Did it work?

Evaluation and energy efficiency indicators

Buildings

Buildings energy efficiency sessions in partnership with:

UCL ENERGY INSTITUTE

UCL

BEEP

INDO-SWISS BUILDING ENERGY EFFICIENCY PROJECT

IEA #energyefficientworld

Energy Efficiency Training Week: Buildings programme

1. **Where to start:** Energy use in buildings
2. **Where to start:** Energy efficiency potential in buildings
3. **Toolkit:** Energy efficient building design
4. **Toolkit:** Energy efficient building technologies

   Special session. Technology demonstration

   Where do I get help? IEA's Technology Collaboration Programmes
5. **Toolkit:** Energy efficiency policies and target setting
6. **What are the steps?** Enabling investment with energy efficiency policies
7. **What are the steps?** Implementing building energy codes and standards
8. **What are the steps?** Building operations and procurement

   Special session. The multiple benefits of energy efficiency
9. **Did it work?** Evaluation and energy efficiency indicators

   Where do I get help? International and regional energy efficiency initiatives
10. **Energy efficiency quiz:** Understanding energy efficiency in buildings

9. Did it work? Evaluation and energy efficiency indicators

Trainers: Brian Dean and Ian Hamilton

Purpose: To teach the fundamentals of tracking progress with energy efficiency indicators that are applicable to the buildings sectors. The course will include a discussion of IEA's methodologies and how to collect or model data that can be used to estimate progress from energy efficiency efforts.

Scenario: Leadership wants to know how effective the building energy efficiency policies have been. *How do you determine the benefits of your policies and programmes?*

Evaluation

What is evaluation?

Ex-ante evaluation

Ex-post evaluation

What is evaluation?

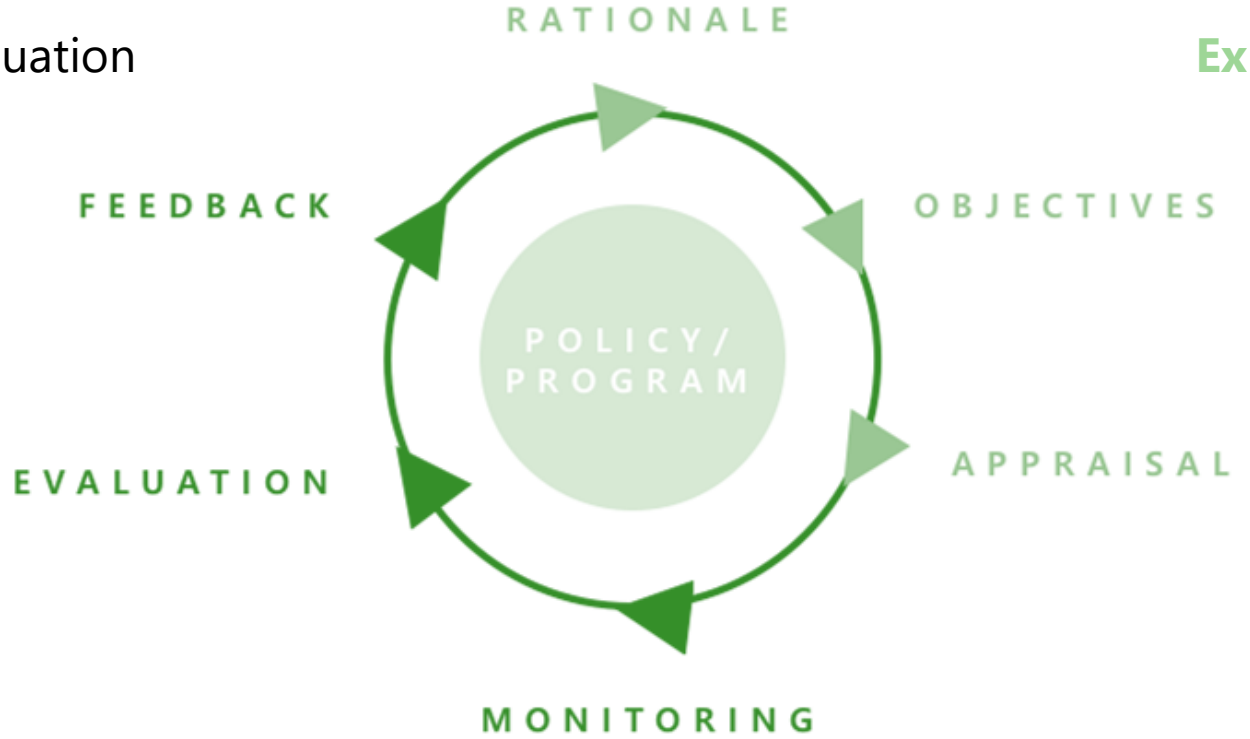
Evaluation is an **objective** process of understanding **how** a policy or programme was implemented, **what** effects it had, for whom and **why.**

It leads to **more effective** policies and programmes

When should you evaluate?

Ex-post evaluation

Ex-ante evaluation



The term **ex-post** is a phrase meaning "after the fact“

The term **ex-ante** is a phrase meaning "before the event“

Ex-ante evaluation analysis approaches

1. **Technical potential:** analysing the total energy efficiency potential without any economic or market constraints *(e.g. analysing the energy savings potential if all buildings used best available technology)*

2. **Economic potential:** analysing the energy efficiency potential assuming economic constraints for cost effectiveness *(e.g. analysing the energy savings potential if buildings used the most-efficient cost-effective technology)*

3. **Market potential :** analysing the energy efficiency potential assuming market constraints in implementing energy efficiency *(e.g. analysing the energy savings potential using a adoption curve to estimate typical market implementation given the available policies and technologies)*

Technical potential, economic potential and market potential are used for different purposes

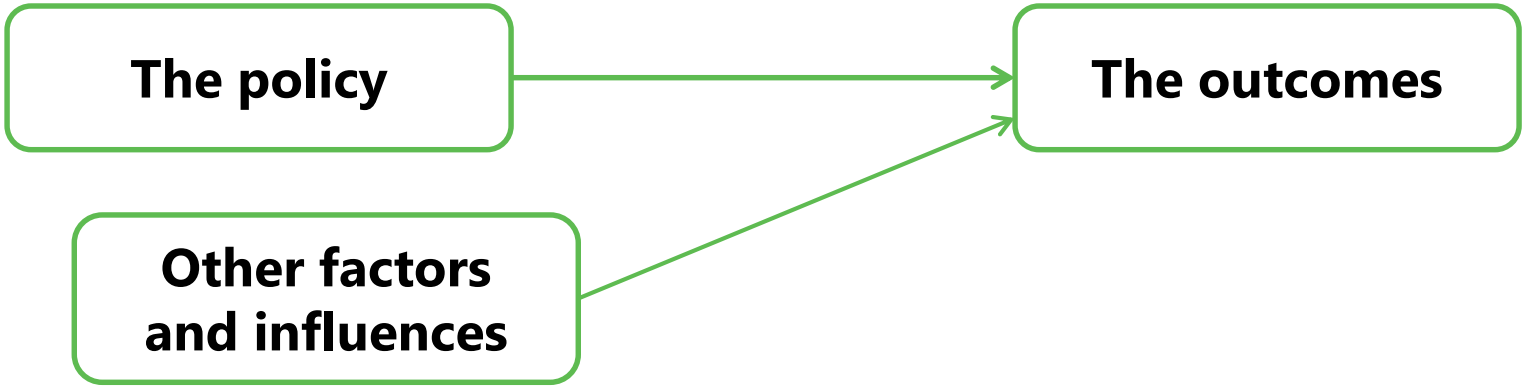
Ex-post evaluation: did it work?

Measuring activities and outputs is straightforward, if not simple.
Outcomes / impacts are more difficult…

Why is it more difficult?

Ex-post evaluation: did it work?

Measuring activities and outputs is straightforward, if not simple.
Outcomes / impacts are more difficult…



Other factors include:

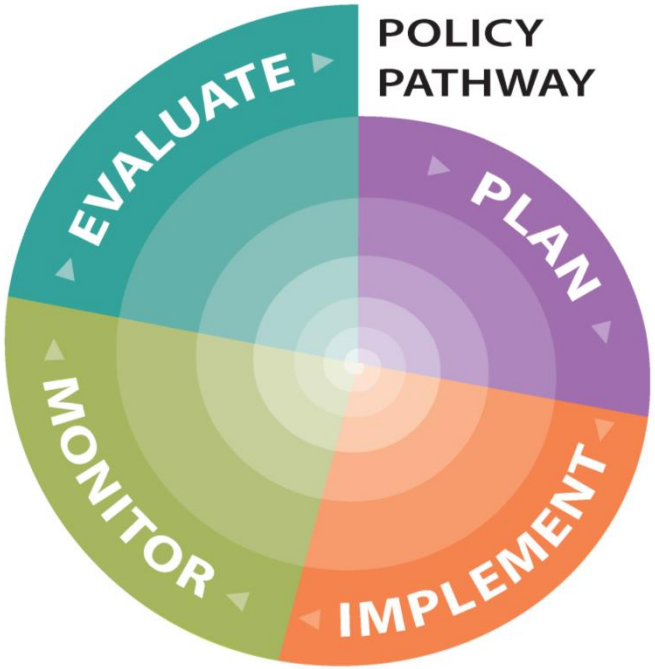
- Global, national, local trends / events
- Other policies
- Something you haven't even thought of…

Energy efficiency data

Indicators manuals

Indicators data pyramid

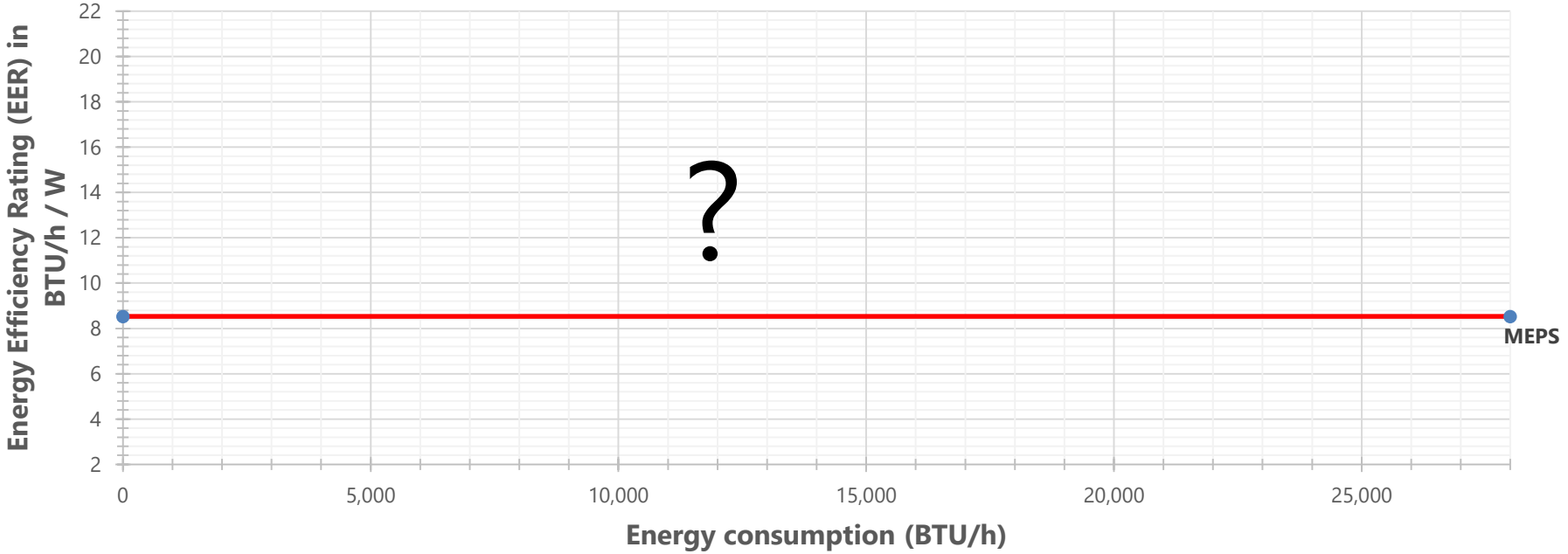
Data is essential at all stages of the policy cycle



- **Plan:** Inform policy design based on current state and ambition
- **Implement:** Adapt the policy during adoption and enforcement stages
- **Monitor:** Track how the policy is performing
- **Evaluate:** Use the data to see what happened and why

Each step requires appropriate data to be effective

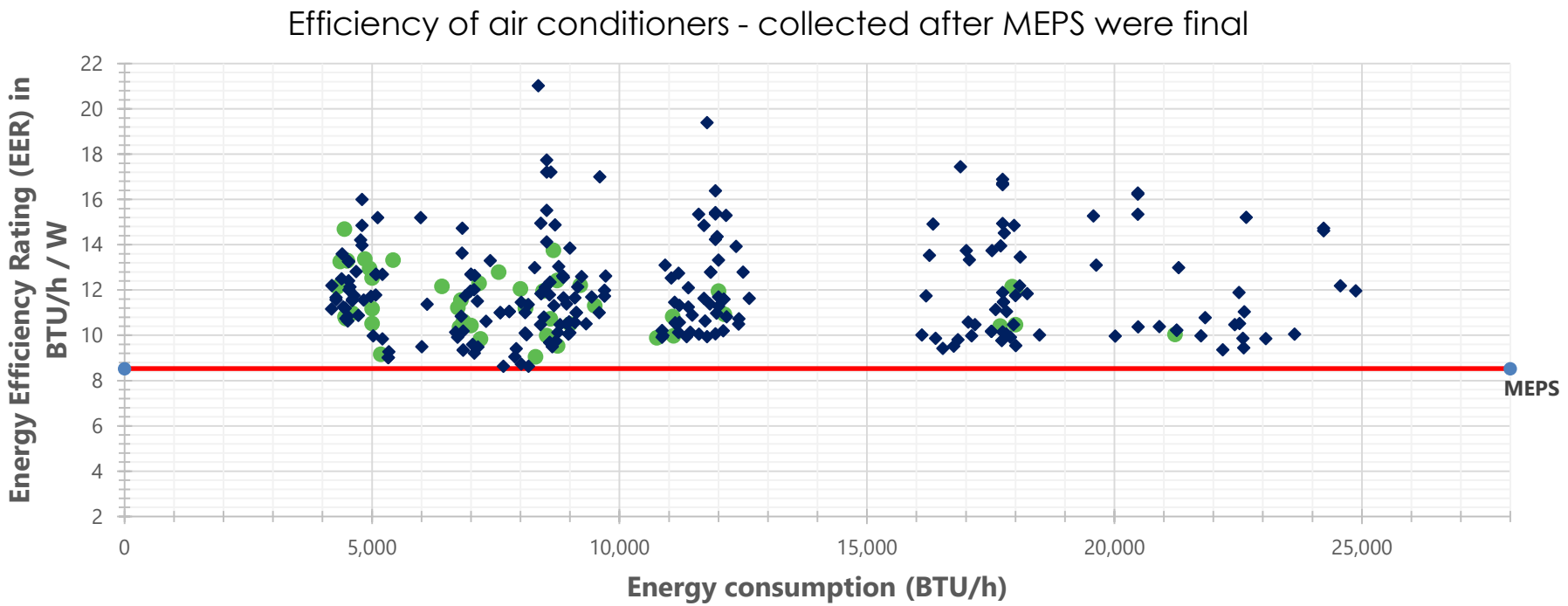
Why do we need data for policy design?



Where do you set your minimum energy performance standards (MEPS)?

Without national market data, you may set the MEPS here…

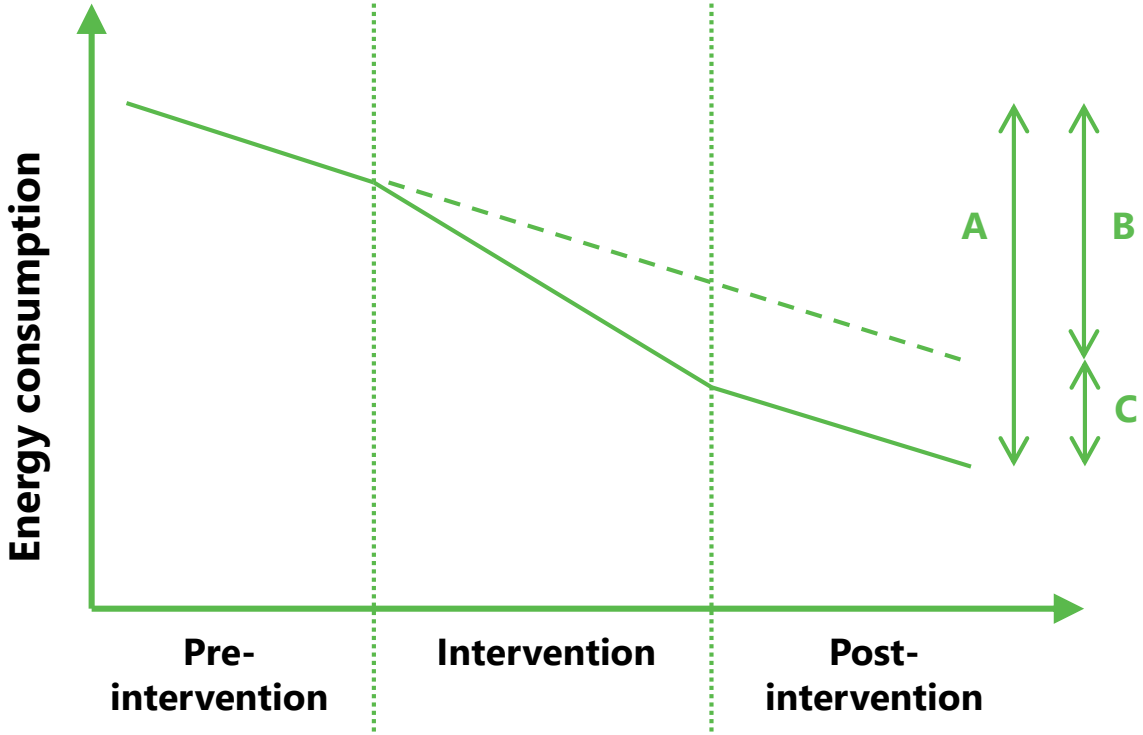
Why do we need data for policy design?



In this case, without appropriate data, MEPS were set too low.

Providing an unfair advantage to benefit importers over local companies…

How does data help in implementation?



Impacts are assessed compared to "control" group (what would have happened)

Monitoring and Evaluation

Monitoring provides headline data on policy performance

- W*hat happens as a result of the policy?*

Evaluation provides an *understanding* of what is happening / has happened

- *Why and what can be done about it?*

Why is monitoring and evaluation needed?

- Understand what happens as a result of the policy
- Verify the policy is performing as expected
- Ability to change policy during its implementation
- Learn for other policies
- Understand the energy efficiency and energy market more
  - What drives changes in the market?
  - How do energy consumers react?

Main sources of data, information and indicators

- Management information/reporting
- Measurement e.g. meter readings, compliance data
- Experiments/testing
- Modelling
- Surveys
- Interviews and focus groups

Resource of methods for capturing data, information and indicators

Home » ClassicStats » Topics » Energy efficiency » EE Indicators Manual

Energy Efficiency Indicators Statistics: Country Practices Database

A supplement to the publication Energy Efficiency Indicators: Fundamentals on Statistics, this database presents practices on collection of data for developing efficiency indicators from a variety of OECD Members and non-Members.

Practices are searchable by country and territory, sector, methodology and type of available documentation. By sharing these experiences, we hope to help countries and organisations to develop their own energy efficiency indicators programmes.

Countries, territories and economies

- Albania
- Australia
- Austria
- Belarus
- Belgium
- Bosnia and Herzegovina
- Brazil
- Bulgaria
- Canada

Sector

- Industry
- Residential
- Services
- Transport

Methodology

- Administrative sources
- Measuring
- Modelling
- Surveying

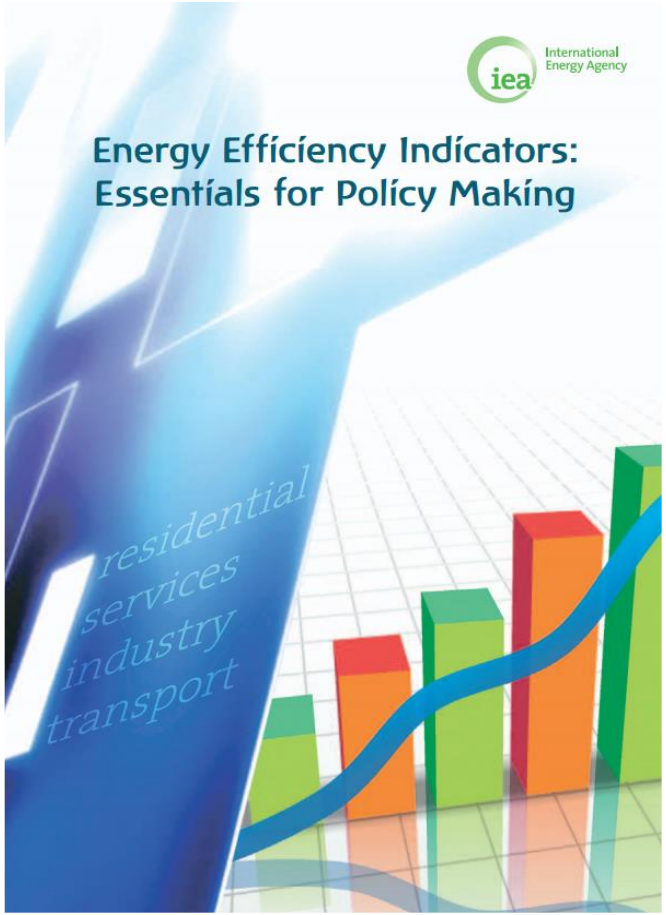
Available content

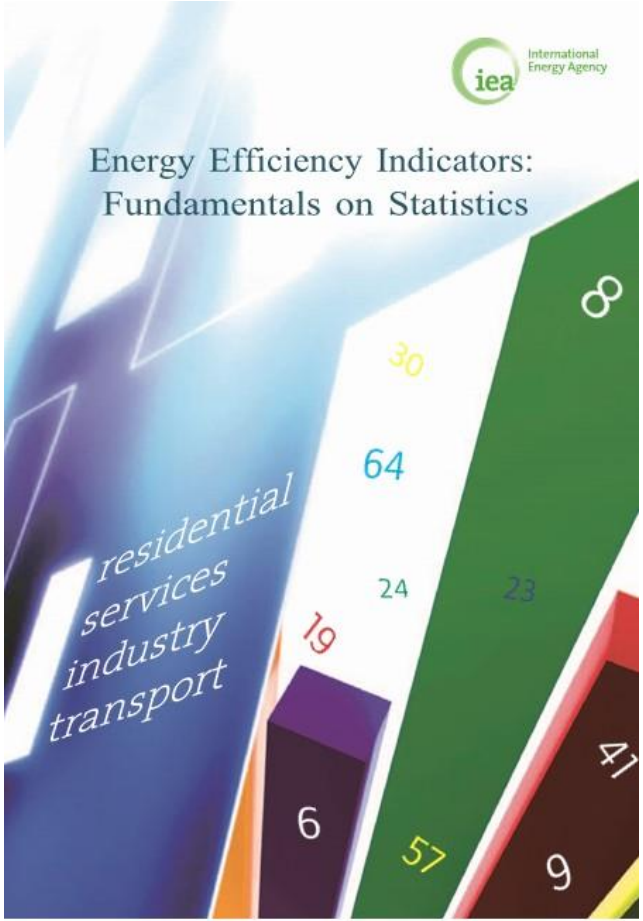
- methodology
- project web site
- questionnaire
- report
- results

Search by keywords

Reset Search

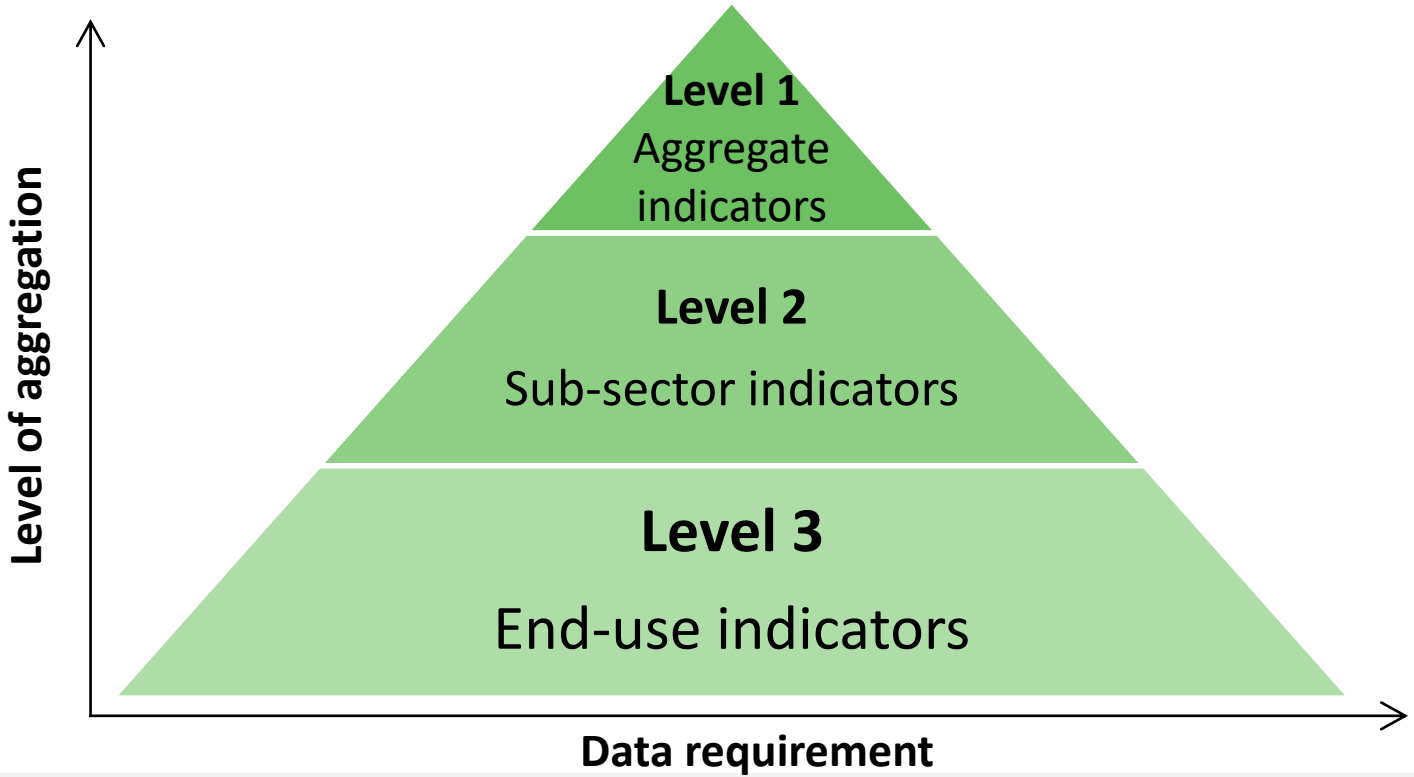
Energy efficiency indicators: manuals





Source: IEA energy efficiency indicators

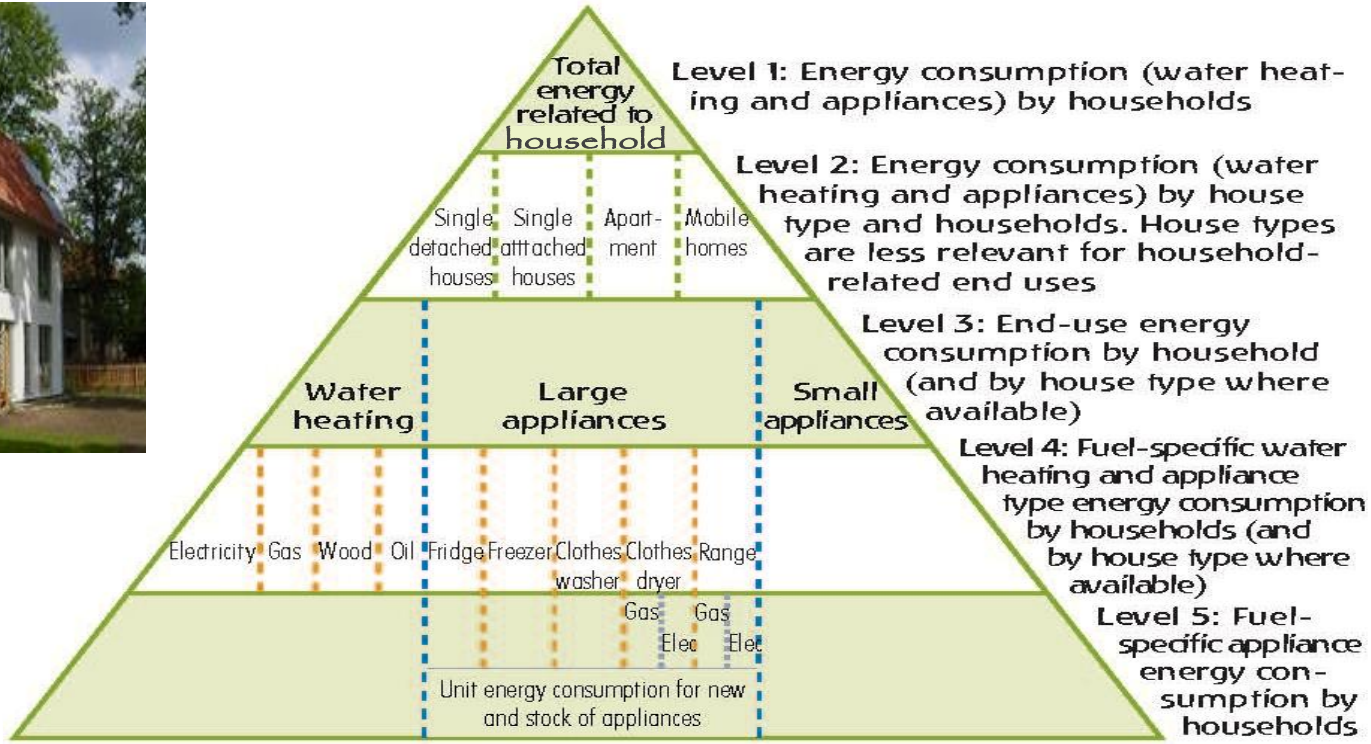
Energy efficiency indicators pyramid



More detailed data is required to get to Level 3 indicators

Source: IEA energy efficiency indicators

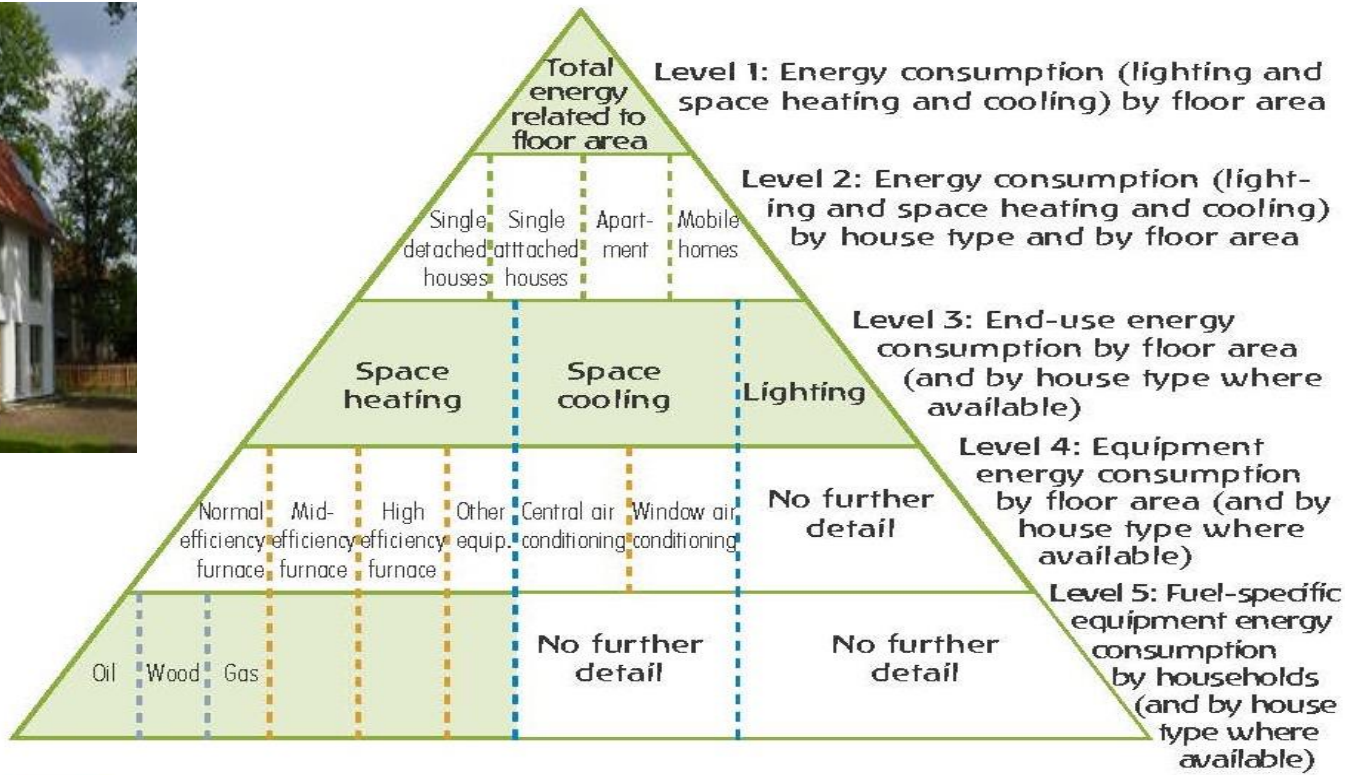
Energy efficiency indicators pyramid: residential per household



Data and analysis can be used to get end-use and fuel values

Source: IEA energy efficiency indicators

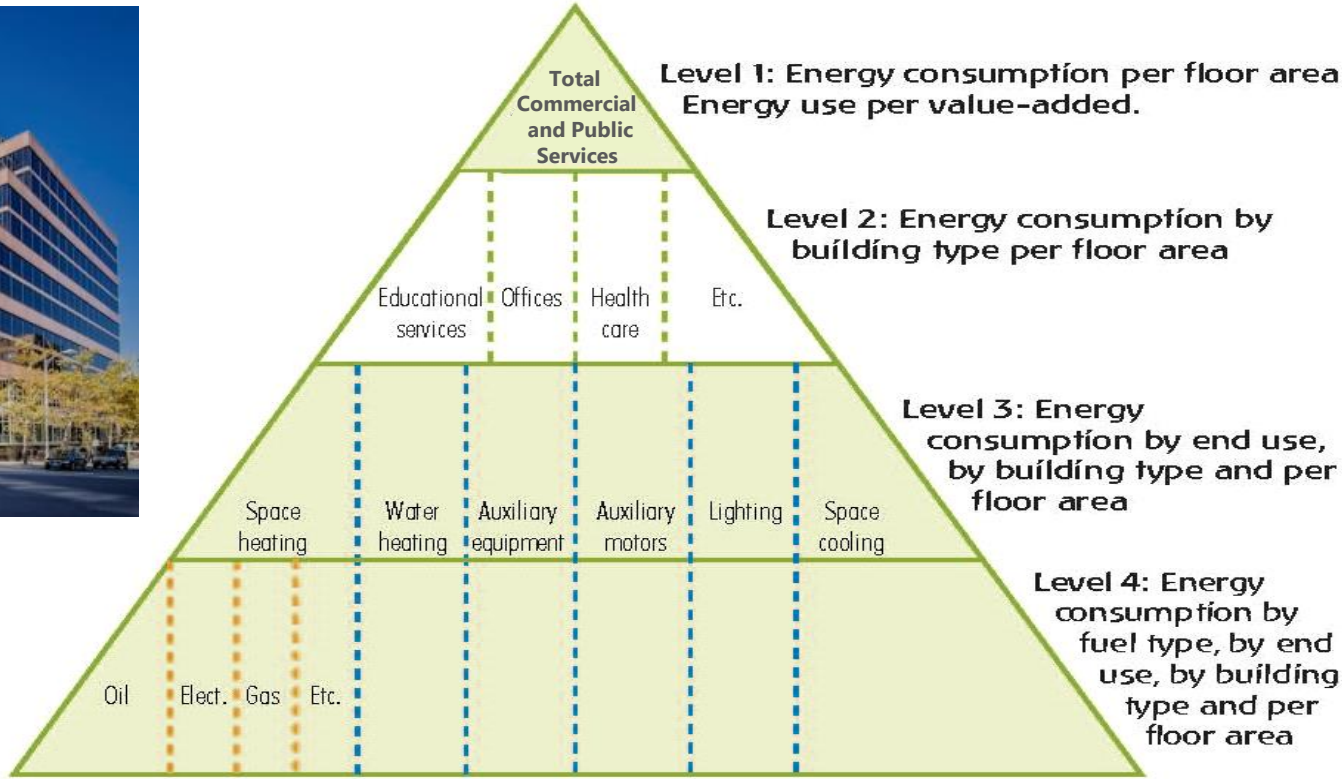
Energy efficiency indicators pyramid: residential per floor area



Data and analysis can be used to get end-use and fuel values

Source: IEA energy efficiency indicators

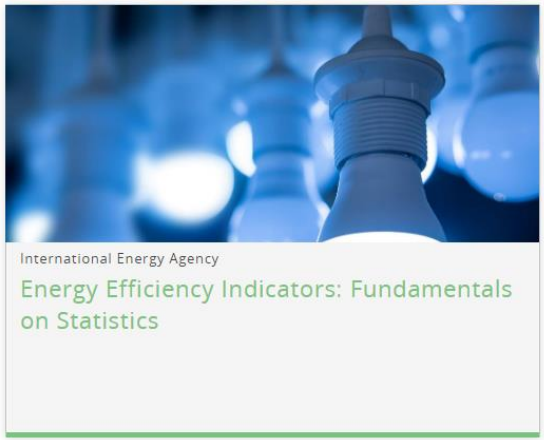
Energy efficiency indicators pyramid: non-residential per floor area



Data and analysis can be used to get end-use and fuel values

Source: IEA energy efficiency indicators

Energy efficiency indicators: online courses



- Step-by-step and sector-by-sector through energy efficiency indicators.
- Self-paced and interactive.
- No set time limit to complete the course, to fit into your professional and personal lives.

Energy efficiency indicators online course: expert videos

Previous Next

The IEA's Work on Energy Efficiency

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Data Collection Methods: An Overview

Bookmark this page

Welcome to lesson 3 of Module 3, where we will review the 4 key methods for data collection and how they can be applied in the context of the services sector.

*Please check your network firewall if the video does not load automatically.

IEA, 2014, Energy Efficiency Indicators: Fundamentals on Statistics

Energy efficiency indicators online course: interactive exercises

Course Introduction: Energy Efficiency 101 > Lesson > Energy Efficiency Potential In Four Sectors

Previous Next

Energy Efficiency Potential In Four Sectors

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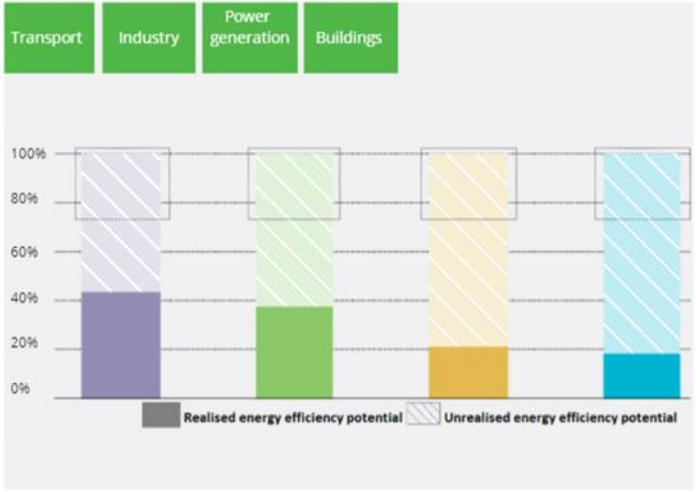
Energy efficiency gains can be realised in many economic sectors. The graph below shows the realised vs unrealised potential for energy efficiency in four sectors. Do you know which sectors offer the highest potential? Have a guess and try to associate the four sectors with each column. Drag and drop accordingly. This exercise does not count for your final grade.



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Practice Exercise: Building Indicators Using Energy and Activity Data

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Energy and activity data are indispensable for the construction of indicators. Energy consumption data usually serves as a numerator, while activity data serves as a denominator. For example, to construct the indicator "space cooling energy consumption per value added" (C2a) we need the energy data "total cooling energy consumption" and the activity data "total value added".

Have a look at the incomplete equations, as well as the list of energy and activity data beneath them. Drag and drop the data to build five indicators, each one associated to an end use in the services sector. Reflect on the level of disaggregation of the indicators you constructed.

Space heating = ?

Lighting = ?

Water heating = ?

Space cooling = ?

Other equipment = ?

ENERGY DATA	ACTIVITY DATA
• Total heating energy consumption	• Total floor area cooled
• Total cooling energy consumption	• Total floor area heated
• Water heating energy consumption in office buildings	• Number of employees for warehouses
• Lighting energy consumption in schools	• Number of students for schools
• Other equipment energy consumption in warehouses	• Number of employees for offices

Energy efficiency indicators online course: assessment tests

Module 2: Assessment Test

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1. In the context of the residential sector, understanding how various factors impact energy consumption is essential to determine where the largest potential to reduce energy consumption lies.

1.0 point possible (graded)

- True
- False

Submit

Save

2. Which are the six main end uses in the residential sector:

1.0 point possible (graded)

- Space heating
- Water heating

Energy efficiency indicators online course: interactive discussion forums

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Module 3: Discussion Forum

Bookmark this page

Discussion

Topic: / Energy efficiency indicators for the services sector

Hide Discussion

Add a Post

Barriers to data collection in the services sector To construct energy efficiency indicators, statisticians need both energy data and activity data. Yet in the case of services sector both activity and energy data might be har...	2
? Main end use in the services sector in your country What is the main end use in the services sector in your country?	1
Addressing data collection challenges in the services sector Think about these challenges in the case of your country and try to propose possible solutions for improving data collection in key services subsectors such as office buildi...	1

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Evaluation approaches

Energy performance metrics: Typically primary level indicators (e.g. energy per person) that do not clearly show the role of efficiency.

Energy demand analysis: A "bars held" or "what if" approach by holding indicators constant than can under-estimate energy efficiency gains

Decomposition analysis: Can be complex to understand, but very valuable

Energy performance metrics

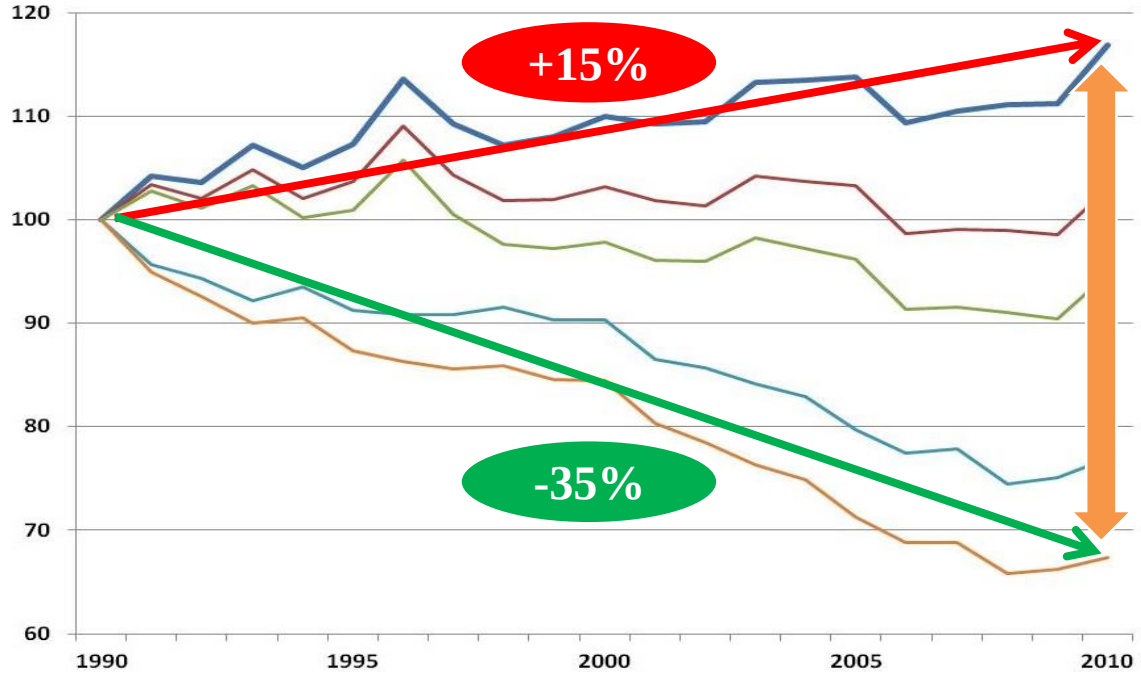
Limitations

Energy consumption

Energy per person

Energy per floor area

Evaluation: choosing the right metric



What are these types of energy performance metrics <u>not</u> telling us about energy demand and efficiency progress?

Behaviour?

Technology?

Efficiency?

Income?

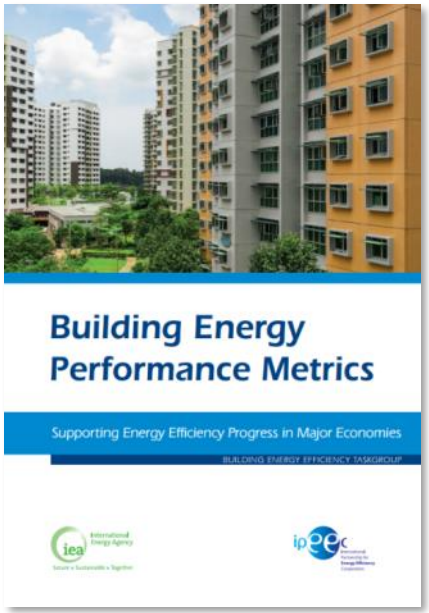
Index: 1990=1. Data for IEA18 (Australia, Austria, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Slovakia, Spain, Sweden, Switzerland, UK, USA).
TC: Temperature Corrected.

The right energy performance metric is crucial to understanding & tracking progress over time.

Source: IEA energy efficiency indicators database

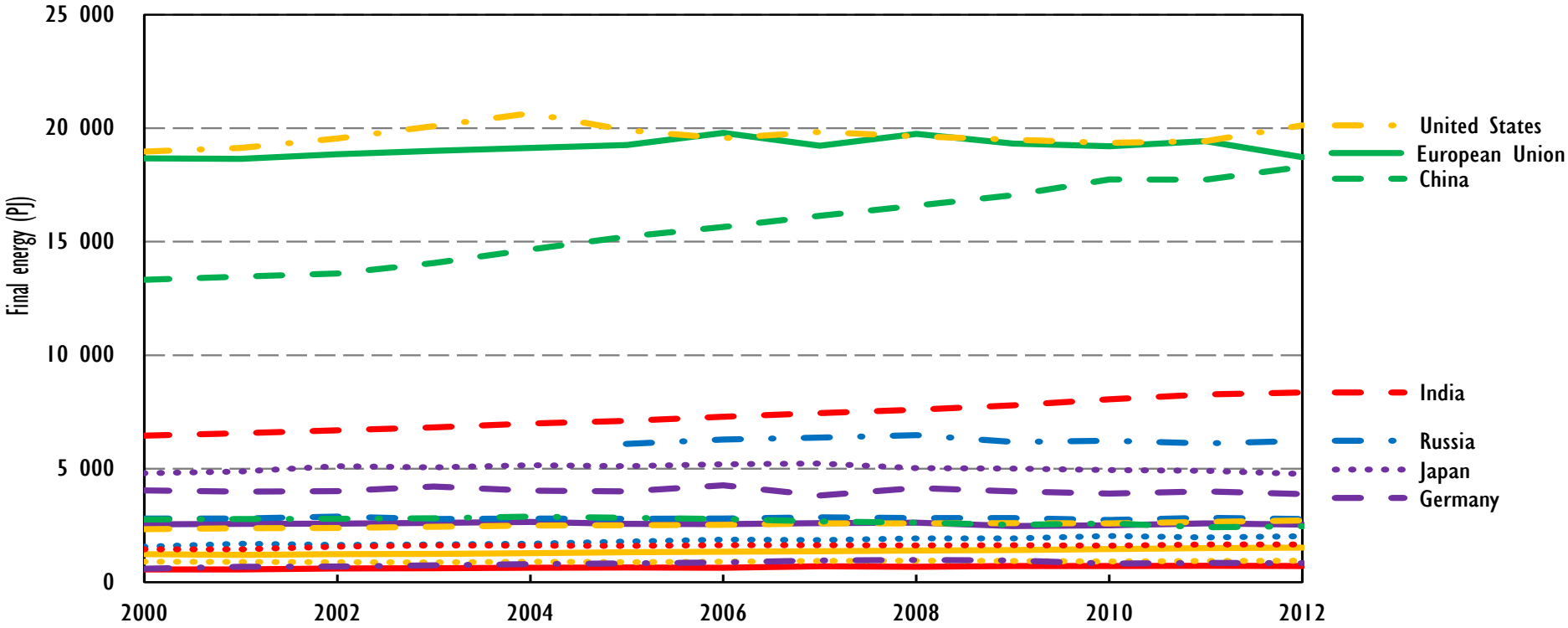
Limitations of Energy Performance Metrics

- Metrics cannot predict variation in overall energy consumption or quantify the impact of individual components or factors on overall energy consumption.
- It is often necessary to undertake more detailed analysis to fully understand the combined impact of a number of different factors or driving forces on overall energy consumption.



Source: IEA Building Energy Performance Metrics 2015

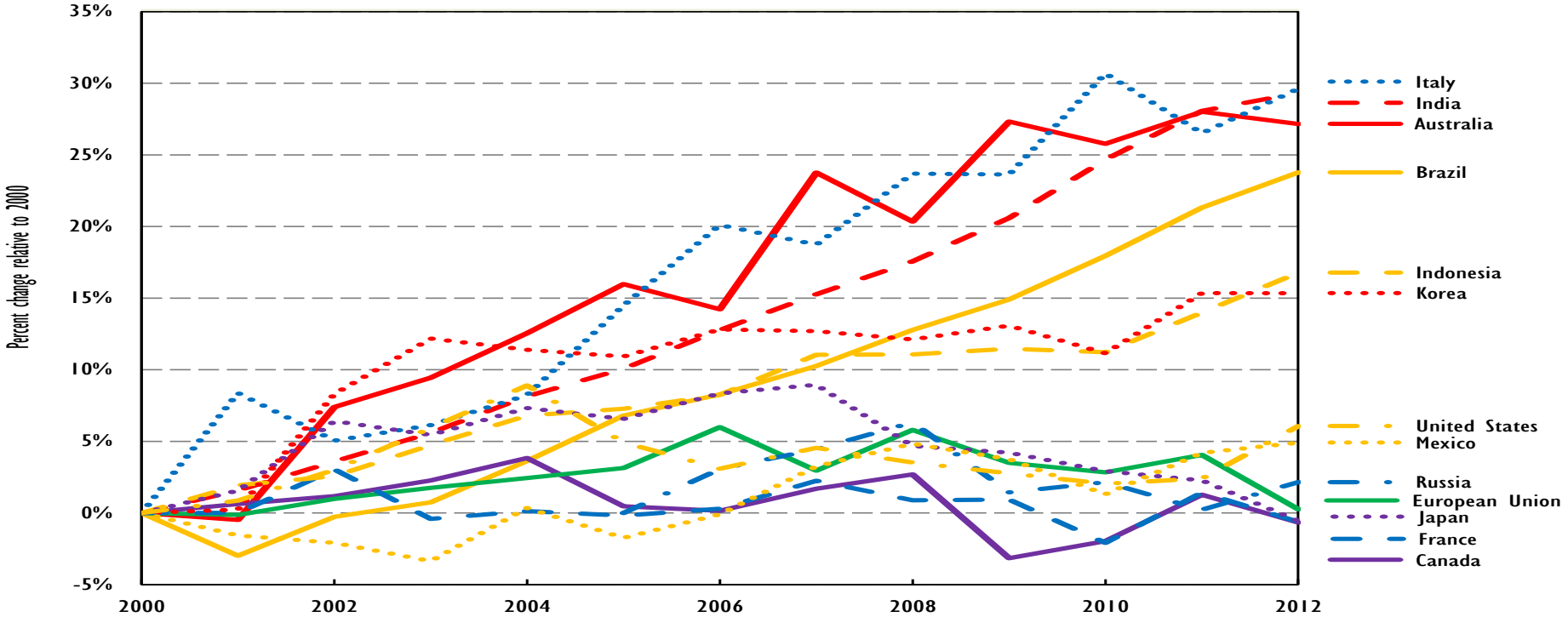
Building energy performance metrics: energy consumption



What does this tell us about energy efficiency in buildings?

Source: IEA Building Energy Performance Metrics 2015

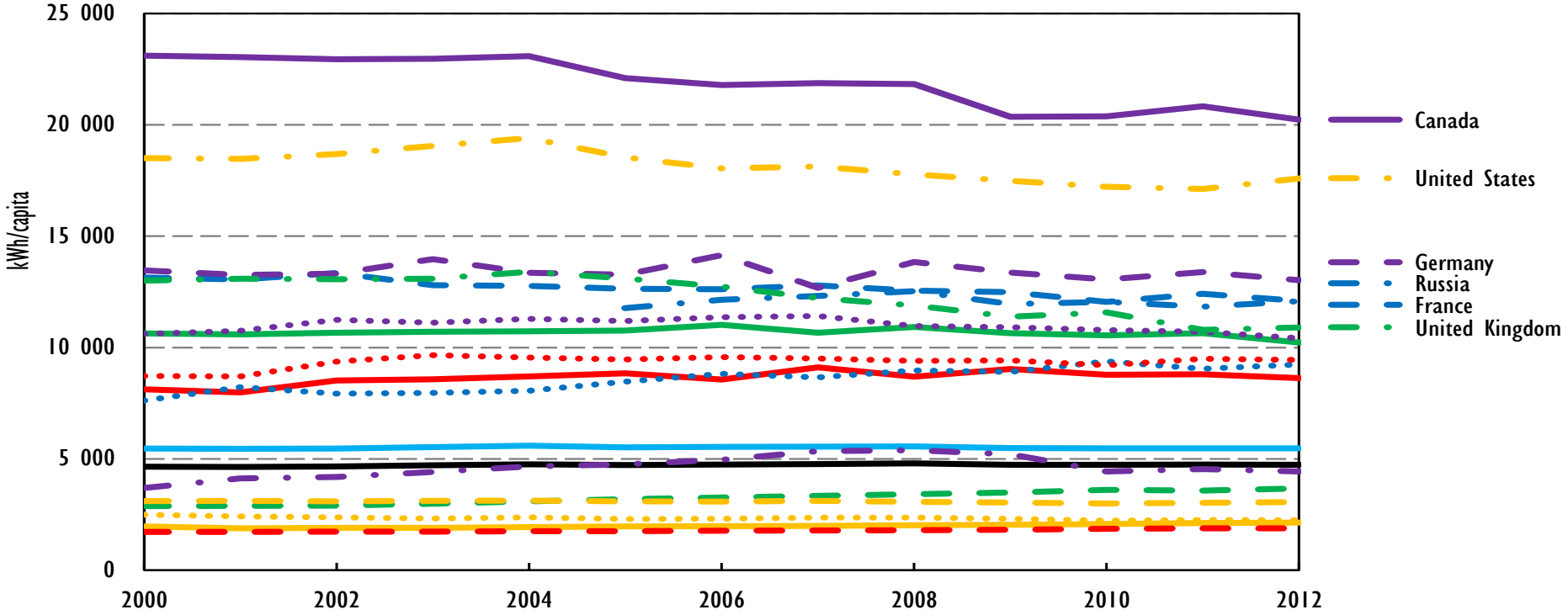
Building energy performance metrics: change in energy consumption



What does this tell us about energy efficiency in buildings?

Source: IEA Building Energy Performance Metrics 2015

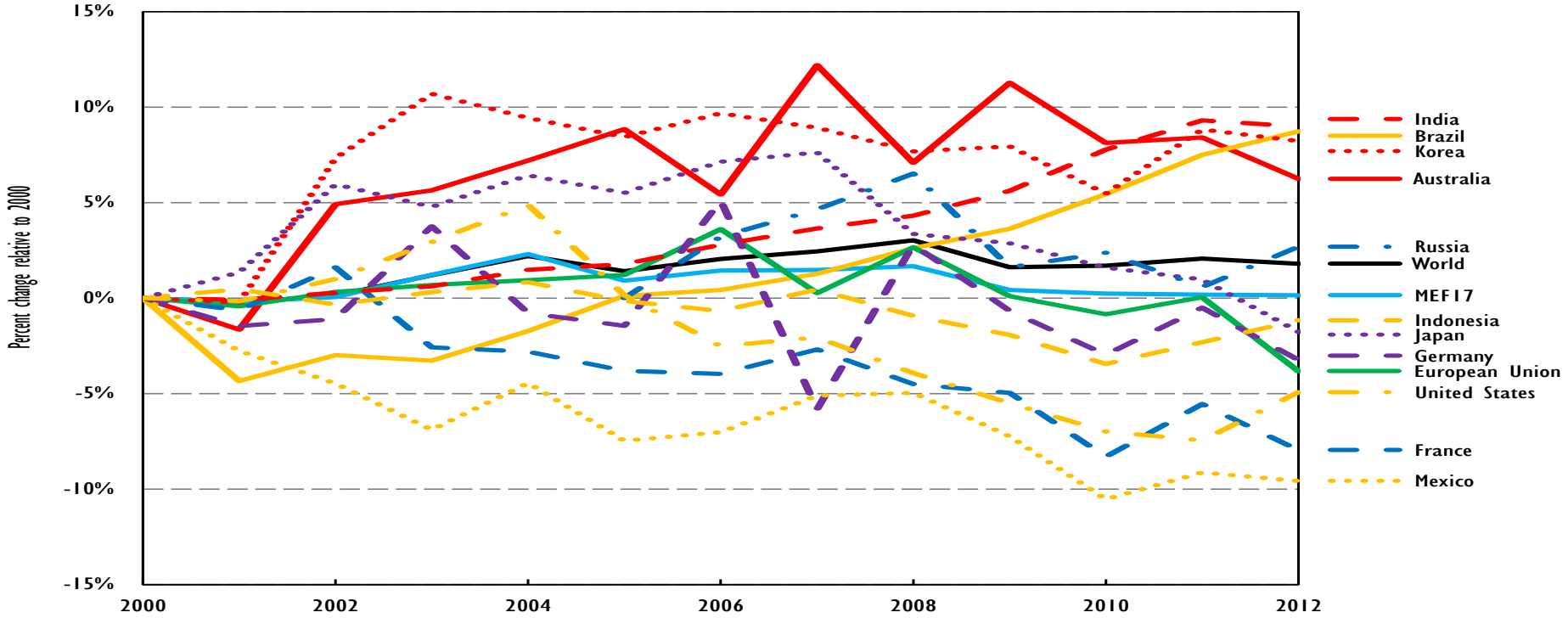
Building energy performance metrics: energy per person



What does this tell us about energy efficiency in buildings?

Source: IEA Building Energy Performance Metrics 2015

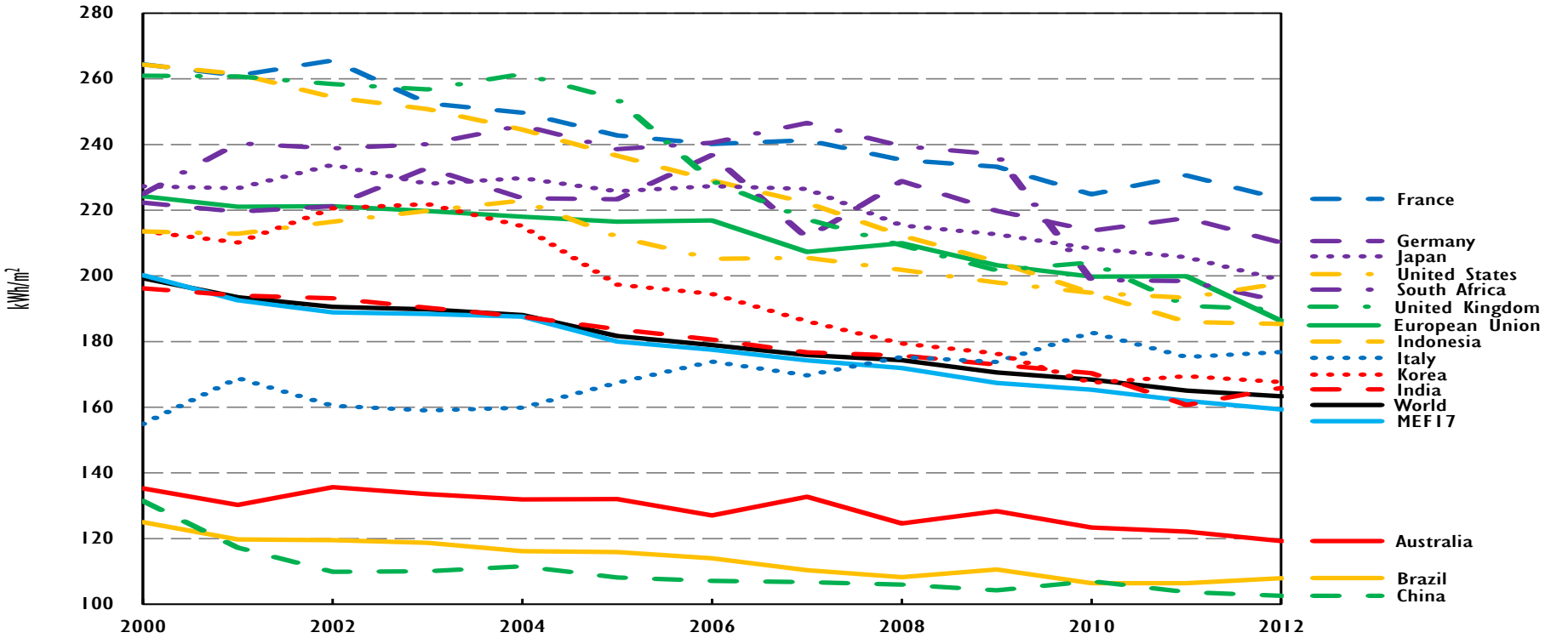
Building energy performance metrics: change in energy per person



What does this tell us about energy efficiency in buildings?

Source: IEA Building Energy Performance Metrics 2015

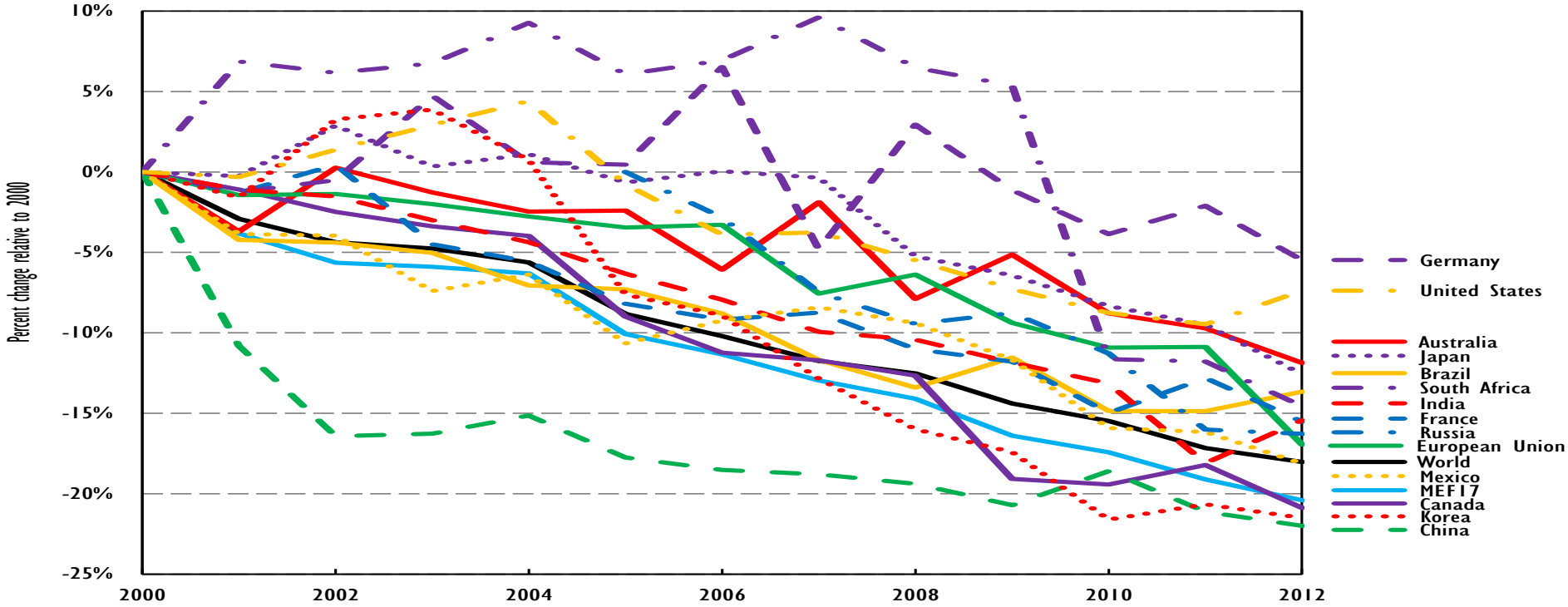
Building energy performance metrics: energy per floor area



What does this tell us about energy efficiency in buildings?

Source: IEA Building Energy Performance Metrics 2015

Building energy performance metrics: change in energy per floor area



What does this tell us about energy efficiency in buildings?

Source: IEA Building Energy Performance Metrics 2015

Energy demand analysis

Bars held analysis

Evaluation: Energy demand/bars held analysis or "what if" analysis

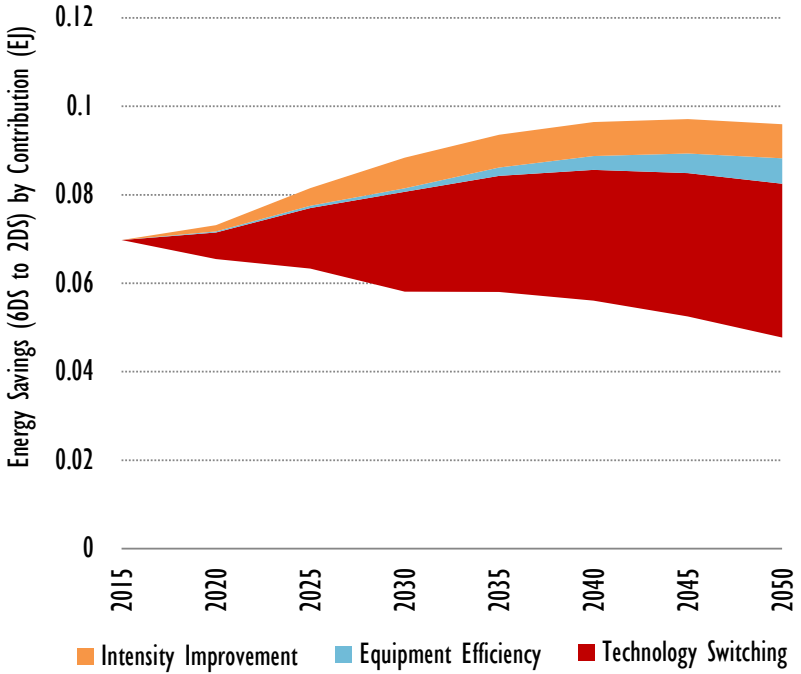
- Proportional distribution of energy savings

How much energy service?
Depends on behaviour, income, culture, etc.

How are we meeting energy service demand?
e.g. incandescent bulbs v. CFLs or LEDs

$$Energy_{total} = \sum_{tech} \frac{Energy_{useful} * share_{tech}}{Efficiency_{tech}}$$

How efficient is the technology used?

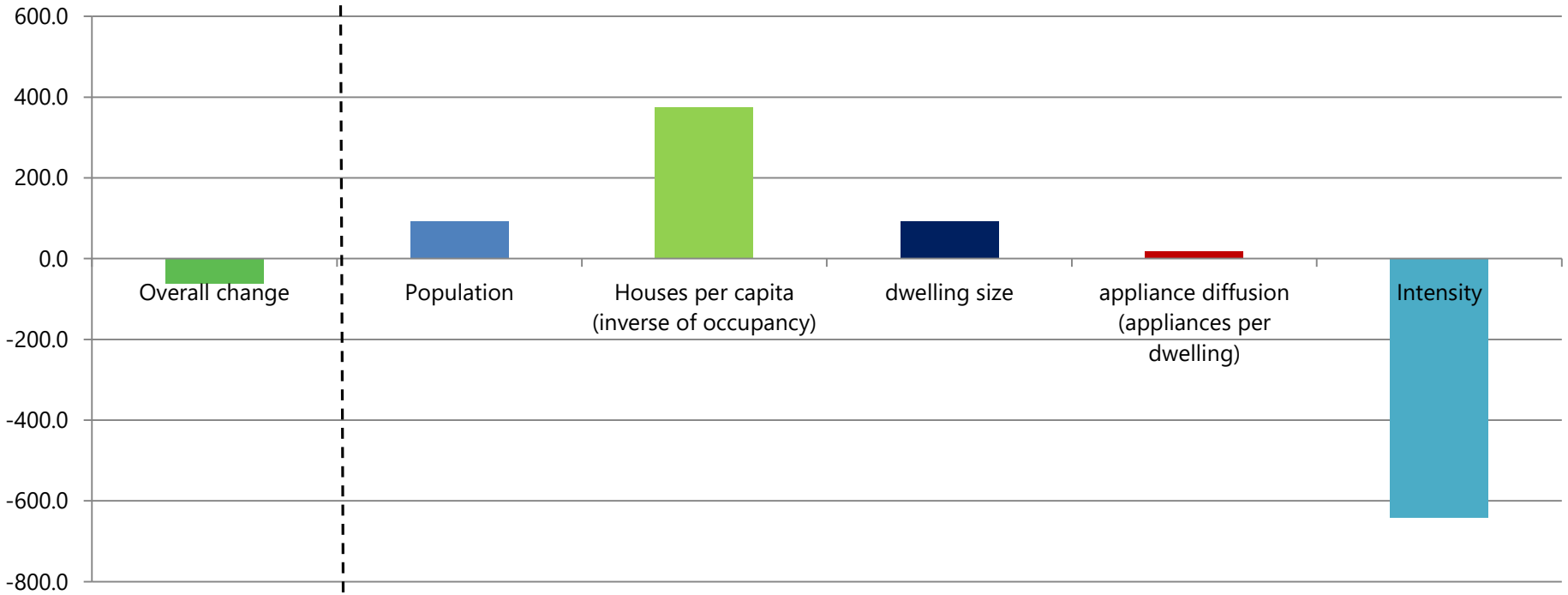


Source: IEA Energy Technology Perspectives

Decomposition

Logarithmic Mean Divisia Index (LMDI)

Evaluation: Building energy decomposition

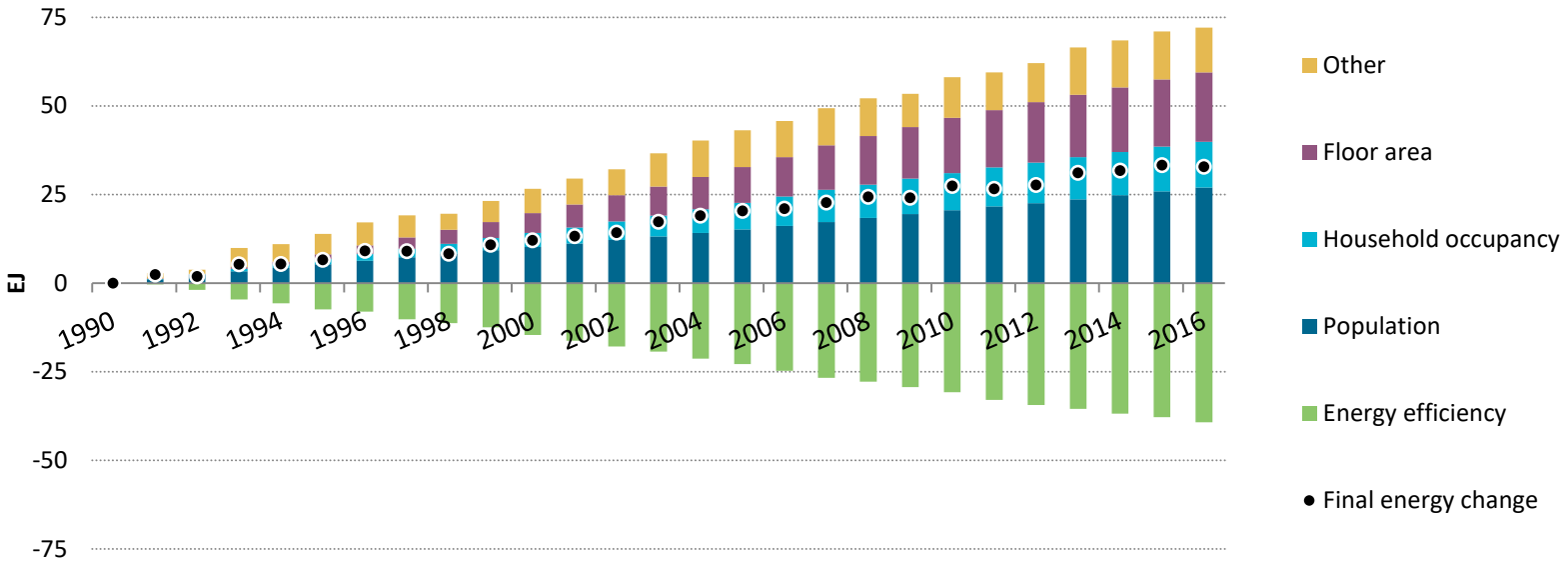


Proportional distribution of energy savings by holding only changing one indicator at a time. Decomposition analyses can be extremely valuable – but complex.

Source: IEA Energy Technology Perspectives

Evaluation: Building energy decomposition

Decomposition of global final energy demand in buildings by key contribution



Through decomposition, we can see that energy efficiency is significant, but not keeping up with the growth in total energy consumption in buildings.

Source: IEA Energy Technology Perspectives 2017

Process for Tracking Progress

Key steps in the process

Examples

Tracking progress: Key steps in the process

Step 1: Identify what needs to be tracked

- *What story should be told?*
- *What were the objectives?*
- *What are the risks?*

Step 2: Define the tracking indicators

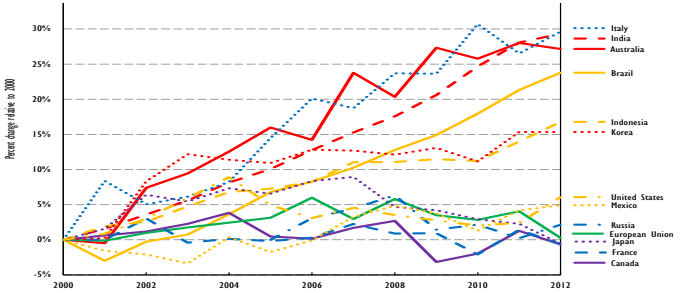
- *What performance metrics can you use?*
- *What data is needed?*

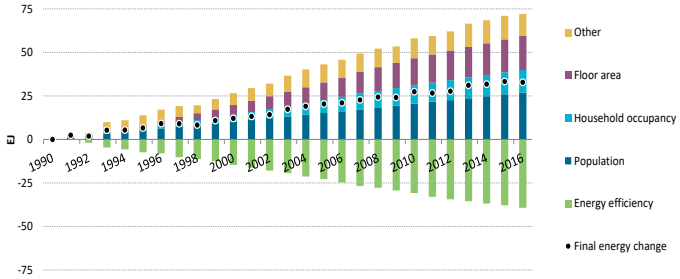
Step 3: Assess the data

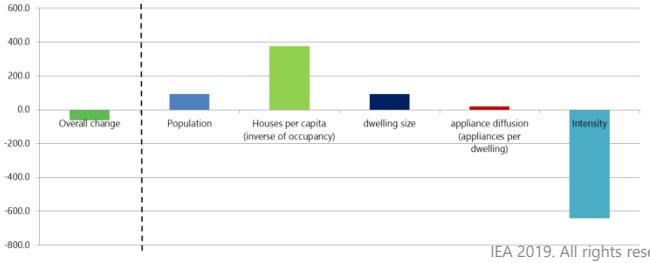
- *What analysis method should you use?*

Step 4: Tell the story

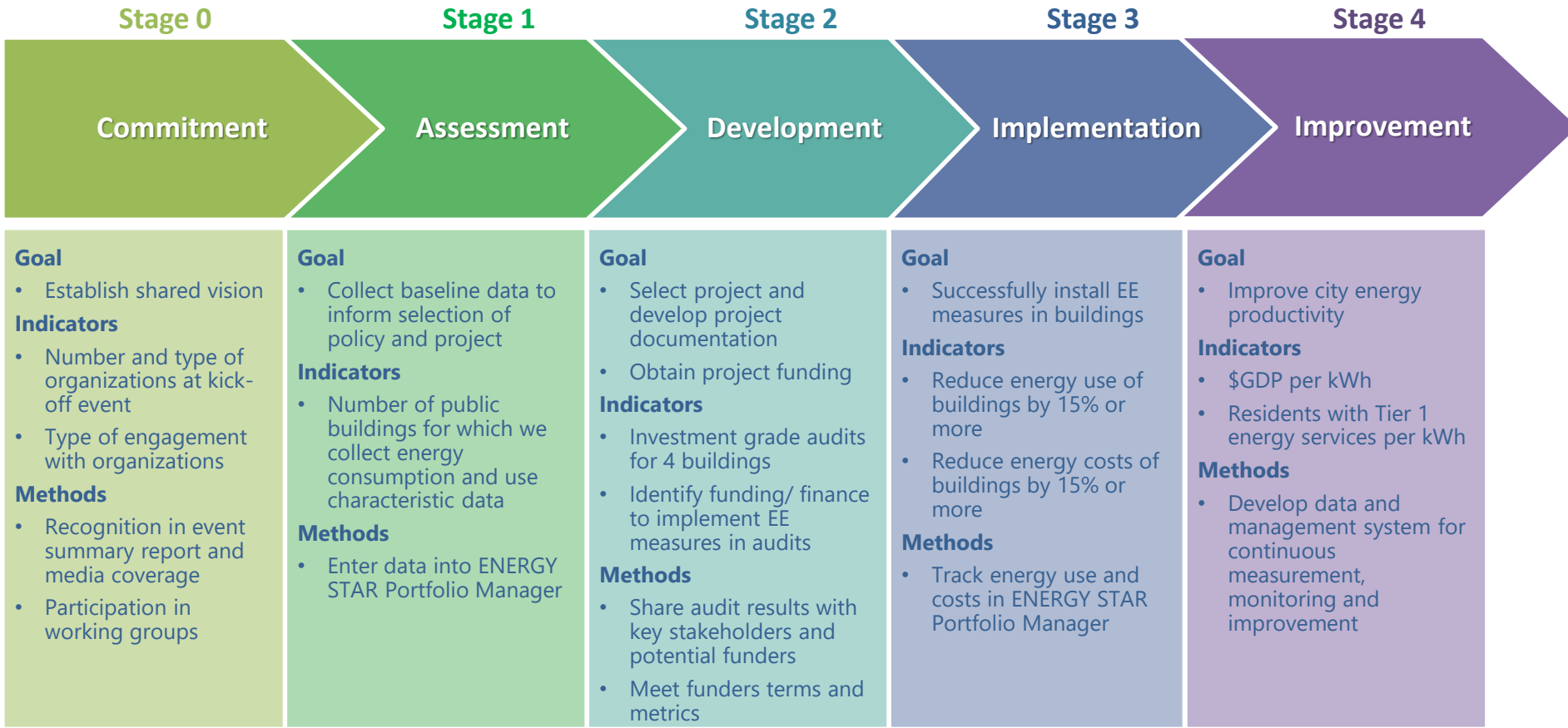
- *How do you visualise the results?*
- *How would it vary across countries?*







Example: Tracking progress in the Building Efficiency Accelerator



Source: Building Efficiency Accelerator

Tracking progress example: cooling

Step 1: Identify what needs to be tracked

- *What story should be told about the impact of cooling?*
  - *What objectives could be achieved through policies on cooling?*
  - *What are the risks and threats from increasing cooling energy use?*

Potential issues related to cooling

- *Demand for and access to cooling thermal comfort*
- *Energy used for cooling based on AC efficiency levels*
- *Peak electricity loads, grid stability and power sector investments*
- *Job creation through design, manufacturing, selling or installing ACs*
- *Sales tax and public budgets financial impacts*
- *Market availability of efficient products*

Tracking progress example: cooling

Step 2: Define the tracking indicators

- *What performance metrics can you use?*
- *What data do you have on cooling and buildings?*

Issues with metrics and indicators

- *How do you separate the influences? (Income; demand; population; climate; efficiency)*
- *What options are there for metrics?*
    - *Final energy use for cooling*
    - *Final energy use for cooling per square meter cooled per cooling degree-day*
    - *Change in average efficiency of ACs (stock, sold, manufactured, imported, exported)*
    - *Share of products covered by labels or MEPS policies*

Tracking progress example: cooling

Step 3: Assess the data

- *What analysis method can you use?*
- *Which method will provide the information needed?*

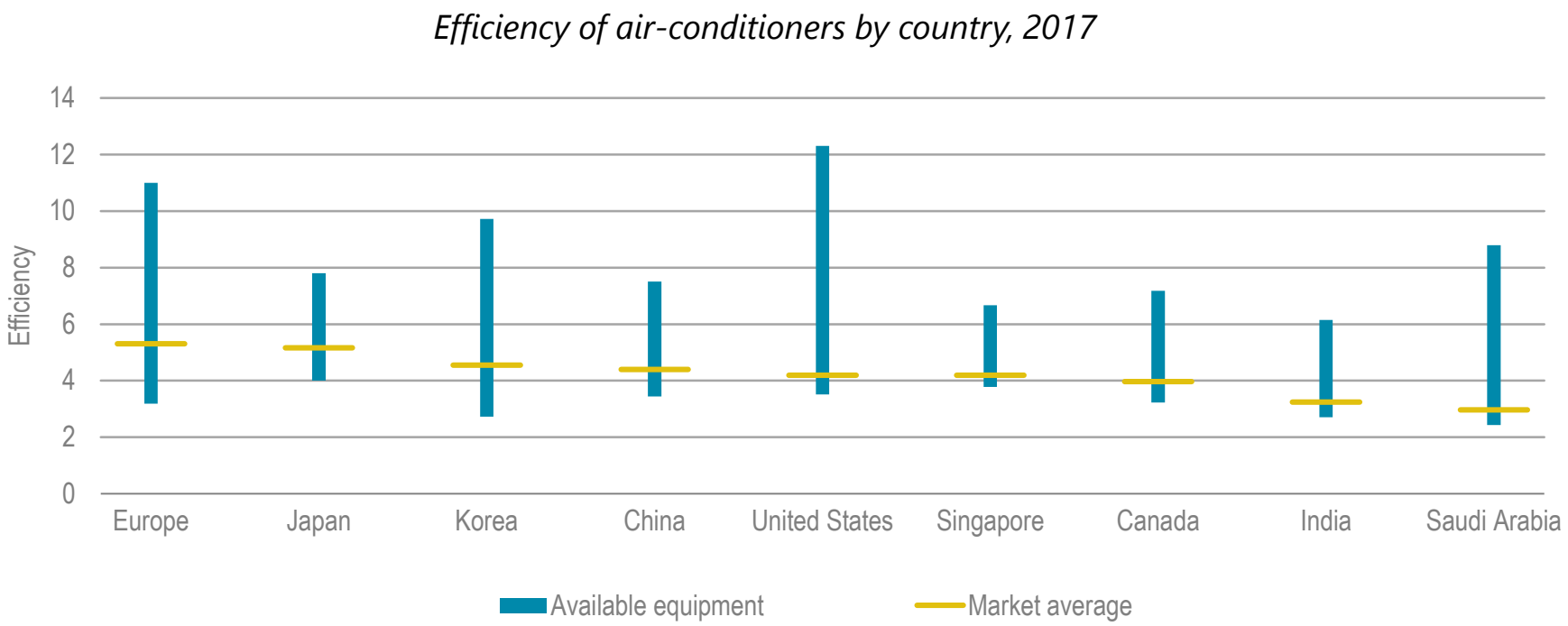
Step 4: Tell the story

- *How do you visualise the data?*
- *What part of the story is important for your country?*

Issues with metrics and indicator analysis methods

- *What results will be compelling and told with simple visuals or statements?*
- *What options are there for methods?*
    - *Energy performance metrics*
    - *Bars held analysis*
    - *Energy decomposition (LMDI)*

Tracking progress: cooling example 1

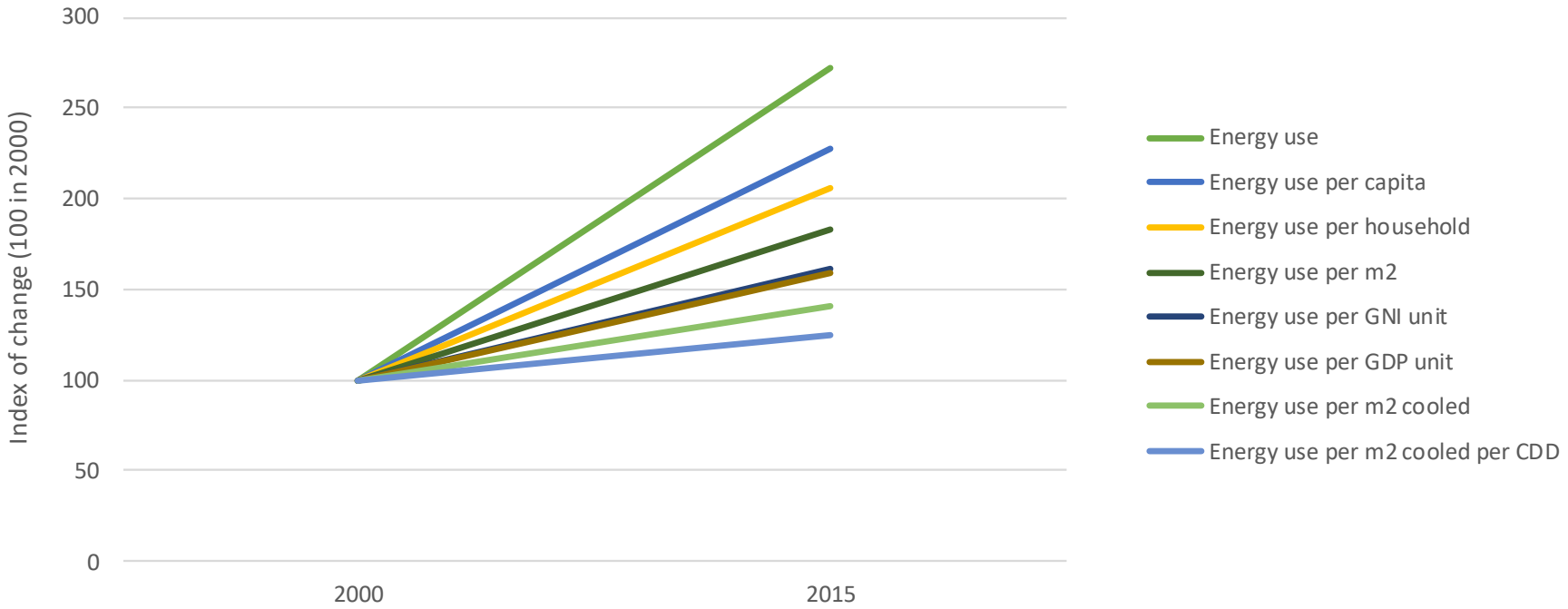


Best available technology efficiency levels vary widely between countries.
And, best available technology is much more efficient than the market average.

Source: IEA

Tracking progress: cooling example 2

Change in global cooling energy use illustrated by different metrics, 2000-15

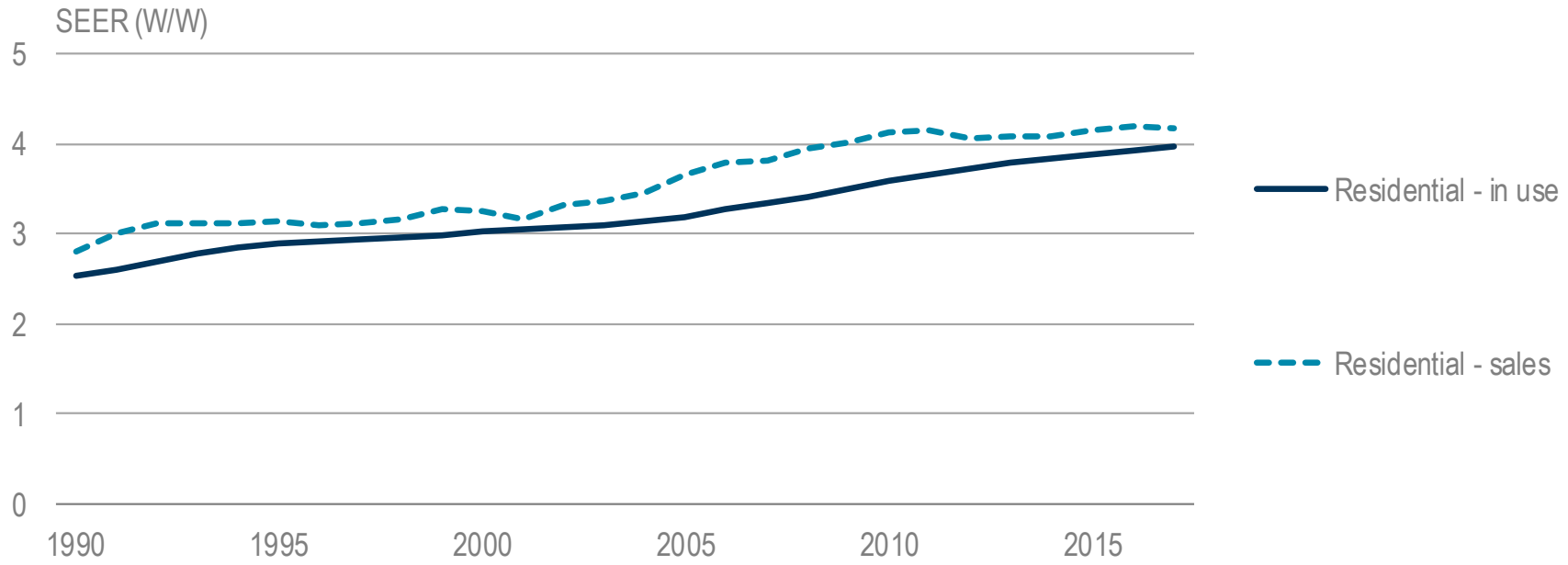


"Energy use per m² cooled per CDD" may be an accurate performance indicator at the building. But depending on the story you want to tell, "energy use" offers a different story for the country.

Source: IEA

Tracking progress: cooling example 3

Global weighted average residential SEER of air-conditioners, 1990-2017

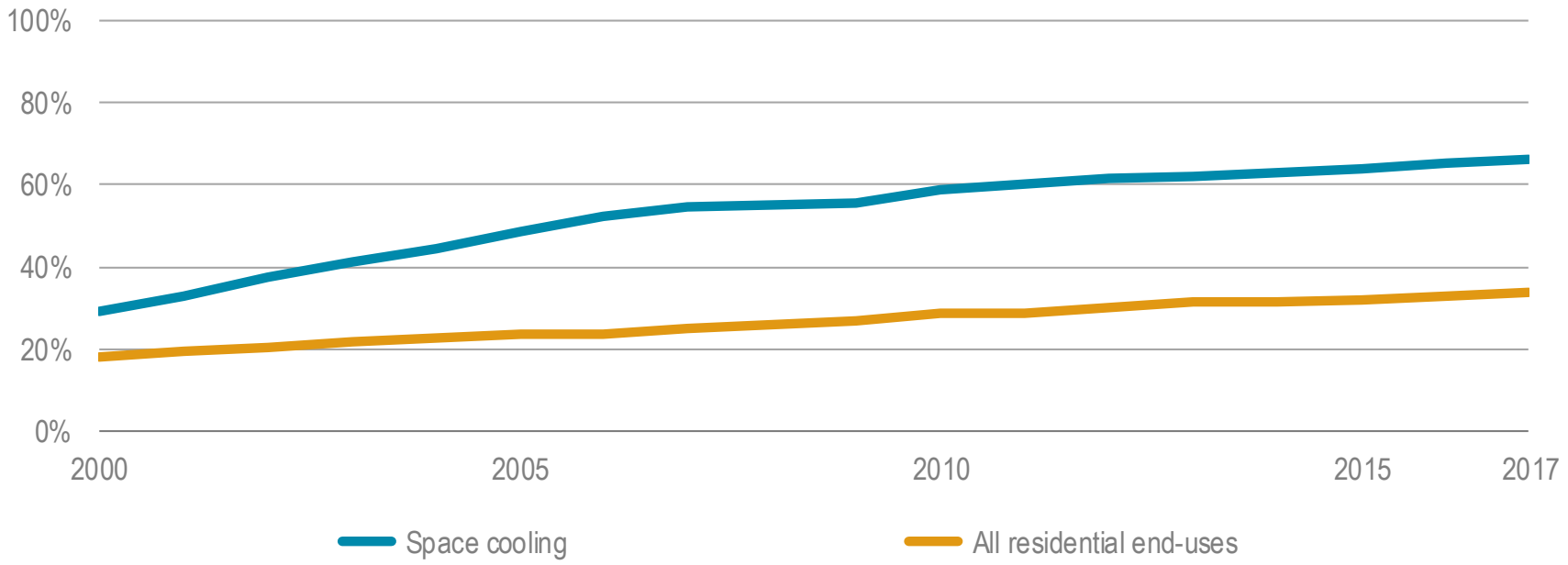


More efficient cooling technologies are being sold.
But the efficiency levels are well below the best available technologies.

Source: IEA

Tracking progress: cooling example 4

Share of building energy use covered by regulations, 2000-17

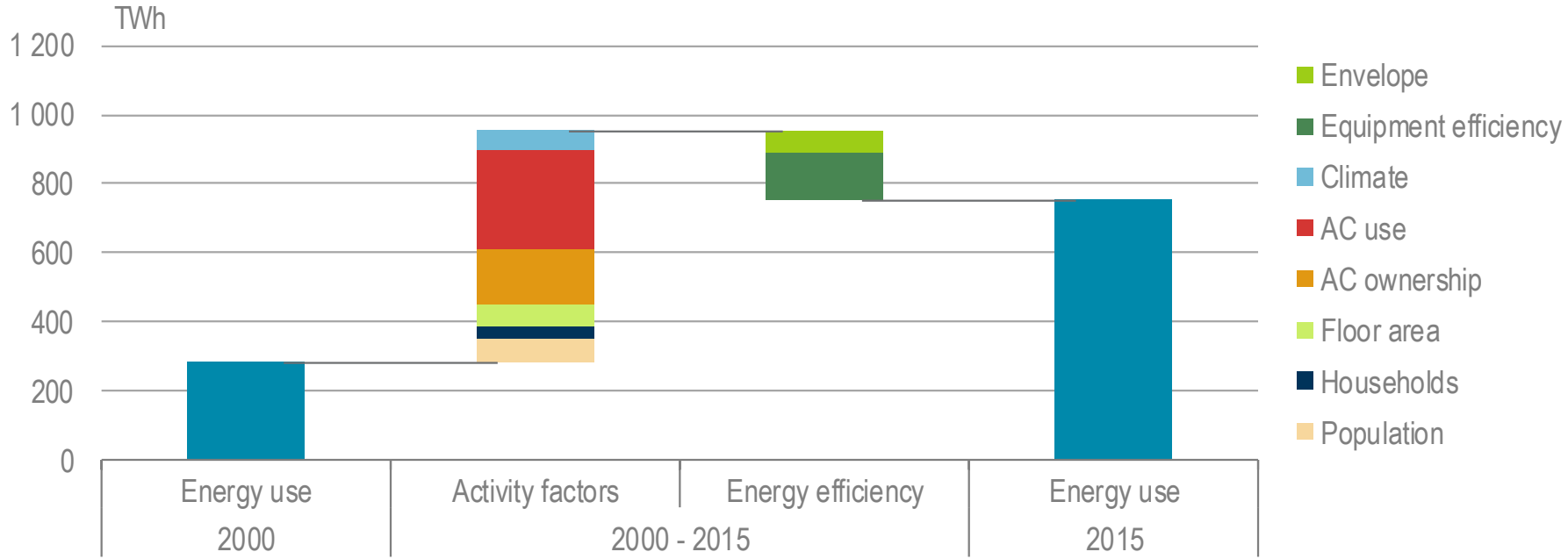


Increasingly more policies are covering space cooling energy use.
But the strength of those policies are not keeping pace with best available technologies.

Source: IEA

Tracking progress: cooling example 5

Global decomposition of final energy use for cooling by key contribution, 2000-15



Energy efficiency has saved 200 TWh of cooling final energy from 2000 to 2015, but this has been offset by activity factors contributing to a 650 TWh increase during this period.

Source: IEA

Group discussion

Scenario:

The Minister wants to know how effective the building energy efficiency policies have been.

How do you go about answering this?

www.iea.org

IEA #energyefficientworld

Energy efficiency indicators: residential buildings

Space Heating

Indicator	Coverage	Energy data	Activity data	Code	Recommended indicator
Space heating energy consumption per capita	Overall	Total space heating energy consumption	Total population	H2a	
Space heating energy consumption per dwelling	Overall	Total space heating energy consumption	Total number of dwellings	H2b	
Space heating energy consumption per floor area (idem per floor area heated)	Overall	Total space heating energy consumption	Total floor area	H2c	☺
	By dwelling type	Space heating energy consumption of dwellings type A	Floor area of dwellings type A	H3a	
	By heating system	Space heating energy consumption of dwellings with system α	Floor area of dwellings with heating system α	H3b	
	By energy source	Space heating energy consumption of dwellings with energy source Z	Floor area of dwellings with energy source Z	H3c	

Heating | Cooling | Water heating | Lighting | Cooking | Appliances

Energy efficiency indicators: residential buildings

Space Cooling

Indicator	Coverage	Energy data	Activity data	Code	Recommended indicator
Space cooling energy consumption per dwelling with air conditioning (A/C)	Overall	Total space cooling energy consumption	Total number of dwellings with A/C	C2a	
Space cooling energy consumption per floor area of dwellings with A/C	Overall	Total space cooling energy consumption	Total floor area cooled	C2b	☺
	By dwelling type	Space cooling energy consumption of dwellings type A	Floor area cooled of dwellings type A with A/C	C3a	
	By type of cooling system	Space cooling energy consumption of dwellings with A/C system α	Floor area cooled of dwellings with A/C system α	C3b	
	By energy source	Space cooling energy consumption of dwellings with A/C system energy source Z	Floor area cooled of dwellings with A/C energy source Z	C3c	

Heating Cooling Water heating Lighting Cooking Appliances

Energy efficiency indicators: residential buildings

Water Heating

Indicator	Coverage	Energy data	Activity data	Code	Recommended indicator
Water heating energy consumption per capita	Overall	Total water heating energy consumption	Total population	W2a	
Water heating energy consumption per dwelling	Overall	Total water heating energy consumption	Total number of dwellings	W2b	☺
	By type of water heating system	Water heating energy consumption for dwellings with water heating system α	Total number of dwellings with water heating system α	W3a	
	By type of energy source	Water heating energy consumption for water heating systems with energy source Z	Total number of dwellings with systems with energy source Z	W3b	

Heating Cooling Water heating Lighting Cooking Appliances

Energy efficiency indicators: residential buildings

Lighting

Indicator	Coverage	Energy data	Activity data	Code	Recommended indicator
Lighting energy consumption per capita	Overall	Total lighting energy consumption	Total population	L2a	
Lighting energy consumption per dwelling	Overall	Total lighting energy consumption	Total number of dwellings	L2b	☺
	By dwelling type	Lighting energy consumption of dwellings of type A	Number of dwellings of type A	L3a	
Lighting energy consumption per floor area	Overall	Total lighting energy consumption	Total floor area	L2c	
	By dwelling type	Lighting energy consumption of dwellings of type A	Total floor area of dwellings type A	L3b	

Heating Cooling Water heating Lighting Cooking Appliances

Energy efficiency indicators: residential buildings

Cooking

Indicator	Coverage	Energy data	Activity data	Code	Recommended indicator
Cooking energy consumption per capita	Overall	Total cooking energy consumption	Total population	K2a	
Cooking energy consumption per dwelling	Overall	Total cooking energy consumption	Total number of dwellings	K2b	☺
	By energy source	Cooking energy consumption with cooking energy source Z	Number of dwellings with cooking energy source Z	K3a	

Heating Cooling Water heating Lighting Cooking Appliances

Energy efficiency indicators: residential buildings

Appliances

Indicator	Coverage	Energy data	Activity data	Code	Recommended indicator
Appliances energy consumption per capita	Overall	Total appliances energy consumption	Total population	A2a	
Appliances energy consumption per dwelling	Overall	Total appliances energy consumption	Total number of dwellings	A2b	
Energy consumption per appliance unit	By appliance type	Energy consumption for all appliances of type A	Number of appliances of type A	A3a	☺

Heating Cooling Water heating Lighting Cooking Appliances

Energy efficiency indicators: non-residential buildings

Space Heating

Indicator	Coverage	Energy data	Activity data	Code	Recommended indicator
Space heating energy consumption per value added	Overall	Total heating energy consumption	Total value added	H2a	
Space heating energy consumption per floor area	Overall	Total heating energy consumption	Total floor area	H2b	☺
	By heating system	Heating energy consumption with system α	Floor area heated with heating system α	H3a	
	By energy source	Heating energy consumption with energy source Z	Floor area heated with energy source Z	H3b	
Space heating energy consumption per unit of activity	By service category	Heating energy consumption for service category A	Unit activity of service category A	H3c	

Heating Cooling Water heating Lighting Other equipment

Energy efficiency indicators: non-residential buildings

Space Cooling

Indicator	Coverage	Energy data	Activity data	Code	Recommended indicator
Space cooling energy consumption per value added	Overall	Total cooling energy consumption	Total value added	C2a	
Space cooling energy consumption per floor area cooled	Overall	Total cooling energy consumption	Total floor area cooled	C2b	☺
	By space cooling system	Cooling energy consumption by cooling system α	Floor area with cooling system α	C3a	
	By service category	Cooling energy consumption for service category A	Floor area cooled of service category A	C3b	
Space cooling energy consumption per unit of activity	By service category	Cooling energy consumption for service category A	Unit activity of service category A	C3c	

Heating Cooling Water heating Lighting Other equipment

Energy efficiency indicators: residential buildings

Water Heating

Indicator	Coverage	Energy data	Activity data	Code	Recommended indicator
Water heating energy consumption per value added	Overall	Total water heating energy consumption	Total value added	W2a	
Water heating energy consumption per unit of activity	By service category	Water heating energy consumption for service category A	Unit activity of service category A	W3a	☺

Heating Cooling Water heating Lighting Other equipment

Energy efficiency indicators: residential buildings

Lighting

Indicator	Coverage	Energy data	Activity data	Code	Recommended indicator
Lighting energy consumption per value added	Overall	Total lighting energy consumption	Total value added	L2a	
Lighting energy consumption per floor area	Overall	Total lighting energy consumption	Total floor area	L2b	
	By service category	Lighting energy consumption for service category A	Floor area of service category A	L3a	
Lighting energy consumption per unit activity	By service category	Lighting energy consumption for service category A	Unit activity of service category A	L3b	☺

Heating Cooling Water heating Lighting Other equipment

Energy efficiency indicators: residential buildings

Other equipment

Indicator	Coverage	Energy data	Activity data	Code	Recommended indicator
Other equipment energy consumption per value added	Overall	Total other equipment energy consumption	Total value added	E2a	
	By service category	Other equipment energy consumption for service category A	Value added of service category A	E3a	
Other equipment energy consumption per floor area	Overall	Total other equipment energy consumption	Total floor area	E2b	
Other equipment energy consumption per unit of activity	By service category	Other equipment energy consumption for service category A	Unit activity of service category A	E3b	☺

Heating Cooling Water heating Lighting Other equipment