Principles of developing energy efficiency indicators

Roberta Quadrelli – Head, Energy balances, prices, emissions, efficiency
IEA Energy Data Centre

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IEA
Overview

- Energy efficiency indicators: **Why?**

- Starting from **energy balances**: benefits and limits of high-level indicators

- Beyond the energy balance: **energy efficiency indicators**

- **How to collect** energy efficiency data?
Energy efficiency indicators: why?
But what indicators help us track energy efficiency?
Does energy intensity track energy efficiency?

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

Source: IEA World energy balances, 2017
What drives energy intensity trends?

Energy intensity (TPES/GDP)

Source: IEA World energy balances, 2017

Efficiency progress and also other factors (mainly structural changes)
How to disentangle efficiency from other drivers?

Drivers of final energy consumption in IEA

Note: Analysis based on the IEA Energy Efficiency Indicators database (2016 edition). TFC in this analysis covers the following sectors: residential, industry and services, passenger and freight transport. It does not include agriculture, non-energy, and energy supply sectors. The energy consumption decomposed in this analysis represents 90% of TFC in IEA countries in 2015.

How to quantify emission savings due to efficiency?

Efficiency estimated to have reduced IEA CO₂ emissions from fuel combustion by 13% in 2015.

How to project energy demand?

Cooling is the fastest growing use of energy in buildings.

Without action to address energy efficiency, energy demand for space cooling will more than triple by 2050 – consuming as much electricity as all of China and India today.

Share of final electricity demand growth to 2050

- Space cooling: 37.0%
- Residential appliances: 25.5%
- Heating: 12.4%
- Lighting: 7.8%
- Other services: 17.4%

Source: IEA, The future of cooling, 2018
How to estimate potential energy demand policy impacts?

Growth of gasoline demand from cars in a hypothetical country (2016-2030)

Historical annual vehicle mileage and fuel efficiency are key indicators for forward-looking analysis, affecting both expected demand growth and possible policy impacts.
End-use data and indicators are the answer

IEA Energy Efficiency Indicators: Essentials for Policy Makers manual
Starting from energy balances: benefits and limits of high-level indicators
Most countries collect statistics to develop energy balances.
From energy balances we derive high-level information:

- **Supply**
- **Transformation**
- **Final consumption**

### Energy intensity, Self-sufficiency ...

### Efficiencies of transformation sector

### Shares of energy consumption by sector
For example, shares of sectors in total final consumption

Key to understand where energy is used and to define policy priorities
And more specific sectoral indicators

Residential energy use per capita

Belarus
Kazakhstan
Uzbekistan
Ukraine
Azerbaijan
Georgia
Republic of Moldova
Armenia
Kyrgyzstan
Turkmenistan
Tajikistan

Coupling sectoral demand 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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Data source: IEA, Energy efficiency indicators.
Choosing the most appropriate indicators is essential

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.
Balances are very useful but do not track end-uses

**ENERGY BALANCE**

<table>
<thead>
<tr>
<th>Category</th>
<th>Coal</th>
<th>Crude</th>
<th>Oil Products</th>
<th>Gas</th>
<th>Nuclear</th>
<th>Hydro</th>
<th>Geoth/Solar</th>
<th>Biofuels &amp; Waste</th>
<th>Electricity</th>
<th>Heat</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTHER</td>
<td>136.42</td>
<td>0.23</td>
<td>425.87</td>
<td>633.44</td>
<td>-</td>
<td>-</td>
<td>14.37</td>
<td>834.05</td>
<td>820.32</td>
<td>145.22</td>
<td>3036.92</td>
</tr>
<tr>
<td>Residential</td>
<td>76.58</td>
<td>-</td>
<td>222.89</td>
<td>418.55</td>
<td>-</td>
<td>-</td>
<td>6.98</td>
<td>805.42</td>
<td>395.81</td>
<td>97.97</td>
<td>2024.19</td>
</tr>
<tr>
<td>Comm. and public serv.</td>
<td>23.3</td>
<td>-</td>
<td>107.32</td>
<td>173.79</td>
<td>-</td>
<td>-</td>
<td>1.15</td>
<td>16.33</td>
<td>338.31</td>
<td>32.47</td>
<td>692.67</td>
</tr>
<tr>
<td>Agriculture/forestry</td>
<td>9.57</td>
<td>0.02</td>
<td>102.97</td>
<td>5.58</td>
<td>-</td>
<td>-</td>
<td>0.16</td>
<td>7.02</td>
<td>36.2</td>
<td>3.36</td>
<td>164.88</td>
</tr>
<tr>
<td>Fishing</td>
<td>0.01</td>
<td>-</td>
<td>5.69</td>
<td>0.02</td>
<td>-</td>
<td>-</td>
<td>0.03</td>
<td>-</td>
<td>0.36</td>
<td>0.06</td>
<td>6.17</td>
</tr>
</tbody>
</table>

**Residential:**
- no breakdown by end-use
  - space heating
  - space cooling
  - water heating
  - lighting
  - cooking
  - appliances
Efficiency indicators need to track energy end-use trends

Examples:
- Total energy supply / population / GDP
- Residential energy / population / number of dwellings / floor area
- Space heating energy consumption / floor area
- ...

It is important to collect more disaggregated data than those of energy balances
Beyond the energy balance: energy efficiency indicators

Analysing energy 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

Energy consumption by end-use, country B
Selected energy intensities, country B

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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
- Passenger-kilometers
- Tonne-kilometers

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Energy consumption by mode/vehicle type, country D

Activity data:
- Vehicle stocks
- Passenger-kilometers
- Tonne-kilometers

Selected energy intensities, country D

Vehicle stock

Distance travelled

Occupancy

Load
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

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Energy consumption by end-use, country A

Selected energy intensities, country A
How to collect energy efficiency data?
Energy efficiency indicators: stronger data requirements

More easily available data:
Energy balances

Aggregated Indicators

TPES/GDP
TFC/Population
....

End-use efficiency indicators

Energy /ton steel
Heating /square meters

Process/appliance efficiency indicators

Energy /dry process
and also... higher data accuracy requirements

Understand the accuracy of energy/activity data – and match boundaries
Addressing the challenge: the IEA experience

- Agreed by member countries in 2009 (IEA Ministerial)
- Developed with international community of experts, based on historical work on indicators (Odyssee, LBNL, etc.)
- A user-friendly Excel template (available online)
- Collects energy consumption and activity data
- Covers four sectors: residential, services, industry, transport
- A new publication: *Energy efficiency indicators Highlights*
The IEA energy efficiency indicators (EEI) template

Energy Efficiency Indicators Template
country name

<table>
<thead>
<tr>
<th>COUNTRY DATA SECTION (to be reviewed)</th>
<th>Energy consumption &amp; Activity data for:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MACRO_ECONOMIC DATA</td>
<td>INDUSTRY</td>
</tr>
<tr>
<td>COMMODITIES</td>
<td>SERVICES</td>
</tr>
<tr>
<td>INDUSTRY</td>
<td>RESIDENTIAL</td>
</tr>
<tr>
<td>SERVICES</td>
<td>TRANSPORT</td>
</tr>
<tr>
<td>RESIDENTIAL</td>
<td></td>
</tr>
<tr>
<td>TRANSPORT</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>IEA DATA and AGGREGATE INDICATORS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ELECTRICITY GENERATION</td>
<td></td>
</tr>
<tr>
<td>BASIC INDICATORS</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SUPPORT TOOLS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>USER REMARKS</td>
<td>To incorporate comments associated to the data from the individual sheets</td>
</tr>
<tr>
<td>DATA COVERAGE</td>
<td>Generates a graphical summary of data coverage (completed vs. expected)</td>
</tr>
<tr>
<td>SINGLE INDICATOR GRAPHS</td>
<td>To generate a graph for one energy indicator</td>
</tr>
<tr>
<td>MULTIPLE INDICATORS GRAPHS</td>
<td>To generate a graph comparing trends from multiple indicators</td>
</tr>
<tr>
<td>CONSISTENCY CHECKS</td>
<td>To run the integrated consistency checks</td>
</tr>
</tbody>
</table>
Methods used by countries to collect data for indicators

- **Administrative sources**
  - before starting new data collection

- **Surveys**
  - representative sample
  - possibly expanding existing surveys

- **Metering and measuring**
  - costly but very effective for monitoring specific equipment efficiency

- **Modelling**
  - complementary to surveys or stand alone
IEA country practices database

An example of how to benefit from each other’s work  
http://www.iea.org/eeindicatorsmanual/
IEA country practices database

- Practices in surveying, administrative sources, modelling and metering across sectors
- Questionnaires and other material available
- Links to various national administrations work

Feel free to share your practice with us!
IEA tools to support indicators development

➢ Fundamentals on statistics:
  to provide guidance on how to collect the data needed for indicators
  ▪ Includes a compilation of existing practices from across the world
  ▪ https://goo.gl/Y8QD1G

➢ Essentials for policy makers:
  ▪ to provide guidance to develop and interpret energy efficiency indicators
  ▪ https://goo.gl/agcNg2

Both available also in Chinese
IEA indicators manuals are now an online course accessible to all

- Global tool; self-paced and interactive
- For policy makers and statisticians
- Use by all countries is welcome

https://edx.iea.org/

Recently launched by IEA
The IEA Efficiency statistics: Highlights publication and excel database

- Covers 4 sectors (residential, services, industry and transport)
  - Annual end use energy data, by product
  - End use energy efficiency indicators
  - Carbon intensity indicators
- Available online

http://www.iea.org/media/statistics/EnergyEfficiencyIndicators.xls

https://webstore.iea.org/energy-efficiency-indicators-2017-highlights

Energy efficiency indicators: an area of fast development
The importance of end-use data for energy efficiency policy

• Detailed end-use energy / activity data and indicators are vital for energy demand policy and planning, across sectors and end-uses.

• Data collection needs appropriate resources - Having no data will cost more!

• Collaboration among statistics and policy experts - and among institutions that may contribute relevant data – is essential to enhance outcomes.

The IEA is committed to facilitate national work and exchange across countries, with a view to strengthening the long-term institutional capacities.
Energy consumption data:
- Space heating*
- Space cooling*
- Lighting
- Other building use
- Non-building use
* Temperature corrected, using HDD & CDD

Activity data:
- Value added
- Number of employees
- Services floor area

Energy consumption by end-use, country C

Selected energy intensities, country C