Tracking efficiency in the transport sector

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Why is the transport sector important?

Transportation is important for multiple reasons such as economic activity and mobility.
1. What we can learn from **energy balances**?

2. What can we learn from **energy efficiency indicators**?

3. **Developing** energy efficiency indicators

4. How to **collect data**?
What can we learn from energy balances?
Transport is the second largest sector in APEC, first in IEA

In the APEC economies, the transport sector accounts for 30% of final energy consumption, that is, slightly less than industry and about the same as residential and commercial sectors together. In the IEA, it represents 38%.

Total final energy consumption\(^1\) in APEC economies and IEA economies in 2019

\(^1\) Total final energy consumption excluding non-energy use
\(^2\) Other includes agriculture, forestry, fishing and non-specified final consumption

Source: IEA Energy Balances, 2021
Road transport consumes the most energy by far, mostly oil.

Energy consumption in transport sector\textsuperscript{1} in APEC economies in 2019

By mode

- Road: 86%
- Rail: 3%
- Domestic aviation: 3%
- Domestic navigation: 0%
- Other: 3%

By fuel

- Oil products: 89%
- Natural gas: 2%
- Biofuels and waste: 3%
- Electricity: 6%

\textsuperscript{1} Transport sector on these graphs follow energy efficiency definitions and exclude pipeline transport

Source: IEA Energy Balances, 2021

Road transport represents the largest share, and transport consumption is heavily dependent on oil products.
Transport consumption grows fast

Transport energy consumption grew by 1.9% every year for the past decade in APEC economies, that is, 0.4% faster than TFC (1.5% growth).

Source: IEA Energy Balances, 2021

1 Transport sector on this graph follows energy efficiency definitions and excludes pipeline transport.
Road transport plays uneven role within APEC economies

Energy consumption in road transport grow faster in past 5 years than in the beginning of the decade, but with very different profiles depending on the economy.

Growth of energy consumption in road transport in APEC economies since 2009

Source: IEA Energy Balances, 2021
What else do we need to know to track efficiency in transports?

➢ What is the share of \textit{passenger vs. freight} transport?

➢ How much energy is needed to transport \textit{one passenger over one kilometre}?

➢ Which \textit{mode} is more \textit{intensive}: train, bus or car?

➢ How does it \textit{compare} to other economies in the region?
What can we learn from energy efficiency indicators?
Road, the largest mode, is mostly for passengers in IEA

Energy consumption in transport in IEA, 2018

- Road: 89%
- Passenger cars*: 59%
- Freight road: 27%
- Rail: 2%
- Air: 7%
- Water: 2%
- Buses: 2%
- Motorcycles: 1%

Source: IEA Energy Efficiency Indicators, 2020

More detailed data allows to understand which segment and which mode consumes the most energy.
Which end use is the most consuming in each sector – Examples

Largest end uses by sector in Korea (left) and the United States (right), 2019

On two example economies, with very different geography and energy profile, one wonders what drives the consumption in the transport sector.

Source: IEA Energy Efficiency Indicators, 2021
How intensive is passenger transport – Examples

Passenger transport energy intensity (MJ/pkm, left) and carbon intensity (kgCO2/pkm, right) in Korea (2019, top) and United States (2018, bottom)

Pkm refers to passenger-kilometre, that is, the product of occupancy, vehicle stock and distance travelled.

Surprisingly, their energy and carbon intensities are very similar. What data is needed to learn more?

Source: IEA Energy Efficiency Indicators, 2021
In the passenger segment, the share of each mode and vehicle type varies significantly from one economy to the other.

Source: IEA Energy Efficiency Indicators, 2021
Breaking into different intensity for each mode – Examples

Passenger transport energy intensity (MJ/pkm) and carbon intensity (kgCO2/pkm, right) in Korea (2019, top) and United States (2018, bottom)

Source: IEA Energy Efficiency Indicators, 2021

Mode shares allow to break down energy and carbon intensities in each economy, providing key information to tailor different policies.

Pkm refers to passenger-kilometre, that is, the product of occupancy, vehicle stock and distance travelled.

Source: IEA Energy Efficiency Indicators, 2021
What drives energy consumption depends on segment – Example

Decomposition into drivers of energy consumption

<table>
<thead>
<tr>
<th>Segment</th>
<th>End use</th>
<th>Activity</th>
<th>Structure</th>
<th>Efficiency effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger transport</td>
<td>Cars/light trucks, buses, trains, domestic airplanes, domestic ships</td>
<td>Passenger-kilometres (pkm)</td>
<td>Share of pkm</td>
<td>Energy consumption per pkm</td>
</tr>
<tr>
<td>Freight transport</td>
<td>Trucks, trains, domestic airplanes, domestic ships</td>
<td>Tonne-kilometres (tkm)</td>
<td>Share of tkm</td>
<td>Energy consumption per tkm</td>
</tr>
</tbody>
</table>

End use and activity data allow to analyse energy consumption and identify the impact of three main drivers.

Source: IEA Efficiency Indicators Documentation 2021
What drives energy consumption depends on segment – Example

Drivers of transport energy consumption – Freight (left) and passenger (right) segments – United States (2000-2018)

The consumption of each segment is driven by very different factors, to be analysed to design performant policies.

Source: IEA Energy Efficiency Indicators, 2021
Developing energy efficiency indicators
What drives the energy consumption in each sector?

We need increased data coverage

- building end uses (space heating, space cooling, water heating, lighting…)
- economic sub-sectors (iron and steel, chemicals, food, textiles, wood, mining, agriculture…)
- transport segments and modes (freight or passenger; road, rail, air or water)

Detailed consumption data on end uses and subsectors are needed to understand the drivers in each sector.
Energy efficiency indicators – Definition

Generic Energy Efficiency Indicator

Energy Consumption

Activity
Transport indicators – Energy and activity data

Energy consumption data

- Transport segments
  - Passenger
  - Freight

- Transport modes
  - Road
  - Rail
  - Air
  - Water
  - Other

Activity data

- Vehicle stocks
- Passenger-kilometres
- Tonne-kilometres
Transport indicators – Energy and activity data

Energy consumption data

- Transport segments
  - Passenger
  - Freight

- Transport modes
  - Road
  - Rail
  - Air
  - Water
  - Other

Activity data

- Vehicle stocks
- Passenger-kilometres
- Tonne-kilometres
The transport sector requires large amounts of data because it can be split in several ways (segment, mode, vehicle type, and fuel) and because activity data are composite (pkm and tkm).

### Selected modes and vehicle types by segment

<table>
<thead>
<tr>
<th>Mode</th>
<th>Segment</th>
<th>Passenger</th>
<th>Freight</th>
</tr>
</thead>
</table>
| Road | Cars, SUV and personal light trucks  
(gasoline, diesel, battery and PHEV)  
Motorcycles  
Buses     |                                                           | Trucks  
(light, medium, heavy) |
| Rail | Passenger trains  
(metro, conventional, high speed) |                                                           | Freight trains  |
| Air  | Passenger airplanes     |                                                           | Freight airplanes  |
| Water| Passenger ships         |                                                           | Freight ships  |
How to collect data on transport?
Methods used to collect data for indicators

- Administrative sources
  - Basis as often gathers many data
  - To be consulted before starting new data collection

- Surveys
  - The key: a representative sample
  - Possibly expanding existing surveys

- Metering and measuring
  - Costly but very effective for monitoring specific equipment efficiency

- Modelling
  - Complementary to surveys or stand alone
The most efficient methodology depends on each sector, as they require different data from different sets of consumers and institutions.

### Table 7.3 - Summary of the main data needed for transport indicators and examples of possible sources and methodologies

<table>
<thead>
<tr>
<th>Data</th>
<th>Source</th>
<th>Methodology</th>
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<tbody>
<tr>
<td>Energy data</td>
<td>National energy balance</td>
<td>Administrative sources</td>
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<td></td>
<td>National energy statistics</td>
<td>Modelling</td>
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<td>Total transport consumption</td>
<td>Vehicle-km (tkm)</td>
<td>Vehicle registers/</td>
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<td>Consumption by sub-sector</td>
<td>National energy balance</td>
<td>Administrative</td>
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<td>Mobility surveys</td>
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<td>Consumption by segment</td>
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<tr>
<td>Consumption by vehicle type</td>
<td>Mobility surveys</td>
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<td>Modelling</td>
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</tbody>
</table>

**Source:** Energy Efficiency Indicators - Fundamentals on Statistics
Calculation of transport activity data
Activity data for efficiency indicators in transport

*Passenger-km* or *tonne-km*

- Occupancy
- Vehicle stock
- Distance travelled
Activity data for efficiency indicators in transport

\[ V\text{-km} = 5\text{km} + 5\text{ km} = 10 \text{ v-km} \]

\[ P\text{-km} = 6 \text{ passengers} \times 5 \text{ km} = 30 \text{ p-km} \]

\[ \text{Avg. load} = \frac{p\text{-km}}{v\text{-km}} = \frac{30}{10} = 3 \text{ p/v} \]
Total vkm and total pkm calculation – Example

For one vehicle, \( \text{vkm} \) is the total distance travelled in a period.

For a stock of vehicles, one can compute

\[
\begin{align*}
\text{vkm} &= \text{number of vehicles} \times \text{average distance per vehicle (km)} \\
\text{pkm} &= \text{vkm} \times \text{average occupancy} \\
\text{tkm} &= \text{vkm} \times \text{average load}
\end{align*}
\]

with occupancy as the number of passenger per vehicle, and load as the mass of goods transported.

Pkm and tkm increase with the length of distance travelled and with the number of passenger or the amount of goods carried.