Transport: Review of Indicators, Data Gaps and Data Collection

Pretoria, 28-29 January 2015

Taejin PARK

Energy Data Centre

International Energy Agency

Workshop 2 of 3

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Session 1. Group C: Transport

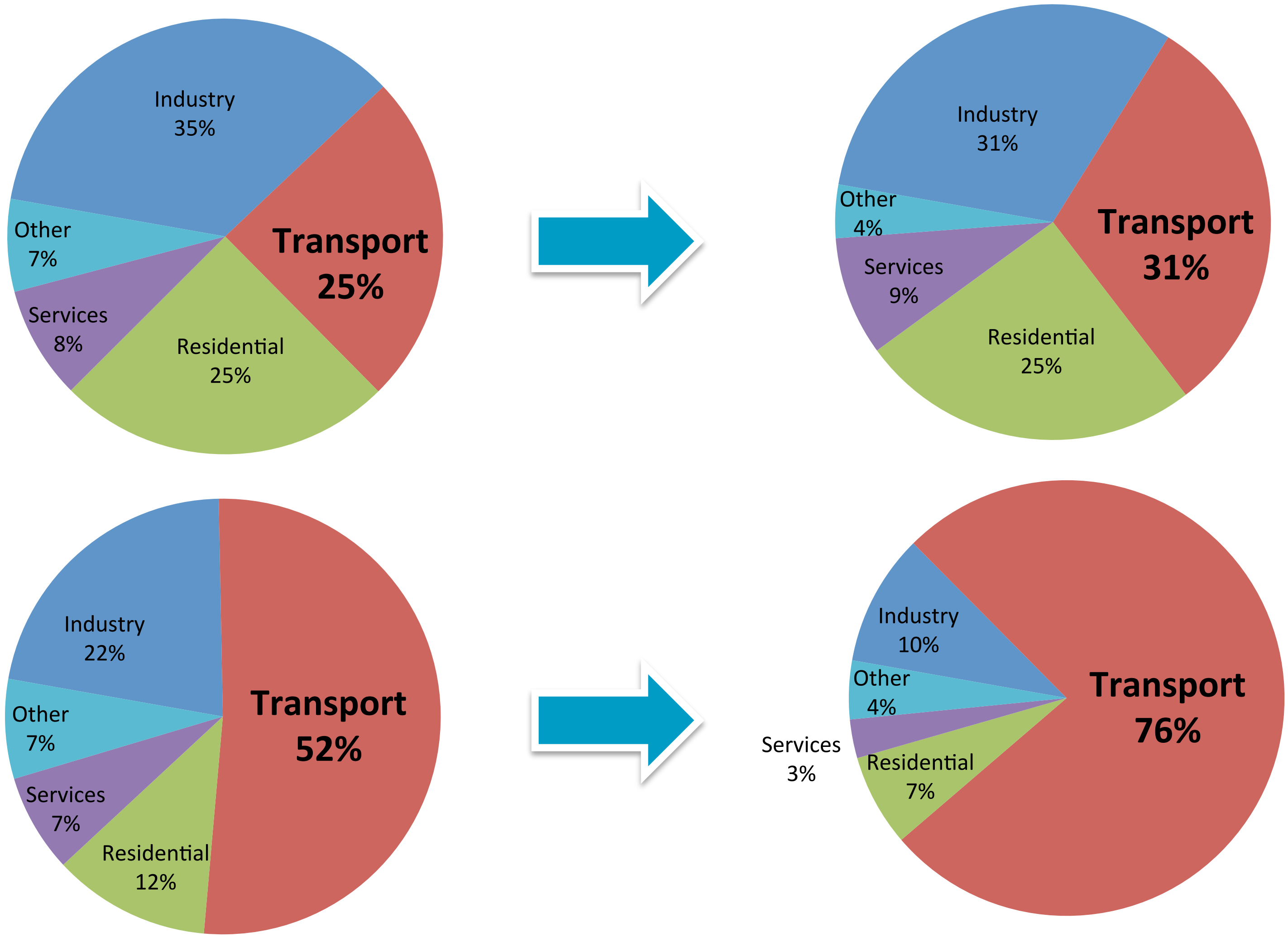
- **Session 1.** Review of Indicators, Data Gaps and Data Collection
  - Content
    1. Overview of transport sector
    2. Data requirements
    3. Data collection overview
  - Key Questions
    1. What data are already collected and what else is needed?
    2. What are the main challenges to collect further data?
    3. How can the necessary data be collected?

Global energy consumption in transport

1973 / 2012

Total

Oil products

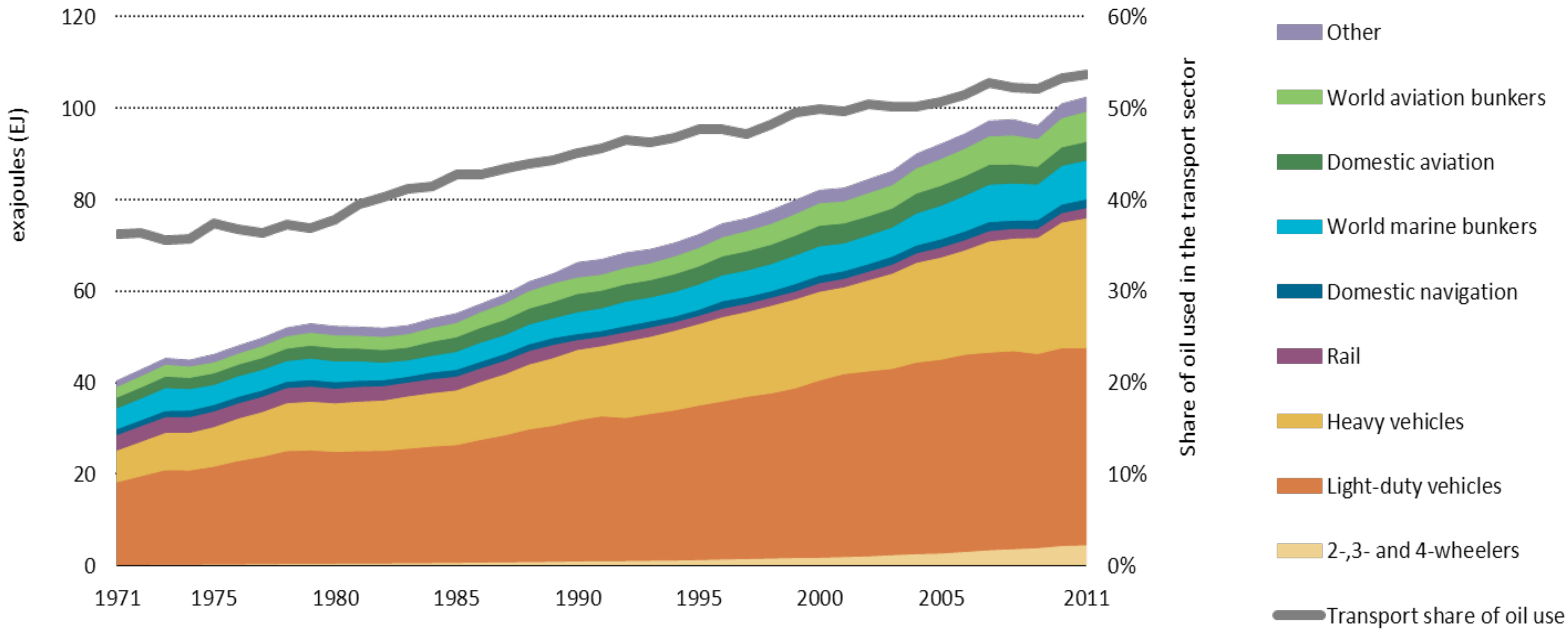


Source: IEA World Energy Balances 2014

- Share of transport increased, especially for oil

Global energy consumption in transport

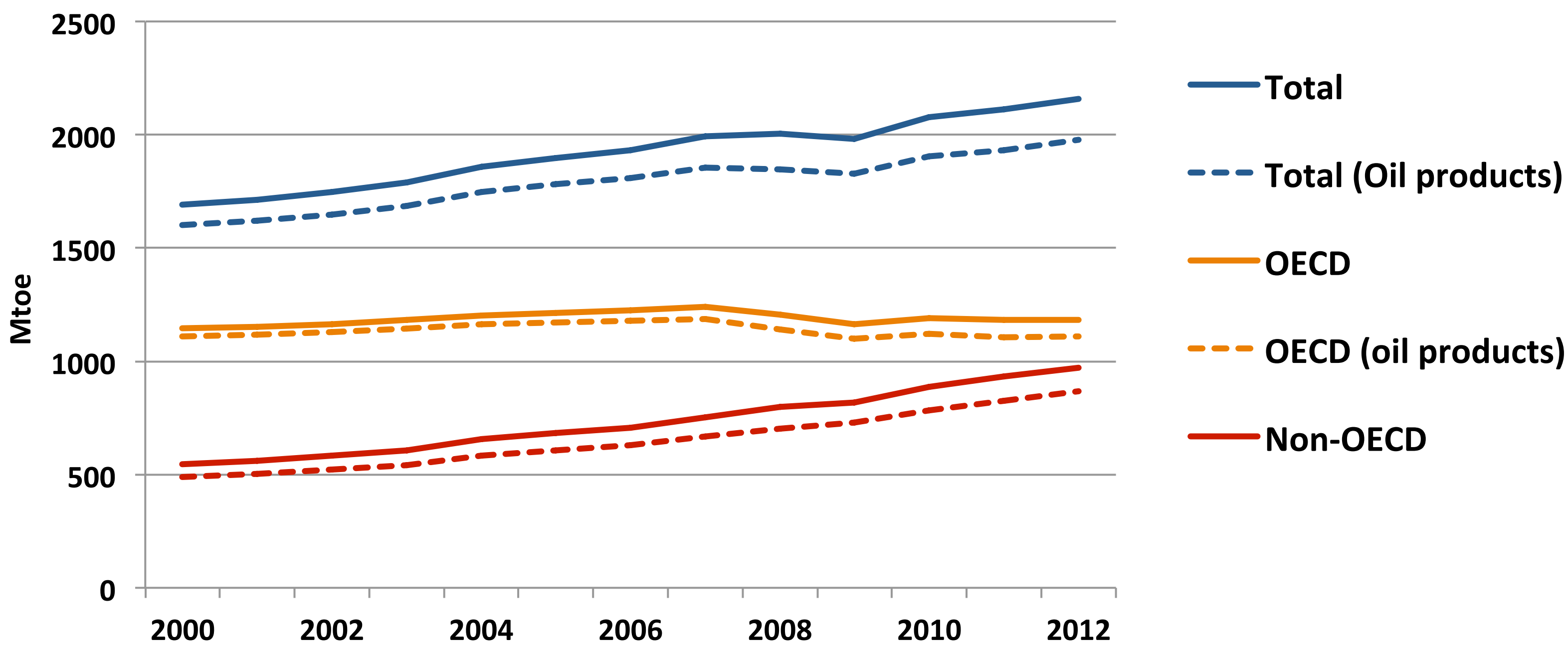
- **World transport energy use by mode, 1971-2011**



- Most energy consumption takes place in road – with a growing share

Global energy consumption in transport

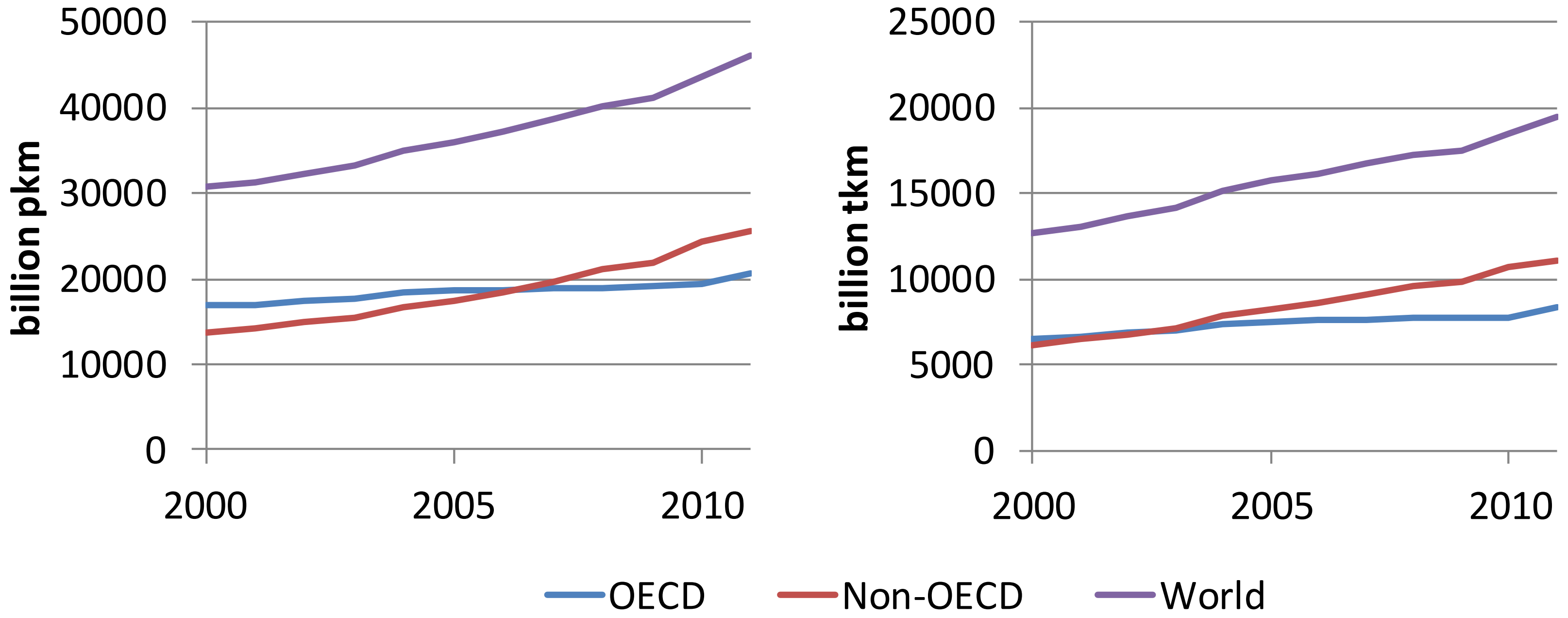
Transport energy use by region, 2000-2012



- Transport energy grew by 28% in 2000-2012
- Largest transport energy consumption still occurs in the OECD
- The share of non-OECD is increasing very fast

Transport activity trends

Passenger and freight transport by region



- Transport activity grew in 2000-2011 (50% passenger and 54% freight)
- Growth in non-OECD faster than in OECD, both for passenger and freight

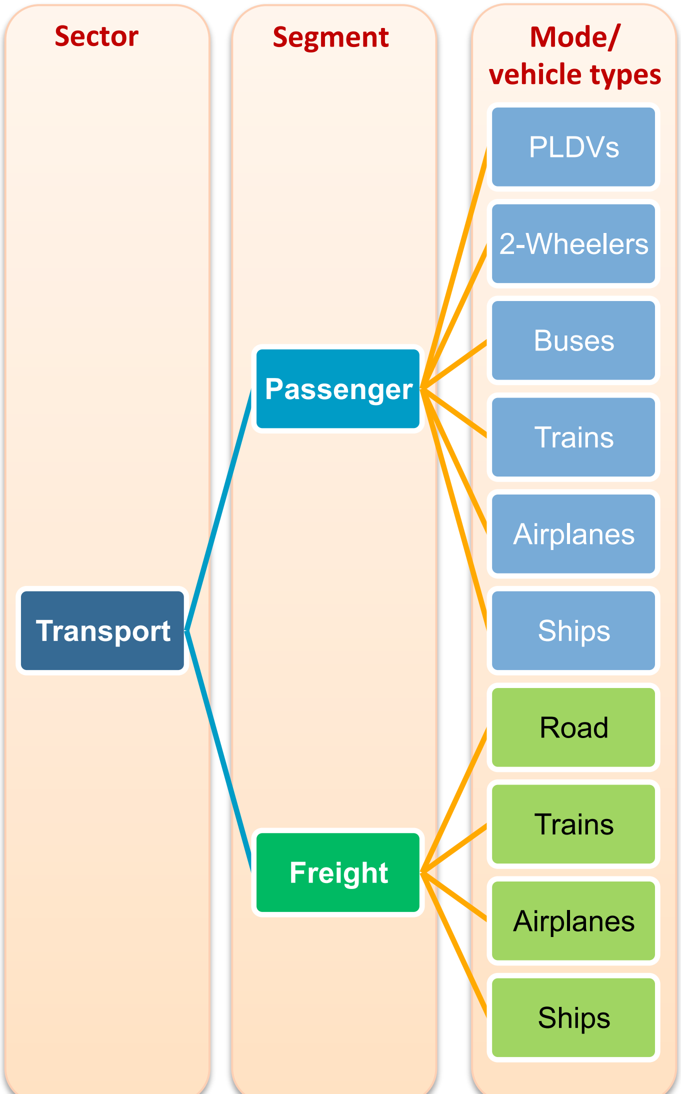
Transport: defining energy efficiency

- Transport MORE and FURTHER with a given fuel consumption
  - 3 elements to consider:
    1. Quantity transported
    2. Distance travelled
    3. Energy consumption

- Energy efficiency indicator $= Energy/Activity = Energy/Quantity * Distance$
  - *Q: Is it more energy efficient to use public transport instead of personal cars?*

- Energy saving ≠ Energy efficiency
  - Improving energy efficiency is just one way of saving energy

Data requirements – IEA's approach



By fuel type

Energy Efficiency Indicator = $\frac{\text{energy}}{\text{activity}}$

Passenger- or tonne-kilometer (pkm or tkm):

= vkm * occupancy (or load)

= stocks * average mileage * occupancy (or load)

Data requirements – energy & activity

- **Energy**
  - IEA collects global statistics on energy by mode & fuel type
    - Usually, available through top-down approach (e.g supply data)
  - IEA energy efficiency indicators collect energy consumption data **by segment**, **mode/vehicle type**, fuel type

Data requirements – energy & activity

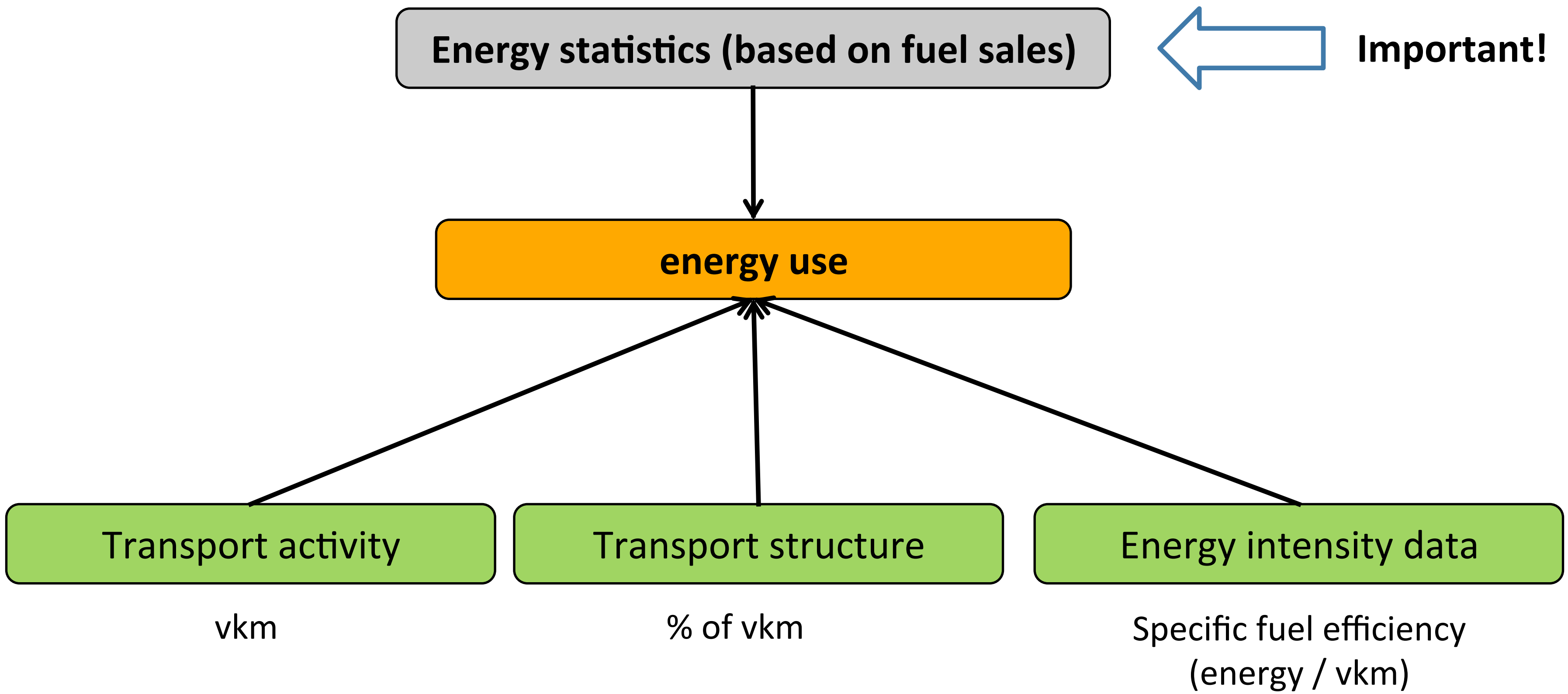
- **Activity** *pkm = vkm × occupancy = stocks × average mileage × average occupancy*

  - **Vehicle stocks**
    - Generally available (e.g. ministries, statistical offices)
    - Can be calculated from new registrations & scrappage
    - Vehicle classification is not the same everywhere

  - **Average mileage & average occupancy (or average load)**
    - Household surveys, travel diaries, odometer readings, public transport operators; less frequently available
    - Often estimated

Data validation: linking energy & activity

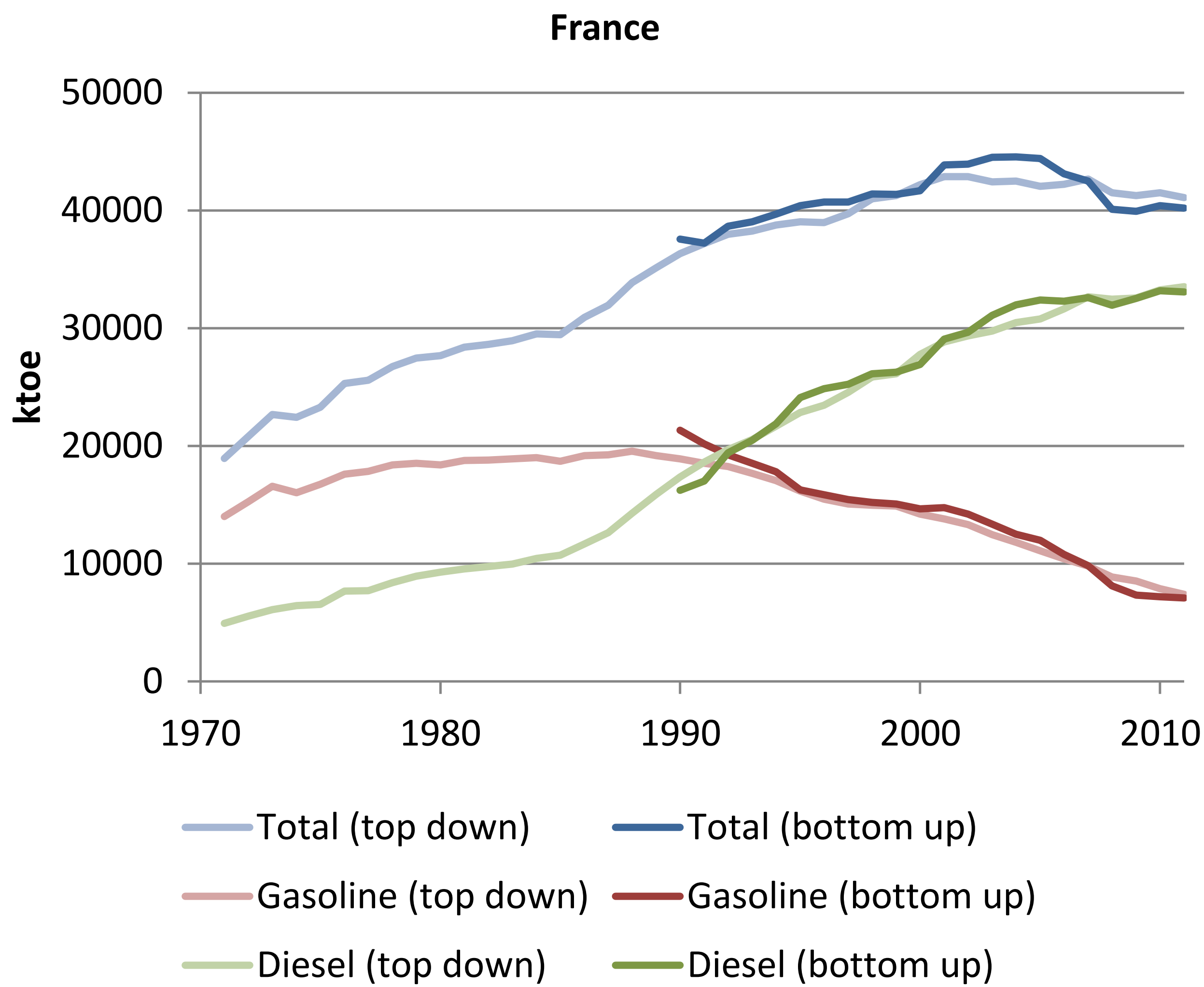
TOP DOWN



BOTTOM UP

Data validation: linking energy & activity

- **Matching bottom-up and top-down approaches**



Data requirements – some challenges

- **Disaggregating modes (e.g. commercial vehicles)**
  - Very diverse: vehicle classification is not uniform across countries
  - Fuel use of CVs highly depend on mission profile and load

Data requirements – some challenges

Occupancy and load

- Difficult to measure; weighted average required

- Public passenger transport
  - Occupancy rates vary by time, route types, along each route
  - Differing nature of operators (public vs private)
  - Need for surveys and legal obligations
  - Estimations can be useful for the viability of public transport supply

- Freight transport
  - Result from average load on laden trips & the share of empty running
  - Load on laden trips differ along each journey
  - Depend highly on mission profile
  - Need for surveys and legal obligations

Data collection methods

- Administrative sources
- Surveying
- Measuring/metering
- Modelling

IEA country practice database:

http://www.iea.org/eeindicatorsmanual/

Data	Source	Methodology
Energy data		
Total transport consumption	National energy balance National energy statistics	Administrative sources Modelling
Consumption by sub-sector	National energy balance National energy statistics	Administrative sources Mobility surveys Modelling
Consumption by segment		Mobility surveys Modelling
Consumption by vehicle type		Mobility surveys Modelling
Activity data		
GDP, population	National statistics offices	Administrative sources
Vehicle-km (vkm)	Vehicle registers/ Roadworthiness testing services/ Inspecting organisations Municipalities/Transport authorities National and international databases Transport ministries	Measurements: odometer readings Measurements: road traffic count Administrative sources Mobility surveys Modelling
Passenger-km (pkm)	National and international databases Transport ministries	Administrative sources Mobility surveys
Tonne-km (tkm)	National and international databases Transport ministries	Administrative sources Mobility surveys, freight surveys
Vehicle stocks*	Statistics offices Manufacturers National and international databases Vehicle registers	Administrative sources Administrative sources/ measurements
Fuel economy	Manufacturers	Administrative source Modelling

Administrative sources: mapping existing data that could fit your purposes

Table 3.1 • Pros and cons of using administrative data sources

Pros	Cons
• Avoid cost of a new data collection process • Relatively quick availability • Increased synergy between institutions • Raise profile and interest of energy efficiency among various services	• Boundary issues: potential mismatch between definitions and target populations of existing data and data needed • Challenges in establishing and maintaining communication with the source organisation • Potential costs (direct and indirect, such as purchase data, or establish agreements, change data formats, etc.) • Time investment in search for data sources

The importance of harmonised definitions

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Surveying: collecting ad-hoc data from a representative sample

Table 3.2 • *Pros and cons of using surveying*

Pros	Cons
• Relatively cost-effective, given extensive information collected • Ad hoc design of items collected based on purpose • Representativeness/statistical significance • Overall, comprehensive and good quality information	• Potentially high absolute cost • Time consuming • Need for further estimation work (e.g. extrapolation between years) • Risk of incomplete responses, biases, sampling errors • Requirement of staff training

A regulatory framework would enhance success

Measuring: collecting actual detailed data

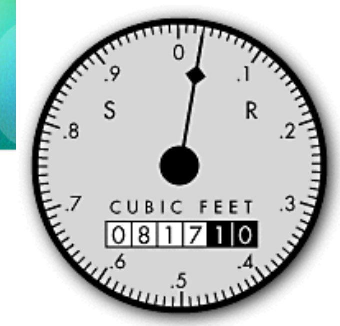

Table 3.3 • Pros and cons of using measuring

Pros	Cons
• Provides actual energy consumption at end-use or equipment level • High accuracy of data collected • Can shed light on actual behavioural patterns • Can be a key complement to other methodologies	• High cost of equipment • Small sample of population and time/lack of representativeness • Possible malfunctioning of equipment • Difficulties in finding volunteers

Generally costly / small sample

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Modelling: producing output based on assumptions

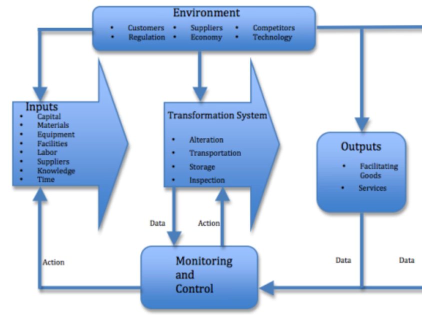


Table 3.4 • Pros and cons of using modelling

Pros	Cons
• Cost-effective • Designed based on purpose • Can consolidate data from multiple sources • Can provide estimates of variables that cannot be measured • Allows validation of bottom-up estimates against national energy statistics	• Relies on availability of input data • Depends on quality of input data • Depends on assumptions made • Transparency may be an issue

Largely relies on quality of input data

Discussion topics

1. What data are already collected and what else is needed?

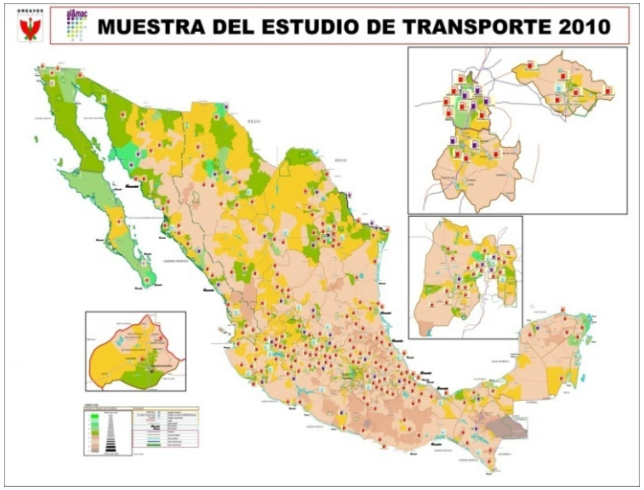
2. What are the main challenges to collect further data?

3. How can the necessary data be collected?

Examples for discussion: Surveys

Example of Mexico

- 5 min questionnaire at fuel stations
- Sample size: 545 fuel stations 26265 vehicles
- 4 months from start to finish
- Costs: approx 60 000 €



MILEAGE

Vehicle Type → Vehicle Age → Total Mileage → Driving time per day → Km/day estimated

PASSENGERS

Vehicle Type → Vehicle Model → Passengers on board → Stated average occupancy → Estimated average occupancy

TONS

Vehicle Type → Vehicle Model → Load on board → Stated average load → Estimated average load

Examples for discussion: Metering

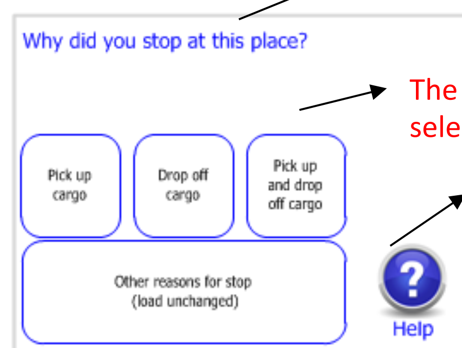
Example of Canada

- GPS data logger
  - Vehicle activity directly from the engine
  - Qualitative questions through the touch screen
- Sample size: 20000 vehicles
- 21 days to complete
- Incentives: vehicle usage report & cash prize

Main screen of electronic logger device:

How a question screen looks:

The question being asked.



The possible answers to select by touch.

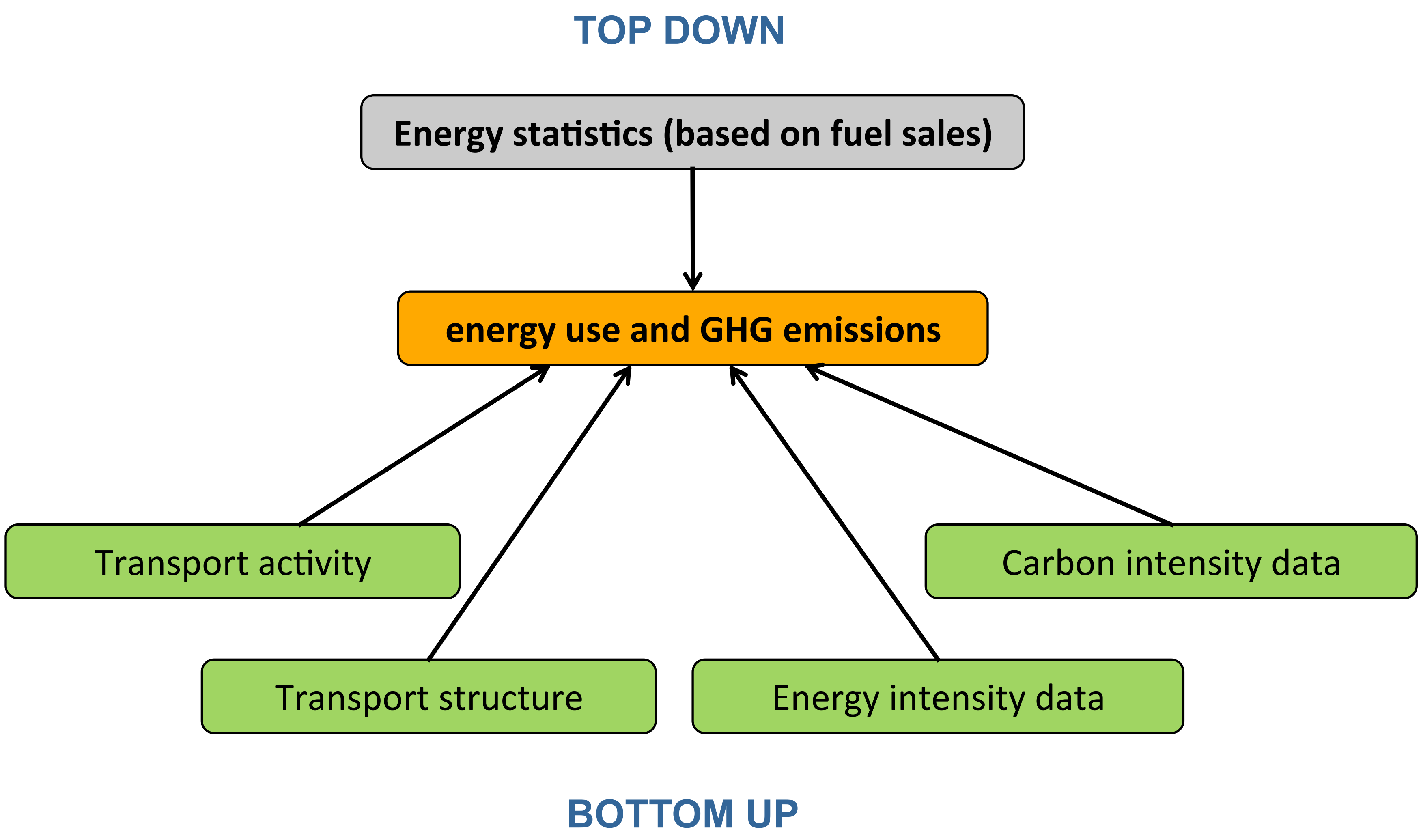
Help button to get more information on the question.

More information available at: http://www.iea.org/eeindicatorsmanual/tme01.php

Data requirements – additional

- Emission factors
  - Either linked to vkm (e.g. regulated pollutant emissions) or fuel consumption (e.g. GHG), either including upstream emissions (well-to-tank) or excluding them (tank-to-wheel)
- Transportation infrastructure
  - Linking vehicle activity with the network extension is helpful to better understand congestion issues and investment needs to avoid it
- Costs, prices and taxes
  - Vehicle, infrastructure and fuel prices and taxes, revenues from ticket sales
  - Information on the household expenditures for transportation, governmental and private expenditures for transportation infrastructure and vehicles, governmental revenues from road tax and fuel taxes, public and private expenditures for public transport services…
- Other data
  - Safety- and noise-related, e.g. needed to estimate the social cost of transport (including externalities)
  - Related with material demand, e.g. to allow the assessment of life-cycle energy use and emissions

Linking activity and fuel use



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Linking activity and fuel use

- **ASIF approach**
  - ***A**ctivity of vehicle*
  - ***S**tructure* of the organization of vehicle across services, modes, vehicle classes and powertrain groups
  - ***I**ntensity* of each of the vehicles in this structure

→ ***F**uel consumption*

The calculation is based on Laspeyres identities

$$F=\sum_i F_i = A\sum_i (A_i/A)(F_i/A_i) = A\sum_i S_i I_i = F$$

F	total Fuel use
A	vehicle activity (expressed in vkm)
F_i	fuel used by vehicles with a given set of characteristics (e.g. by service, mode, vehicle and powertrain)
$A_i/A = S_i$	sectoral structure (same disaggregation level)
$F_i/A_i = I_i$	energy intensity, i.e. the average fuel consumption per vkm (same disaggregation level)

Linking activity, fuel use and GHG emissions

Extended ASIF approach

- Extended to evaluate CO_2 emissions

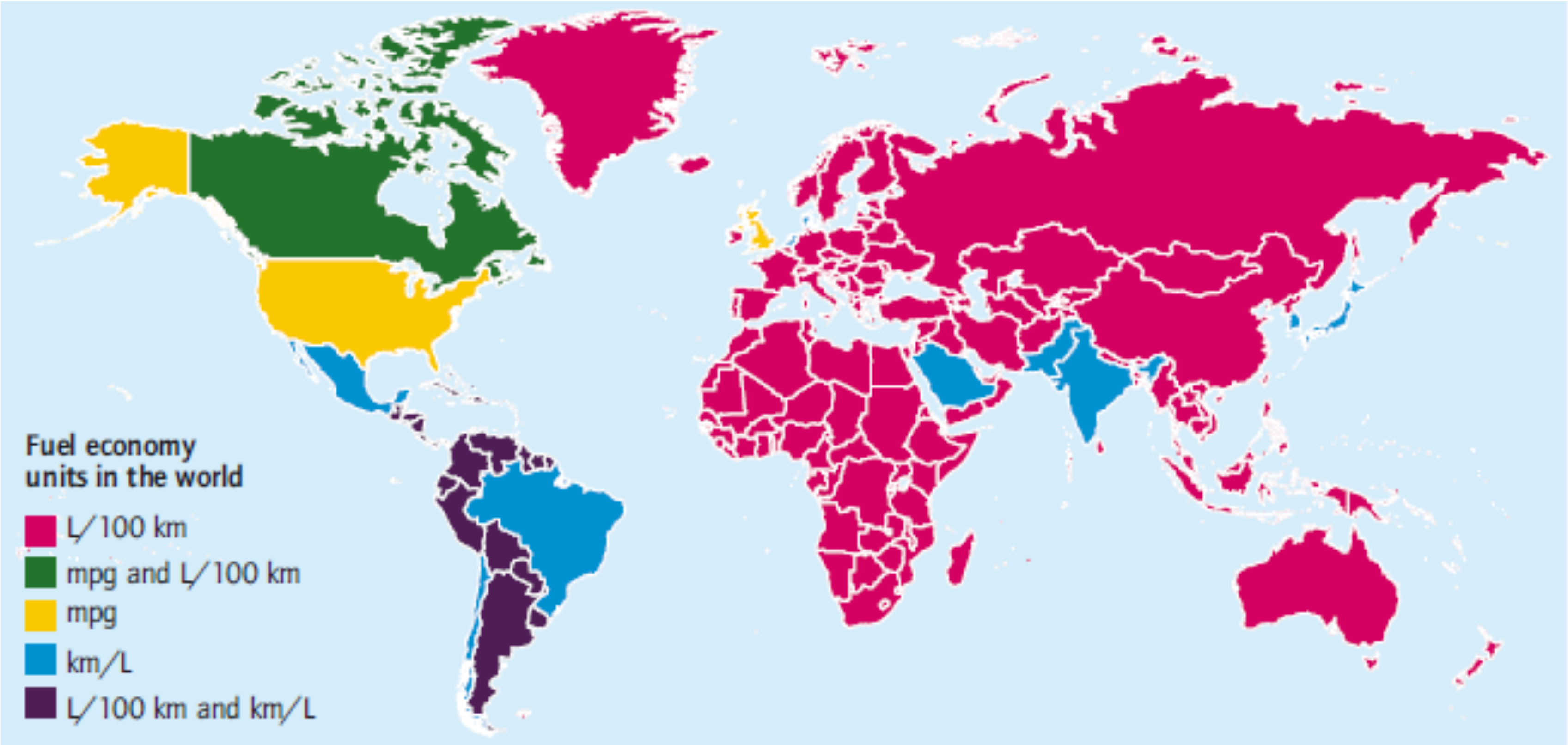
This extension is suitable to the case of where several energy carriers need to be considered

$$E=\sum_i E_i = A\sum_i (A_i/A)(F_i/A_i)(F_{ij}/F_i)(E_{ij}/F_{ij}) = A\sum_i S_i I_i EF_{ij} = E$$

E	emissions
E_i	emissions due to the the vehicle i
F_{ij}	fuel (energy carrier) j used in the vehicle i
EF_{ij}	emission factor for the fuel (energy carrier) j used in the vehicle i

Energy intensity data

- Energy intensity = fuel use per vkm
- This is measured in different units around the world
  - “fuel economy”(travel/consumption, e.g. MPG)
  - “fuel consumption” (consumption/travel, e.g. L/100 km)



Carbon intensity data

Linking fuel use and CO_2 emissions

- Carbon intensity varies by fuel type and over time

Substantial differences

- Tank-to-wheel (TTW)

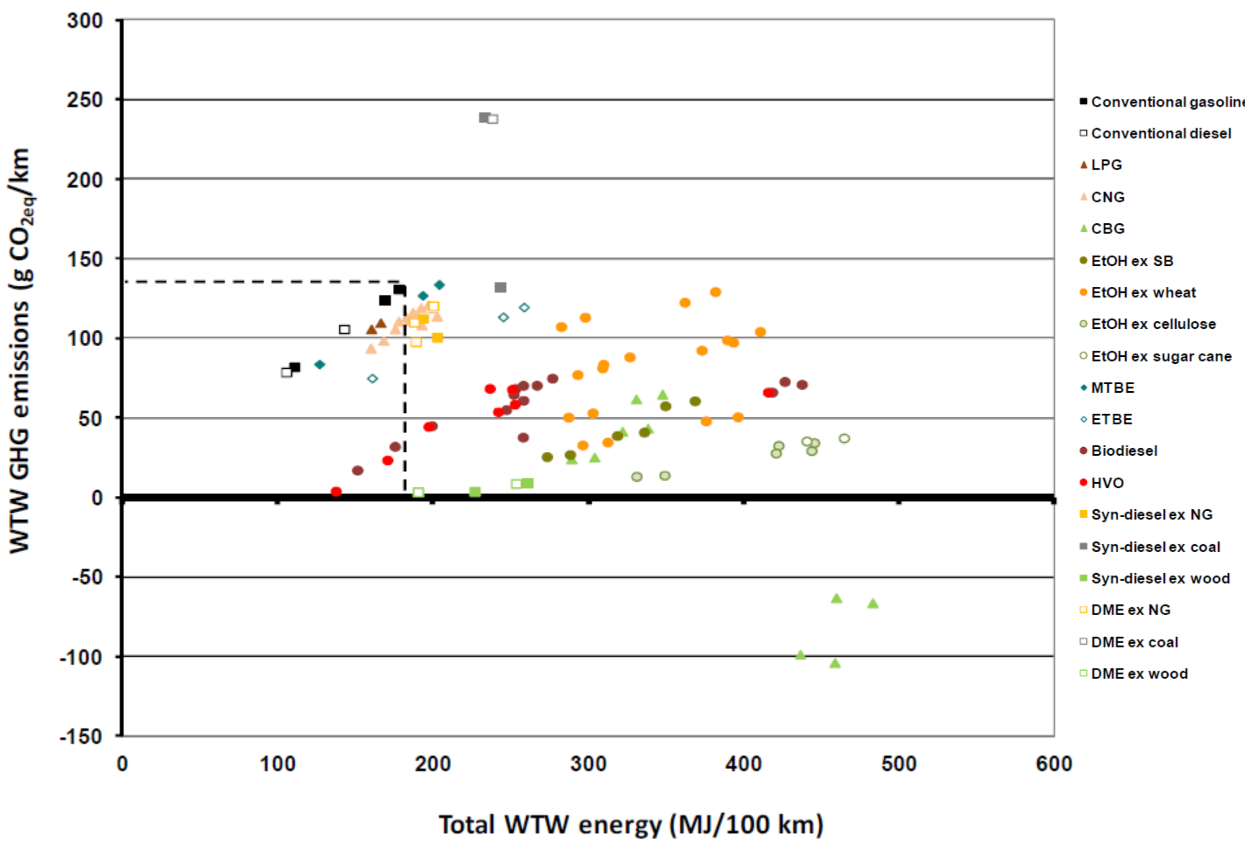
  emissions due to fuel combustion

  IPCC: biomass-based fuels have zero TTW emissions (to avoid double counting with emissions from energy transformation and agriculture, forestry and other land use

- Well-to-wheel (WTW)

  emissions due to fuel combustion AND fuel production

  biomass-based fuels do not have zero WTW emissions



Source: EC - Joint Research Centre-EUCAR-CONCAWE collaboration, Well-to-wheels Report, Version 4.a, 2014

Transport activity data

Disaggregating modes: the example of Commercial Vehicles

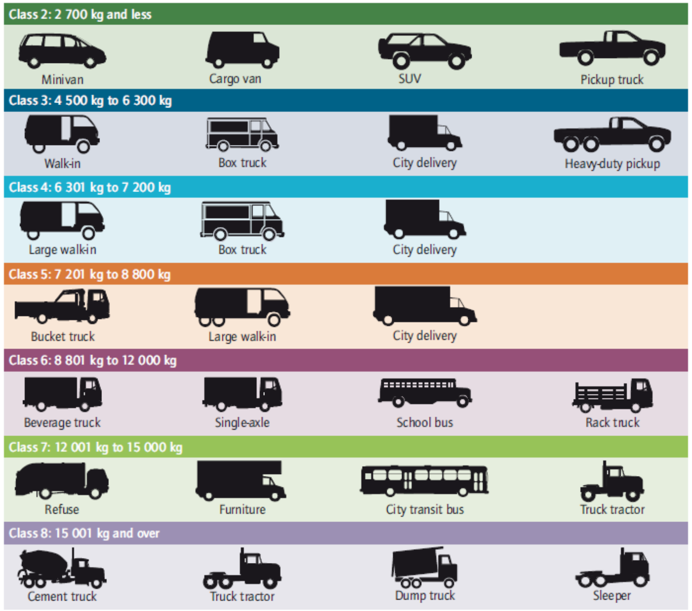
- The CV subsector is very diverse: vehicle classification is not uniform across countries

UN Regulations

Passenger transport (buses)	
M2	> 8 seats + driver, maximum mass < 5 t
M3	> 8 seats + driver, maximum mass > 5 t
Class I	with areas for standing passengers
Class II	principally seated passengers, standing possible
Class III	seated passengers only
Goods transport (trucks and trailers)	
N	Trucks
N1	maximum mass < 3.5 t
N2	maximum mass > 3.5 t and < 12 t
N3	maximum mass > 12 t
O	Trailers
O1	maximum mass < 0.75 t
O2	maximum mass > 0.75 t and < 3.5 t
O3	maximum mass > 3.5 t and < 10 t
O4	maximum mass > 10 t

Source: Consolidated Resolution on the Construction of Vehicles

United States



Source: US DoE, 2011.

- Fuel use of CVs highly depend on mission profile and load
- The proper balance of detail vs. data availability needs to be found

Transport: data collection

Pretoria, 28-29 January 2015

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Data collection methods

Four methods are mainly used to collect and deal with data on transport activity and transport energy use

1. Administrative sources
2. Surveying
3. Measuring/metering
4. Modelling

Administrative sources

- Make use of existing information and data:
  - National energy balances
  - Transport activity statistics from public transport operators and government agencies – e.g. railway operators
  - Vehicle registration data (e.g. government or associations of vehicle manufacturers)
  - Vehicle import/export data (e.g. from trade offices/border control services/private sector vehicle trade associations)
  - Vehicle characteristics (by size/fuel) from government organizations (e.g. US EPA or EU EEA) and comparative studies issued by NGOs (e.g. ICCT, T&E)
  - Activity patterns: mode share, travel, trip, fuel content, fuel consumption, travel patterns from specific studies (e.g. mobility in cities, published by UITP)

- Great way to get comprehensive, often official data, however:
  - Collection methodology (and data quality) sometimes unclear
  - Comparisons between providers may be difficult

Surveys

- Data collection via direct observation or questionnaires regarding travel activities, energy use, etc.
- Can be labour intensive, require large sample sizes, etc.
- Tends to provide estimates, not hard data
- Can provide very rich information, useful to understand variations, correlations, and other aspects of the sample
- Examples:
  - National travel survey
  - Household surveys, focus groups
  - Survey of fleets, trucking companies
  - Observational (e.g. roadside) surveys

Surveys

Example of Mexico

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- Sample size: 545 fuel stations 26265 vehicles
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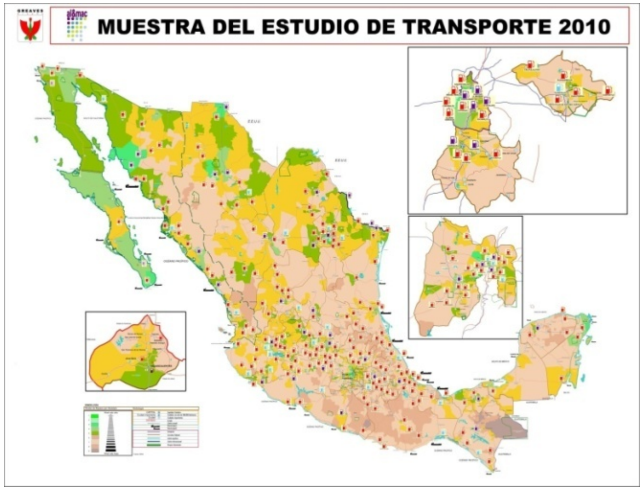

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Measuring and metering

- Direct observation, usually of a physical phenomenon

- Can use existing metering systems or involve creating new ones
  - Roadside car counters
  - Vehicle fuel economy testing
  - Car fuel economy computers (in use performance)
  - Tailpipe emissions detection systems
  - Speed detection systems
  - Atmospheric concentration metering

- Typically reliable but often expensive
  - Based on scientific and repeatable tests
  - Sample size and data processing requirements will affect costs

Metering

Example of Canada

Canadian VEHICLE USE Study
Powering Informed Decisions

- GPS data logger
  - Vehicle activity directly from the engine
  - Qualitative questions through the touch screen
- Sample size: 20000 vehicles
- 21 days to complete
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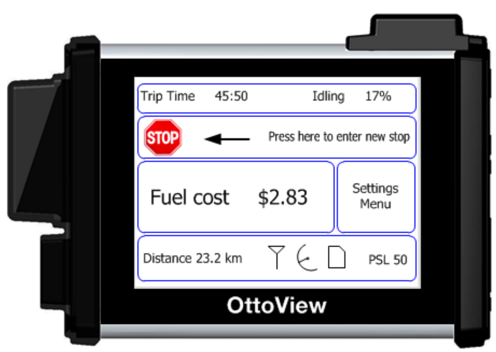
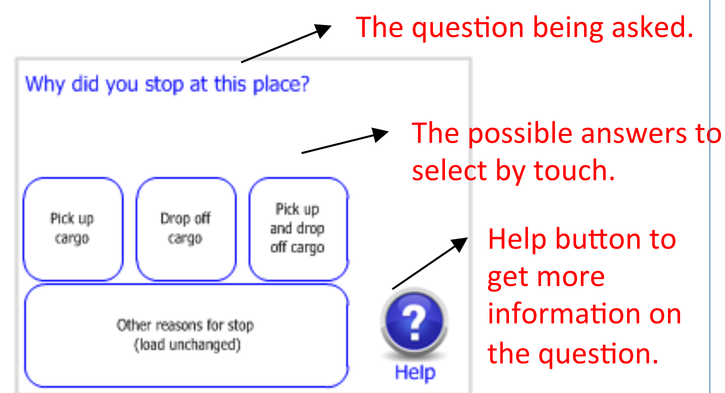
Main screen of electronic logger device:



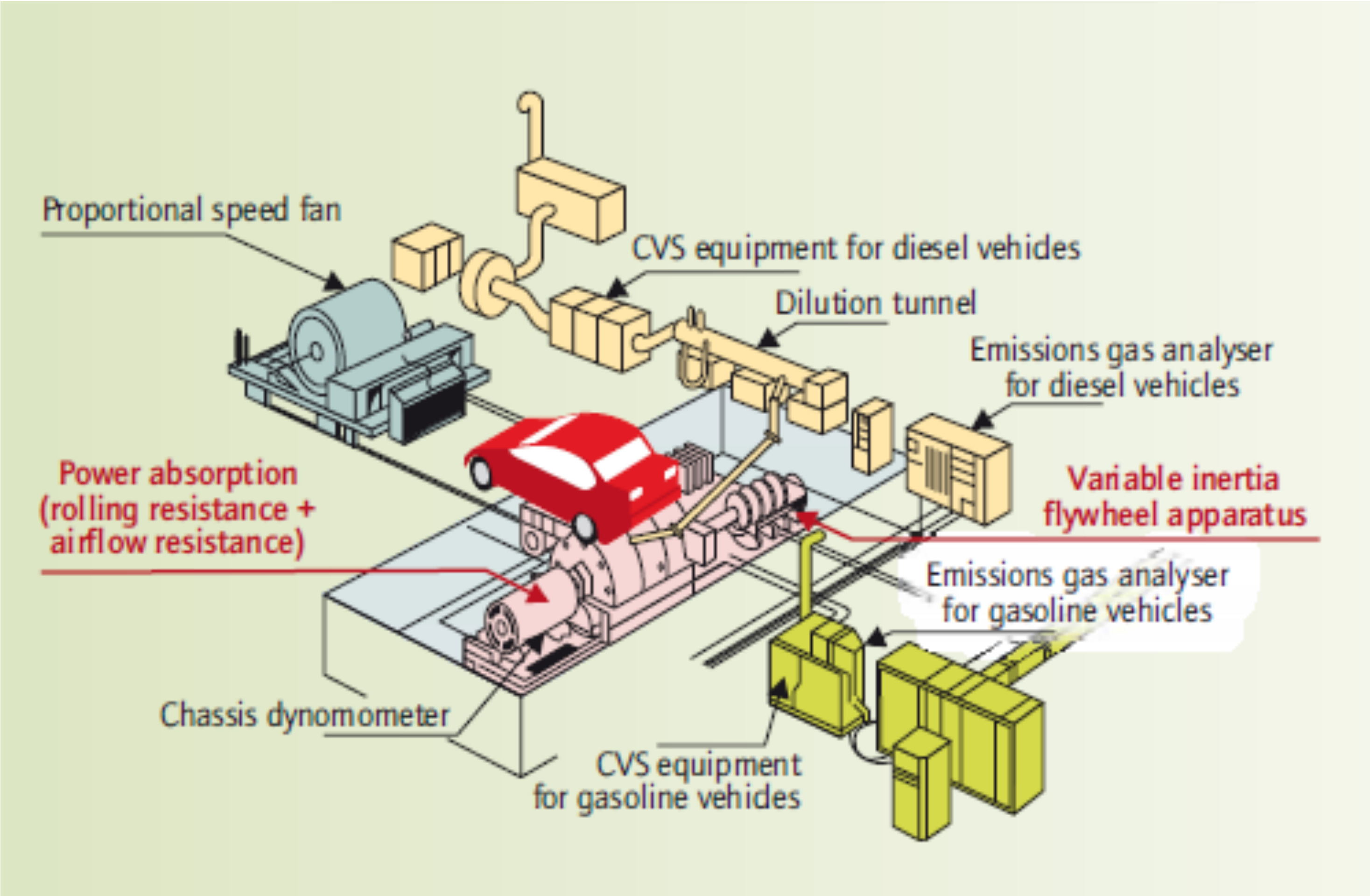
How a question screen looks:



More information available at: http://www.iea.org/eeindicatorsmanual/tme01.php

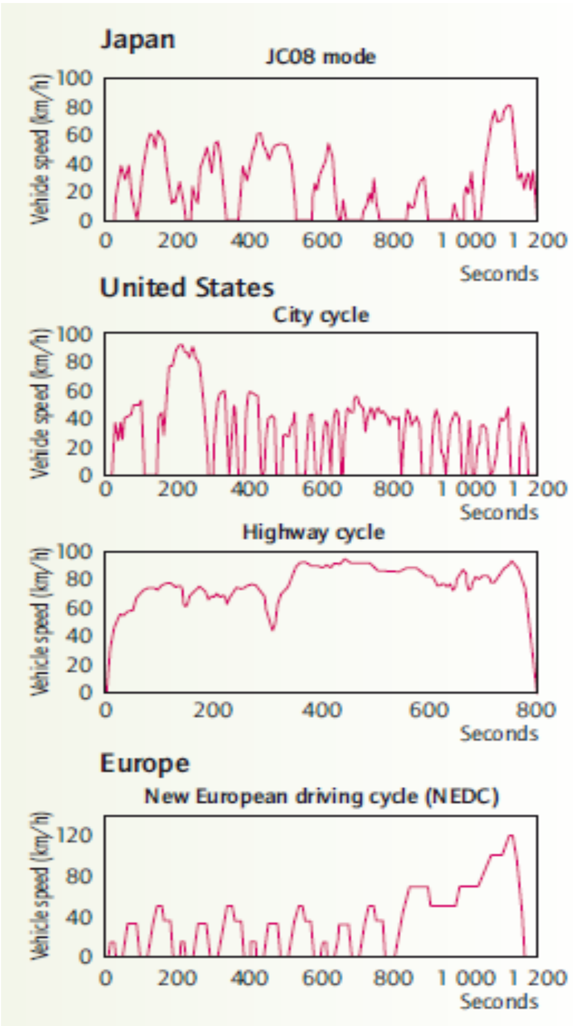
Measuring

Example of fuel consumption and pollutant emission from cars



Measuring

Example of fuel consumption and pollutant emission from cars



- Different test cycles in the US, Japan and Europe exist (regulatory formulation to unify them under development in UN framework)
- To make tested data comparable across countries (and tests), conversion formulas have to be used
- On-road fuel economy often higher than tested fuel economy (approx. 15% - 30%) due to:
  - Climate conditions
  - Use of auxiliary aggregates
  - Road conditions
  - Nature of driving cycles (e.g. not realistic)
  - Vehicle preconditioning

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Modelling

What if data shows gaps?

- Statistical methods: interpolation, curve fitting etc.
- Use of correlations/elasticities
- Elimination of degrees of freedom and reality check, e.g. the least certain parameter is adjusted to match certain data

Energy use = Vehicle stock * Fuel consumption * Mileage

What if reality is too diverse?

- Modelling/simulation e.g. heavy duty vehicle fuel economy

Modelling

Example of the Mobility Model historical database

The IEA Mobility Model comprises an historical database:

- Stock data
- Travel data (pkm)
- Mileage data (km/y)
- Fuel consumption data (L/100 km)

→ Primarily based on the collection and comparison of published information

→ Bottom-up results on the energy consumption are checked against historic fuel consumption by sector and fuel type (from import/ export/production balances: remember the example of France?)

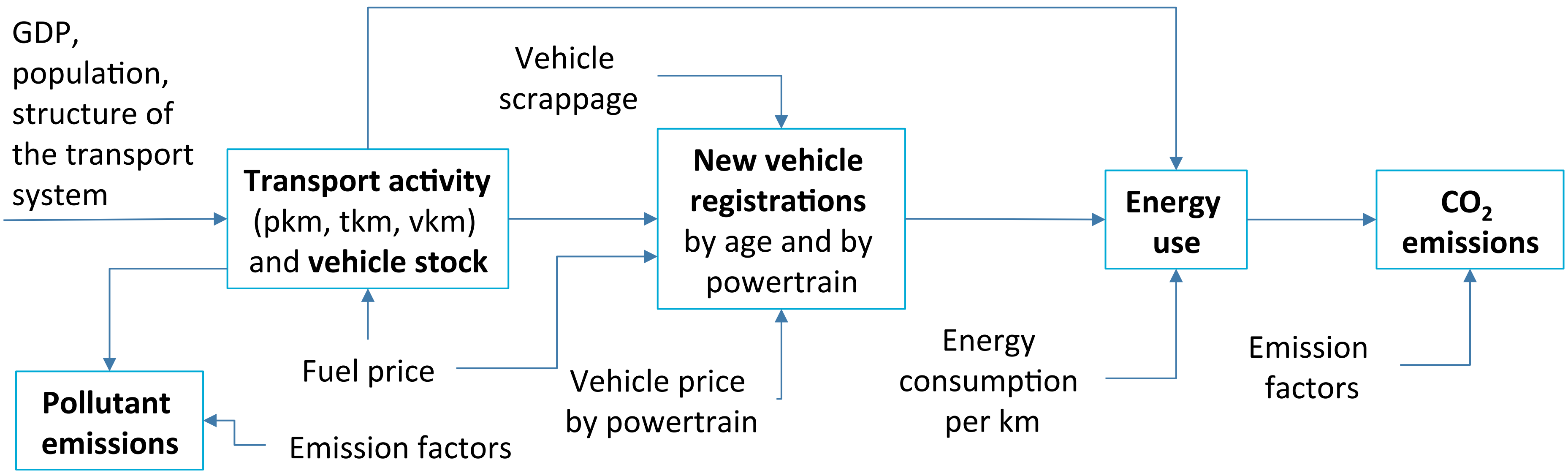
→ Fitted adjusting the least reliable data

The IEA Mobility Model

What is it?

- MoMo is a spreadsheet model of global transport
  - Mainly focused on vehicles and energy use, but also covering emissions, safety, infrastructure and materials use
  - Analysis of a multiple set of scenarios and projections to 2050
  - Based on hypotheses on GDP and population growth, vehicle fuel economy, fuel costs, travel demand, and vehicle and fuel market shares
- World divided in 29 regions, including several specific countries
  - USA, Canada, Mexico, Brazil, France, Germany, Italy, United Kingdom, Japan, Korea, China, India
- MoMo contains a large amount of information (data) on technology and fuel pathways
  - Full evaluation of life cycle greenhouse gas emissions
  - Cost estimates for new light duty vehicles (LDV), fuels and fuel taxes
  - Valuation of transport sector expenditures to 2050: vehicles, fuels and infrastructure
  - Module on material requirements for LDV manufacturing

MoMo: key modelling steps



- Generation of transport activity (pkm, tkm, vkm) and vehicle stock
- Evaluation of new vehicle registrations by powertrain and characterization of the vehicles by age
- Calculation of the energy use
- Estimation of CO_2 and pollutant emissions

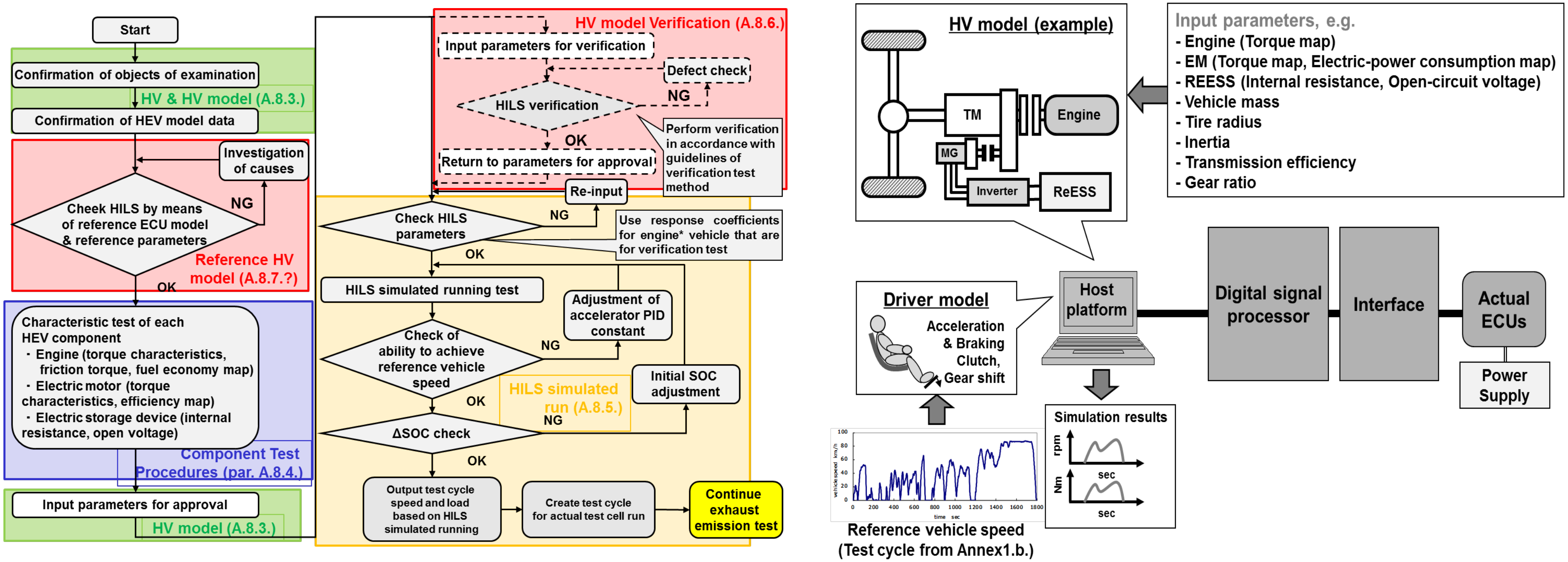
Who supports this work?

- MoMo is supported by a partnership comprising 16 institutions
- Six companies (BP, Honda, Nissan, Shell, Statoil and Toyota) have been financing the project development since the end of the SMP

Modelling

Simulation of HDV fuel economy

- Hardware In the Loop System (HILS)
  - Running the internal combustion engine on the test bench using the heavy duty engine test cycle
  - Calculate the engine operating conditions by performing a simulated run



Source: UNECE, World Forum for the Harmonization of Vehicle Regulations, Working Party on Pollution and Energy, informal working group on Heavy Duty Hybrids (HDH)

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Transport: Indicators Accounting

Pretoria, 28-29 January 2015

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Workshop 2 of 3

Session 2. Group C: Transport

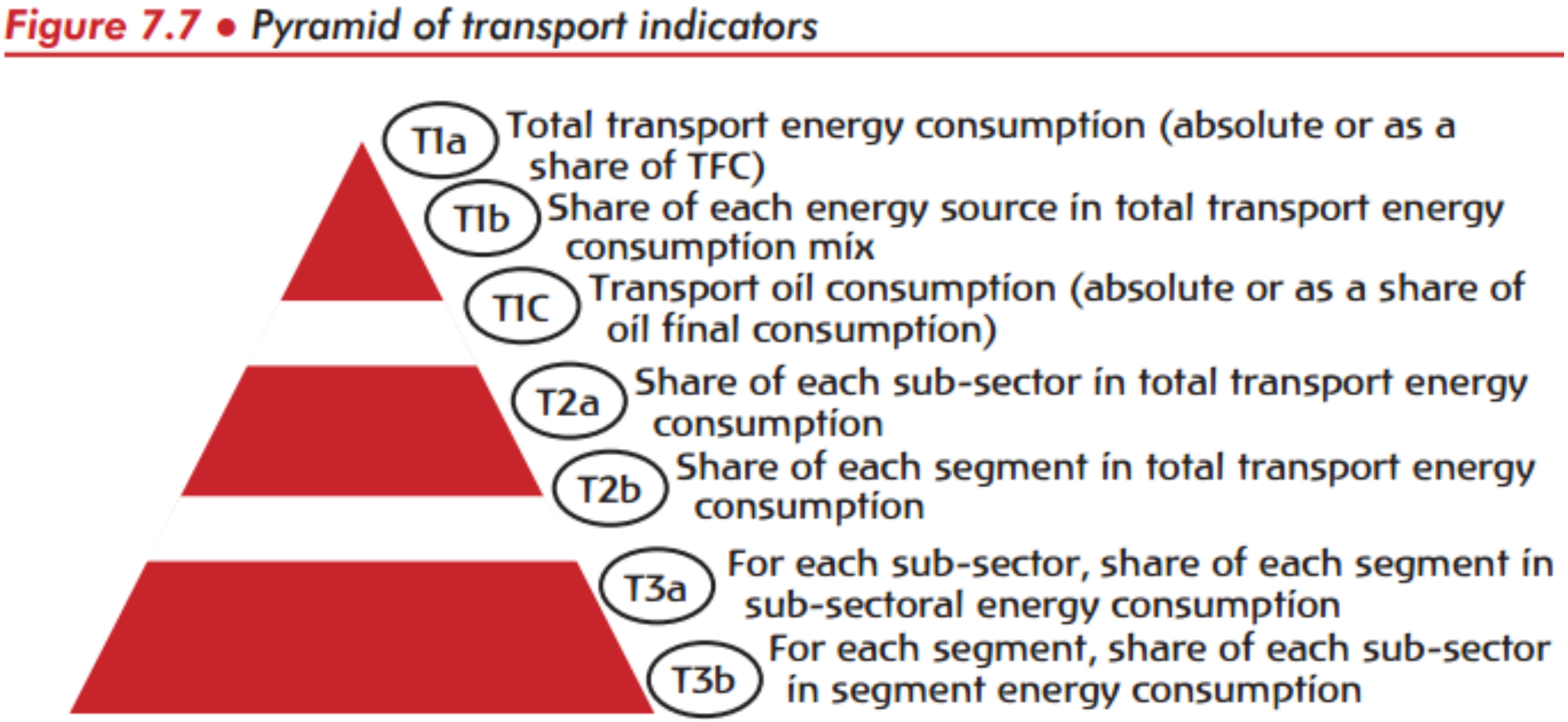
- **Session 2.** Indicators accounting
  - Content
    1. Monitoring impacts through indicators
    2. Projecting energy demand
    3. Assessing energy efficiency potentials

    Key Questions
    1. What key indicators would need to be developed to track energy efficiency in transport and assess potentials for savings?
    2. What are the main challenges to develop key indicators?
    3. What data gaps should be addressed?

Assessing Energy Efficiency Potentials in Transport

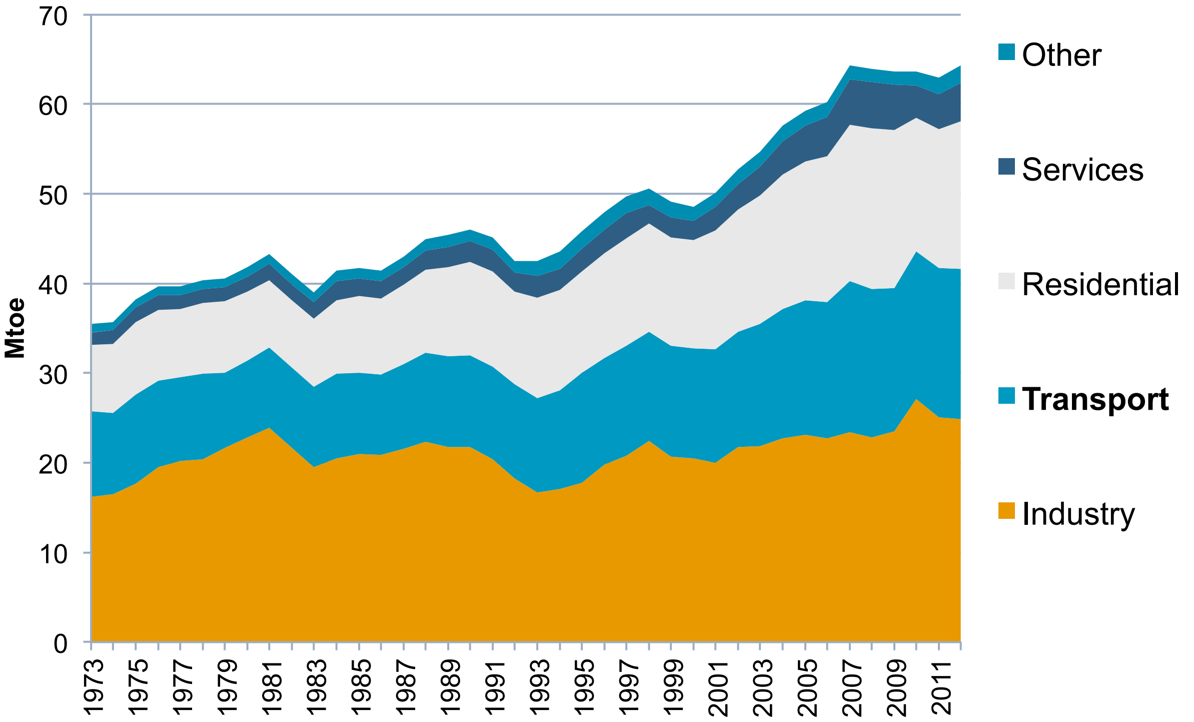
- **Why are energy efficiency indicators needed?**
  - **Do we know how efficient our transport is?**
  - **Where are the largest energy saving potentials?**
  - **What strategies should we consider for future energy demand?**

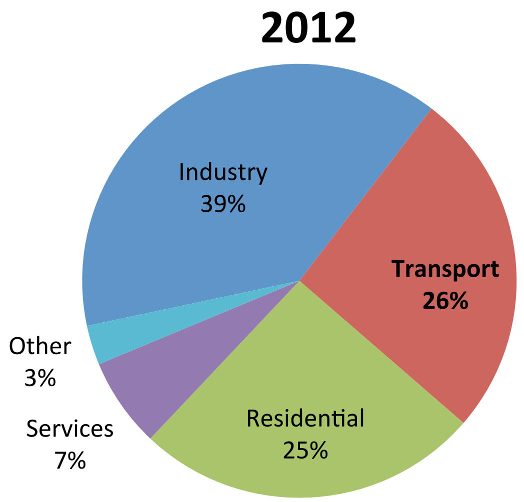
Where to start? Sectoral indicators



- **Usefulness vs. data requirement**

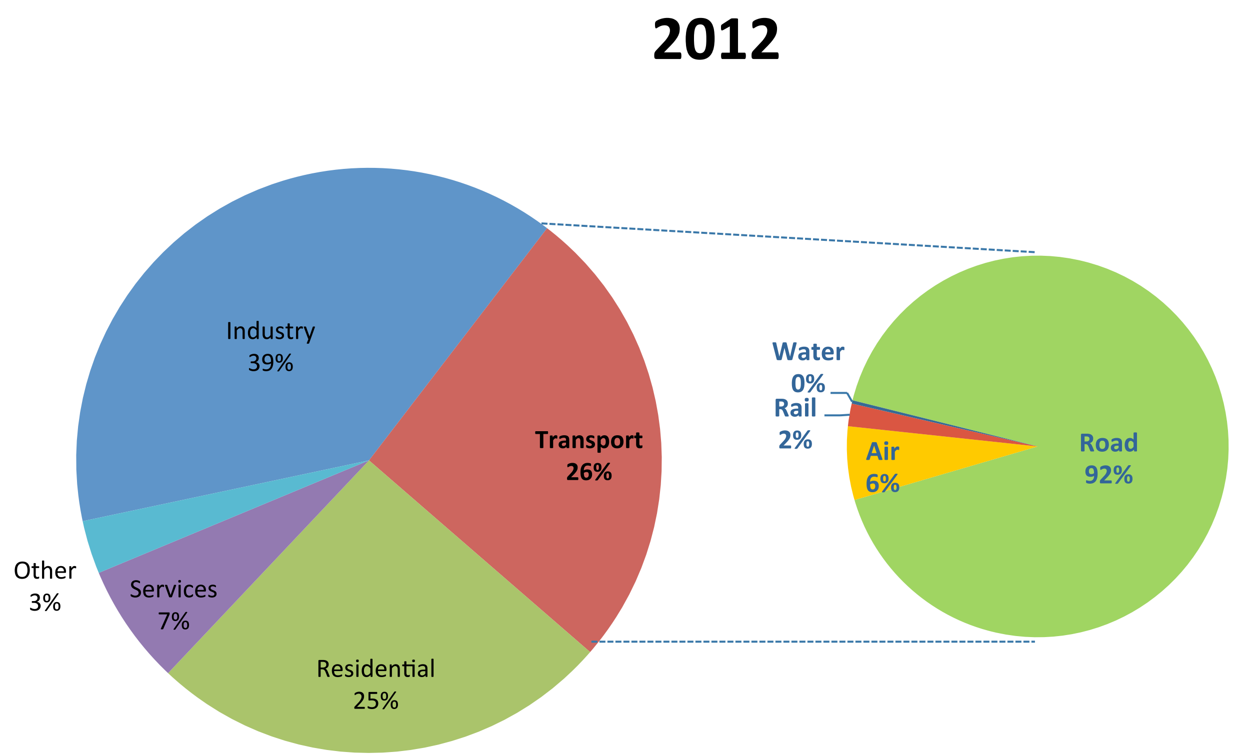
South African examples: level 1 indicators





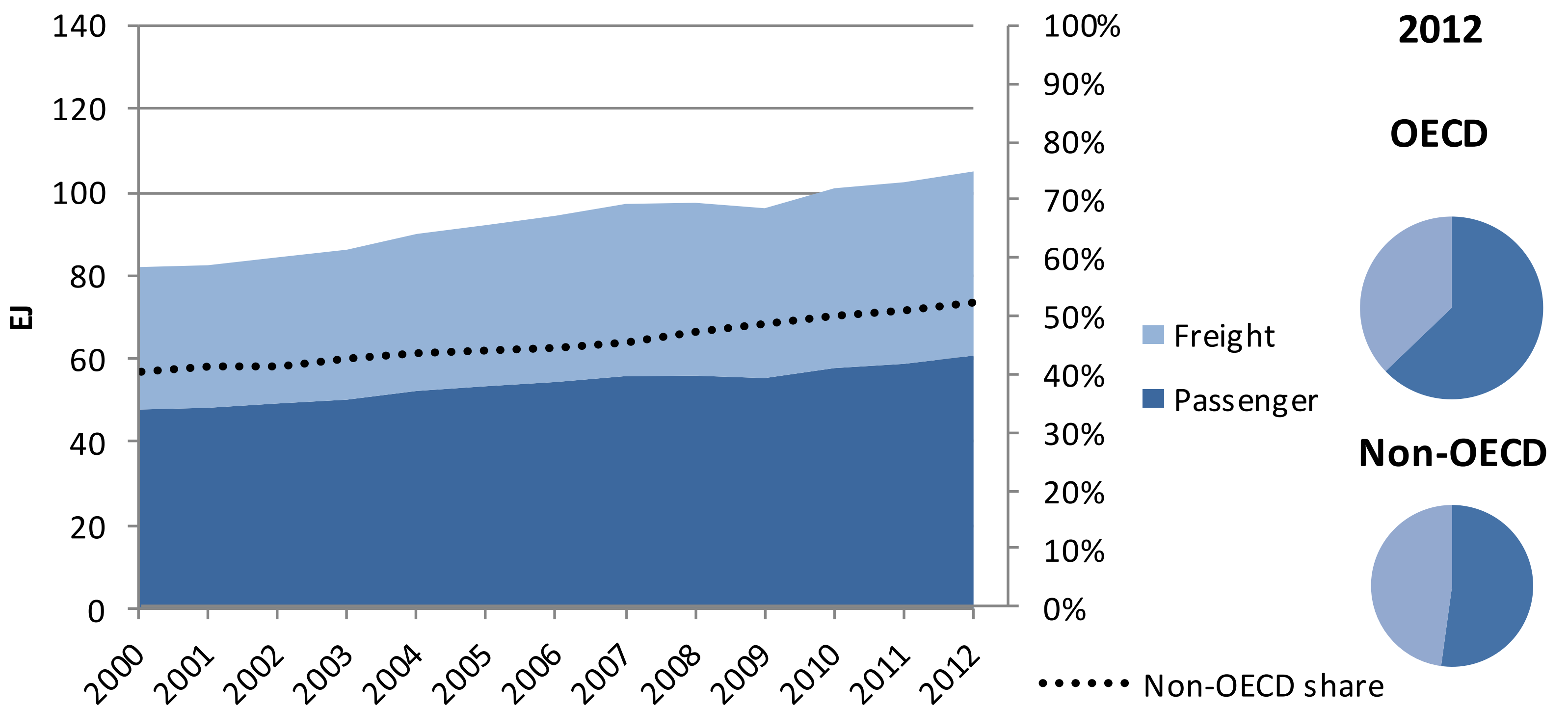
- Share of transport: 26% in 2012

South African examples: level 2 indicators



- Road transport dominates
- 62% of national oil products used in road transport
- Level 3 indicators (by segment, by vehicle types) available?

Global transport energy consumption



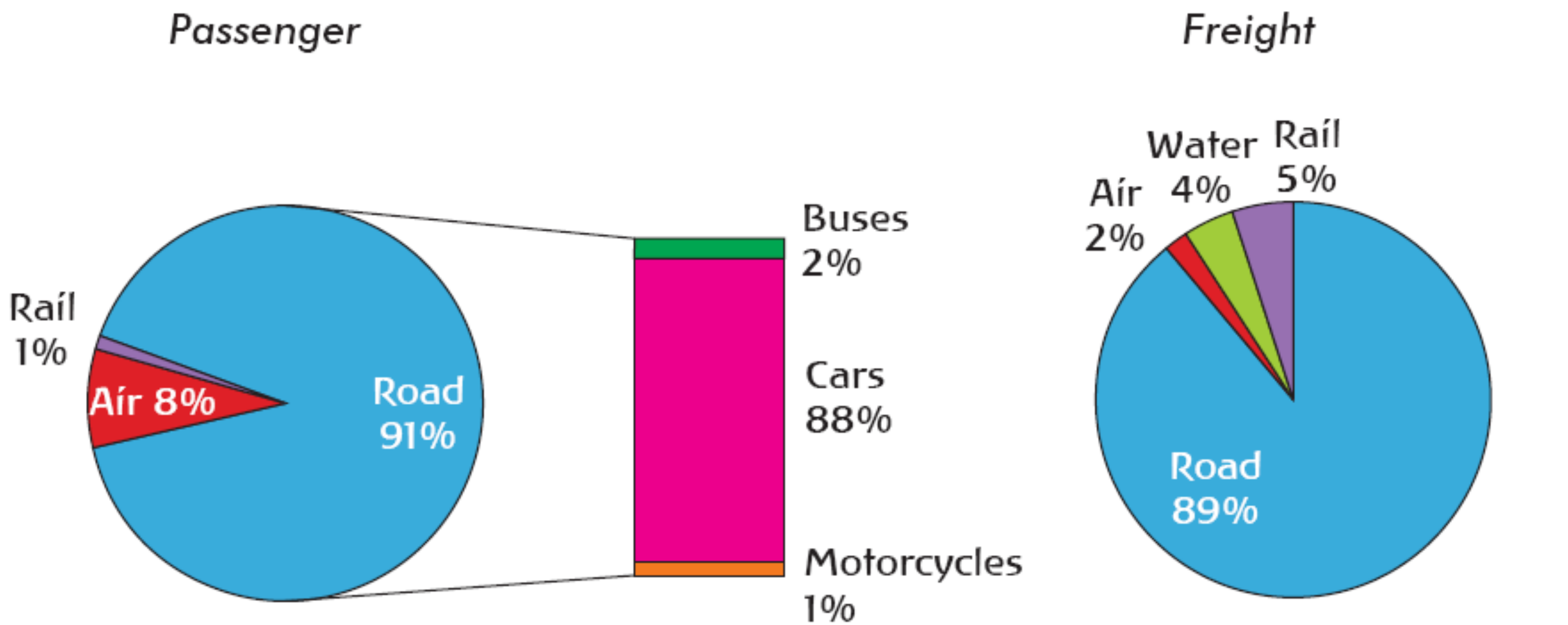
Source: IEA energy balances and IEA Mobility Model

- Transport energy demand goes to passenger & freight services
- Very distinctive motivations, organizations and drivers

⇨ **Need to examine passenger and freight transport separately**

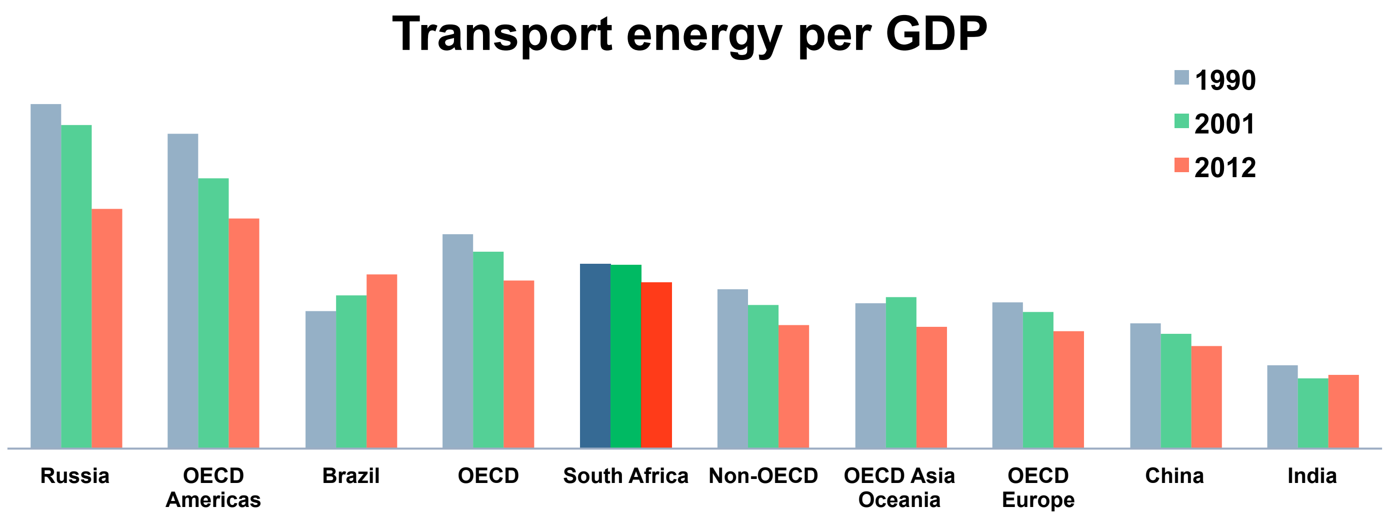
OECD examples: level 3 indicators

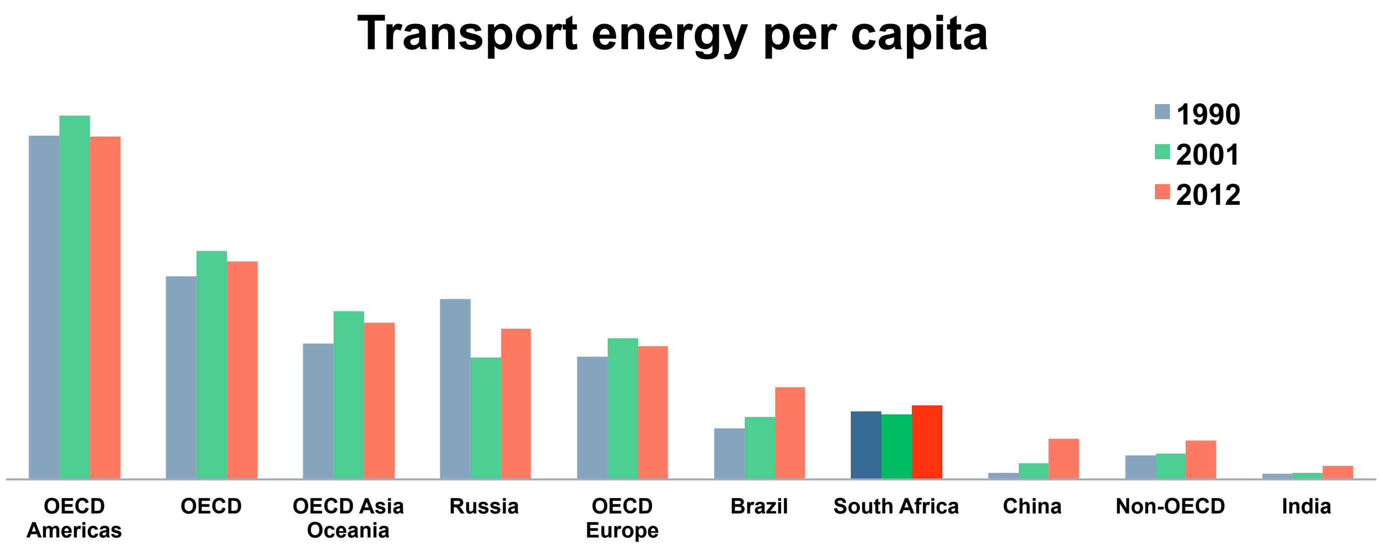
Figure 7.5 • Energy consumption by sub-sector and mode/vehicle type for passenger and freight transport (for a total of 23 OECD countries, 2010)



- Level 3 indicators available for South Africa?

South African examples: some other indicators





South Africa – Road transport energy by segment: IEA estimation

Source: Estimation by IEA Mobility Model

- Share of freight transport energy increased over recent decades

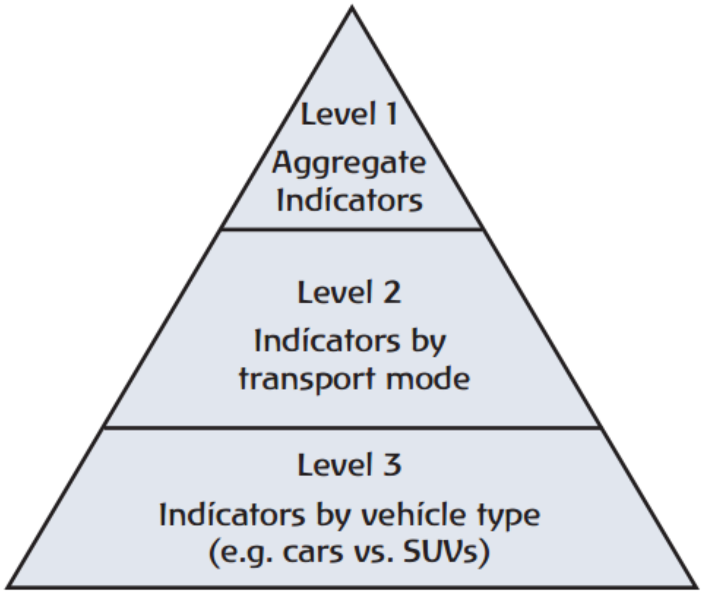
⇨ **Freight transport energy is important**

⇨ **Different from global trends**

- What would be the main driver?

Moving to segments: passenger indicators

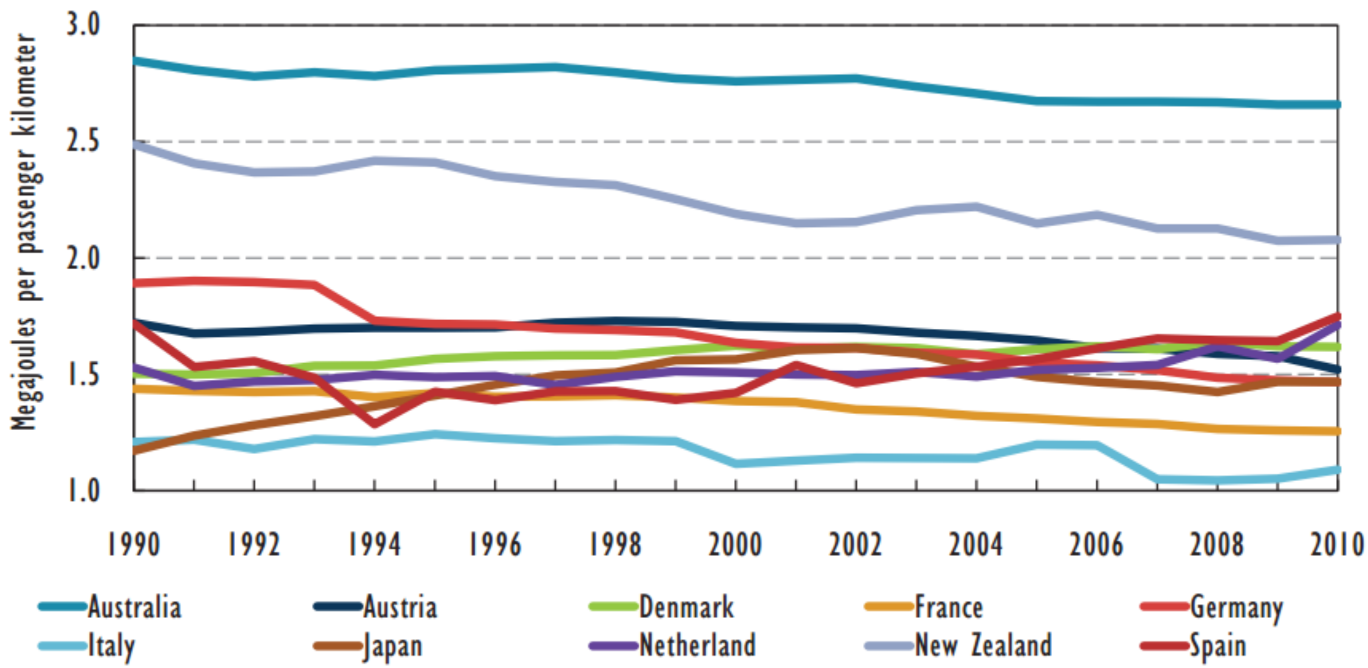
Figure 6.5 • Detailed indicators pyramid for passenger transport



- Key indicator: **energy per pkm**
- Allows tracking impacts having to do with the overall passenger mobility
- Q: how to improve energy efficiency of passenger transport?

OECD examples: level 1 passenger indicators

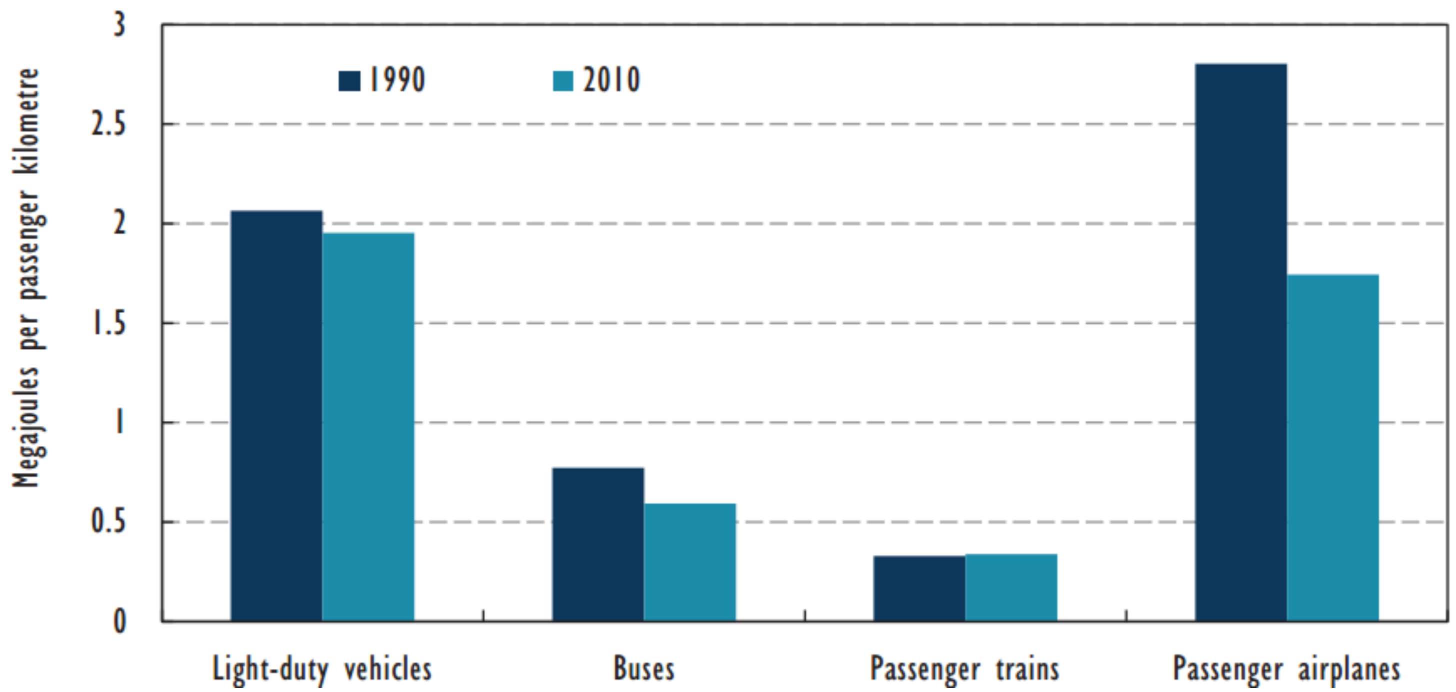
Figure 6.6 • Example of level 1 indicator for selected countries: passenger transport energy consumption in passenger-kilometre



- What could drive the differences among countries?

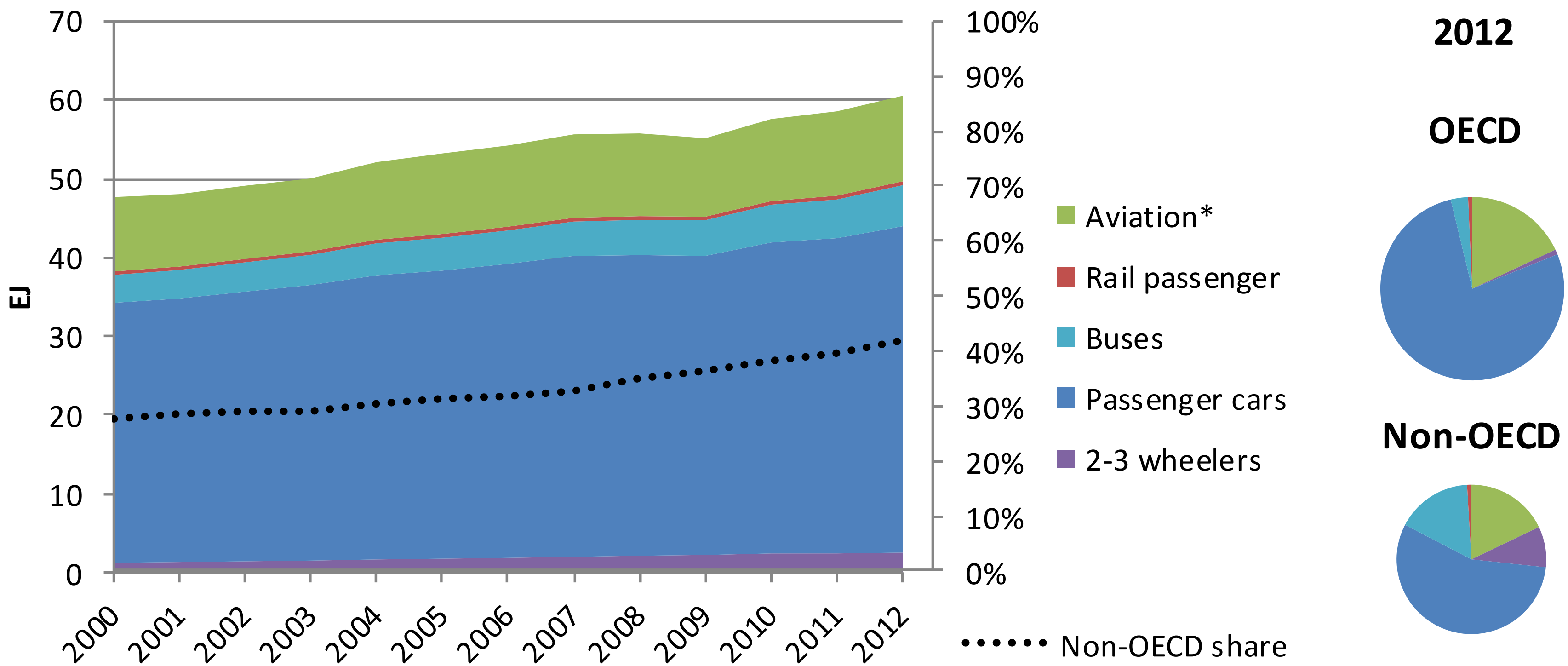
OECD examples: level 2 indicators

Figure 6.7 • Example of level 2 indicators for IEA15: energy consumption per passenger-kilometre by transportation mode



- Preferred mode matters in addition to fuel efficiency of vehicles

Passenger transport energy use by mode

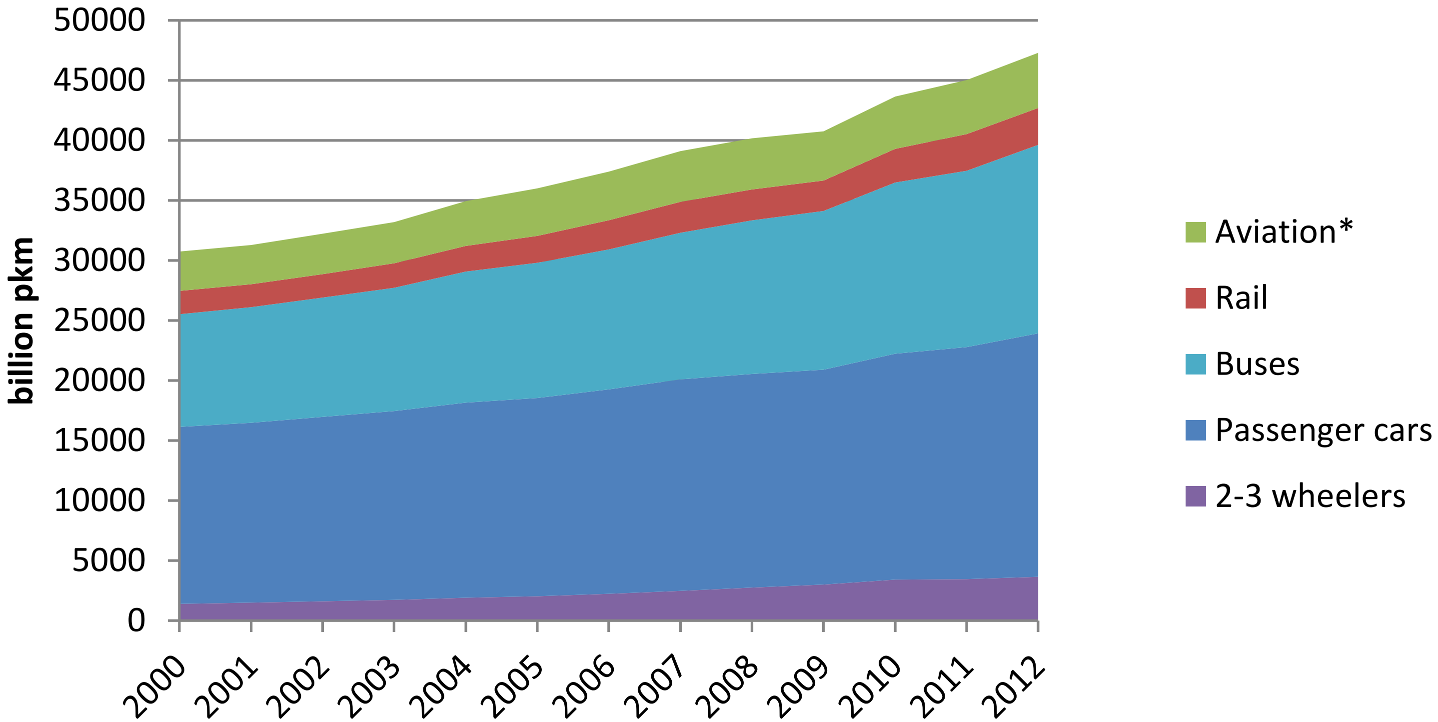


Source: IEA energy balances and IEA Mobility Model

* Includes international bunkers

- Most energy consumption (and growing) is for cars
  - Non-OECD countries experience the most radical changes
  - OECD: lower economic growth and close to car ownership saturation

Passenger transport activity by mode

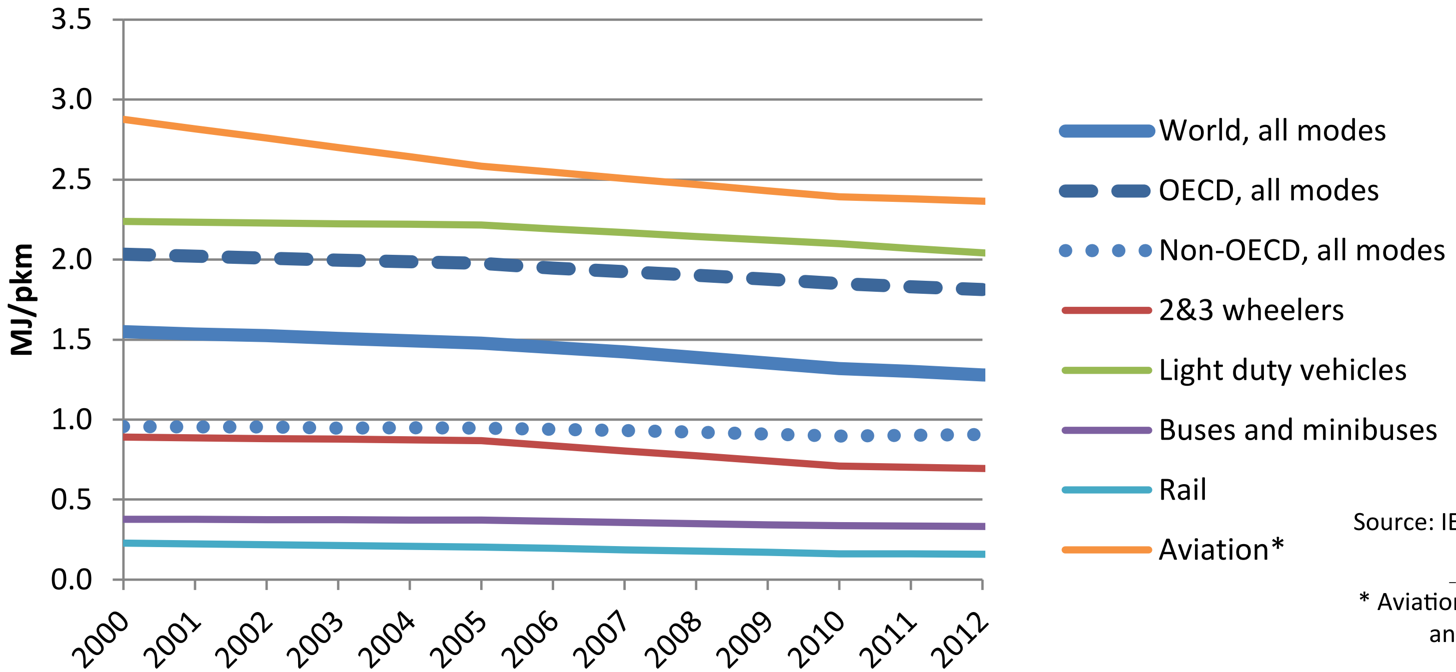


Source: IEA energy balances and IEA Mobility Model

* Aviation only allocated to passenger transport activity

- When looking at activity, collective transport modes (higher average loads) gain importance
  - This is especially relevant in non-OECD countries

Is passenger transport becoming more efficient?



Source: IEA energy balances, IEA Mobility Model

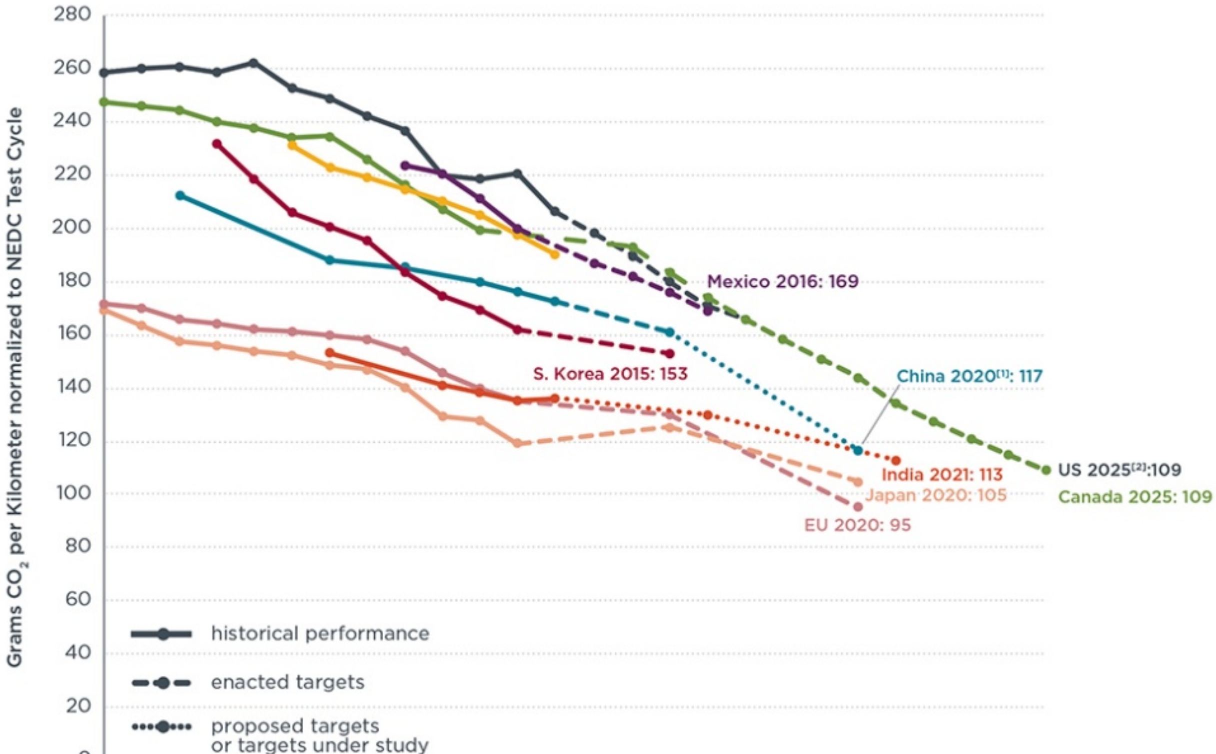
* Aviation includes international bunkers and is only allocated to passenger transport activity

Yes

- OECD has a worse performance (high share of personal vehicles, lower load factors) but faster improvement
- Non-OECD improvement rate slower (shift to personal vehicles)
- Most energy intensive modes (aviation, cars) have fastest improvements

Is passenger transport becoming more efficient?

- **Evolution from 2005 to 2010, light passenger vehicles (cars)**

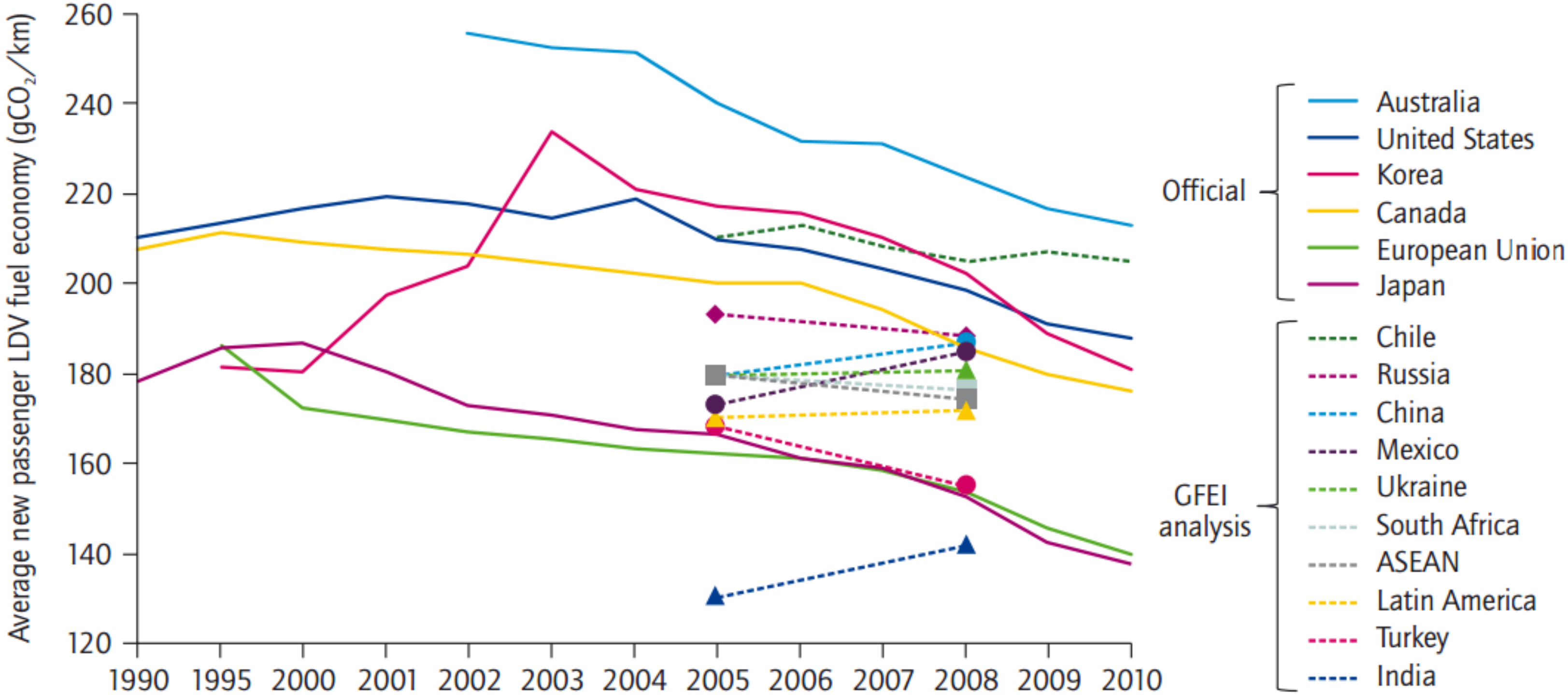


[1] China's target reflects gasoline vehicles only. The target may be higher after new energy vehicles are considered.
[2] US, Canada, and Mexico light-duty vehicles include light-commercial vehicles.
[3] Supporting data can be found at: http://www.theicct.org/info-tools/global-passenger-vehicle-standards

- The evolution of the specific fuel consumption of vehicles influences the way energy demand develop with respect to transport activity
- Light passenger vehicles experienced some improvement in recent years

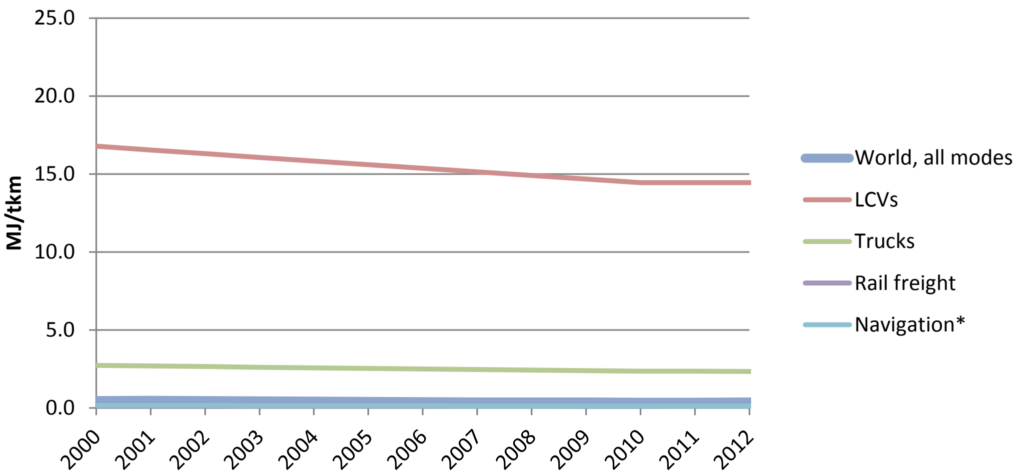
Is passenger transport becoming more efficient?

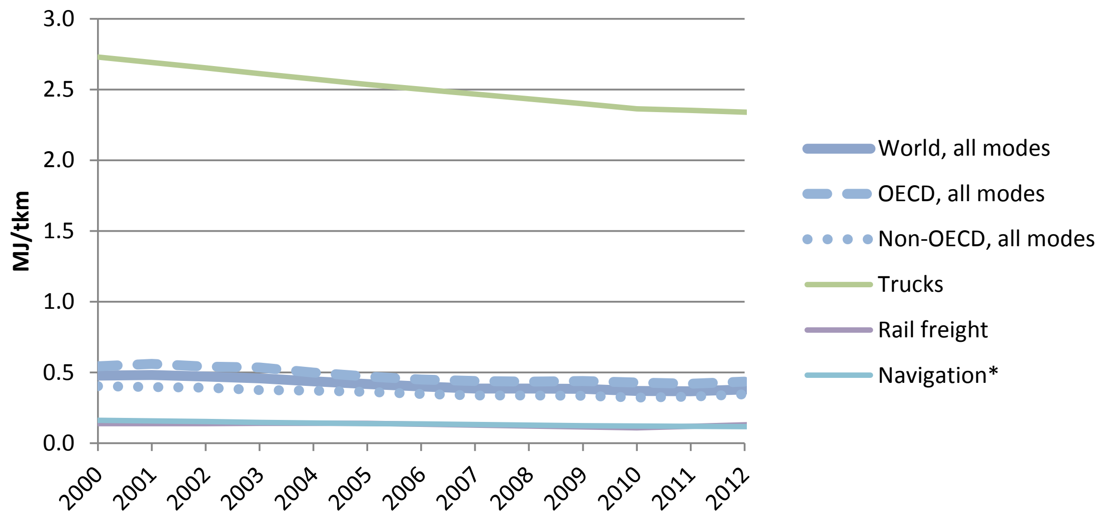
Figure 1. Average new passenger LDV tested fuel economy by country/region, 1990-2011



Source: Technology Roadmap: Fuel Economy of Road Vehicles (IEA, 2012)

Is **freight transport** becoming more efficient?





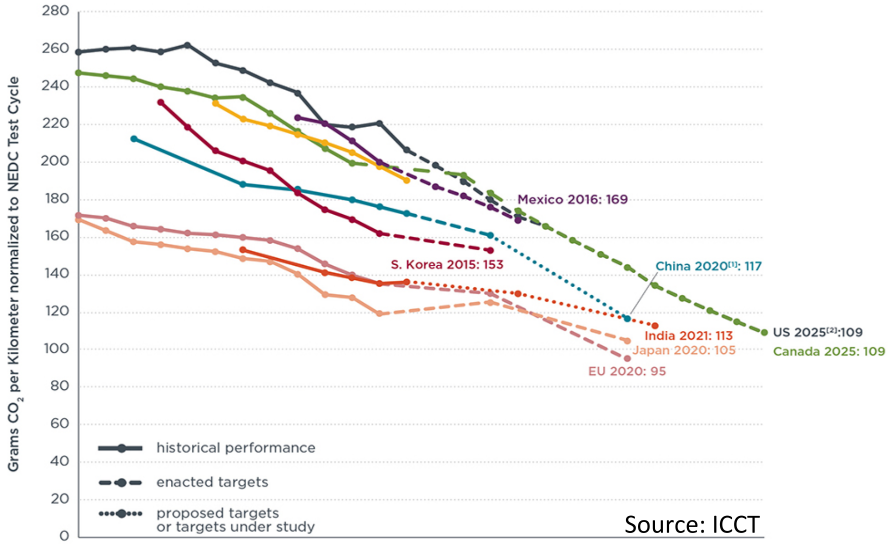
Yes

- The OECD vs. Non-OECD gap is narrower than in passenger transport (due to the weight of navigation)
- LCVs much less efficient than other modes, but important in cities
- Road much less efficient than rail and shipping

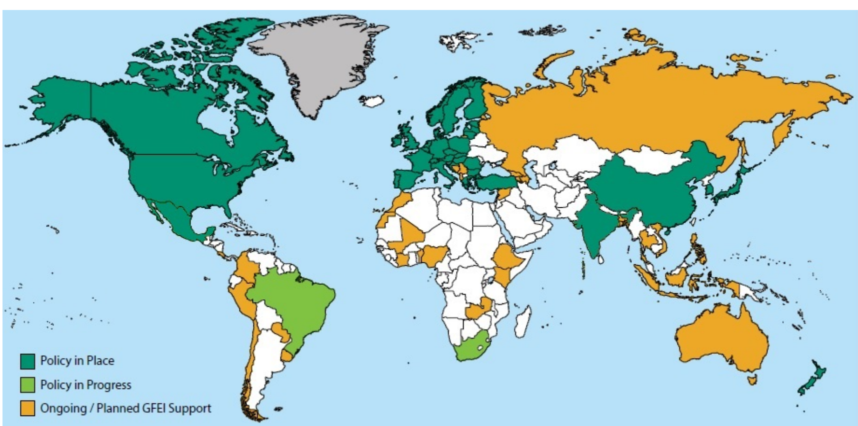
Sources: IEA energy balances, IEA Mobility Model, UNCTAD Review of Maritime Transport, UIC rail transport database

* Navigation allocated only to freight transport, itncludes international bunkers

Are cars becoming more efficient?



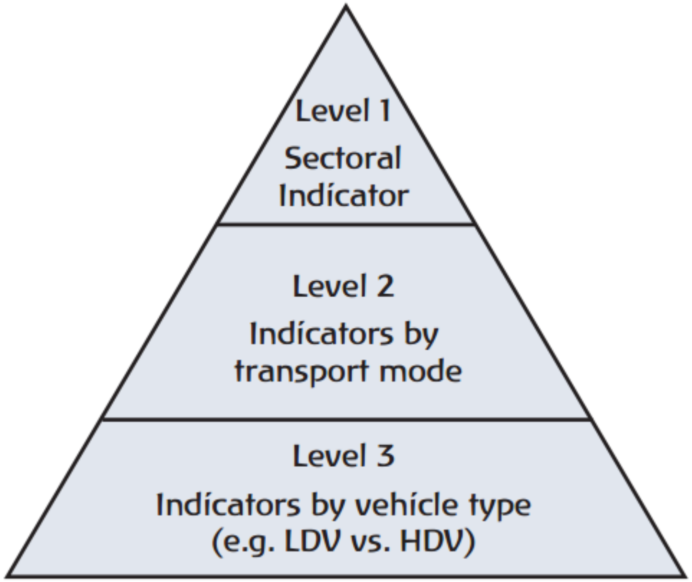
[1] China's target reflects gasoline vehicles only. The target may be higher after new energy vehicles are considered.
[2] US, Canada, and Mexico light-duty vehicles include light-commercial vehicles.
[3] Supporting data can be found at: http://www.theicct.org/info-tools/global-passenger-vehicle-standards



- Almost 80% of the global passenger car market is already regulated
- Regulated regions show remarkable progress, close to 3% improvement per year since 2005
- Non-regulated markets lack behind, mainly because of a shift towards larger & more powerful cars)
- Global average fuel economy improved 1.8% annually since 2005
- Recent trend: widening gap between tested and real on-road fuel economy (need to monitor test procedures)

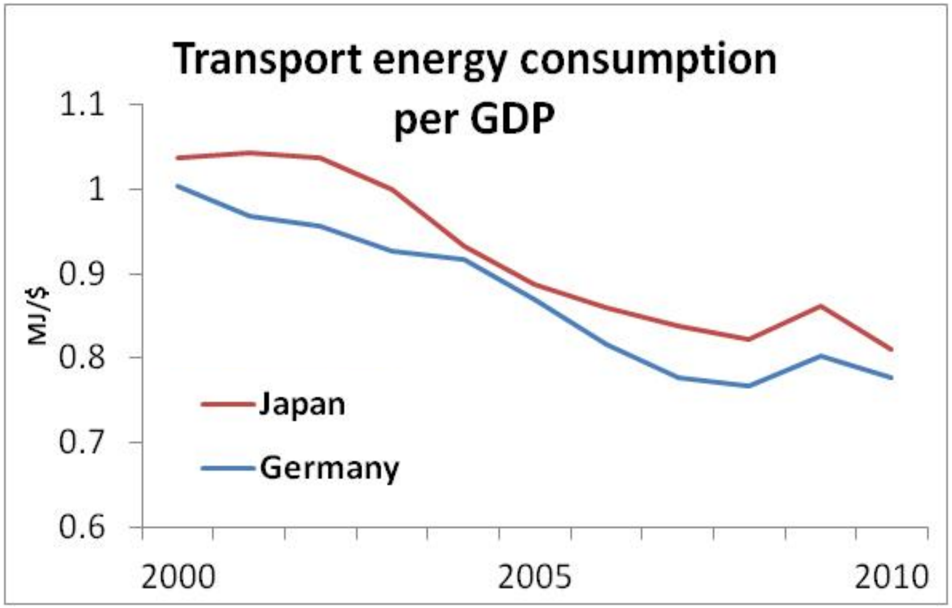
Moving to segments: freight indicators

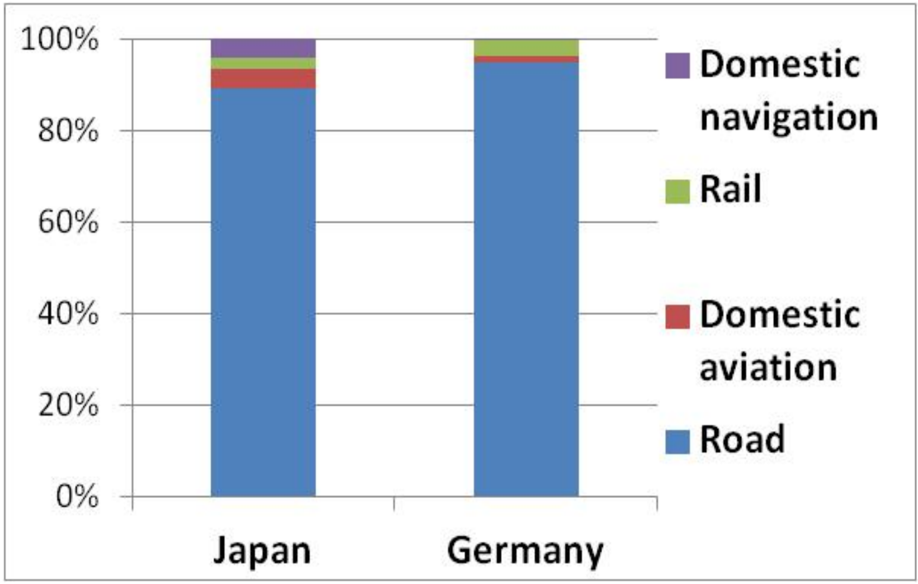
Figure 6.14 • Detailed indicators pyramid for freight transport



- Key indicator: **energy per tkm**
- Allows tracking the impacts having to do with the whole supply chain
- As in the case of passenger transport, parameters can differ for specific needs (e.g. fuel economy of heavy duty trucks)

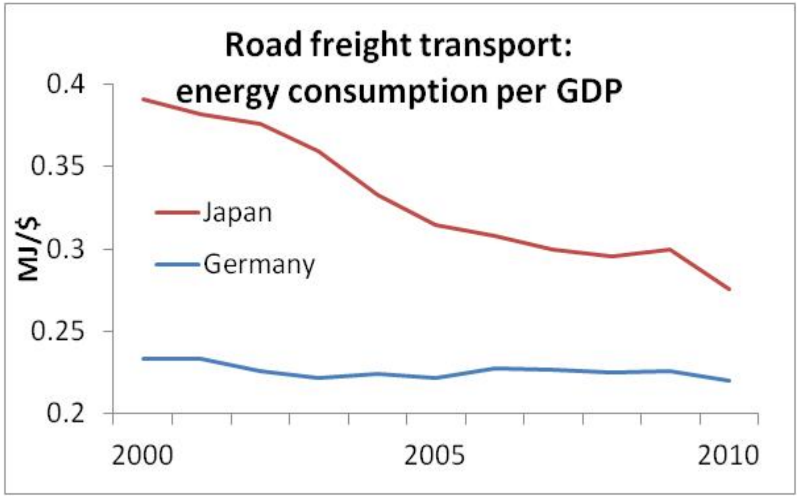
Examples: Japan and Germany

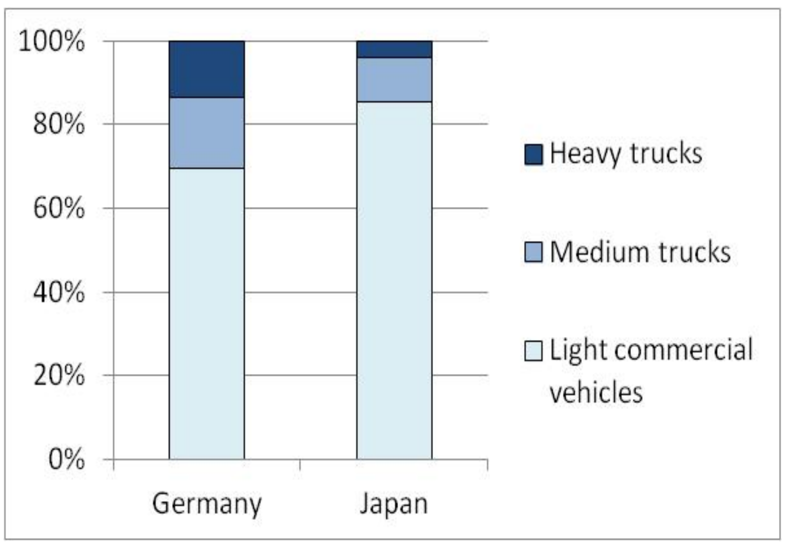


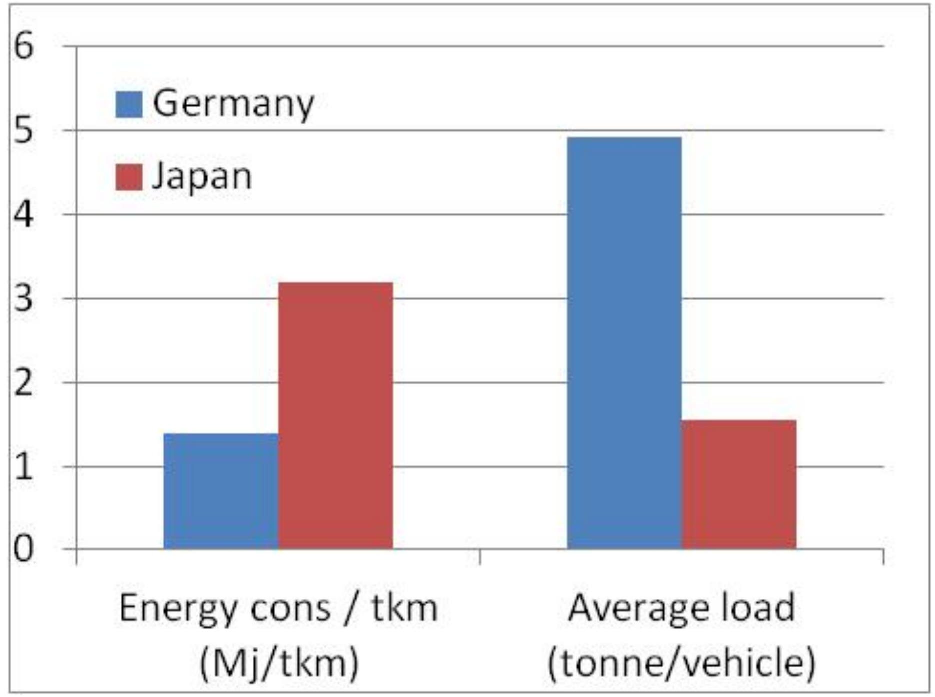


At high level: comparable features

Examples: Japan and Germany







At detailed level: intensities and structures are very different

Projecting future transport demand

- **Transport sector evolves over time**
  - **Especially important for emerging economies**
- **Needs to be proactive**
- **Projection is a key step for transport planning and target setting**

Drivers of demand for transport activity

Transport activity (vkm, pkm, tkm) and vehicle stock are largely determined by:

- Relationships linking **GDP and population** with transport activity and modal choice
  - GDP per capita is linked personal vehicle ownership and modal choice
  - Economic output (GDP) with tonnes lifted
- Effects of changes in the **cost** of driving and moving goods
  - Elasticities of pkm, tkm, average travel and average loads also affect transport activity and modal choice

Drivers of demand for transport activity

Transport activity (vkm, pkm, tkm) and vehicle stock are largely determined by:

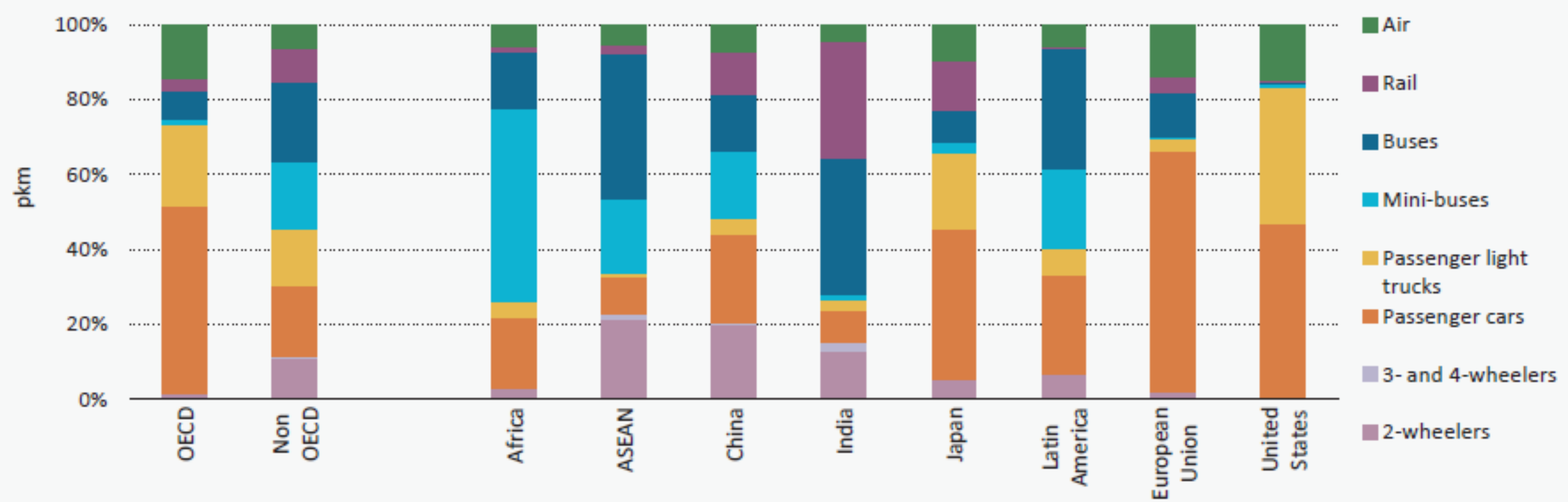
- **Structural** changes in the transport system
  - Passenger: related with the role of public transport
  - Freight: related with economic and trade structures, impacting on the average haul length and modal choice

- Transport demand and modal choices are also modulated under the **travel time budget** (TTB) constraint

Drivers of demand for transport activity

Shares of pkm on different modes across the world

- Passenger cars dominate in high income countries
  - Fuel taxation, population density, urban environments
  - Lower income countries see much larger importance of two wheelers and collective transport modes



Notes: Shares are based on estimated total passenger-kilometres, nationally and regionally, for each mode. ASEAN is Association of Southeast Asian Nations.

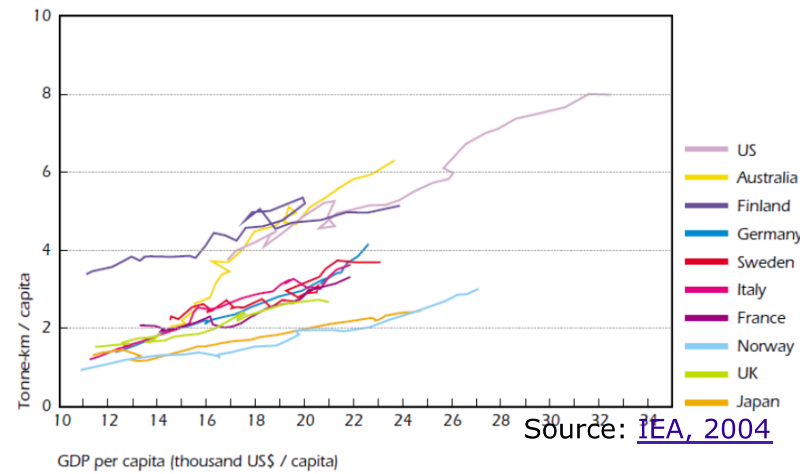
Drivers of demand for transport activity

Large freight

- Transport activity (tkm) proportional to GDP (figure)

Tkm = load (also proportional to GDP) * vkm (constant by distance class)

Freight transport activity and GDP



Source: [IEA, 2004]

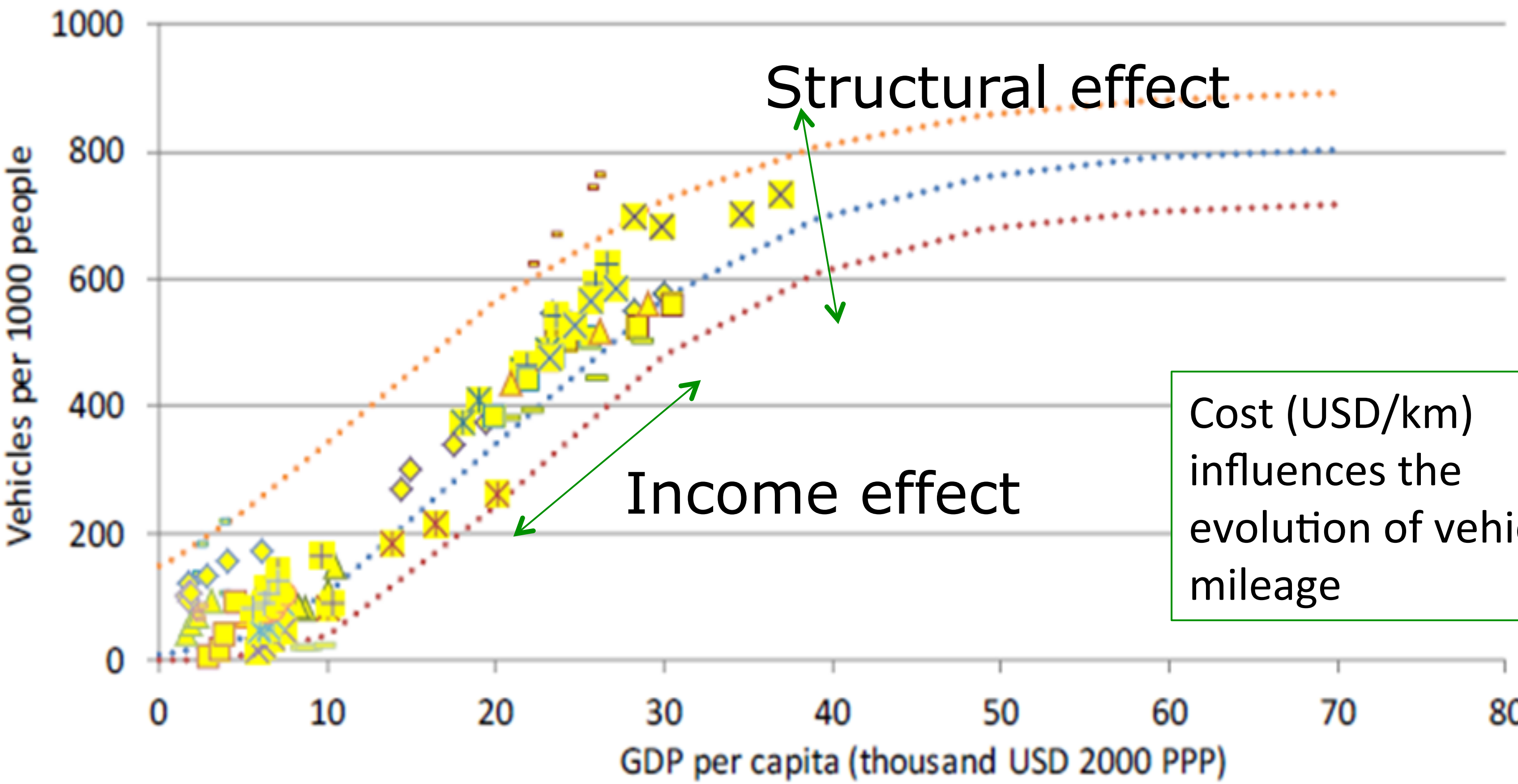
Tonnes lifted by mode are subject to structural changes, driven by:

- The trade-related nature of the economy
- the origin/destination of goods
- the type of goods transported
- the modal competitiveness

- Tkm and loads are also subject to the influence of the cost of moving goods (through elasticities)

Drivers of demand for transport activity

Motorized personal vehicles for passenger transport



Cost (USD/km) influences the evolution of vehicle mileage

Sources: elaboration of national and international databases, building on the information referenced in [UNECE, 2012]

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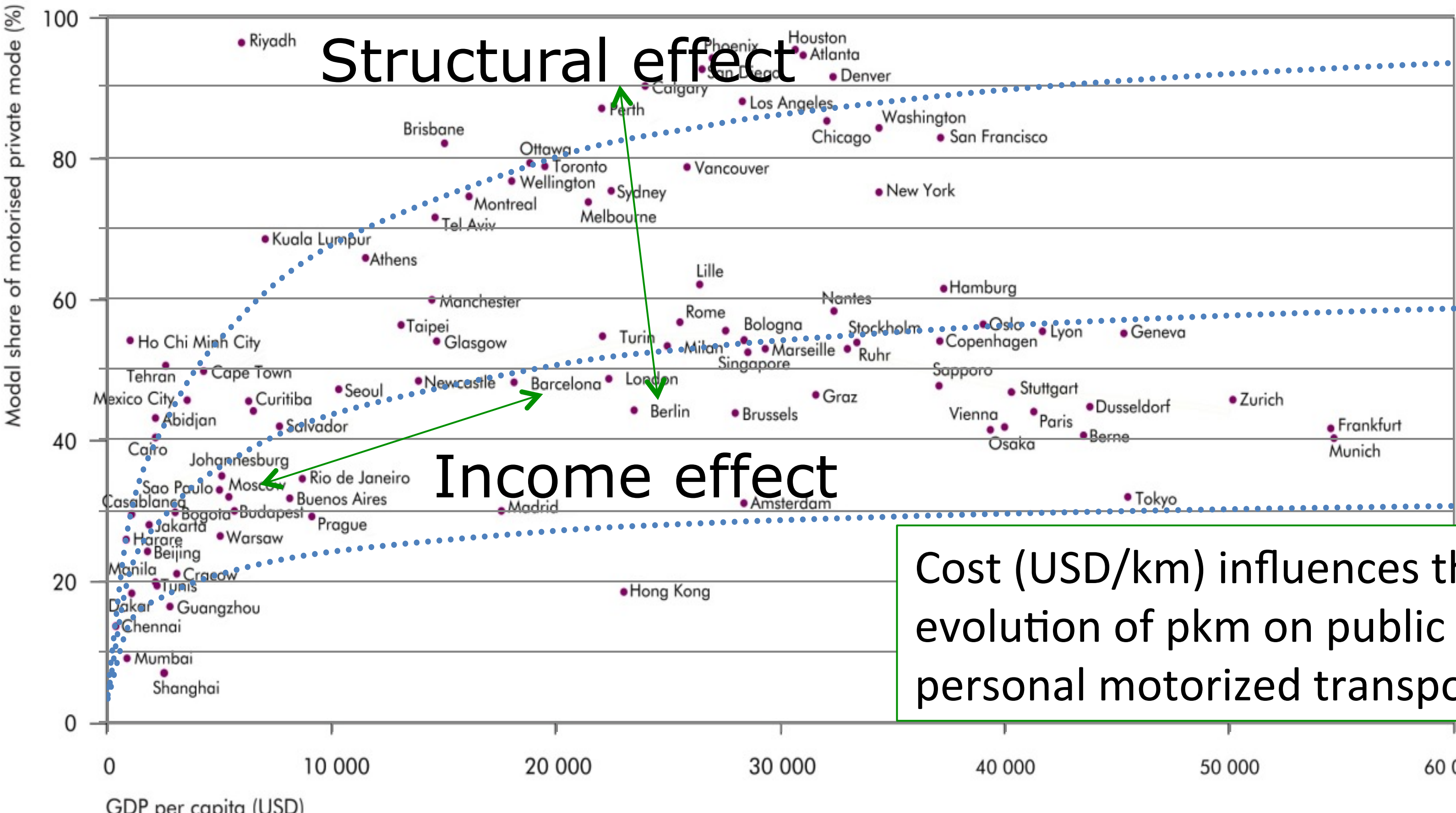
Drivers of demand for transport activity

Public passenger transport

Modal share of personal vehicles in total personal and public transport

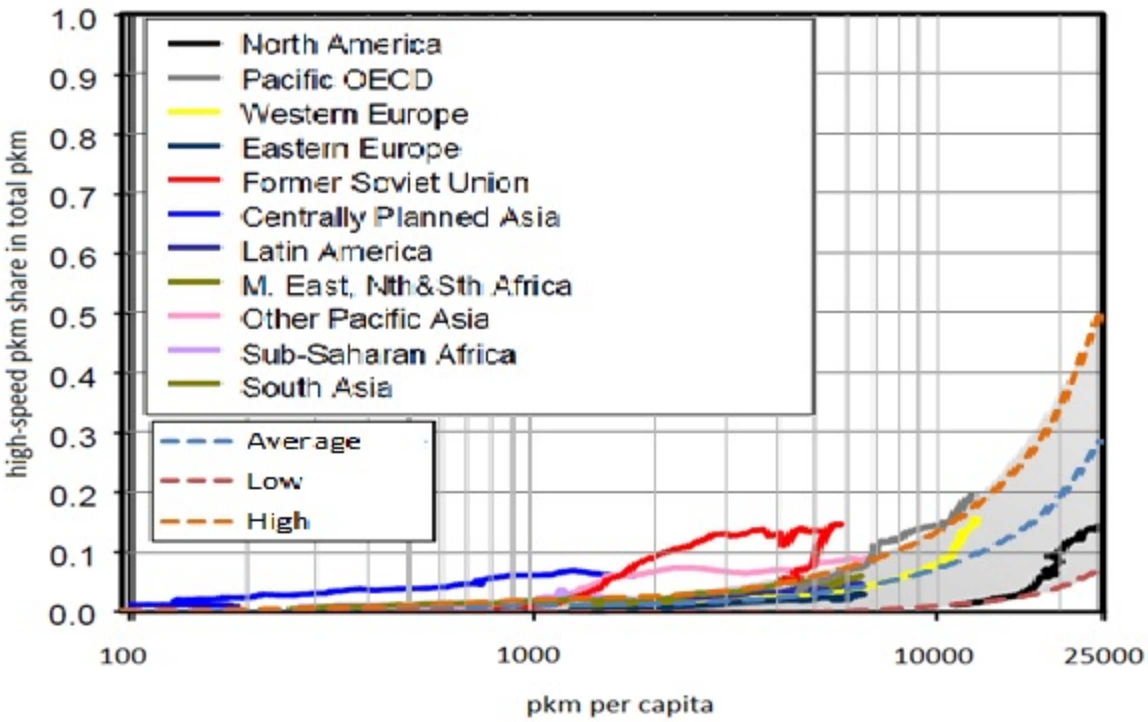


Cost (USD/km) influences the evolution of pkm on public and personal motorized transport

Source: elaboration of UITP, quoted by IEA, 2008

Drivers of demand for transport activity

Air passenger transport

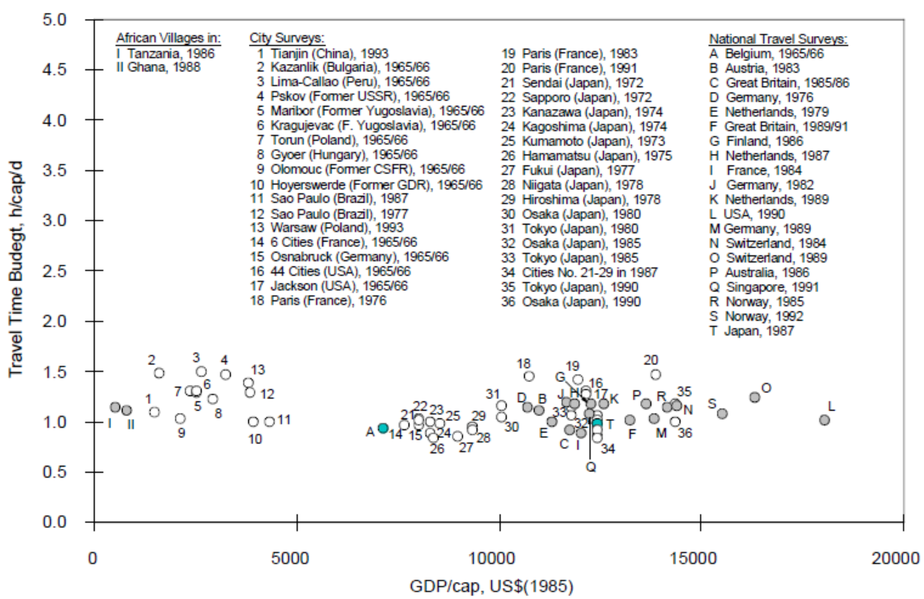


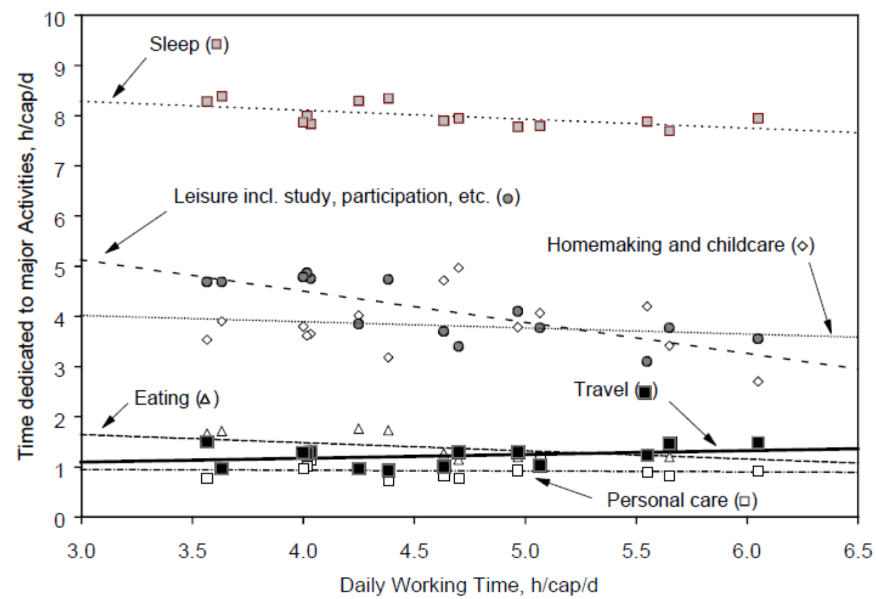
Source: elaboration of Schäfer, 2005

Drivers of demand for transport activity

Travel time budget (TTB)

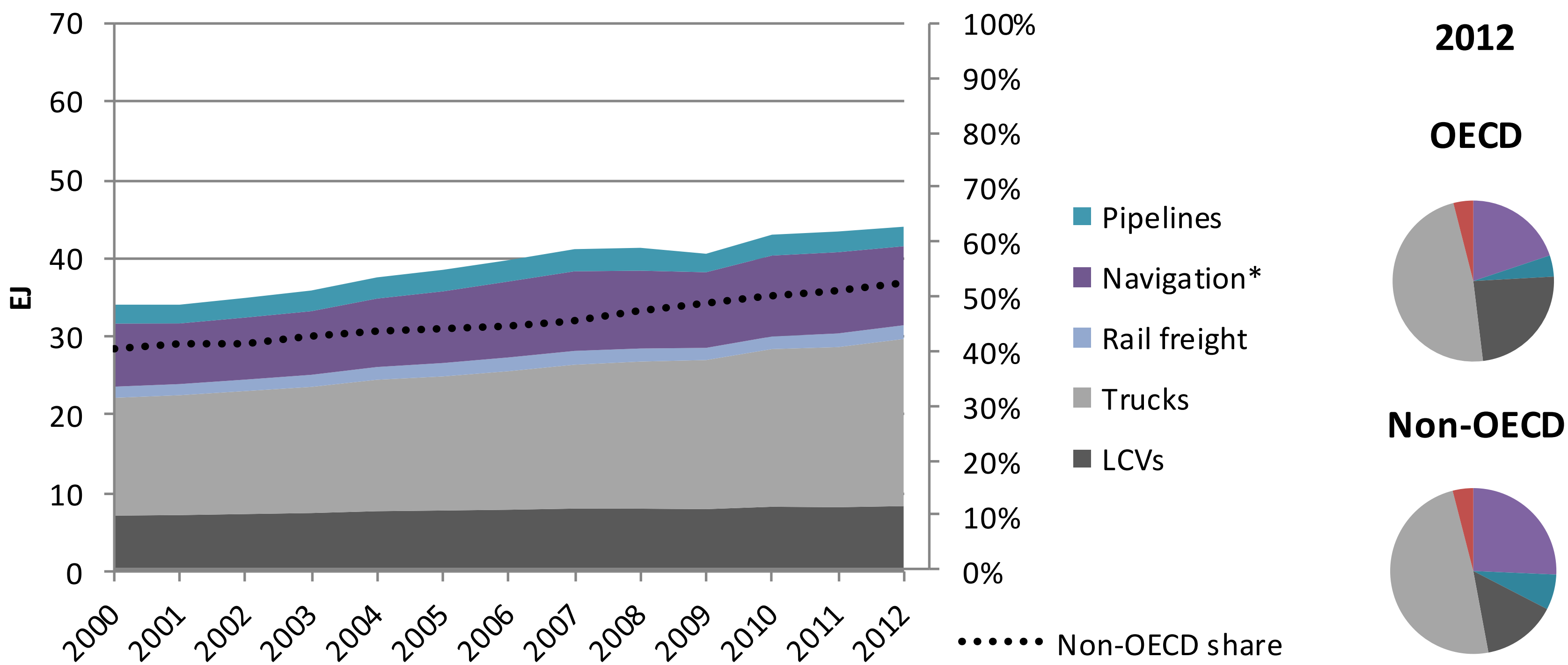
- Average travel time constant across a wide range of average incomes
- Time dedicated to travel unchanged for a wide range of daily working hours





Source: Schäfer, 2005

Freight transport energy use by mode

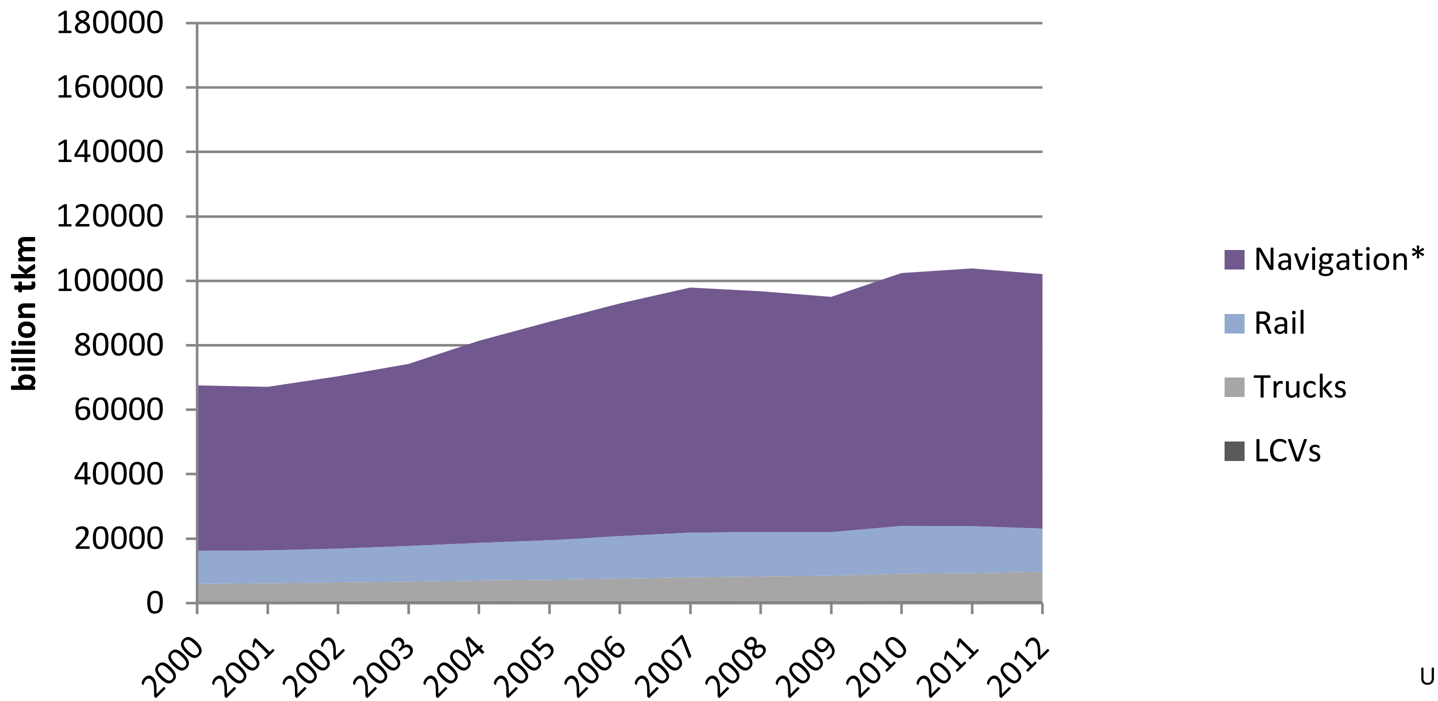


Source: IEA energy balances and IEA Mobility Model

* Includes international bunkers

- Road takes the lion's share also for freight
  - Trucking experiences the fastest growth
  - LCVs (energy intensive) have larger growth potential in non-OECD

Freight transport activity by mode



Source: IEA Mobility Model, UNCTAD Review of Maritime Transport, UIC rail transport database

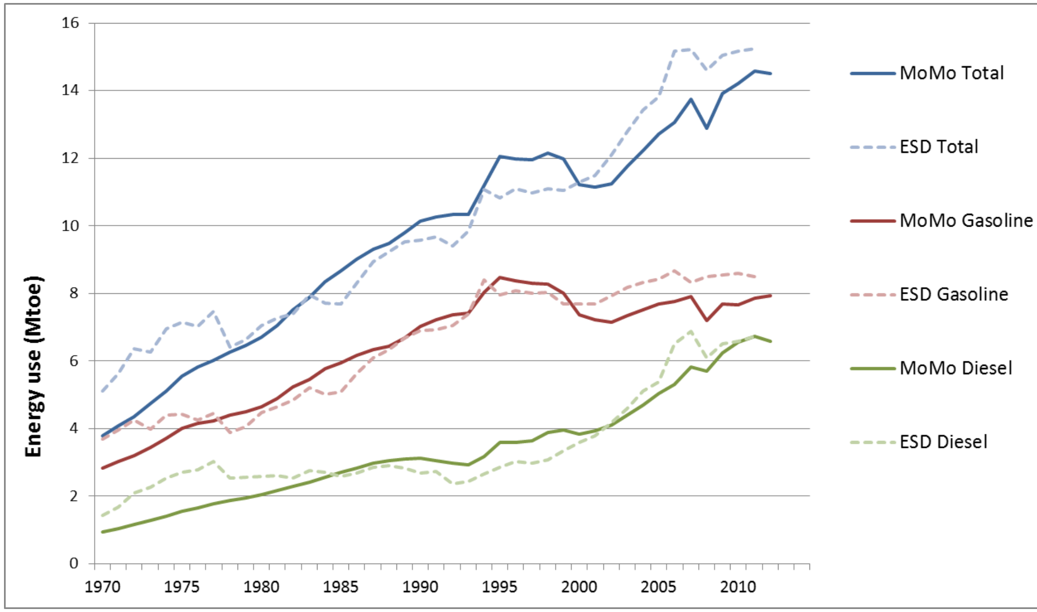
* Navigation allocated only to freight transport

- When looking at activity
  - shipping outweights all other modes
  - rail becomes comparable to road, but only highly used in a few countries: United States (26%), China (26%), Russia (20%), India (6%)

Focus on South Africa, road

IEA bottom-up energy estimation

- New registrations by fuel type
- Average vehicle scrappage age
  Assumed a gap with OECD regions
- Vehicle stock
- Average vehicle mileage
  Assumed based on considerations on road conditions (lower speed) and constant usage time



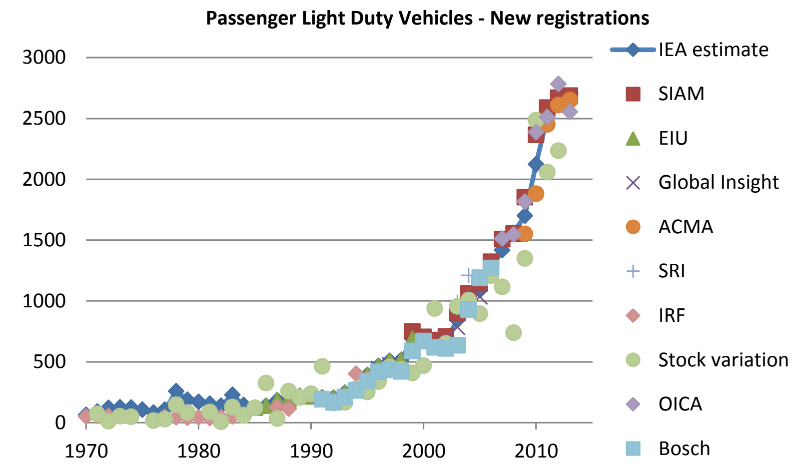
- Vehicle-km
- Data on fuel economy of new registrations
  Assumptions from technical considerations (slightly worse then OECD, improvement delayed by 5 to 10 years) for most modes but road (GFEI data)
- Energy use in IEA balance

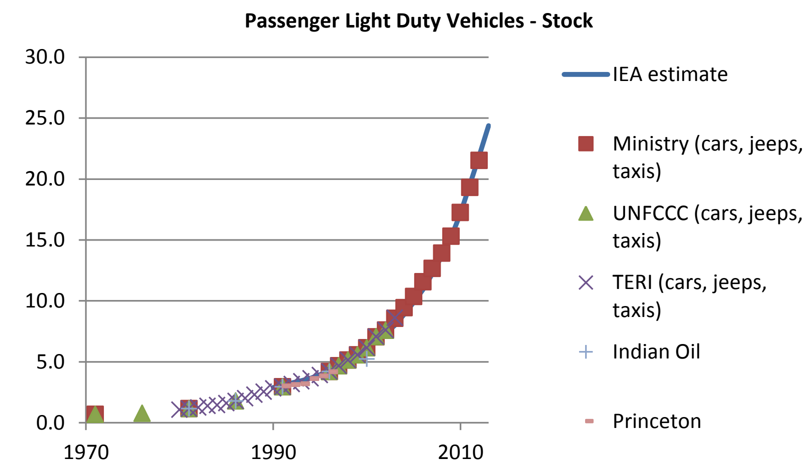
Sources: IEA energy balances, IEA Mobility Model

Focus on South Africa, road

Bottom-up energy estimation: issues

- New vehicle registrations by fuel type
  - Data available from NAAMSA, OICA, specific companies (e.g. Bosch), consultants (e.g. Global Insight, SRI), research papers (e.g. University of Michigan), IRF
- Vehicle stock
  - Stock variation from ministerial data has same magnitude of new registrations from available sources
  - Ministerial data on stock consistent with assumption mentioned earlier





Sources: IEA Mobility Model (using several published data)

- Passenger-km, tonne-km

  Assumptions needed on average vehicle load by mode

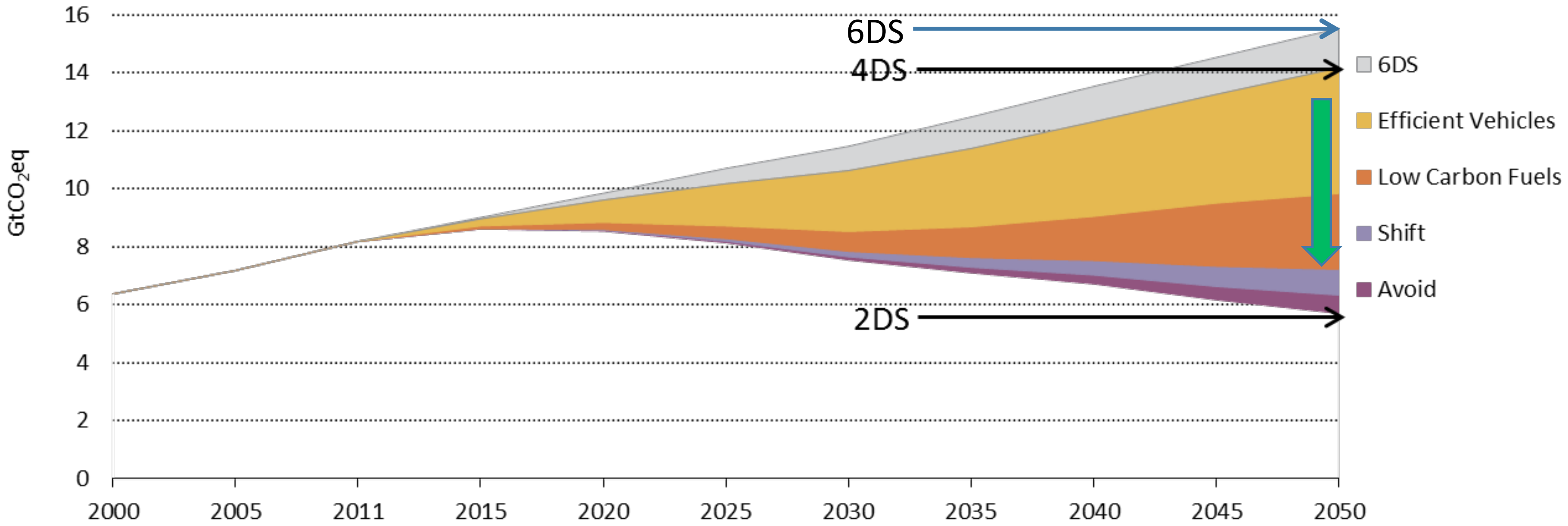
  Results roughly consistent with data from Indian planning commission

From data to policy: indicators to assess potentials

- **Energy use = Activity × Structure × Intensity**
- **Energy saving = Avoid or Shift or Improve**

- Improving efficiency is **not** the only option!

Avoid-shift-improve: an integrated strategy



Source: *IEA ETP 2014*

- Examples of IEA scenarios to low(er)-carbon transport
  - Avoid unnecessary travel
  - Shift to more efficient modes
  - Improve the energy efficiency of each mode (fuel efficiency + load factor)

Discussion topics

1. What key indicators would need to be developed to track energy efficiency in transport and assess potentials for savings?

2. What are the main challenges to develop key indicators?

3. What data gaps should be addressed?

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Transport: Energy Efficiency Target Setting

Pretoria, 28-29 January 2015

Taejin PARK
Energy Data Centre
International Energy Agency

Workshop 2 of 3

Session 3. Group C: Transport

Session 3. Energy Efficiency Target Setting

- Content
  1. Understanding context
  2. Transport policies: avoid-shift-improve approach
  3. Conclusion

- Key Questions
  1. What are your policy priorities in transport? (energy saving, climate change mitigation, access to mobility, safety, etc.)
  2. In what area would there be the largest potential to achieve your priorities and what would be the most effective policy options (avoid/shift/improve)?
  3. How can indicators be used in setting targets and monitoring progress?

Energy efficiency in transport: broad thinking

Why are transport policies needed?

- **To reduce increasing energy demand**
- **To attenuate negative impacts**
  - Damage to the environment
  - Health related issues (local pollutants / noise)
  - Injuries / fatalities
  - Economic loss (congestion / fuel / time / accidents)
- **To (try to) provide equal access to mobility**
  - Basic principle individuals should be able to move freely
  - Social equity
  - Access to employment and services

Three policy levers

AVOID/REDUCE

Reduce or avoid travel or the need to travel

- Integration of transport and land-use planning
- Smart logistics concepts
- …

SHIFT

Shift to more environmentally friendly modes

- Transport Demand Management
- Mode shift to Non-Motorized Transport
- Mode shift to Public Transport
- …

IMPROVE

Improve the energy efficiency of transport modes and vehicle technology

- Low-friction lubricants
- Optimal tire pressure
- Low Rolling Resistance Tires
- Speed limits Eco-Driving (Raising Awareness)
- Shift to alternative fuels
- …

Source: GTZ

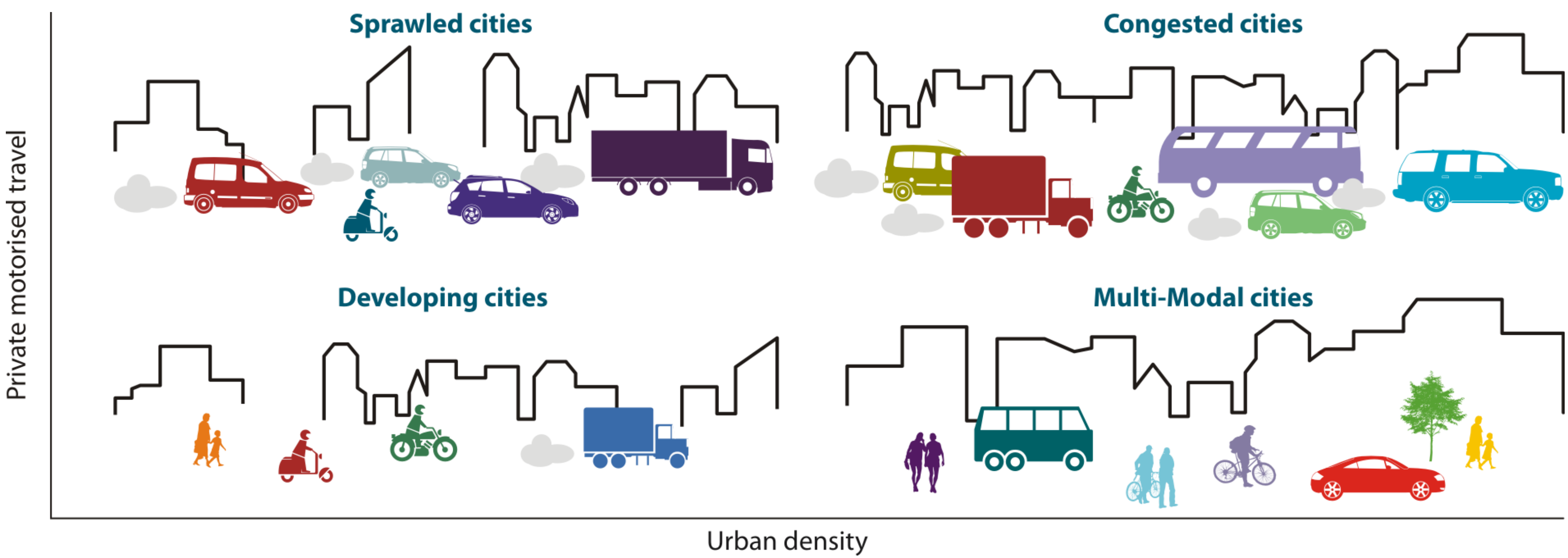
Understanding drivers of demand

- **Two key parameters driving transport demand**
  - Travel Time Budget (TTB): how much time do you have/are you will to spend travelling each day?
    - Impacts: Distance to destination (land use planning), access (transport service provision/choice), information (ITS)
  - Travel Money Budget (TMB): how much money can you/are you willing to spend on transport?
    - Considerations: affordability (service provision), social/cultural preferences (policy environment), pricing (policy tools)

Rebound effects: demand increases as budget grows (or is substituted)

Understanding context

How do policy and planning impact travel decisions?



Transport energy use

A. **Avoid**

- **Land use, urban design, teleworking**

B. **Shift**

- **Low carbon transport modes**

C. **Improve**

- **Efficient vehicles, technology**

Avoid – land use planning

Land use shapes transport, which in turn shapes land use

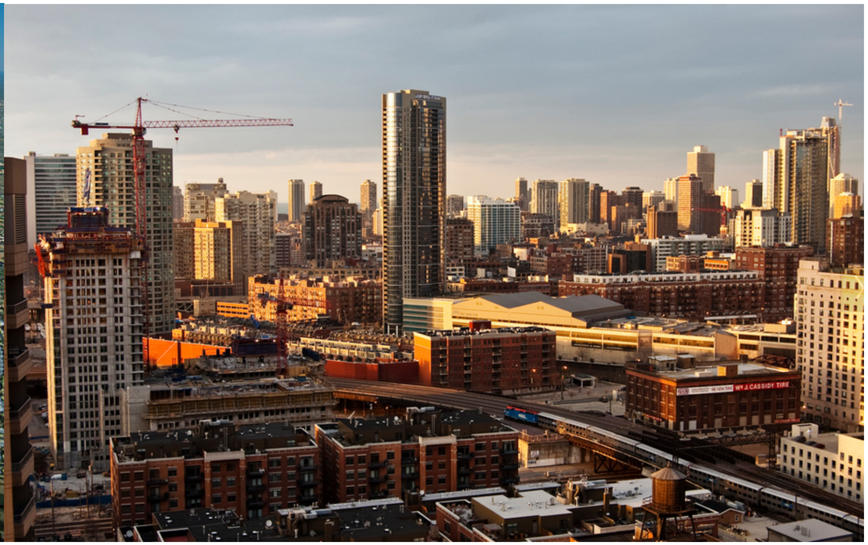
 

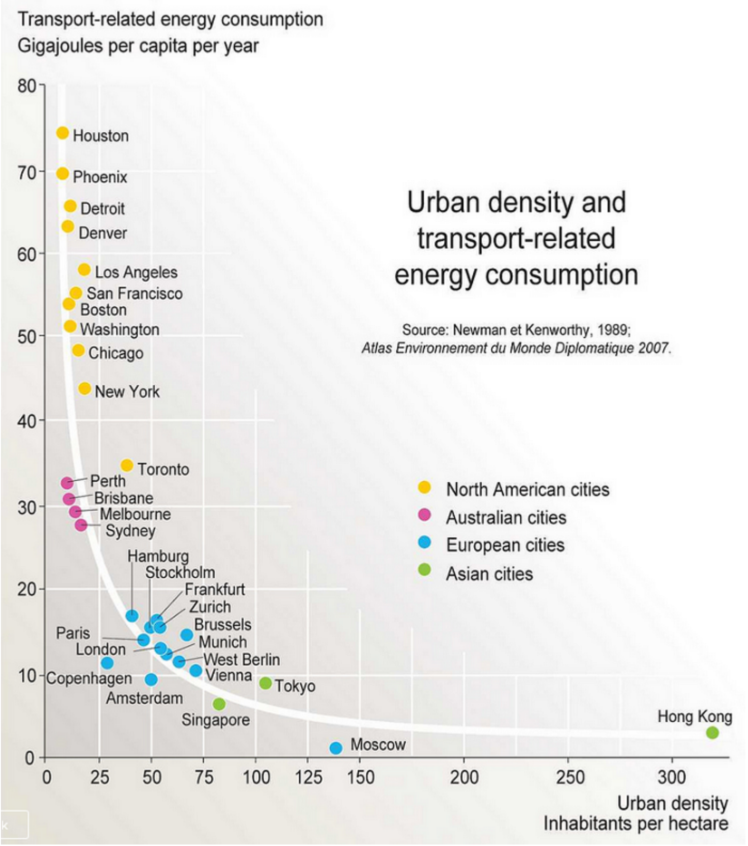
Photo source: Flickr

The most energy efficient trip is the trip not performed.

Avoid – land use and urban design

- **A 10% increase in urban density reduces per capita travel vehicle kilometer by 1% - 3%**

- **Compact development policy:**
  - Population near employment
  - Access and proximity to transit
  - Mixed-use development
  - Pedestrian, bicycle, transit-friendly design

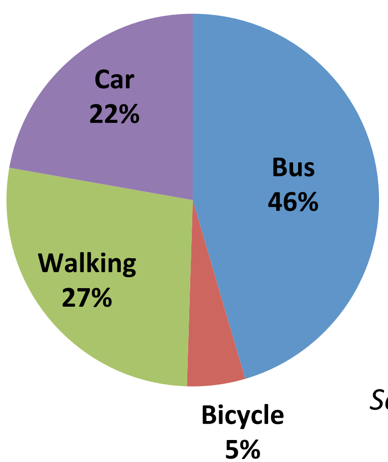


Avoid – land use and urban design

Example: Curitiba, Brazil

- Innovative land use planning with integrated with transport planning
- Result

Modal share



Source: IPPUC, 2009

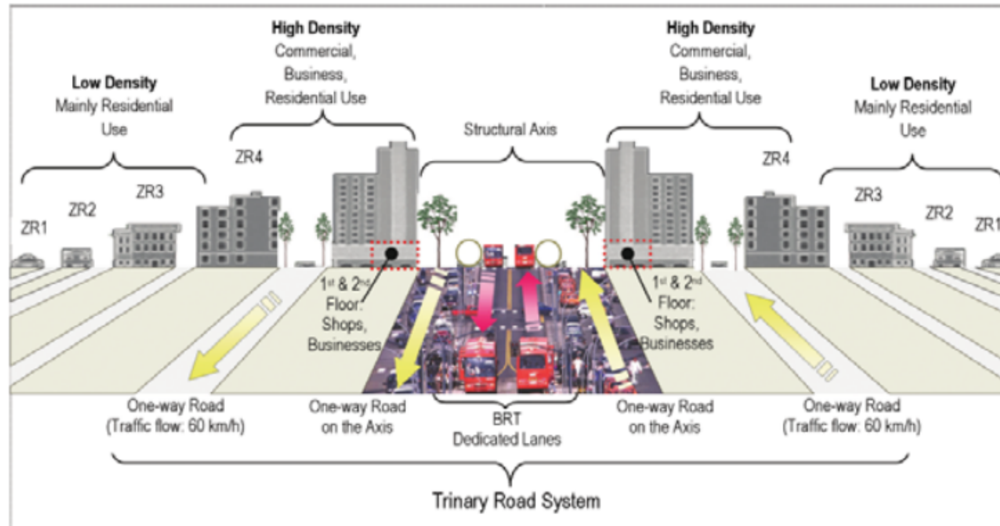


Figure 3.7 The Trinary Road System in Curitiba

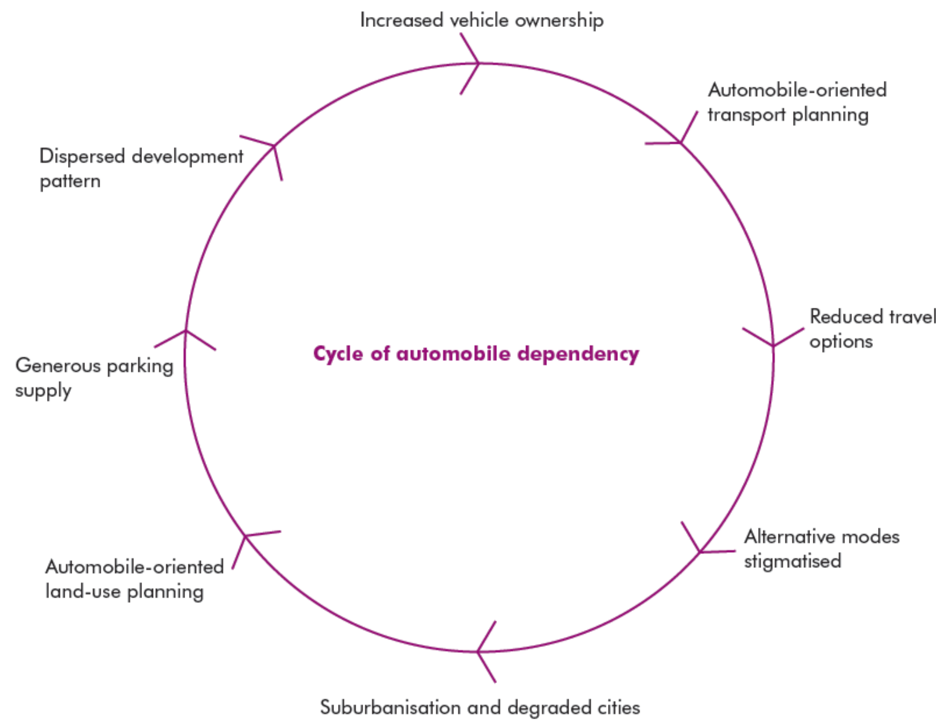
Source: Author compilation (Hinako Maruyama) based on IPPUC (2009a), Hattori (2004), and pictures supplied by IPPUC.
Note: km/h = kilometers per hour.

Source: ESMAP

Avoid – parking policies

- Cars are parked more than 90% of the time
- 2-3 spaces per vehicle
- Estimate more than 90% parking is free (US)

Figure 5.25 ▶ Cycle of automobile dependency



Source: Adapted from Litman (2008b).

Avoid – teleworking (remote commuting)

- One-day telework per week can reduce (in principle) commuting related vehicle travel by as much as 20%.
- Local regulations should not inhibit teleworking.
- Marginal cost of vehicle travel is high to justify telework.
- Enabling telecommunication infrastructure.

Avoid (+ Shift + Improve) – road pricing

- Stockholm congestion charge
  - Trial 1st Jan – 31st July 2006
  - Charge differed by time-of-day (€1.10, €1.60, €2.20) and levied on inward and outward journeys
  - Many exemptions (ecovehicles, taxis, public transport)
  - Increase in public transport services (7%) 4 months before start
  - Attitudes changed during trial
- London congestion charge Feb 2003-present
  - Congestion down 25% from pre-charge

Transport energy use

A. Avoid

- Land use, urban design, teleworking

B. Shift

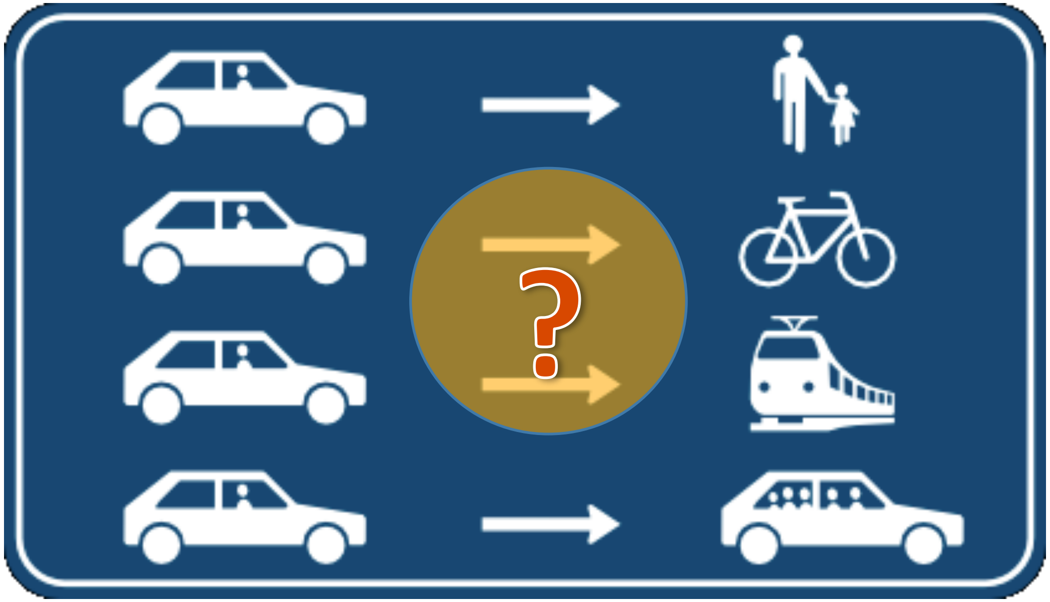
- Low carbon transport modes

C. Improve

- Efficient vehicles, technology

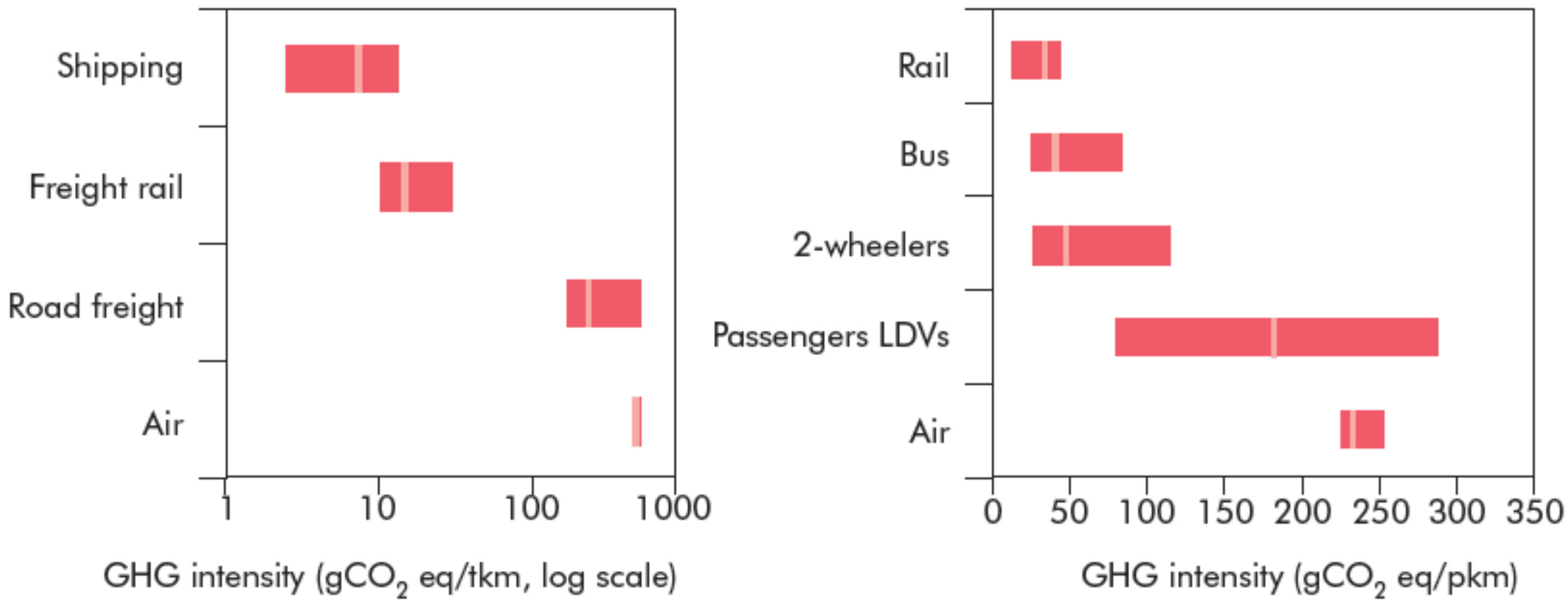
Shift transport energy use

- Aim is to use the most energy efficient mode
- Optimal mode depends on trip distance / location



Shift transport energy use

▶ GHG efficiency of different modes, freight and passenger, 2005

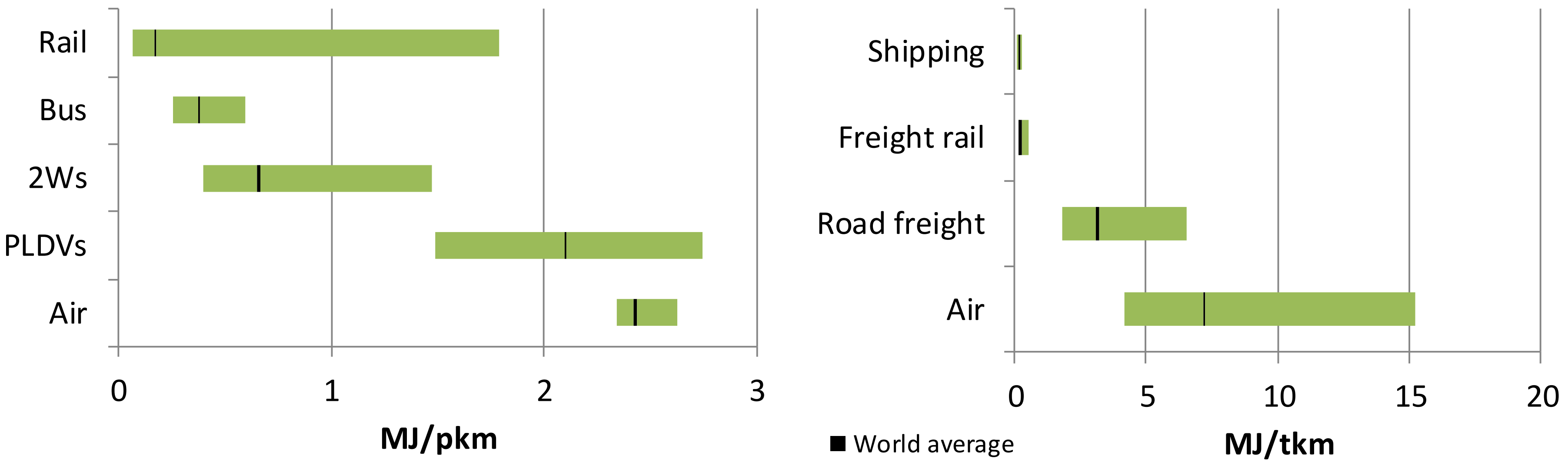


Note: The clear line indicates world average, the bar representing MoMo regions' discrepancy.

Sources: IEA Mobility Model database; Buhaug (2008).

Modal choices affect final energy demand

Energy efficiency of different modes of transport, 2010



- Air and light road passenger modes are more energy-intensive than collective passenger transport modes
- Air and light road freight modes are also more energy intensive than large road vehicles, rail and shipping

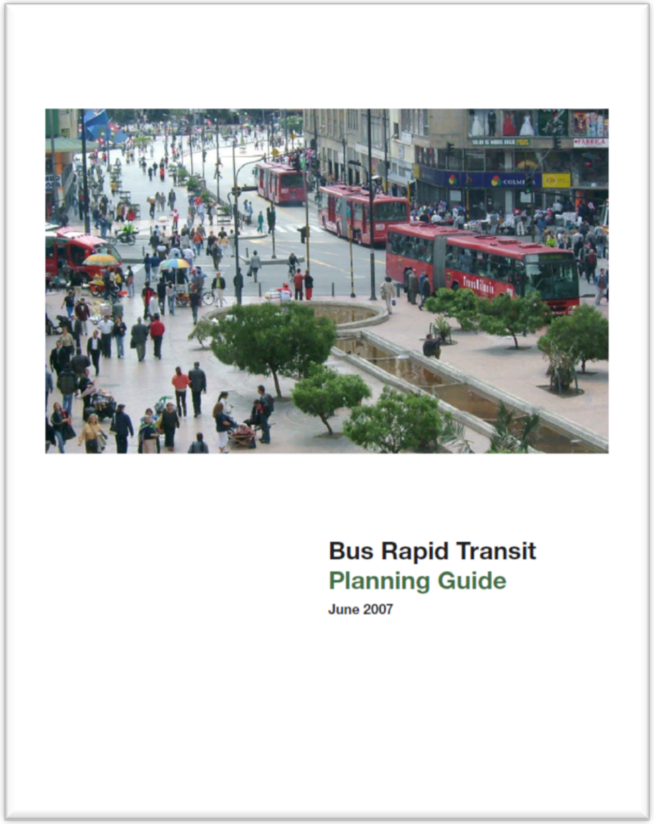
Overview of mass transit options

	Bus rapid transit	Light rail system	Metro
Capacity (Passengers per line in one hour)	10,000 to 20,000 (Sometimes going up to 40,000 Bogota BRT)	10,000 to 20,000	12,000 to 45,000 (Sometimes going up to 80,000 Hong Kong Metro)
Costs (Million USD per km of length)**	5 to 27	13 to 40	27 to 330
Existing Networks in 2011(km) **	2,139	15,000	10,000
CO_2 per passenger (gCO_2/pkm) **	14 to 22	4 to 22	3 to 21
Typical Fuel	Diesel	Electricity	Electricity

Source: ** Data from IEA, 2012 Energy Technology Perspectives 2012, rest from Newman and Salter, 2011

Shift – bus rapid transit (BRT)

- Bogota's BRT a reference: 100+ systems in world today (cities in Columbia, Ecuador, China, India, Brazil….)
- Significant CO_2 reduction - 25% - 39% (IEA estimate).
- Advantages: improved fuel efficiency, higher speeds and less stop-and-go traffic on dedicated routes

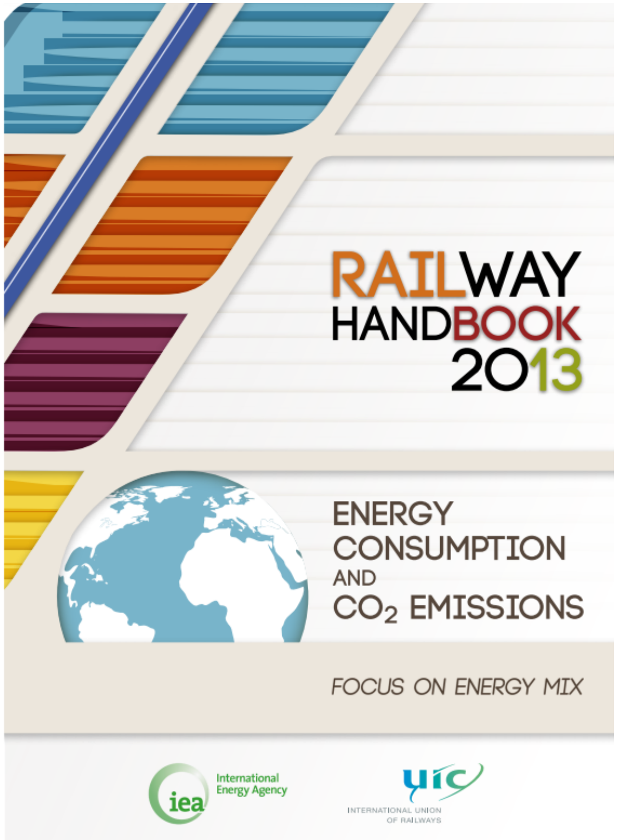


More on BRT planning and development:

https://go.itdp.org/display/public/live/Bus+Rapid+Transit+Planning+Guide

Shift – rail

- Rail carries 9% of global transport activity – but only accounts for 3% of transport energy/emissions
- Rail efficiency per pkm shrank 30% between 2000 and 2010 – and can improve more in the future
- HSR is excellent alternative to short flights – but only a handful of countries are planning new HSR lines



Check out the new UIC/IEA Rail handbook:

http://www.uic.org/spip.php?article3193

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Shift – car sharing (commuting)

- **Limitation: requires users to be within convenient distance**
- **Participation in car sharing on average reduces car travel by 3 000 km/year**
- **More formal programmes, like Paris Autolib' entering market. Risk is attracting non-drivers to programme.**

Shift – non-motorised transport (NMT)

Cycling:

- Infrastructure provisions: lanes, parking, traffic signals
- Funding / cycling mode relationship:
  - Amsterdam: US$ 39/resident, Cycling 35%,
  - USA: US$ 1.5/resident, Cycling 1%.
- Bicycle "sharing" (rental) services
- Viable alternative for short trips
- Best promoted for densely populated city centers

Shift – non-motorised transport (NMT)

Walking:

- **Pedestrian infrastructure, amenities and services are often neglected.**
- **Pedestrian friendly policies:**
  - **Safe sidewalks**
  - **Well marked, respected crossings**
  - **Car-free zones**
  - **Traffic calming measures**
- **Walkability Index: modal conflict, security from crime, crossing safety, motorist behavior, benches and street lighting, etc.**

Transport Energy Use

A. Avoid
- Land use, urban design, teleworking

B. Shift
- Low carbon transport modes

C. Improve
- Efficient vehicles, technology

Improve transport energy use

- Technology efficiency policy
  - Standards
  - Alternative technology
  - Components

Technology leapfrogging

- Behavioural policy
  - Promotion & awareness
  - Incentives for cleaner vehicles

Improve – IEA recommendations

5.1 Fuel-efficient tyres

- Labelling on tyre rolling resistance
- Tyre pressure monitoring systems (TPMS)

5.2 Fuel efficiency standards for light-duty vehicles

5.3 Fuel efficiency standards for heavy-duty vehicles

5.4 Eco-driving

- Driver training
- In-car feedback instruments

Overview of Regulation Specifications

Country or Region	Target Year	Standard Type	Unadjusted Fleet Target/Measure	Structure	Targeted Fleet	Test Cycle
U.S.(include California) (enacted)	2016	Fuel economy/ GHG	34.1 mpg* or 250 gCO_2/mi	Size-based corporate avg.	Cars/Light trucks	U.S. combined
U.S. (enacted)	2025	Fuel economy/ GHG	49.1 mpg** or 165 gCO_2/mi	Sizewbased corporate avg.	Cars/Light trucks	U.S. combined
Canada (enacted)	2016	GHG	153 (157)*** gCO_2/ km	Size-based corporate avg.	Cars/Light trucks	U.S. combined
EU (enacted) EU (proposed)	2015 2020	CO_2	130 gCO_2/km 95 gCO_2/km	Weight.-based corporate average	Cars/SUVs	NEDC
Japan (enacted) Japan (enacted)	2015 2020	Fuel economy	16.8 km/L 20.3 km/L	Weight-class based corporate average	Cars	JC08
China (enacted) China (under study)	2015 2020	Fuel economy	6.9 L/100km 5 L/100km	eight-class based per vehicle and corporate average	Cars/SUVs	NEDC
South Korea (enacted)	2015	Fuel economy/ GHG	17 km/L or 140 gCO_2/ km	Weight-based corporate average	Cars/SUVs	U.S. combined
Mexico (enacted)	2016	Fuel economy/ GHG	35.1 mpg or 157 g/ km	Size-based corporate avg.	Cars/Light trucks	U.S. combined
Brazil (enacted)	2017	Fuel economy	1.82 MJ/km	Weight-based corporate average	Cars	U.S. combined
India (proposed)	2016 2021	CO_2	130 g/km 113 g/km	Weight-based corporate average	Cars/SUVs	NEDC

FIGURE 9 HDV Global Regulatory Landscape
(Items in blue are ICCT expectations (not public announcements))

Country/ Region	Regulation Type	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Japan	Fuel economy						Phase 1 regulation implemented starting MY 2015					
United States	GHG/ Fuel efficiency	Standard proposal	Final rule		Phase 2	Regulation implemented starting MY 2014 (mandatory DOT program starts MY 2016)						Phase 2 implementation
China	Fuel consumption	Test procedure finalized	Industry standard proposal	Industry standard implemented	National standard adopted		Regulation implemented starting MY 2015					
European Union	CO2 test procedure	Technical studies			Impact assessment/ Test procedure finalized					Policy implementation		
Canada	GHG			Standard proposal	Final rule	Regulation implemented starting MY 2014						Phase 2
Korea	Fuel efficiency	Technical studies			Impact assessment	Test procedure finalized	Poicy implementation (second half of 2015)					
Mexico	Fuel efficiency				Proposal			Regulation implemented starting MY 2016				Phase 2 implementation
California	End-user requirements	Requirements for new tractors, trailres (2011+)			Additional reqs. for existing tractors and trailers (<MY 2010)				Additional reqs. for existing trailers and reefers (<MY 2010)			

Source: GFEI (2014)

Global Fuel Economy Initiative

TARGETS

		2005	2008	2011	2030
OECD average	average fuel economy (Lge/100km)	8.1	7.6	7.0	
	annual improvement rate (% per year)	-2.2% (2005–2008)		-2.7% (2008–2011)	
		-2.4% (2005–2011)			
Non-OECD average	average fuel economy (Lge/100km)	7.5	7.6	7.5	
	annual improvement rate (% per year)	0.4% (2005–2008)		-0.6% (2008–2011)	
		-0.1% (2005–2011)			
Global average	average fuel economy (Lge/100km)	8.0	7.6	7.2	
	annual improvement rate (% per year)	-1.7% (2005–2008)		-1.8% (2008–2011)	
		-1.8% (2005–2011)			
GFEI target	average fuel economy (Lge/100km)	8.0			4.0
	annual improvement rate (% per year)	-2.7% (2005–2030)			
		2012 base year →			-3.0%

THE GFEI FUEL ECONOMY TARGETS
From 2005 baseline:

- **30%** reduction in L/100km by 2020 in all new cars in OECD countries
- **50%** by 2030 in all new cars globally
- **50%** by 2050 in all cars globally

- **2030: new light vehicle fuel consumption/km 50% better than in 2005**
- **2050: stock-average light vehicle fuel consumption/km 50% better than in 2005**

Improve – other policy measures

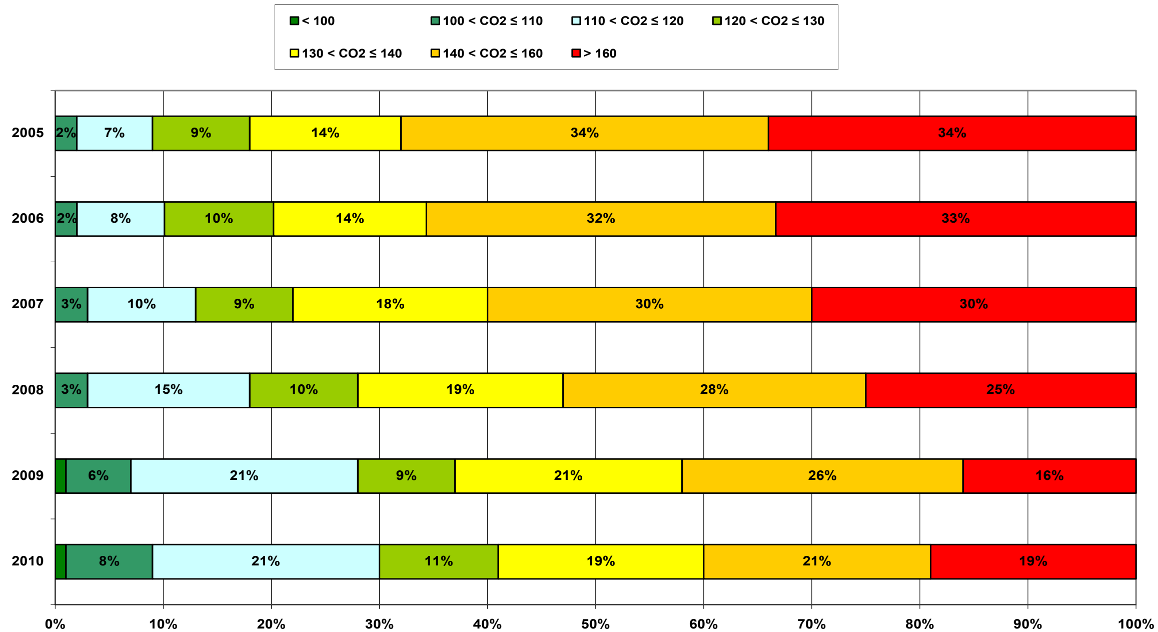
- Fuel switching
- Electric vehicles
- Pricing, subsidies and incentives

Improve – fuel pricing

- Fuel prices strongly influence “driving culture”
  - Countries with higher fuel prices drive smaller cars and less
- Fuel subsidies skew market and are inequitable

Improve – taxes and incentives

- CO_2-differentiated purchase, registration and ownership fees, annual circulation (mileage) tax
- Scrappage schemes, feebates
- Special tax credits for hybrid or electric vehicles



Change in sales by CO2 classes (5 main EU markets) (Source AAA – Renault)

Improve – potential rebound effects

- As cars become more efficient, mileage is rising
  - Cost of use should rise accordingly
- High up-front costs may lead to willingness to use vehicles, no matter the cost of use
- Technological answers have to be implemented with accompanying measures to counter balance negative effects

Avoid – review

- Building cities from scratch is not often possible
- Timeframe to alter urban design is usually very long
  - Bigger effects to be seen in the long term
- Dense environments with good transit use less energy
- Energy and GHG savings potential enormous as life style are altered for generations
- Policy changes not always easy – often a cultural change

Shift – review

- Getting people out of their cars is not easy
- Potential efficiency from shifts is large
- Many programmes can be low-cost and highly effective
- Risk of rebound effects
  - Typically, these are still offset by efficiency gains
- Building access/choice critical to successful shifting
- Consumer behaviour changes can require incentives

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Improve – review

- Improve is major component of improving transport energy efficiency and reaching emissions targets
- Many technologies commercially available and cost effective – better policies and regulation needed to push market
- Other technologies need to be brought to market; cost/ subsidies/incentives can help achieve this
- Policies should address demand/rebound effects

Overcome financing challenges

- Key questions
  - What can be funded through users?
    - E.g. Fuel economy, new tire manufacturing standards
  - How to re-direct public sector funding towards multi-modal infrastructure services
    - National gov. co-finance, centralised funding arrangements
  - How to tap private sector?
    - Bond financing: traditional, climate, social impact bonds

Source: Partnership on Sustainable Low Carbon Transport (2014)

Transport roadmaps

- Biofuels for transport
- Electric and plug-in hybrid vehicles
- Fuel economy of road vehicles
- Hydrogen (in preparation)

Transport policy pathways

- Improving the fuel economy of road vehicles

Focus in the "improve" component of our low carbon scenarios

Global Fuel Economy Initiative

GLOBAL FUEL ECONOMY INITIATIVE
www.globalfueleconomy.org

Six core partners: FIA Foundation, UNEP, IEA, ITF, ICCT and UC Davis, financial support from GEF and EU

GFEI recognized as leading initiative in energy and climate reports and discussions

FIA Foundation for the Automobile and Society
UNEP
UCDAVIS INSTITUTE OF TRANSPORTATION STUDIES
iea International Energy Agency
icct THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION
International Transport Forum

Global Fuel Economy Initiative

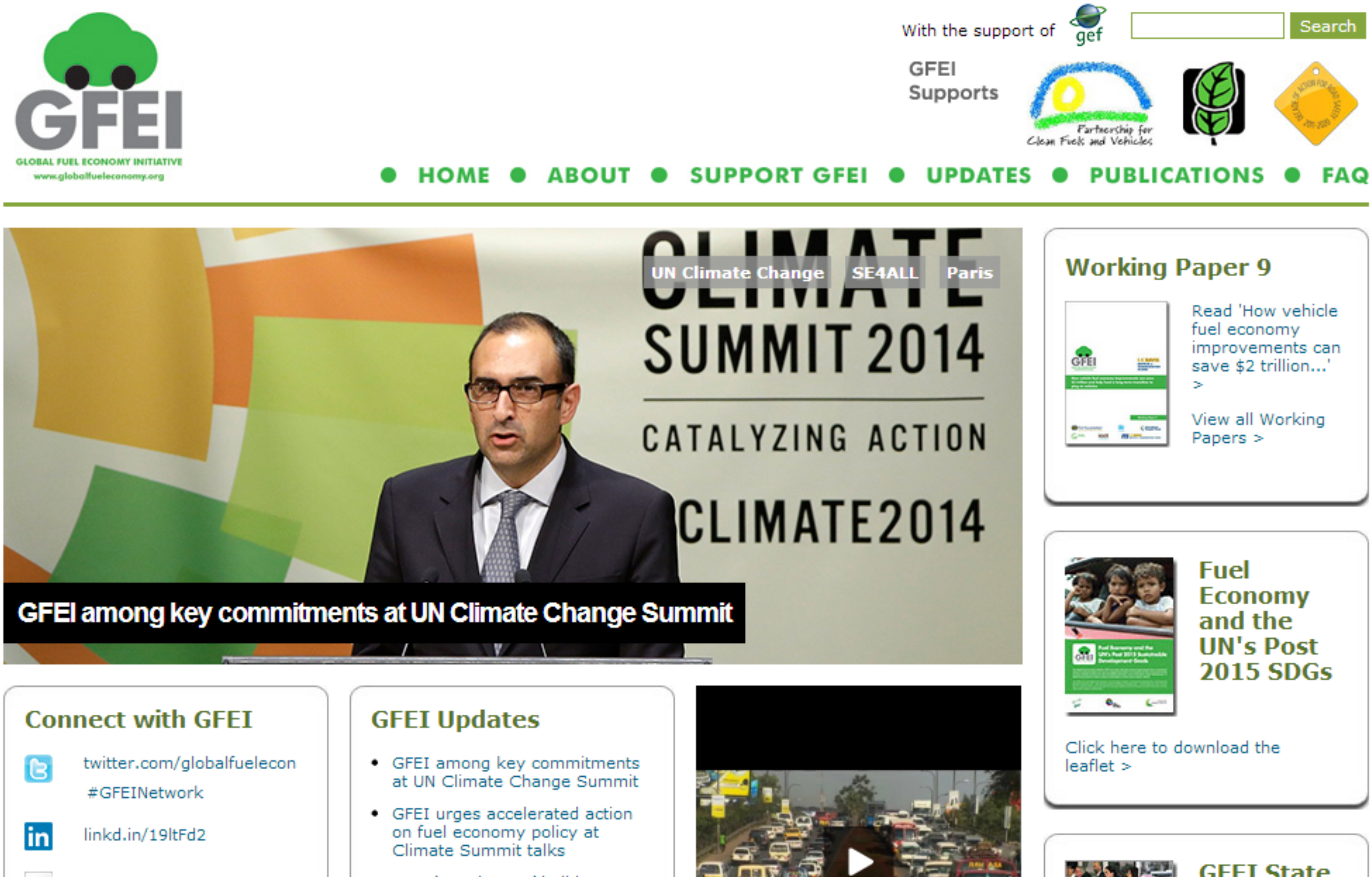
"How can we maximize the benefits of fuel efficiency in LDVs on a global scale, given the projected expansion of the global fleet?"

- Analysis: data gathering, modeling, baseline development, projections
- Evaluation: policy tools and options
- Strategy development: organization of dialogues
- Outreach: Awareness raising, communication

RESEARCH

IN-COUNTRY POLICY SUPPORT

GLOBAL CAMPAIGNS



Biofuels for transport

Technology roadmap

Bioenergy from heat and power roadmap: primary bioenergy demand in low-carbon ETP scenario increasing from 3 EJ today to 160 EJ in 2050; 100 EJ for generation of heat and power, the includes the supplies used for the 27 EJ of final energy demand in transport in 2050

Key points

- Long-term biofuel use in transport focused on modes with lower chances to access to electrification (aviation, shipping and road freight)
- Advanced biofuels crucial for sustainability aspects. Cost reductions necessary.
  - Need for sound policy framework for issues related with direct and indirect land use change, trade will be increasingly relevant
  - **Need for support to bridge research gap, development of scaled-up demonstration facilities, as well as deployment investment**

Electric and plug-in hybrid vehicles

Technology roadmap

Focus on light vehicles (higher chances to electrify)

Roadmap vision: industry and governments should attain a combined EV/PHEV sales share of at least 50% of light vehicle sales by 2050

2020: target of 20 million PHEVs/BEVs on the road

Key points

- PHEV/BEV stock in 2013 was 50 times smaller than 2020 target above, but 2013 global sales were 210k, nearly double than in 2012*
- Policy support critical: cost-competitiveness (battery costs 1st target) and provision of adequate recharging infrastructure (links to smart grids and the vehicle-grid interface)
- Improved understanding of consumer needs, desires, behavior needed
- Global EV sales more than doubled between 2011 and 2012

* Source: ICCT, 2014

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Fuel economy of road vehicles

Technology roadmap

Addressing both light duty and heavy duty vehicles

<u>Key points</u>

- Investing in fuel economy is cost-effective
- Most technologies already commercially available, some need additional research to become commercially viable
- Market uptake low due to a number of barriers
- Potential improvement by 2030 ranges from 30% to 50%
- Heavy vehicles: potential lower/costs higher than for light vehicles, but
  - Heavy duty vehicle mileage higher than cars (larger fuel savings)
  - Percentage cost increase for fuel efficient technologies on heavy duty vehicles is similar to passenger cars

Hydrogen

Technology roadmap

- Attempt to give more detailed insights on how hydrogen could contribute to decarbonizing the energy system in order to achieve a 2 degree Celsius target
- The main focus of the roadmap will be on energy demand applications:
  - **Transport sector including a special focus on hydrogen transmission, distribution and retail infrastructure**
  - **Large scale energy storage and energy integration aspects**
  - **Hydrogen in the buildings sector**
  - **Hydrogen in the industry sector**
- Aims at providing a broader view integrating possible sectoral synergies

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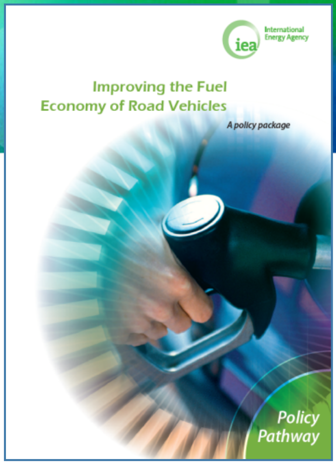


Fuel economy of road vehicles

Policy pathway

Addressing both light duty and heavy duty vehicles

Includes a case study on Japanese HDV fuel economy standards

Policy focus: tested fuel efficiency (not in-use operation)

<u>Key points</u>

- Improving the efficiency of existing vehicles impractical and costly: the focus must be on new registrations
- Best practice is to adopt an integrated approach combining three policy elements:
  - fuel economy and/or CO_2 emissions labelling/information
  - vehicle fuel economy and/or CO_2 emission standards/regulations
  - fiscal measures such as vehicle taxes/incentives and fuel taxes
- Four steps: plan, implement, monitor, evaluate
- Best mix and prioritization depend on specific circumstances

Global Campaigns:

Rio+20

GFEI made a commitment as part of SLoCat's transport group

G20

Energy Efficiency is a key component - Working with US Government/Australia

SE4ALL

GFEI is a High Impact Opportunity under the Se4ALL Initiative, and as such has had success as part of the SDG development process

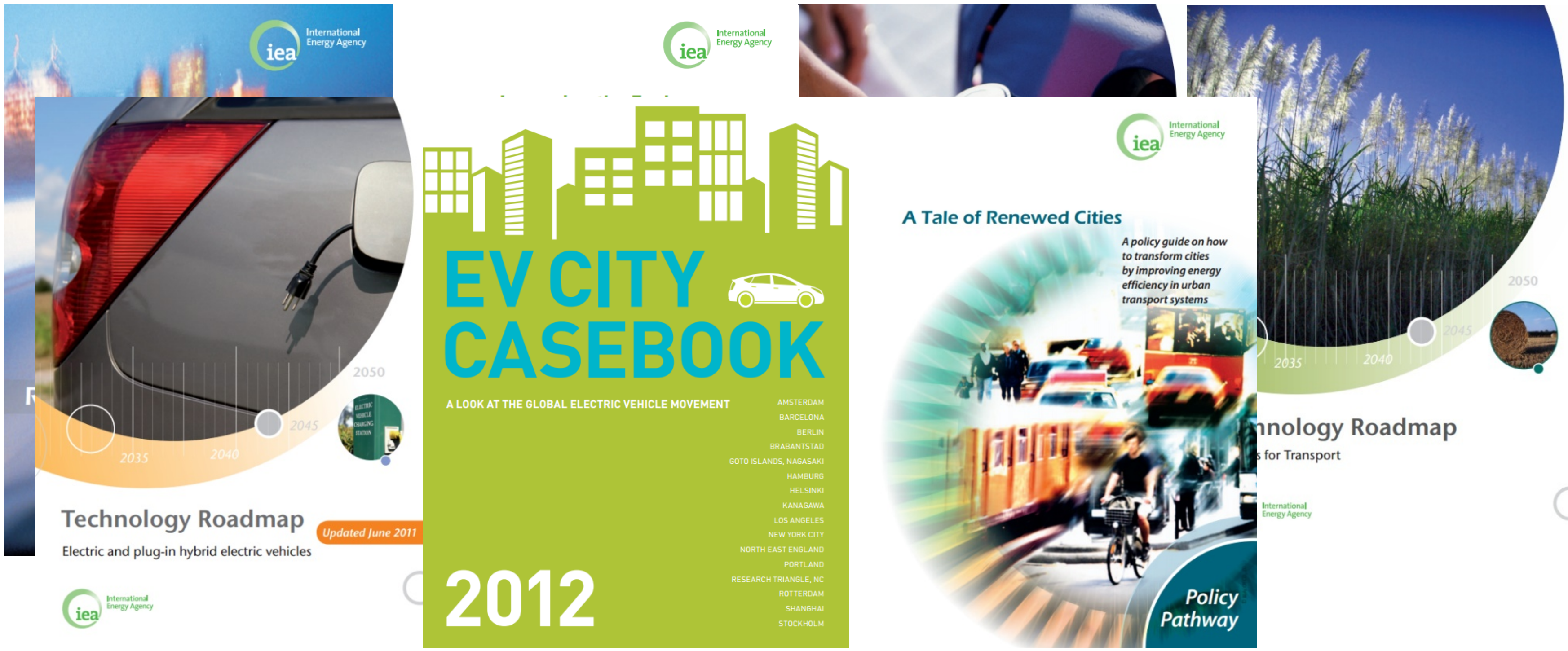
Sec Gen. Climate Summit

GFEI is an accelerator at the Sec Gen's Climate Summit

POST 2015 Framework

GFEI is supporting an energy band transport target on fuel economy/efficiency

Resources



IEA Policy Pathway Series: http://www.iea.org/publications/policypathwaysseries/

IEA Technology Roadmaps: https://www.iea.org/roadmaps/

National target setting examples

- GFEI: Public-private partnership to double vehicle efficiency
- UIC: 50% reduction in CO2 emissions from train operations by 2030, and 75% reduction by 2050 (specific average CO2 relative to a 1990 baseline – ie. reduction of emissions per passenger/km + tonne/km)
- UITF: Double the market share of public transport use around the world by 2025
- UEMI: Increase the market share of electric vehicles in cities to least 30%, of all new vehicles (incl. cars and motorized 2-3 wheelers) sold on annual basis by 2030