



energy

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Energy efficiency indicators: *The IEA approach*

Mafalda Silva and Charles Michaelis

Pretoria, 15 October 2019



IEA #energyefficientworld

Session 4 overview

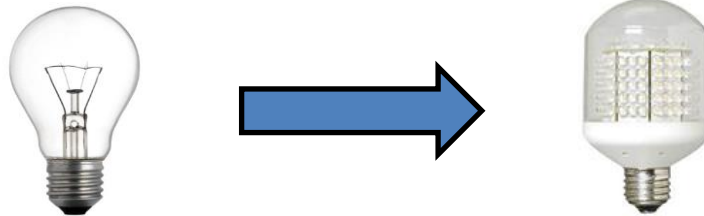
- The need for more detailed data to track progress energy efficiency policies
- Beyond the energy balance: energy efficiency indicators
- The IEA approach of collecting end use data and developing efficiency indicators
- Example of energy Efficiency Indicators in Sub-saharan Africa
- Practical exercise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

What is energy efficiency?

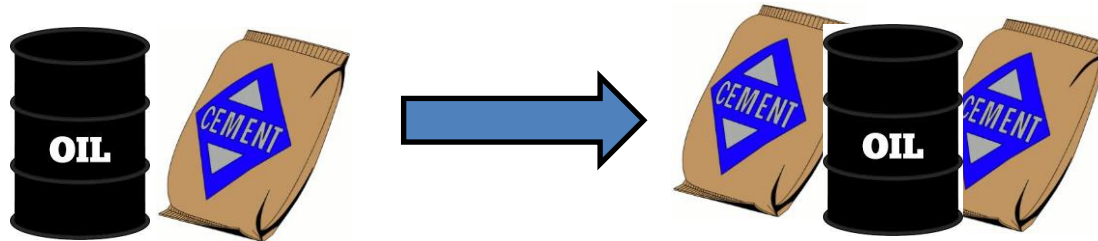
Is this energy efficiency?

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

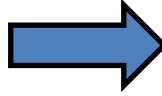


What is energy efficiency?

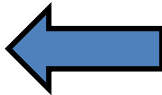
Is this energy efficiency?

Warm up:
Yes / No / Maybe

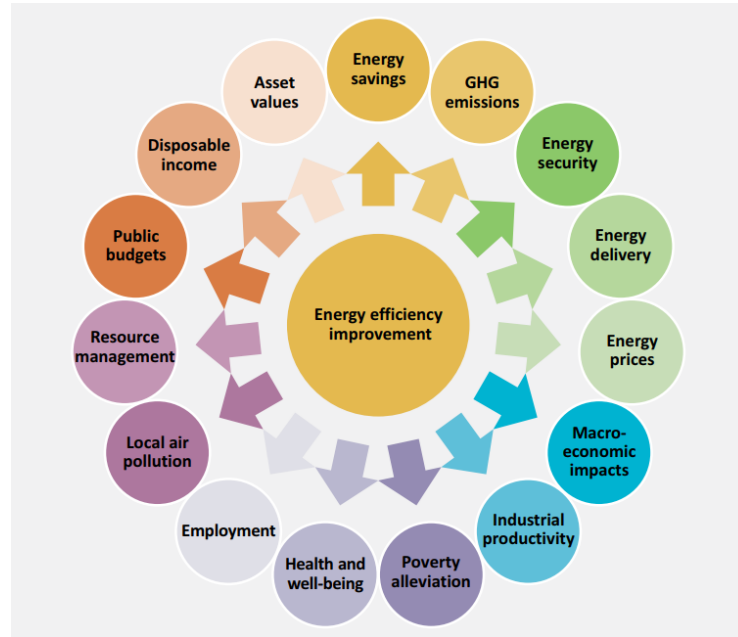
- Consume **LESS** energy because of **CHANGE** in service
e.g. economic restructuring



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



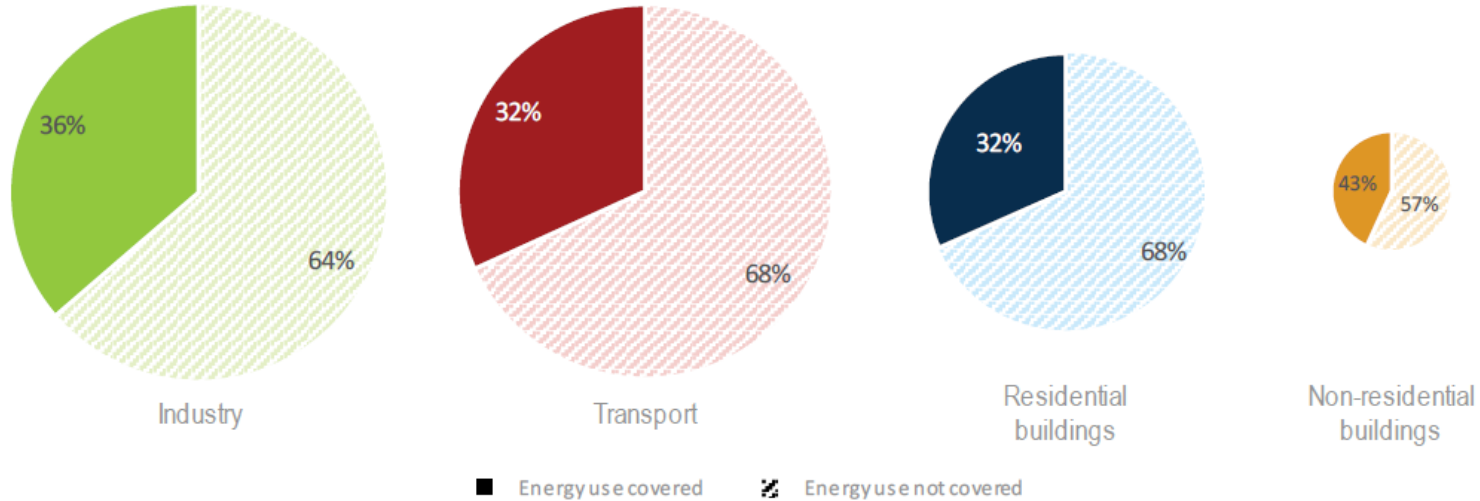
The importance of energy efficiency – Multiple benefits



Source: IEA (2014), *Capturing the multiple benefits of energy efficiency*, All rights reserved.

Environmental, economic and social benefits from energy efficiency

There's still a large potential untapped



Notes: The size of pie charts is approximately proportionate to total final consumption in each sector.

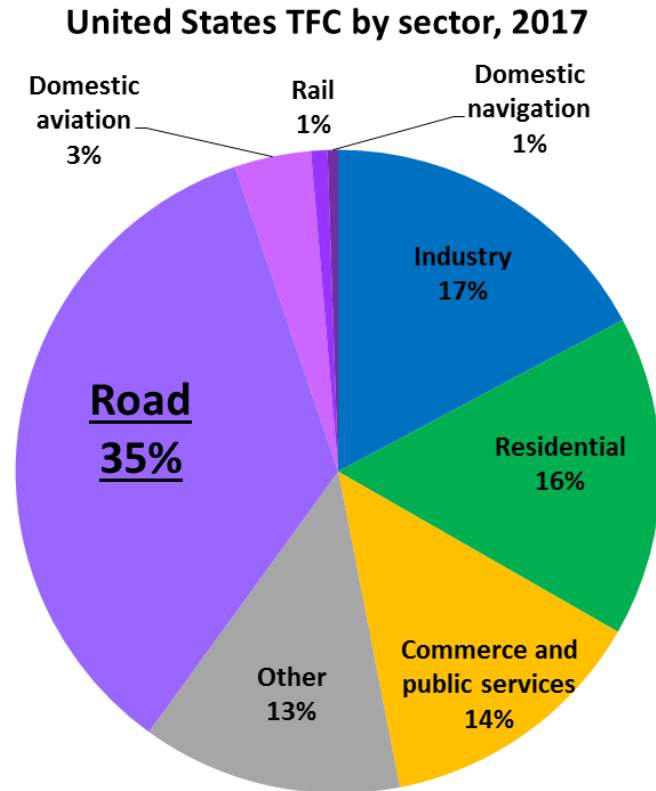
Share of energy consumption covered by existing policies

Source: IEA (2018), *Energy efficiency 2018*.

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

Energy efficiency indicators

Balances data example



Data source: IEA (2019), *World energy balances*, All rights reserved.

IEA 2019. All rights reserved.

**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-kilometres

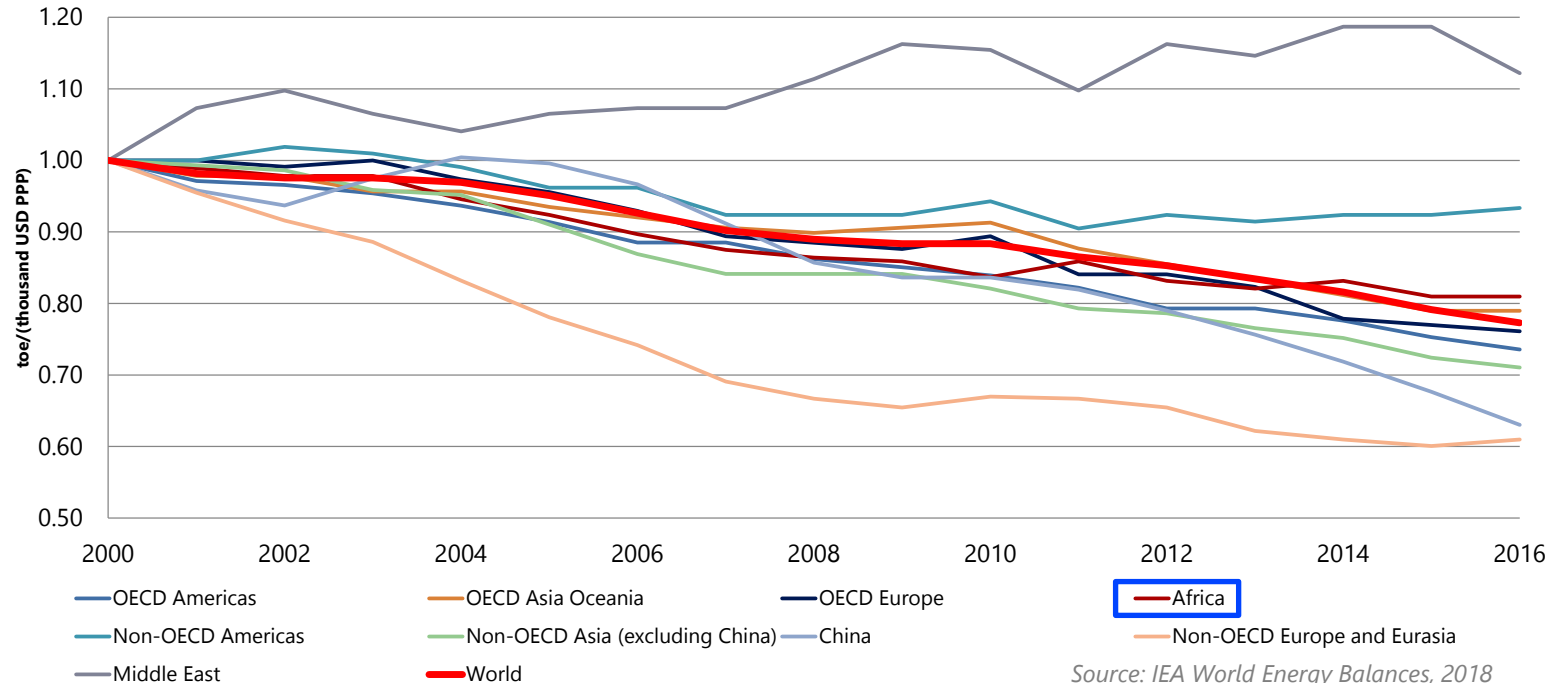


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iea

Does energy intensity track energy efficiency?

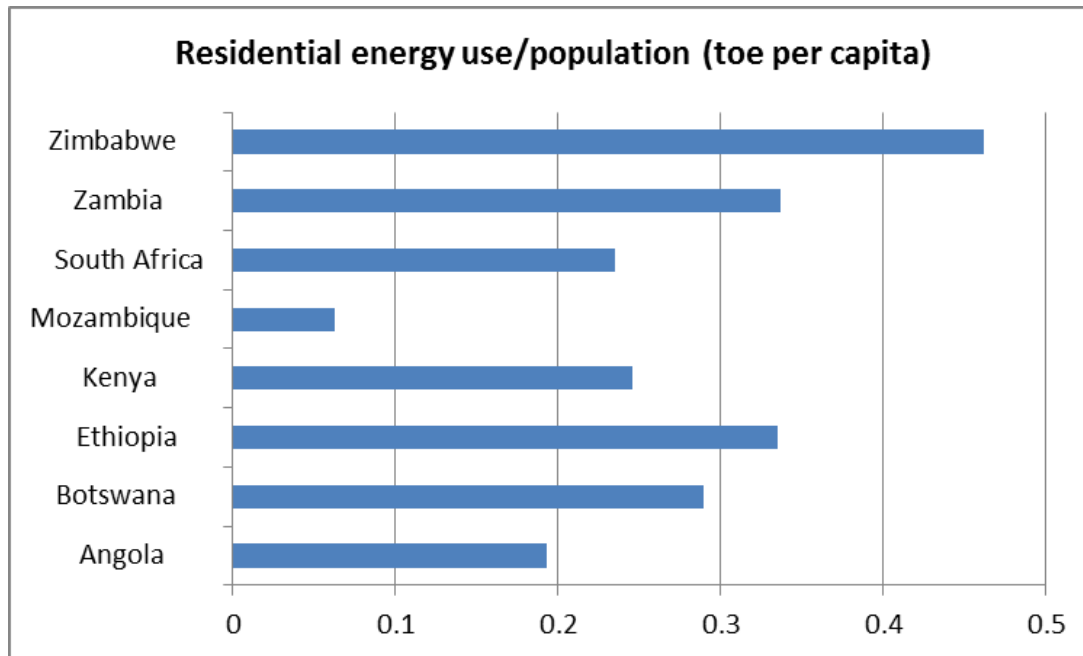
Energy intensity (TPES/GDP)



Source: IEA World Energy Balances, 2018

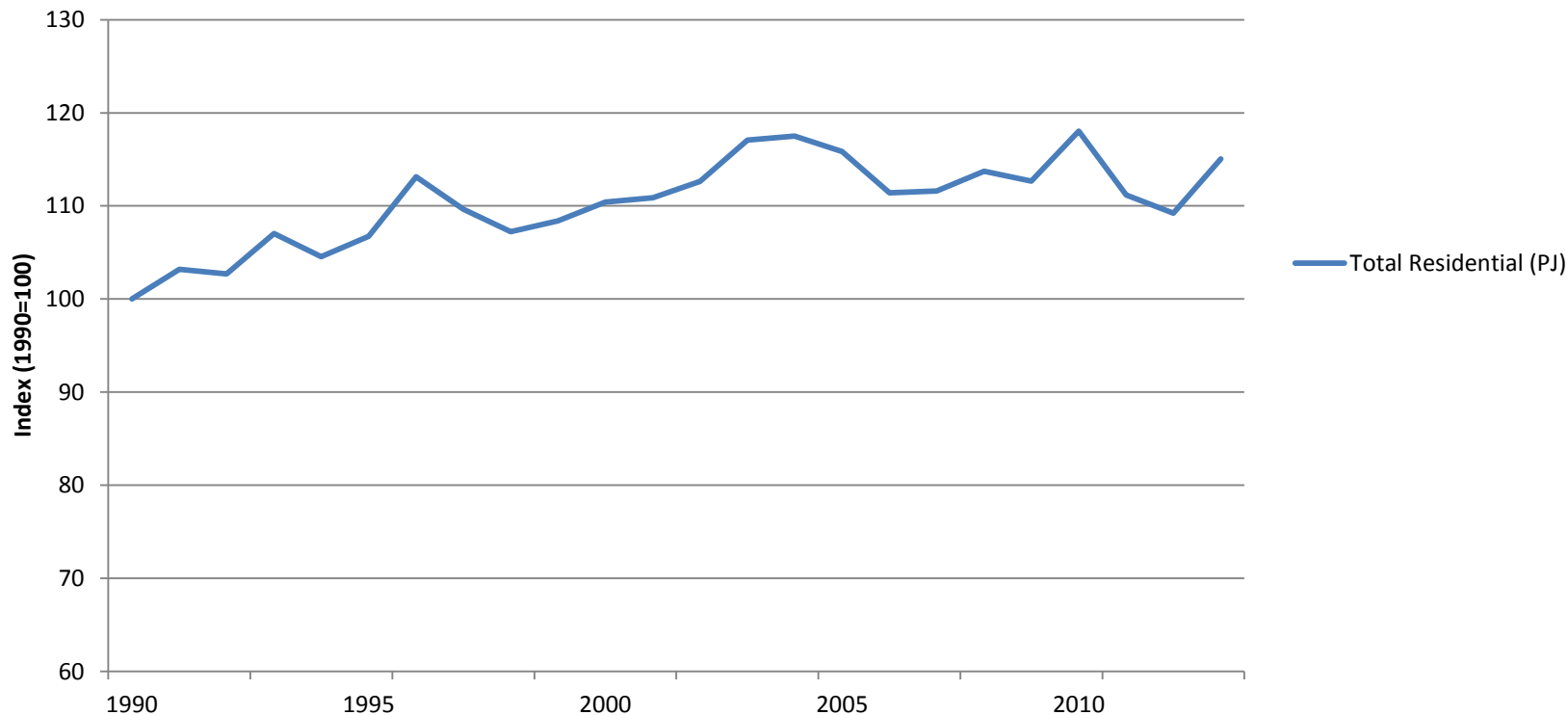
Energy intensity has generally decreased across regions.
Using less energy per GDP means “decoupling” economic growth from energy use

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

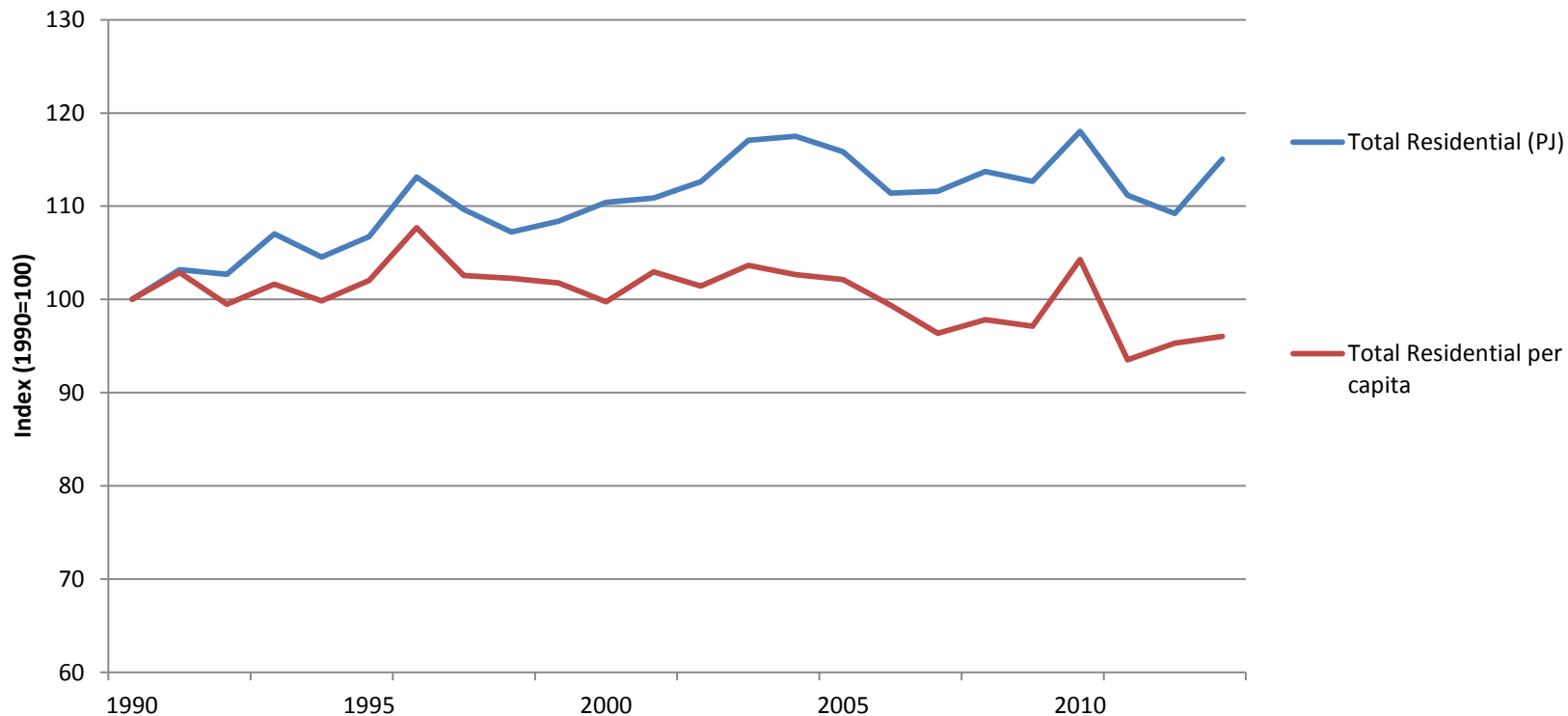
Data source: IEA, Energy efficiency indicators.



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* Temperature correction using heating degree days

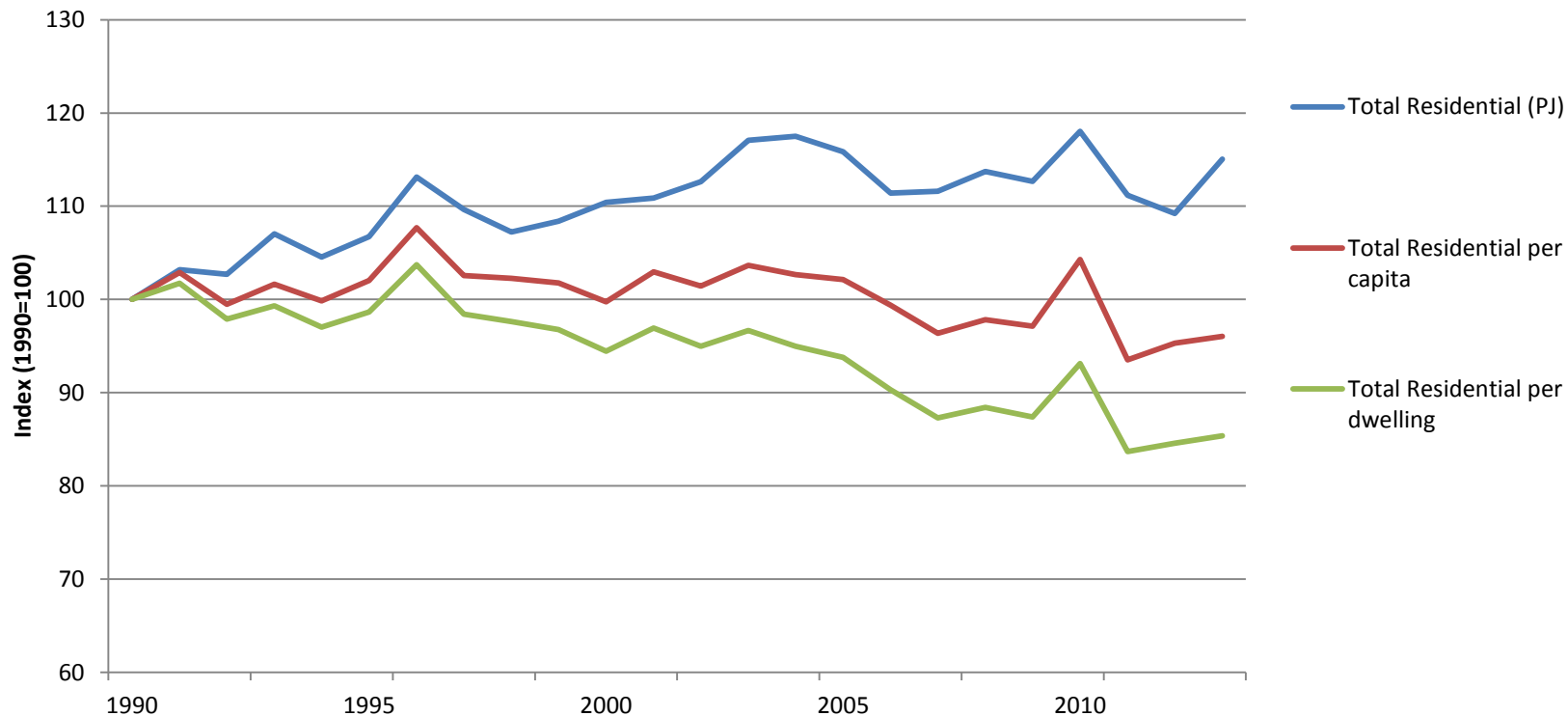
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- But do aggregated indicators tell us the full story?

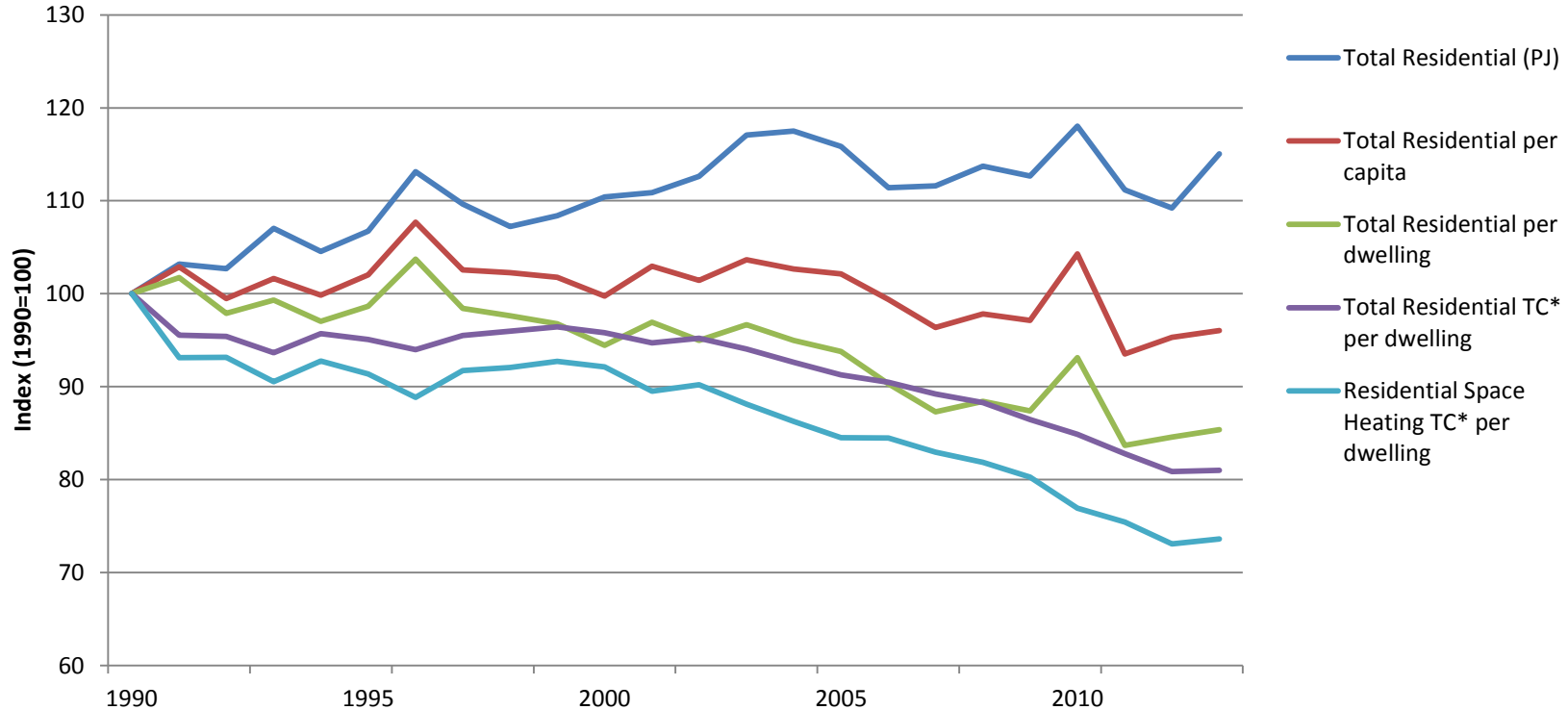


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- Choosing the most appropriate indicators is essential

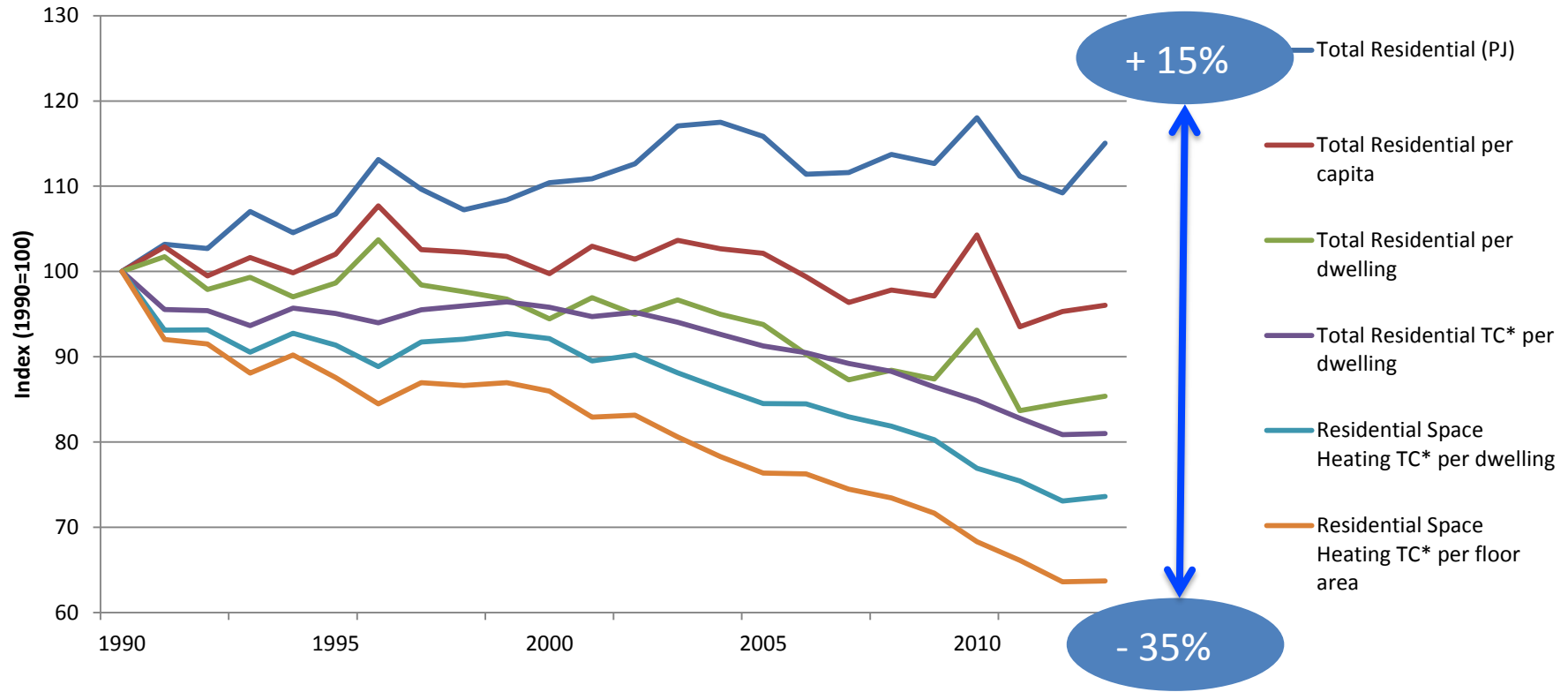


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* Temperature correction using heating degree days

Data source: IEA, Energy efficiency indicators.

Balances are very useful but do not track end-uses

ENERGY BALANCE

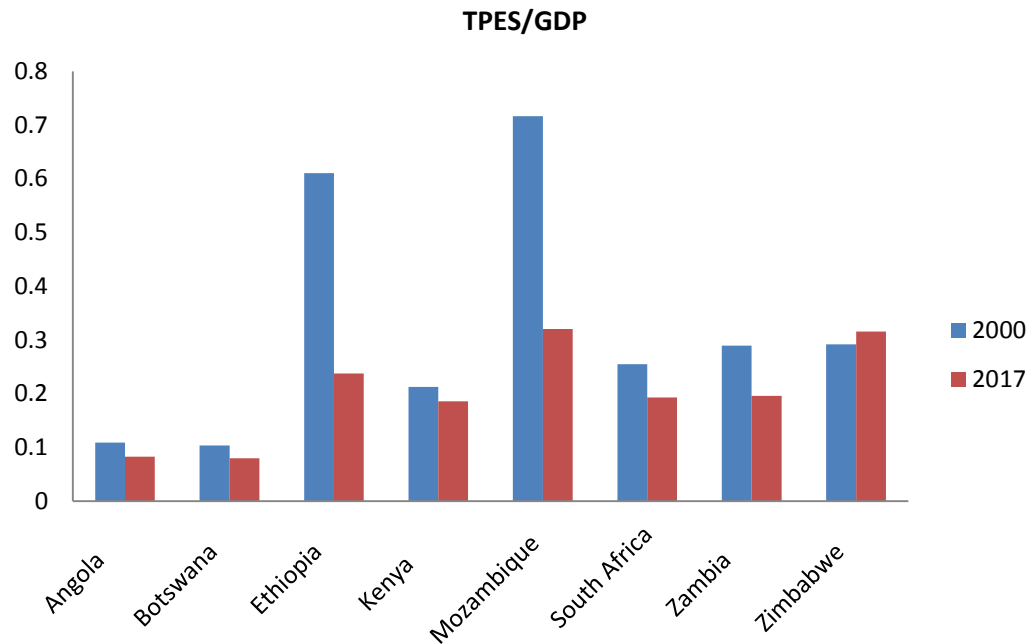
	Coal	Crude	Oil Products	Gas	Nuclear	Hydro	Geoth /Solar	Biofuels & Waste	Electricity	Heat	Total
OTHER	136.42	0.23	425.87	633.44	-	-	14.37	834.05	820.32	145.22	3036.92
Residential	76.58	-	222.89	418.55	-	-	6.98	805.42	395.81	97.97	2024.19
Comm. and public serv.	23.3	-	107.32	173.79	-	-	1.15	16.33	338.31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

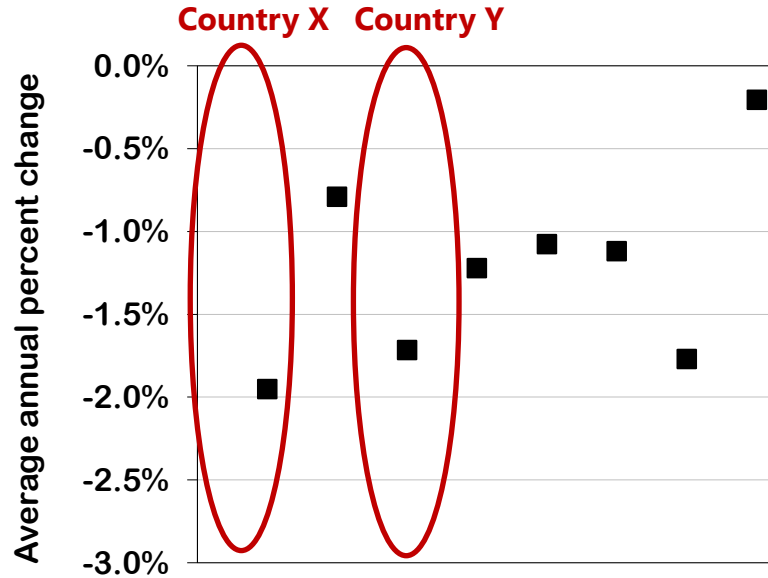


Source: IEA World energy balances, 2019

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

Understanding aggregated indicators requires attention

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



Data source: IEA, *Energy efficiency indicators*. All rights reserved.

Quiz!!

Which country has decreased more its energy intensity?

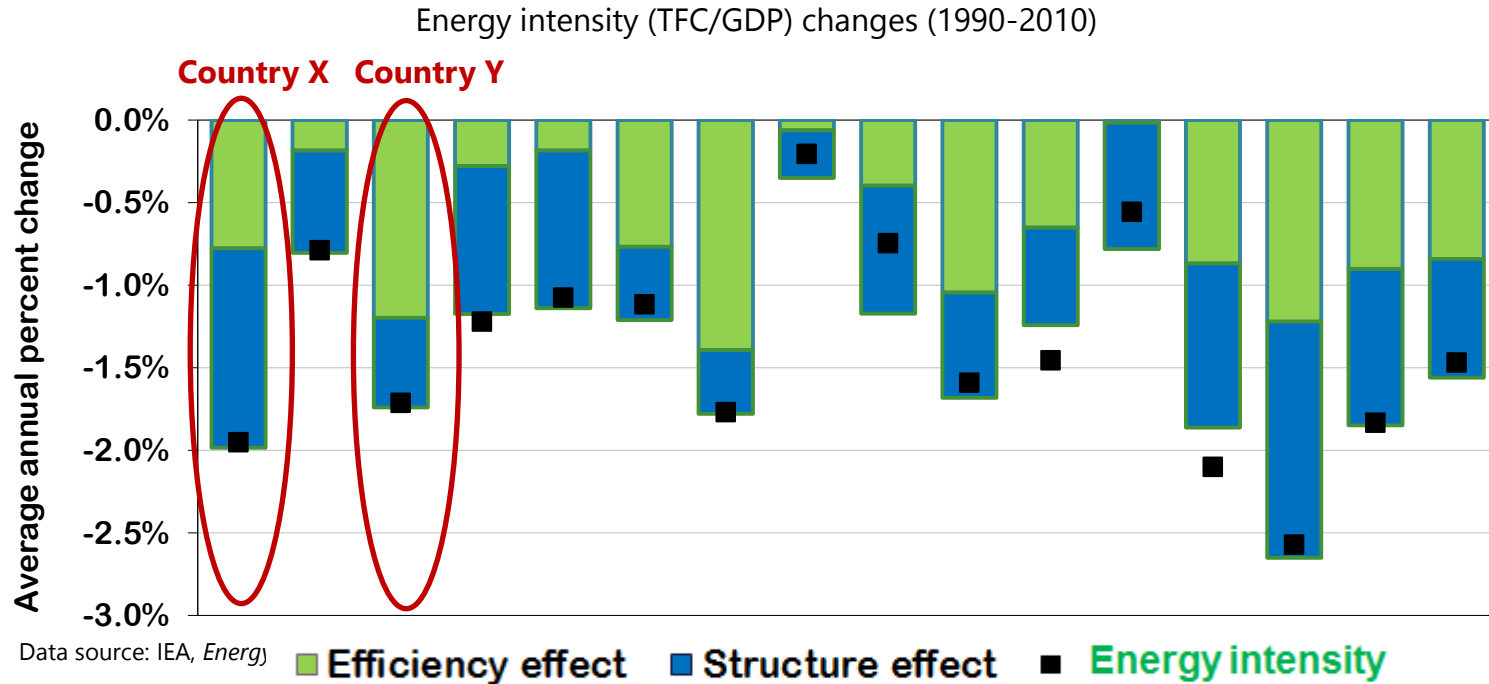
(Country X / Country Y)

Can we say that Country X has improved more in ENERGY EFFICIENCY?

(Yes / No / Maybe)

Intensity decreased more in country X

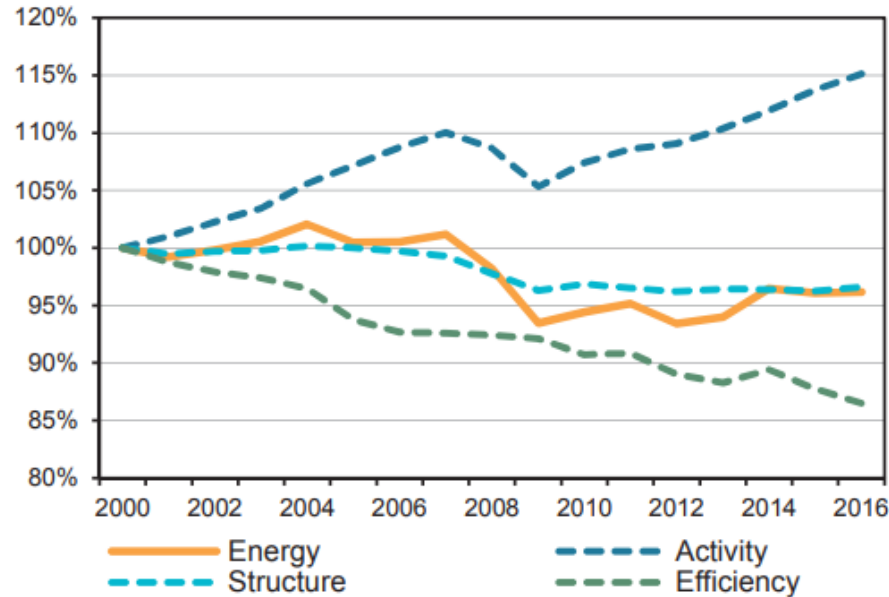
Aggregated indicators are sometimes used inappropriately



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

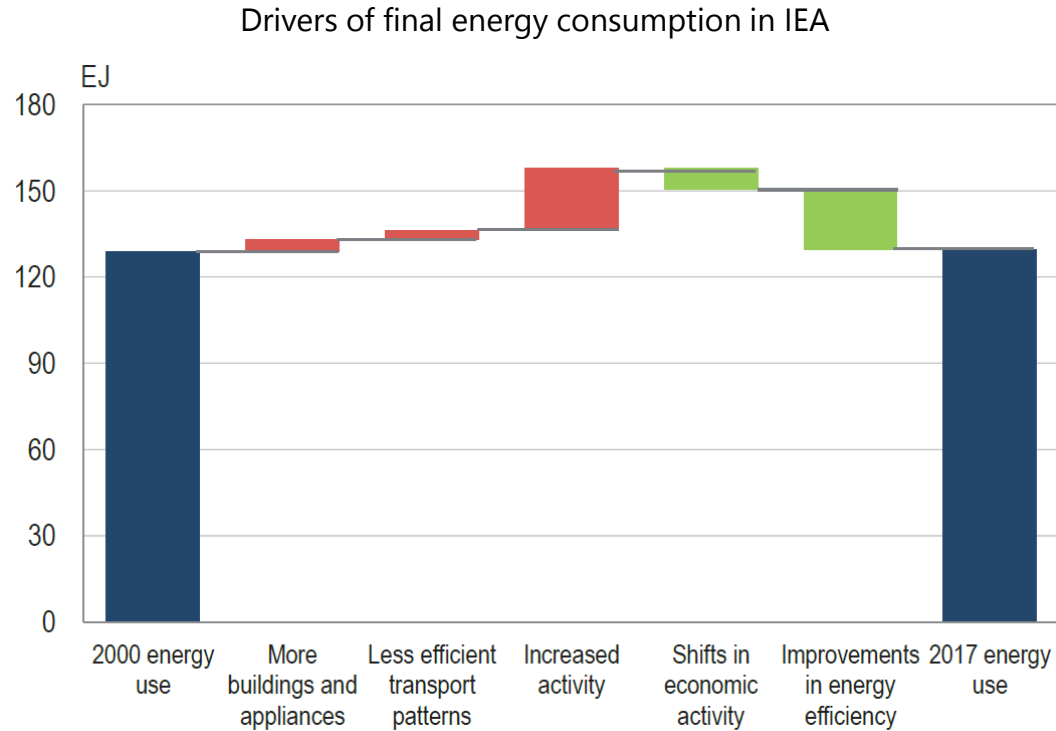
Disentangling efficiency from other driver

Drivers of final energy consumption in IEA



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

Disentangling efficiency from other driver

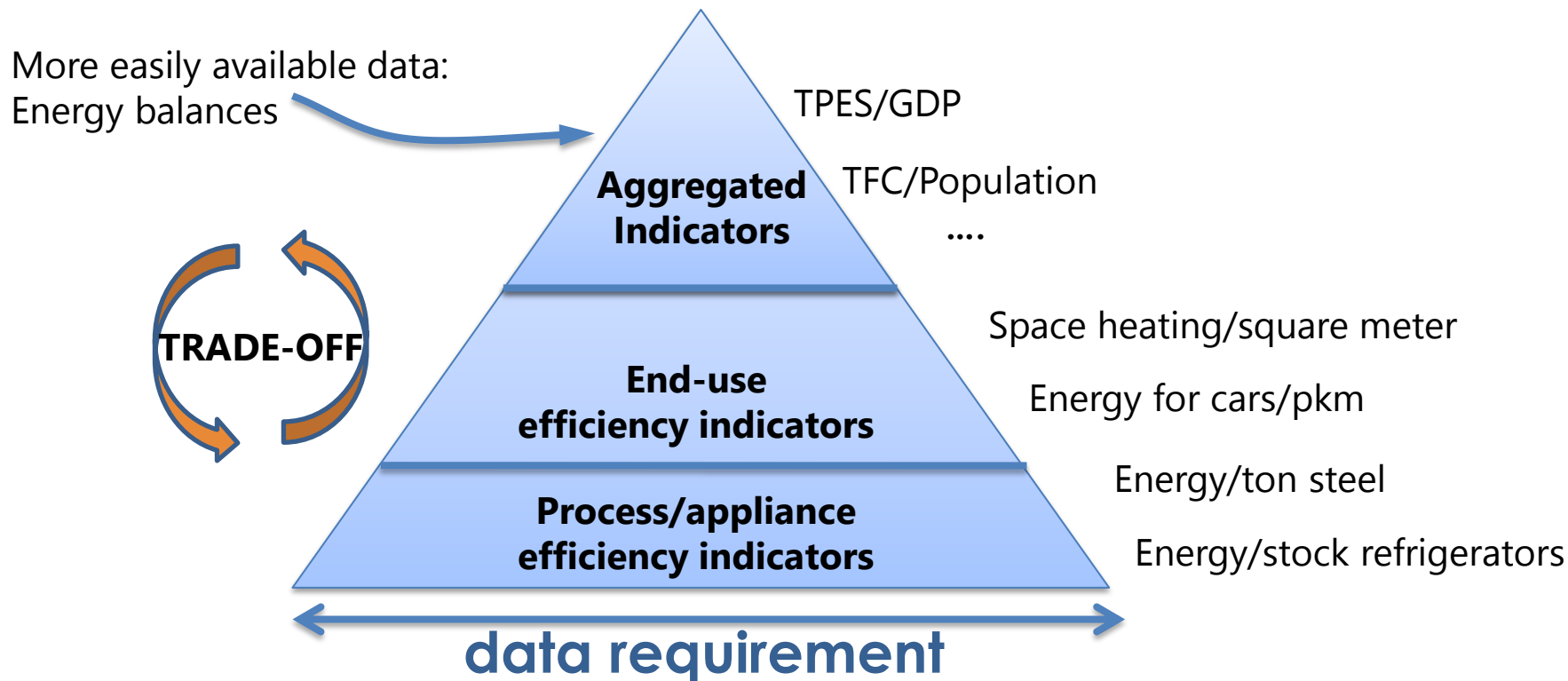


Source: IEA (2018), *Energy Efficiency Indicators*, All rights reserved, Paris, based on IEA Energy efficiency indicators database, 2018.

Beyond the energy balance: energy efficiency indicators

Analyzing energy end-uses

Energy efficiency indicators: stronger data requirements

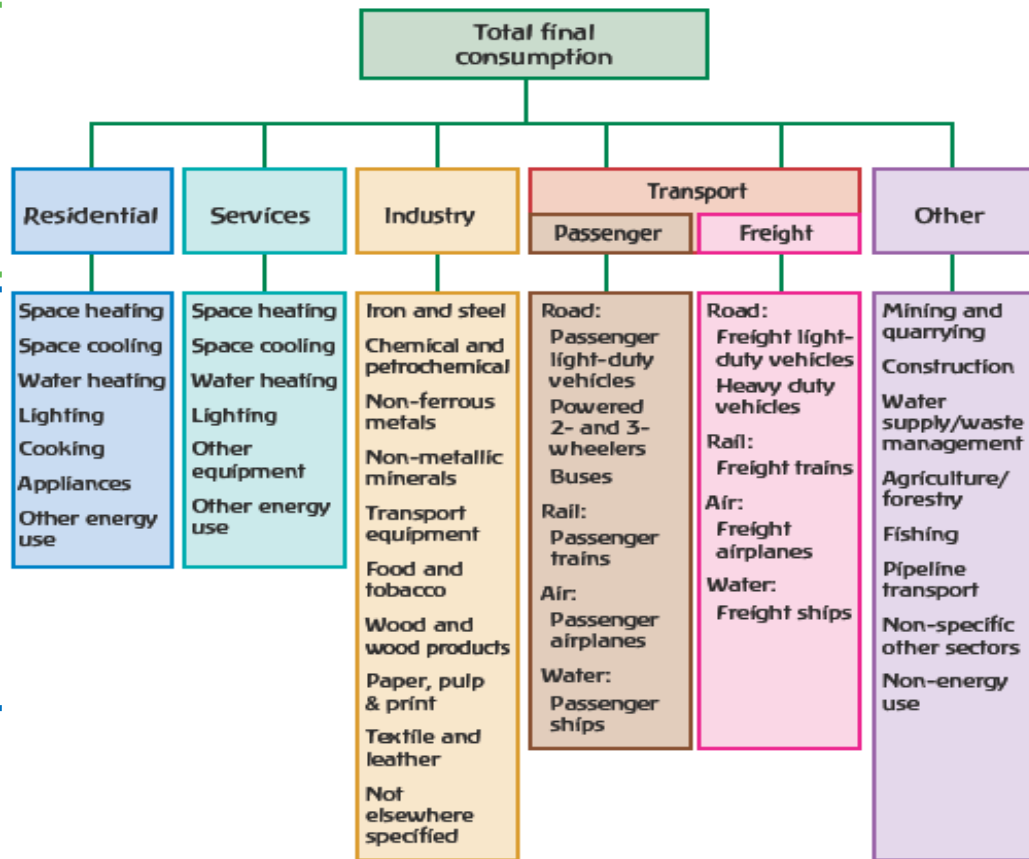


What are the data needed to develop relevant disaggregated indicators?

Understanding end-uses across sectors

Energy balances:
Sectoral consumption

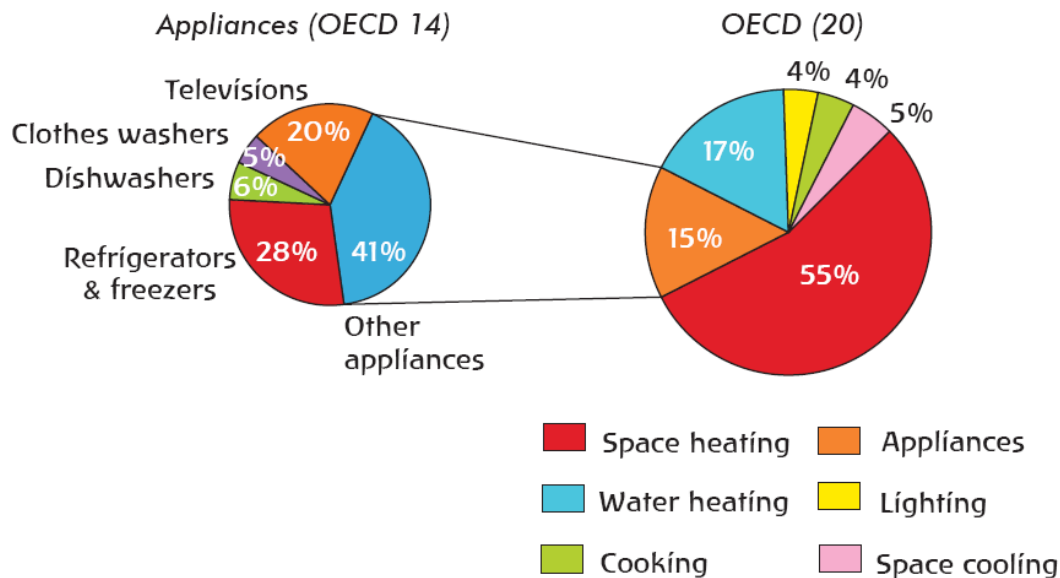
Energy efficiency:
End-use consumption



IEA Energy Efficiency Indicators:
Fundamentals on Statistics, 2014

Beyond energy balances: monitoring energy efficiency

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

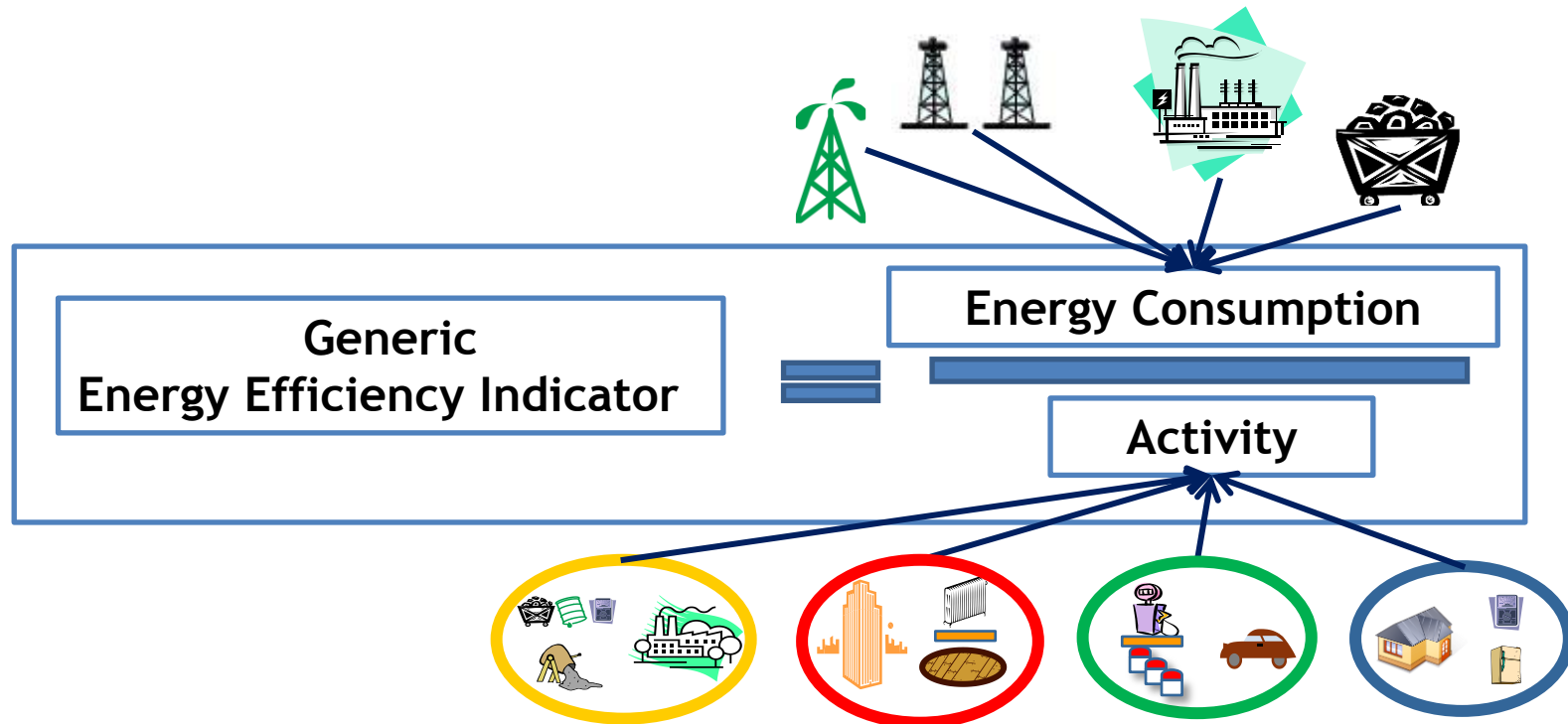


Note: The breakdown into individual appliances is available only for 14 countries.

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

Starting from energy balances and getting more insights in energy efficiency

Efficiency indicators link energy to activity across end-uses



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

Occupied dwellings vs total dwellings



Primary residences



Unoccupied dwellings



Vacation homes

Residential: matching energy and activity

QUIZ

Water heating

floor area (m²)



of dwellings



Residential: matching energy and activity

QUIZ

Appliances

floor area (m²)



of dwellings



Residential: matching energy and activity

QUIZ

Appliances

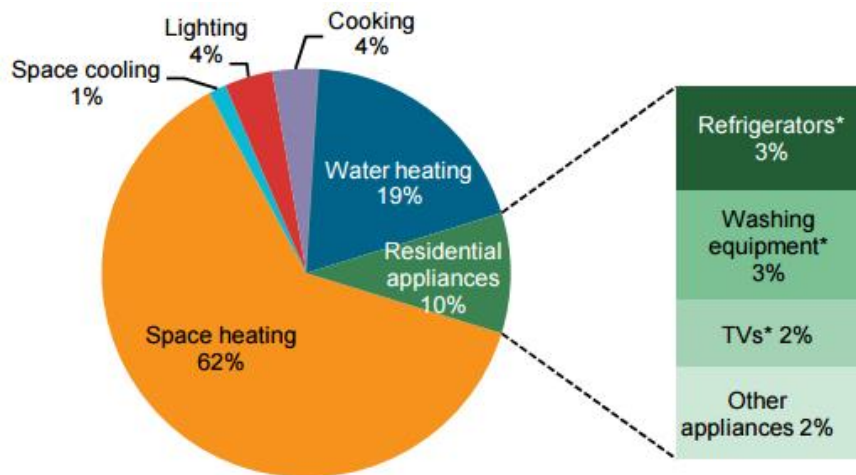
floor area (m²)



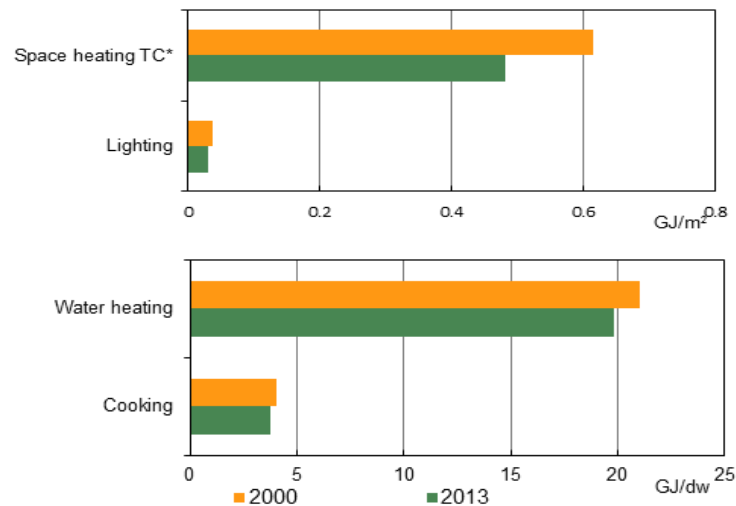
Appliance stocks



Example of insights from end use data: residential sector



Example of shares of end -uses on energy consumption



Example of selected energy intensities

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



Value added



Volume

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
- Vehicle- kilometres
- Passenger-kilometers
- Tonne-kilometers



Vehicle stock



Distance travelled

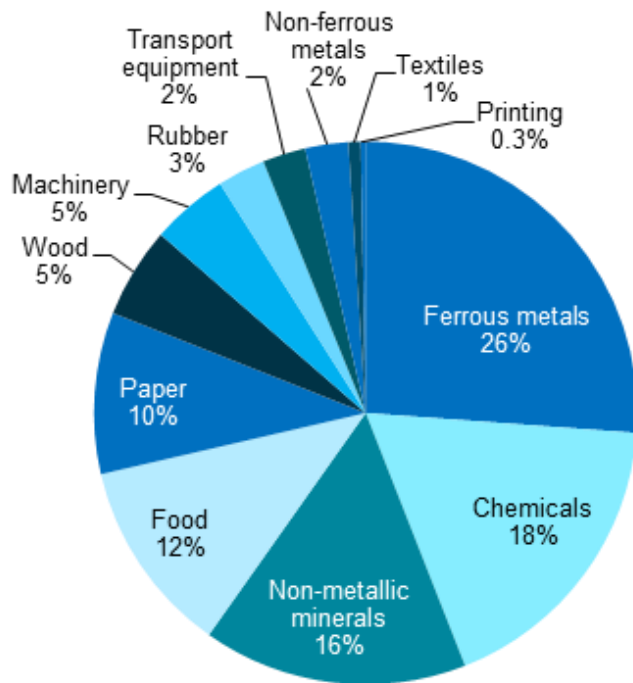


Occupancy

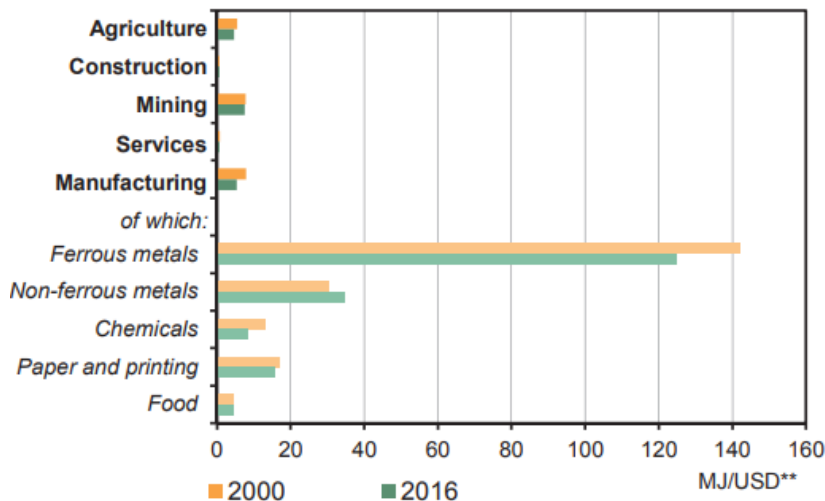


Load

Data and indicators for the industry sector



Example of shares of industry subsectors on energy consumption



Example of selected energy intensities

Activity data for efficiency calculation in transport

Passenger-km or tonne-km



Occupancy



Load factor

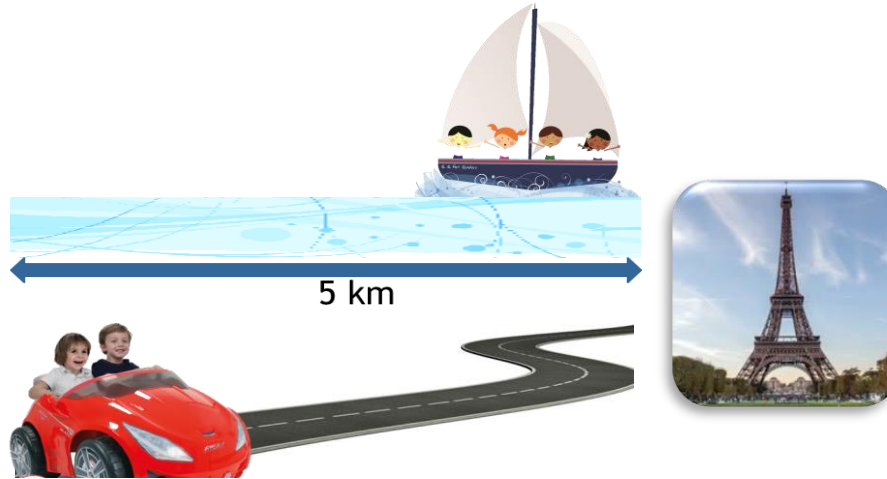


*Vehicle
stock*



*Distance
travelled*

Activity data for efficiency calculation in transport

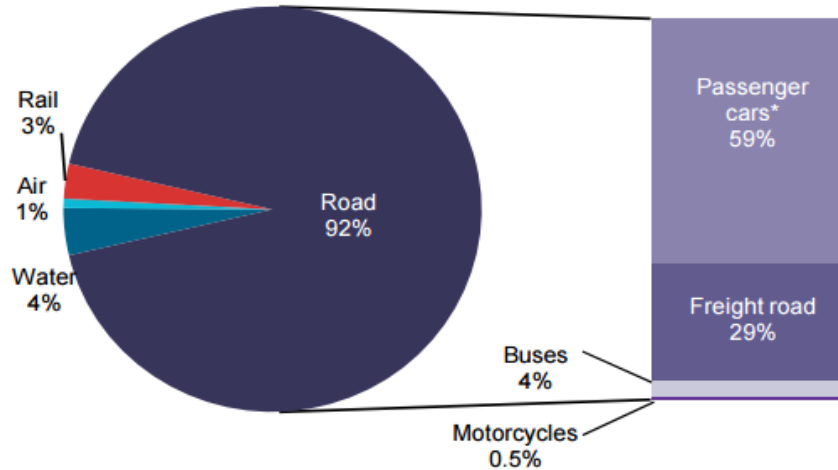


$$V_{km} = 5km + 5 km = 10 \text{ vkm}$$

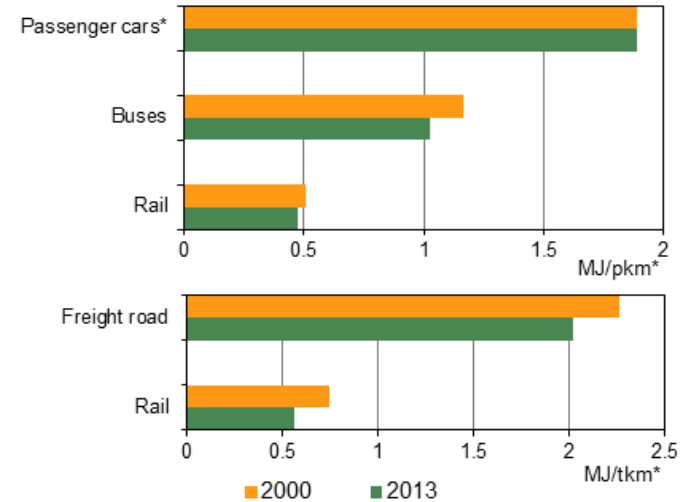
$$P_{km} = 6 \text{ passengers} * 5 \text{ km} = 30 \text{ pkm}$$

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

Example of insights from end use data: transport sector



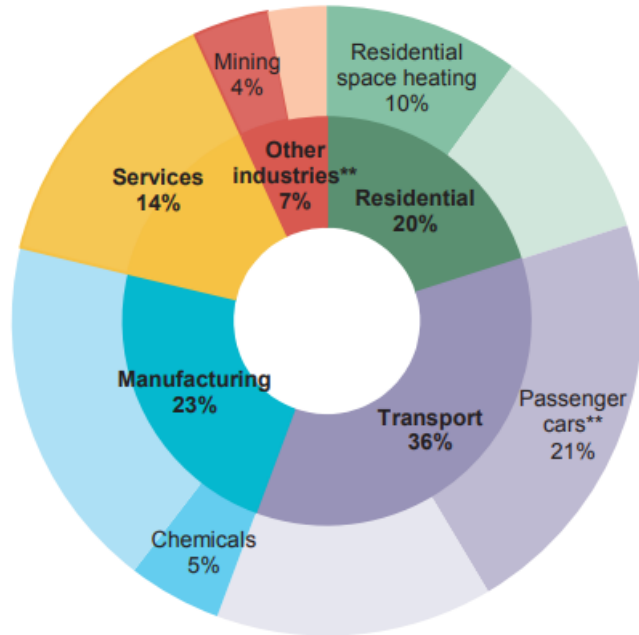
Shares by mode/vehicle type on energy consumption, country Y



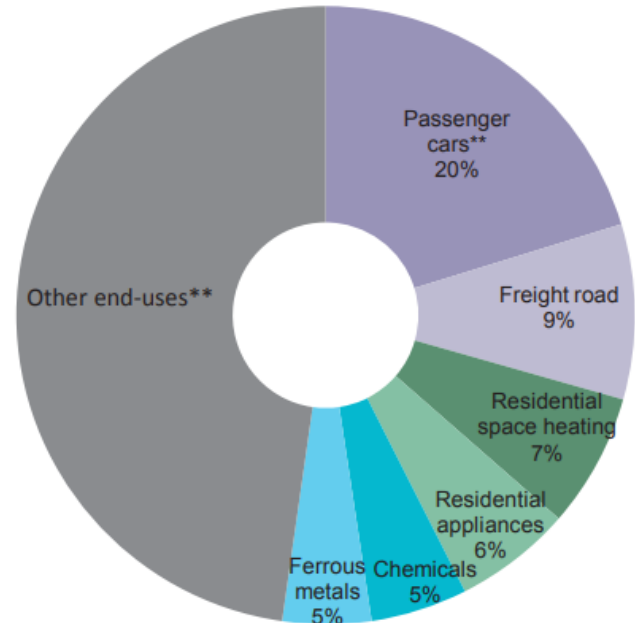
Selected energy intensities, country Y

Insights from end use data

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

IEA Members recognize the value of end use data work

- Agreed by member countries in 2009 (IEA Ministerial)
- **Developed with international community of experts**, (Odyssey, 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 screenshot shows the 'Energy Efficiency Indicators Template' interface. At the top, there is a blue header with the IEA logo and the text 'Energy Efficiency Indicators Template' and 'country name'. Below this is a table with two columns: 'COUNTRY DATA SECTION (to be reviewed and updated)' and 'INDICATOR DESCRIPTION'. The table lists various indicators for different sectors: COMMODITIES, INDUSTRY, SERVICES, RESIDENTIAL, and TRANSPORT. Each sector has a corresponding indicator description. Below the table, there is a section titled 'IEA DATA and AGGREGATE INDICATORS' which includes 'ELECTRICITY CONSUMPTION', 'BASIC INDICATORS', and 'SUPPORT TOOLS'. Each of these sections has a brief description. At the bottom, there is a text box asking if the user has any questions or needs assistance, with an email address 'write to: energydata@iea.org'. There is also a 'START' button and a 'Click on the START button to begin working' instruction.



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	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

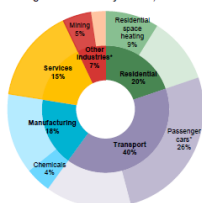
The end-use data collected and published by the IEA

Country		Sector		End use		Energy product		Energy indicator	
Country		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)	
								Fuel intensity (liters/100 vkm)	
		Services		Space heating				Passenger-kilometer energy intensity (MJ/pkm)	
				Space cooling		(...)		Tonne-kilometer energy intensity (MJ/pkm)	
		Industry		Lighting				Vehicle-kilometer energy intensity (MJ/pkm)	
				Other				Other	
				Textiles					
				Chemicals					
				Paper					
				Minerals					
				Basic metals					
				Other					
		Transport		Passenger cars					
				Buses					
				Passeng. trains					
				Trucks					
				Passeng. trains					
				Other					

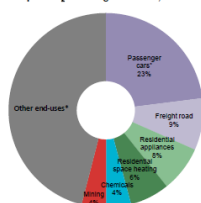
Energy Efficiency Indicators Highlights

Cross-sectoral overview

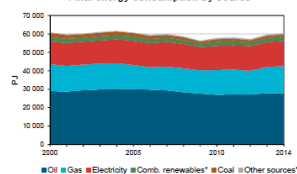
Largest end-uses by sector, 2014



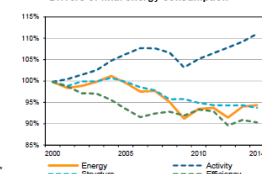
Top-6 CO₂ emitting end-uses, 2014**



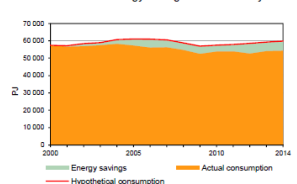
Final energy consumption by source



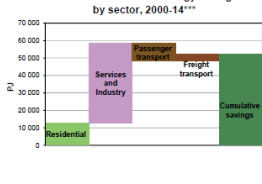
Drivers of final energy consumption***



Estimated energy savings from efficiency***



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

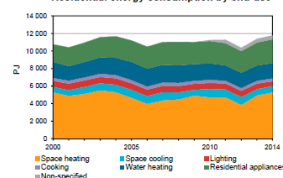


*Other industries includes agriculture, mining and construction; passenger cars includes cars, sport utility vehicles and personal trucks; other end-uses includes the remaining part of emissions beyond the top-6; comb. renewables includes combustible renewables and wastes; other sources includes heat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

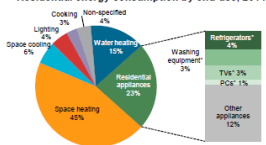
Residential sector

	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 (person/dwelling)
2000	10 772	84	282	38	196	2.8
2014	11 792	79	319	37	181	2.8

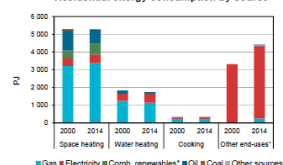
Residential energy consumption by end-use



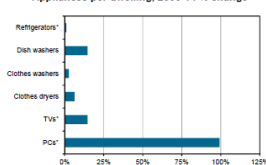
Residential energy consumption by end-use, 2014



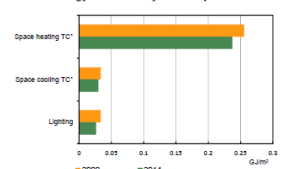
Residential energy consumption by source



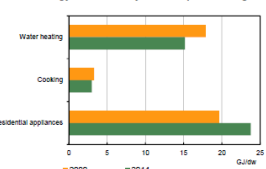
Appliances per dwelling, 2000-14 % change



Energy intensities by end-use per floor area



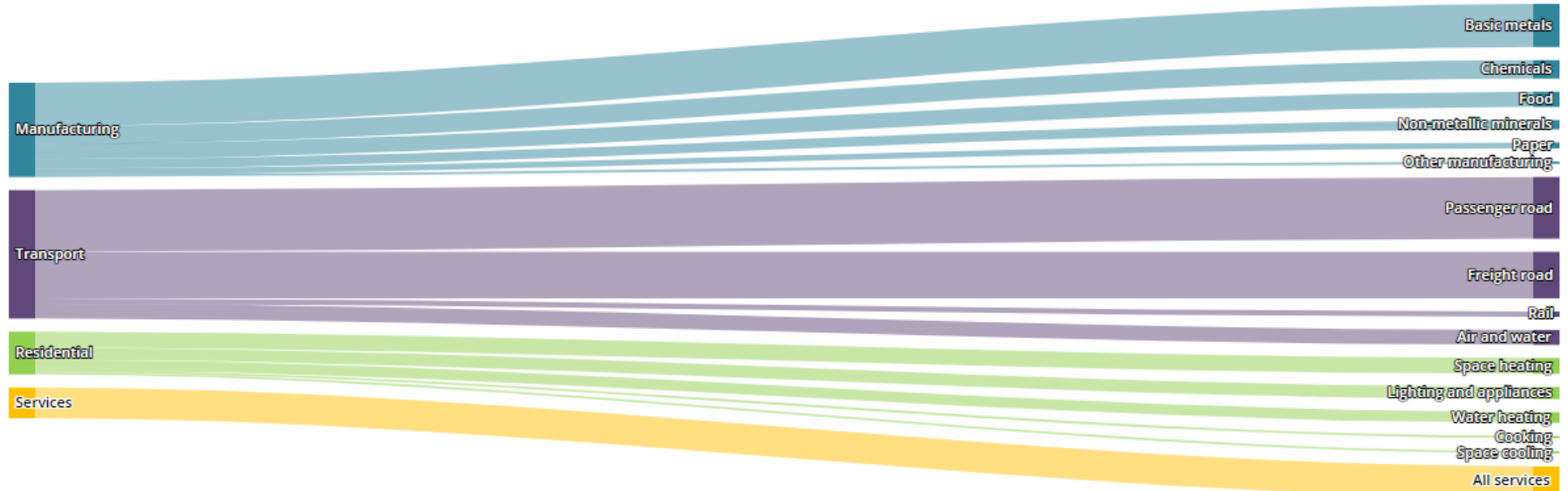
Energy intensities by end-use per dwelling



<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

IEA resources : methodologies on indicators

➤ Fundamentals on statistics:

to provide guidance on how to collect the data needed for indicators

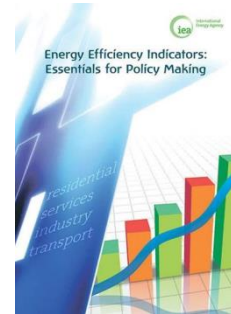
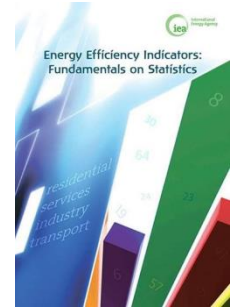
- Includes a compilation of existing practices from across the world
- <https://webstore.iea.org/energy-efficiency-indicators-fundamentals-on-statistics>

➤ Essentials for policy makers:

- To provide guidance to develop and interpret indicators
- <https://webstore.iea.org/energy-efficiency-indicators-essentials-for-policy-making>

Both available also in:

*Spanish
Russian
Chinese*



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

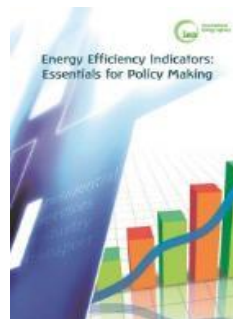
IEA e-learning courses: capacity building on energy efficiency data

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

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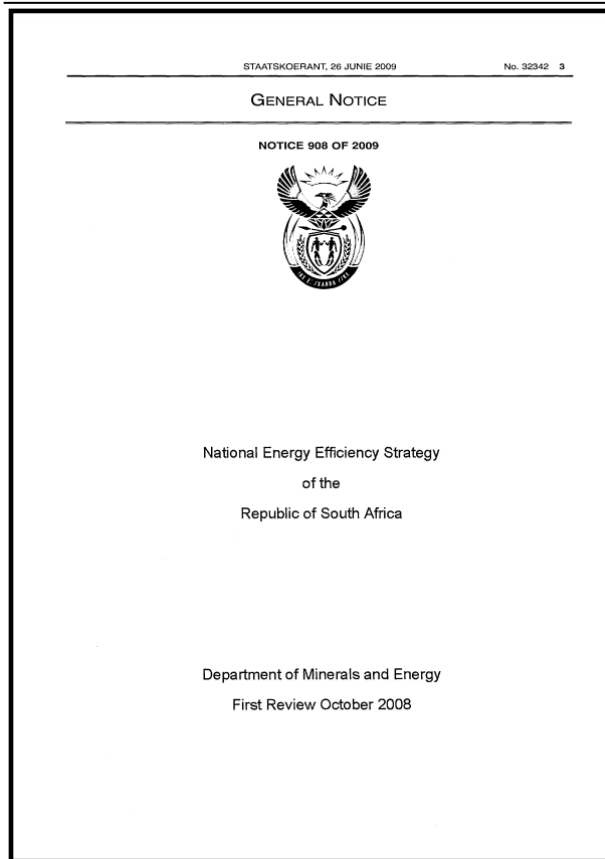
- **Energy Efficiency Indicators: Essentials for Policy Making**



Energy Efficiency Indicators

Examples of application

Example of application – South Africa



Industry and Mining: Target of 15% reduction of TFC

- 1% per year improvement of energy intensity for **iron and steel**
- 1% per year improvement of energy intensity for **chemical and petrochemical**
- 10% final energy demand for **mining** by 2015
- 2% per year improvement for **paper, pulp and printing**
- 2% per year improvement for **cement**

Commercial and public buildings: Target of 20% reduction of TFC

Transport: Target of 9% reduction of TFC

Residential: Target of 10% reduction of TFC

Example of application – South Africa... and prospects for the post 2015 National Energy Efficiency Strategy

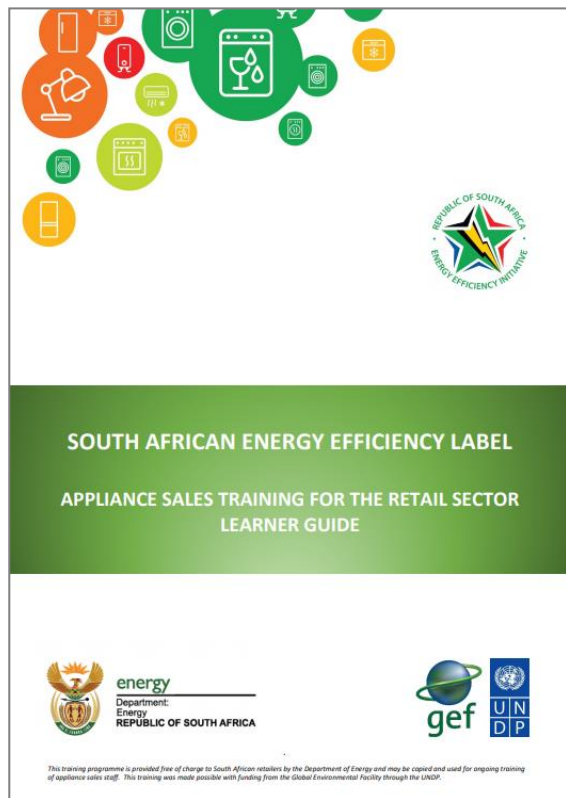
HOW WILL WE MEASURE SUCCESS?

(example from residential sector)

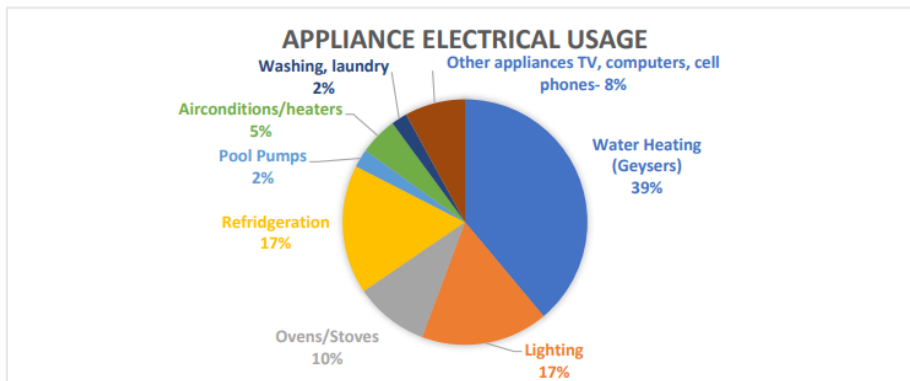
- The continued development and maintenance of the existing Department of Energy **database of household appliance sales** will provide the necessary data for monitoring the **appliances target**.
- For the **buildings target**, the main challenge is **assessing the baseline** – it is likely that a **survey** of a representative sample of dwellings would be necessary for this.

Source: post 2015 National Energy Efficiency Strategy (draft)

Example of application – South Africa – S&L program



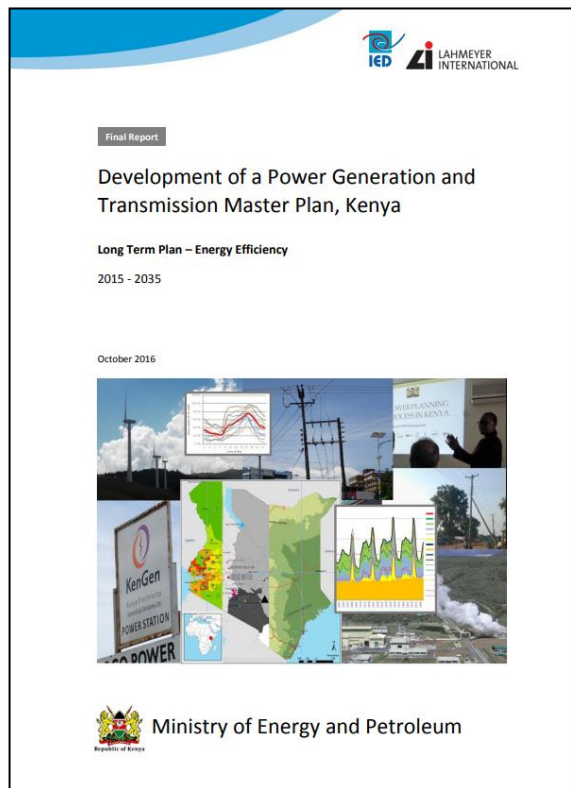
- Typical household usage of electricity in South African homes (based on research from Eskom IDM)



- These data served as input for the design Standards and Labelling programme, which determined that the following appliances should be included in the programme:

1. Audio-visual equipment – TVs, ...;
2. Fridges; 3. Freezers ;Combinations; 10.
4. Fridge-Freezers; 5. Electric Ovens; 11.
- Electric Lamps; 6 . Dishwashers; 12. Air-conditioners
- Water heaters; 7. Washing Machines ;
8. Tumble Dryers; 9. Washer-Dryer

Example of application – Kenya



• Examples of Energy efficiency programmes:

- Standard and labelling programme financed by the Global Environment Fund (GEF)

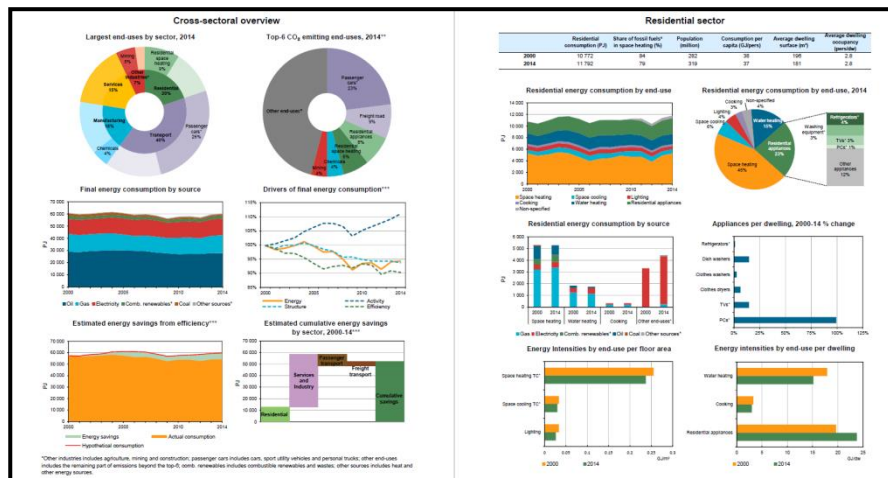
Table 3-2: EE programmes implemented or launched

Sector	EE technology
Residential	Refrigerators; lighting (CFL); air-conditioners
Commercial	Display refrigerators; air-conditioners; lighting (CFL)
Industrial	AC motors; lighting (CFL)

Source: Standard and labelling programme (GEF)

- Replacement of incandescent lamps (ICLs) with Compact Fluorescent Lamps (CFLs)
- **Potential of EE evaluated in each sector**

The IEA mission on data



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

To collect and disseminate reliable data to inform policy-making



energy

Department:
Energy
REPUBLIC OF SOUTH AFRICA