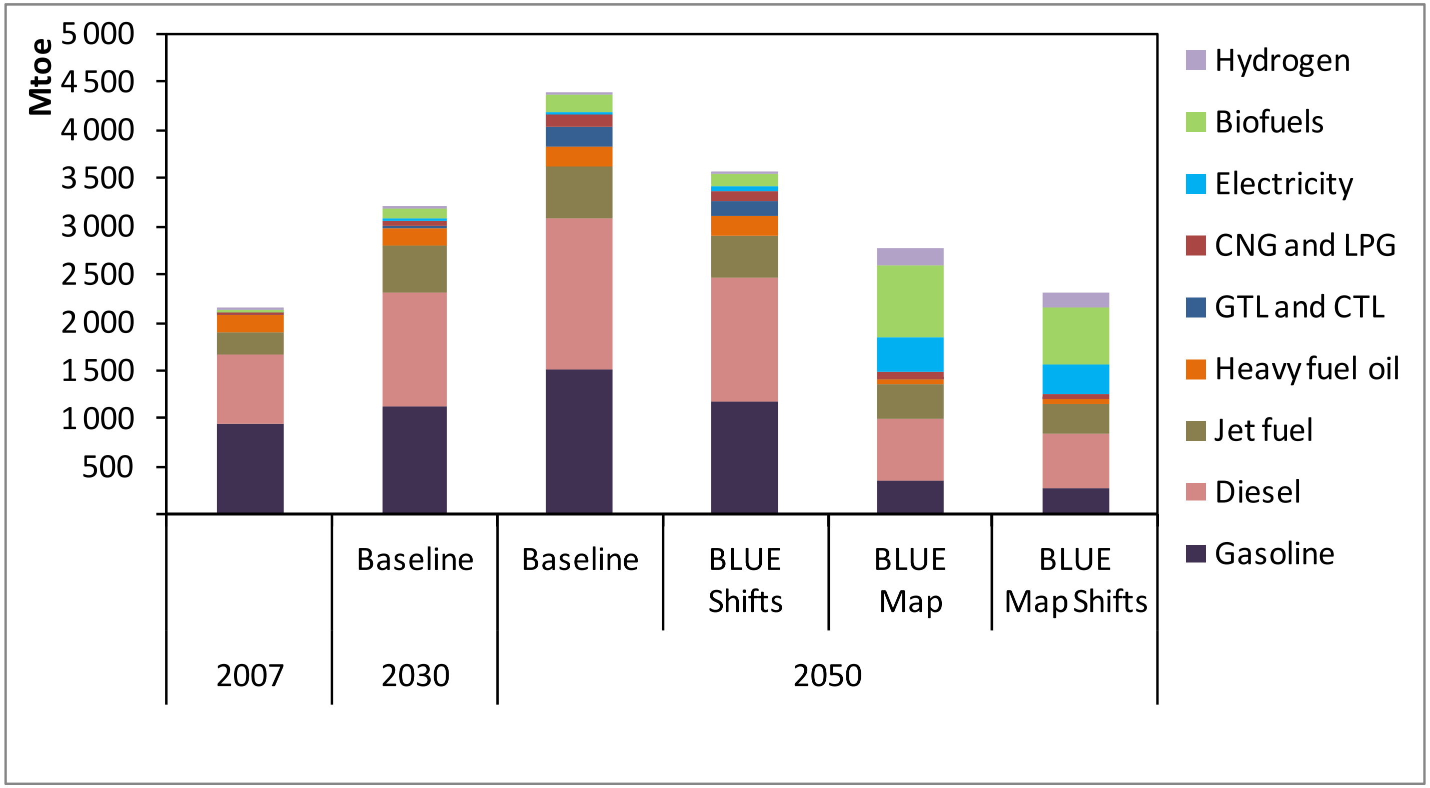
    $500 million per BRT system, making $500 billion for 1000 cities. This compares to $150 trillion the planet will spend on cars and fuels in next 40 years. This is the type of thing we will explore…

Modal Shift Outcomes (Passenger Travel): Baseline vs. BLUE Shifts Case in 2050

Shifting 25% of LDV and air travel can cut total energy use by 20% in 2050



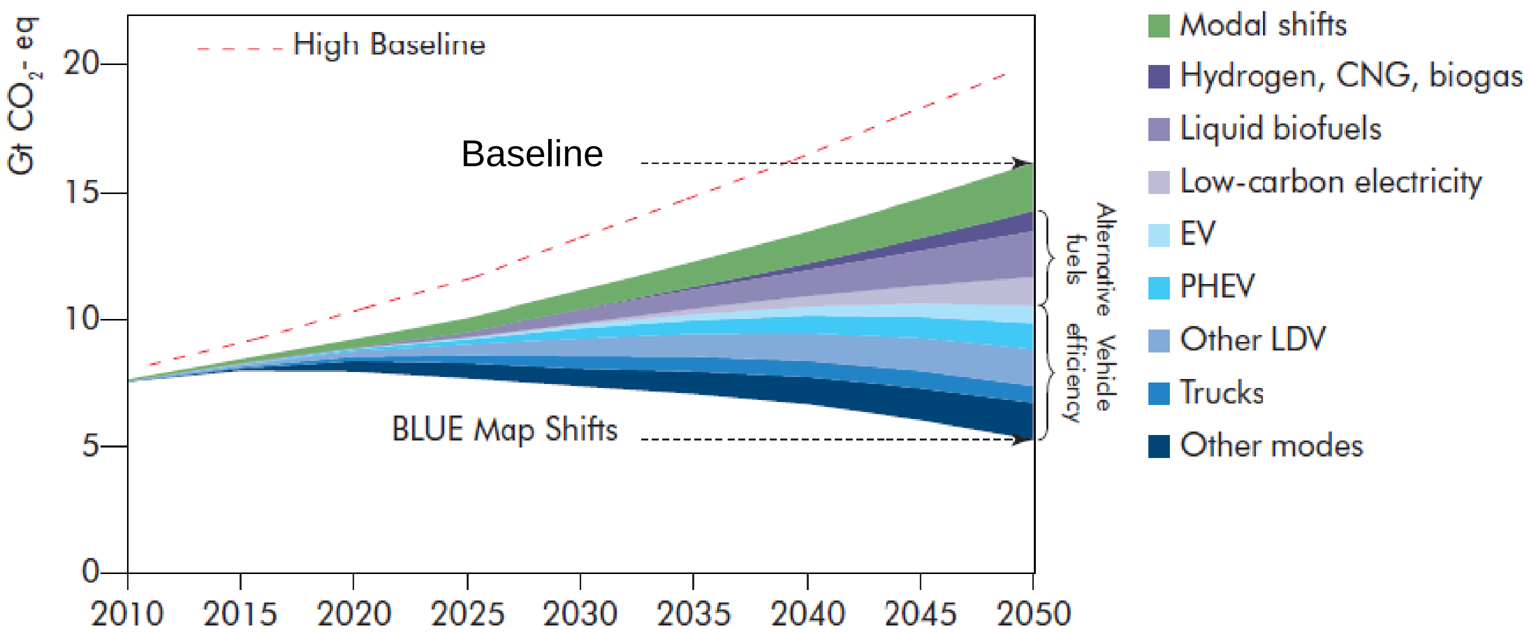
Transport Energy Use by ETP Scenario



- *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

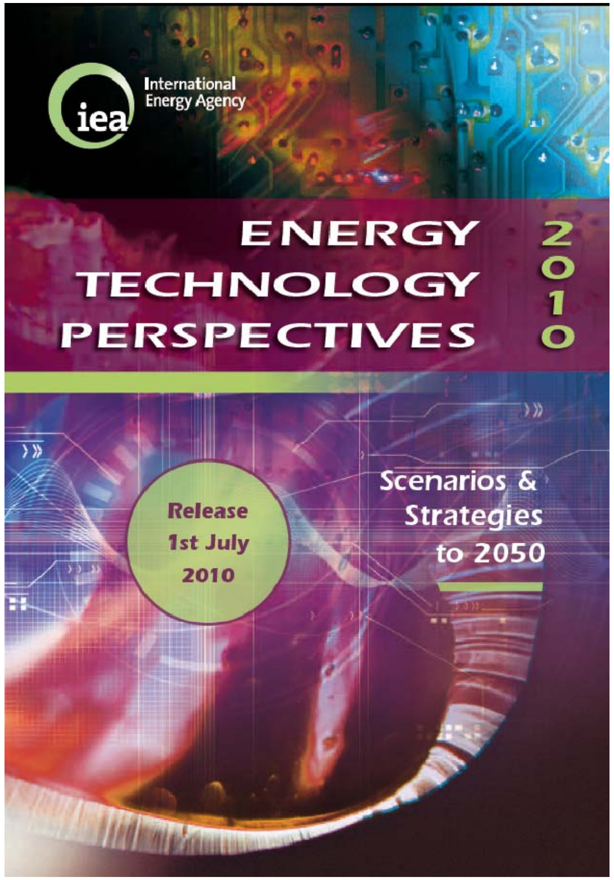
(well-to-wheel CO_2-eq)



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

- Without policy interventions oil use and related CO_2 emissions worldwide could double by 2050
- 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
  - Modal shifts via smart growth and strong investments in state-of-art transit and bus systems
- Infrastructure database will first give us a baseline and then allow for cost projections
- Shifting 25% of LDV and air travel can cut total energy use by 20% in 2050



Thank You

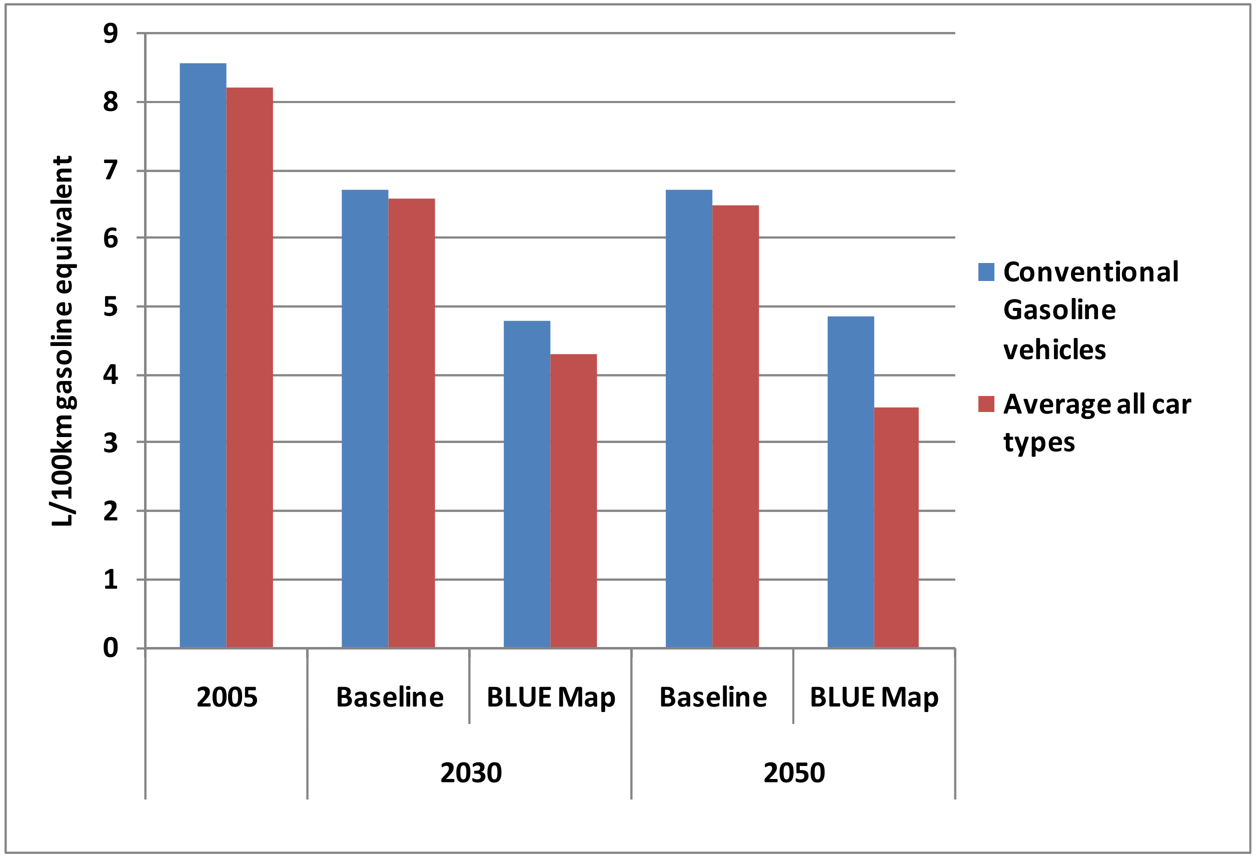
www.iea.org/techno/etp/index.asp

Backup Slides

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.

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

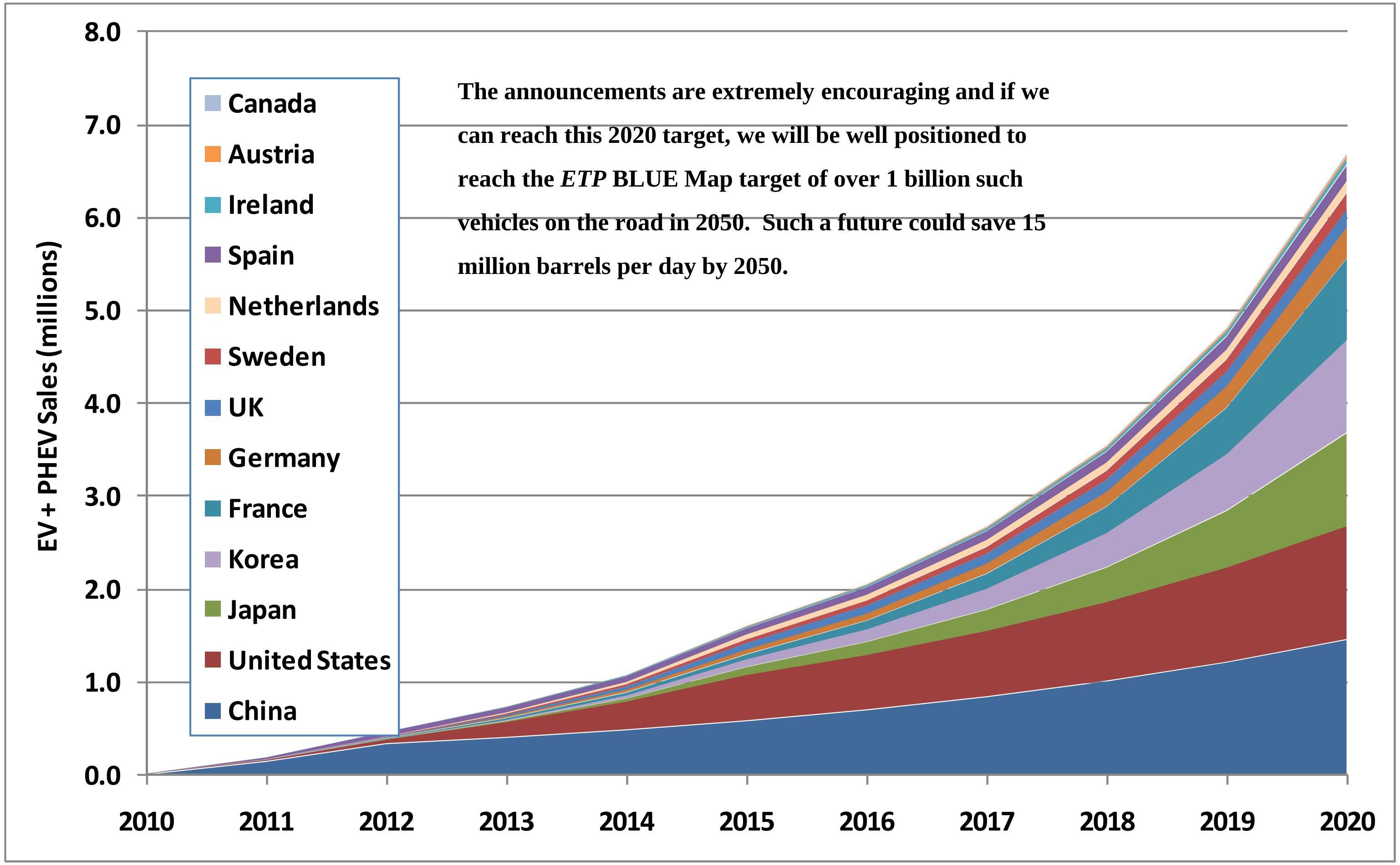


Figure based on announced national sales and stock targets, with assumed 20% annual sales growth after target is met, if target is before 2020 (e.g. China's target is for end of 2011).

EV / PHEV sales could reach nearly seven million by 2020

IEA EV/PHEV Roadmap: some technical findings

- **EV incremental costs could be high unless all of these targets are met:**
  - Battery costs drop to $300/kWh (target for 2015)
  - Vehicle range on batteries is limited (e.g. 150 km)
  - Batteries last nearly the life of vehicles (e.g. 15 years) and are amortized over this time frame

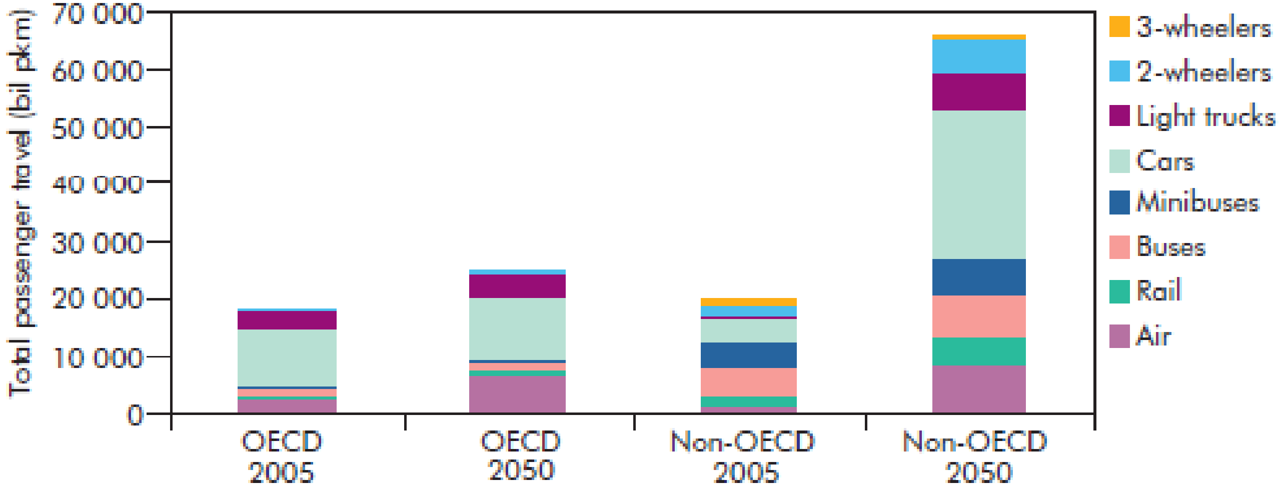
- **Electricity demand does not look like a significant issue on a regional scale before 2030**
  - 200 tWh in 2025 v. 13,000 OECD-wide

- **But…**
  - Could become an issue in specific areas
  - Availability of low-CO2 generation will be key
  - Load management; grid integration issues emerge
  - EV/PHEV share of world generation could reach 10% by 2050

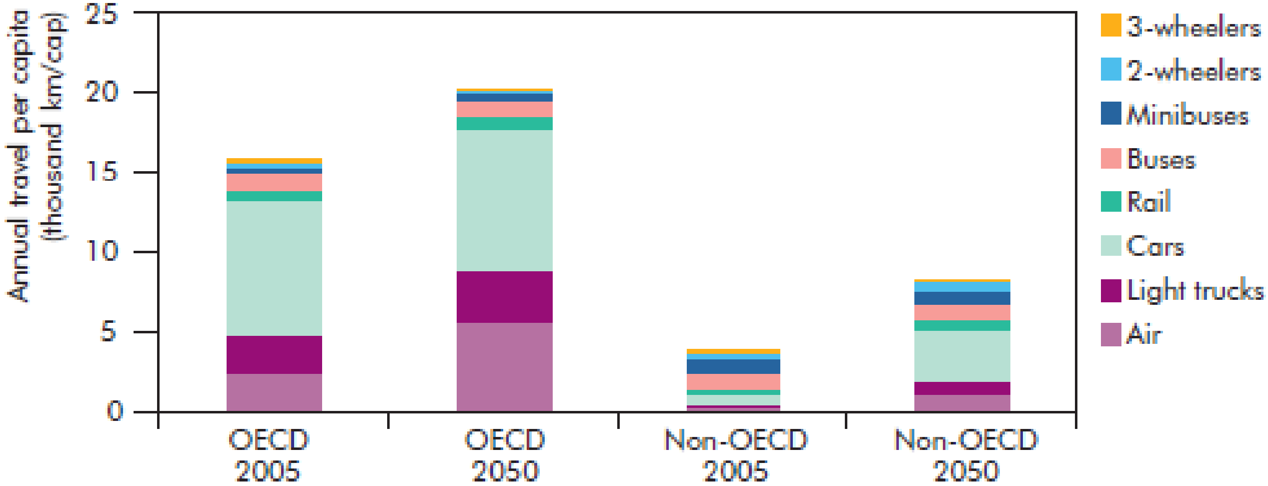
IEA travel projection: land passenger travel by mode and region, Baseline scenario

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

Total

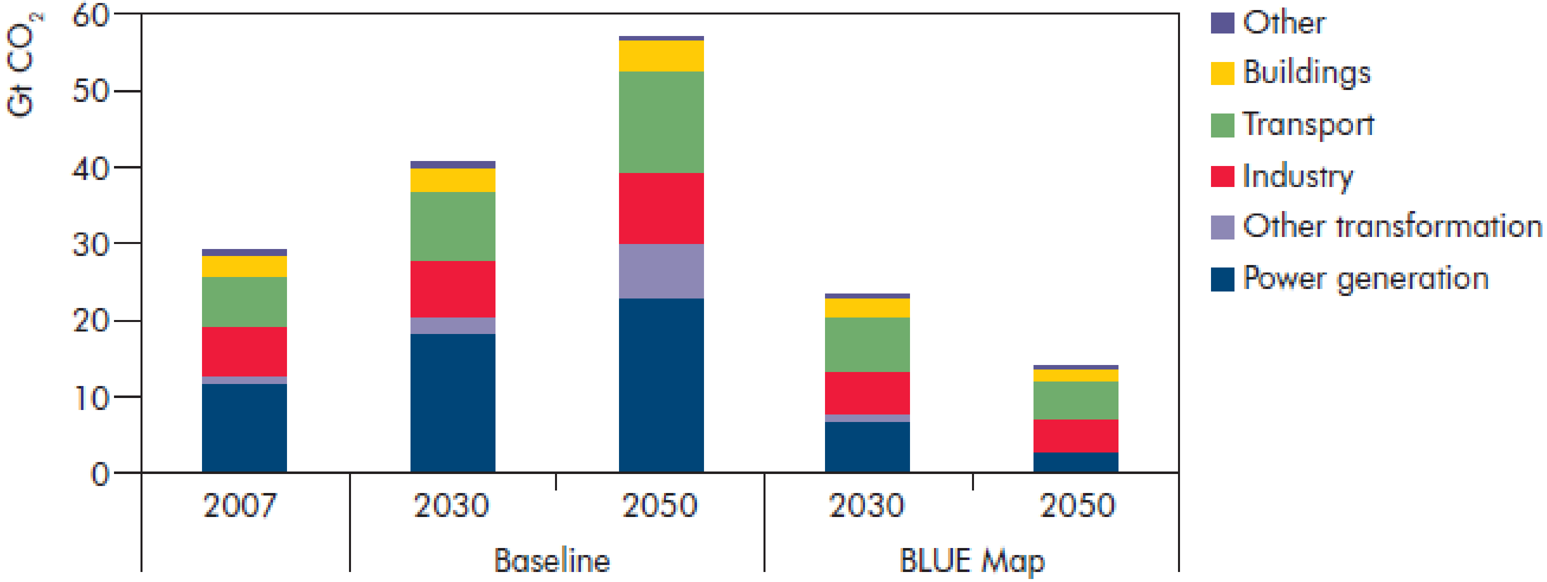


Per capita



IEA ETP 2010: BLUE Map requires strong CO2 reductions from all sectors

Figure 2.1 ▶ Global CO_2 emissions in the Baseline and BLUE Map scenarios



In the Baseline, transport accounts for about 23% of CO2 in 2007, rising to nearly 30% by 2050. In BLUE Map, all sectors cut CO2 emissions dramatically. Transport must make major cuts in order to achieve global target of 50% reduction