Joint APEC-IEA training workshop on end-use energy consumption data

June 28th-30th – Thomas ELGHOZI and Jungyu PARK

International Energy Agency

International Energy Agency

Tracking efficiency in the transport sector

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June 30th – Joint APEC-IEA training workshop

Why is the transport sector important?

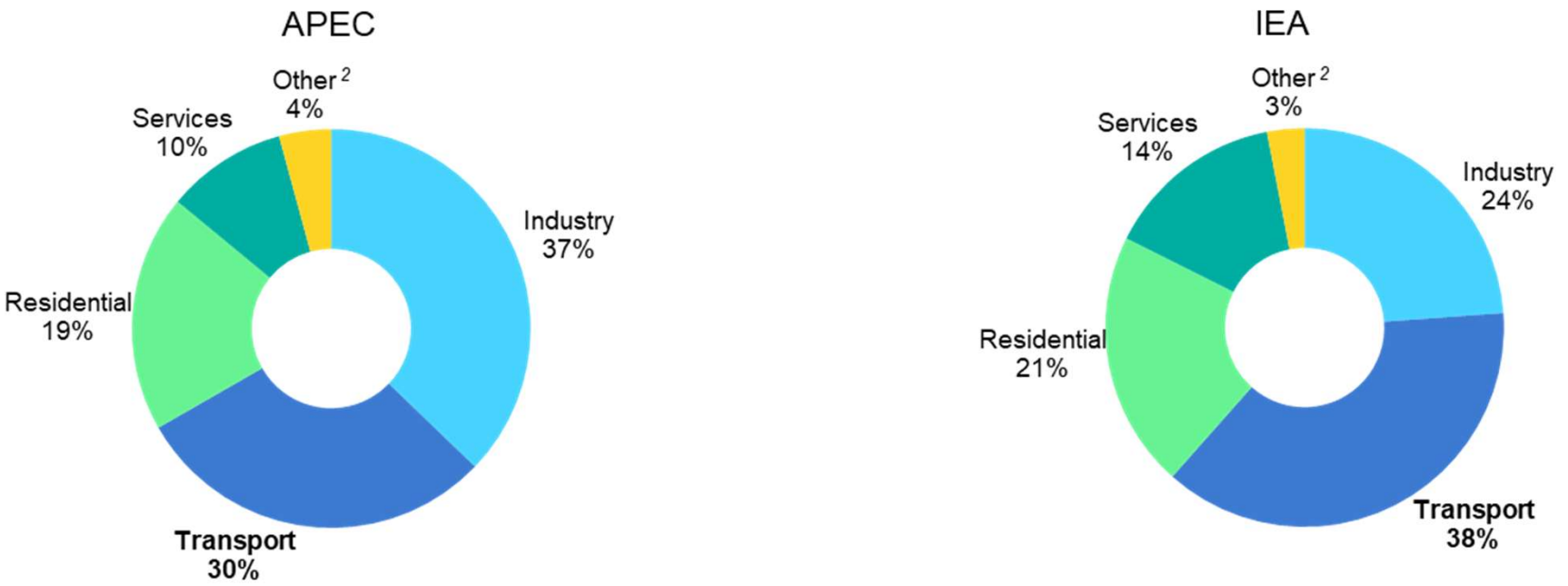
Transportation is important for multiple reasons such as economic activity and mobility.

Contents

What can we learn from energy balances?

Transport is the second largest sector in APEC, first in IEA

Total final energy consumption[1] in APEC economies and IEA economies in 2019



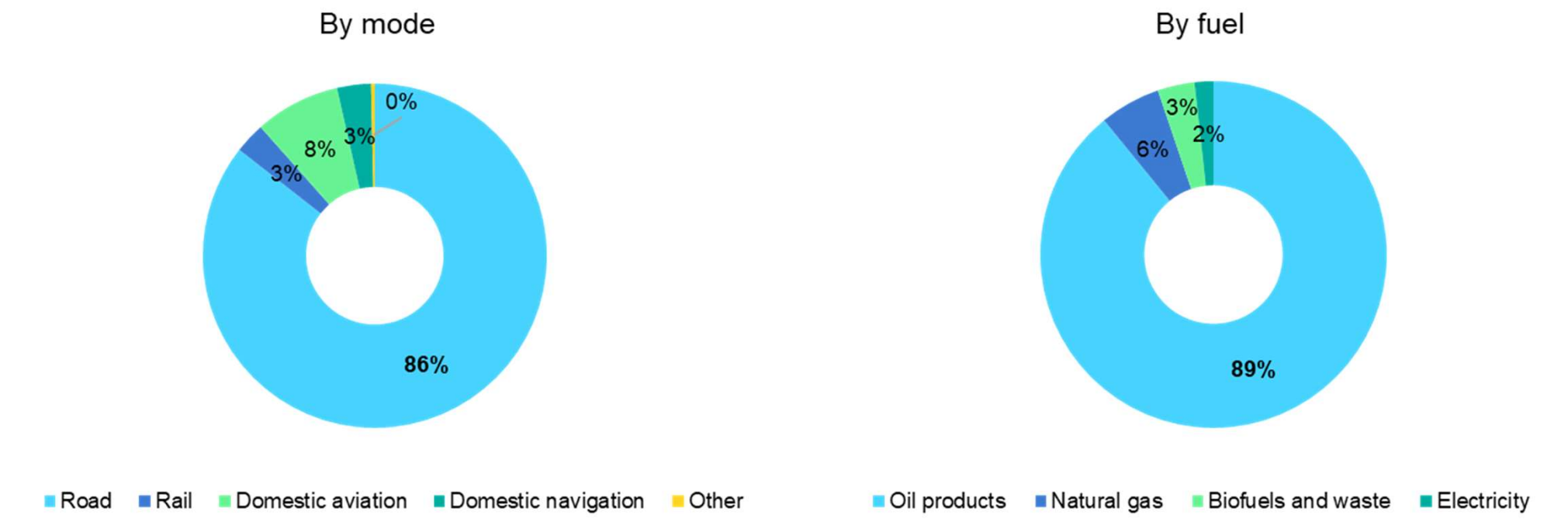
[1] Total final energy consumption excluding non-energy use
[2] Other includes agriculture, forestry, fishing and non-specified final consumption

Source: IEA Energy Balances, 2021

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%.

Road transport consumes the most energy by far, mostly oil

Energy consumption in transport sector[1] in APEC economies in 2019



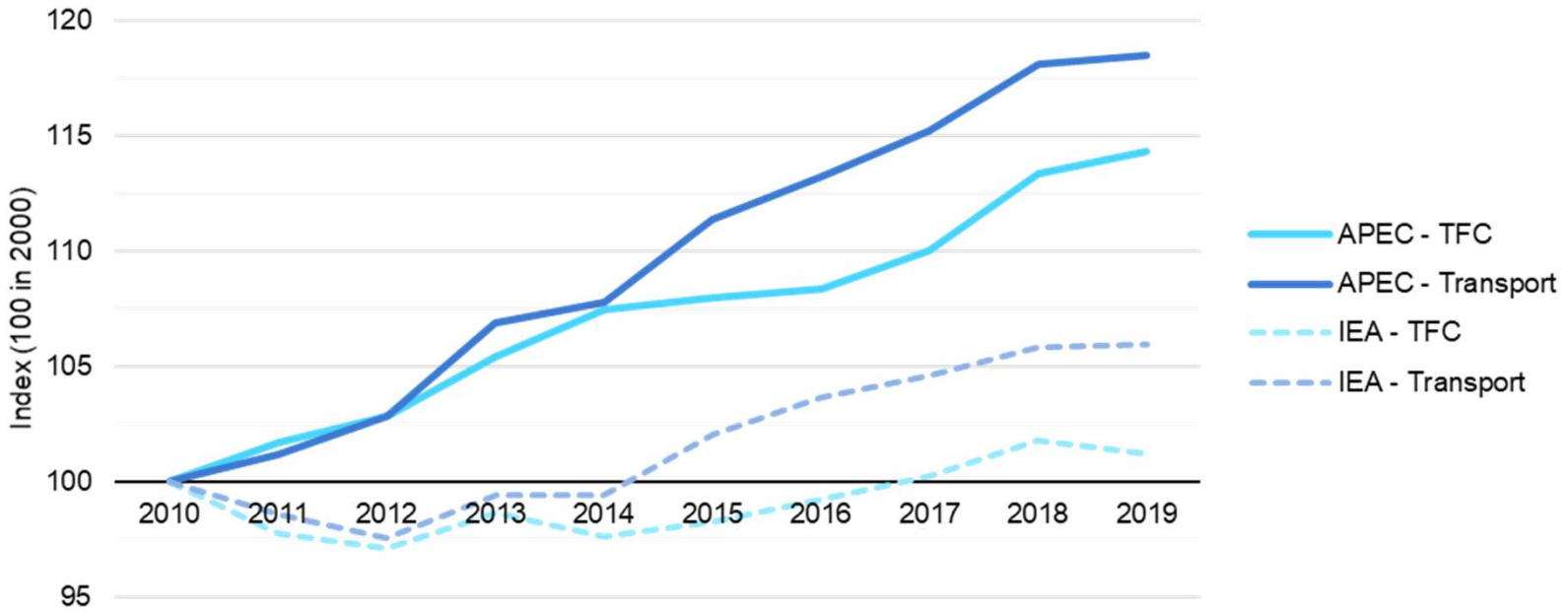
[1] *Transport sector on these graphs follow energy efficiency definitions and exclude pipeline transport*

Source: IEA Energy Balances, 2021

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

Transport consumption grows fast

Growth of energy consumption in transport sector[1] with respect to total final energy consumption since 2010

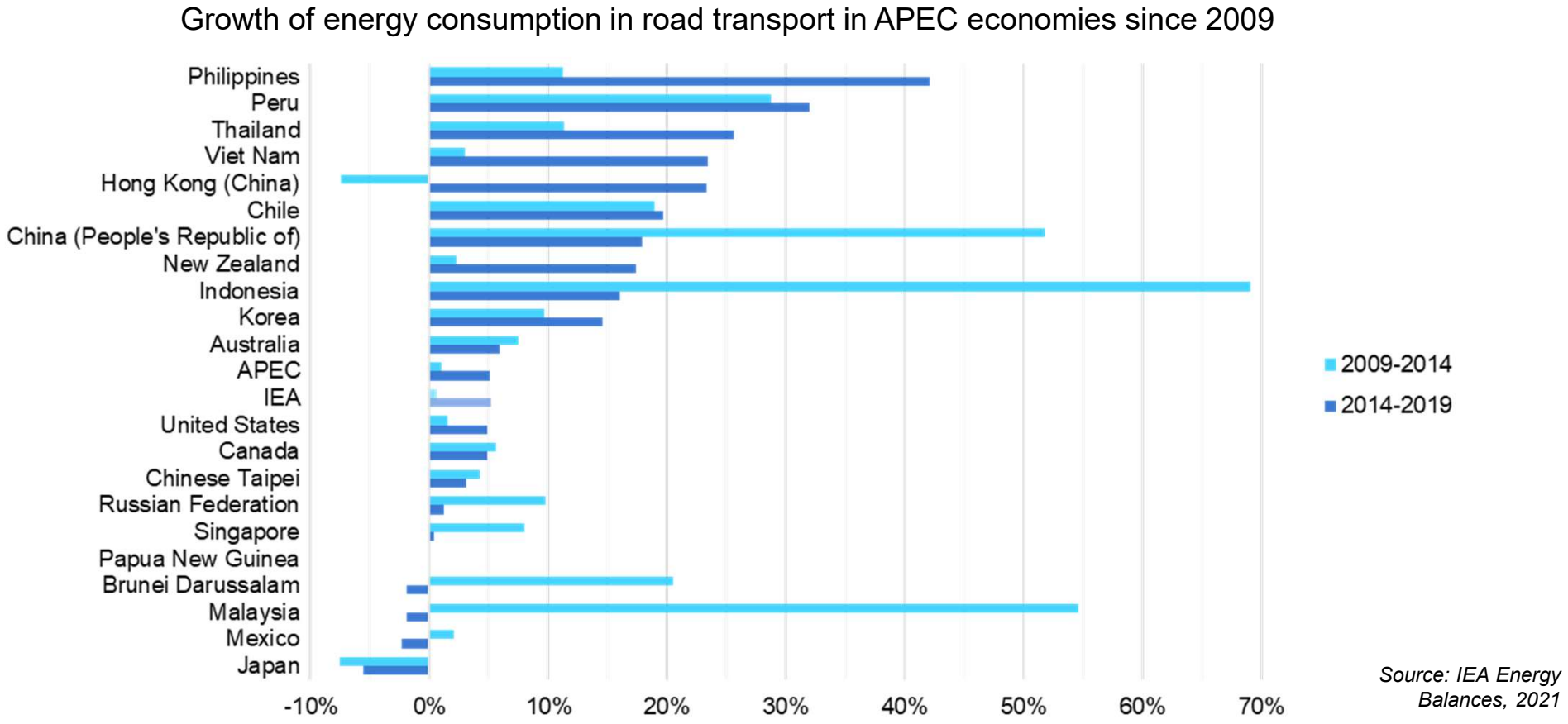


[1] Transport sector on this graph follows energy efficiency definitions and excludes pipeline transport

Source: IEA Energy Balances, 2021

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).

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.

What else do we need to know to track efficiency in transports?


- What is the share of **passenger vs. freight** transport?

- How much energy is needed to transport **one passenger over one kilometre**?



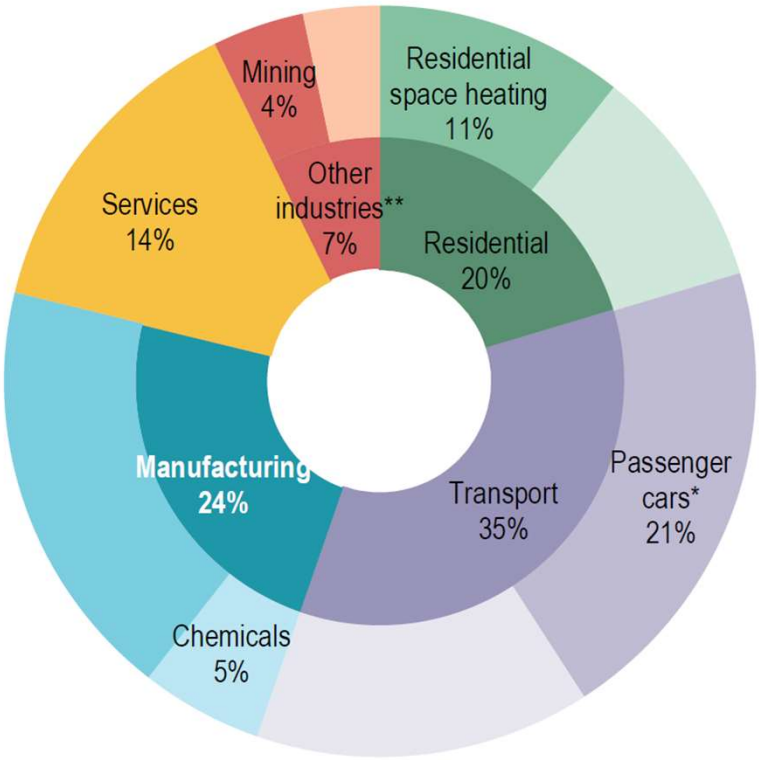

- Which **mode** is more **intensive**: train, bus or car?

- How does it **compare** to other economies in the region?

What can we learn from energy efficiency indicators?

Necessity of data on energy consumption by end-use (IEA)

Largest end uses by sector in IEA[1], 2018



Source: IEA Energy Efficiency Indicators, 2020

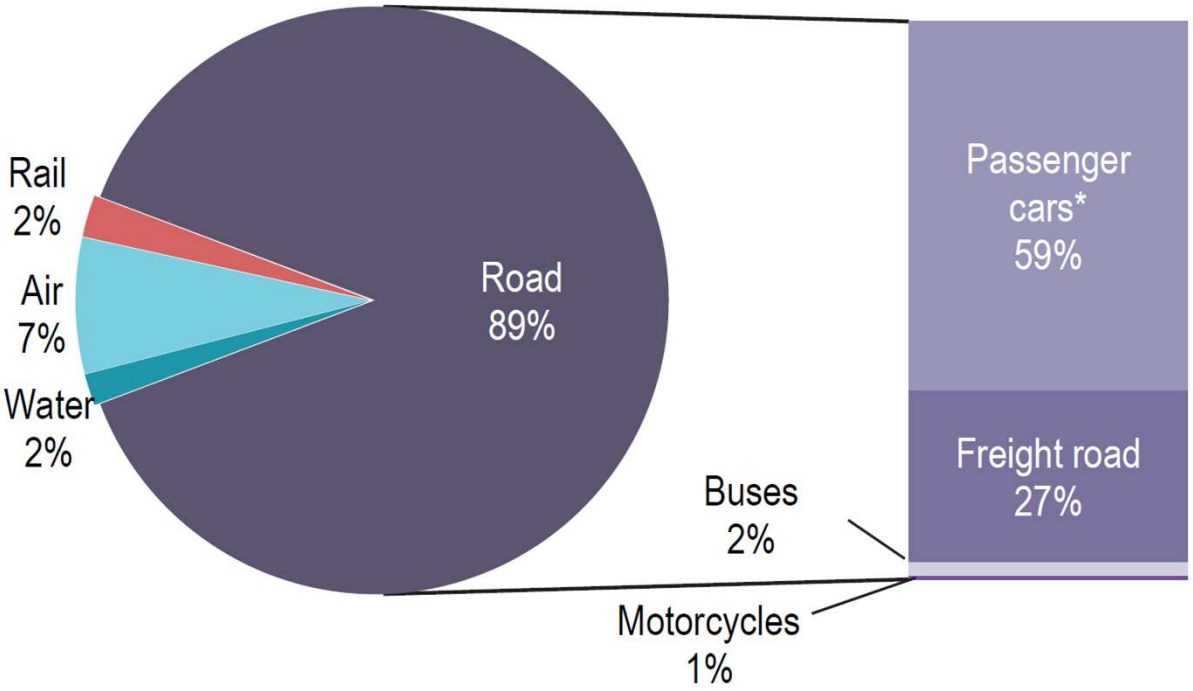
[1] The IEA aggregate refers to twenty-four IEA member countries for which data covering most end-uses area available: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Poland, Portugal, Slovak Republic, Spain, Switzerland, the United Kingdom and the United States. These countries represented about 92% of the total IEA final energy consumption for 2018.

** Passenger cars includes cars, sport utility vehicles and personal trucks.*
*** Other industries includes agriculture, mining and construction.*

Detailed data on energy consumption by end use / sub-sector form a necessary starting point, but are not enough.

Road, the largest mode, is mostly for passengers in IEA

Energy consumption in transport in IEA, 2018

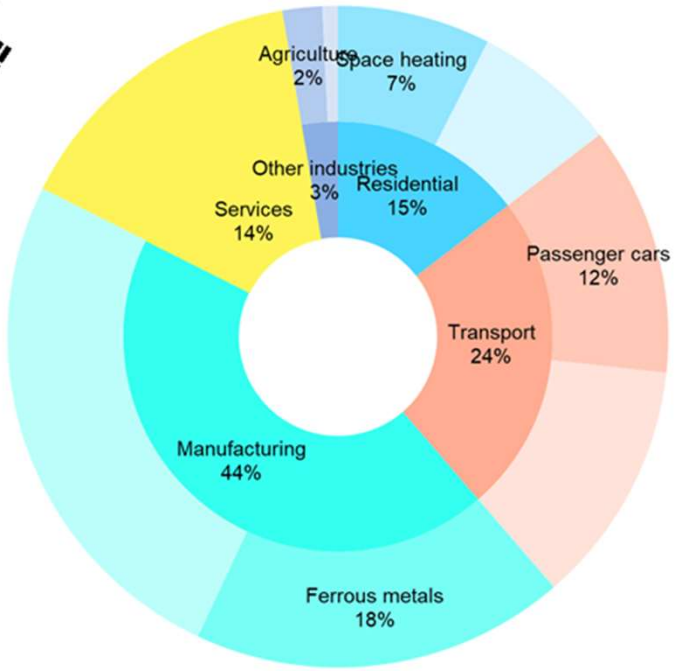


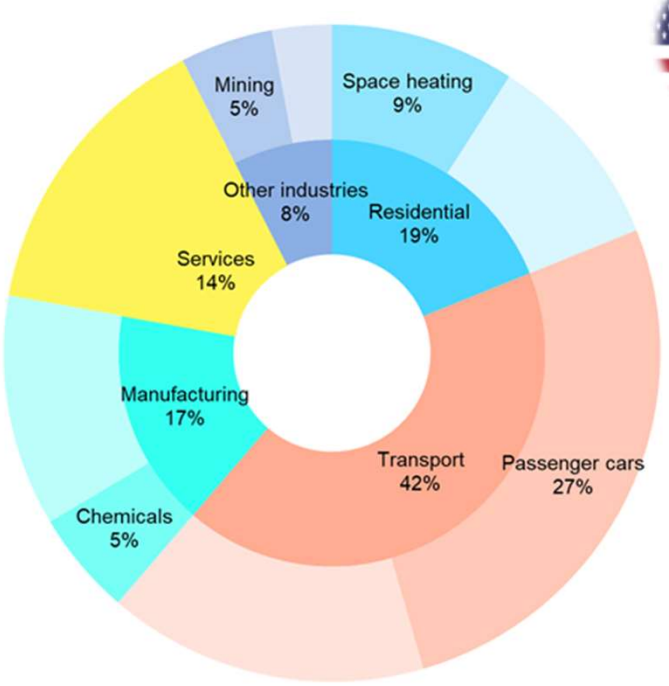
Source: IEA Energy Efficiency Indicators, 2020

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



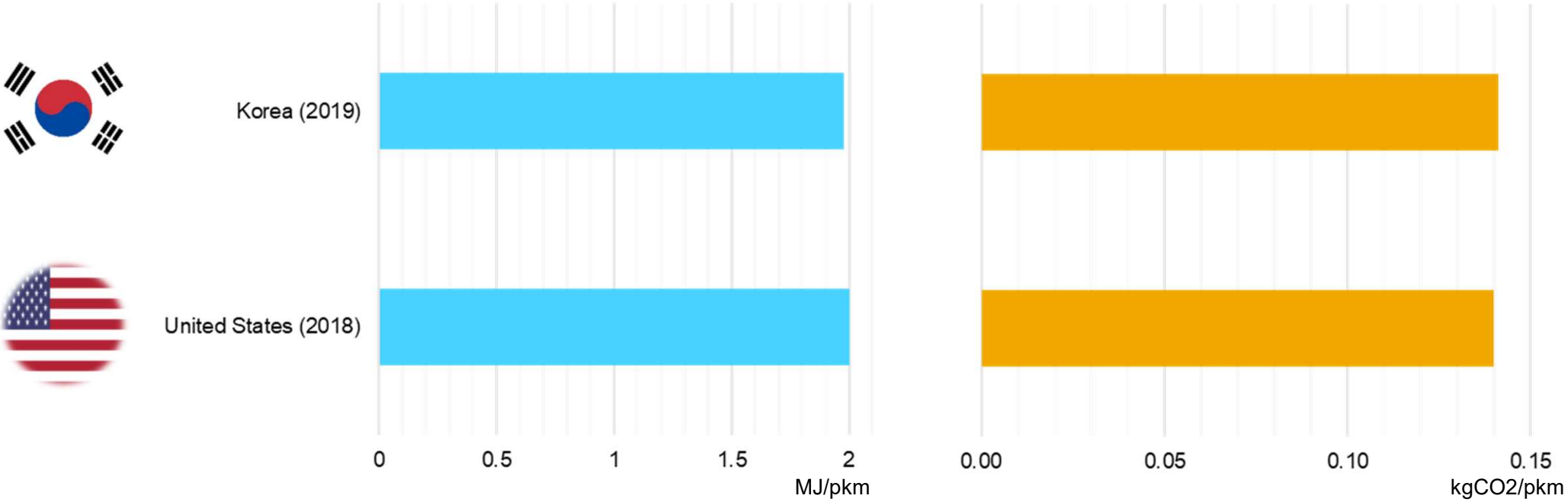


Source: IEA Energy Efficiency Indicators, 2021

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

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)



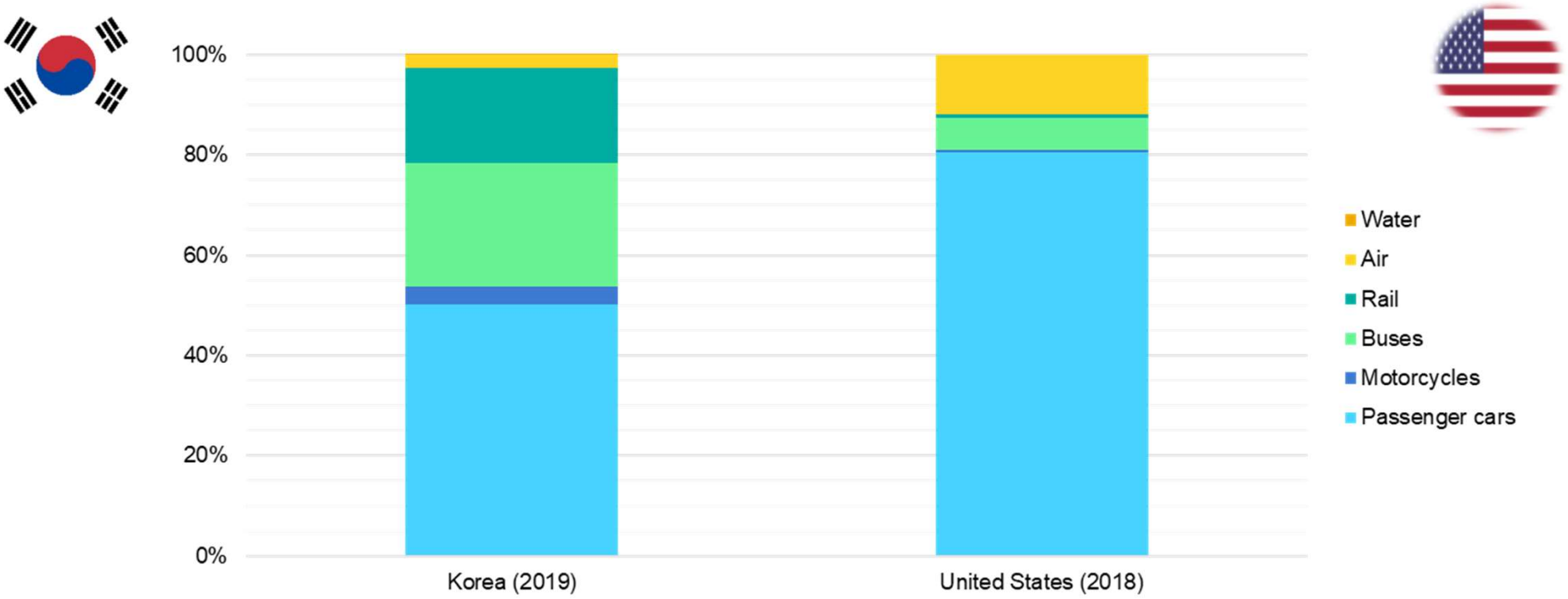
Pkm refers to passenger-kilometre, that is, the product of occupancy, vehicle stock and distance travelled.

Source: IEA Energy Efficiency Indicators, 2021

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

Split into different modes and vehicle types – Examples

Activity share in passenger transport in Korea (2019, left) and United States (2018, right)

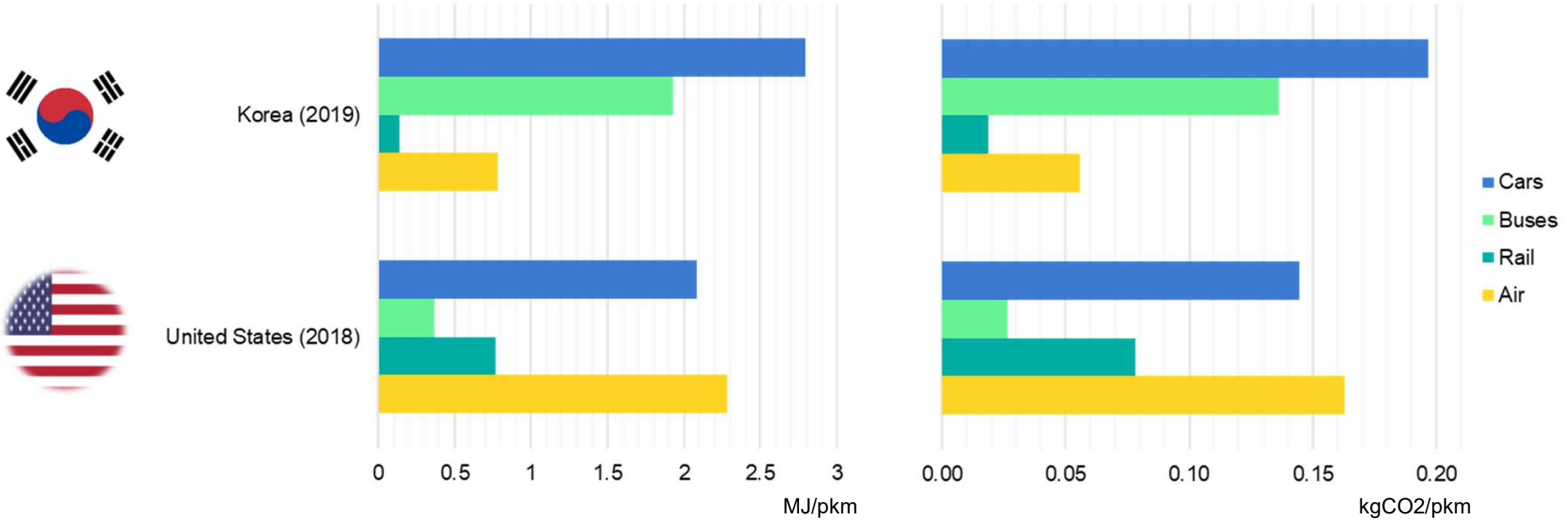


Source: IEA Energy Efficiency Indicators, 2021

In the passenger segment, the share of each mode and vehicle type varies significantly from one economy to the other.

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)



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

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.

What drives energy consumption depends on segment – Example

Decomposition into drivers of energy consumption

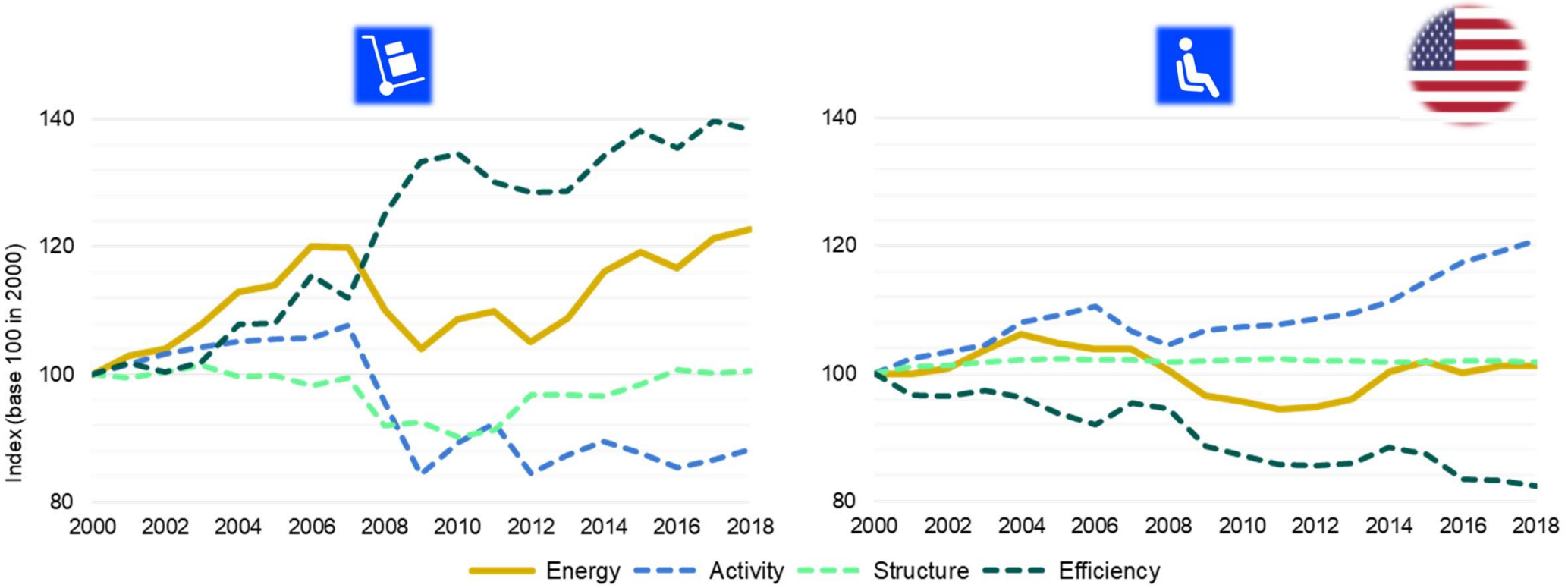
Segment	End use	Activity	Structure	Efficiency effect
Passenger transport	Cars/light trucks, buses, trains, domestic airplanes, domestic ships	Passenger-kilometres (pkm)	Share of pkm	Energy consumption per pkm
Freight transport	Trucks, trains, domestic airplanes, domestic ships	Tonne-kilometres (tkm)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

Source: IEA Efficiency Indicators Documentation 2021

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

What drives energy consumption depends on segment – Example

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



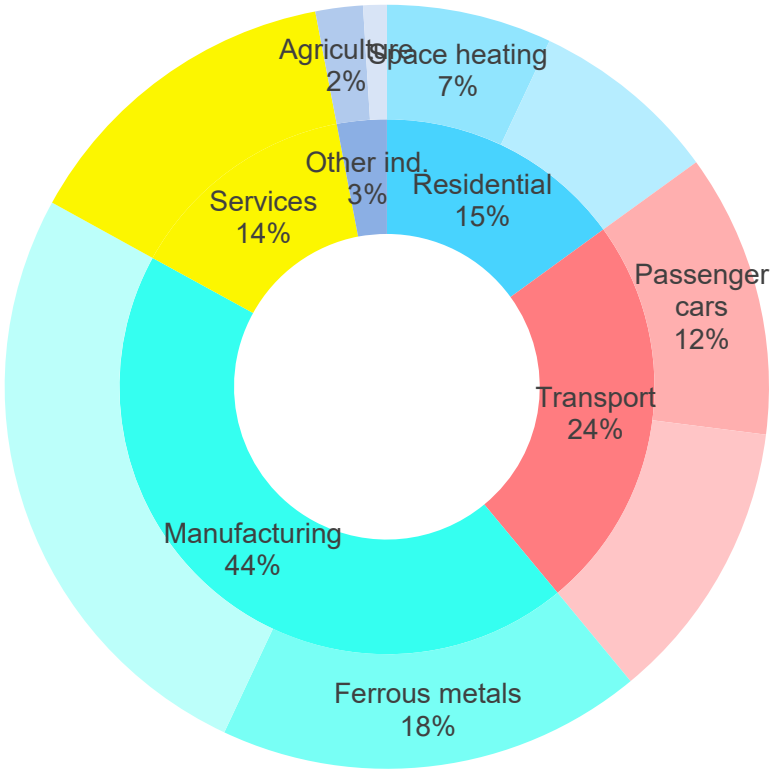
Source: IEA Energy Efficiency Indicators, 2021

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

Developing energy efficiency indicators

Energy efficiency indicators – Data coverage ambition

Additional data for energy efficiency indicators



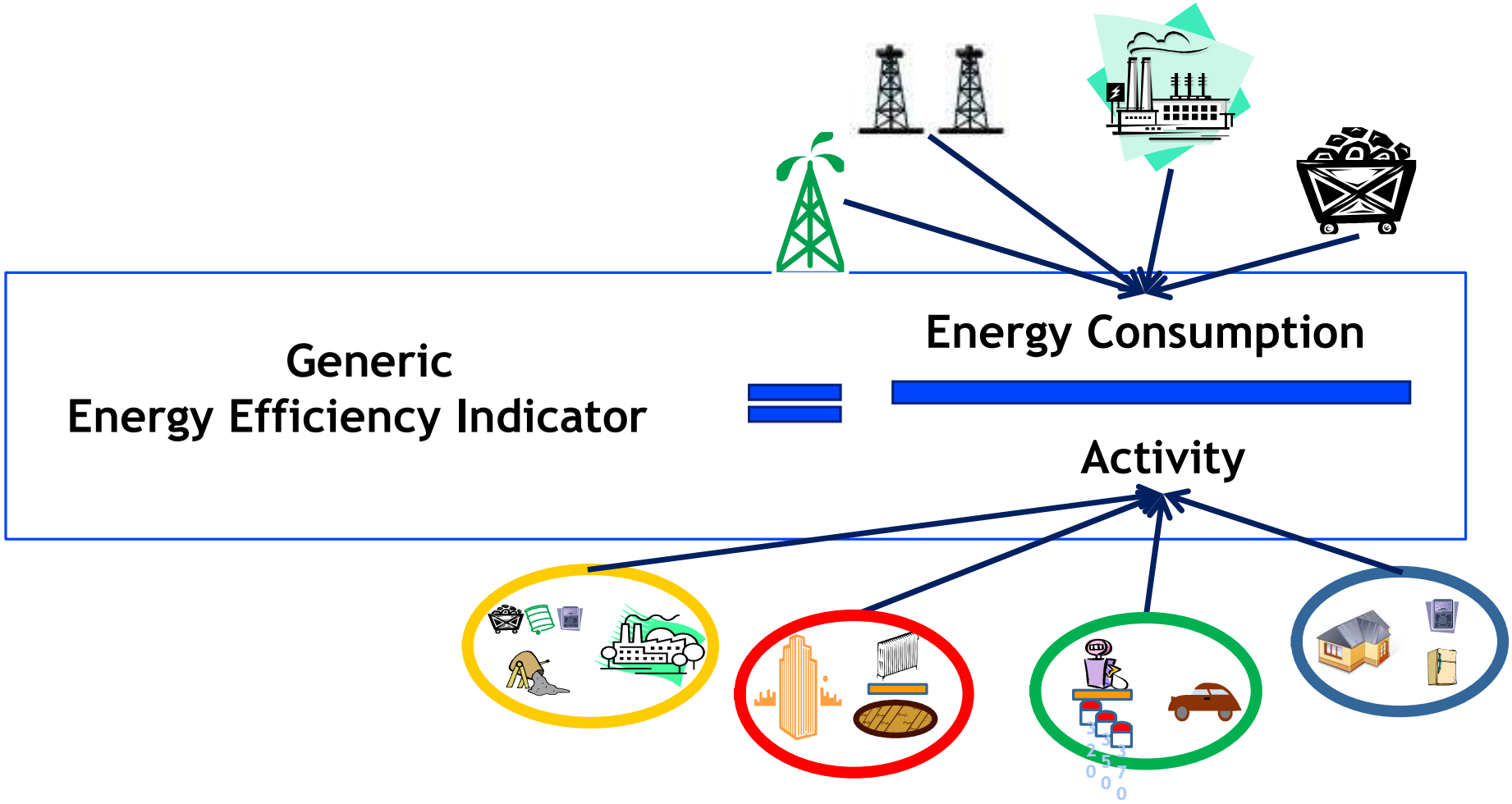
What **drives the energy consumption** in each sector?

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



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

Passenger

Freight

Road

Air

Rail

Water

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

Vehicle stock

Load

Distance travelled

Occupancy

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

Passenger *Freight*

Vehicle stock

Load

Distance travelled

Occupancy

Water

Selected modes and vehicle types by segment

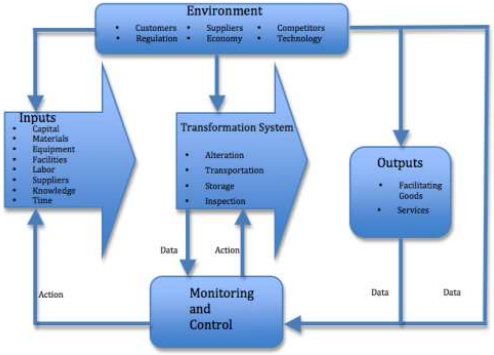
Mode \ Segment	Passenger	Freight
Road	Cars, SUV and personal light trucks *(gasoline, diesel, battery and PHEV)* Motorcycles Buses	Trucks *(light, medium, heavy)*
Rail	Passenger trains *(metro, conventional, high speed)*	Freight trains
Air	Passenger airplanes	Freight airplanes
Water	Passenger ships	Freight ships

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).

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



Methods used to collect data – Which tool for which data

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

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

Source: Energy Efficiency Indicators - Fundamentals on Statistics

The most efficient methodology depends on each sector, as they require different data from different sets of consumers and institutions.

Methods used to collect data – Which tool for which data

Type of data / Methodology	Consumption data		Macro-economic data	Activity data		
	Sectoral and sub-sectoral	Detailed by segment / vehicle type		Distance-related (vkm, pkm, tkm)	Vehicle stocks	Fuel economy
Administrative sources	National energy statistics and balances		National statistics offices	National / international databases	Statistics offices Manufacturers Regulating institutions	Manufacturers
Surveys	Consumers	Consumers		Transport ministries		
Measuring				Regulating institutions Transport authorities	Regulating institutions	
Modelling				Transport ministries		

The most efficient methodology depends on each sector,
as they require different data from different sets of consumers and institutions.

IEA members recognize the value of end-use data work

- Agreed by member countries in 2009 (IEA Ministerial)

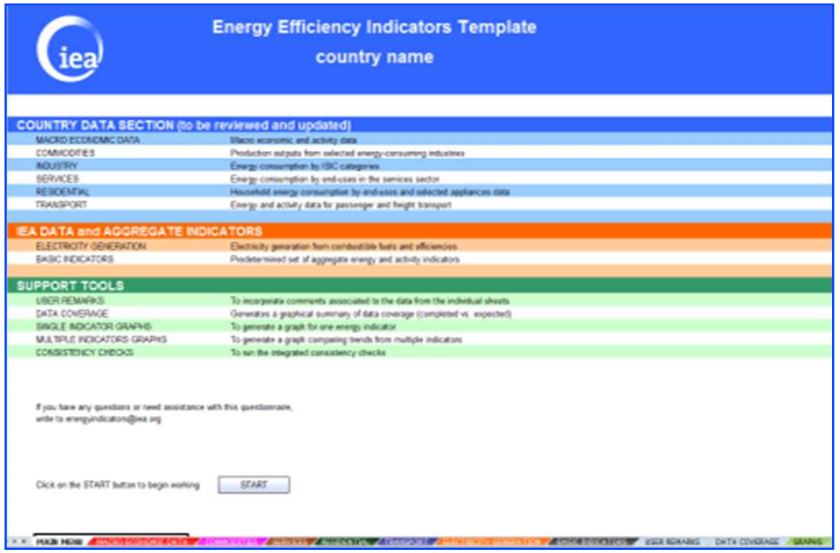
  Developed with **international community of experts** (Odyssee, LBNL, etc.)

- A user-friendly **Excel questionnaire** (available online)

  Collects **energy consumption** and **activity** data

  Covers **four sectors**: residential, services, industry, transport

- Publication and database available at https://www.iea.org/reports/energy-efficiency-indicators



Energy Efficiency Indicators – New user-friendly publication

6 sectoral graphs on transport

user-friendly interactive slicers

underlying data tables

country-comparison, cross-sectoral and sectoral interactive graphs

full database of energy and carbon per sector, as well as activity and drivers

To increase visibility of energy efficiency, improve user experience and allow immediate visual interpretation.

IEA resources – Methodology on indicators

- **Fundamentals on statistics**
  - To provide guidance on **how to collect the data** needed for indicators
  - Includes a compilation of existing practices from across the world
  - https://www.iea.org/reports/energy-efficiency-indicators-fundamentals-on-statistics

- **Essentials for policy makers**
  - To provide guidance to **develop and interpret indicators**
  - Includes a compilation of existing practices from across the world
  - https://www.iea.org/reports/energy-efficiency-indicators-essentials-for-policy-making

Both available in Chinese, French, Russian and Spanish

International guidelines are key to ensure comparability of data and indicators across countries.

IEA e-learning courses – Capacity building on energy efficiency data

POWERED BY OPENedX

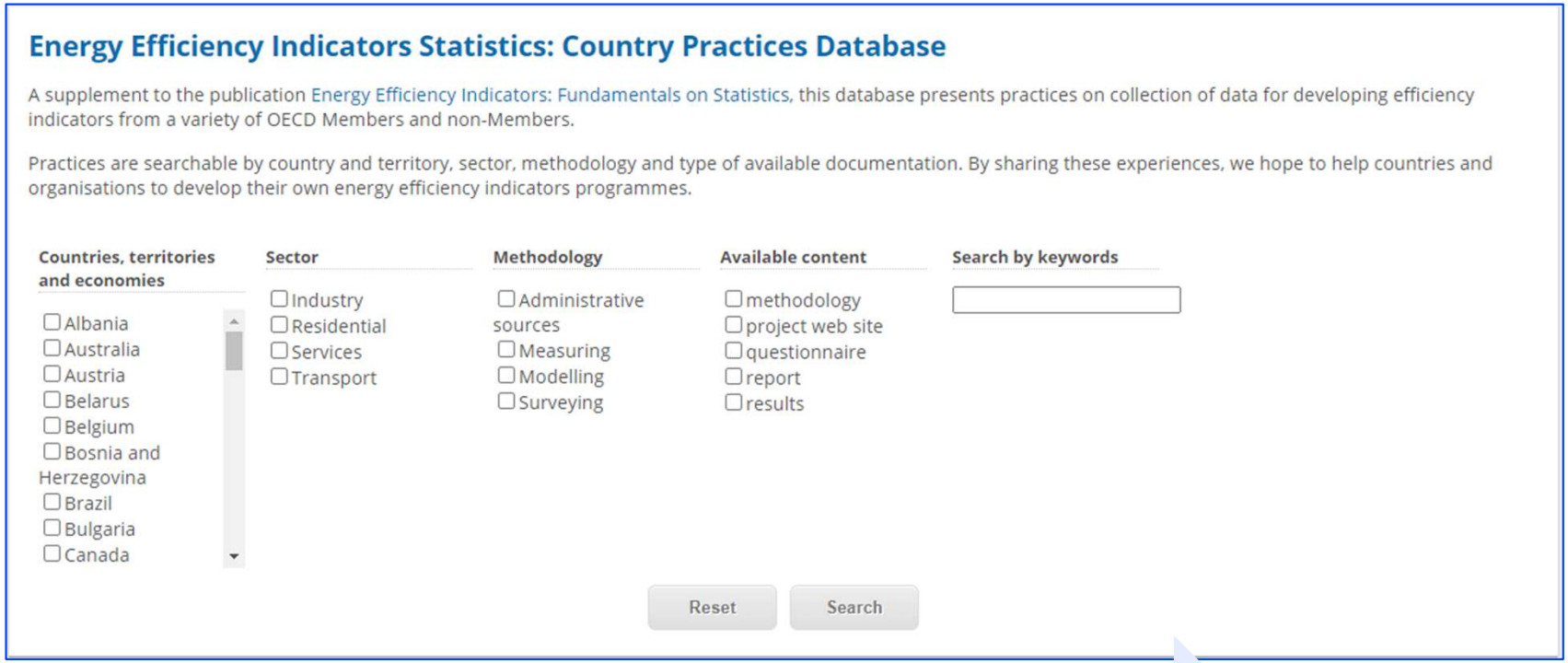
- **Fundamentals on statistics**

- **Essentials for policy makers**

Both available on

https://elearning.iea.org/

IEA sharing platform – Country practices database



Contact us and share your practice

https://delegates.iea.org/delegates/eeindicatorsmanual/

A searchable database, gathering data collection practices from a variety of countries, to share expertise worldwide.

Calculation of transport activity data

Activity data for efficiency indicators in transport

Passenger-km or ***tonne-km***

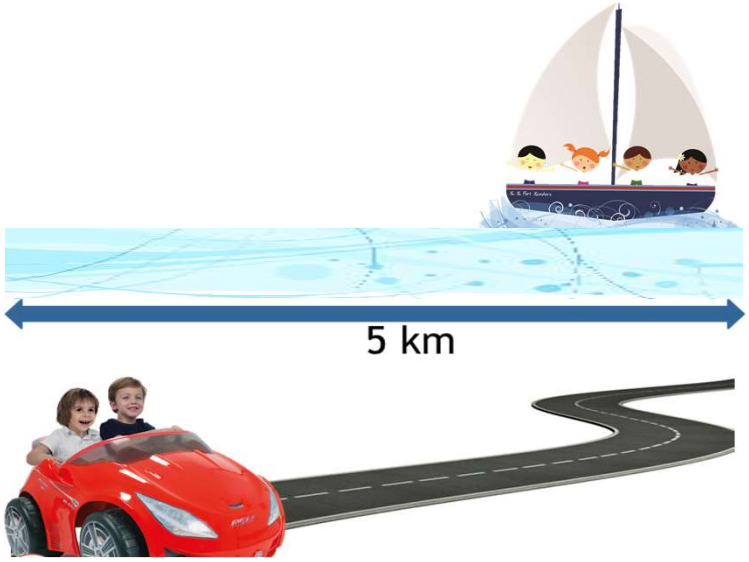
Occupancy

Load factor

Vehicle stock

Distance travelled

Activity data for efficiency indicators in transport



V-km = 5km + 5 km = 10 v-km

P-km = 6 passengers * 5 km = 30 p-km

Avg. load = p-km/v-km = 30 / 10 = 3 p/v

Total vkm and total pkm calculation – Example

For one vehicle, **vkm** is the total distance travelled in a period.

For a stock of vehicles, one can compute

vkm = number of vehicles x average distance per vehicle (km)

pkm = vkm x average occupancy

tkm = vkm x average load

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.