Collecting energy efficiency data for transport

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IEA Energy Data Centre

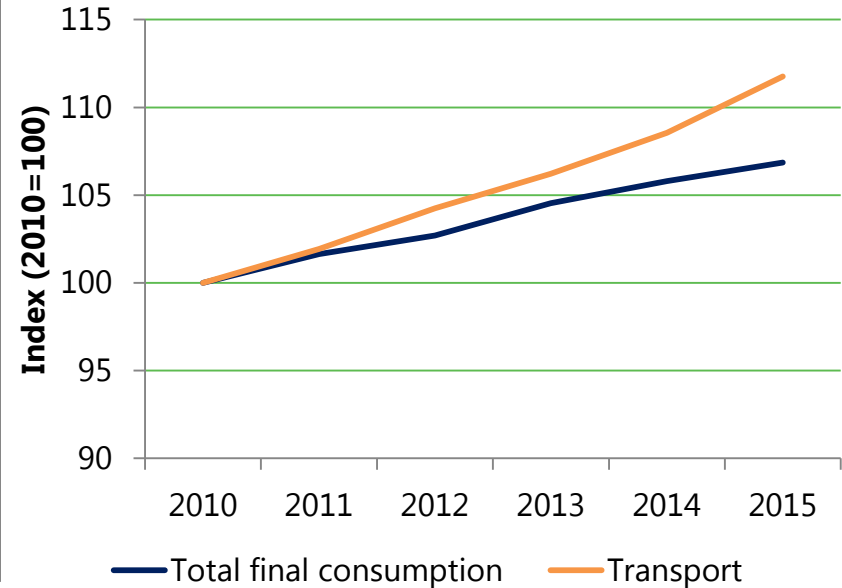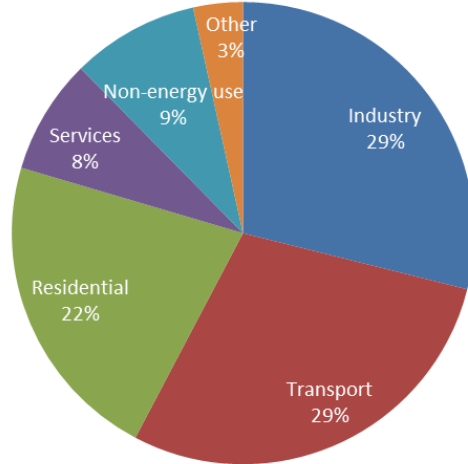Beijing, 23rd to 25th May 2018

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Content

1. Why are **transport efficiency indicators** important?

2. **What data** do we need for transport efficiency indicators?

3. **Collecting the data**: principles and country examples

Why are transport efficiency indicators important?

World energy consumption in transport grows fast

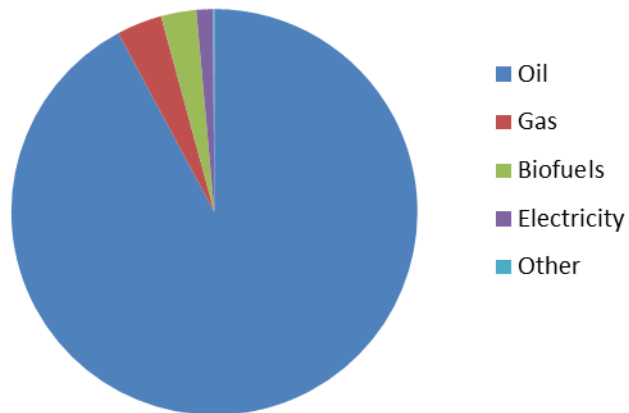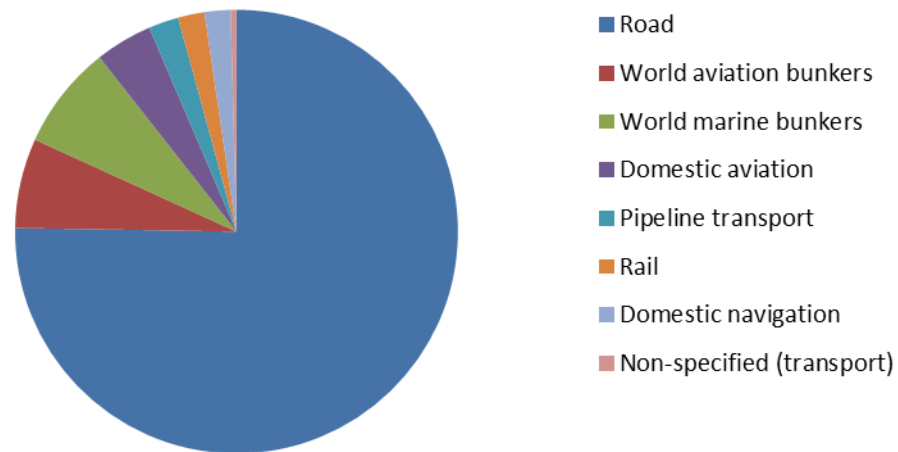## World total final consumption by sector, 2015

Industry 29%

Transport 29%

Residential 22%

Non-energy use 9%

Services 8%

Other 3%

Index (2010=100)

Total final consumption — Transport

Source: *IEA World Energy Balances, 2017*

Energy consumption in transport sector

World transport consumption by source, 2015
- Oil
- Gas
- Biofuels
- Electricity
- Other

World transport by sub-sector, 2015
- Road
- World aviation bunkers
- World marine bunkers
- Domestic aviation
- Pipeline transport
- Rail
- Domestic navigation
- Non-specified (transport)

Source: *IEA World Energy Balances, 2017*

Basic transport energy consumption data are available

In order to compile annual energy balances, most statistical offices collect:

- **Total** annual energy consumption in transport

- Split by **fuel**

- Split by **sub-sector/mode** (road, rail, navigation, aviation)
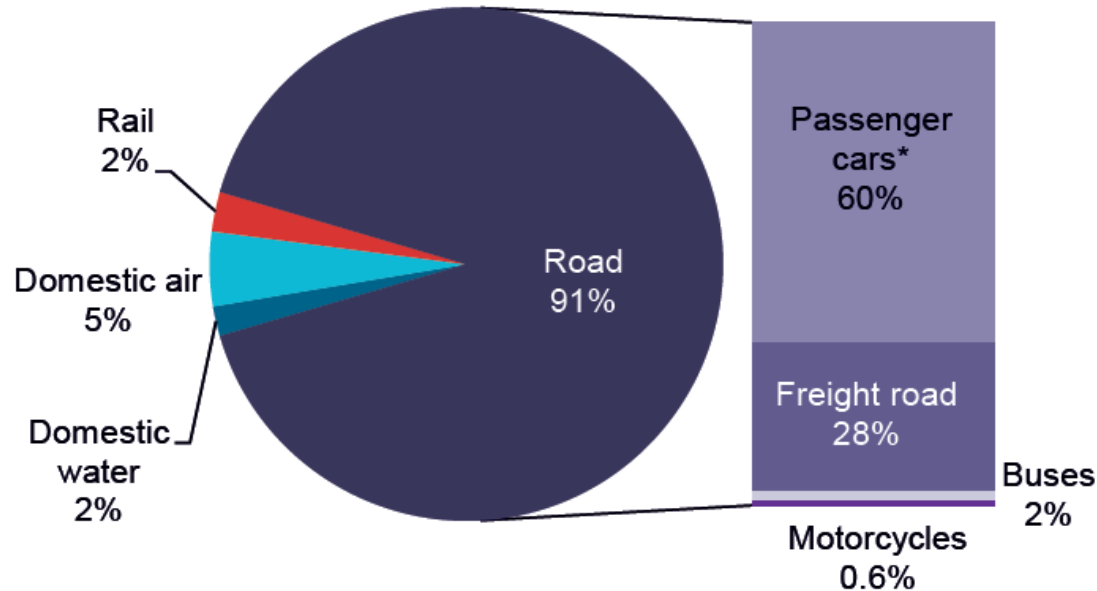
Data currently available provide a high level view on transport

What else do we need to know?

- What is the split between passenger transport and freight transport?

- How much energy is spent in my country to transport one passenger on a distance of one kilometer?

- How does it compare to other countries in my region?

- What consumes less energy per km to travel in my country – a bus, a car or a train?
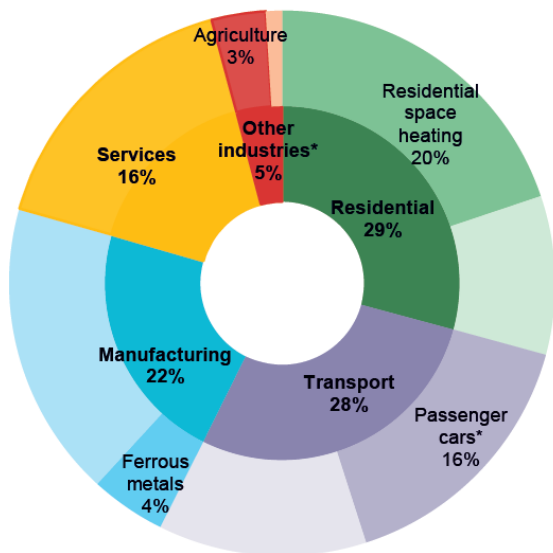
- Etc.

With additional data we can see where energy is used

Figure 12. Energy consumption in transport in IEA, 2013

Rail 2%
Domestic air 5%
Domestic water 2%
Road 91%
Passenger cars* 60%
Freight road 28%
Buses 2%
Motorcycles 0.6%

Source: *IEA Energy Efficiency Indicators, 2016*

Energy by end use: examples

- France
- United States

Largest end-uses by sector, 2013 (France)

- Agriculture 3%
- Other industries* 5%
- Residential space heating 20%
- Residential 29%
- Services 16%
- Transport 28%
- Passenger cars* 16%
- Manufacturing 22%
- Ferrous metals 4%

Largest end-uses by sector, 2014 (United States)

- Mining 5%
- Other industries* 7%
- Residential space heating 9%
- Residential 20%
- Services 15%
- Manufacturing 18%
- Chemicals 4%
- Transport 40%
- Passenger cars* 26%

Source: *IEA Energy Efficiency Indicators, 2016*

Transport activity by mode/vehicle type: examples
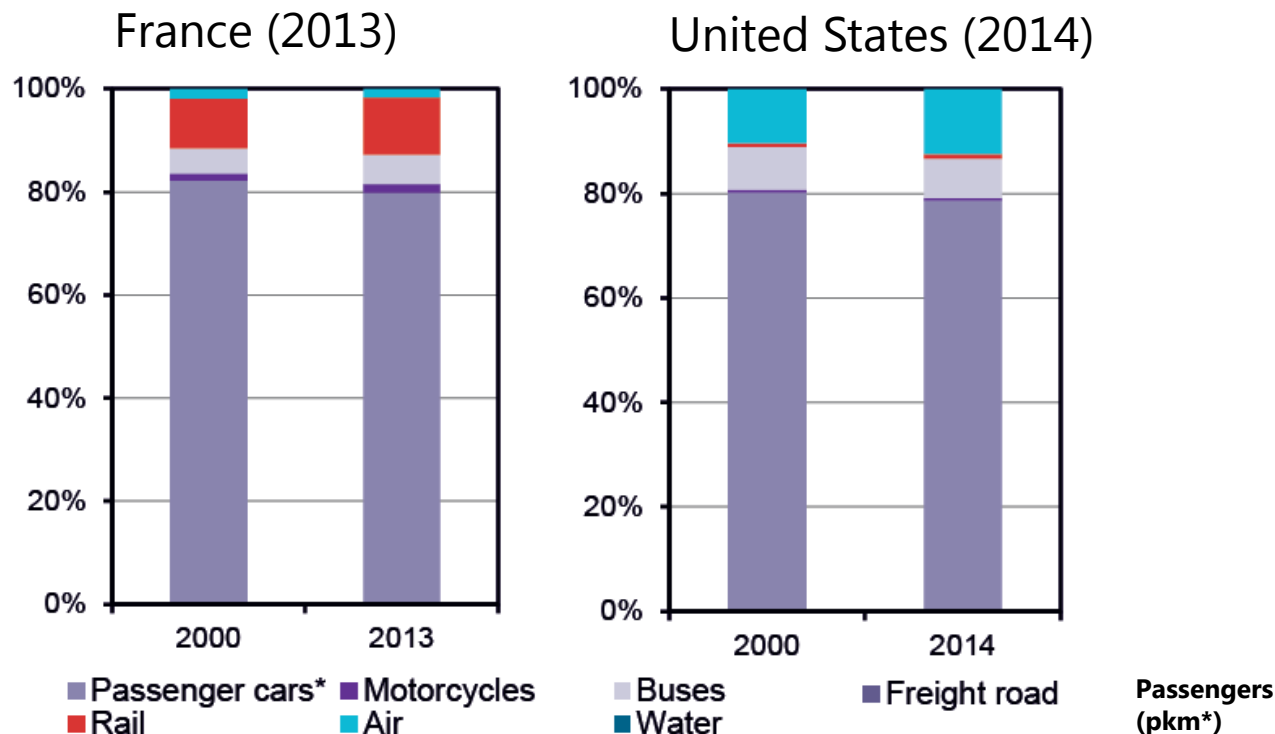
France (2013)   United States (2014)

Legend:
- Passenger cars*
- Motorcycles
- Buses
- Freight road
- Rail
- Air
- Water

Passengers (pkm*)

Source: *IEA Energy Efficiency Indicators, 2016*
*Transport excludes international marine and aviation bunkers, pipelines, and when possible fuel tourism; pkm refers to; passenger cars includes cars, sport utility vehicles and personal trucks;.

Energy intensities in passenger transport : examples
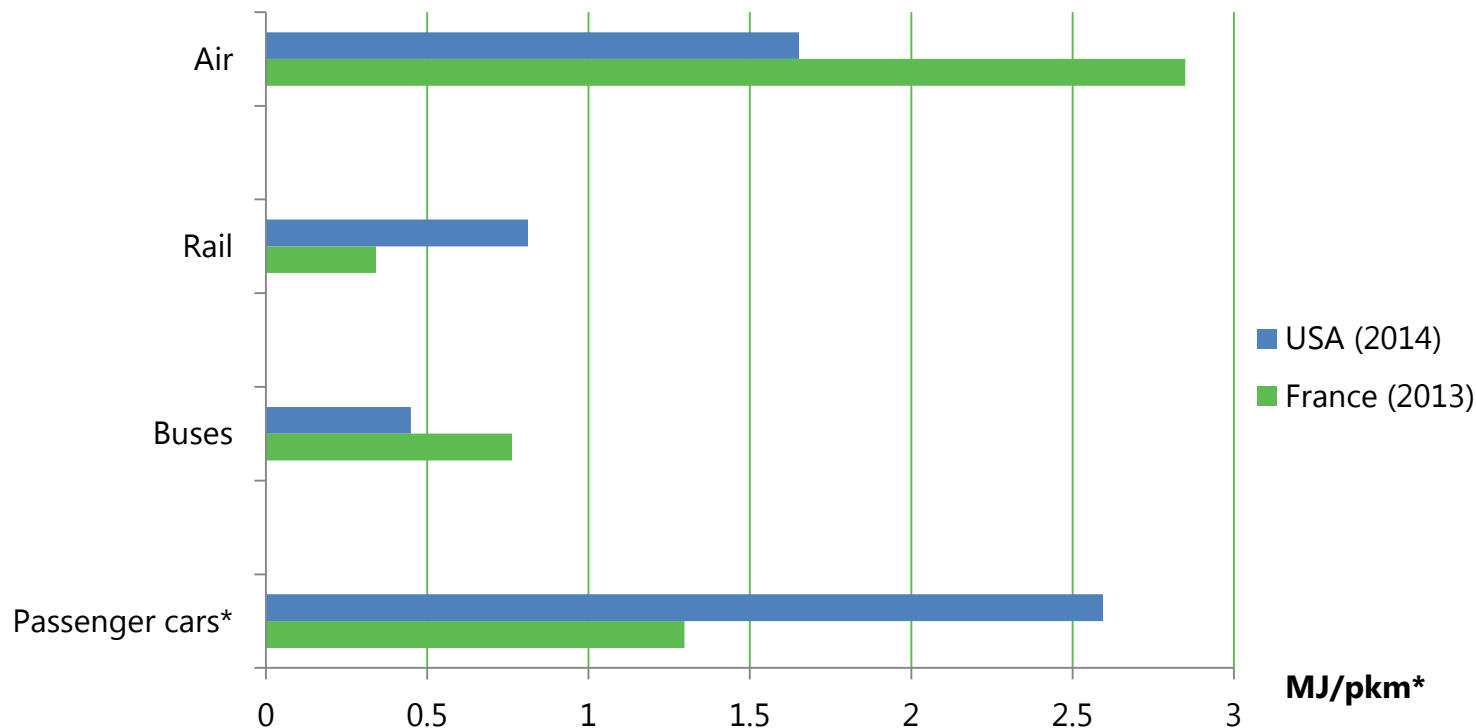
USA (2014)
France (2013)

MJ/pkm*

Source: *IEA Energy Efficiency Indicators, 2016*
*Transport excludes international marine and aviation bunkers, pipelines, and when possible fuel tourism; pkm refers to; passenger cars includes cars, sport utility vehicles and personal trucks;.

What data do we need for transport efficiency indicators?

Transport sector

Energy consumption data:
- Transport segment
  - passenger
  - freight
- Transport modes
  - road,
  - rail,
  - air,
  - water,
  - etc.

Activity data:
- Vehicle stocks
- Passenger-kilometers
- Tonne-kilometers

Vehicle stock

Distance travelled

Occupancy

Load

Selected modes/vehicle types by segment and sub-sector

Segment Sub-sector	Passenger	Freight
Road	Powered 2- to 4- wheelers Passenger light-duty vehicles (PLDVs) Buses	Freight light-duty vehicles Heavy-duty vehicles (HDV) Other
Rail	Passenger trains	Freight trains
Air	Passenger airplanes	Freight airplanes
Water	Passenger ships	Freight ships

IEA, *Energy Efficiency Indicators: Fundamentals on Statistics*, 2014

Data requirements - activity

Passenger transport				Freight transport			
Road	Rail	Waterways	Air	Road	Rail	Waterways	Air
Personal cars	Passenger Trains	Passenger Ships	Passenger Airplanes	Trucks	Freight Trains	Freight Ships	Freight Airplanes
Buses							
Motorcycles							
- Passenger-kilometres (gasoline, diesel, LPG, …)				Tonne-kilometres			
- Vehicle kilometres (gasoline, diesel, LPG, …)				Tonnes			
- Number of vehicles in use (gasoline, diesel, LPG, …)				Number of vehicles in use			

pkm = vkm x occupancy = stocks x average mileage x average occupancy

Vehicle stocks
- Mostly available in many countries (e.g. Ministries, Statistical offices)
- Can be estimated using vehicle data base
- Vehicle classification is not the same by countries

Average mileage & occupancy (load)
- Rarely available
- Can be found in household surveys, travel diaries, odometer readings in vehicle database, public transport utilities
- Often estimated

Activity data for efficiency calculation in transport

Vehicle stock × Distance travelled × Occupancy / Load factor = Passenger-km or tonne-km

IEA, *Energy Efficiency Indicators: Fundamentals on Statistics*, 2014
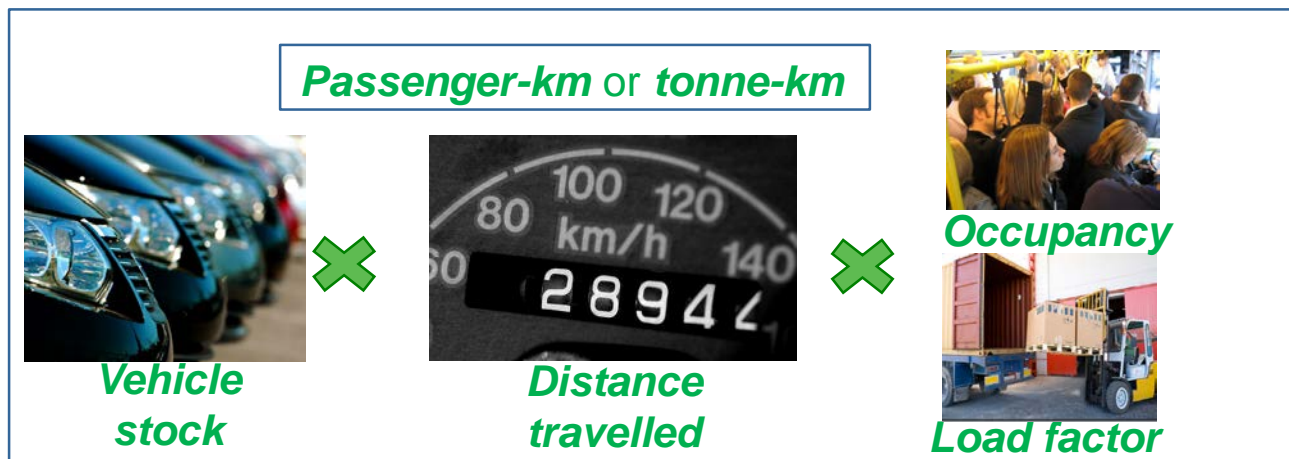
Collecting the data: principles and country examples

Where to get data?

- Administrative sources

- Surveys

- Measuring/metering

- Modelling

Data	Source	Methodology
Vehicle stocks*	Statistics offices Manufacturers National and international databases Vehicle registers	Administrative sources Administrative sources/ measurements
Fuel economy	Manufacturers	Administrative source Modelling

Data	Source	Methodology
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

* Collecting additional data on vehicle sales can be extremely useful to validate/complement stock information

IEA Country practice database: https://www.iea.org/eeindicatorsmanual/

Examples of methods for energy data

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

IEA, *Energy Efficiency Indicators: Fundamentals on Statistics*, 2014

Examples of methods for activity data

Data	Source	Methodology
Activity data		
GDP, population	National statistics offices	Administrative sources
Vehicle-km (vkm)	Vehicle registers/ Roadworthiness testing services/ Inspecting organisations	Measurements: odometer readings
	Municipalities/Transport authorities	Measurements: road traffic count
	National and international databases	Administrative sources
	Transport ministries	Mobility surveys Modelling
Passenger-km (pkm)	National and international databases	Administrative sources
	Transport ministries	Mobility surveys
Tonne-km (tkm)	National and international databases	Administrative sources
	Transport ministries	Mobility surveys, freight surveys

IEA Energy Efficiency Indicators:
Fundamentals on Statistics, 2014

Administrative sources

- Annual fuel use from national energy balances
  (collected via questionnaires sent to ministries and national statistical offices)

- Activity statistics from transport operators and government agencies
  (e.g. railway operators)

- Vehicle registration data, with detailed characteristics from respective government bodies and the private sector (e.g. associations of vehicle manufacturers)

- Vehicle import/export data, with detailed characteristics (e.g. from trade offices/border control services/private sector vehicle trade associations)

- Vehicle characteristics (by size/fuel) from government organisations (e.g. US EPA or EU EEA) and comparative studies issued by NGOs

- Studies on: mode share, travel, trips, fuel content, fuel consumption, travel patterns..

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

- Collection methodology (and data quality) sometimes unclear

- Comparisons between providers may be difficult

Examples of administrative sources: Japan

Sources:

- Government statistics office
- Manufacturers
- International organizations

Manual for Passenger vehicles average fuel economy performance calculation
http://libterra.co.jp/Manual(JAMA2006V2).pdf

Surveys

- National travel survey
- Survey of fleets, trucking companies
- Observational (e.g. roadside) surveys
- Household surveys, focus groups

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
- The people

Cons:

- Can be labour intensive, require large sample sizes, etc.
- Estimates, not hard data

Examples of surveys: Australia

Format	Elements Collected	Frequency
Paper form sent by mail	Vehicle fuel efficiency Type and volume of annual fuel consumed Distance travelled Vehicle size (weight/capacity/volume) Vehicle age group	2 years

Proportion of vehicles and total kilometres travelled, State/territory of registration-Year ended 30 June 2012
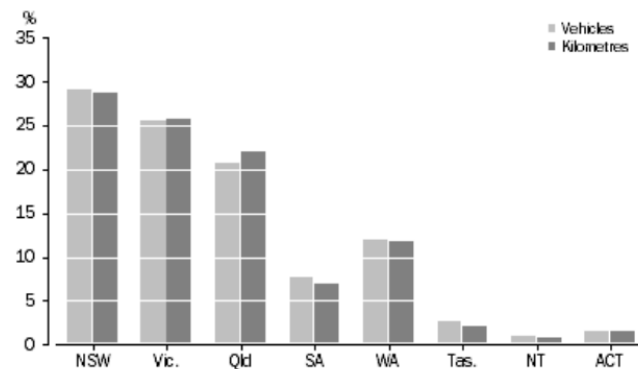
Mandatory survey to: Registered road vehicle owners (government and private)

Measuring and metering

- Direct observation
- Can use existing metering systems or create new ones
  - Odometers
  - 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

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

Measuring /metering example: Canada (1)

Canadian Vehicle Use Study (CVUS) by Transport Canada Vehicles equipped with GPS and a screen so that driver inputs some information regarding the trip.

Data collected not only for energy purposes: "The electronic data logger also uses the GPS technology and records the spatial coordinates that could be used in analysis of traffic congestion, road safety and infrastructure planning"
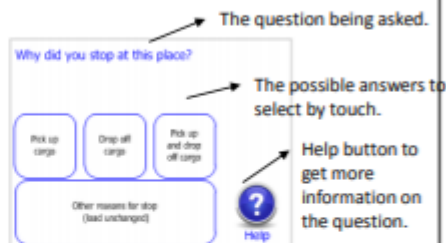
Elements collected:

- Trip patterns over time

- Fuel consumption over time

- Carrier utilisation pattern and impact on fuel economy

- Impact of fuel switching on vehicle fuel economy

Canadian Vehicle Use Study

Main screen of electronic logger device:

How a question screen looks:

The question being asked.

Why did you stop at this place?

The possible answers to select by touch.

Help button to get more information on the question.

- The logger device records accurate vehicle activity at one-second intervals (e.g. distance, time, speed, fuel, etc.) directly from the vehicle's engine.
- The logger touch screen captures the remaining trip questions.
  - ❖ Light: Driver Age/Sex, # Passengers, Trip Purpose, Fuel Information
  - ❖ Heavy: Trip Purpose, Facility Type (Origin), Configuration, Trailer Style, Cargo (Weight/Volume), Cargo Type (Best Description)

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Canadian Vehicle Use Study

- The logger is also easy to install by connecting the logger to the vehicle's connector socket via a 16-pin (SAE J1979 Standard) or 9-pin connector cord (SAE J1939 Standard) usually located under the dashboard or behind the driver's seat.

- Should the connector socket not use a 16 or 9 pin connector cord, the logger can be connected to the cigarette lighter via a 12 volt connector cord adapter.

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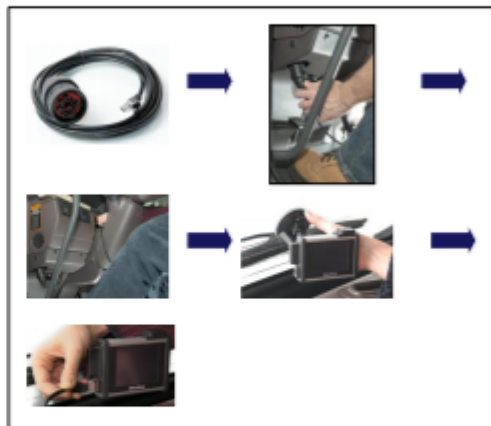
Modelling example: Ukraine – State Road Transport Research Institute (Kiev)

Mileage (*Activity*)
- Total mileage in vehicle kilometers (vkm)

Combine official statistics with data from state companies (commercial vehicles) and insurance companies (passenger vehicles)

Vehicle stock (*Structure*)
- Of cars, buses, light commercial vehicles and heavy duty vehicles
- with split for diesel and gasoline powertrains

Combine official stock statistics and data from electronic registry
- Data adjustment based on scrappage assumptions

Average specific consumption (*Intensity*)
- Specific energy use (l/100km)

Obtain data on fuel economy from European Environment Agency (EEA)

Transport fuel consumption

Sound modelling of transport energy demand requires extensive data gathering efforts

Collecting data for transport efficiency indicators

- Transport efficiency requires detailed monitoring

- Energy efficiency indicators are a good framework to monitor the sector

- Data needs to be collected for energy and activity, across modes and vehicle types

- Countries are using a variety of methodologies to collect data: administrative sources, surveys, metering and modelling

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