Energy efficiency indicators: Fundamentals

Mafalda Silva Energy efficiency indicators

Jakarta, 16-20 July 2018

IEA

➢ Energy efficiency indicators: **Why?**

➢ Starting from energy balances: benefits and limits of high-level indicators

➢ Beyond the energy balance: **energy efficiency indicators**

➢ The **IEA** approach

Energy efficiency indicators: why?

Indicators: key to set targets and track efficiency progress

Reduce **EI** by **20% in 2020** **30% in 2025** based on 2005 level

Country	Targets on Energy Efficiency
Brunei Darussalam	Reducing Energy Intensity (TFC/GDP) to 2035 by 45% based in 2005 level.
Cambodia	• Reducing TFC by 20% in 2035 compared to BAU. • Industry: up to 20% in garment factories and 70% in ice factories • Residential: up to 50% • Commercial: 20 to 30% • Rural Electrification Energy Savings: up to 80% • Replacement of biomass use 30-50%
Indonesia	• To achieve 1% **energy intensity** reduction per annum. • Reducing TFC in 2025 by 17% in industry, 20% in Transportation, 15% in household, 15% in commercial building compared to BAU.
Lao PDR	Reducing TFC 10% in 2030 compared to BAU.

ASEAN PLAN OF ACTION FOR ENERGY COOPERATION (APAEC) 2016-2025
PHASE I: 2016-2020

One Community for Sustainable Energy

Source: ASEAN Plan of Action for Energy Cooperation (APAEC)

Indicators: key to set targets and track efficiency progress

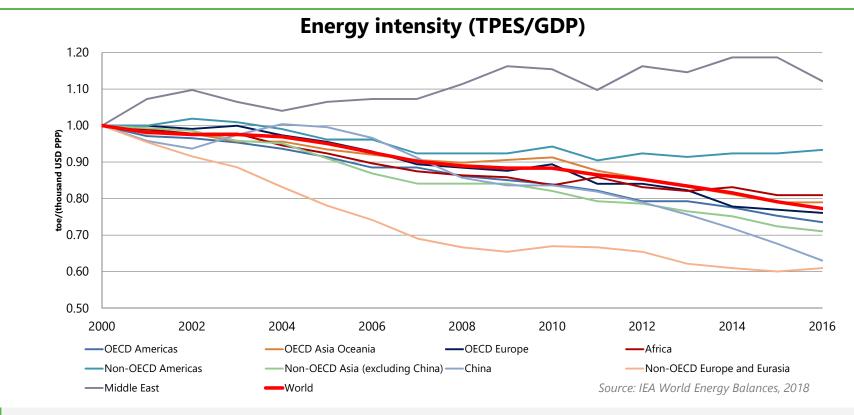ASEAN PLAN OF ACTION FOR ENERGY COOPERATION (APAEC) 2016-2025
PHASE I: 2016-2020

Reduce **EI** by **20% in 2020 30% in 2025** based on 2005 level

| Country	Targets on Energy Efficiency
Malaysia	Reducing **Electricity** Consumption by 8% in 2025.
Myanmar	Reducing **Electricity** Consumption by 20% in 2030.
Philippines	• Reducing **TFC** by 1% per year until 2040, equivalent with the reduction of one third of energy demand. • Reducing **Energy Intensity** (TFC/GDP) by 40% in 2040 as compared to 2005 level.
Thailand	Reducing **Energy Intensity** (TFC/GDP) by 30% in 2036 compared 2010 level.
Vietnam	• Reducing **TFC** by 8% in 2020 as compared to BAU. • Reduce **Energy Intensity** of Energy Intensive Industries by 10% by 2020.

But what indicators?
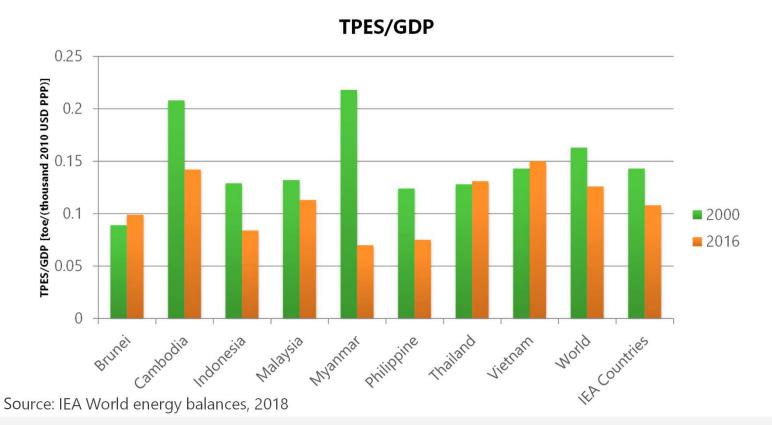
Source: ASEAN Plan of Action for Energy Cooperation (APAEC)

Does energy intensity track energy efficiency?

Energy intensity (TPES/GDP)

Legend:
- OECD Americas
- OECD Asia Oceania
- OECD Europe
- Africa
- Non-OECD Americas
- Non-OECD Asia (excluding China)
- China
- Non-OECD Europe and Eurasia
- Middle East
- World

Source: IEA World Energy Balances, 2018

Energy intensity has generally decreased across regions.
Using less energy per GDP means "decoupling" economic growth from energy use
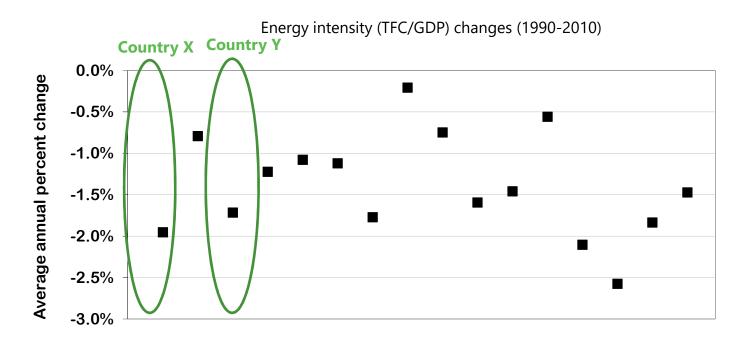
What drives energy intensity trends?

TPES/GDP

Source: IEA World energy balances, 2018

Efficiency progress but also other factors (mainly activity /structural changes)

Understanding aggregated indicators requires attention

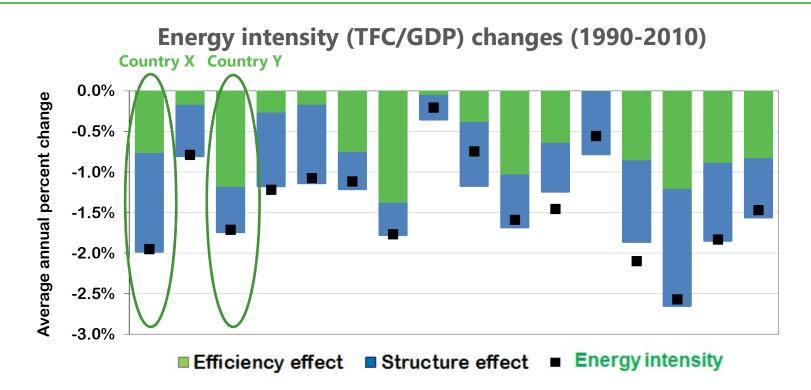Energy intensity (TFC/GDP) changes (1990-2010)

Intensity decreased more in country X, but is it proper to say that Country X has improved more in energy efficiency?

Data source: IEA, Energy efficiency indicators.

Aggregated indicators are sometimes used inappropriately

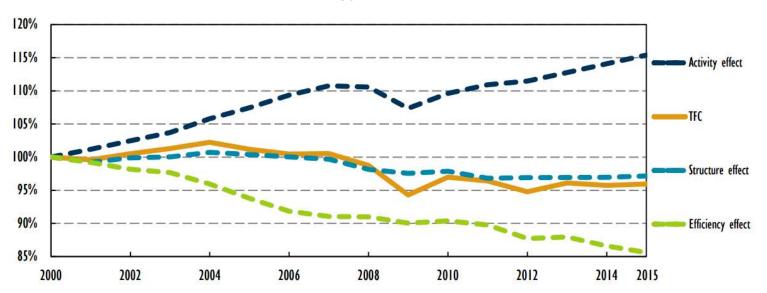**Energy intensity (TFC/GDP) changes (1990-2010)**

Country X intensity reduction was mostly due to structural changes, while country Y improved more in energy efficiency.

Data source: IEA, Energy efficiency indicators.

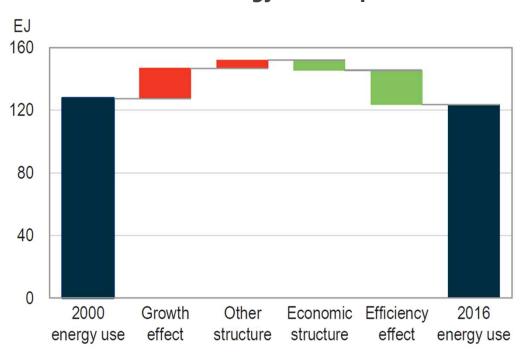# How to disentangle efficiency from other drivers?

Drivers of final energy consumption in IEA

Note: Analysis based on the *IEA Energy Efficiency Indicators* database (2016 edition). TFC in this analysis covers the following sectors: residential, industry and services, passenger and freight transport. It does not include agriculture, non-energy, and energy supply sectors. The energy consumption decomposed in this analysis represents 90% of TFC in IEA countries in 2015.

Source: IEA (2016), *Energy Efficiency Market Report*, OECD/IEA, Paris, based on IEA Energy efficiency indicators database.

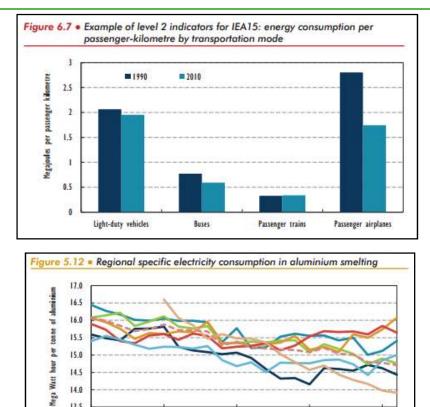# How to disentangle efficiency from other drivers?

Drivers of final energy consumption in IEA

End-use data and indicators are the answer

Figure 6.7 • Example of level 2 indicators for IEA15: energy consumption per passenger-kilometre by transportation mode

Figure 5.12 • Regional specific electricity consumption in aluminium smelting

Source: IAI (International Aluminium Institute) (2013), Primary Aluminium Production, IAI, London. See http://www.world-aluminium.org/statistics/ for definitions of geographical aggregations.
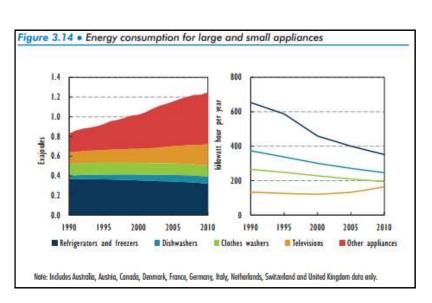
Figure 3.14 • Energy consumption for large and small appliances

Note: Includes Australia, Austria, Canada, Denmark, France, Germany, Italy, Netherlands, Switzerland and United Kingdom data only.

IEA Energy Efficiency Indicators:
Essentials for Policy Makers, 2014

Energy Efficiency Indicators
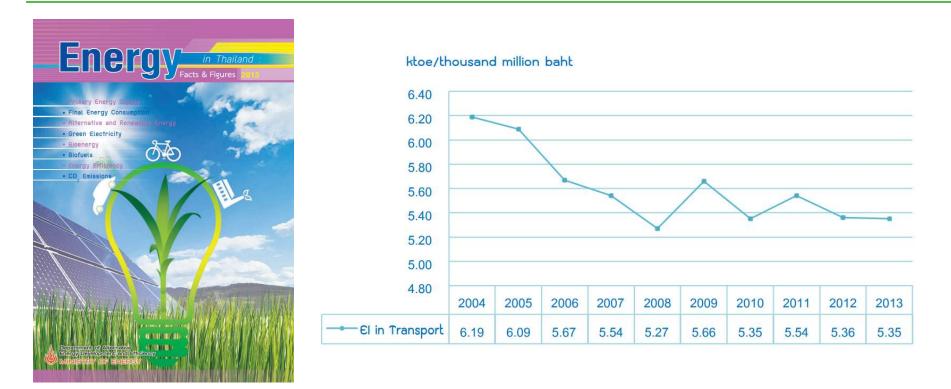
PHILIPPINES – Selected Industrial Subsector Intensities

Energy Efficiency Indicators

ktoe/thousand million baht

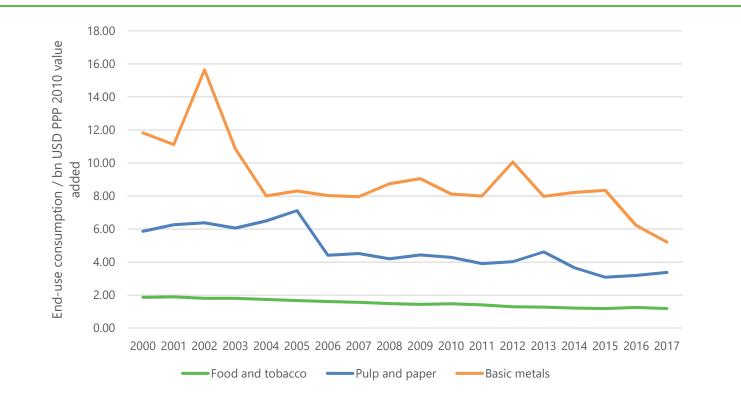|	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
EI in Transport	6.19	6.09	5.67	5.54	5.27	5.66	5.35	5.54	5.36	5.35

THAILAND – Publications on Energy Efficiency Indicators (Transport)

Source: http://weben.dede.go.th/webmax/sites/default/files/fact2013.pdf
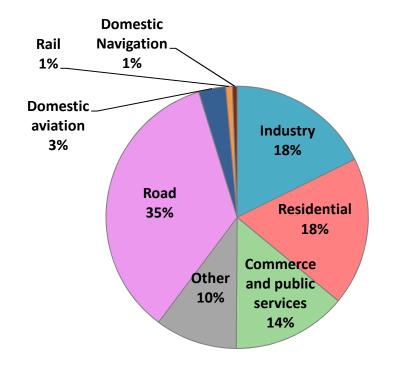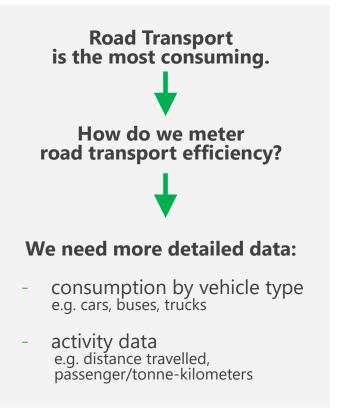
Starting from energy balances: benefits and limits of high-level indicators

Balances data example

Unite States TFC by sector, 2014

Pie chart: Industry 18%, Residential 18%, Commerce and public services 14%, Other 10%, Road 35%, Domestic aviation 3%, Domestic Navigation 1%, Rail 1%

Road Transport is the most consuming.

↓

How do we meter road transport efficiency?

↓

We need more detailed data:

- consumption by vehicle type
  e.g. cars, buses, trucks

- activity data
  e.g. distance travelled, passenger/tonne-kilometers

Data source: IEA (2016), World energy balances.
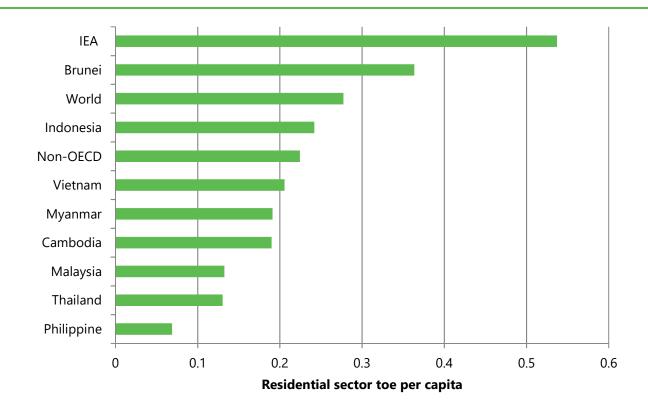
For example, shares of sectors in total final consumption*

* Total Final Consumption
excluding Non-energy uses

Legend: ■ Residential ■ Transport ■ Industry ■ Services ■ Others

Source, IEA World Energy Balances, 2018

Key to understand where energy is used and to define policy priorities
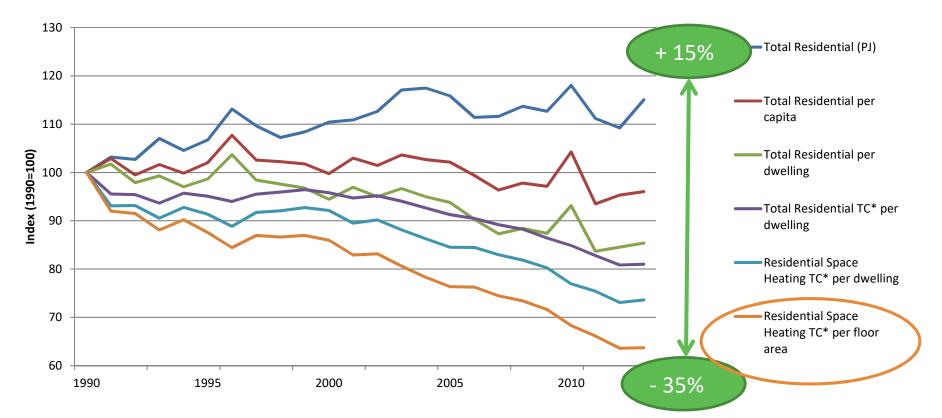
And more specific sectoral indicators

Residential sector toe per capita

Country	Value
IEA	~0.54
Brunei	~0.36
World	~0.28
Indonesia	~0.24
Non-OECD	~0.22
Vietnam	~0.21
Myanmar	~0.19
Cambodia	~0.19
Malaysia	~0.13
Thailand	~0.13
Philippine	~0.07

Coupling sectoral demand data with socio-economic data

Choosing the most appropriate indicators is essential

Index (1990=100)

Total Residential (PJ)

Total Residential per capita

Total Residential per dwelling

Total Residential TC* per dwelling

Residential Space Heating TC* per dwelling

Residential Space Heating TC* per floor area

+ 15%

- 35%

Data for IEA 20 (Australia, Austria, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Netherlands, Norway, Slovakia, Spain, Sweden, Switzerland, UK, USA).
* Temperature correction using heating degree days
Data source: IEA, Energy efficiency indicators.

Balances are very useful but do not track end-uses

ENERGY BALANCE

|	Coal	Crude	Oil Products	Gas	Nuclear	Hydro	Geoth /Solar	Biofules & Waste	Electricity	Heat	Total
OTHER	136.42	0.23	425.87	633.44	-	-	14.37	834.05	820.32	145.22	3036.92
Residential	76.58	-	222.89	418.55	-	-	6.98	805.42	395.81	97.97	2024.19
Comm. and public serv.	23.3	-	107.32	173.79	-	-	1.15	16.33	338.31	32.47	692.67
Agriculture /forestry	9.57	0.02	102.97	5.58	-	-	0.16	7.02	36.2	3.36	164.88
Fishing	0.01	-	5.69	0.02	-	-	0.03	-	0.36	0.06	6.17
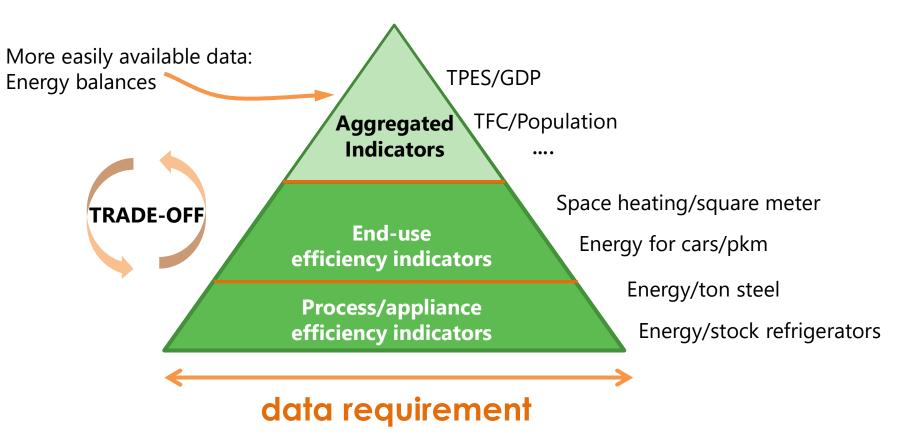
Residential:
no breakdown by end-use
- space heating
- space cooling
- water heating
- lighting
- cooking
- appliances

Energy efficiency indicators: stronger data requirements

More easily available data:
Energy balances

Aggregated Indicators

TPES/GDP

TFC/Population

….

TRADE-OFF

End-use efficiency indicators

Space heating/square meter

Energy for cars/pkm

Process/appliance efficiency indicators
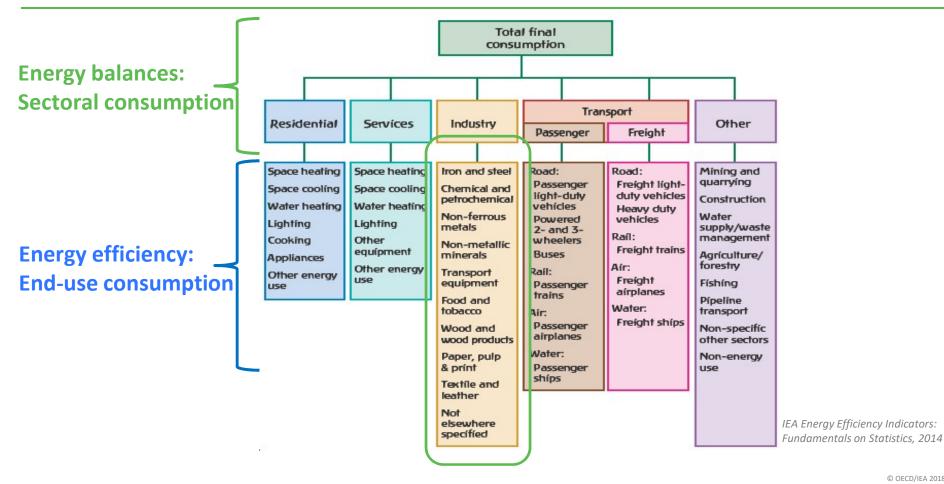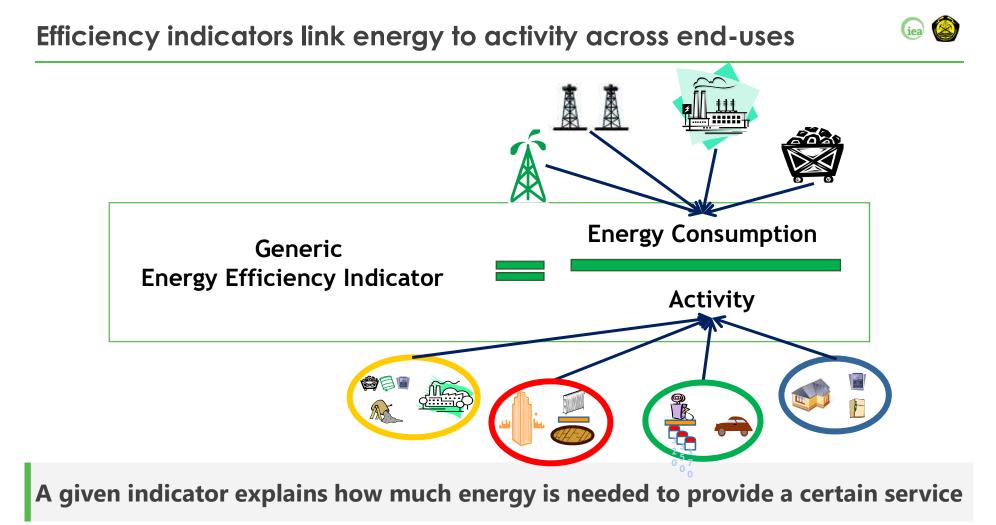
Energy/ton steel

Energy/stock refrigerators

data requirement

Beyond the energy balance: energy efficiency indicators

Analyzing energy end-uses
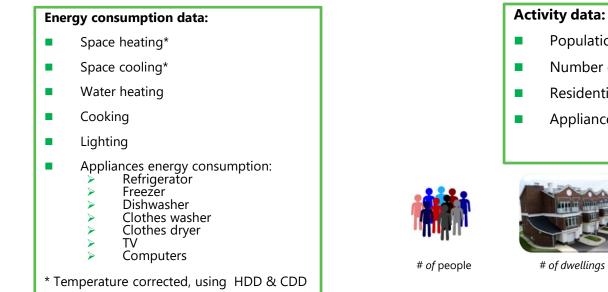
Understanding end-uses across sectors

Energy balances:
Sectoral consumption

Energy efficiency:
End-use consumption

Total final consumption

| Residential | Services | Industry | Transport | | Other |
| | | | Passenger | Freight | |

Residential: Space heating, Space cooling, Water heating, Lighting, Cooking, Appliances, Other energy use

Services: Space heating, Space cooling, Water heating, Lighting, Other equipment, Other energy use

Industry: Iron and steel, Chemical and petrochemical, Non-ferrous metals, Non-metallic minerals, Transport equipment, Food and tobacco, Wood and wood products, Paper, pulp & print, Textile and leather, Not elsewhere specified

Passenger: Road: Passenger light-duty vehicles, Powered 2- and 3-wheelers, Buses; Rail: Passenger trains; Air: Passenger airplanes; Water: Passenger ships

Freight: Road: Freight light-duty vehicles, Heavy duty vehicles; Rail: Freight trains; Air: Freight airplanes; Water: Freight ships

Other: Mining and quarrying, Construction, Water supply/waste management, Agriculture/forestry, Fishing, Pipeline transport, Non-specific other sectors, Non-energy use

IEA Energy Efficiency Indicators: Fundamentals on Statistics, 2014

Efficiency indicators link energy to activity across end-uses

Generic Energy Efficiency Indicator $=$ $\dfrac{\text{Energy Consumption}}{\text{Activity}}$

A given indicator explains how much energy is needed to provide a certain service

Data and indicators for the residential sector

Energy consumption data:

- Space heating*

- Space cooling*

- Water heating

- Cooking

- Lighting

- Appliances energy consumption:
  - Refrigerator
  - Freezer
  - Dishwasher
  - Clothes washer
  - Clothes dryer
  - TV
  - Computers

* Temperature corrected, using HDD & CDD

Activity data:

- Population

- Number of occupied dwellings

- Residential floor area

- Appliances stock and diffusion
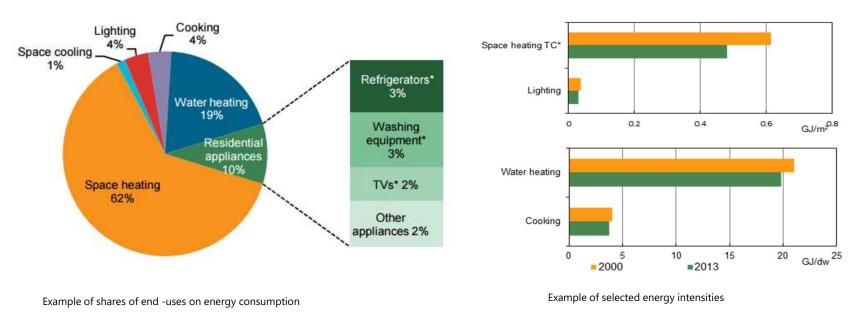
 # of people   *# of dwellings*   *Surface*   *# of appliances*

IEA Energy Efficiency Indicators:
Fundamentals on Statistics

© OECD/IEA 2018
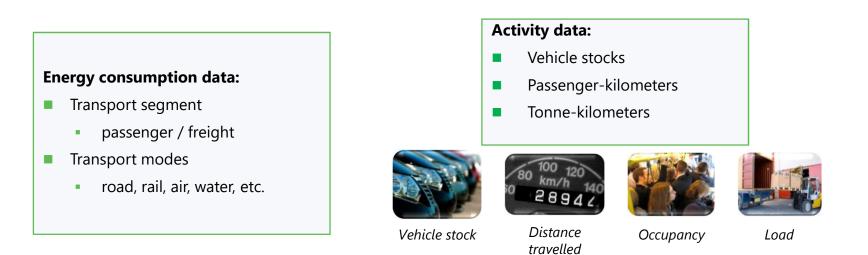
Example of insights from end use data: residential sector
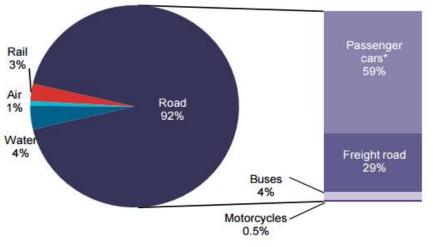
Example of shares of end -uses on energy consumption

Example of selected energy intensities

IEA Energy Efficiency Indicators:
Fundamentals on Statistics

Data and indicators for the 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

IEA Energy Efficiency Indicators: Fundamentals on Statistics

Shares by mode/vehicle type on energy consumption, country Y

Selected energy intensities, country Y

IEA Energy Efficiency Indicators: Fundamentals on Statistics

Data and indicators for the industry sector

Energy consumption data

- (major ISIC sub-sectors):
- Chemical
- Iron and steel
- Non-ferrous metals
  - Aluminum
- Non-metallic minerals
  - Cement
  - Clinker
- Pulp and paper
  - Pulp
  - Paper
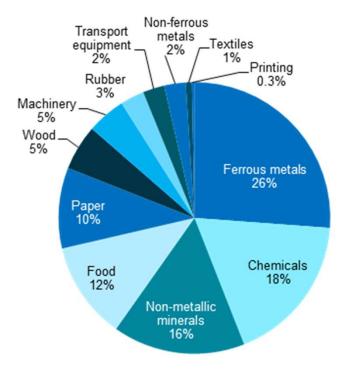- …. etc.
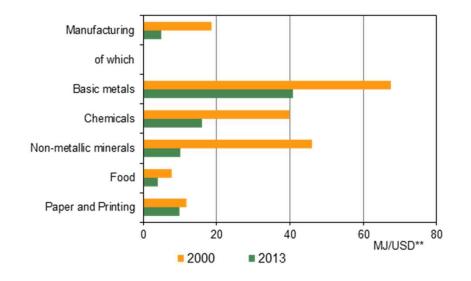
Activity data:

- Value added
- Physical production

Volume   *Value added*

IEA Energy Efficiency Indicators:
Fundamentals on Statistics

Data and indicators for the industry sector

Example of shares of industry subsectors on energy consumption

Example of selected energy intensities

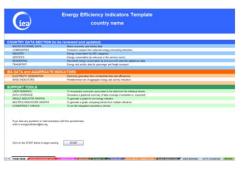*IEA Energy Efficiency Indicators: Highlights 2017c*

The IEA approach

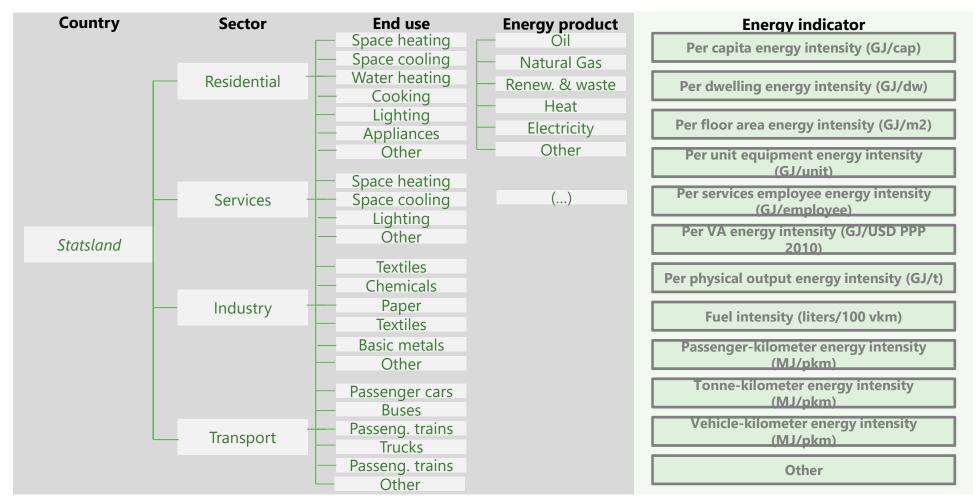# Addressing the challenge: the IEA experience

➢ Agreed by member countries in 2009 (IEA Ministerial)

➢ **Developed with international community of expe**rts,
   based on historical work on indicators (Odyssee, LBNL, etc.)

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

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

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

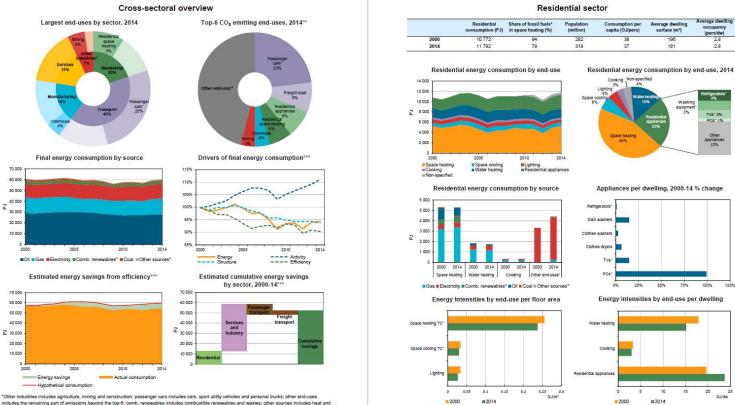➢ **Publication** and **database** : *Energy efficiency indicators Highlights*

The end use data collected and disseminated by the IEA

Country	Sector	End use	Energy product	Energy indicator
Statsland	Residential	Space heating	Oil	Per capita energy intensity (GJ/cap)
		Space cooling	Natural Gas	Per dwelling energy intensity (GJ/dw)
		Water heating	Renew. & waste	Per floor area energy intensity (GJ/m2)
		Cooking	Heat	Per unit equipment energy intensity (GJ/unit)
		Lighting	Electricity	Per services employee energy intensity (GJ/employee)
		Appliances	Other	Per VA energy intensity (GJ/USD PPP 2010)
		Other		Per physical output energy intensity (GJ/t)
	Services	Space heating		Fuel intensity (liters/100 vkm)
		Space cooling	(...)	Passenger-kilometer energy intensity (MJ/pkm)
		Lighting		Tonne-kilometer energy intensity (MJ/pkm)
		Other		Vehicle-kilometer energy intensity (MJ/pkm)
	Industry	Textiles		Other
		Chemicals		
		Paper		
		Textiles		
		Basic metals		
		Other		
	Transport	Passenger cars		
		Buses		
		Passeng. trains		
		Trucks		
		Passeng. trains		
		Other		

Energy Efficiency Indicators Highlights

https://webstore.iea.org/energy-efficiency-indicators-2017-highlights
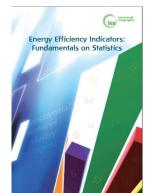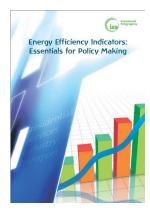
IEA tools to support indicators development

➢ 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://goo.gl/Y8QD1G

➢ Essentials for policy makers:
  ▪ to provide guidance to develop and interpret energy efficiency indicators
  ▪ https://goo.gl/agcNg2

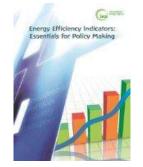# IEA e-learning courses: capacity building on energy efficiency data

- **Energy Efficiency Indicators: Fundamentals on Statistics**

- **Energy Efficiency Indicators: Essentials for Policy Making**
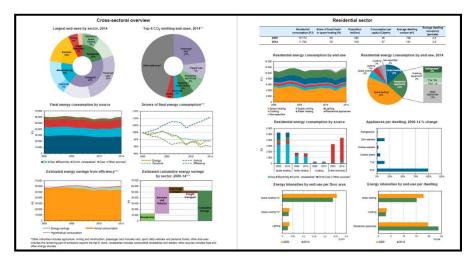

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The IEA mission on data

- To collect and disseminate reliable and relevant data to inform policy - making

https://webstore.iea.org/energy-efficiency-indicators-2017-highlights

- We hope that you join our efforts !

www.iea.org/statistics

IEA