An introduction to decomposition analysis
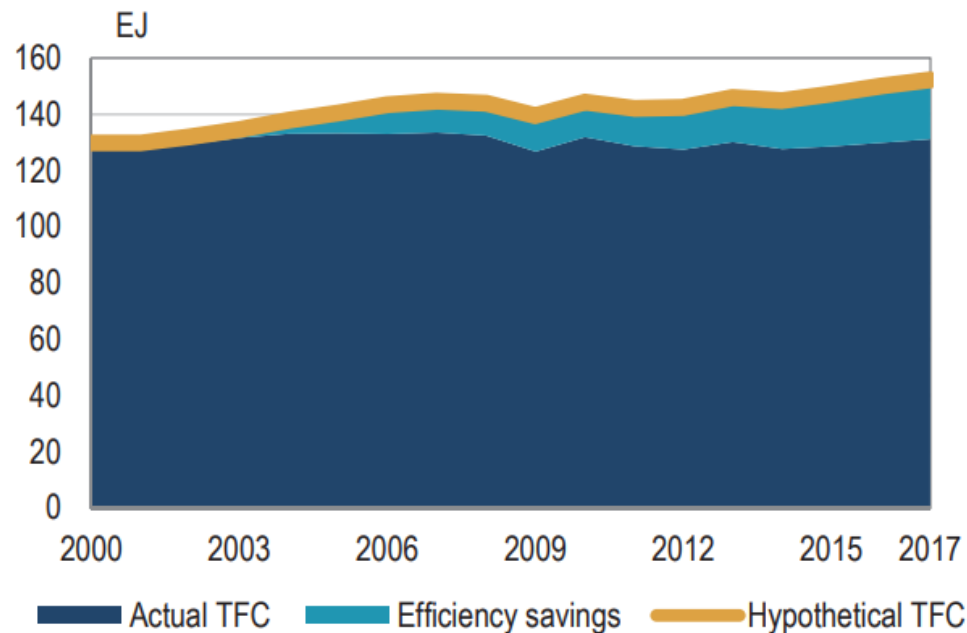
Mafalda Silva and Charles Michaelis

Paris, 23 May 2019

IEA #energyefficientworld

How to estimate energy savings from efficiency over time?

Source: adapted from IEA (2018) *Energy efficiency 2018,* based on the IEA Energy efficiency indicators database, 2018.

Estimated energy savings since 2000 in IEA reached approximately 21EJ, equivalent to energy consumption of Germany, France and UK together.

Drivers of energy consumption: 3 main effects

- **Activity effect**
  - Change in the **overall level** of the activity / level of action that drives energy consumption.

- **Structure effect (Activity mix)**
  - Change in the **mix of activities** within a sector

- **Energy efficiency effect (Intensity)**
  - Changes in **sub-sectoral energy intensities** (i.e. energy used per unit of activity)

Understanding what drives energy consumption is complex

Purpose of decomposition analysis:
Quantify **contribution of specific factors** to the change in energy consumption between a base year and another point in time
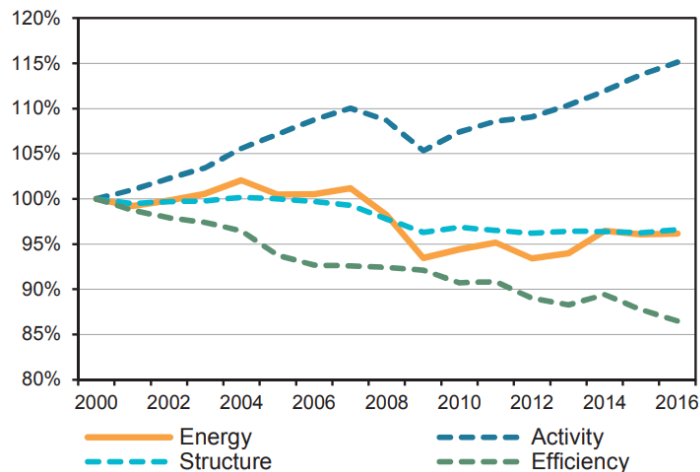
Source: IEA Energy Efficiency Indicators database (2018 edition)

Need to disentangle different factors: activity, structure and efficiency
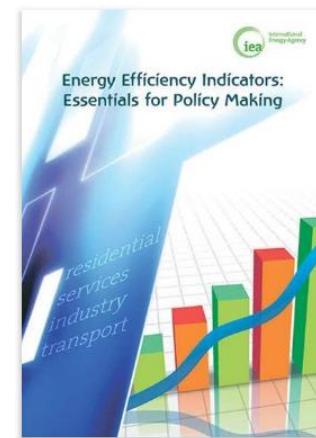
Decomposition analysis

- There are **different methods** – the IEA uses the LMDI

  LMDI = Logarithmic Mean Divisia Index

- Can be applied to <u>specific subsectors</u> or <u>end uses</u> (e.g. space cooling, cars,...) to estimate the energy savings from efficiency.

➤ For more detail: *Energy efficiency indicators: Essentials for policy makers:*

  ▪ to provide guidance to develop and interpret energy efficiency indicators

  ▪ https://goo.gl/agcNg2

Data requirements and indicators for decomposition analysis

EEI data requirements

- Degree of disaggregation of EEI needed affects the data collection requirements

- Sub-sectoral /end-use energy consumption

Schematic representation of energy indicators
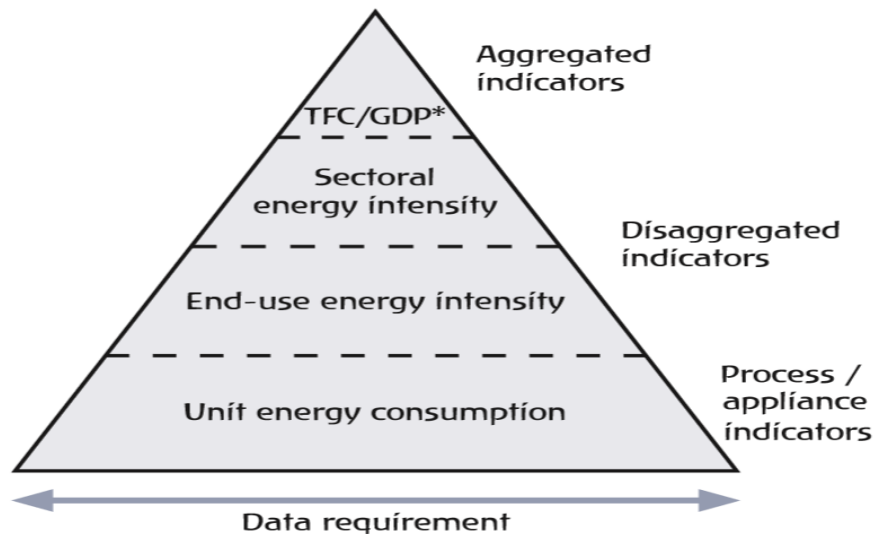
## Schematic disaggregation of sectoral end-uses

Decomposition Analysis in Residential Sector
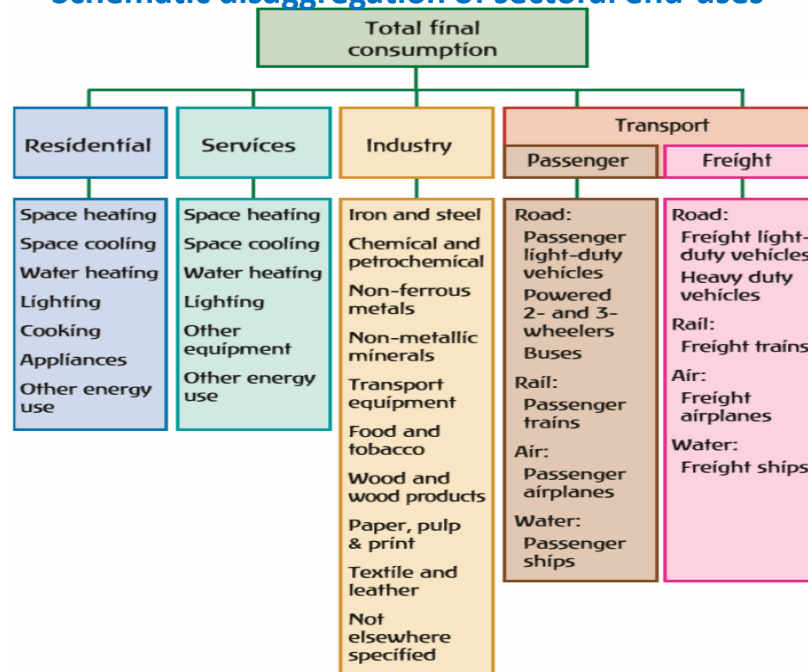
- Metric examples for residential energy decomposition

End-use	Activity (A)	Structure (S)	Intensity (I)
Space heating	Population	Floor-area / Person	Space heating energy* / Floor-area
Space cooling	Population	Floor-area / Person	Space cooling energy** / Floor-area
Water heating	Population	Occupied-dwelling / Person	Water heating energy / Occupied-dwelling
Cooking	Population	Occupied-dwelling / Person	Cooking energy / Occupied-dwelling
Lighting	Population	Floor-area / Person	Lighting energy / Floor-area
Appliances	Population	Appliance stocks / Person	Appliance energy / Appliance stocks

* Adjusted energy using HDD compensation, ** Adjusted energy using CDD compensation

Decomposition examples of residential energy consumption in 2011 relative to 2001

Decomposition Analysis in Industry Sector
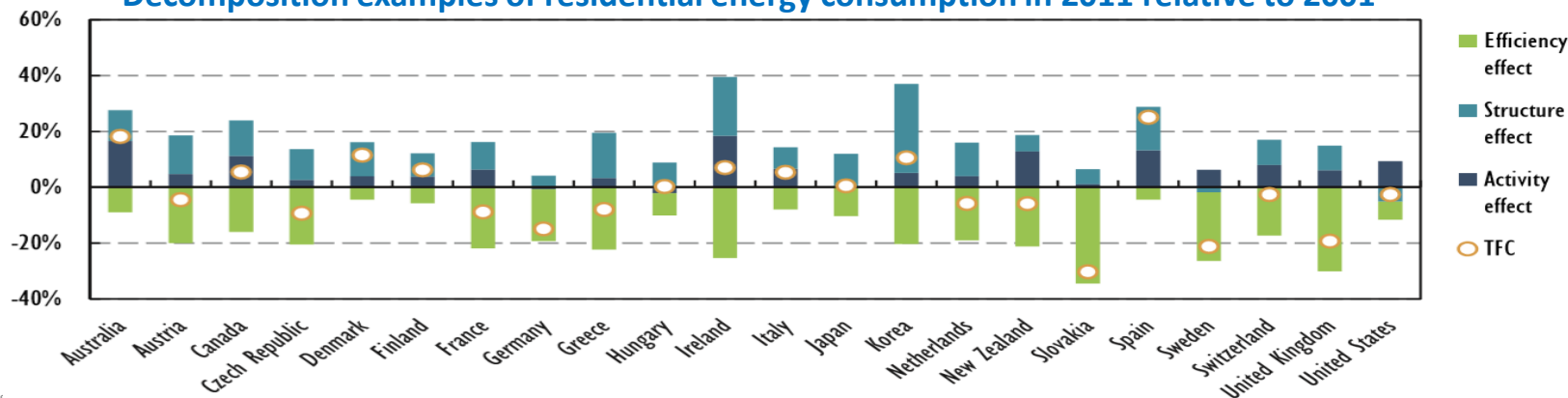
- Metric examples for industry energy decomposition

Sub-sector	Activity (A)	Structure (S)	Intensity (I)
Food products, beverages, tobacco products (ISIC* 10-12)	Value-added	Share of Value-added	Energy / Value-added
Paper and paper products (ISIC 17)	Value-added	Share of Value-added, Production / Value-added	Energy / Value-added, Energy / Production
Chemicals and chemical products (ISIC 20-21)	Value-added	Share of Value-added, Production / Value-added	Energy / Value-added, Energy / Production
Non-metallic mineral products (ISIC 23)	Value-added	Share of Value-added, Production / Value-added	Energy / Value-added, Energy / Production
Basic metal (ISIC 24)	Value-added	Share of Value-added, Production / Value-added	Energy / Value-added, Energy / Production
Fabricated metal products, machinery and equipment (ISIC 25-28)	Value-added	Share of Value-added	Energy / Value-added
Other industry (ISIC 10-32, excluding ISIC 19 and those described above)	Value-added	Share of Value-added	Energy / Value-added

Decomposition Analysis in Transport Sector

- Metrics examples for transport energy decomposition

Mode	Activity (A)	Structure (S)	Intensity (I)
Passenger road (cars, buses...)	Passenger-km	Share of Passenger-km, Registered Vehicle / Passenger-km	Energy / Passenger-km, Energy / Vehicle
Passenger rail	Passenger-km	Share of Passenger-km, Passenger / Passenger-km	Energy / Passenger-km, Energy / Passenger
Passenger domestic air	Passenger-km	Share of Passenger-km, Passenger / Passenger-km	Energy / Passenger-km, Energy / Passenger
Freight road (HDVs)	Tonne-km	Share of Tonne-km, Tonne / Tonne-km	Energy / Tonne-km, Energy / Tonne
Freight rail	Tonne-km	Share of Tonne-km, Tonne / Tonne-km	Energy / Tonne-km, Energy / Tonne
Freight domestic shipping	Tonne-km	Share of Tonne-km, Tonne / Tonne-km	Energy / Tonne-km, Energy / Tonne

Energy efficiency & emissions savings

Avoided global GHG emissions from energy efficiency improvements

Global emissions

Gt CO_2-eq

Actual emissions — — — Without efficiency
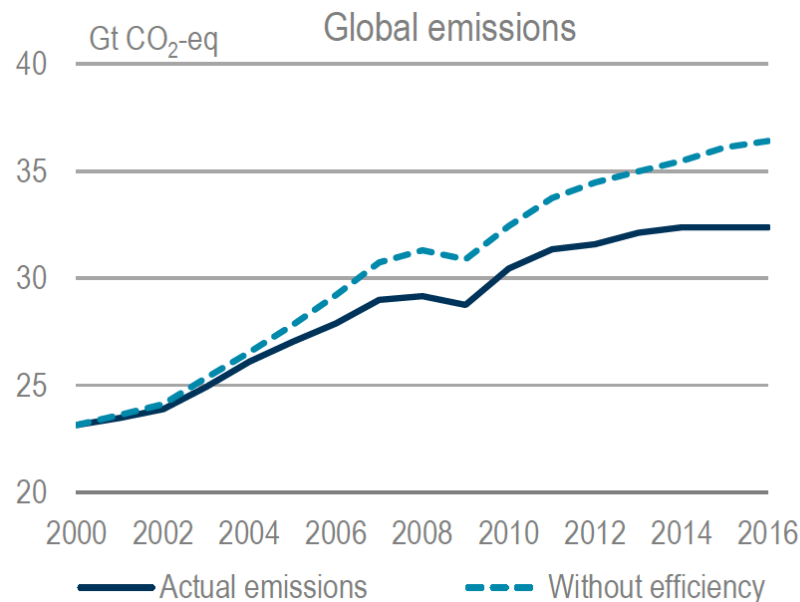
Source: IEA (2017), *Energy Efficiency Market Report*, OECD/IEA, Paris.

Energy efficiency reduced GHG emissions by 4 GtCO$_2$-eq, or 13% of total CO2 emissions in 2016.

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