IEA decarbonisation pathways and transport modelling; the Mobility Model

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WWF – Science-based targets

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The IEA Mobility Model (MoMo) – What is it?

The analytical tool used for projections of transport activity, energy demand and CO_2 emissions

The foundation of transport-related analysis in the IEA

An essential tool for activities on:

- Energy Efficiency: Global Fuel Economy Initiative (GFEI)
- Energy Technology: Electric Vehicle Initiative (EVI)
- Cooperative Efforts: Railway Handbook on Energy Consumption and CO_2 emissions with International Union of Railways

MoMo is shared with:

- other Directorates in the IEA (e.g. WEO; EEfD)
- the International Transport Forum, who uses it for the formulation of its Transport Outlook
- "MoMo partners", i.e. sponsors – mainly from the private sector – that provide Voluntary Contributions and/or in-kind help

The IEA Mobility Model (MoMo) – What is it?

A spreadsheet model of global transport

- focus on vehicles & energy use, but also covers emissions, infrastructure & materials use
- Analysis of scenarios and projections to 2050 (mostly back-casting and “what-if”)

World is divided in 29 regions, including several specific countries

- All G20 countries except Saudi Arabia, as well as regional blocks (e.g. ASEAN, EU and non-EU Nordics, EU 7, Latin America, sub-Saharan Africa, OETE…
- Urban and non-urban disaggregation (following UN and national definitions)

MoMo contains a large amount of data on technology and fuel pathways

- Full evaluation of life-cycle greenhouse gas emissions: with and without (I)LUC
- Cost estimates for new light-duty vehicles (LDV), fuels and fuel taxes
- Estimates of transport sector expenditures to 2050: vehicles, fuels and infrastructure
- Module on material requirements for LDV manufacturing

The MoMo historical database - Data sources:

IEA statistics: country-level energy demand by mode (road, rail, aviation, shipping) and by fuel over time.

Road: Country-level data on stock, new registrations, mileage and fuel economy, urban & non-urban resolution. Main focus of the model due to high energy use.

- Passenger and Freight modes: 2- & 3-wheelers, PLDVs, LCVs, MFTs and HFTs.
- Sources: national statistical offices, vehicle manufacturers associations, vehicle registers, ministries, statistical yearbooks…

Rail: country level data from UIC, urban from UITP and ITDP datasets combined

- Rail: light rail, metro, heavy rail (electric, diesel)

Aviation: data from ICAO and JADC, as well as Boeing, Airbus, ICCT

- Commercial aircraft

Shipping: activity from UNCTAD, IMO, activity projections based on ITF modelling

- International maritime ships (container, general cargo, oil tankers, bulk carriers, other)

Mobility Model scenarios – ASIF

ASIF (Activity, Structure, Intensity → Fuel use) approach

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

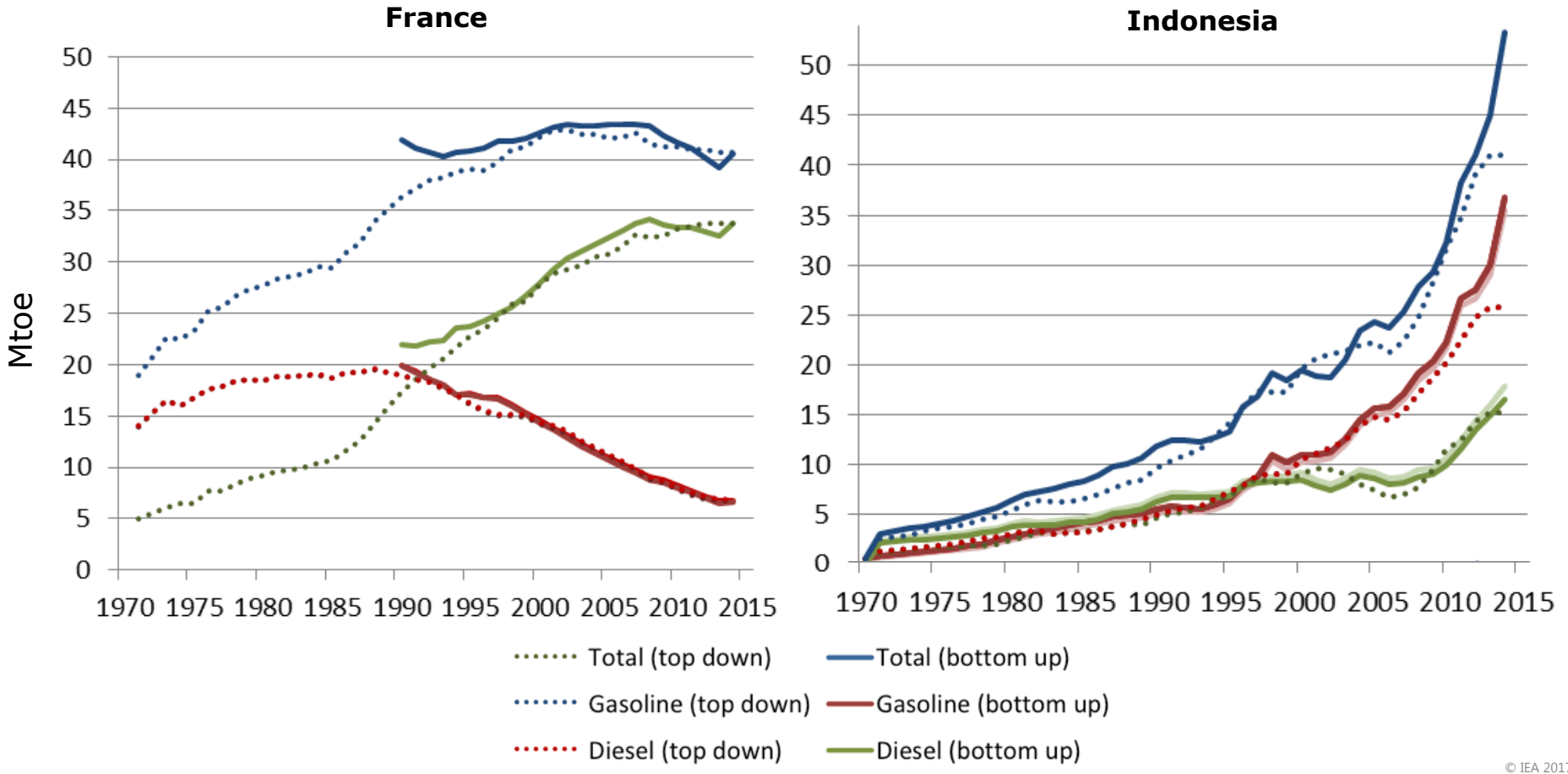
… allow the estimation of ***F****uel consumption*

The calculation is based on Laspeyres identities

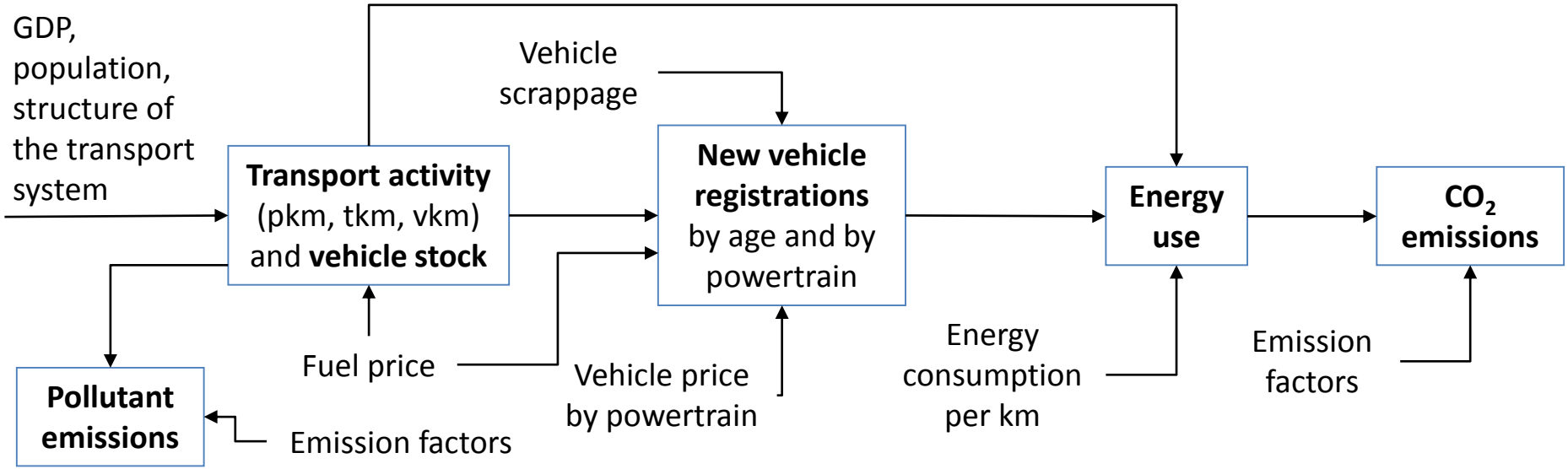
$$F = \sum_i F_i = A \sum_i \left(\frac{A_i}{A}\right)\left(\frac{F_i}{A_i}\right) = \boxed{A \sum_i S_i I_i = F}$$

F	total ***F***uel use
A	vehicle ***A***ctivity (expressed in *vkm*)
F_i	fuel used by vehicles with a given set of characteristics (***i***) (e.g. segments by service, mode, vehicle and powertrain)
$A_i/A = S_i$	sectoral ***S***tructure (same disaggregation level)
$F_i/A_i = I_i$	energy ***I***ntensity, i.e. average fuel consumption per *vkm* (same disaggregation level)

Calibration of historical data

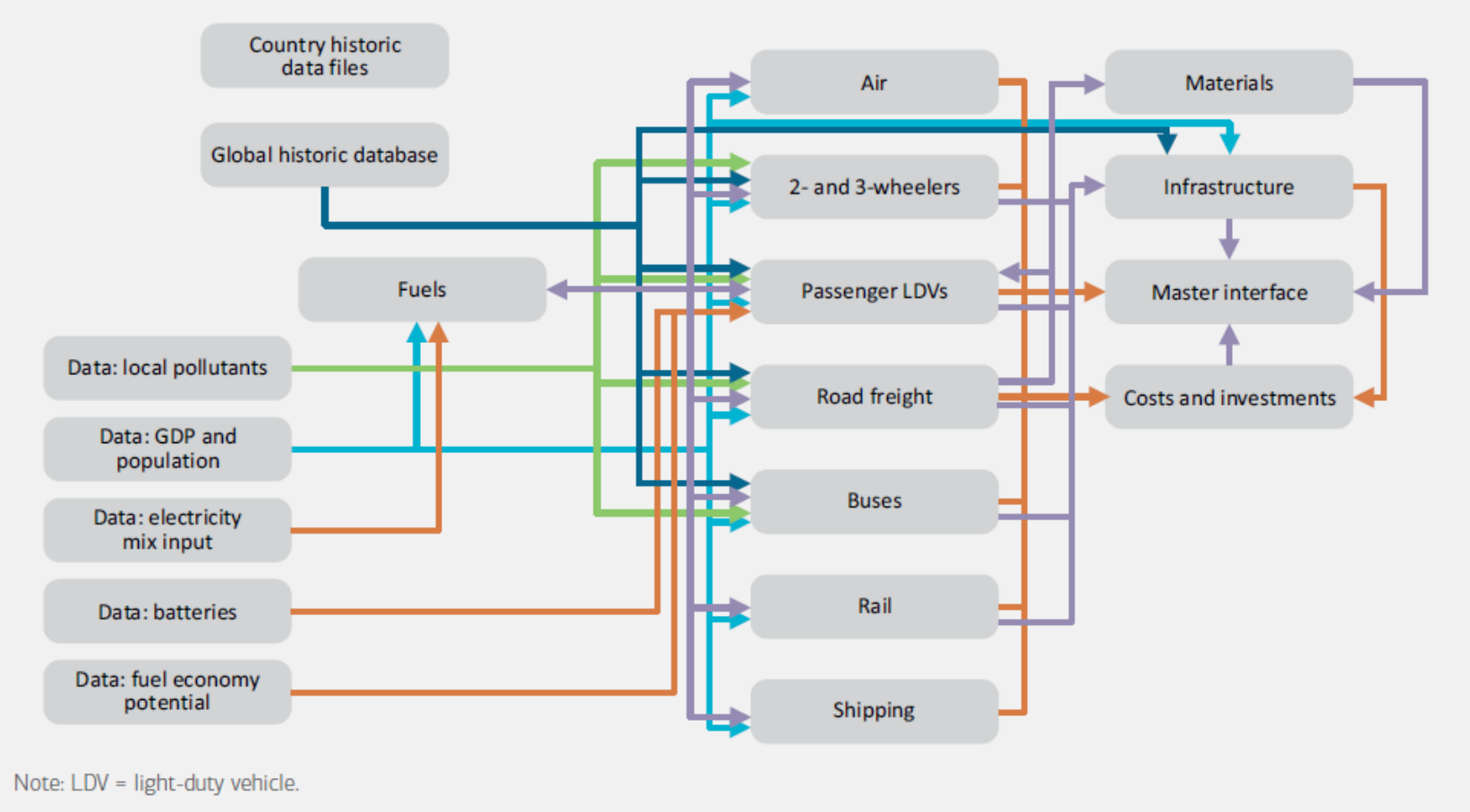


The IEA Mobility Model (MoMo) – Model structure



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

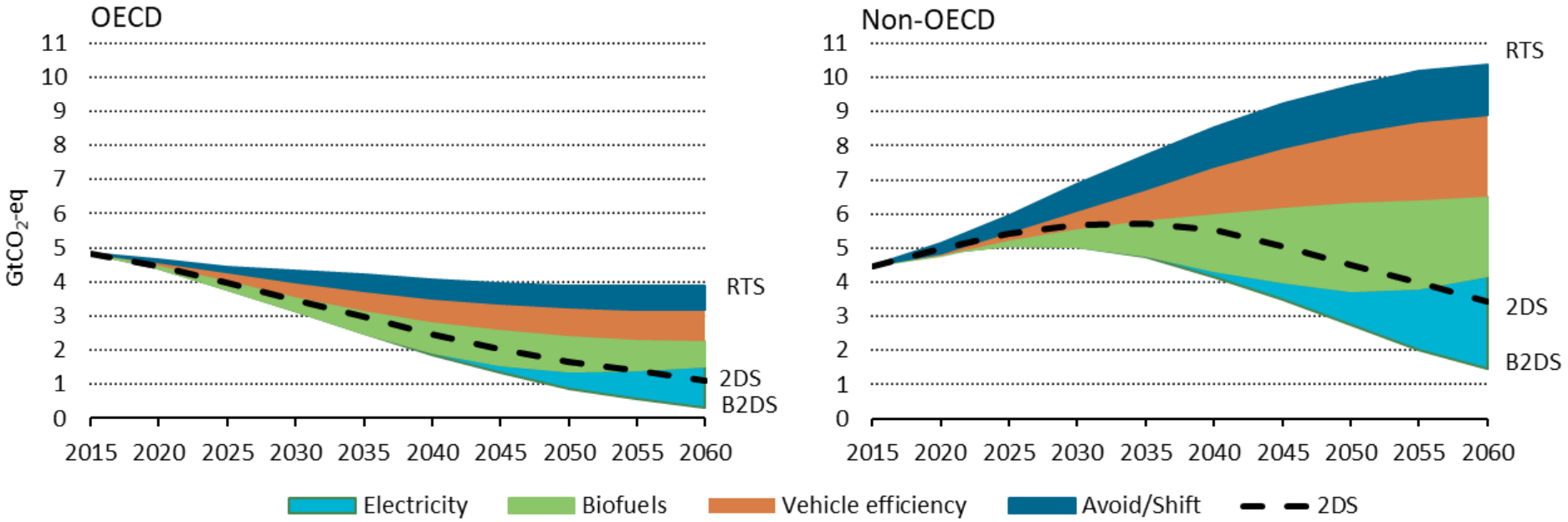
The IEA Mobility Model – a network of spreadsheets



Note: LDV = light-duty vehicle.

Measures are needed across the developed and developing world

Well-to-wheel greenhouse gas emissions in OECD and non-OECD countries by scenario, 2015-2060



Achieving the B2DS target requires OECD countries to reduce WTW GHG emissions by 90% and non-OECD countries by 66% from 2015 levels by 2060.

Analytical capabilities

MoMo has a user interface that allows

- What-if scenario building and back-casting
- Use of elasticities for ownership and mileage
- Mode shift scenario building for passenger travel

MoMo also estimates material requirements and emissions:

- Analysis of future vehicle sales (e.g. fuel cells) and how they impact materials requirements (e.g. precious metals) is possible (needs updating)
- Full life-cycle analysis for GHG emissions from LDVs (including manufacturing) can be calculated

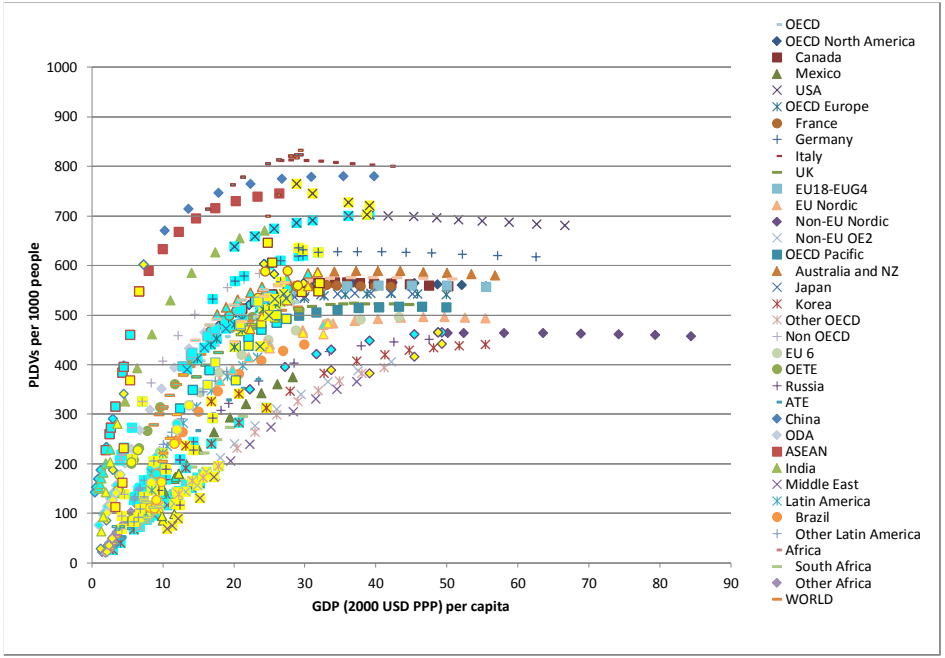
Recent MoMo capacity developments include

- Urban & non-urban travel splits using data from a global set of mobility surveys
- Land transport infrastructure requirements in support of travel demand growth
- Fuel cost, T&D, storage and distribution infrastructure assessment
- Cost estimations from vehicle, fuel and infrastructure investments

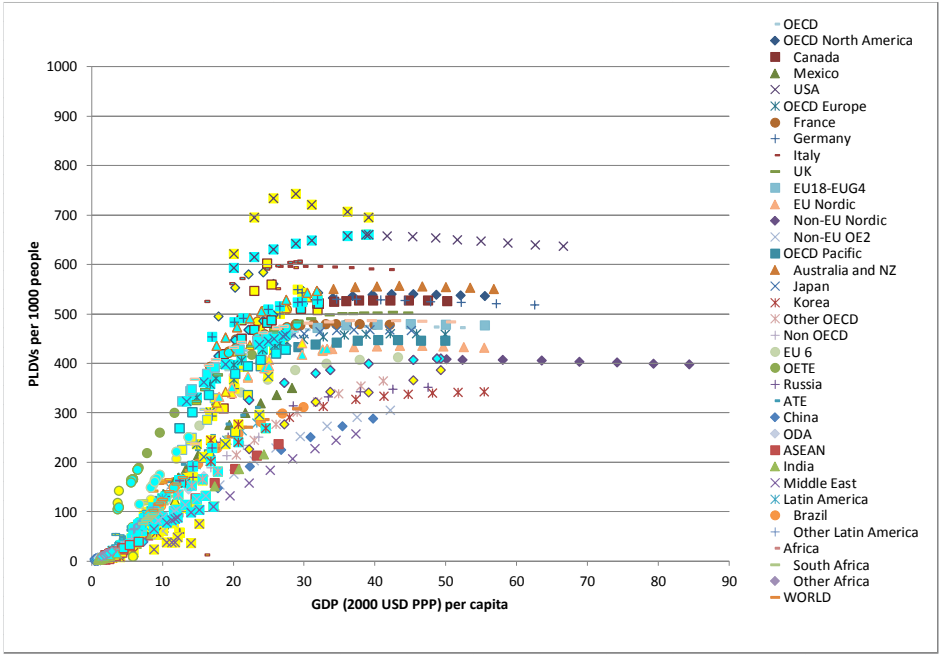
Passenger demand generation

Ownership – data shown refer to urban areas

Personal vehicles



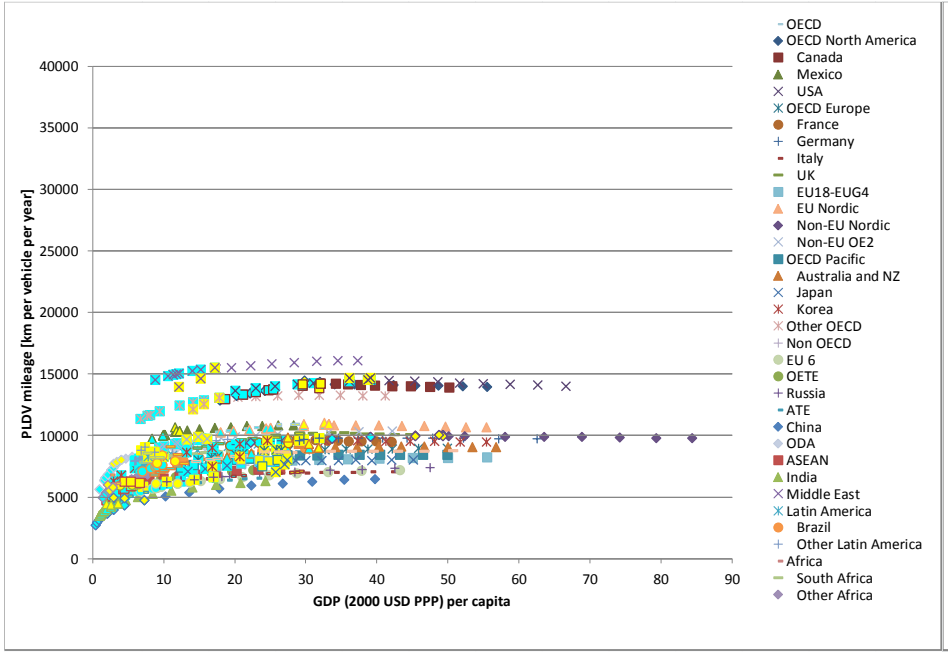
PLDVs



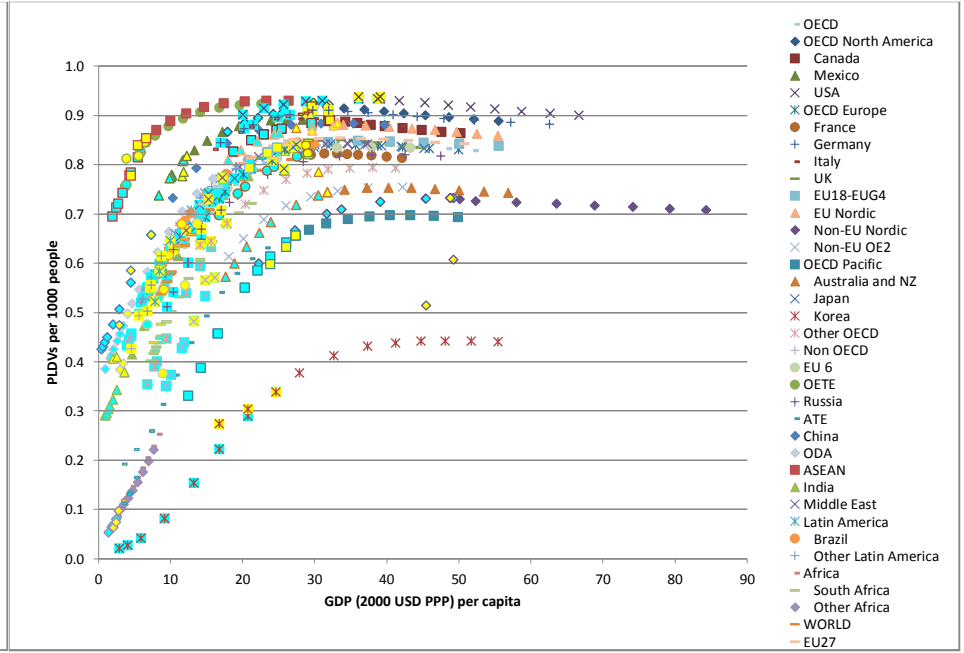
Passenger demand generation

Other relationships (selected examples) – urban data

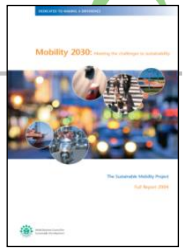
Personal vehicle mileage



Pkm share on PT



A brief history of the Mobility Model (MoMo)

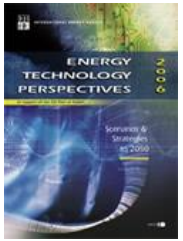


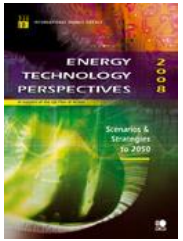
2003 World Business Council for Sustainable Development and the Sustainable Mobility Project (SMP) transport model

Scenarios exploring transport energy use, CO_2 & pollutant emissions, safety & materials use

2004 SMP model developed further as IEA Mobility Model (MoMo)

MoMo data used for the IEA ETP analysis and ETP 2006





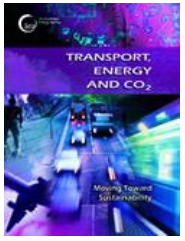
2006-2008

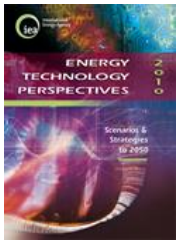
Deeper analysis of vehicle technology potential, including plug-in hybrid electric vehicles (PHEVs)

Elasticities of travel and ownership with respect to GDP and oil prices

Integration of significant historical data in MoMo

Development of scenarios for the IEA Energy Technology Perspectives (ETP) project in 2008





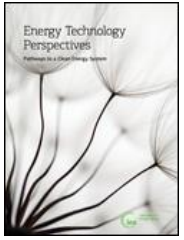
2008-2012

Improved user friendliness and detailed modular approach

Expanded coverage of countries and regions

Development of modal shift scenarios

Vehicle, fuel and infrastructure costs associated to scenario



2013+ Progressive transition to systems dynamics platform

Assessment of urban transport activity and potential

Who supports the work? MoMo partners

- MoMo is supported by a "partnership" - i.e. sponsors – mainly from the private sector – providing Voluntary Contributions and/or in-kind help

Supplemental Slides

What is urban?

- **The United Nations:**
  - "The traditional distinction…based on the assumption that urban areas… provide a different way of life and usually a higher standard of living than…rural areas."
  - "this distinction has 'blurred' in many industrialized countries, and **population density** has replaced socio-economic status as the main feature distinguishing urban from non-urban regions."

Global Population Density