Did it work: Tracking progress with energy efficiency indicators

Buildings: Session 9

Buildings energy efficiency sessions in partnership with:

BEEP

INDO-SWISS BUILDING ENERGY EFFICIENCY PROJECT

UCL ENERGY INSTITUTE

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Energy Efficiency Training Week: Buildings Program

1. **Where to start:** Understanding 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

   Where do I get help? IEA's Technology Collaboration Programmes
5. **Toolkit:** Enabling investment with energy efficiency policies
6. **What are the steps :** Building energy codes and standards

   Site Visit: Schneider Electric
7. **What are the steps:** Set targets and develop policies
8. **Did it work:** Evaluating the multiple benefits of energy efficiency
9. **Did it work:** Tracking progress with energy efficiency indicators

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

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9. Did it work: Tracking progress with energy efficiency indicators

Trainers: John Dulac and Thibaut Abergel

Session: 1.5 hours

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: The Minister wants to know how effective the building energy efficiency policies have been. *How do you go about answering this?*

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Energy efficiency indicators

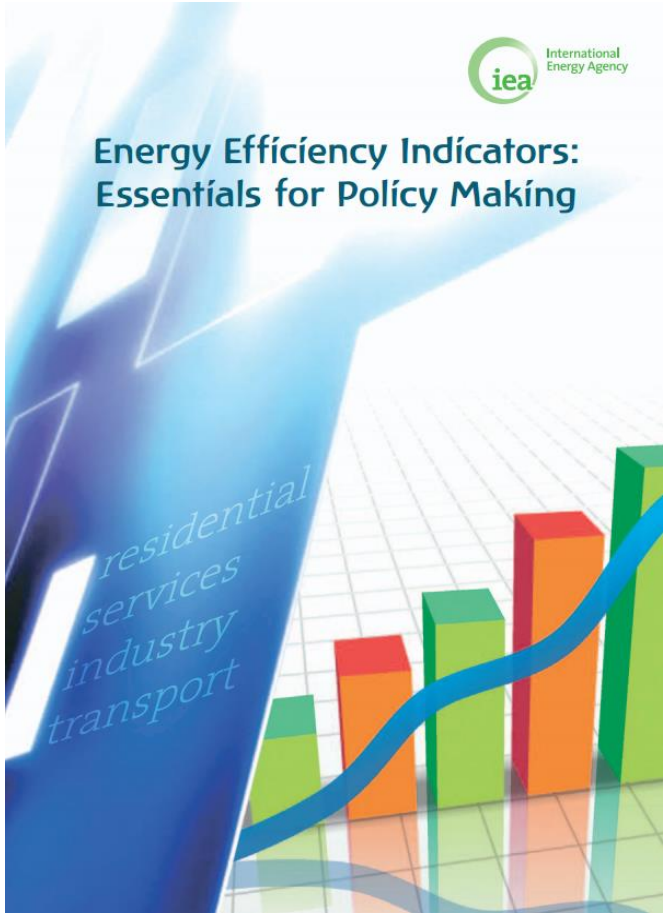
Indicators manuals

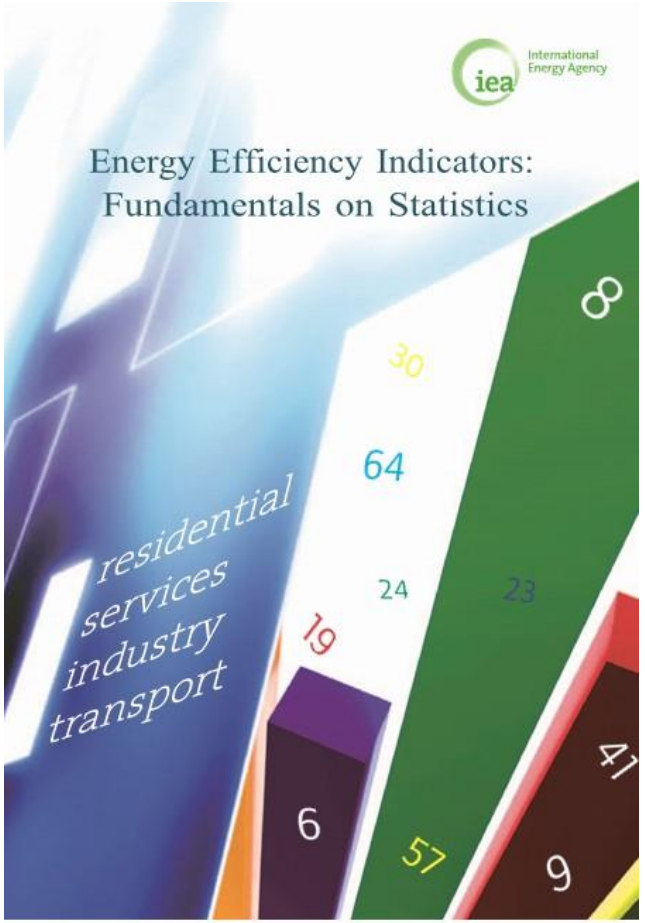
Indicators data pyramid



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Energy efficiency indicators: manuals

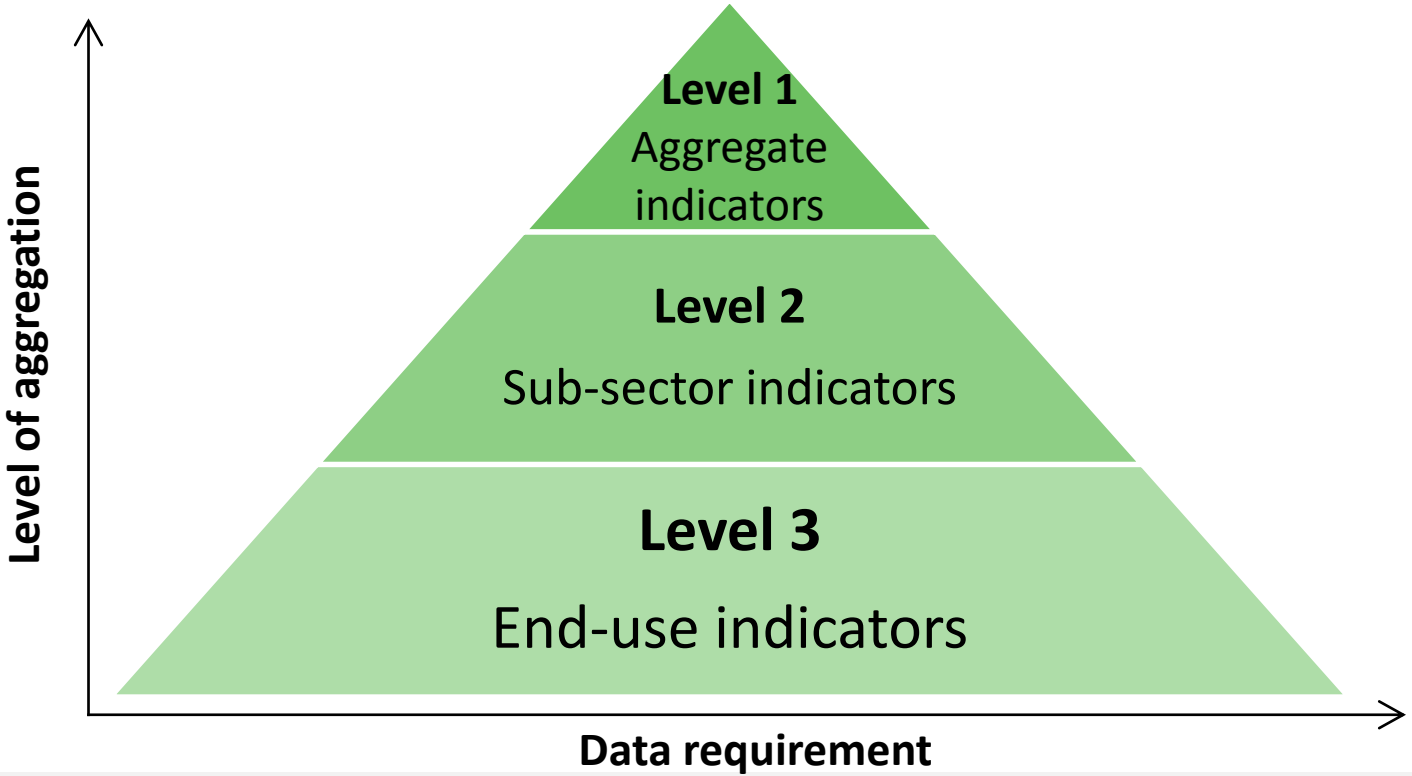




Source: IEA energy efficiency indicators

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Energy efficiency indicators pyramid

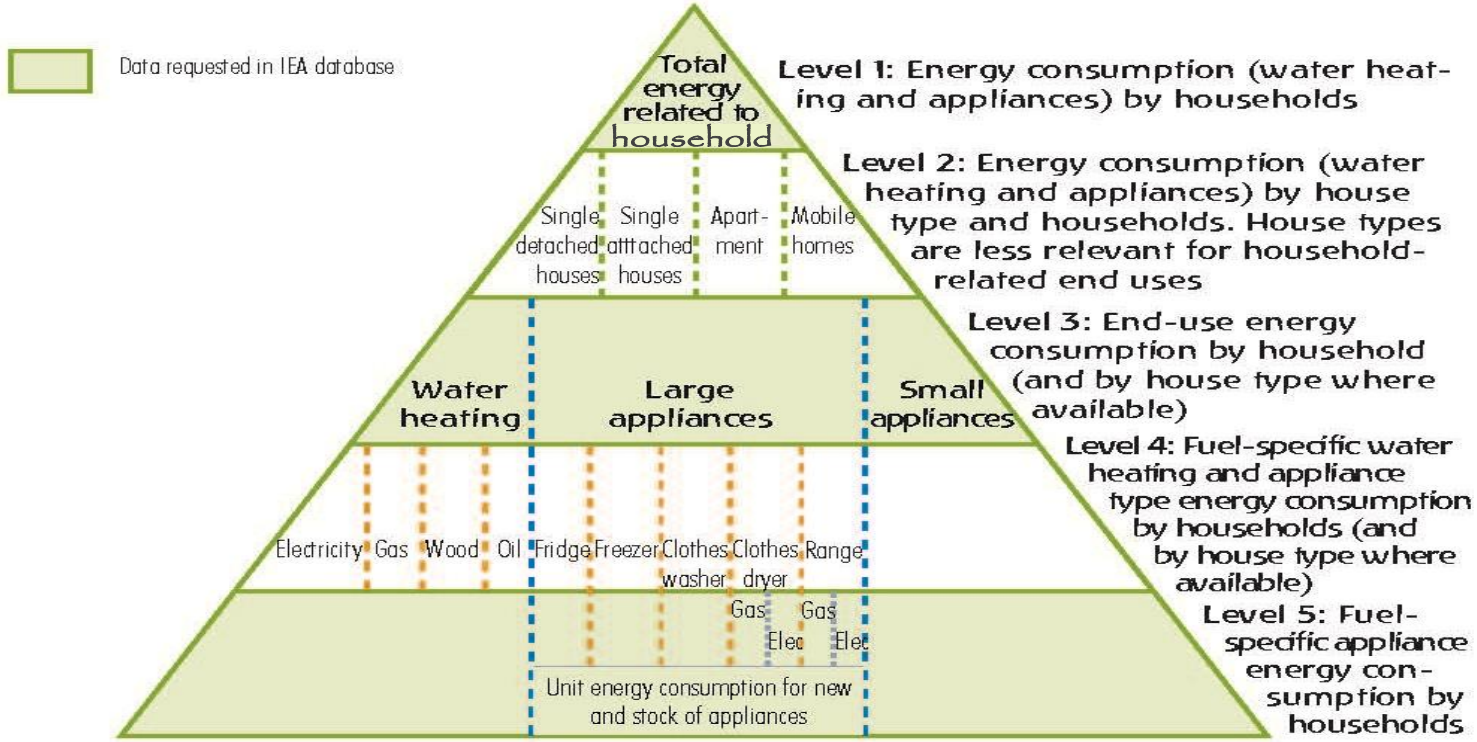


More detailed data is required to get to Level 3 indicators

Source: IEA energy efficiency indicators

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Energy efficiency indicators pyramid: residential per household

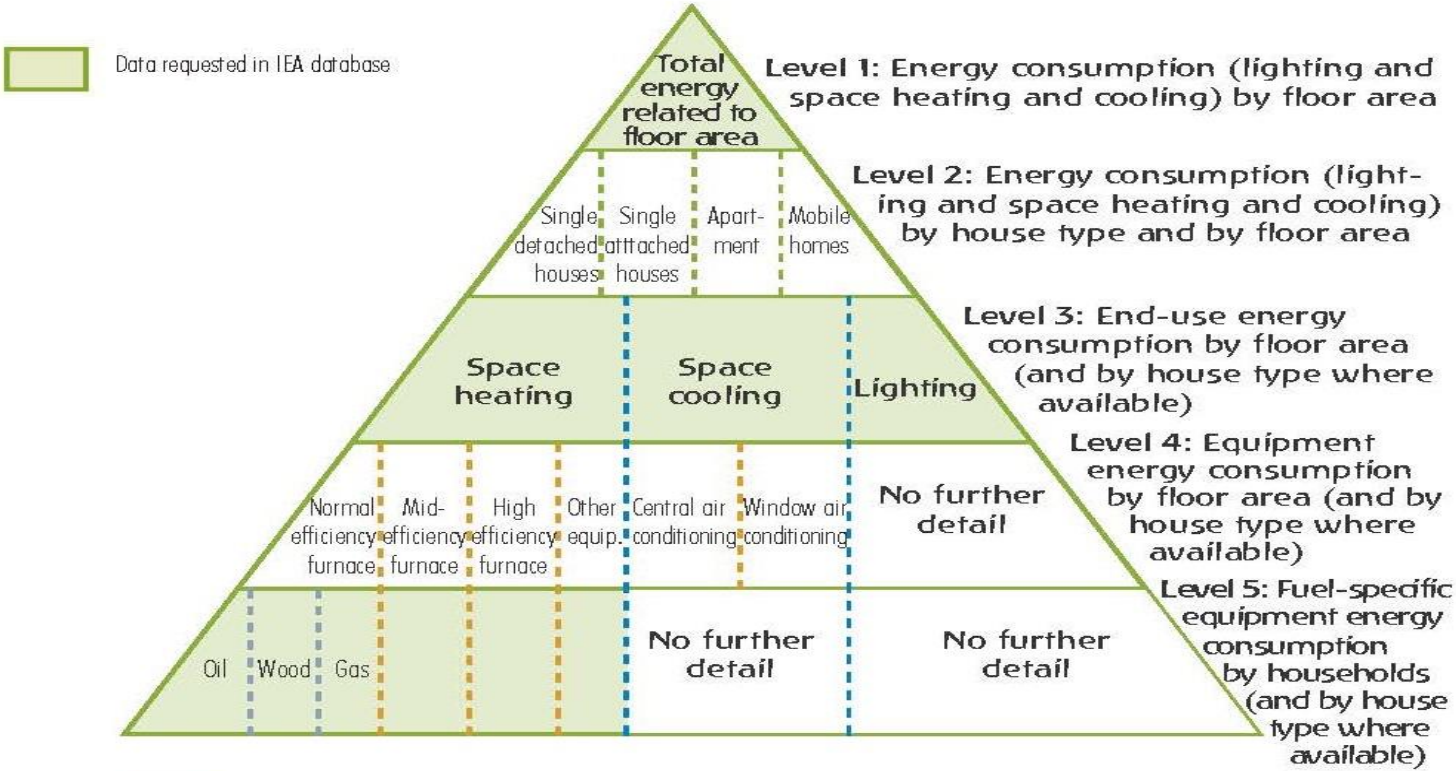


Data and analysis can be used to get end-use and fuel values

Source: IEA energy efficiency indicators

© OECD/IEA 2018

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

© OECD/IEA 2018

Energy efficiency indicators: residential

- Floor area and households (drivers)
- Energy demand
  - Space heating
  - Space cooling
  - Water heating
  - Lighting
  - Cooking
  - Appliances (e.g. refrigerators, washers, televisions)
  - Miscellaneous electricity (e.g. plug loads)

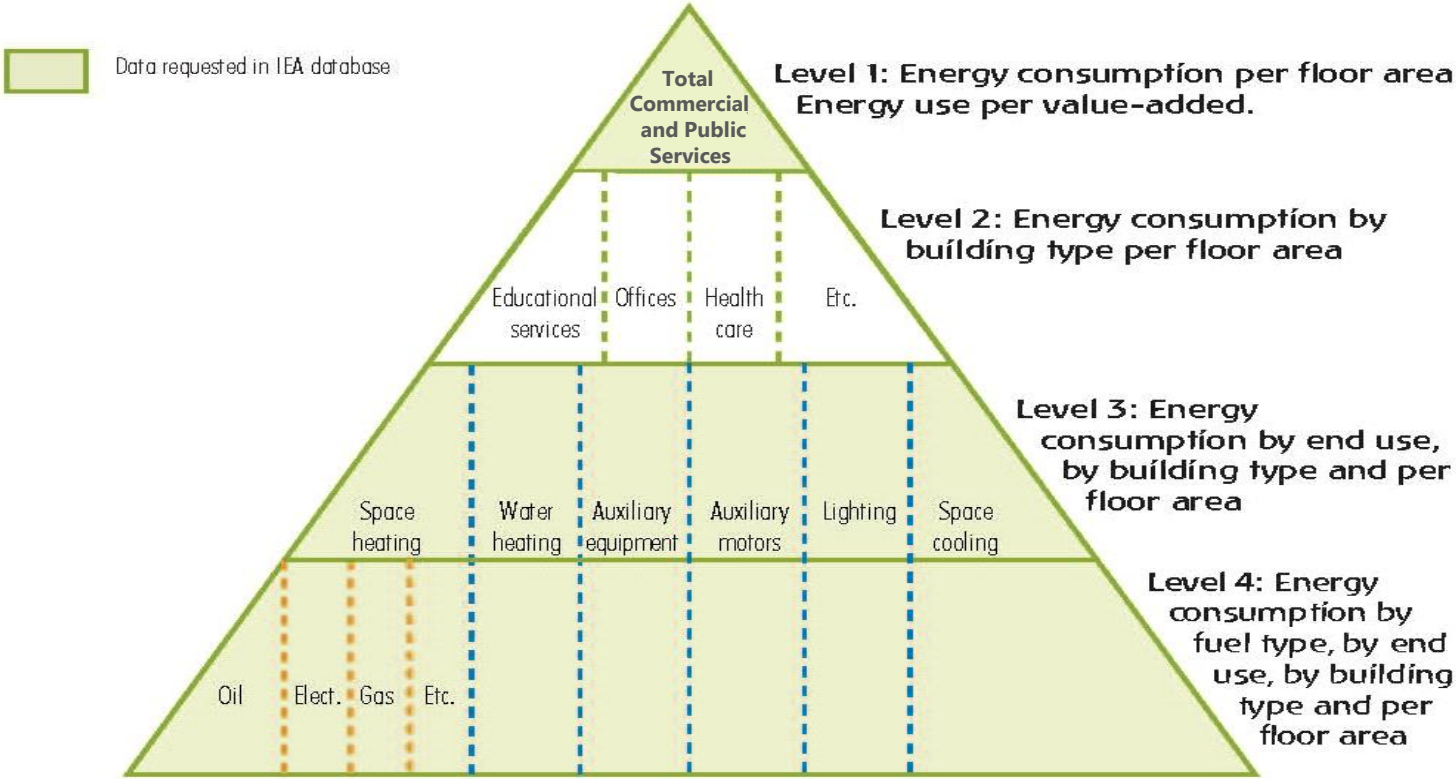




Source: IEA energy efficiency indicators

© OECD/IEA 2018

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

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Energy efficiency indicators: non-residential

- Floor area (driver)
  - (Services value added)
- Energy demand
  - Space heating
  - Space cooling
  - Water heating
  - Lighting
  - Miscellaneous energy (“other”)





Source: IEA energy efficiency indicators

© OECD/IEA 2018

Tracking progress 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

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Energy performance metrics

Limitations

Energy consumption

Energy per person

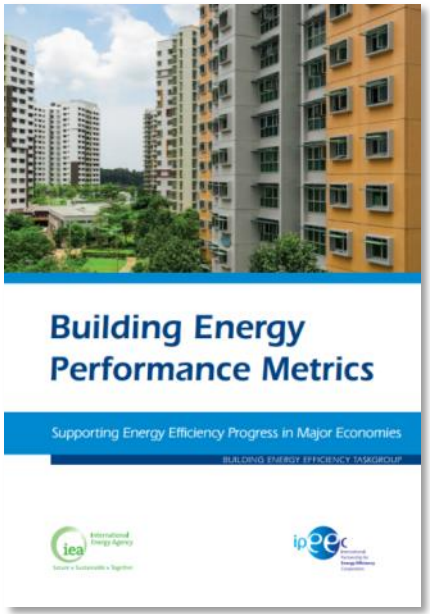
Energy per floor area



© OECD/IEA 2017

Limitations of Energy Performance Metrics

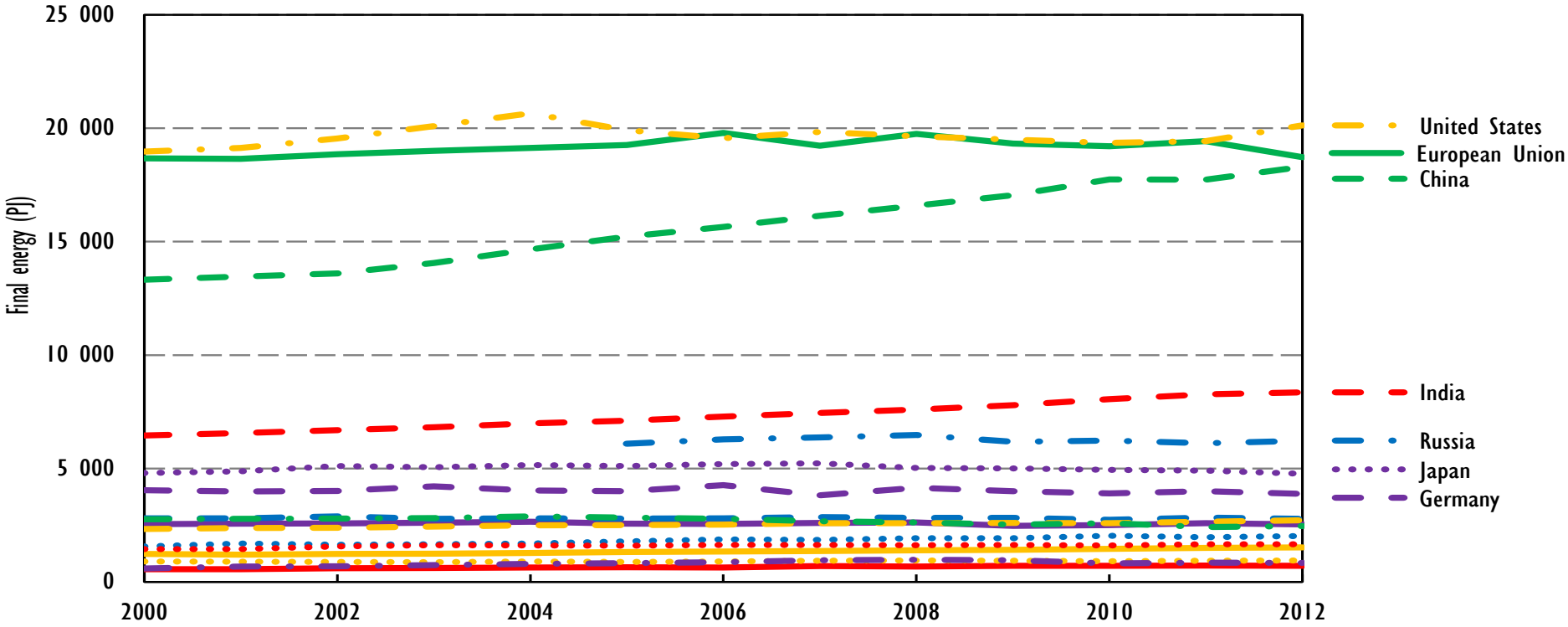
- Metrics cannot predict variation in overall energy consumption or quantify the impact of individual components or factors on overall energy consumption
- It is often necessary to undertake more detailed analysis to fully understand the combined impact of a number of different factors or driving forces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



Source: IEA Building Energy Performance Metrics 2015

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Building energy performance metrics: energy consumption

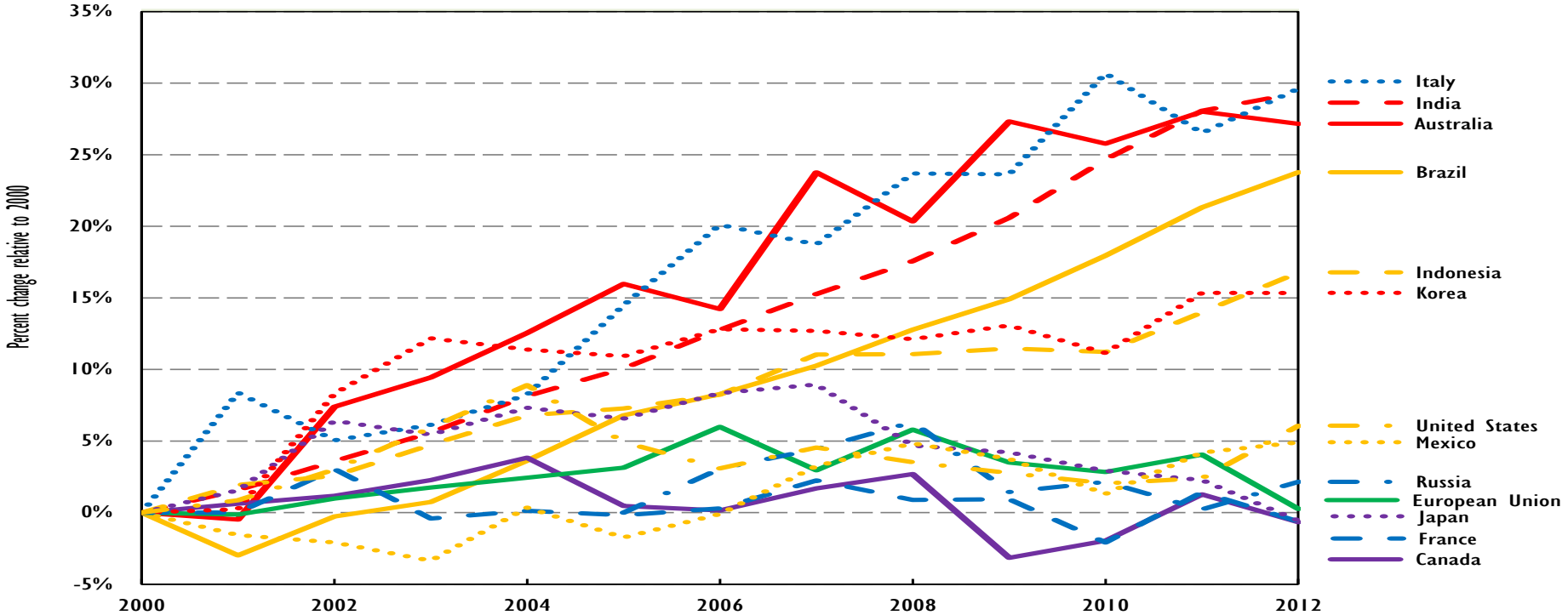


What does this tell us about energy efficiency in buildings?

Source: IEA Building Energy Performance Metrics 2015

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Building energy performance metrics: change in energy consumption

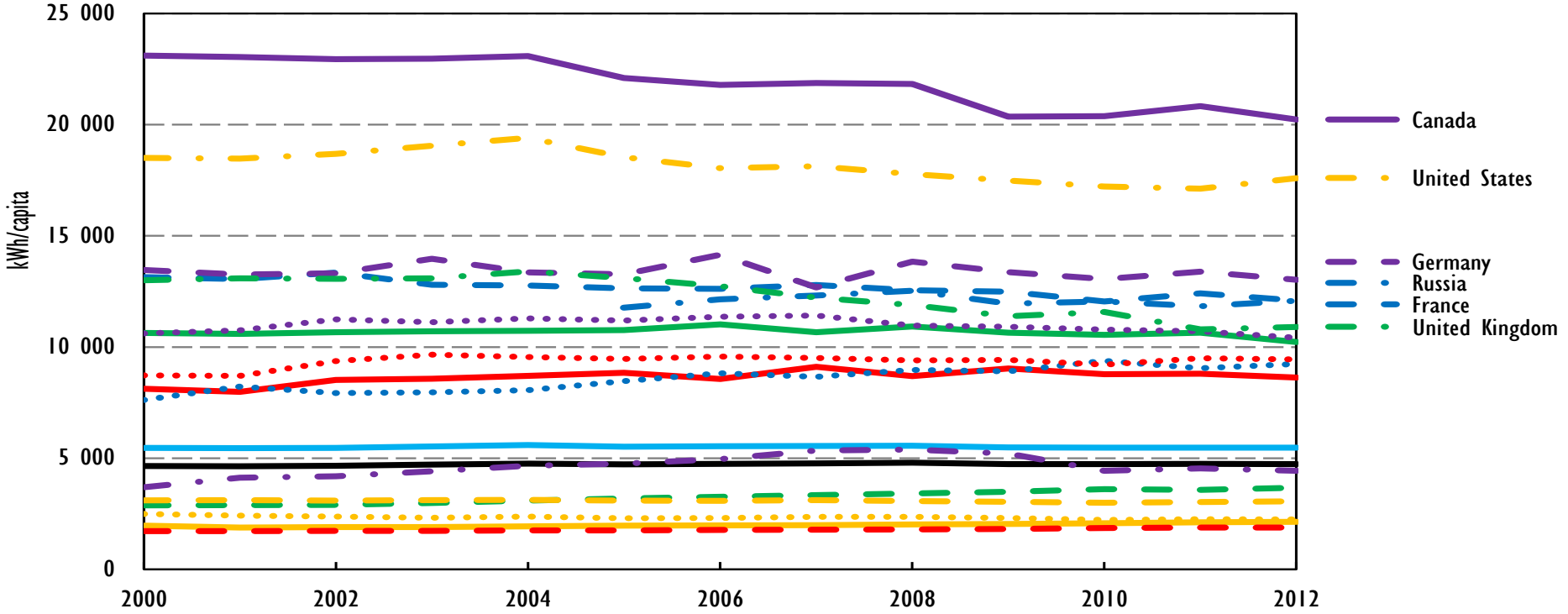


What does this tell us about energy efficiency in buildings?

Source: IEA Building Energy Performance Metrics 2015

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Building energy performance metrics: energy per person

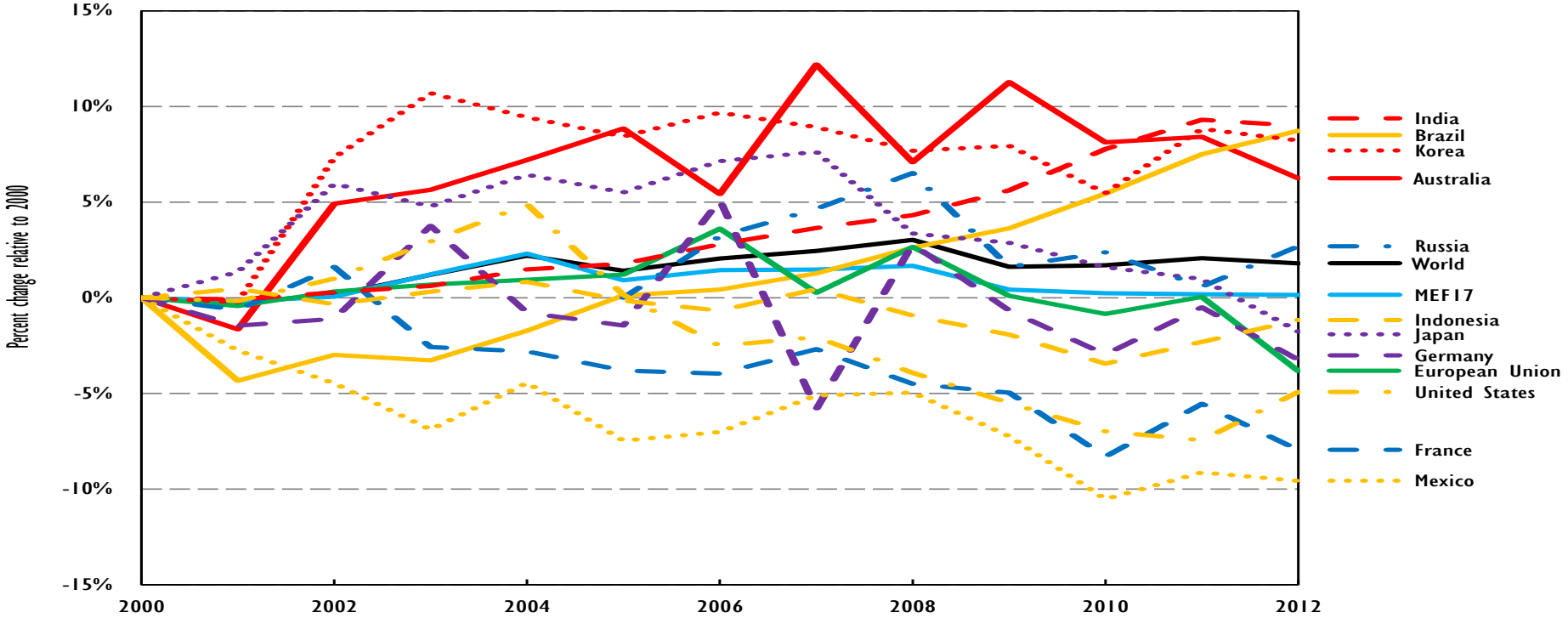


What does this tell us about energy efficiency in buildings?

Source: IEA Building Energy Performance Metrics 2015

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Building energy performance metrics: change in energy per person

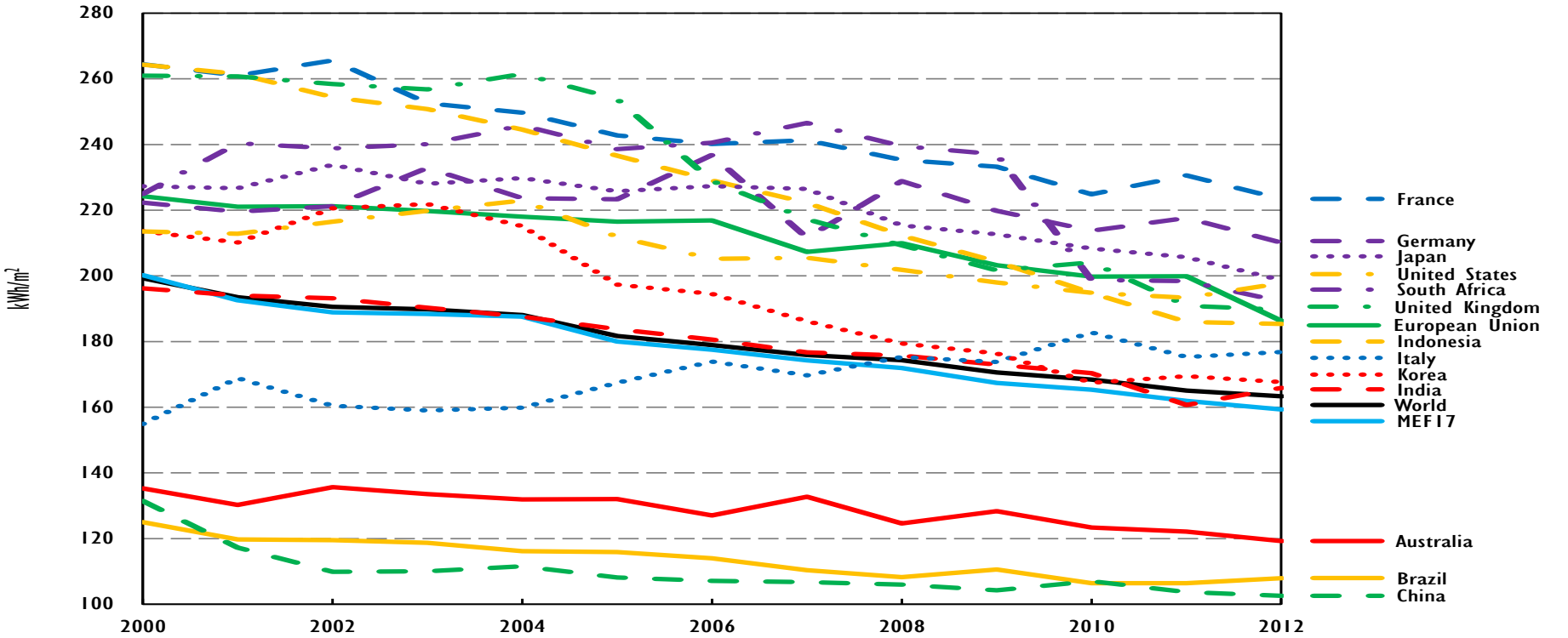


What does this tell us about energy efficiency in buildings?

Source: IEA Building Energy Performance Metrics 2015

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Building energy performance metrics: energy per floor area

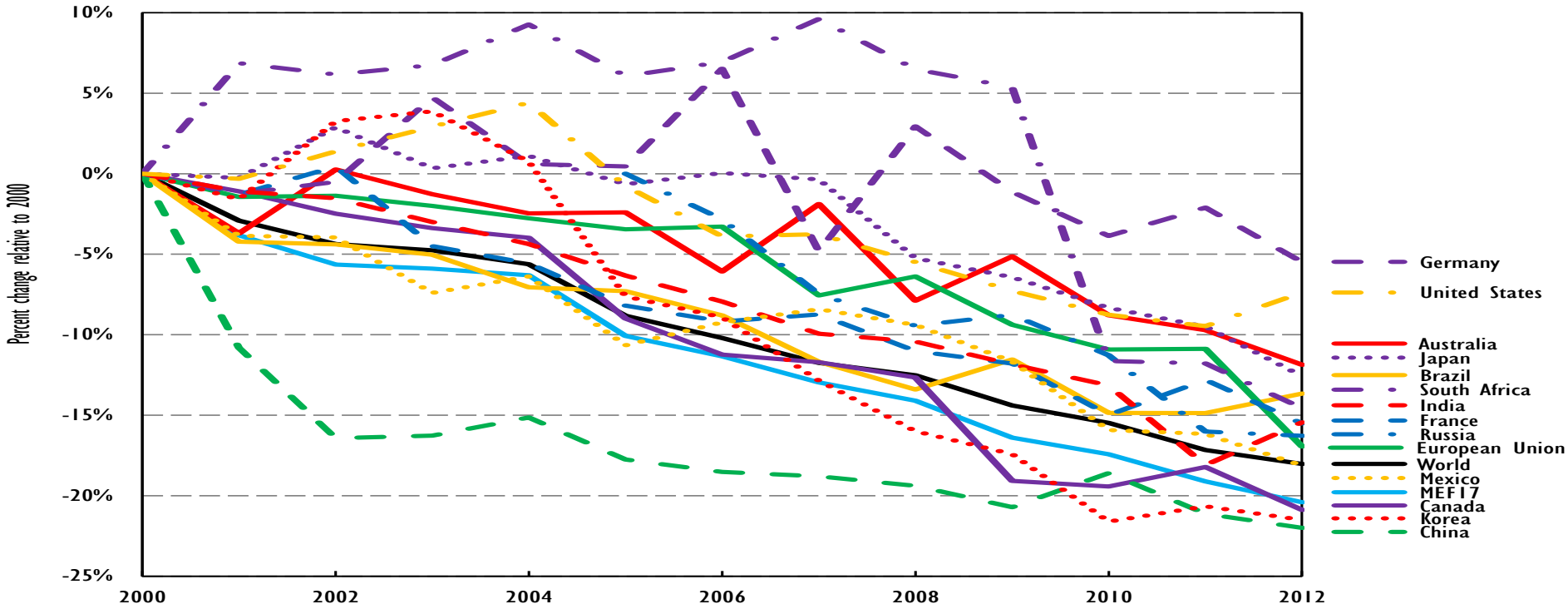


What does this tell us about energy efficiency in buildings?

Source: IEA Building Energy Performance Metrics 2015

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Building energy performance metrics: change in energy per floor area

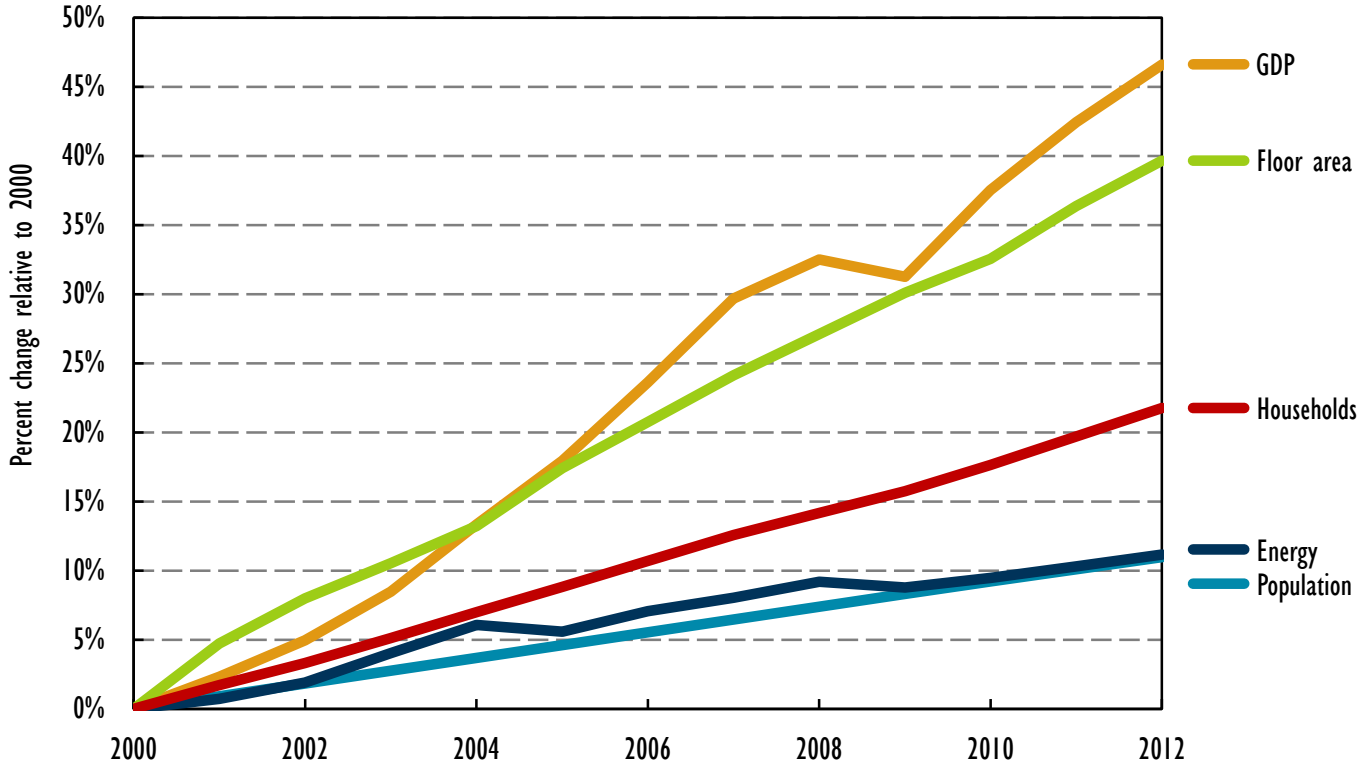


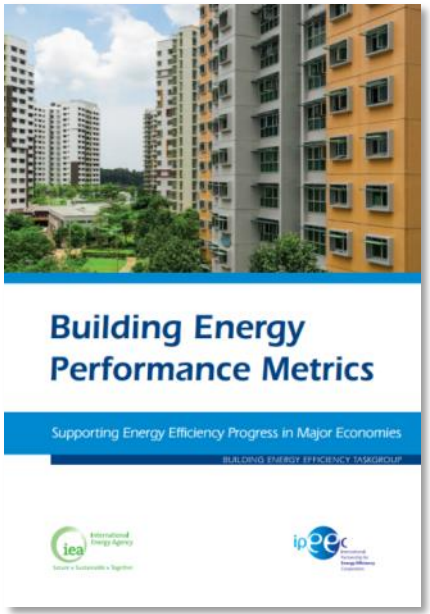
What does this tell us about energy efficiency in buildings?

Source: IEA Building Energy Performance Metrics 2015

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Building energy performance metrics: key information



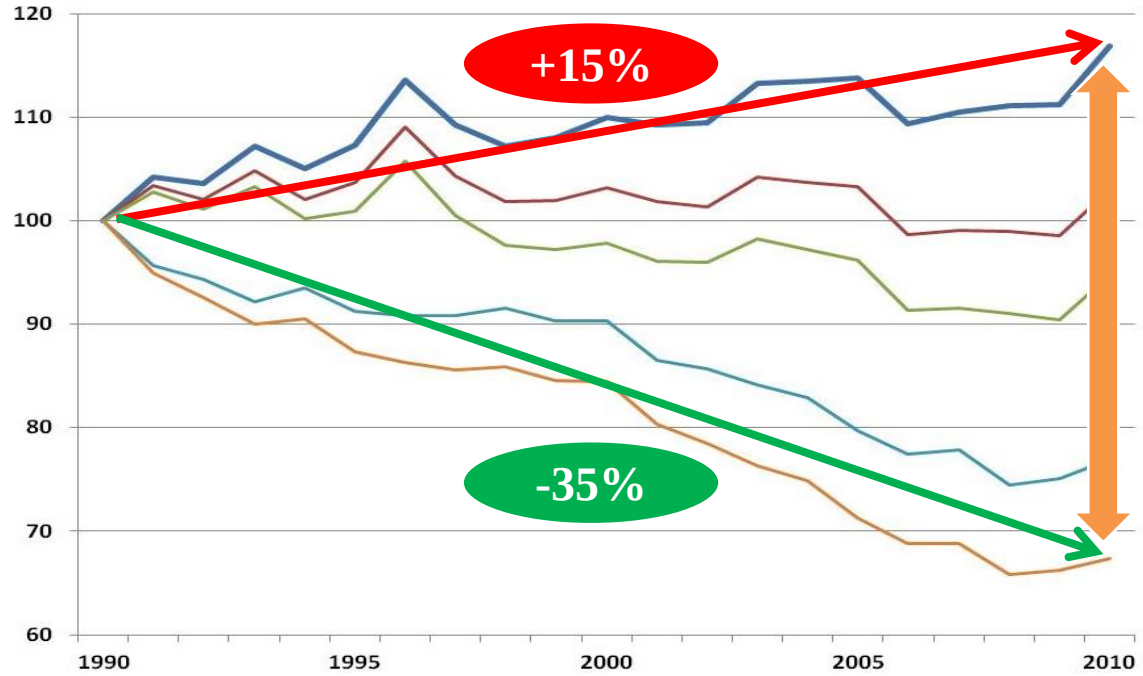


How useful is this information in identifying progress?

Source: IEA Building Energy Performance Metrics 2015

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Building energy performance metrics: 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

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Energy demand analysis

Beyond metrics

Bars held analysis



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Tracking progress: beyond metrics

Understanding different drivers, technology choices and energy efficiency potential are needed for deeper understanding of trends

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

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

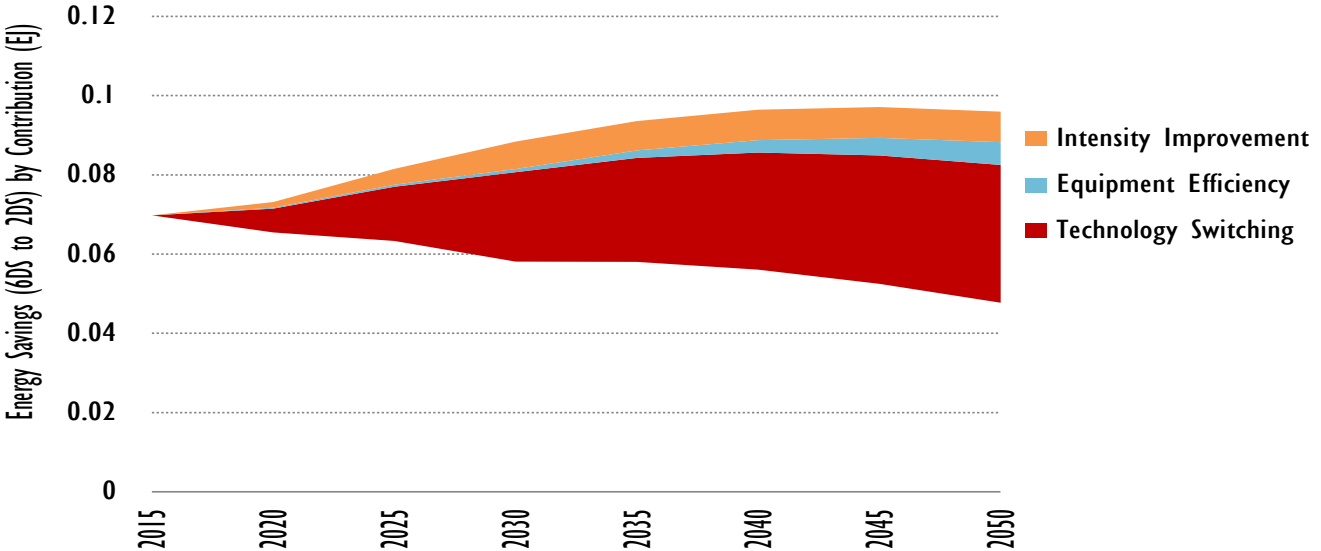
How efficient is the technology used?

Source: IEA Energy Technology Perspectives

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"What if" analysis across indicators

- Proportional distribution of energy savings by holding only changing one indicator at a time



Source: IEA Energy Technology Perspectives

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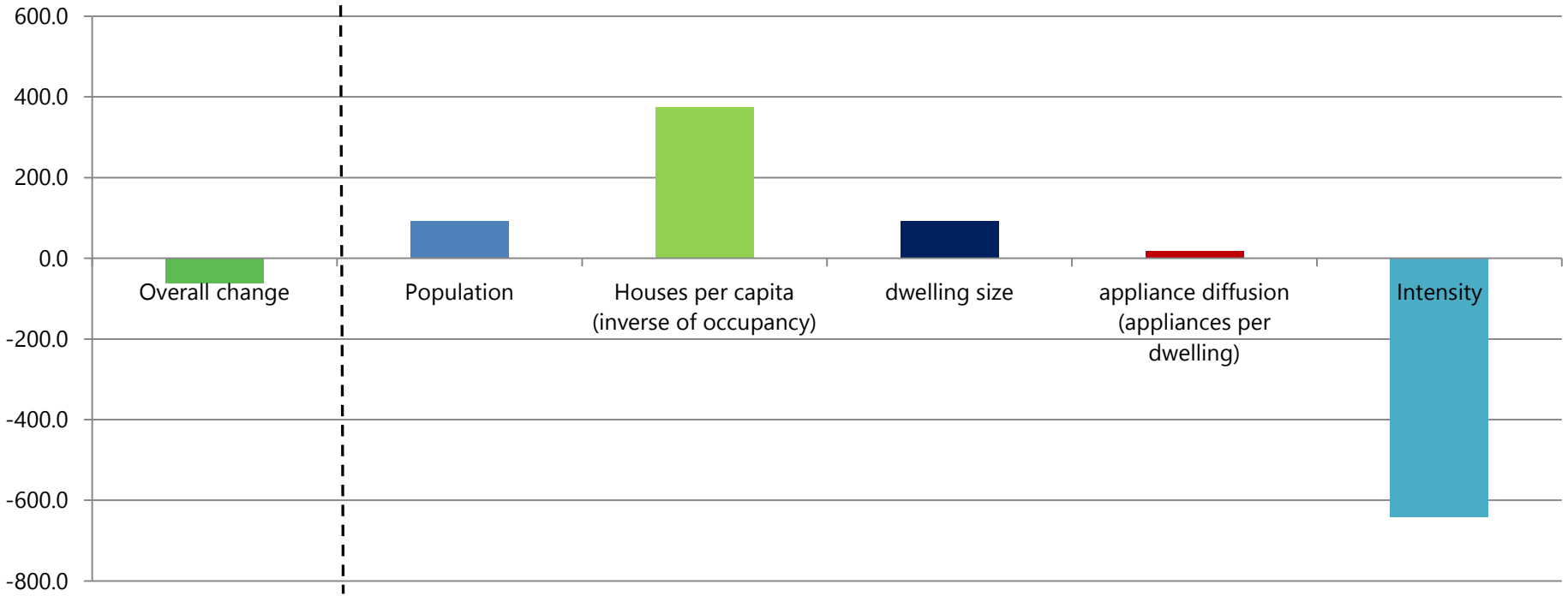
Decomposition

Logarithmic Mean Divisia Index (LMDI)



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Building energy decomposition: breaking down the impacts



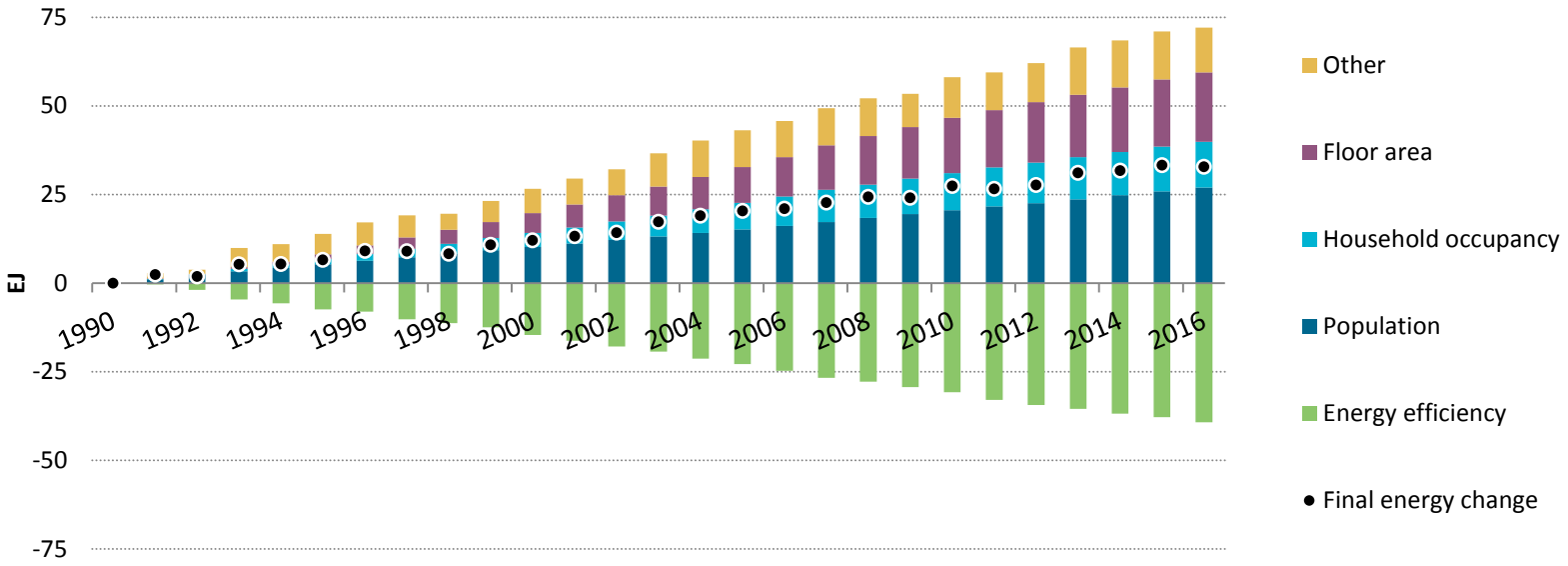
Proportional distribution of energy savings by holding only changing one indicator at a time. Decomposition analyses can be extremely valuable – but complex.

Source: IEA Energy Technology Perspectives

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Building energy decomposition: historical trends and projections

Decomposition of global final energy demand in buildings by key contribution



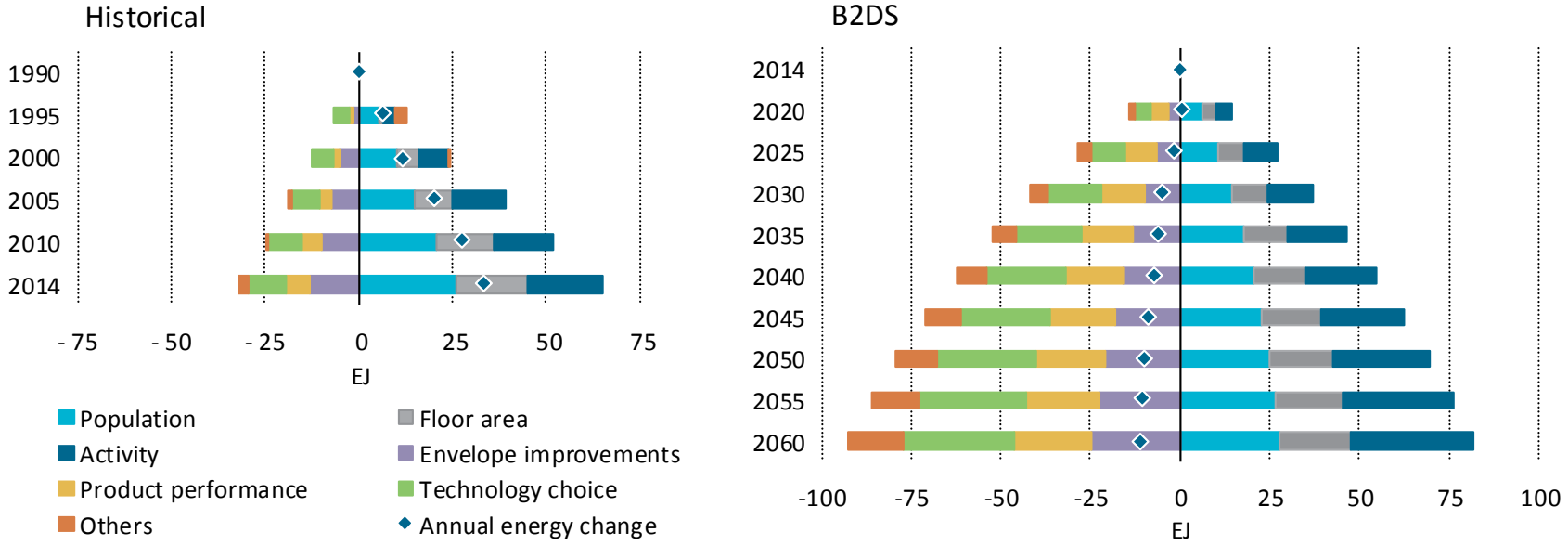
Through decomposition, we can see that energy efficiency is significant, but not keeping up with the growth in total energy consumption in buildings.

Source: IEA Energy Technology Perspectives 2017

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Building energy decomposition: historical trends and projections

Decomposition of global final energy demand in buildings by key contribution



Further, with decomposition, we see that energy efficiency measures under the B2DS reverse historical trends, offsetting increasing global population, building activity and growing floor area.

Source: IEA Energy Technology Perspectives 2017

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Process for Tracking Progress

Key steps in the process

Group exercise



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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

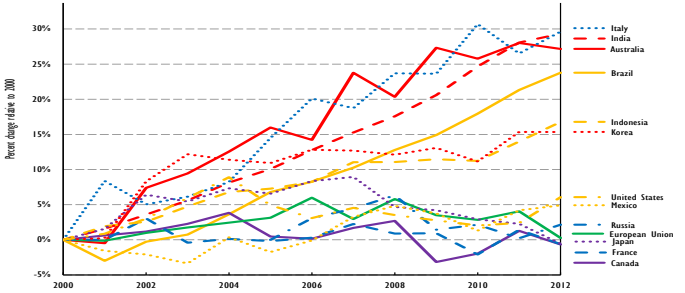
- *What performance metrics can you use?*
- *What data is needed?*

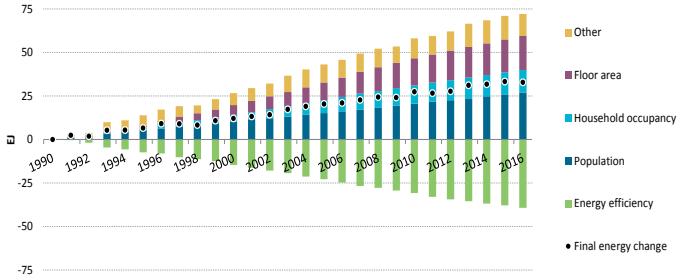
Step 3: Assess the data

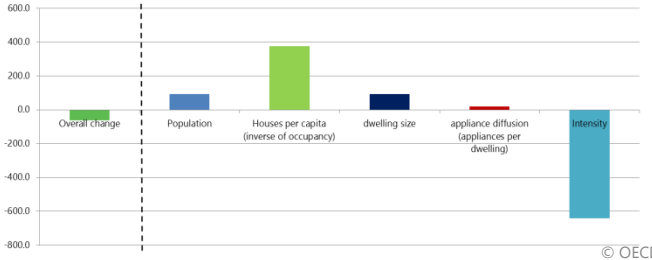
- *What analysis method should you use?*

Step 4: Tell the story

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

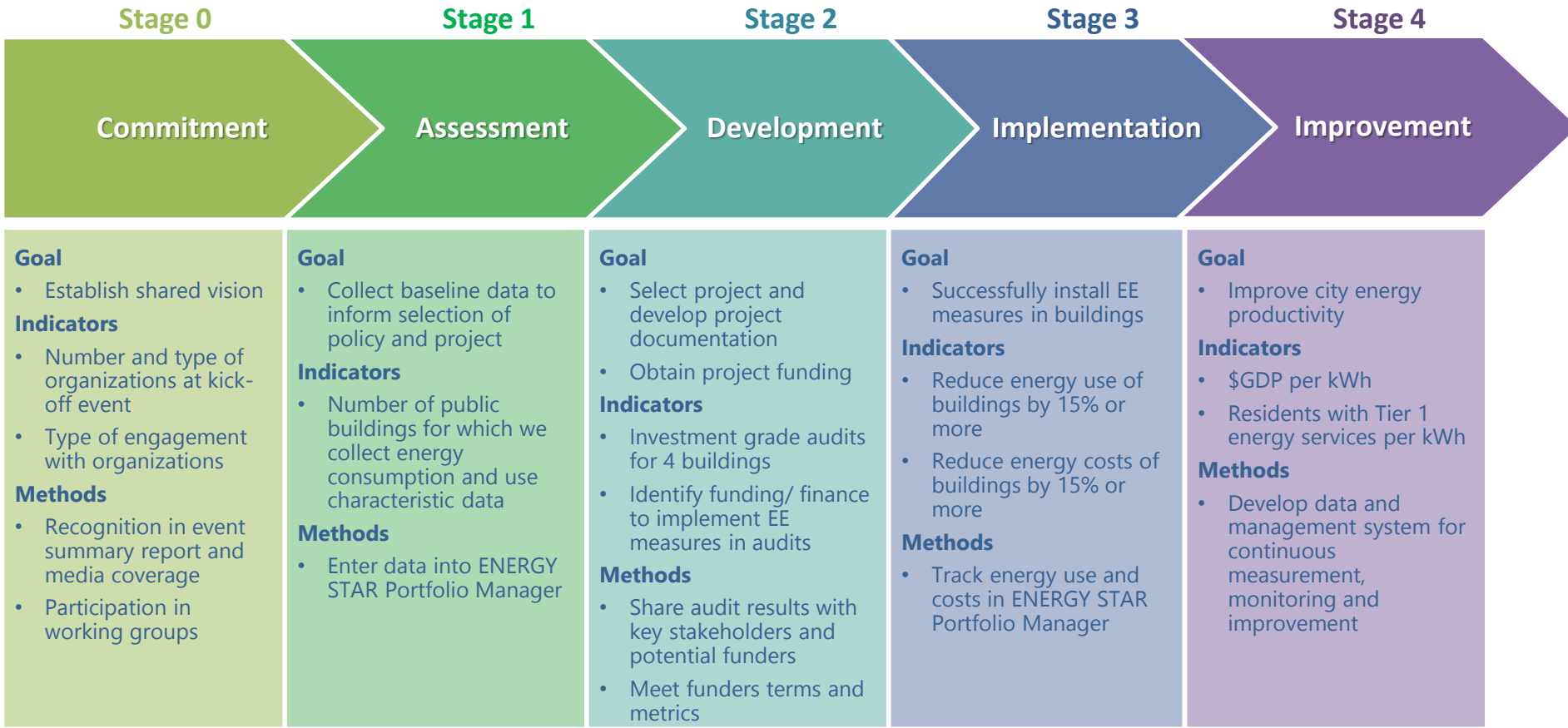






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Example: Tracking progress in the Building Efficiency Accelerator



Source: Building Efficiency Accelerator

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Group discussion and exercise

Scenario:

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

How do you go about answering this?



Group exercise:

- *We will split into groups*
- *We will use the data and calculate progress*
- *We will discuss findings in the main group*

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Group exercise: Track progress in 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?*

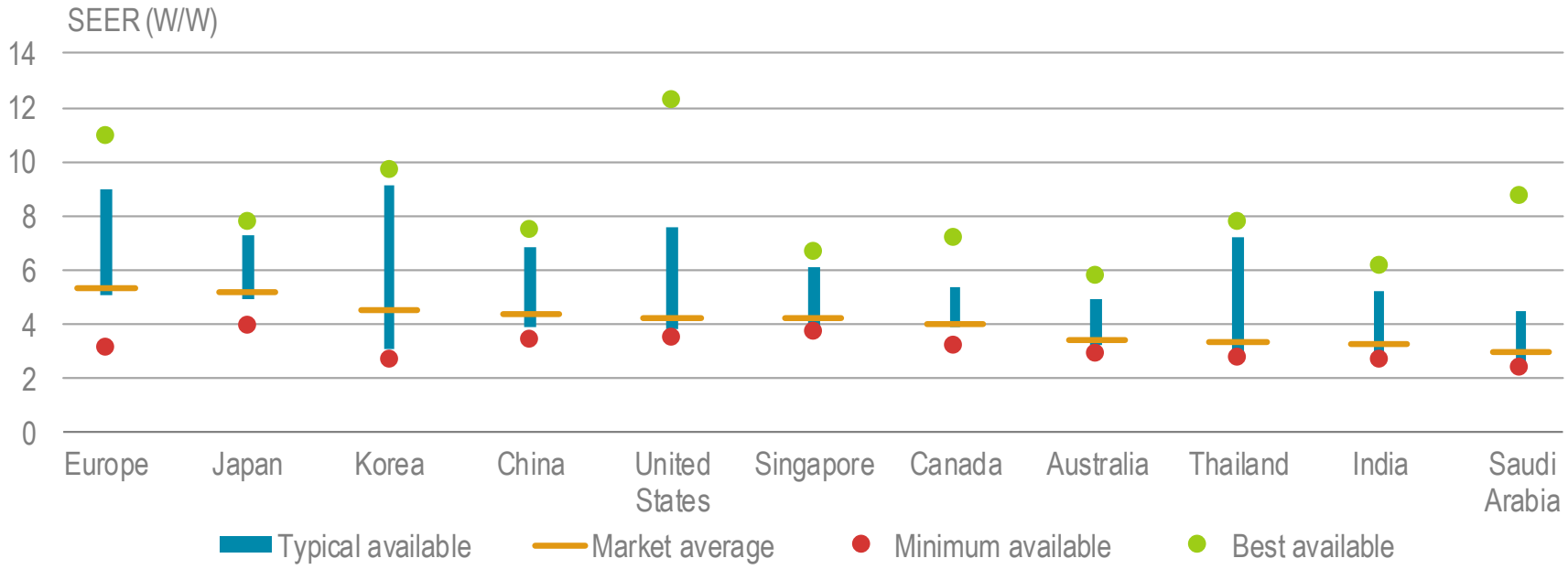
Potential issues related to cooling

- *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*

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Group exercise: tracking progress on space cooling (example 1)

SEER of air-conditioners by country, 2017



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

Source: IEA

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Group exercise: Track progress in cooling

Step 2: Define the tracking indicators

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

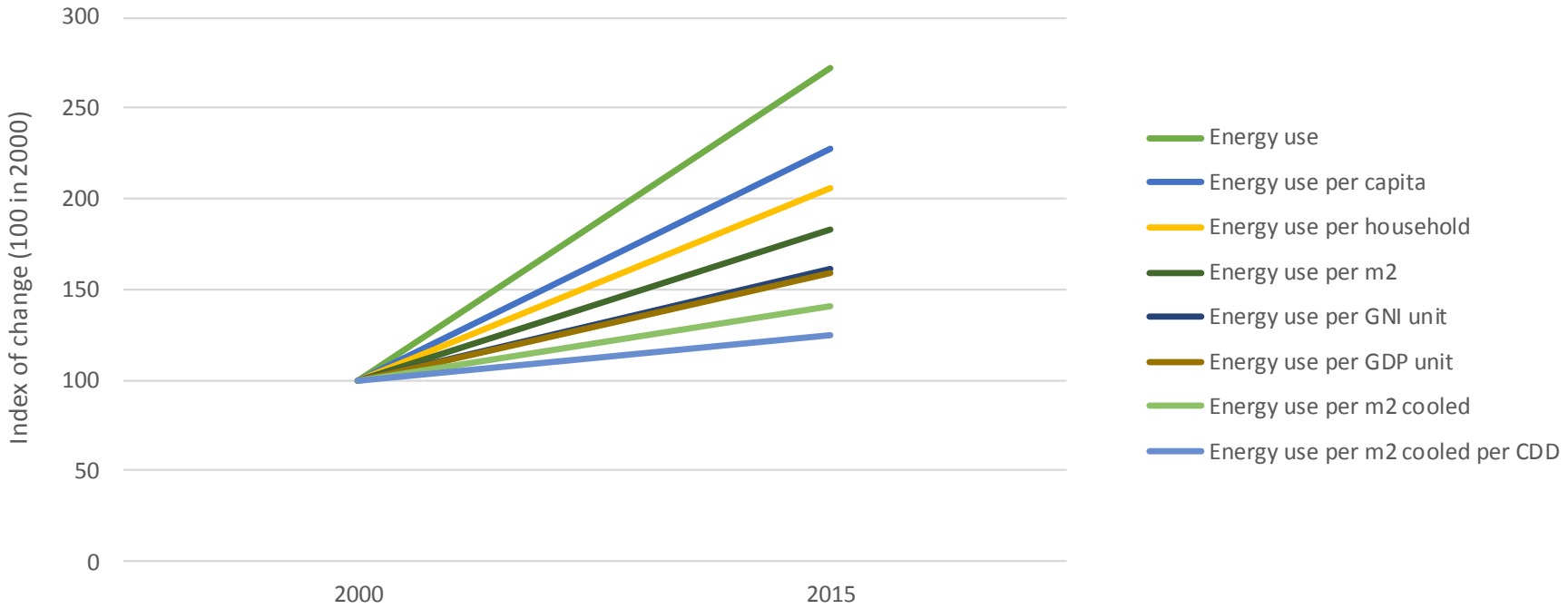
Issues with metrics and indicators

- *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*

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Group exercise: tracking progress on space cooling (example 2)

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



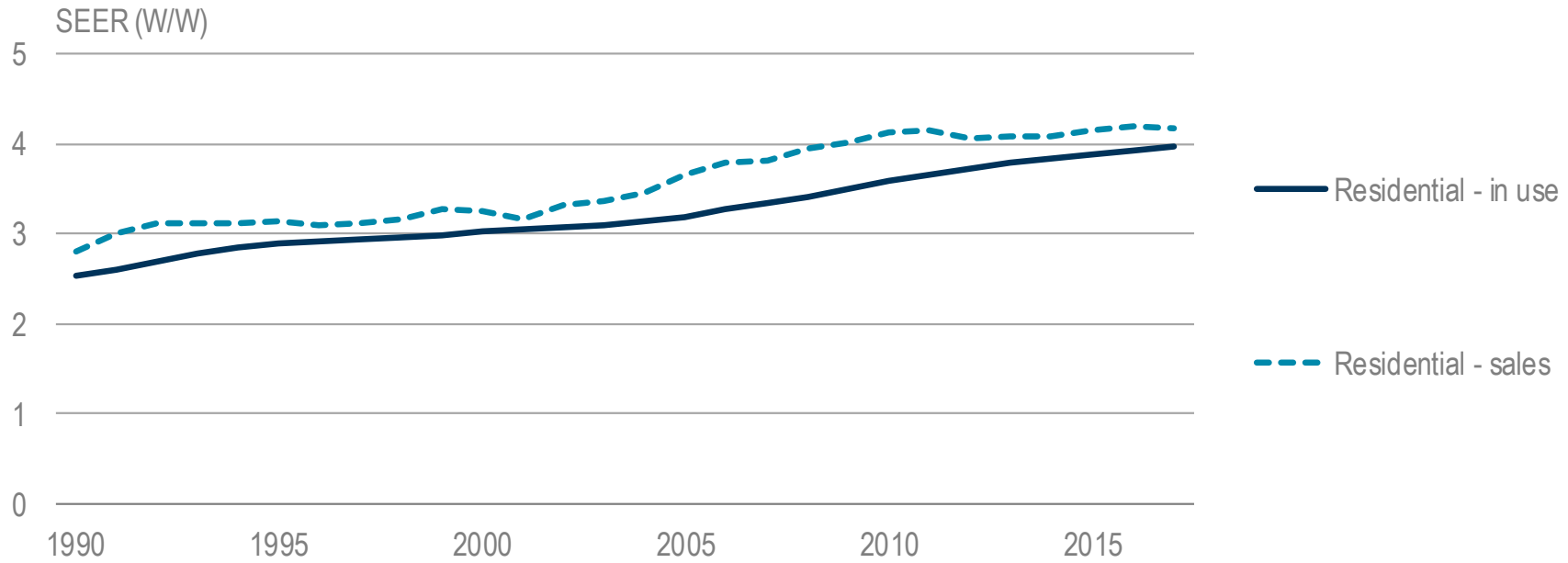
"Energy use per m² cooled per CDD" may be an accurate performance indicator at the building. But depending on the story you want to tell, "energy use" offers a different story for the country.

Source: IEA

© OECD/IEA 2018

Group exercise: tracking progress on space 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

© OECD/IEA 2018

Group exercise: Track progress in 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?*

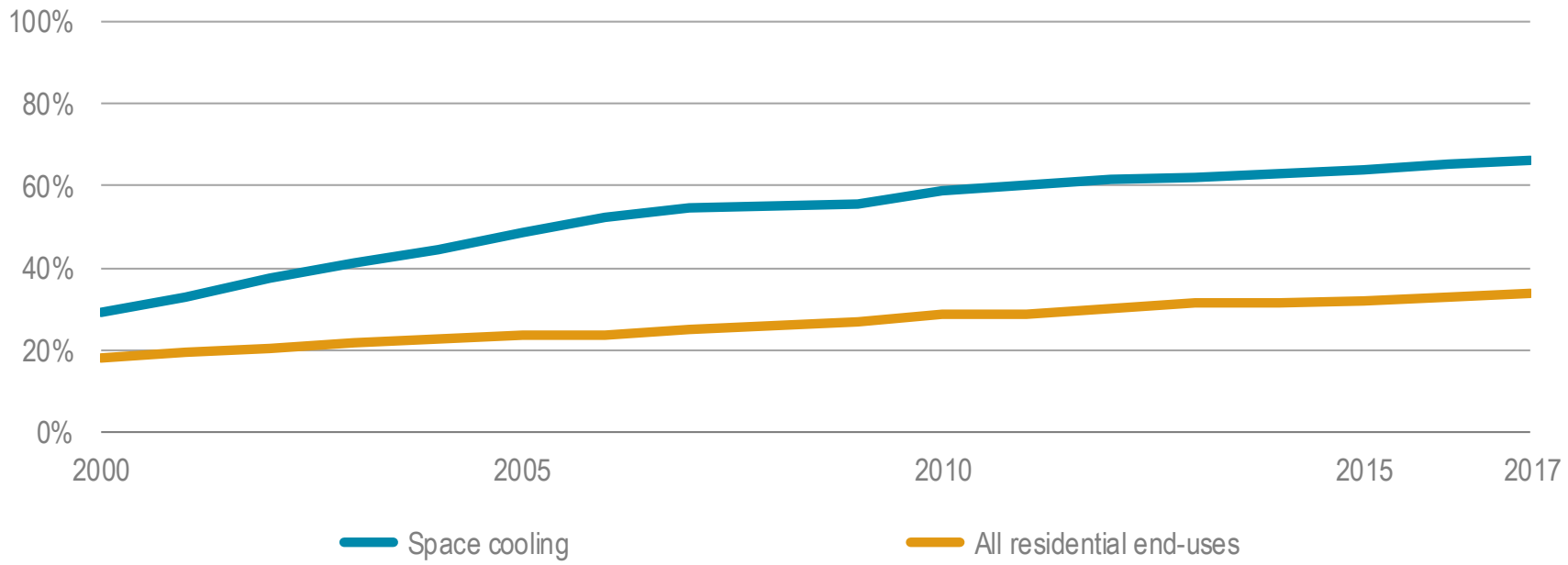
Issues with metrics and indicator analysis methods

- *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)*

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Group exercise: tracking progress on space cooling (example 4)

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



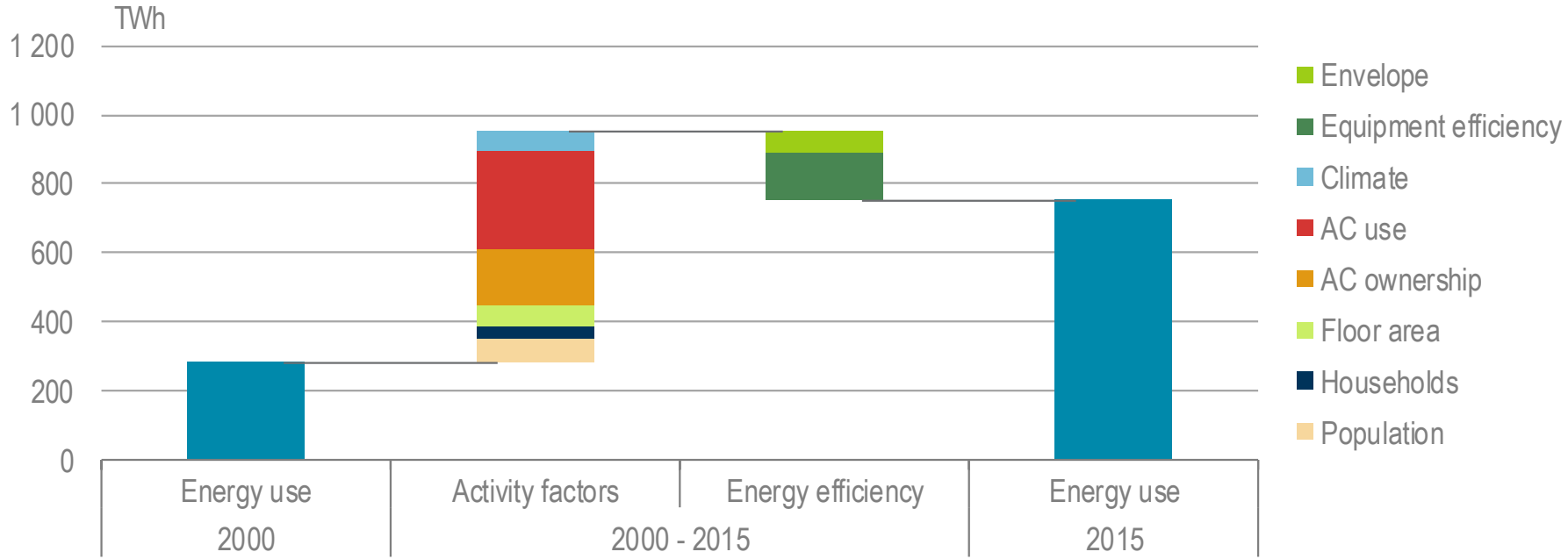
Increasingly more policies are covering space cooling energy use.
But the strength of those policies are not keeping pace with best available technologies.

Source: IEA

© OECD/IEA 2018

Group exercise: tracking progress on space 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

© OECD/IEA 2018

Group discussion and exercise

Scenario:

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

How do you go about answering this?



Group exercise:

- *Split into groups of 3-4 people*
- *Review the handout, use the data and calculate progress*
- *Return to the main group to discuss your methods and findings*

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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