3. Toolkit

Data to support policy making and evaluation

Transport: Session 3

Jakarta, 17 July 2018

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Presentation Outline

1. What data do you need?
2. Where to find data?
3. Transport data collection methods
4. Policy and project evaluation

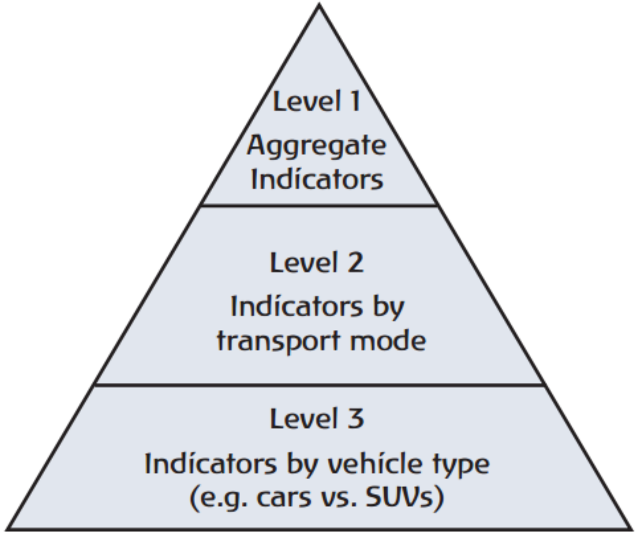
What data do you need?

ASIF approach to estimate energy consumption from road vehicles

Transport energy efficiency indicators to support policy making and evaluation

Using energy efficiency indicators for policy making

Figure 6.5 • Detailed indicators pyramid for passenger transport



How much does the transport sector contribute to a country's energy demand?

Is freight transport more energy efficient by ship or by rail?

What are the implications from the trend to larger passenger cars for transport energy demand?

Using energy efficiency indicators faces a trade off between usefulness of information and data collection requirements

The ASIF approach of IEA's Mobility Model (MoMo)

Distance travelled × **Vehicle stock** × **Energy intensity** = **Energy consumption**

- 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 to calculate ***F****uel consumption*

The ASIF approach of IEA's Mobility Model (MoMo) makes possible to estimate transport fuel consumption by vehicle type and fuel

Linking activity and fuel use – ASIF approach

Distance travelled × Vehicle stock × Energy intensity = Energy consumption

Energy consumption × Emission factor = Transport GHG emissions

The ASIF approach makes possible to estimate transport fuel consumption at sector level

Apply emission factors to quantify climate impacts of fuel consumption

ASIF Approach: Linking Activity and Fuel Use

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)
$A_i/A = S_i$	sectorial ***S***tructure (same disaggregation level)
$F_i/A_i = I_i$	energy ***I***ntensity, i.e. the average fuel consumption per *vkm* (same disaggregation level)

ASIF Approach: Linking Activity and Fuel Use (Extended)

The same methodological approach used for the calculation of fuel consumption (ASIF) can be extended to evaluate CO_2 emissions.

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

$$E = \sum_i E_i = A \sum_i \frac{A_i}{A} \times \frac{F_i}{A} \times \frac{F_{ij}}{F_i} \times \frac{E_{ij}}{F_i} = \boxed{A \sum_i S_i I_i EF_{ij} = E}$$

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

ASIF Approach: Well-to-wheel versus tank-to-wheel

Well-to-wheel: tank-to-wheel emissions + well-to-tank emissions

Using the example of biofuels…

Well-to-wheel

well-to-tank emissions

Production → Logistics → Processing → Distribution → End Use





tank-to-wheel emissions

Aggregate indictors provide limited insight for policy making

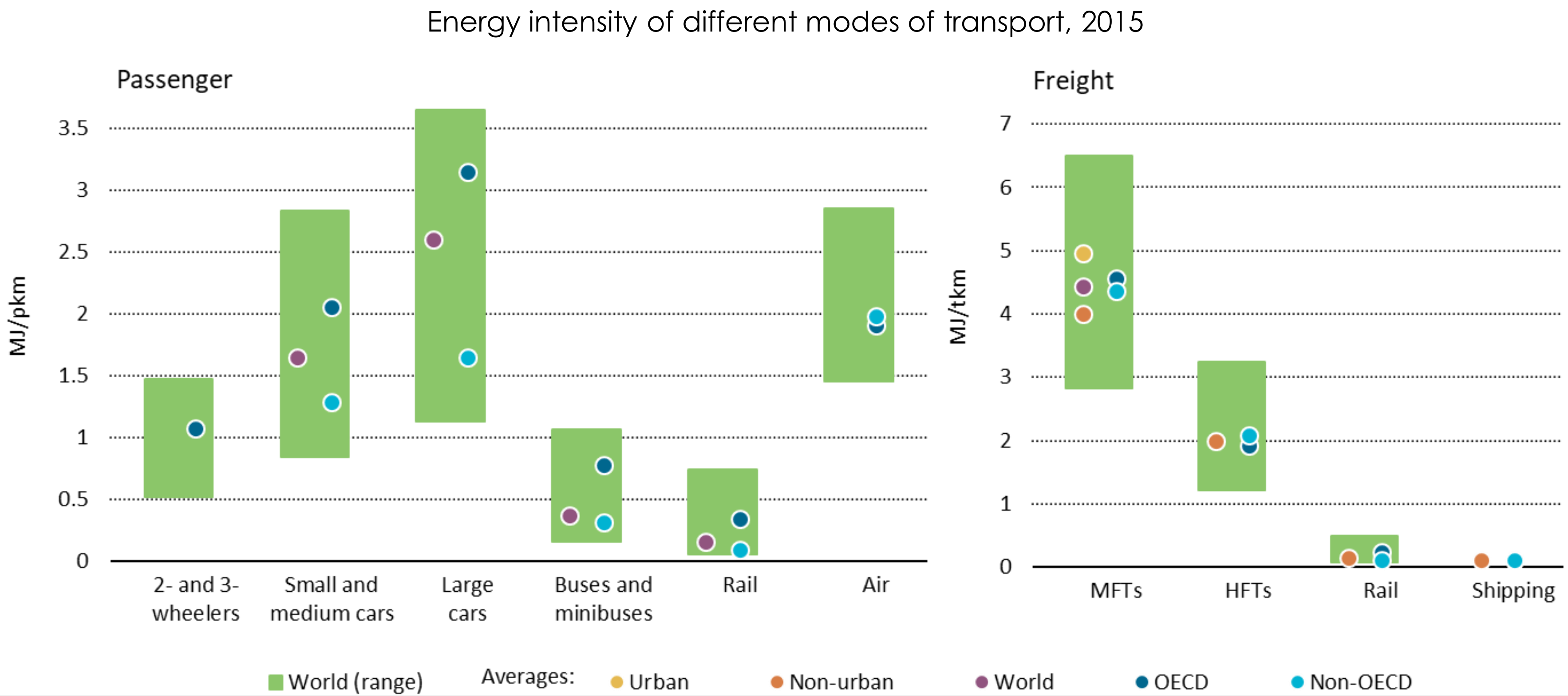
Distance travelled × Vehicle stock × Energy intensity = **Energy consumption**

- 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 to calculate ***F**uel consumption*

Aggregate indicators provide no information on specific energy efficiency of transport modes and are of limited use for policy making

Implications of analysis

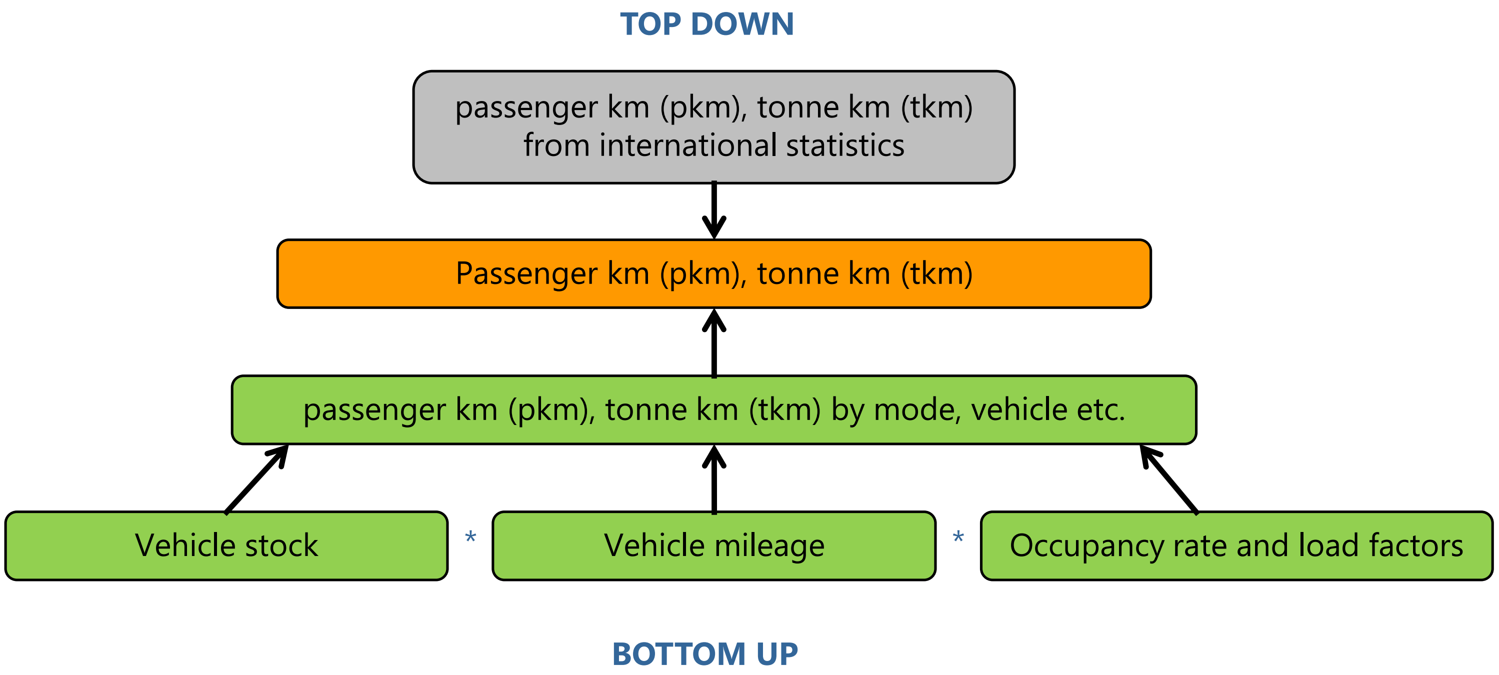


ASIF approach towards analysis can provide understanding and influence modal choice.

Where to find data?

Data: requirements, collection, uncertainties, and analysis

Transport Data: Activity and energy consumption



Vehicle stock

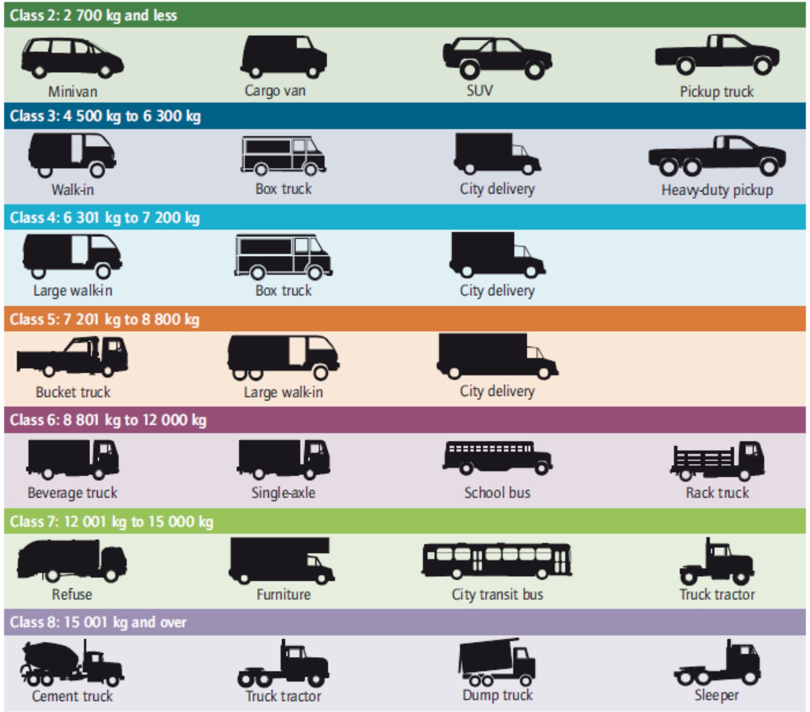
- Generally available from administrative sources
  - e.g. from ministries, statistical offices
  - Available stock data may not be corrected for scrappage
- Stock can be calculated from scrappage and new registrations
  - Industry associations provide sales data
  - Make assumptions on vehicle life time
- Vehicle classification is not the same everywhere
  - Two wheelers
  - Passenger light duty vehicles (PLDV): passenger car and SUV
  - Mass transport: minibus, bus, bus rapid transit (BRT)
  - Commercial vehicles: Light commercial vehicle, medium freight truck, heavy freight truck

Vehicle stock: Classification of commercial vehicles

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

United States



Classification systems for commercial vehicles are inconsistent
An appropriate balance of detail vs. data availability needs to be found

Source: Consolidated resolution on the construction of vehicles (n.a.), US DoE (2011)

Mileage

- Household surveys, travel diaries, odometer readings, public transit operators
- Information less frequently available than data on vehicle stock
- Mileage of vehicles depends on user profile and differs across users: taxi vs. oldtimer car
- Geographical coverage limited to regions where the surveys are performed
- Estimations may use analogies with similar modes in geographical areas with similar fuel taxation and population densities

Occupancy rate and load factors

Public passenger transport

- Peak versus off-peak (evenings, weekends)
- Route types (feeder line, main line)

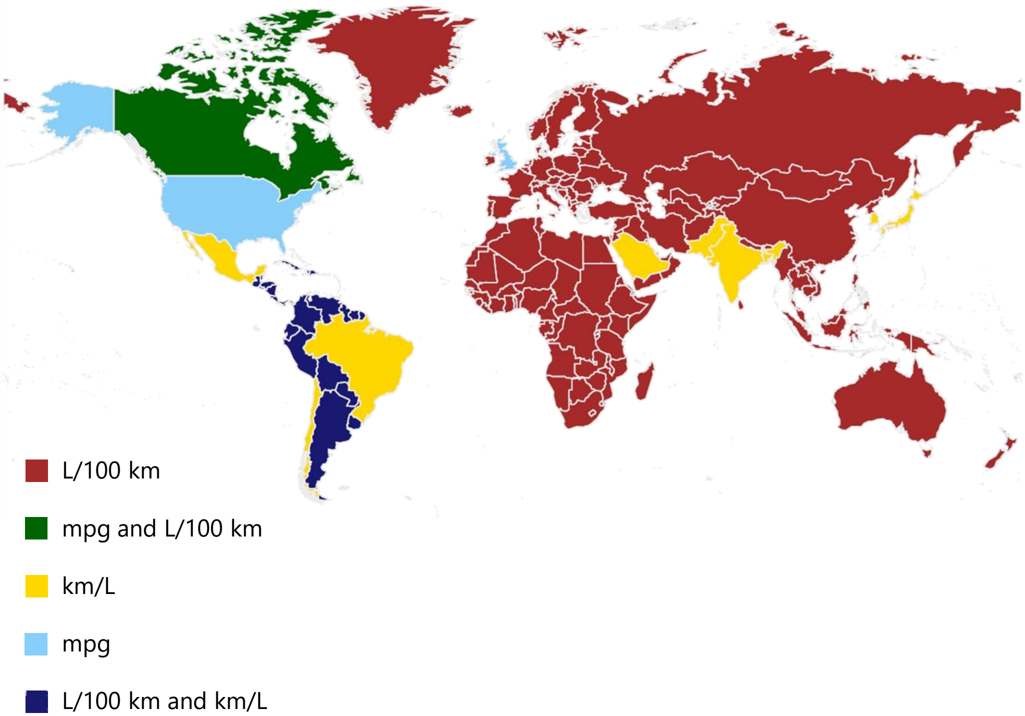
Goods transport

- Average load factors = Average load on laden trips * (1-Share of empty running)
- Load of laden trips varies both among journeys and during a single journey
- Average loads dependent on mission profile, value of goods

Passenger cars

- Estimate occupancy rate based on analogies within geographical areas with similar socio-economic and taxation characteristics

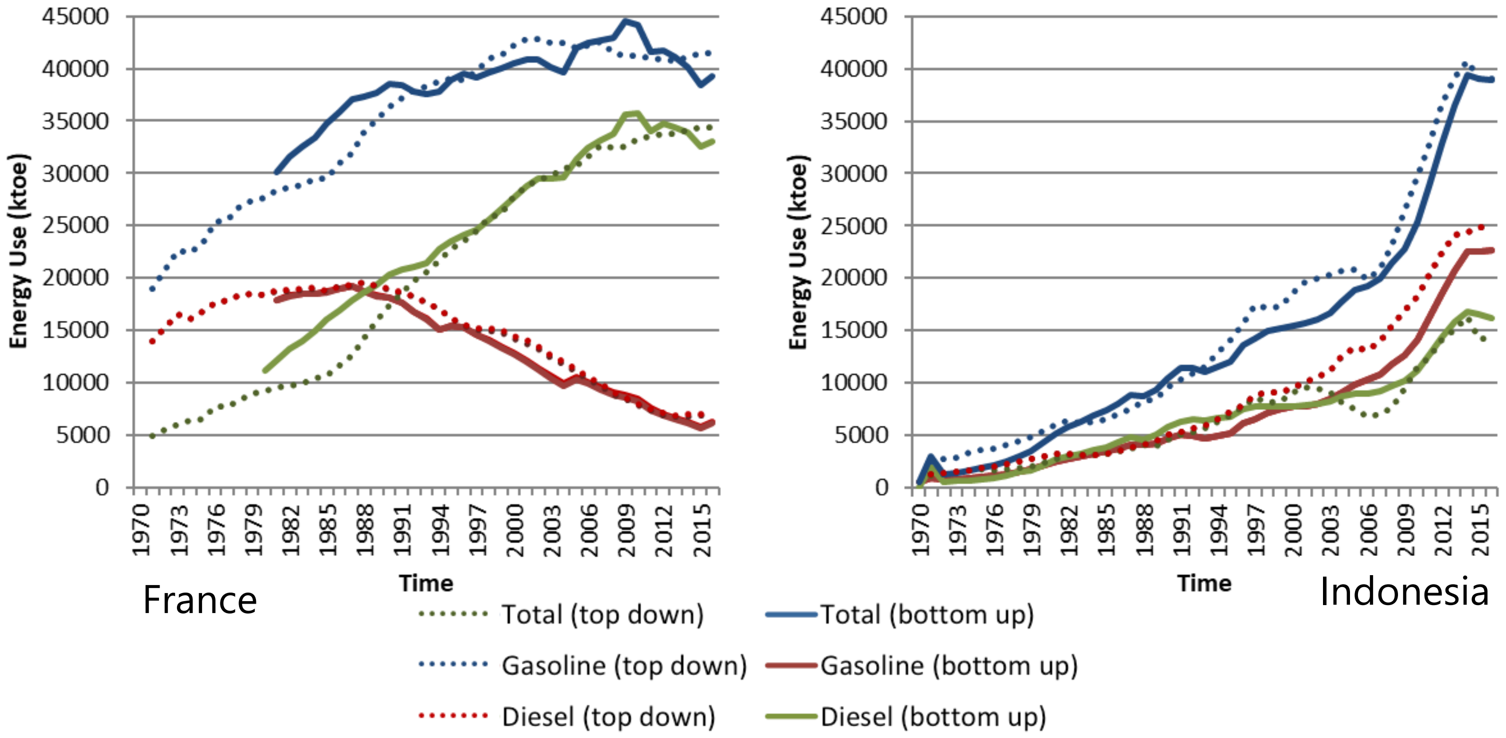
Energy Intensity



- Energy intensity describes **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)

This map is without prejudice to the status of or sovereignty over any territory, to the delineation of international frontiers and boundaries, and to the name of any territory, city or area.

Energy use: Comparing bottom-up and top-down approaches



Dual results of the two complementary transport analysis approaches provides high degree of certainty

Data collection methods

Pros and Cons of using administrative sources, surveys, metering, and estimations

Transport data collection methods

Four methods are typically used to collect and process data on transport activity and energy use:

- **Data collection methods:**
  - Administrative sources
  - Surveys
  - Metering
  - Estimations

➢ What are some examples, in general and in your country, of the data collection sources and methods listed above?

➢ What are some of the pros (benefits) and cons (drawbacks) of collecting data from each source or method?

Transport data collection: Administrative sources

- Annual fuel use from national energy balances
- Activity statistics from transport operators and government agencies
- Vehicle registration data, with detailed characteristics from respective government bodies and the private sector
- Vehicle import/export data, with detailed characteristics
- Vehicle characteristics (by size/fuel) from government organizations and NGO studies

Great way to get comprehensive, often official data, however:

- Collection methodology (and data quality) sometimes unclear
- Comparisons between providers may be difficult

Transport data collection: Surveys

Pros:

- Data collection via direct observation or questionnaires on travel activities, energy use, etc.
- Can provide very rich information, useful for understanding variation, correlations, and other aspects of the sample

Cons:

- Can be labor intensive and require large sample sizes
- Estimates, not hard data

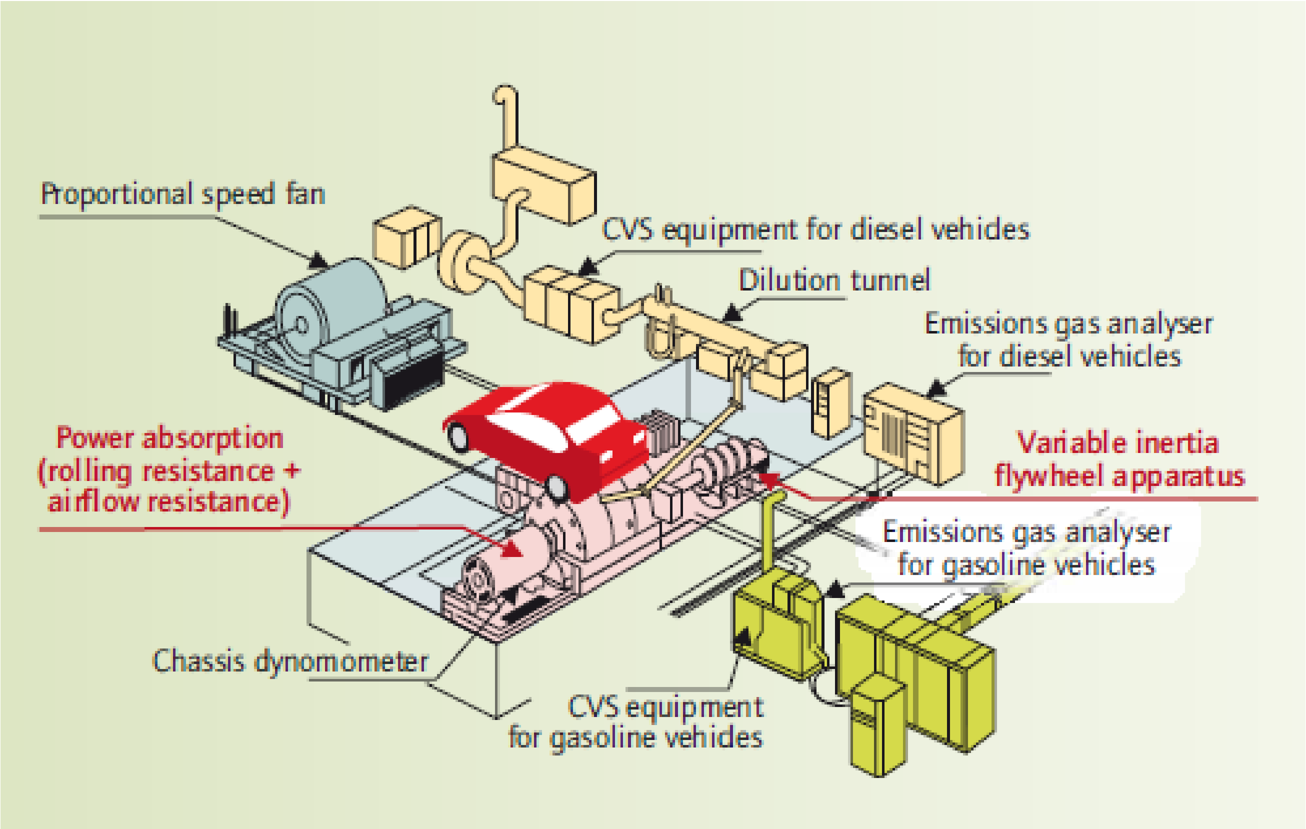
Examples:

- National travel survey
- Household surveys, focus groups
- Survey of fleets, trucking companies

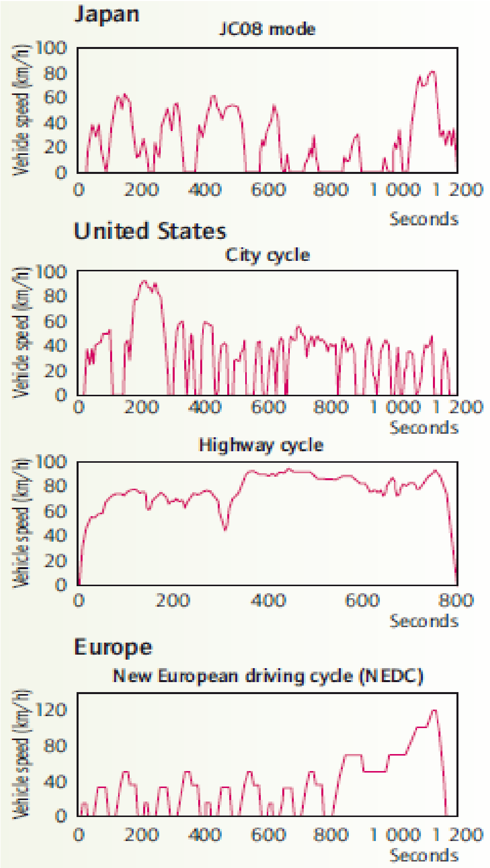
Transport data collection: Measuring and metering

- Pros: Direct observation, usually of a physical phenomenon
  - Can use existing metering systems or involve creating new ones
  - Roadside car counters
  - Vehicle fuel economy testing
  - GPS data and vehicle location monitoring
  - Vehicle fuel economy computers (in use performance)
  - Portable Emissions Monitoring (PEMS)
  - Speed detection systems
  - Atmospheric concentration monitoring
- Cons: Typically reliable but often expensive
  - Based on scientific and replicable tests
  - Sample size and data processing requirements affect costs

Transport data collection: Measuring fuel consumption and emissions



Transport data collection: Measuring fuel consumption and emissions



- Different test cycles in US, Japan & Europe exist
- Use conversion formulas to make tested data comparable
- 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

Transport data collection: Estimations

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**

Transport data collection: MoMo historical database as example for estimations

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

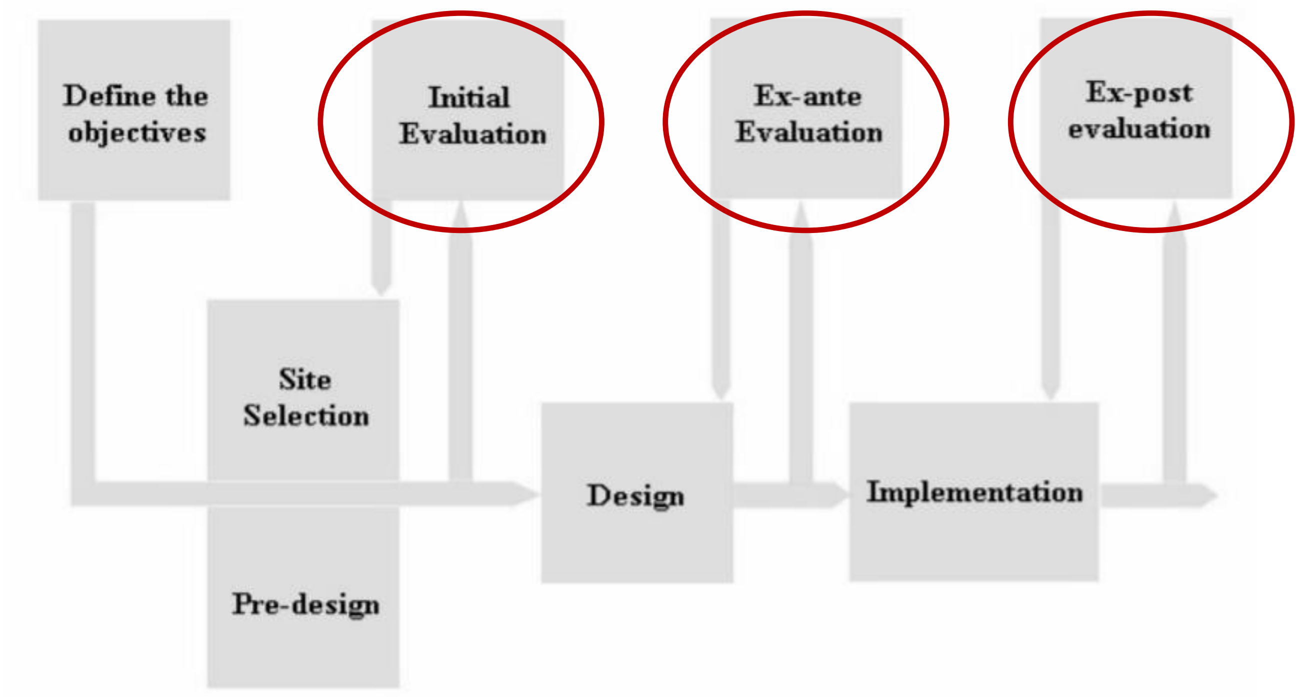
→ Bottom-up results on the energy consumption are checked against historic fuel consumption by sector and fuel type (from import/export/production balances: remember the examples of France and Indonesia?)

→ Fitted adjusting the least reliable data (mileage)

Policy and project evaluation

How to evaluate transport policies and projects

Evaluation steps



Source: Maestro - https://trimis.ec.europa.eu/sites/default/files/project/documents/maestro.pdf

Why does evaluation matter?

Evaluating transport policies and projects

- Project evaluation for specific parts of transport system (e.g. BRT system in Mexico City)
  - Cost benefit analysis to evaluate project results in monetary terms
  - Methods with focus on effectiveness: Difference in difference method
- Indicator-based evaluation of sustainable transport plans (e.g. Cycling plan 2015-2020 of Paris)
  - Transport projects usually integrate in comprehensive transport strategy
  - Indicator based evaluation to capture the current state of transport systems rather than project outcomes

Example of project evaluation: Difference in difference method

- Bel & Holst (2018) evaluate the impact of introducing BRT lines on pollution levels in Mexico City

- Difference in difference method: Evaluate differences in air quality over time at air quality monitoring stations close to BRT line (treatment group) and in areas far from BRT line (control group)
  - CO, NO_x, PM_{10}, and SO_2

- Findings: All pollutants but SO_2 decrease at air quality monitoring stations (treatment group)

Example of strategy evaluation: Indicator-based framework

- Chakhtoura & Pojani (2016) propose a framework for sustainable transport plans with suggested evaluation indicators
  - Authors revise framework and evaluations (internal and external) of four Paris transport plans

- Goals and objectives of transport plans should be SMART (specific, measureable, achievable, relevant, and time bound)
  - Goal: increase reliability of public transport services
  - Objectives: increase public transport use by 2%

- Findings:
  - Despite some negative feedback, Paris' transport plans are overall effective
  - Objectives in transport plans are often not SMART, neither time bound nor measurable
  - One-off evaluation studies do not capture long-term effectiveness

Conclusions

Conclusions

- Substantial data requirements
- Vehicle stock, fuel economy, and energy use are key parameters
- Reality checking is possible
- Bottom-up estimates can be done with limited investment
- Need to compromise between detail and available resources
- The better the historical data set, the more reliable are models
- A good model is an important basis for the definition of effective policy instruments!

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