



Energy efficiency indicators: *The IEA approach*

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Bangkok | 2nd April 2019



IEA #energyefficientworld

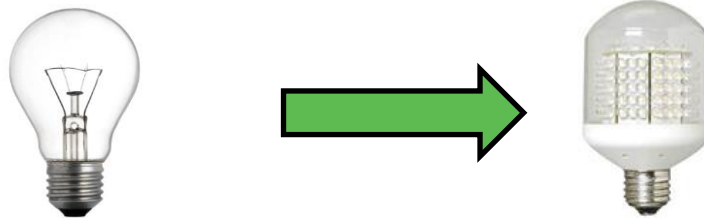
- The need for more detailed data to track progress energy efficiency policies
- Beyond the energy balance: energy efficiency indicators
- The IEA approach of collecting end use data and developing efficiency indicators
- Energy Efficiency Indicators in SEA
- Practical exercise – industry

What is energy efficiency?

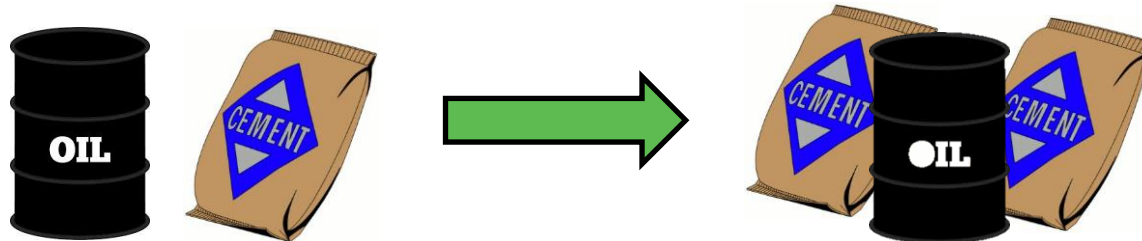
Is this energy efficiency?

Warm up:
Yes / No / Maybe

- Consume **LESS** energy to provide **SAME** service
e.g. substitute incandescent bulbs with LED



- Consume **SAME** energy to provide **MORE** service
e.g. increased production with the same energy



What is energy efficiency?

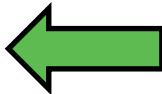
Is this energy efficiency?

Warm up:
Yes / No / Maybe

- Consume **LESS** energy because of **CHANGE** in service
E.g. economic restructuring

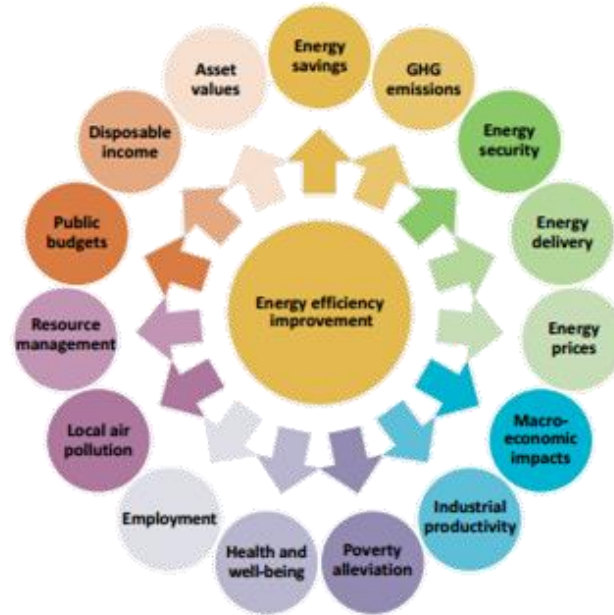


- Consume **LESS** energy and provide **LESS** service
E.g. walk or bike instead of drive



What is the importance of energy efficiency?

The multiple benefits of energy efficiency

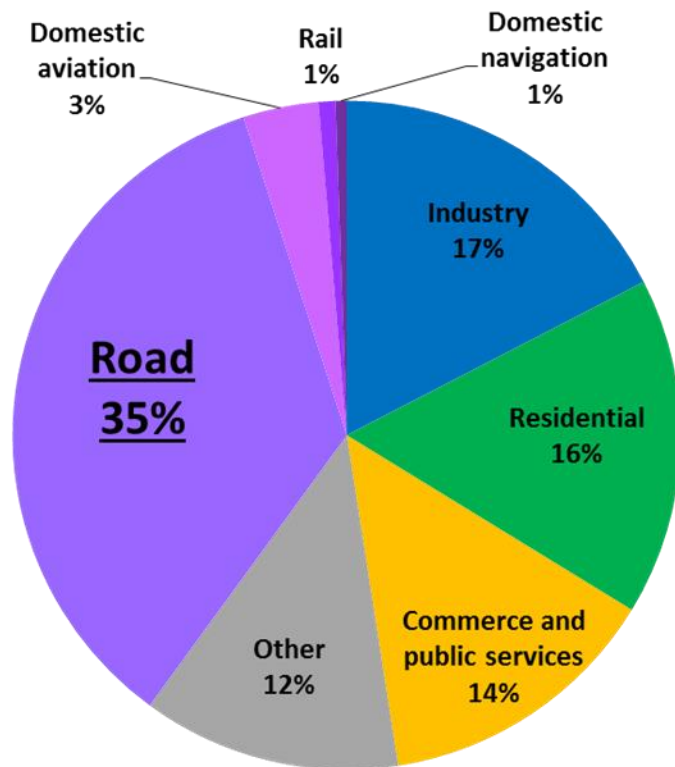


Multiple benefits: Environmental, economic and social

The need for more detailed data to track progress of energy efficiency policies

Energy efficiency indicators

United States TFC by sector, 2016



Data source: IEA (2018), World energy balances.

**Road Transport
is the most consuming.**



**How do we track
road transport efficiency?**

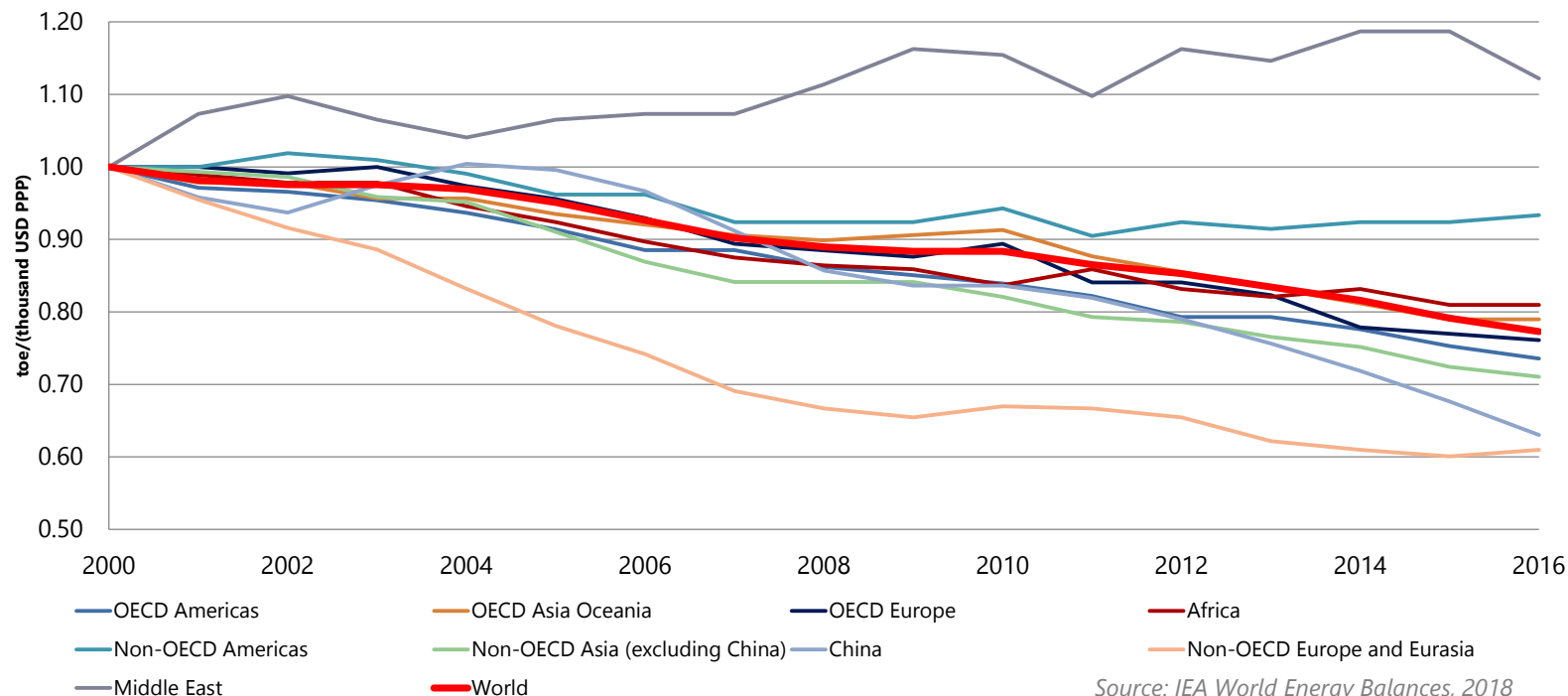


We need more detailed data:

- consumption by vehicle type
e.g. cars, buses, trucks
- activity data
e.g. distance travelled,
passenger/tonne-kilometers

Does energy intensity track energy efficiency?

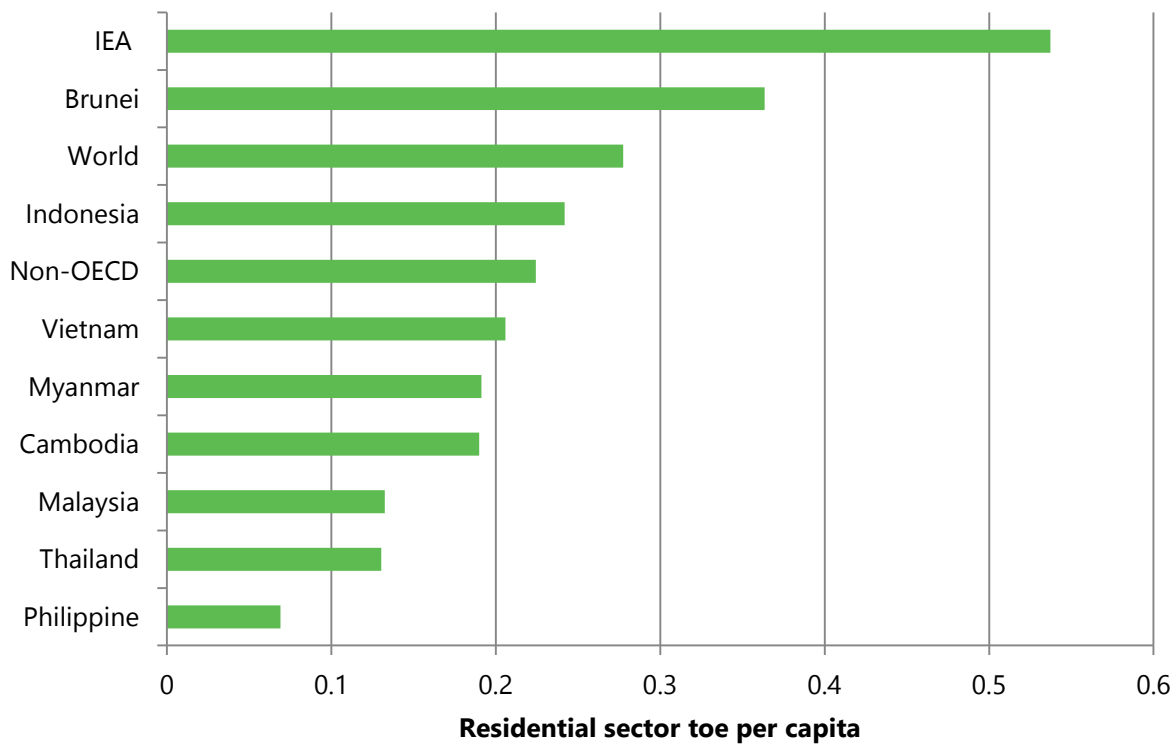
Energy intensity (TPES/GDP)



Source: IEA World Energy Balances, 2018

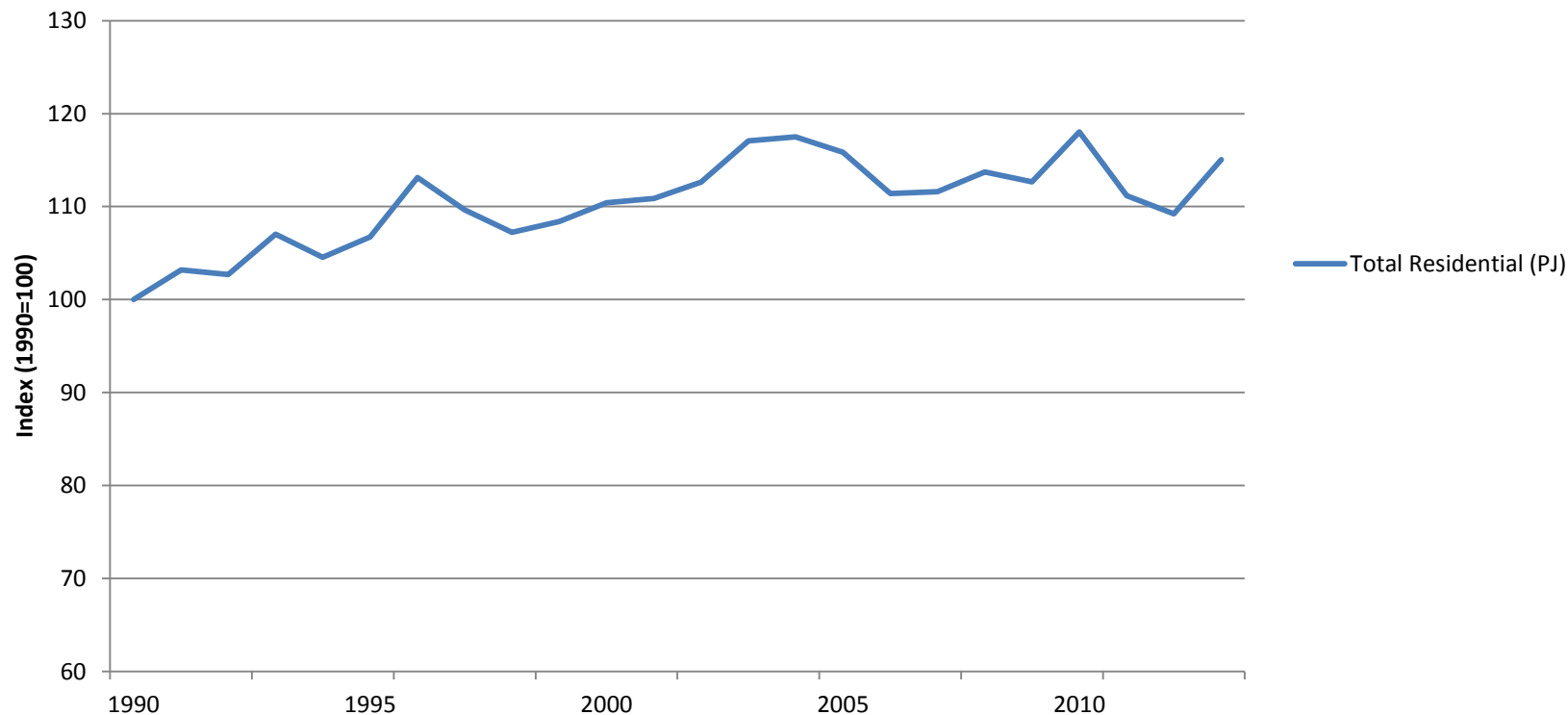
Energy intensity has generally decreased across regions.
Using less energy per GDP means “decoupling” economic growth from energy use

High-level indicators are useful



Coupling sectoral energy data with socio-economic data

But do aggregated indicators tell us the full story?

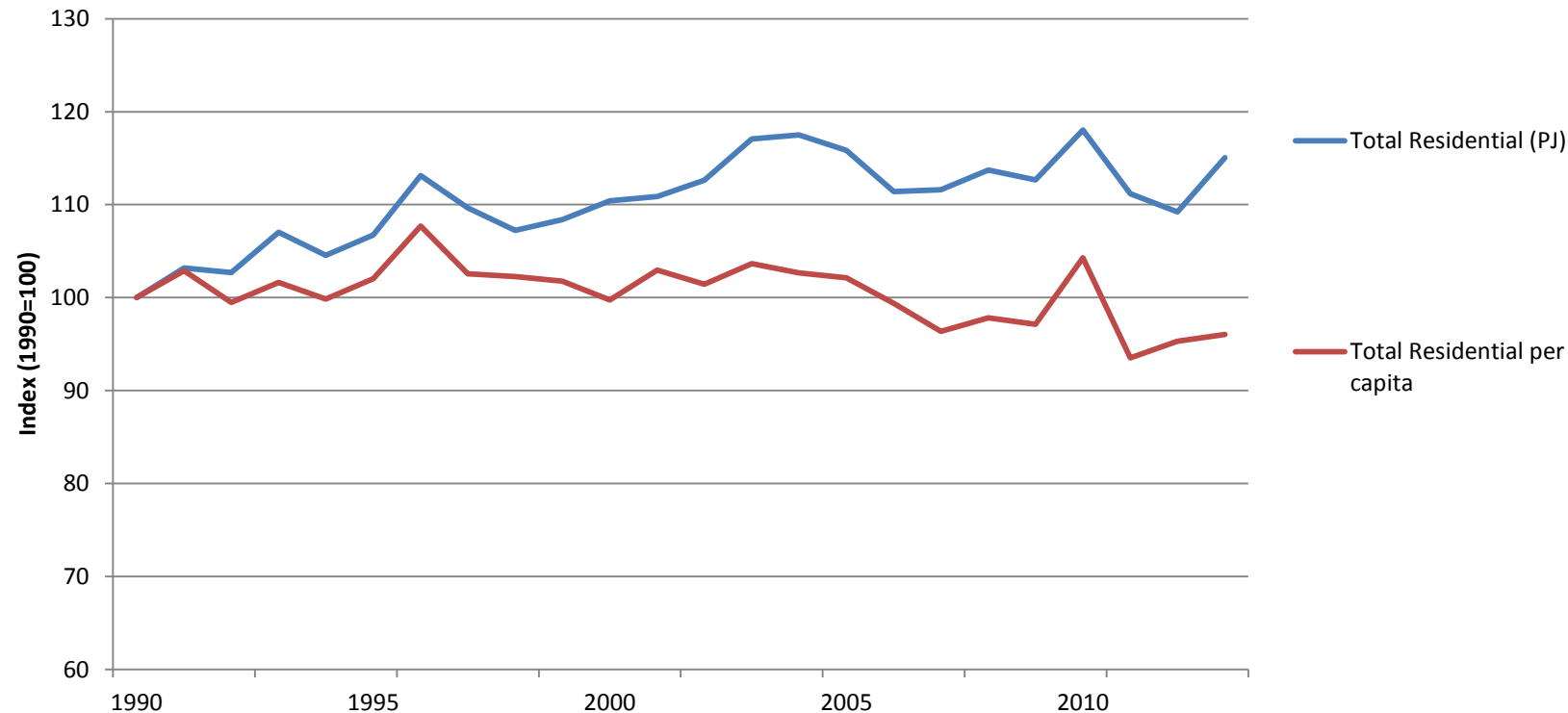


Data for IEA 20 (Australia, Austria, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Netherlands, Norway, Slovakia, Spain, Sweden, Switzerland, UK, USA).

* Temperature correction using heating degree days

Data source: IEA, Energy efficiency indicators.

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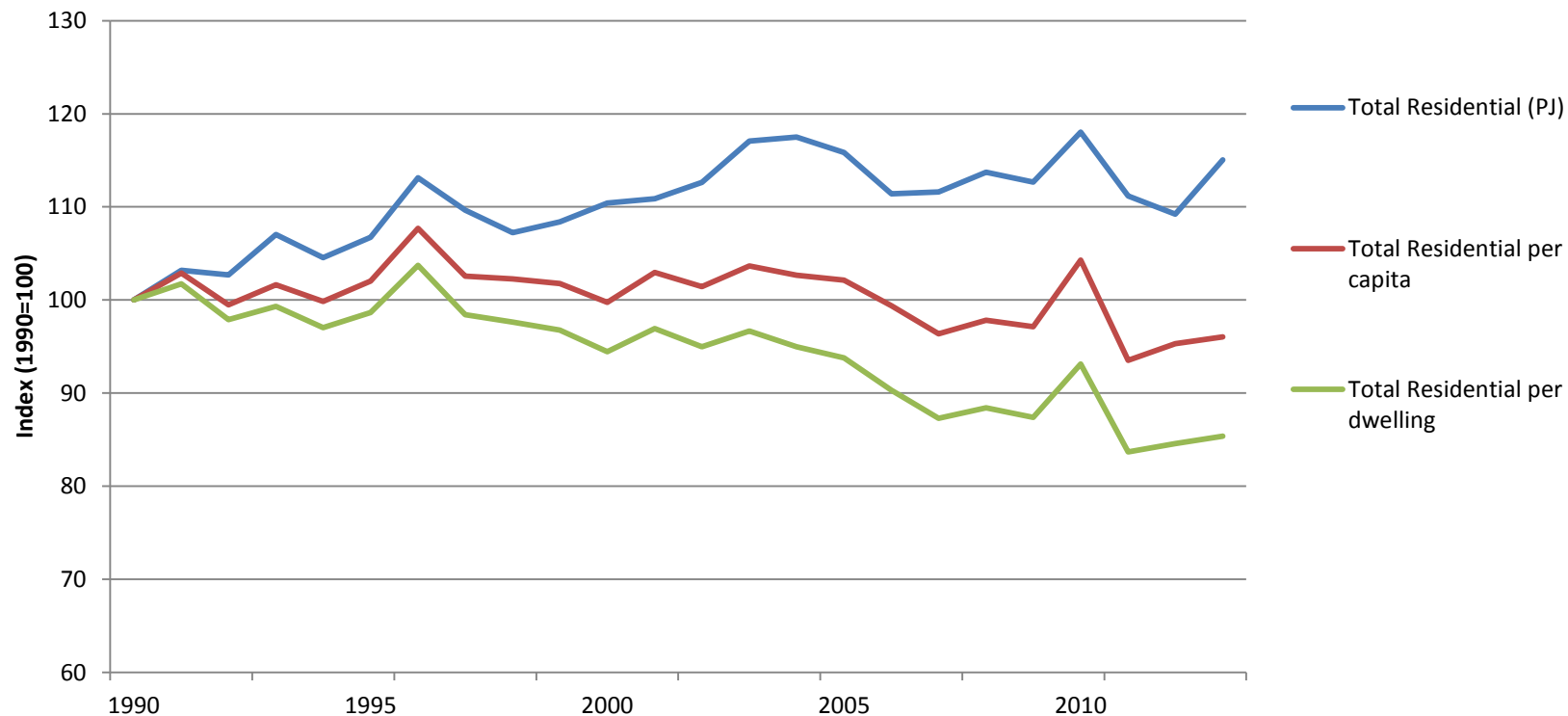


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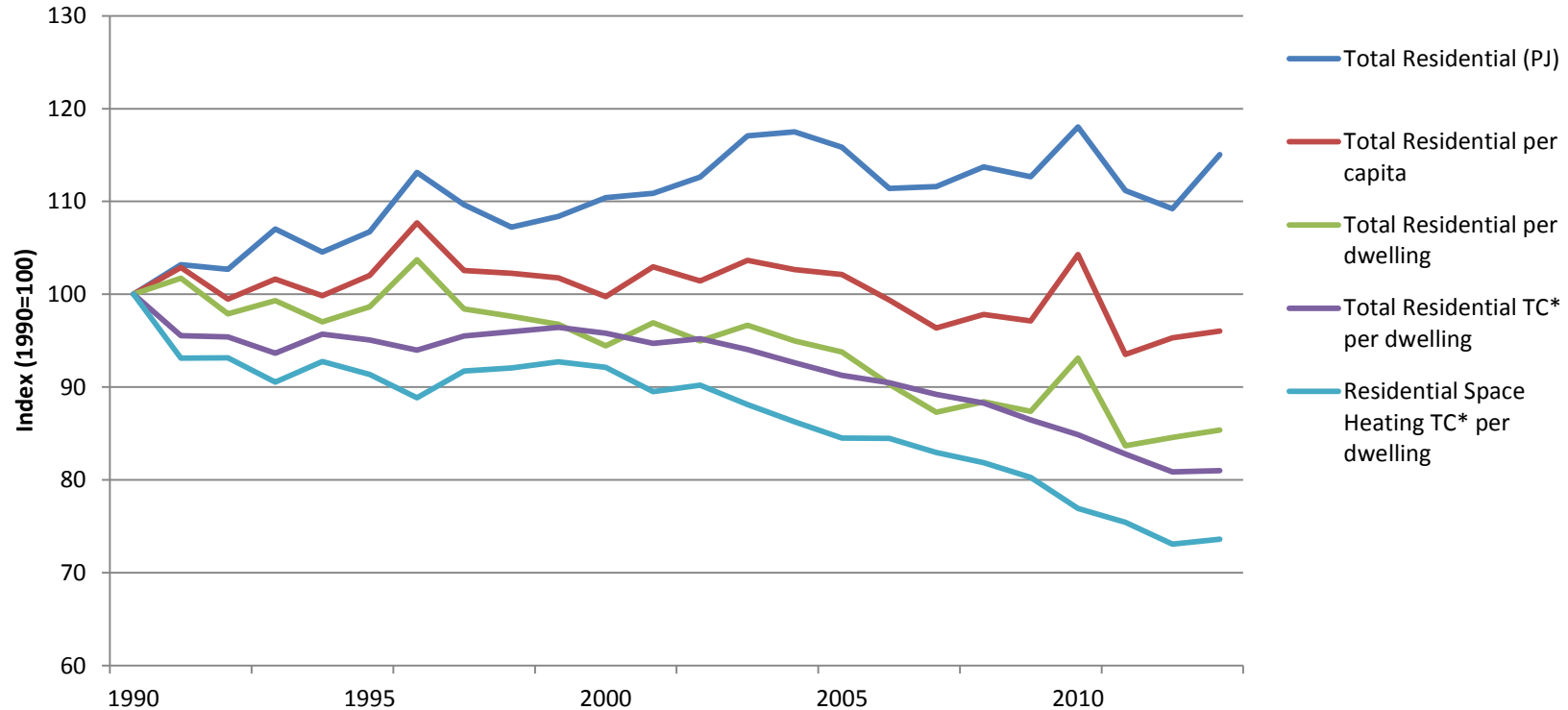


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Choosing the most appropriate indicators is essential

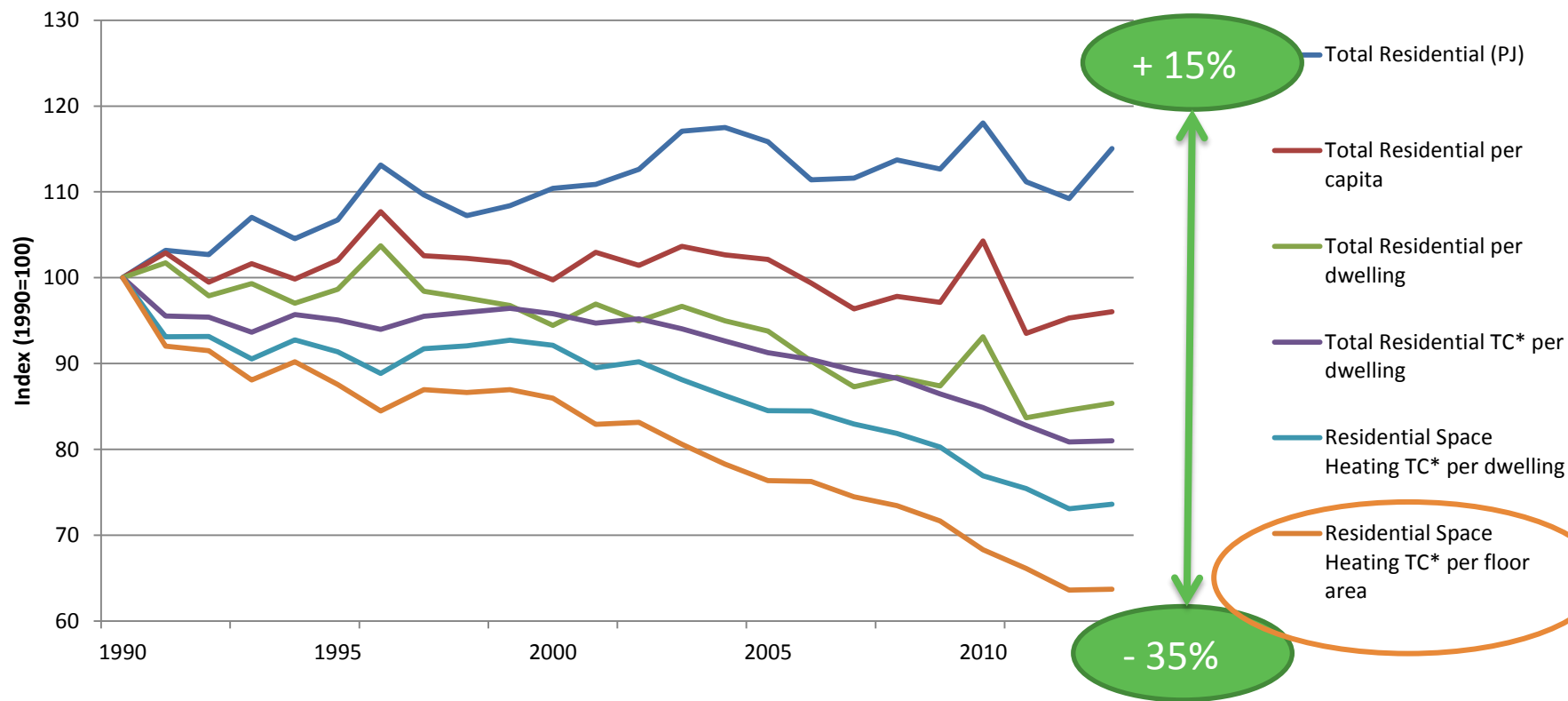


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Balances are very useful but do not track end-uses

ENERGY BALANCE

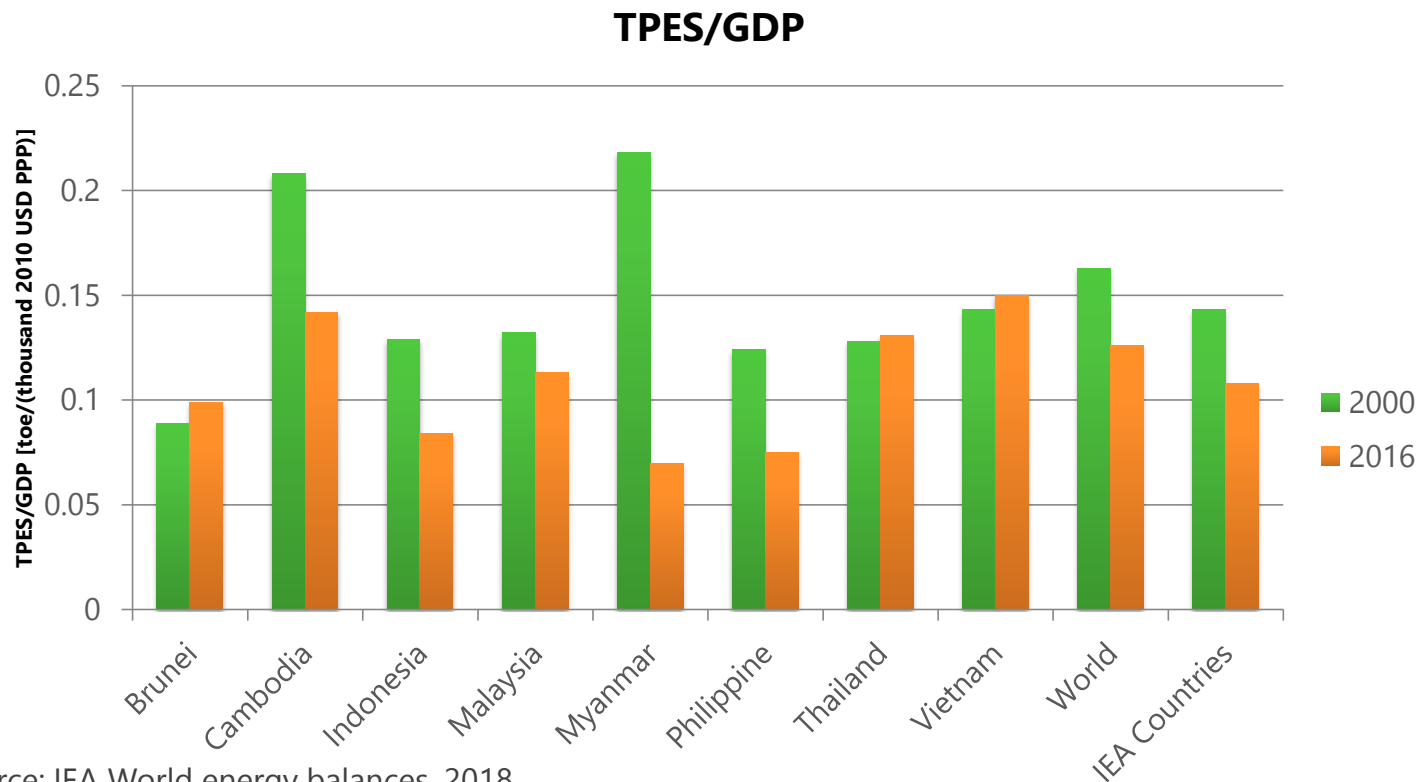
	Coal	Crude	Oil Products	Gas	Nuclear	Hydro	Geoth /Solar	Biofuels & Waste	Electricity	Heat	Total
OTHER	136.42	0.23	425.87	633.44	-	-	14.37	834.05	820.32	145.22	3036.92
Residential	76.58	-	222.89	418.55	-	-	6.98	805.42	395.81	97.97	2024.19
Comm. and public serv.	23.3	-	107.32	173.79	-	-	1.15	16.33	338.31	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

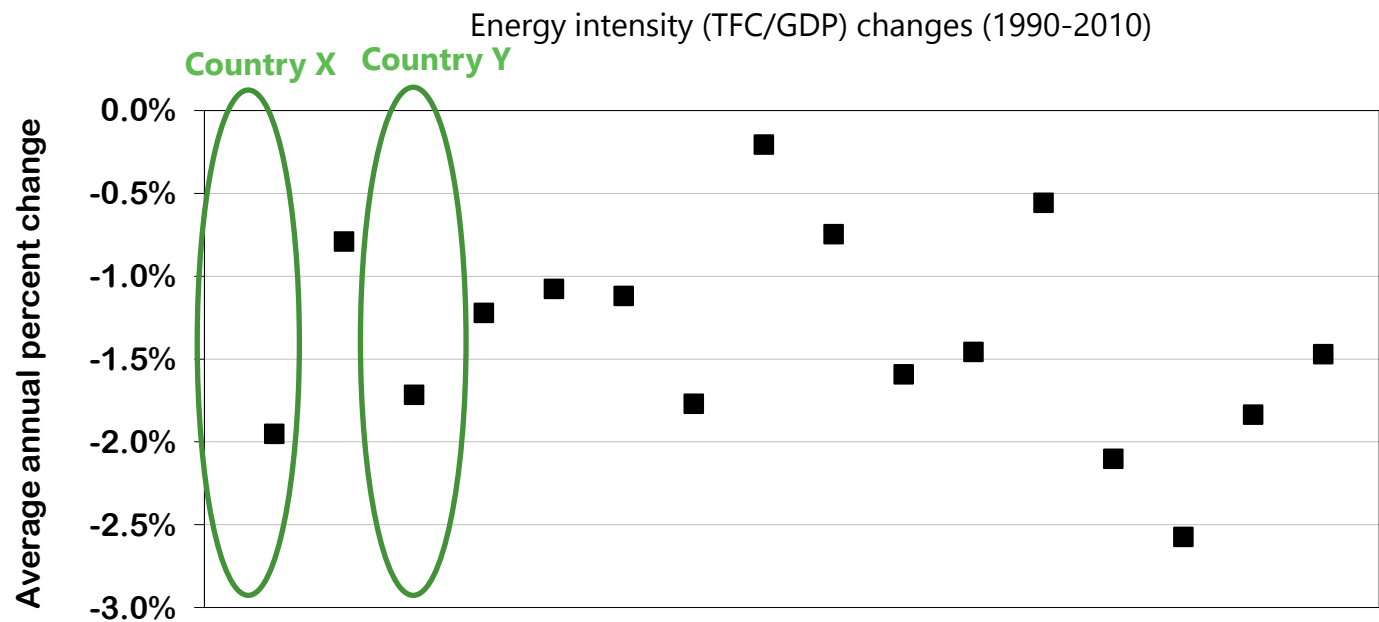
What drives energy intensity trends?



Source: IEA World energy balances, 2018

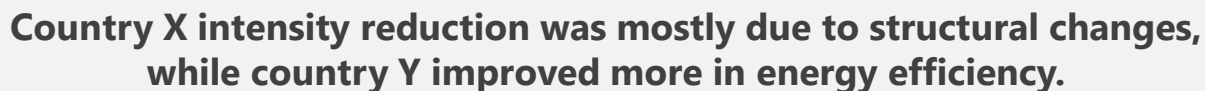
Efficiency progress but also other factors (mainly activity /structural changes)

Understanding aggregated indicators requires attention



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

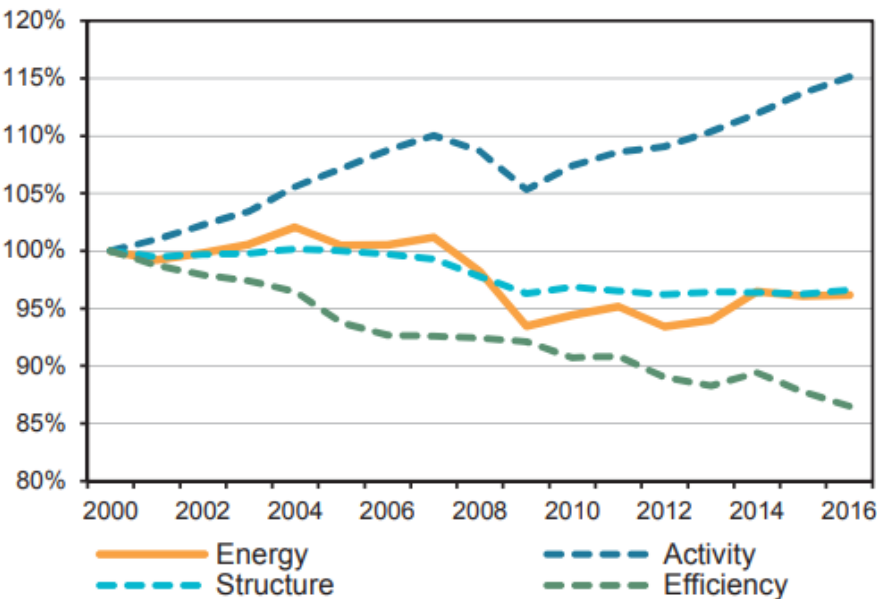
Data source: IEA Energy efficiency indicators.



How to disentangle efficiency from other drivers?

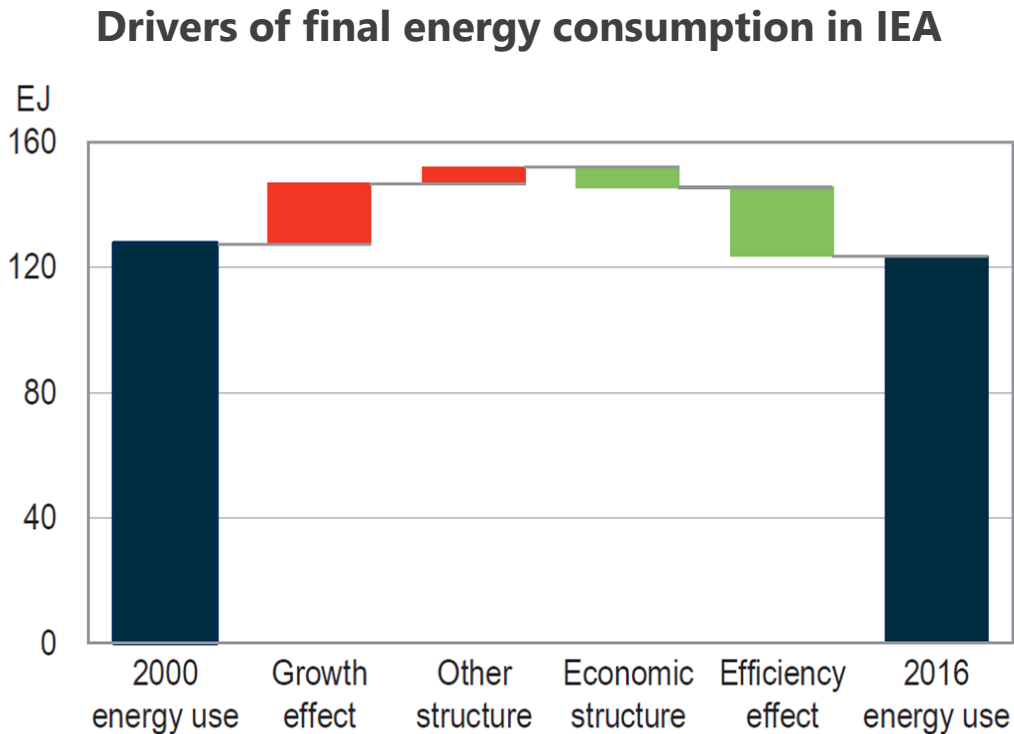


Drivers of final energy consumption in IEA



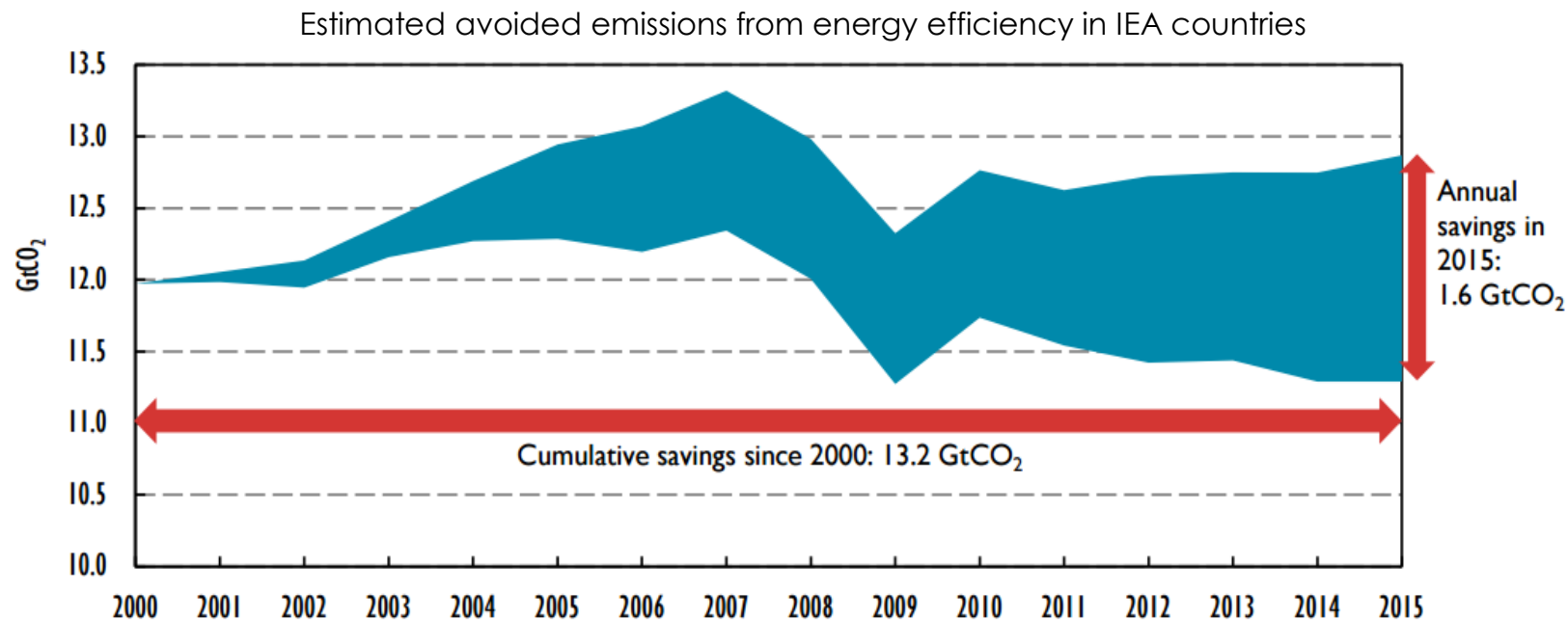
Source: IEA (2017), *Energy Efficiency Indicators*, OECD/IEA, Paris, based on IEA Energy efficiency indicators database.

How to disentangle efficiency from other drivers?



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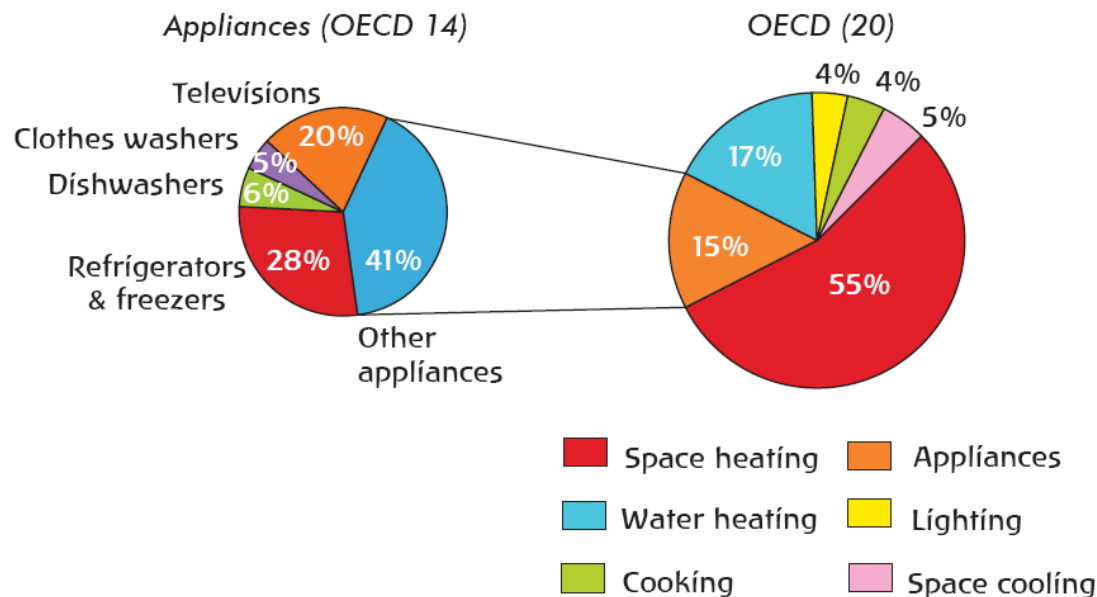
Quantifying emissions avoided due to efficiency



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

Efficiency is estimated to have reduced IEA CO₂ emissions from fuel combustion by 13% (2000-2015).

Figure 4.4 • Breakdown of residential consumption by end use in 2010 for 20 selected OECD countries



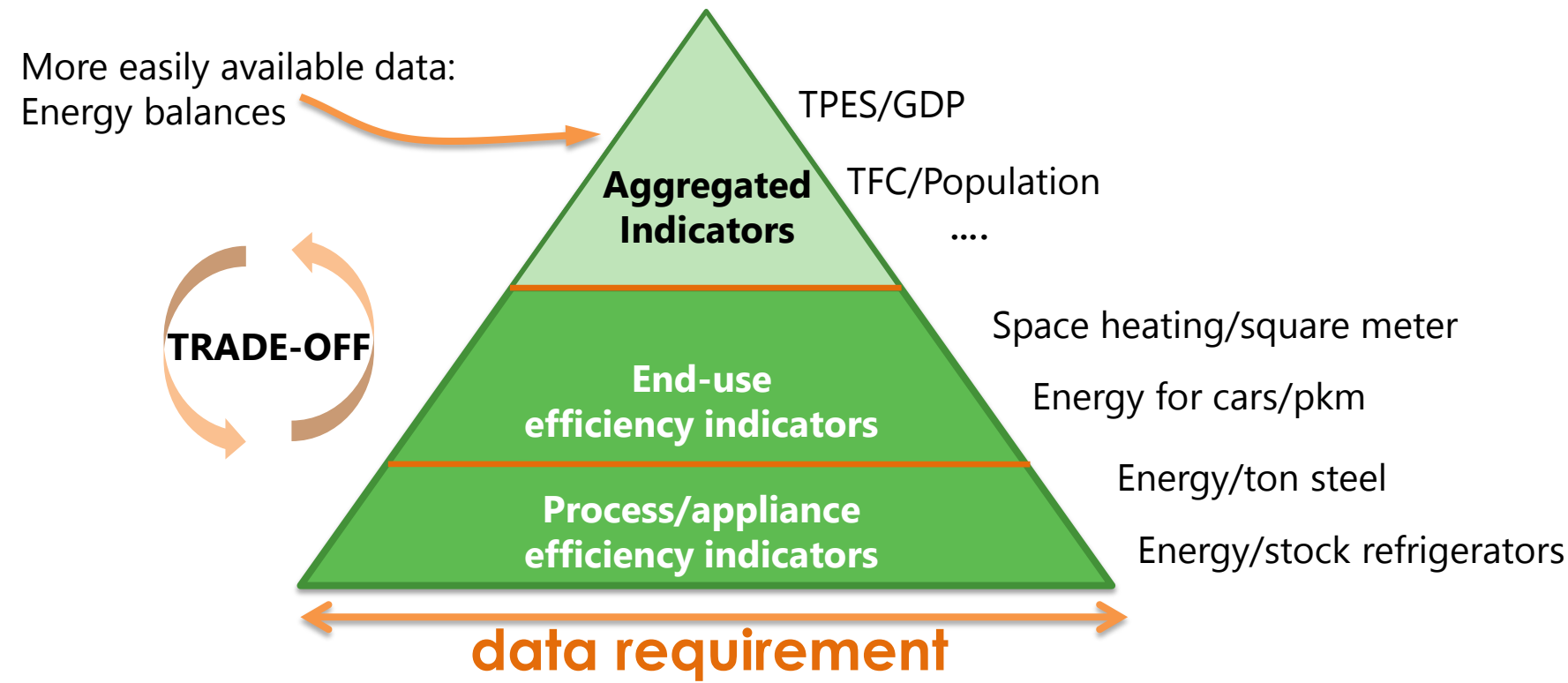
Note: The breakdown into individual appliances is available only for 14 countries.

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

Starting from energy balances and getting more insights in energy efficiency

Beyond the energy balance: energy efficiency indicators

Analyzing energy end-uses

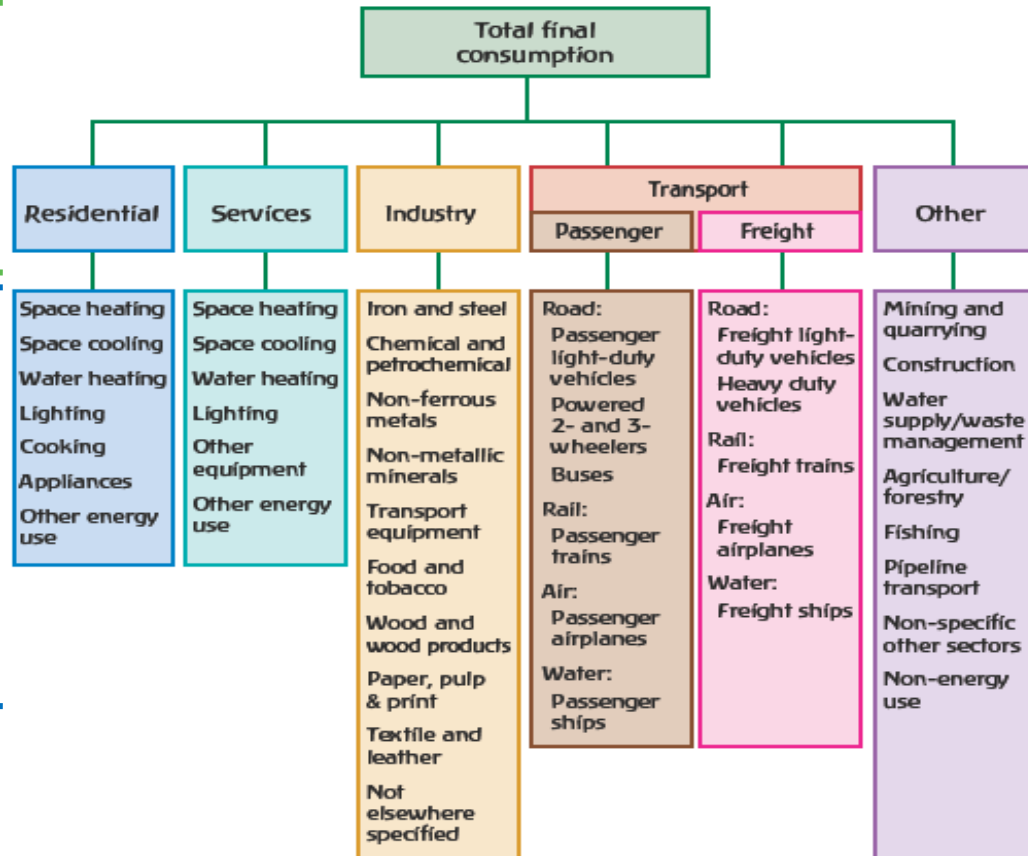


What are the data needed to develop relevant disaggregated indicators?

Understanding end-uses across sectors

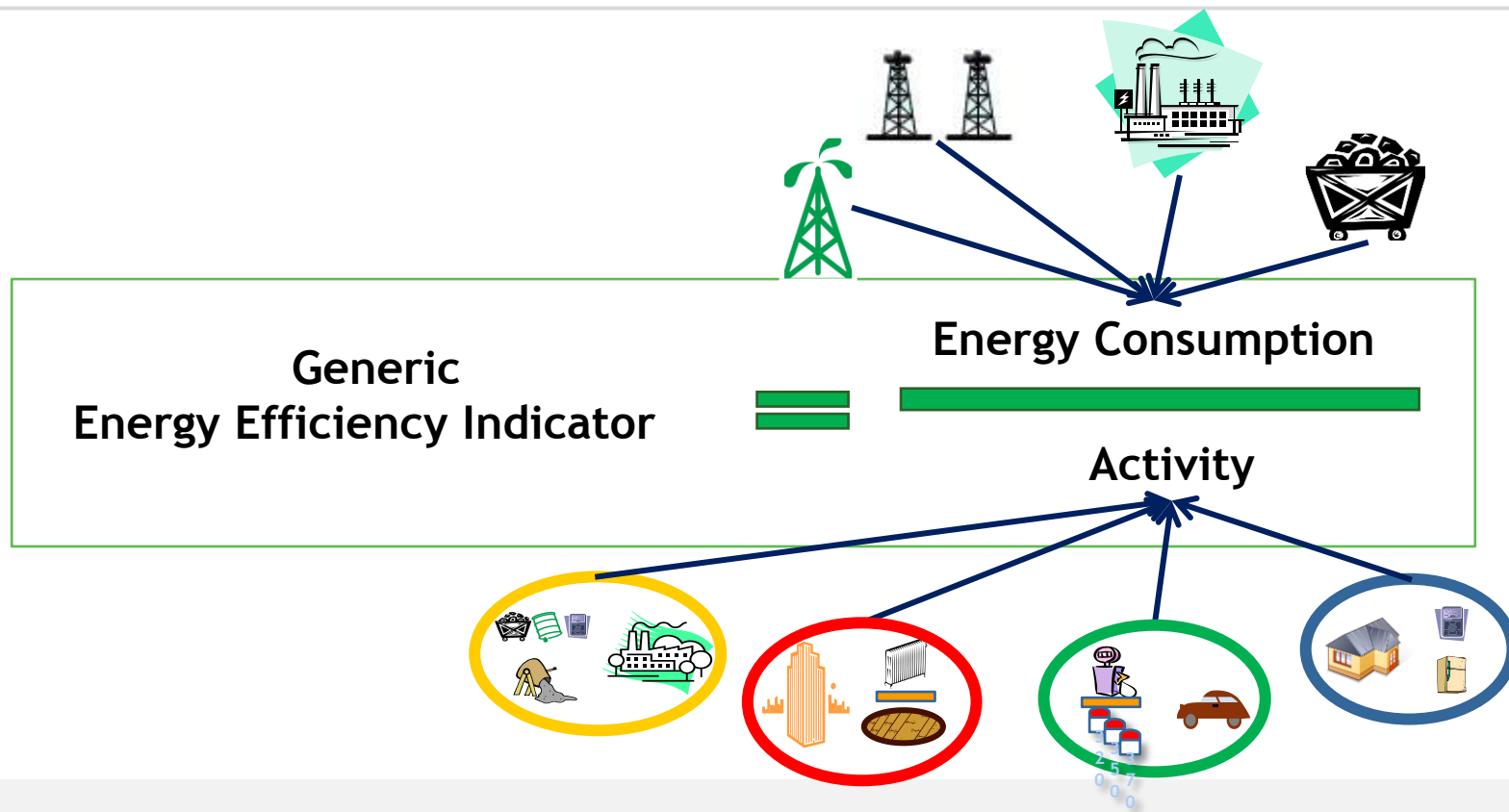
Energy balances:
Sectoral consumption

Energy efficiency:
End-use consumption



IEA Energy Efficiency Indicators:
Fundamentals on Statistics, 2014

Efficiency indicators link energy to activity across end-uses



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

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

QUIZ

Water heating

floor area (m²)



of dwellings



QUIZ

Appliances

floor area (m²)



of dwellings



QUIZ

Appliances

floor area (m²)



Appliance stocks



Occupied dwellings vs total dwellings



Primary residences

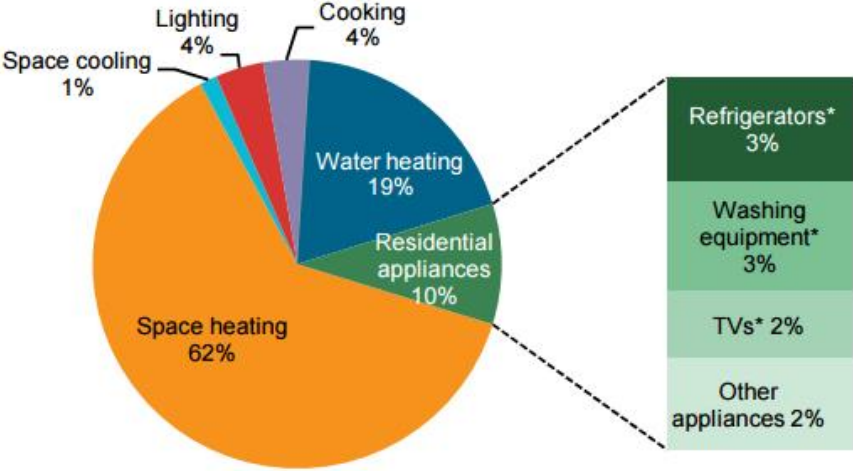


Unoccupied dwellings

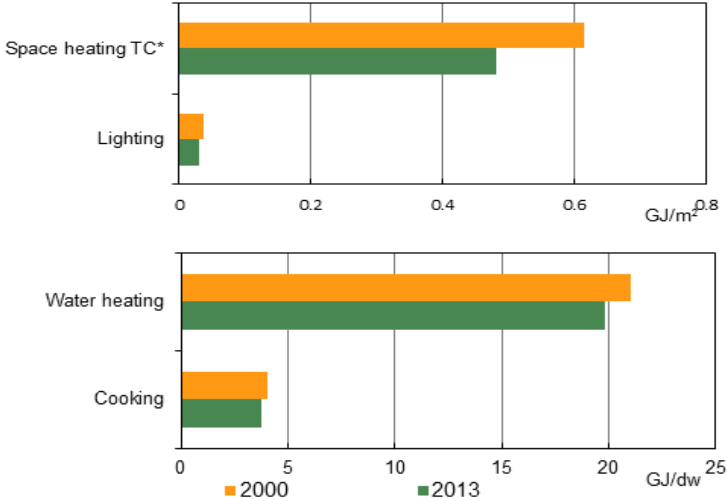


Vacation homes

Example of insights from end use data: residential sector



Example of shares of end -uses on energy consumption



Example of selected energy intensities

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

Passenger-km or tonne-km



Occupancy



Load factor

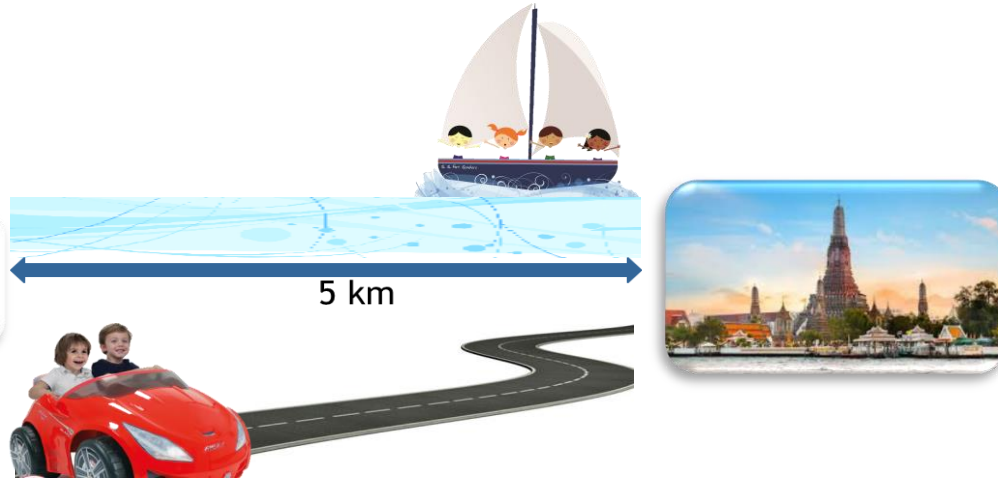


**Vehicle
stock**



**Distance
travelled**

Activity data for efficiency calculation in transport

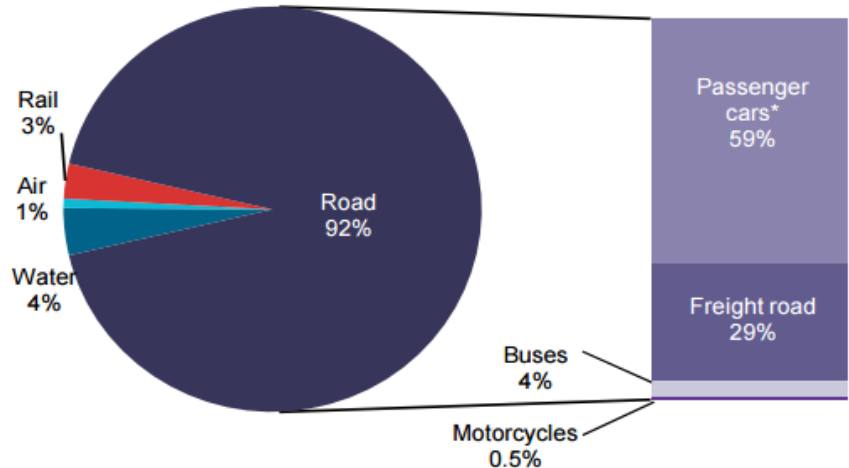


$$V_{km} = 5km + 5 km = 10 \text{ v-km}$$

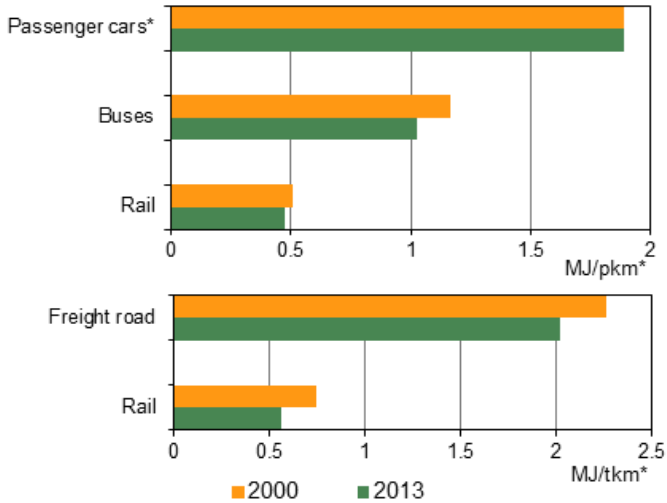
$$P_{km} = 6 \text{ passengers} * 5 km = 30 \text{ pkm}$$

$$\text{Avg. load} = p_{km}/v_{km} = 30 / 10 = 3 \text{ p/v}$$

Example of insights from end use data: transport sector



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



Selected energy intensities, country Y

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:

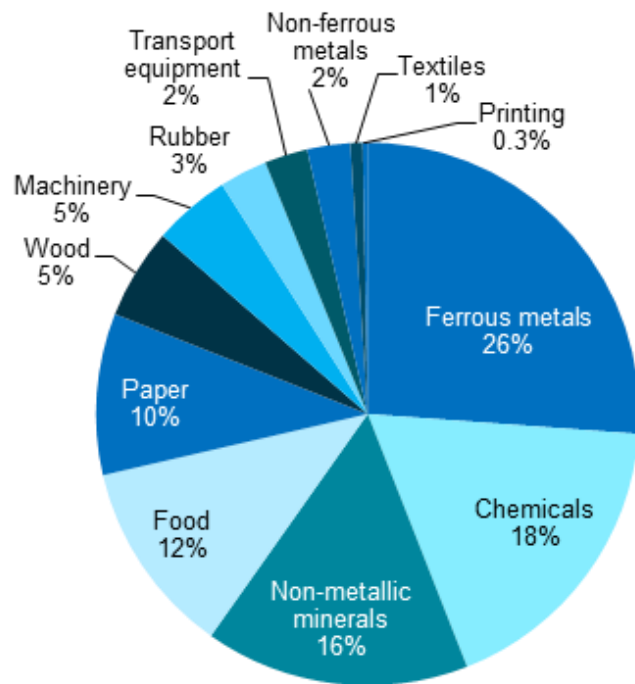
- Value added
- Physical production



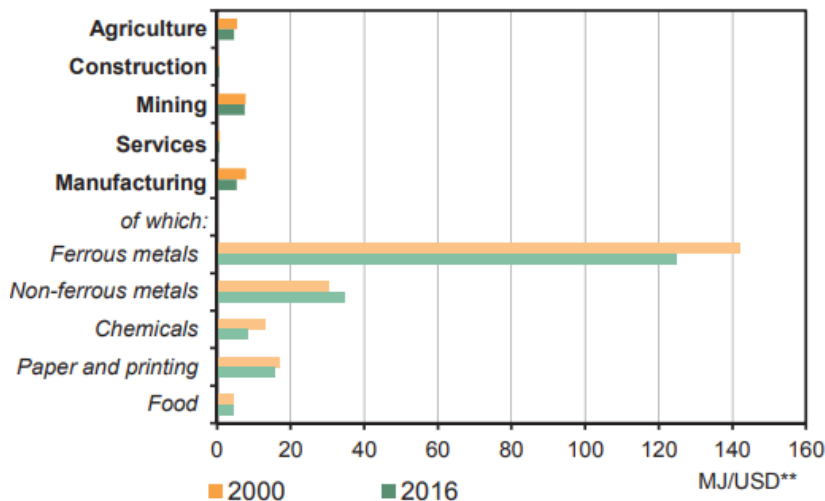
Volume



Value added



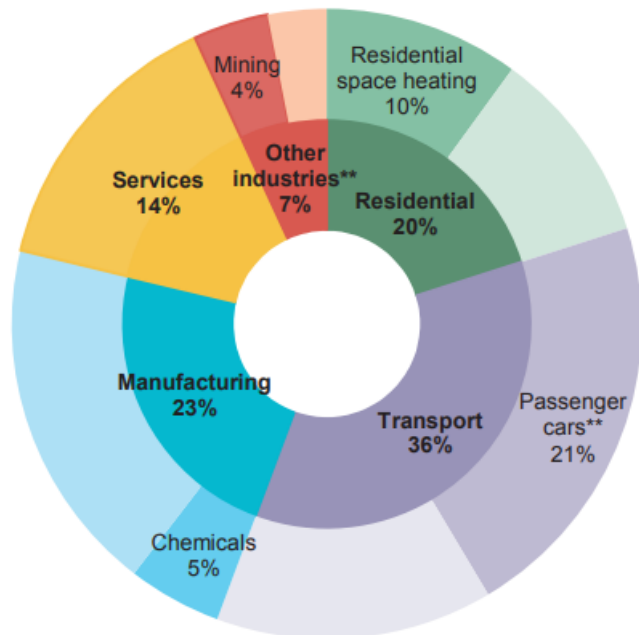
Example of shares of industry subsectors on energy consumption



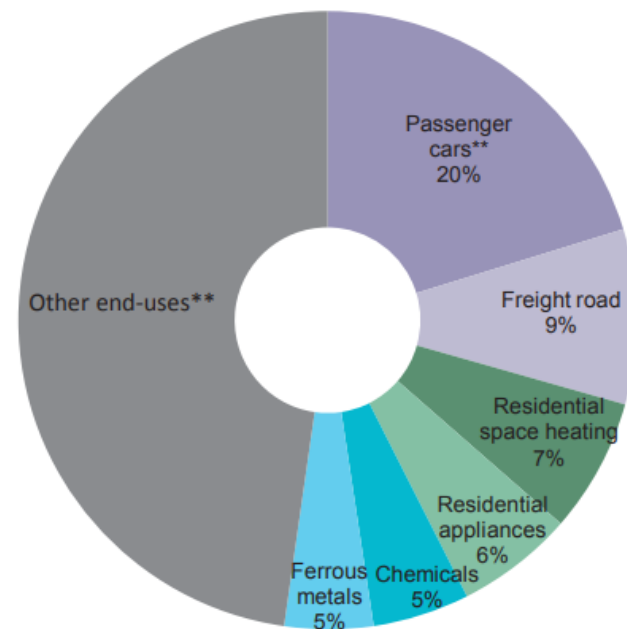
Example of selected energy intensities

What we can learn from efficiency indicators – key points

Largest end-uses by sector, 2016



Top six CO₂ emitting end-uses, 2016***



Source: [IEA Energy Efficiency Indicators Highlights, 2018](#)

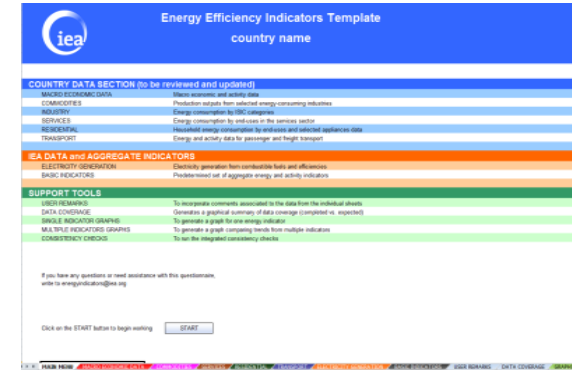
Refers to the 20 IEA countries for which energy efficiency data covering most of the end-uses are available: Australia, Austria, Canada, Czech Republic, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, New Zealand, The Netherlands, Portugal, Spain, Switzerland, the UK and the US.

The IEA approach

collecting end use data and developing efficiency

The energy efficiency indicators questionnaire

- 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** : [Energy efficiency indicators Highlights](#)



A starting point for data collection and gaps assessment

Water Heating											
Oil & Petroleum Products	PJ	0	0	0	0	12.77	11.22	10.22	9.34		
Natural Gas	PJ	0	0	0	0	5.19	5.15	5.07	5.02		
Coal & Coal Products	PJ	0	0	0	0	0	0	0	0		
Combust. Renewables & Waste	PJ	0	0	0	0	7.62	7.75	7.87	8.04		
Heat	PJ	0	0	0	0	0	0	0.04	0.04		
Electricity	PJ	2.18	2.05	2.14	2.22	3.94	3.31	2.76	2.34		
Other	PJ	0	0	0	0	0	0	0	0		
Total	PJ	2.18	2.05	2.14	2.22	29.52	27.42	25.96	24.79		
Cooking											
Oil & Petroleum Products	PJ	0	0	0	0	16.58	16.87	17.17	17.46		
Natural Gas	PJ	0	0	0	0	3.94	4.27	4.61	4.94		
Coal & Coal Products	PJ	0	0	0	0	0	0	0	0		
Combust. Renewables & Waste	PJ	0	0	0	0	0	0	0	0		
Heat	PJ	0	0	0	0	0	0	0	0		
Electricity	PJ	0.59	0.42	0.42	0.46	1.67	2.09	2.64	3.31		
Other	PJ	0	0	0	0	0	0	0	0		
Total	PJ	0.59	0.42	0.42	0.46	22.19	23.24	24.41	25.71		
Lighting											
Electricity	PJ	4.61	4.90	5.11	6.99	7.41	7.54	7.79	5.53		
Other	PJ	0	0	0	0	0	0	0	0		
Total	PJ	4.61	4.90	5.11	6.99	7.41	7.54	7.79	5.53		

Domestic passenger airplanes											
Jet Fuel & Aviation Gasoline	PJ	0.50	0.63	0.75	1.00	0.67	0.42	0.46	0.33	0.50	0.88
Other	PJ	0	0	0	0	0	0	0	0	0	0
Total	PJ	0.50	0.63	0.75	1.00	0.67	0.42	0.46	0.33	0.50	0.88
Energy intensity	MJ/pkm	2.07	2.50	2.20	2.37	0.99	0.27	0.19	0.12	0.14	0.19

The end use data collected and disseminated by the IEA

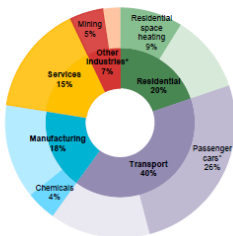


Country	Sector	End use	Energy product	Energy indicator
Statsland	Residential	Space heating	Oil	Per capita energy intensity (GJ/cap)
		Space cooling	Natural Gas	Per dwelling energy intensity (GJ/dw)
		Water heating	Renew. & waste	Per floor area energy intensity (GJ/m2)
		Cooking	Heat	Per unit equipment energy intensity (GJ/unit)
		Lighting	Electricity	Per services employee energy intensity (GJ/employee)
		Appliances	Electricity	Per VA energy intensity (GJ/USD PPP 2010)
		Other	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		

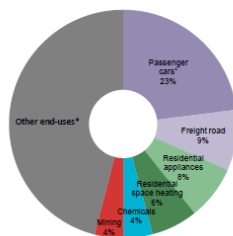
Energy Efficiency Indicators Highlights

Cross-sectoral overview

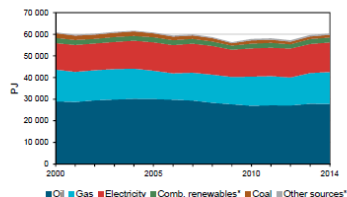
Largest end-uses by sector, 2014



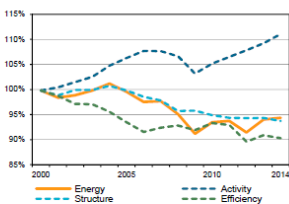
Top-6 CO₂ emitting end-uses, 2014**



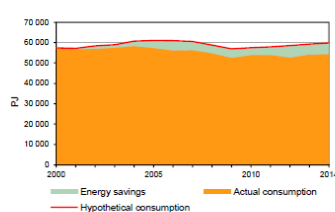
Final energy consumption by source



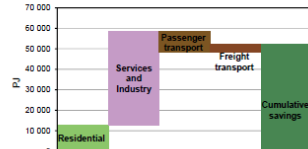
Drivers of final energy consumption***



Estimated energy savings from efficiency**



Estimated cumulative energy savings by sector, 2000-14**

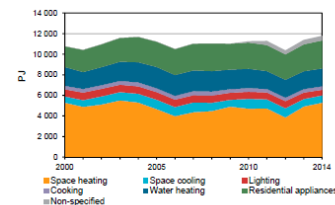


**Other industries includes agriculture, mining and construction; passenger cars includes cars, sport utility vehicles and personal trucks; other end-uses includes the remaining part of emissions beyond the top-6; comb. renewables includes combustible renewables and wastes; other sources includes heat and other energy sources.

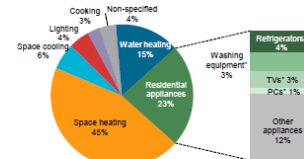
Residential sector

	Residential consumption (PJ)	Share of fossil fuels* in space heating (%)	Population (million)	Consumption per capita (GJ/person)	Average dwelling surface (m ²)	Average dwelling occupancy (pers/dw)
2000	10 772	84	252	38	195	2.8
2014	11 792	79	319	37	181	2.8

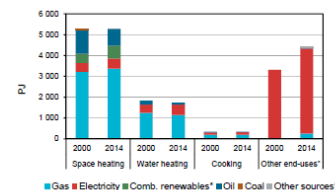
Residential energy consumption by end-use



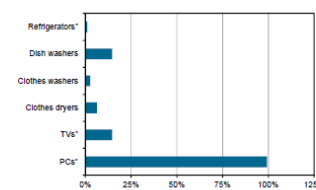
Residential energy consumption by end-use, 2014



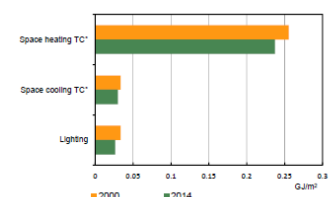
Residential energy consumption by source



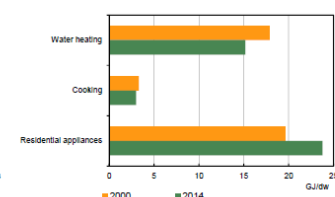
Appliances per dwelling, 2000-14 % change



Energy Intensities by end-use per floor area



Energy intensities by end-use per dwelling



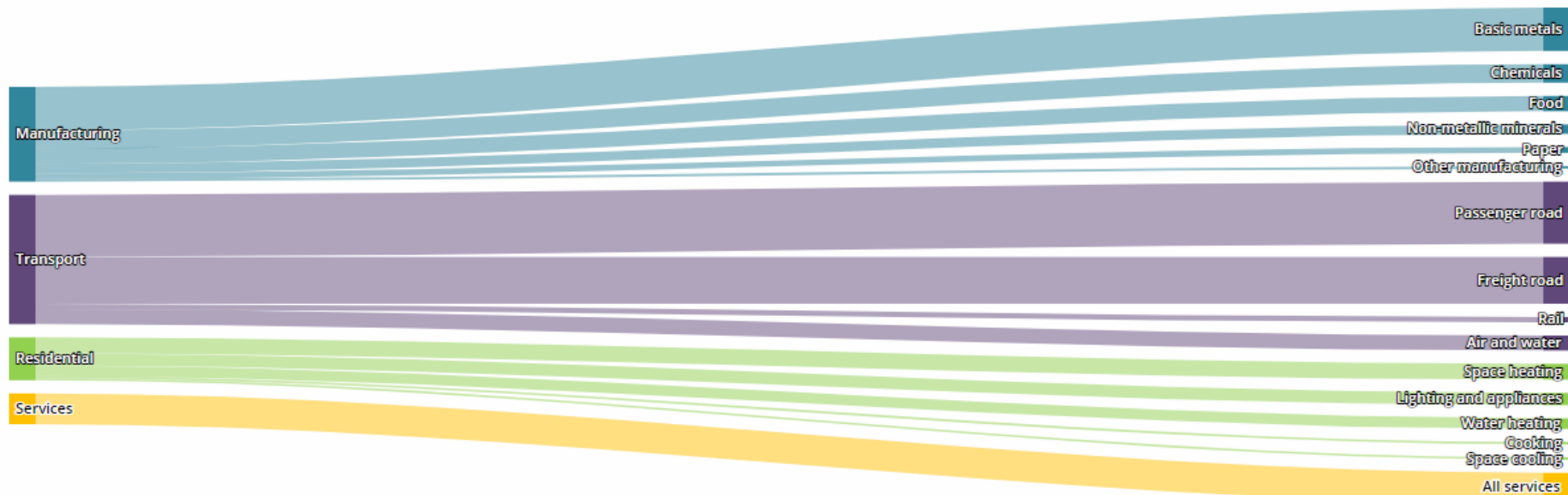
<https://webstore.iea.org/energy-efficiency-indicators-2018-highlights>

A visualization tool for end use data

Show breakdown of final energy consumption for

Australia

in 2016

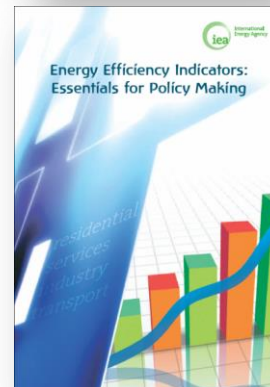
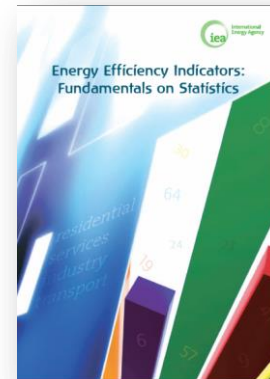


Energy Efficiency Indicators Database, IEA 2018

A Sankey diagram gives quick insights on the size of energy flows

- 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>

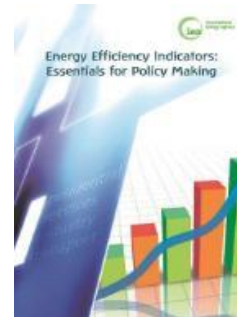


- **Energy Efficiency Indicators: Fundamentals on Statistics**

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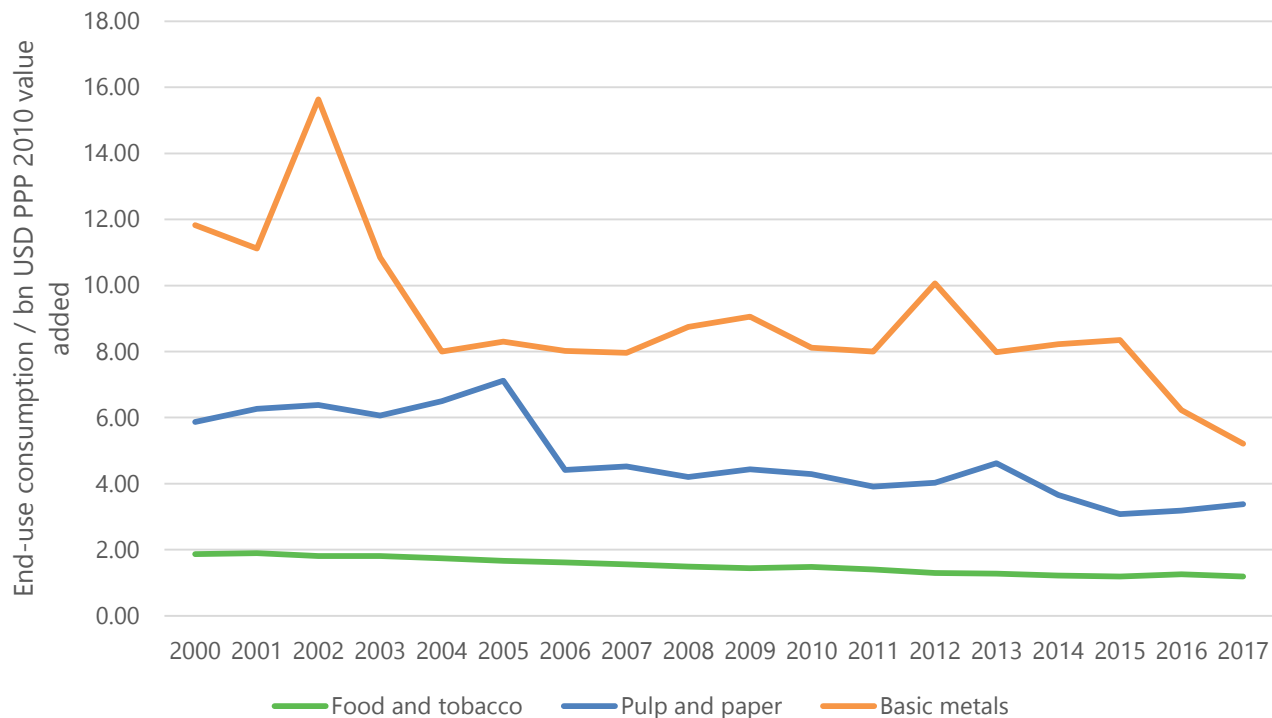
- **Energy Efficiency Indicators: Essentials for Policy Making**



Energy Efficiency Indicators in SEA

Examples of application

Example of application – Philippines



Source: Department of Energy, Philippines Energy Balances Philippines Statistics Authority, National Accounts

PHILIPPINES – Selected Industrial Subsector Intensities

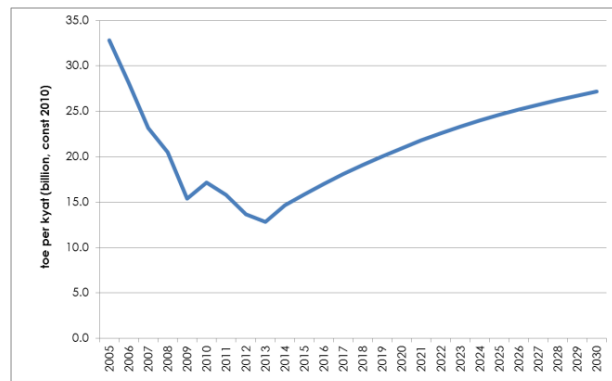
Example of application – Myanmar

Table II-3: Myanmar Energy Efficiency Rates

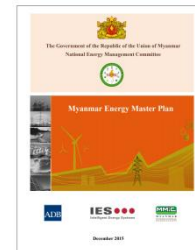
Industry	GJ / ton
Steel	5
Copper	93
Cement	6
Bricks	15
Glass	3
Sugar	2
Paper	15

Sources: EMP Industry Survey conducted by Consultant

Figure I-13: Energy Intensity of Industry Sector – Medium Growth



- Data for the **Myanmar energy master plan** mostly collected from consulting
- Data on energy consumption and physical production for energy-intensive industries
- Industry energy intensities (per value added) used for projections and energy planning work

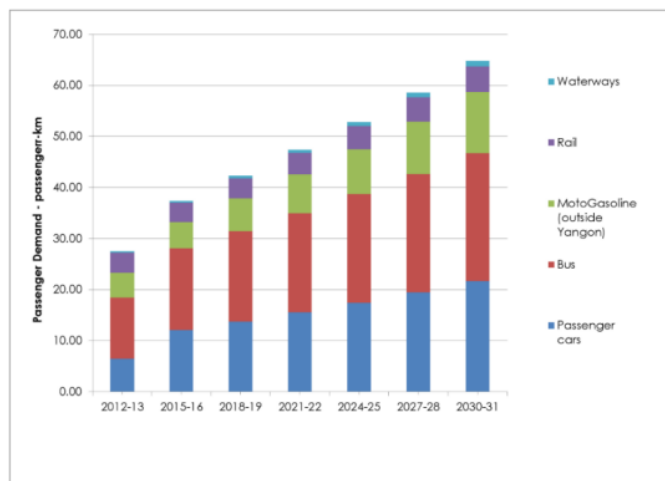


Example of application – Myanmar

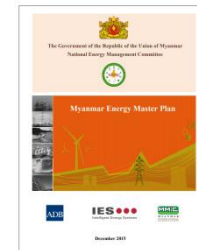
Table I-2: Modelled Passenger Transport Use for Myanmar (2012)

Modality	Fuel	Total Vehicles	Vehicle-km	Activity	Modal Share
		no.	billion veh-km	billion pass-km	% of pass-km
Passenger Vehicle (public and private passenger cars and diesel buses)	Gasoline	176 459	2.60	3.64	13%
	CNG	17 286	0.35	0.49	2%
	Diesel	115 106	1.68	14.31	52%
Motorcycle	Gasoline	3 153 201	3.72	4.83	18%
Rail	Diesel	405	n.a.	3.92	14%
Waterways	Diesel	5 200	n.a.	0.34	1%

Figure I-6: Passenger-km Demand Projections



- Transport activity (pkm) as basis for projections and energy planning work - modelling

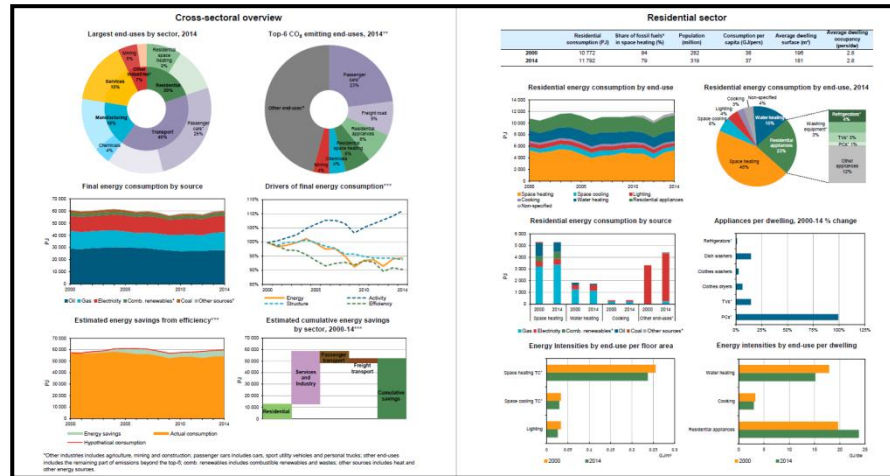


- ***Vietnam Energy Efficiency Standards and Labelling***: The Government of Vietnam introduced legislation to implement MEPS and labelling for **lighting** and **electrical appliances**.
- Regulations for the **labelling** of products in 2013:
 - **mandatory** star rating label
 - air conditioners,
 - electric fans,
 - rice cookers
 - washing machines
 - refrigerators (since 2014)
 - televisions (since 2014)
 - **voluntary** endorsement label
 - lighting products that meet high efficiency performance thresholds.
- **MEPS** came into force in January 2015.



- **Policy design:** Targeted at products (lighting, air conditioners, refrigerators, fans, rice cookers, televisions and washing machines) that account for **80% of household electricity** consumption and a significant proportion of **commercial and industrial** (motors and industrial transformers)
- **Estimated savings** resulting from the label
 - cumulative savings of around 70,000 GWh by 2030
 - saving consumers around VND100,000 billion (AU\$880m)
 - reducing CO₂ emissions by 27 million tonnes
 - cut in household energy bills of over 10%.

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



<https://webstore.iea.org/energy-efficiency-indicators-2018-highlights>

We hope that you join us!



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