Toolkit:
IEA Indicators

Lighting, Appliances & Equipment: Session 4

Kevin Lane, IEA

#EnergyEfficientWorld

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Overview

- IEA indicators – a brief overview
  - Energy efficiency Indicators – why
  - Energy balances – benefits and limits of high level indicators
  - Beyond the energy balance
  - How to collect energy efficiency data
- Equipment/appliance level indicators
- Useful indicators for (S&L) practitioners – beyond IEA indicators
- Data sources
- IEA online energy efficiency indicator training - NEW

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IEA energy efficiency indicator work

- Over 10 years of developing energy efficiency indicators
- Based on statistics from members
- Detailed analysis
- Multiple publications
- https://www.iea.org/topics/energyefficiency/statistics/



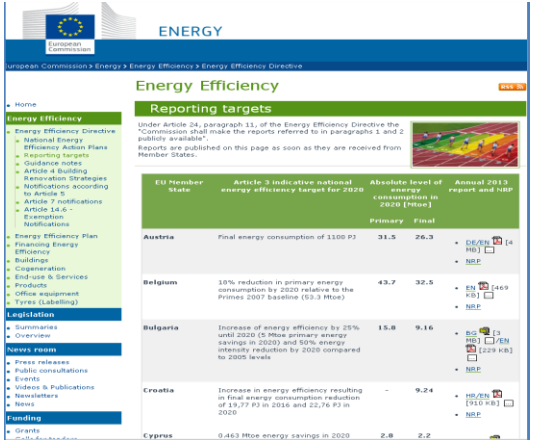
- NEW: On-line indicator training…

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Why use indicators?

Why

- Required to set targets
- Monitor progress
- Benchmarking countries
- Useful for modelling inputs (for national impact assessments, analysis)

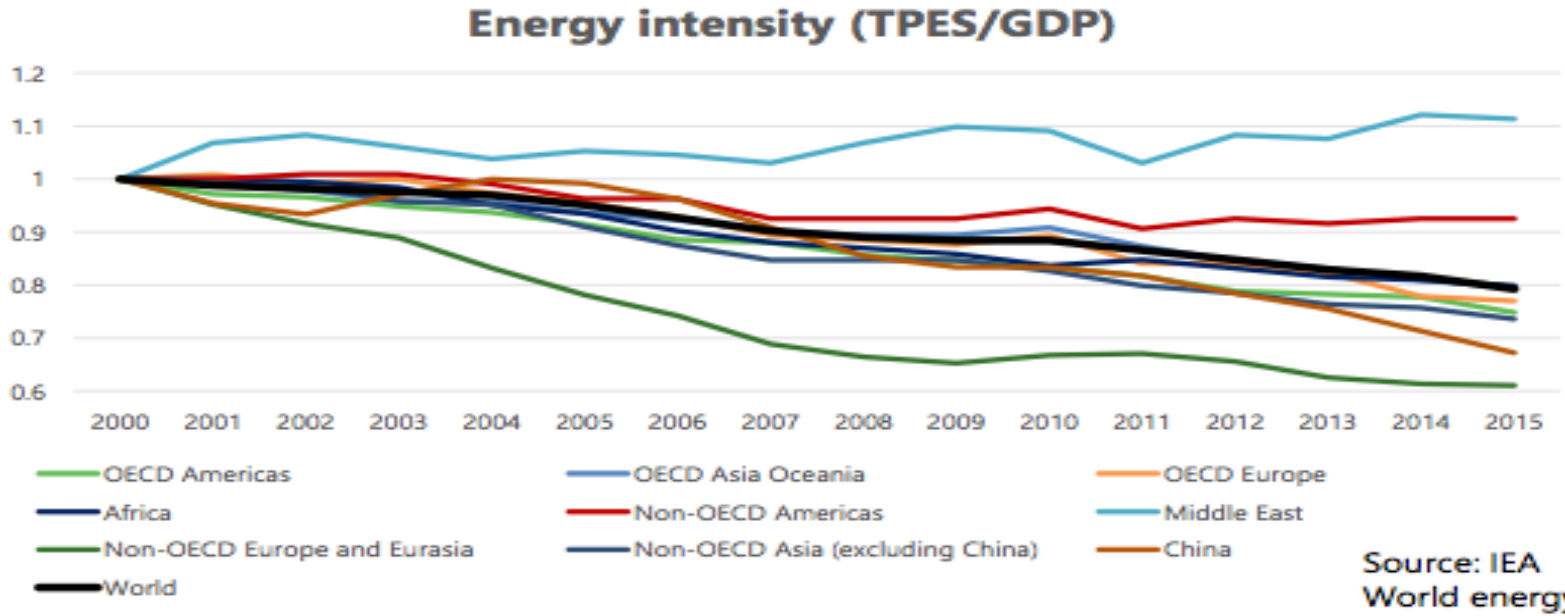


Use of indicators

- Typical indicators based on ‘consumption’ per unit of ‘activity’

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Example. Does energy intensity equal energy efficiency?



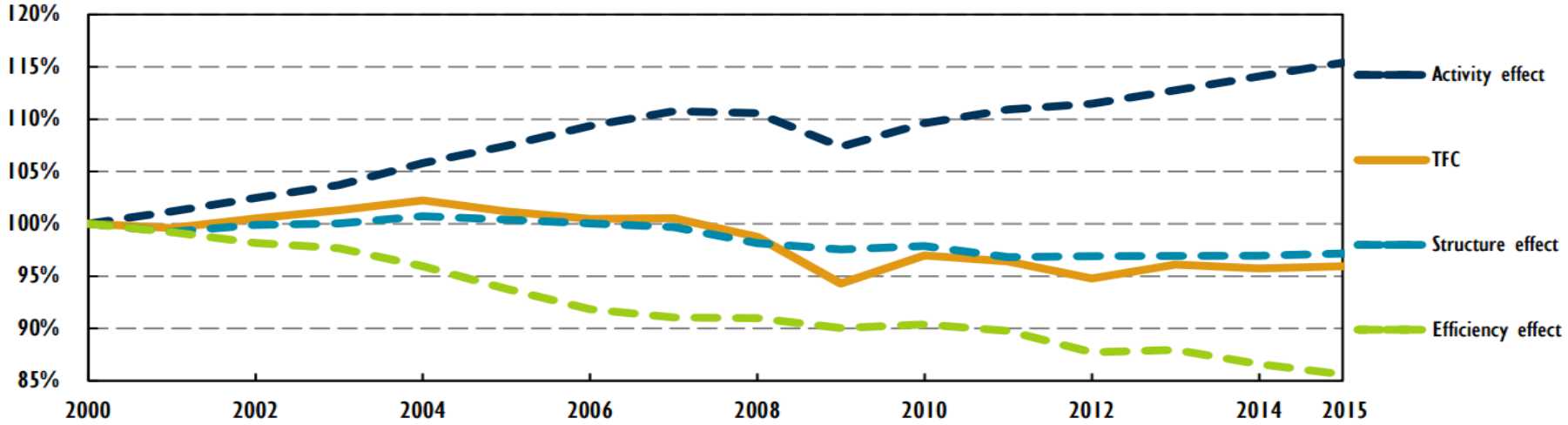
Source: IEA
World energy balances, 2017

Energy intensity has generally decreased
Using less energy per GDP means 'decoupling' economic growth from energy use

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Disentangling efficiency from other drivers

Decomposing energy consumption



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.

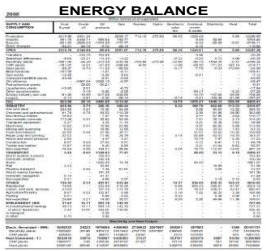
It is possible to 'Decompose' factors that explain changes in energy

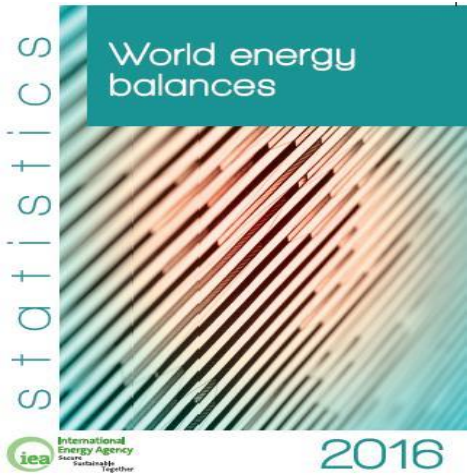
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Most countries collects statistics to build ‘energy balances’









‘Administrative’ data is routinely collected

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From ‘energy balances’ we derive high-level indicators

Supply

Transformation

Final consumption

World

2014

Million tonnes of oil equivalent

SUPPLY AND CONSUMPTION	Coal[1]	Crude oil[2]	Oil products	Natural gas	Nuclear	Hydro	Geotherm./ Solar/ etc.	Biofuels/ Waste	Electricity	Heat	Total
Production	3976.14	4308.45	-	2928.32	661.35	334.94	181.07	1413.06	-	2.10	13805.44
Imports	842.15	2213.37	1193.32	844.32	-	-	-	20.22	61.73	0.01	5175.12
Exports	-863.14	-2159.50	-1242.64	-863.25	-	-	-	-18.97	-59.35	-0.01	-5206.85
Stock changes	-36.66	-12.46	-15.23	-8.81	-	-	-	-1.41	-	-	-74.58
TPES	**3918.49**	**4349.86**	**-64.56**	**2900.58**	**661.35**	**334.94**	**181.07**	**1412.91**	**2.38**	**2.10**	**13699.13**
Transfers	-0.47	-204.86	231.24	-	-	-	-	-	-	-	25.92
Statistical differences	-21.91	0.12	4.51	14.68	-	-	-0.06	0.16	-0.43	-0.45	-3.38
Electricity plants	-2112.98	-40.62	-201.89	-771.07	-653.73	-334.94	-140.89	-95.03	1868.42	-0.72	-2483.47
CHP plants	-164.61	-0.01	-17.07	-307.53	-7.62	-	-2.58	-57.43	179.71	148.31	-228.81
Heat plants	-130.32	-0.68	-13.19	-78.82	-	-	-1.00	-11.45	-0.38	179.67	-56.17
Blast furnaces	-209.84	-	-0.38	-0.16	-	-	-	-0.05	-	-	-210.43
Gas works	-10.92	-	-2.73	5.06	-	-	-	-0.09	-	-	-8.67
Coke/pat.fuel/BKB/PB plants	-76.25	-	-2.80	-0.01	-	-	-	-0.12	-	-	-79.19
Oil refineries	-	-4123.03	4049.60	-	-	-	-	-	-	-	-73.43
Petrochemical plants	-	33.00	-32.62	-	-	-	-	-	-	-	0.38
Liquefaction plants	-9.67	14.03	-	-17.42	-	-	-	-	-	-	-13.07
Other transformation	-0.43	10.07	-0.52	-11.88	-	-	-	-82.90	-	-0.73	-86.40
Energy industry own use	-101.76	-11.42	-205.29	-291.69	-	-	-0.00	-13.94	-174.52	-34.81	-833.44
Losses	-3.89	-8.90	-0.65	-21.77	-	-	-0.01	-0.19	-169.29	-19.58	-224.29
TFC	**1075.42**	**17.57**	**3743.64**	**1419.98**	**-**	**-**	**36.54**	**1151.86**	**1705.90**	**273.77**	**9424.69**
INDUSTRY	**858.49**	**6.80**	**284.67**	**548.54**	**-**	**-**	**0.78**	**193.52**	**725.37**	**123.00**	**2751.17**
Iron and steel	326.62	-	7.71	55.34	-	-	-	3.50	101.39	15.47	513.02
Chemical and petrochemical	99.40	0.06	55.00	121.06	-	-	0.00	1.63	100.81	50.24	428.20
Non-ferrous metals	24.28	-	4.97	16.80	-	-	0.00	0.06	79.63	3.35	129.09
Non-metallic minerals	242.62	0.01	41.50	54.75	-	-	0.00	0.07	51.78	3.12	402.84
Transport equipment	3.63	-	2.06	11.93	-	-	0.00	0.05	23.59	4.04	45.31
Machinery	14.39	-	7.21	25.71	-	-	0.00	0.16	78.57	5.35	131.40
Mining and quarrying	10.28	-	23.01	7.20	-	-	0.00	0.17	29.52	2.31	72.48
Food and tobacco	32.20	0.01	10.92	45.22	-	-	0.00	30.82	40.51	11.01	170.69
Paper pulp and printing	19.03	-	4.47	23.25	-	-	0.20	61.18	33.92	11.90	153.95
Wood and wood products	3.63	-	2.07	2.90	-	-	0.00	7.59	10.20	2.02	28.41
Construction	4.86	-	28.81	6.79	-	-	0.00	0.33	15.02	1.34	57.16
Textile and leather	13.95	0.01	4.02	6.24	-	-	0.00	0.27	28.71	6.96	60.16
Non-specified	60.60	6.71	102.91	171.33	-	-	0.57	78.69	131.73	5.91	558.45
TRANSPORT	**2.86**	**-**	**2426.33**	**97.90**	**-**	**-**	**0.00**	**73.89**	**26.04**	**-**	**2627.02**
World aviation bunkers	-	-	168.48	-	-	-	-	-	-	-	168.48
Domestic aviation	-	-	107.52	-	-	-	-	-	-	-	107.52
Road	-	-	1864.65	38.10	-	-	-	73.12	0.27	-	1976.14
Rail	2.81	-	29.66	-	-	-	-	0.25	19.95	-	52.68
Pipeline transport	-	-	0.35	59.00	-	-	-	-	2.72	-	62.06
World marine bunkers	-	-	194.64	-	-	-	-	0.08	-	-	194.72
Domestic navigation	-	-	53.35	0.11	-	-	-	0.43	-	-	53.88
Non-specified	0.05	-	7.69	0.70	-	-	0.00	0.01	3.09	-	11.54
OTHER	**155.39**	**0.18**	**424.53**	**613.41**	**-**	**-**	**35.76**	**884.45**	**954.49**	**150.78**	**3218.98**
Residential	75.05	-	207.08	419.66	-	-	27.09	847.51	460.41	105.31	2142.13
Comm. and public services	34.97	-	85.50	181.72	-	-	6.48	24.49	376.24	35.25	744.64
Agriculture/forestry	15.13	0.01	105.89	8.68	-	-	1.25	9.83	47.92	3.15	192.87
Fishing	0.00	-	5.84	0.06	-	-	0.07	0.01	0.50	0.02	6.50
Non-specified	30.23	0.16	19.22	3.29	-	-	0.87	2.60	69.42	7.05	132.85
NON-ENERGY USE	**58.68**	**10.60**	**598.11**	**160.13**	**-**	**-**	**-**	**-**	**-**	**-**	**827.52**
in industry/transf./energy	58.12	10.60	566.46	160.13	-	-	-	-	-	-	795.31
of which: chem./petrochem.	*3.17*	*10.54*	*414.10*	*158.57*	-	-	-	-	-	-	*586.38*
in transport	-	-	5.38	-	-	-	-	-	-	-	5.38
in other	0.56	-	26.27	-	-	-	-	-	-	-	26.83
Electricity and Heat Output											
Electr. Generated - TWh	**9707.49**	**143.71**	**879.30**	**5154.83**	**2535.33**	**3894.71**	**1005.26**	**492.85**	**-**	**2.34**	**23815.80**
Electricity plants	*9118.58*	*143.69*	*813.79*	*3969.05*	*2508.52*	*3894.71*	*996.84*	*278.57*	*-*	*1.14*	*21724.90*
CHP plants	*588.91*	*0.01*	*65.51*	*1185.77*	*26.81*	*-*	*8.42*	*214.28*	*-*	*1.20*	*2090.90*
Heat Generated - PJ	**3669.47**	**19.31**	**622.05**	**6071.39**	**26.46**	**-**	**383.65**	**923.88**	**8.40**	**97.64**	**13822.24**
CHP plants	*1770.68*	*0.15*	*184.33*	*3661.43*	*26.46*	*-*	*12.46*	*555.18*	*0.44*	*51.42*	*6262.55*
Heat plants	*3898.79*	*19.16*	*437.72*	*2409.97*	*-*	*-*	*371.19*	*368.70*	*7.96*	*46.22*	*7559.69*

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Energy intensity, Self-sufficiency …

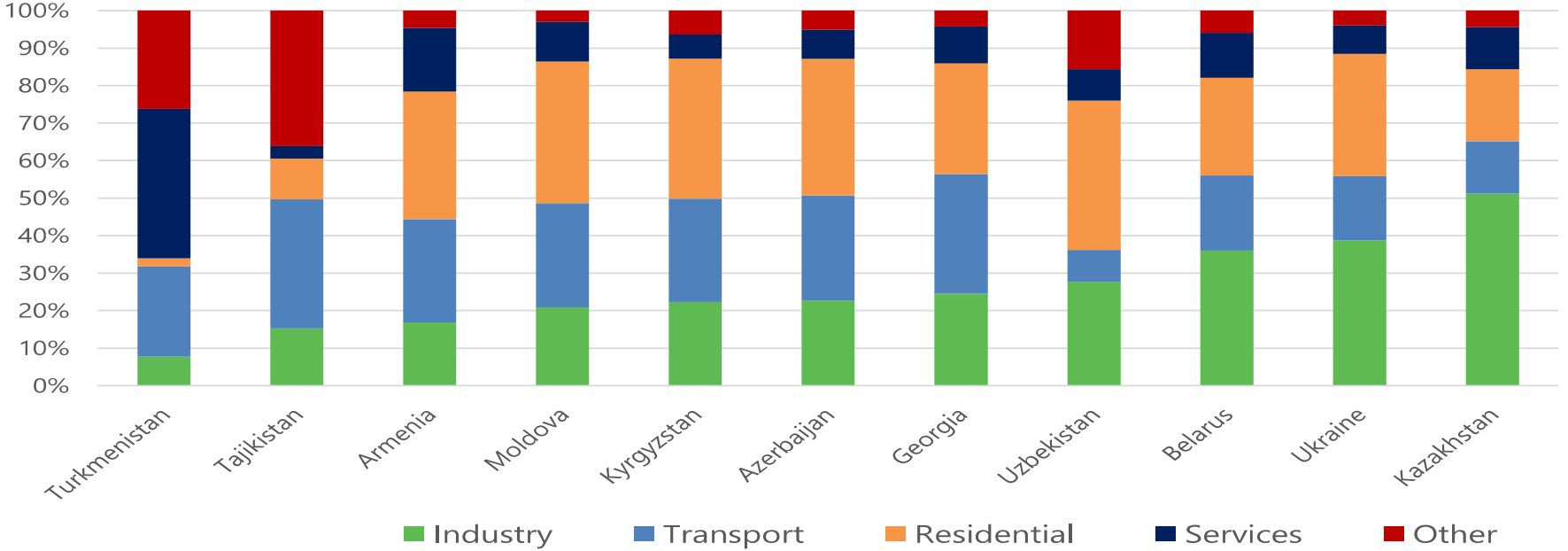
Efficiencies of transformation sector

Shares of energy consumption by sector

National data usually collected for ‘energy balances’

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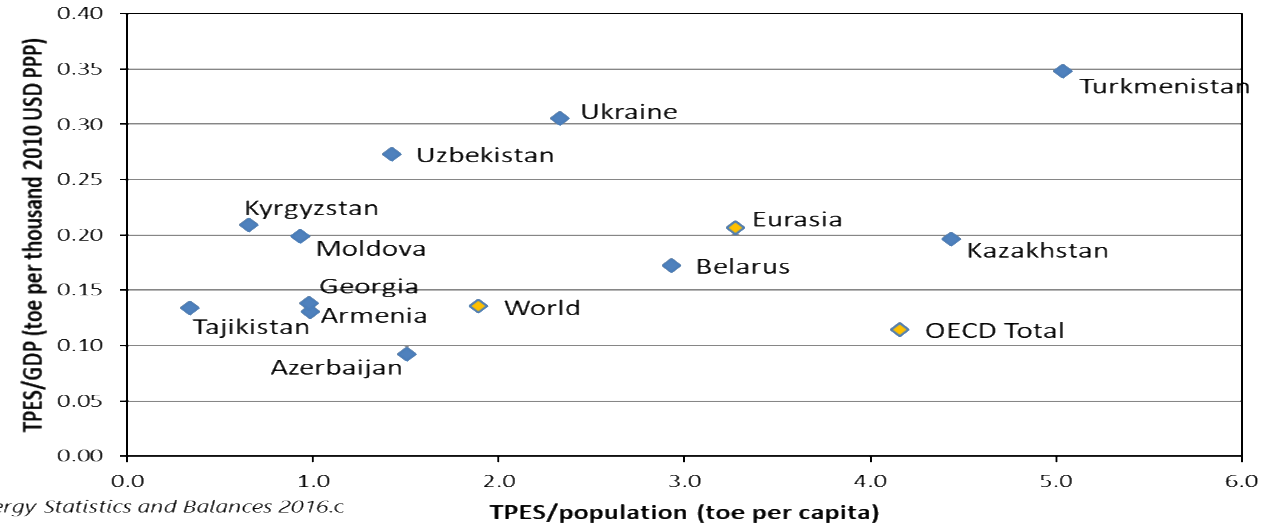
For example, shares of sectors in total final consumption



Key to understand where energy is used and to define policy priorities

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We can derive economy-wide indicators



Data source: IEA, *World Energy Statistics and Balances 2016.c*

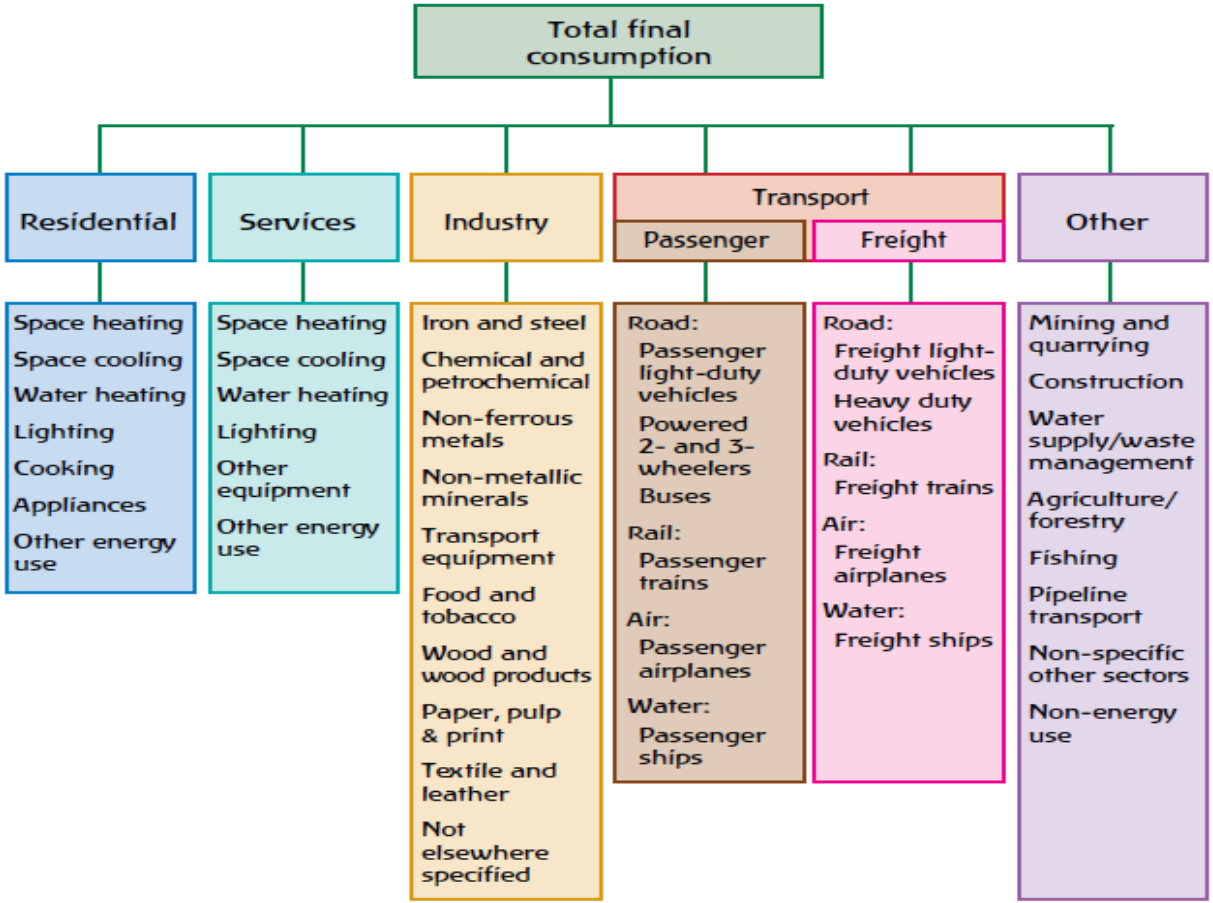
Coupling energy supply data with societal data – useful for benchmarking

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Background: Disaggregation of total energy consumption

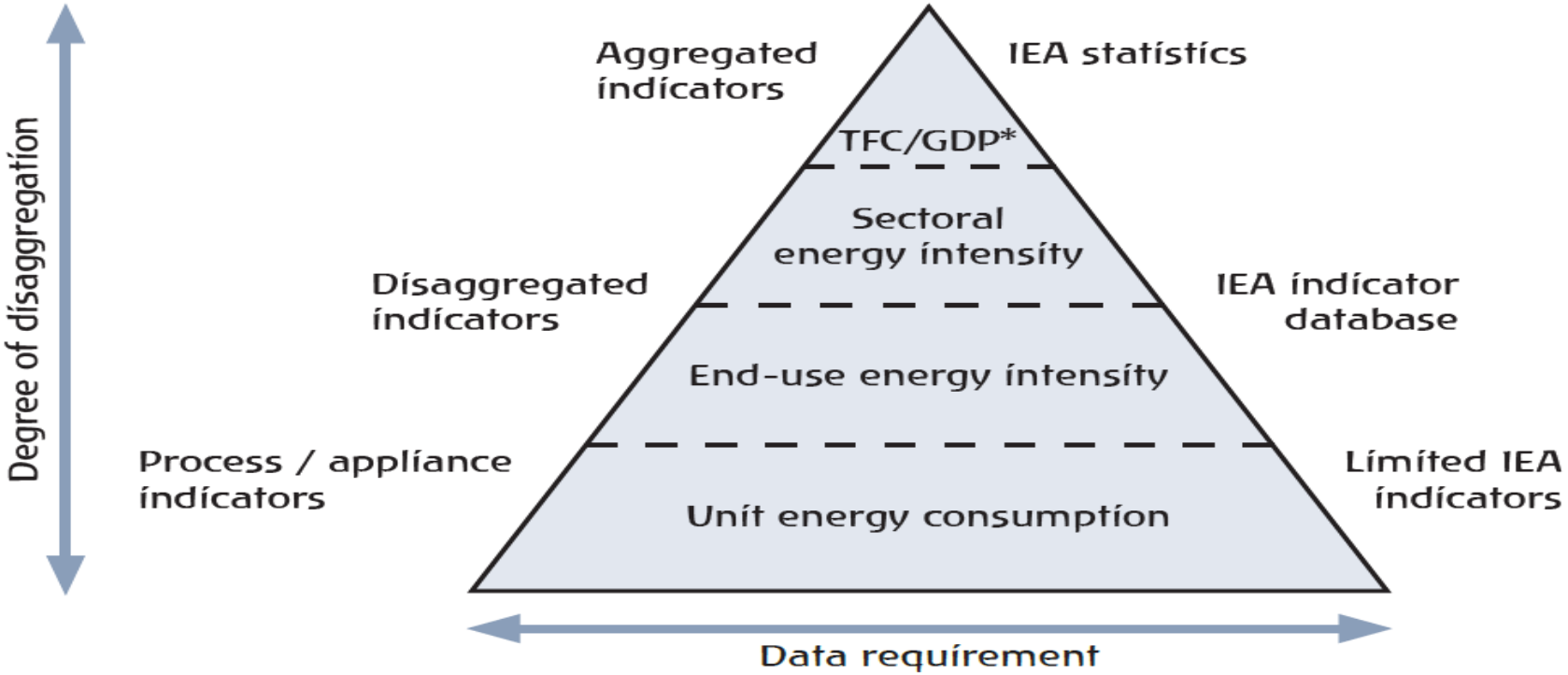
Source: Energy balance

Source: Other



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Background: IEA energy indicator pyramid



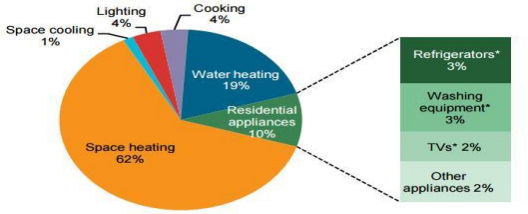
For Appliance/Equipment Efficiency indicators – bigger challenge

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Residential indicators. Which 'activity' data?

Energy consumption data:

- Space heating*
- Space cooling*
- Water heating
- Cooking
- Lighting
- Appliances energy consumption:
  - Refrigerator
  - Freezer
  - Dishwasher
  - Clothes washer
  - Clothes dryer
  - TV
  - Computers



Energy consumption by end-use, country B

* Temperature corrected, using HDD & CDD

Activity data:

- Population
- Number of occupied dwellings
- Residential floor area
- Appliances stock and diffusion



# of people



# of dwellings



Surface

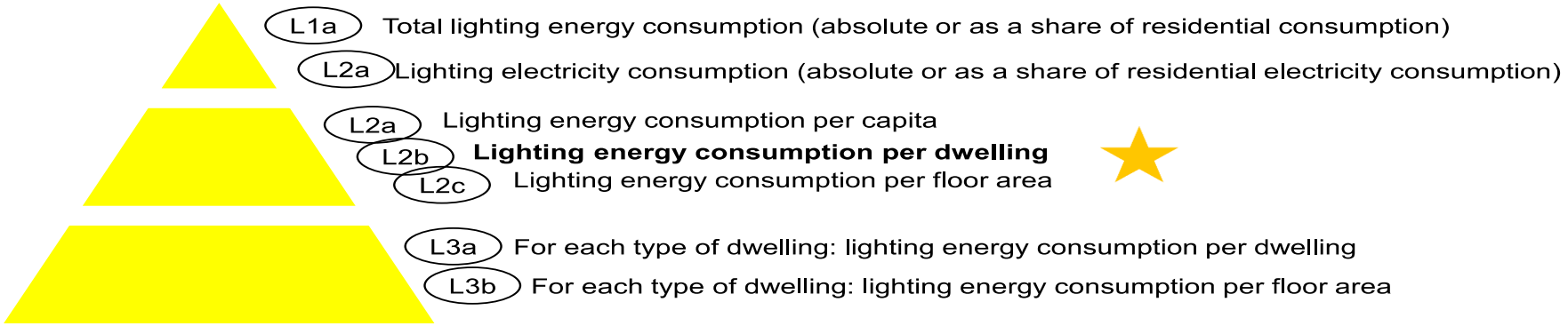


# of appliances

Choice of activity data. For appliances S&L policy regulators may want more disaggregation

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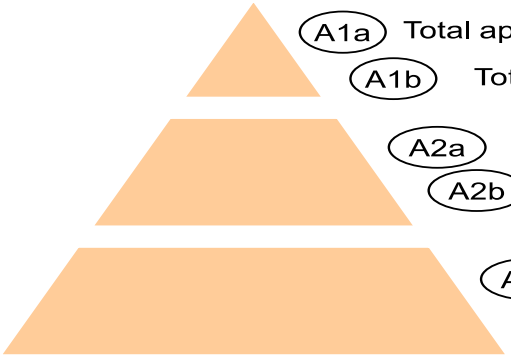
Pyramid for lighting indicators



For appliances insufficient detail for S&L policy regulators

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Pyramid for appliance indicators



A1a Total appliances energy consumption (absolute or as a share of residential energy consumption)

A1b Total appliances electricity consumption (absolute or as a share of residential electricity consumption

A2a Appliances energy consumption per capita

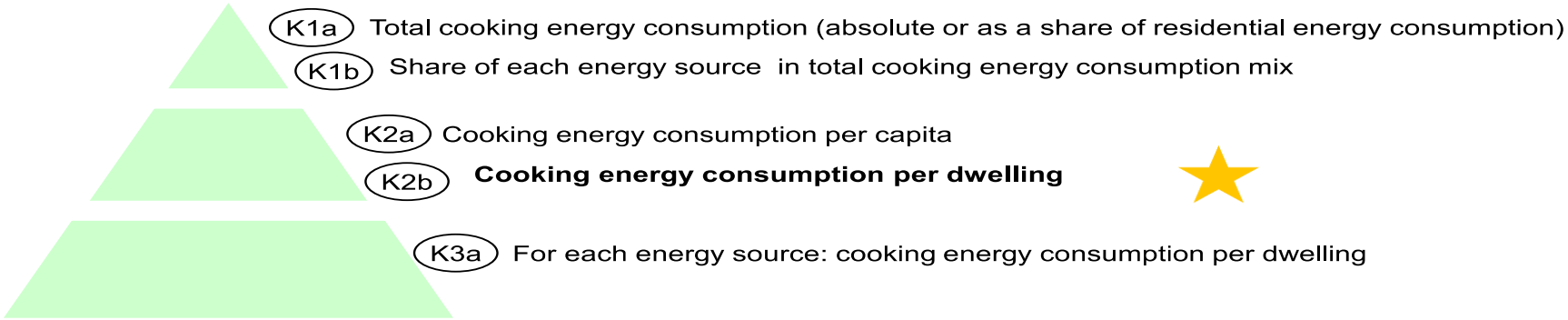
A2b Appliances energy consumption per dwelling (and per dwelling with electricity)

A3a **For each appliance type: energy consumption per appliance unit**

For appliances insufficient detail for S&L policy regulators

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Pyramid for cooking appliance indicators

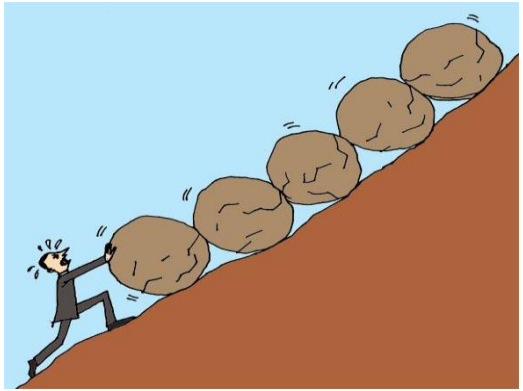


For appliances insufficient detail for S&L policy regulators

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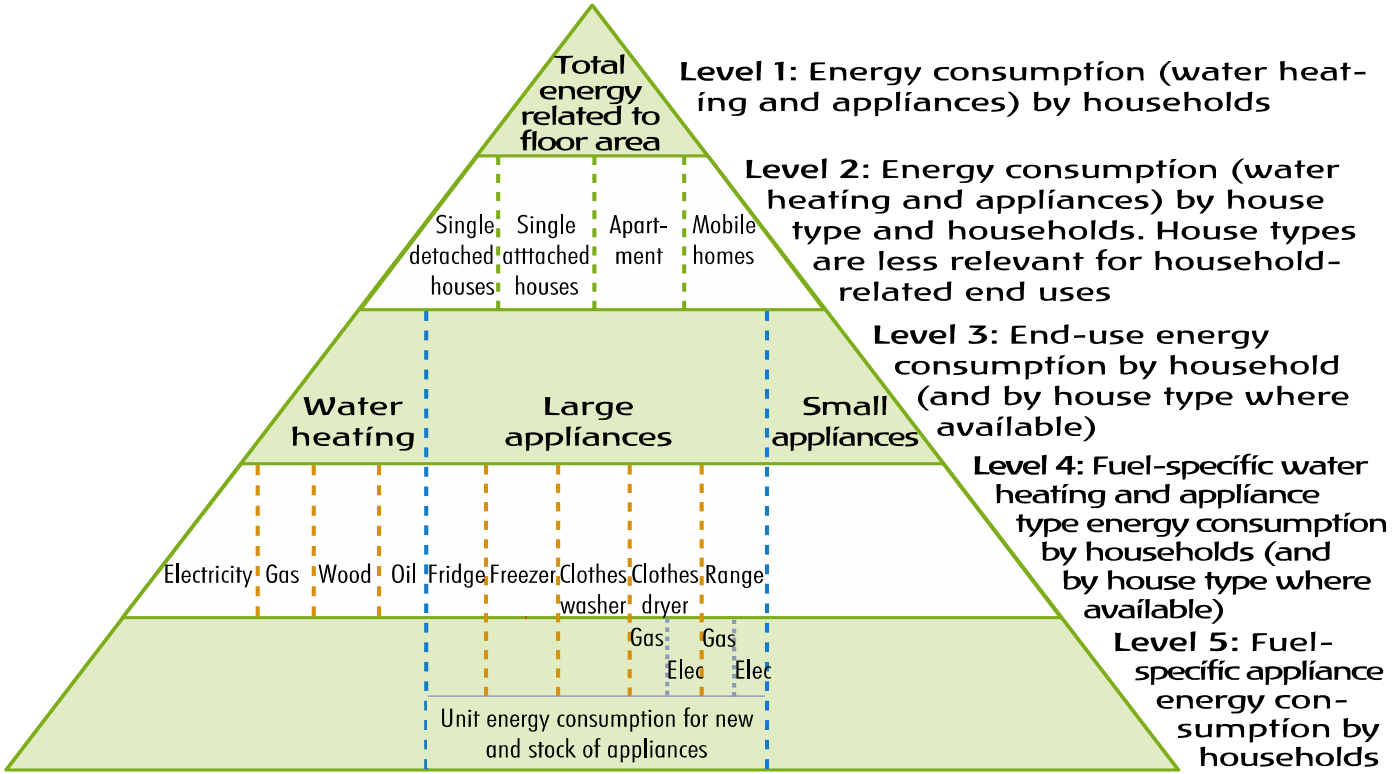
Challenges for residential sector

- Many consumers
- Many providers, in some cases
- Often no regulation
- Difficult to measure end-use energy demand
- Difficult to get activity data



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Background: indicator pyramid – detailed option



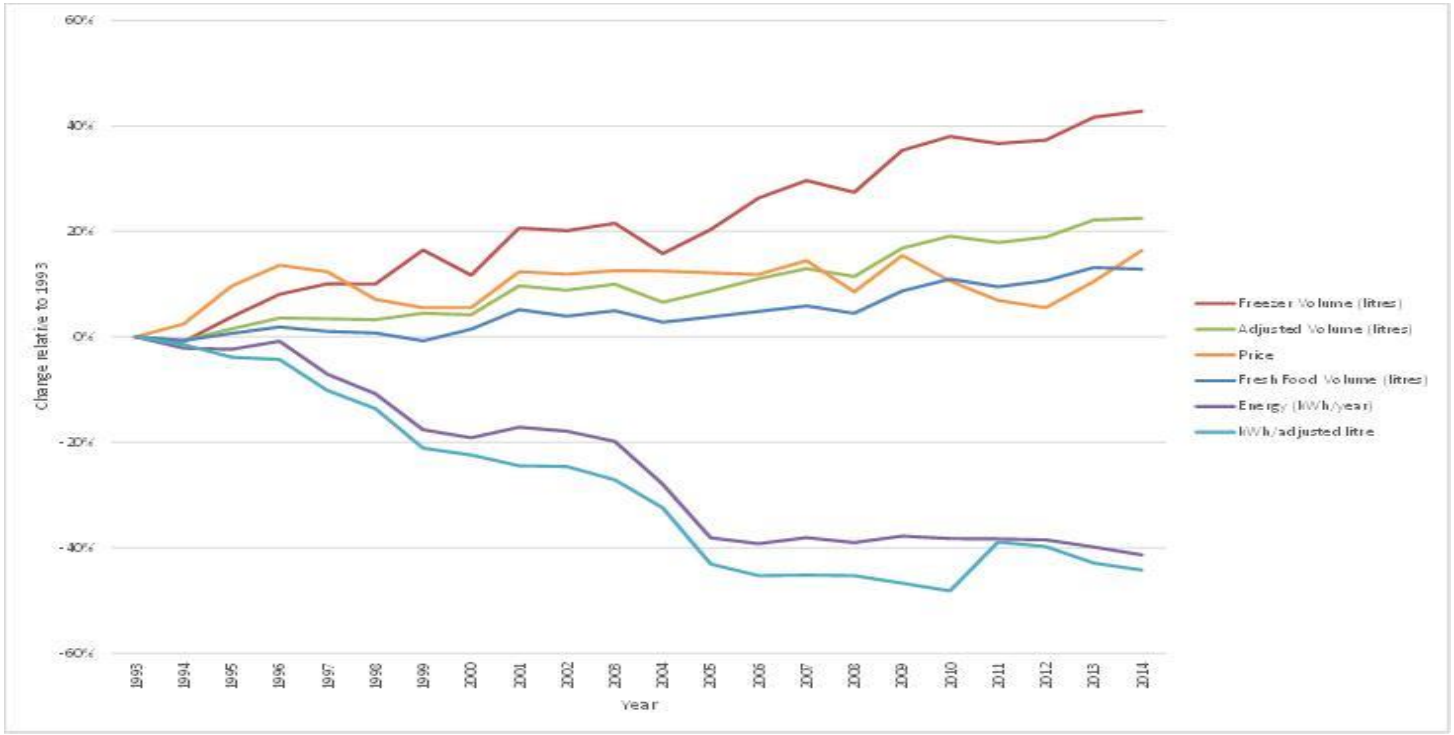
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Appliance efficiency indicators – Beyond IEA indicators

- Average energy per appliances, or per household (Unit Energy Consumption, UEC)
  - kWh/year
- UEC value (Level 3 on pyramid) masks underlying changes
  - Use by consumer (e.g. washes per year, hours of TV use)
  - Change in appliance performance features (e.g. size)
- These UEC values are for the installed 'stock' of equipment
- However, S&L policy is aimed at 'sales' of new appliances.
  - Time delay before most of the stock is affected by S&L policy
- Ideal indicators for tracking S&L programmes
  - **Average new efficiency** (EEI) or kWh/service (e.g. kWh/litre, kWh/kg)
  - Develop separate indicator/metric of size (e.g. litres, or kg)
  - Useful as an earlier indicator of S&L success than a 'stock' figure

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Good practice S&L indicators – Australia – Beyond IEA indicators



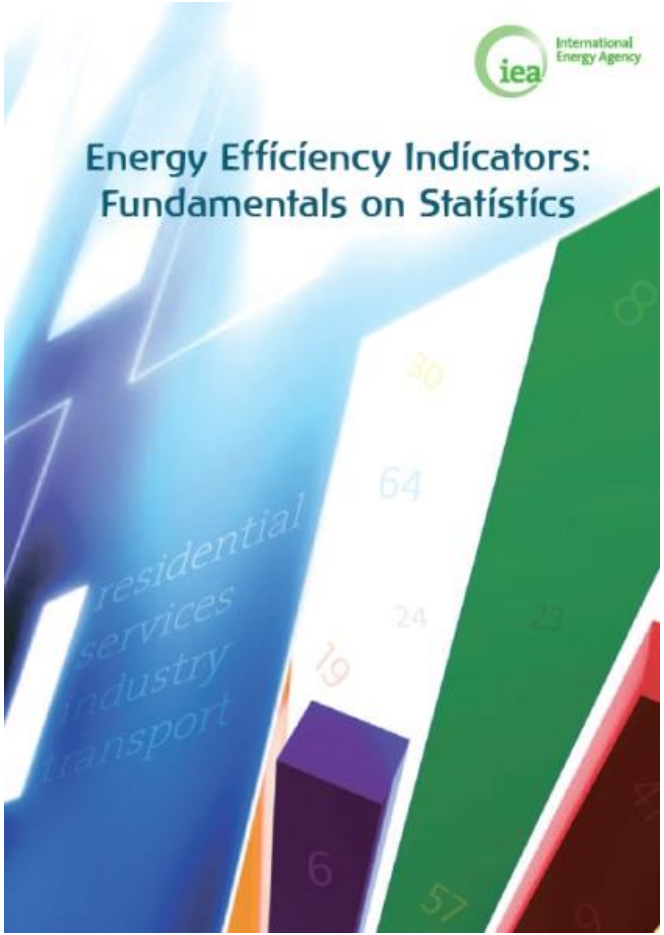
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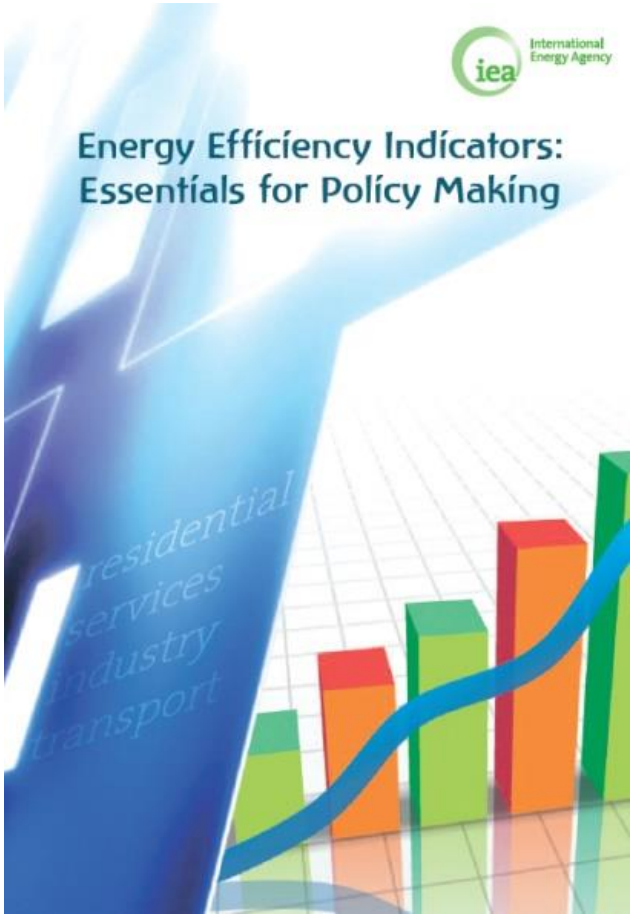
Methods used by countries to collect data

- Administrative sources
- Surveys (data on: usually ownership, sales volume, use)
  - Representative sample, large panels (e.g. ownership)
  - Possibly expanding existing surveys
- Metering and measuring (data on: energy consumption, use)
  - Costly but very effective for monitoring specific equipment
  - Appliance tested in Laboratory (test conditions), or in situ (actual)
- 'Smart' metering
  - At household level, automated disaggregation
  - Appliance self-metering
- Modelling (national impacts, decomposition, analysis)
  - Complementary to surveys or stand alone

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IEA - Energy Efficiency Indicators – online courses





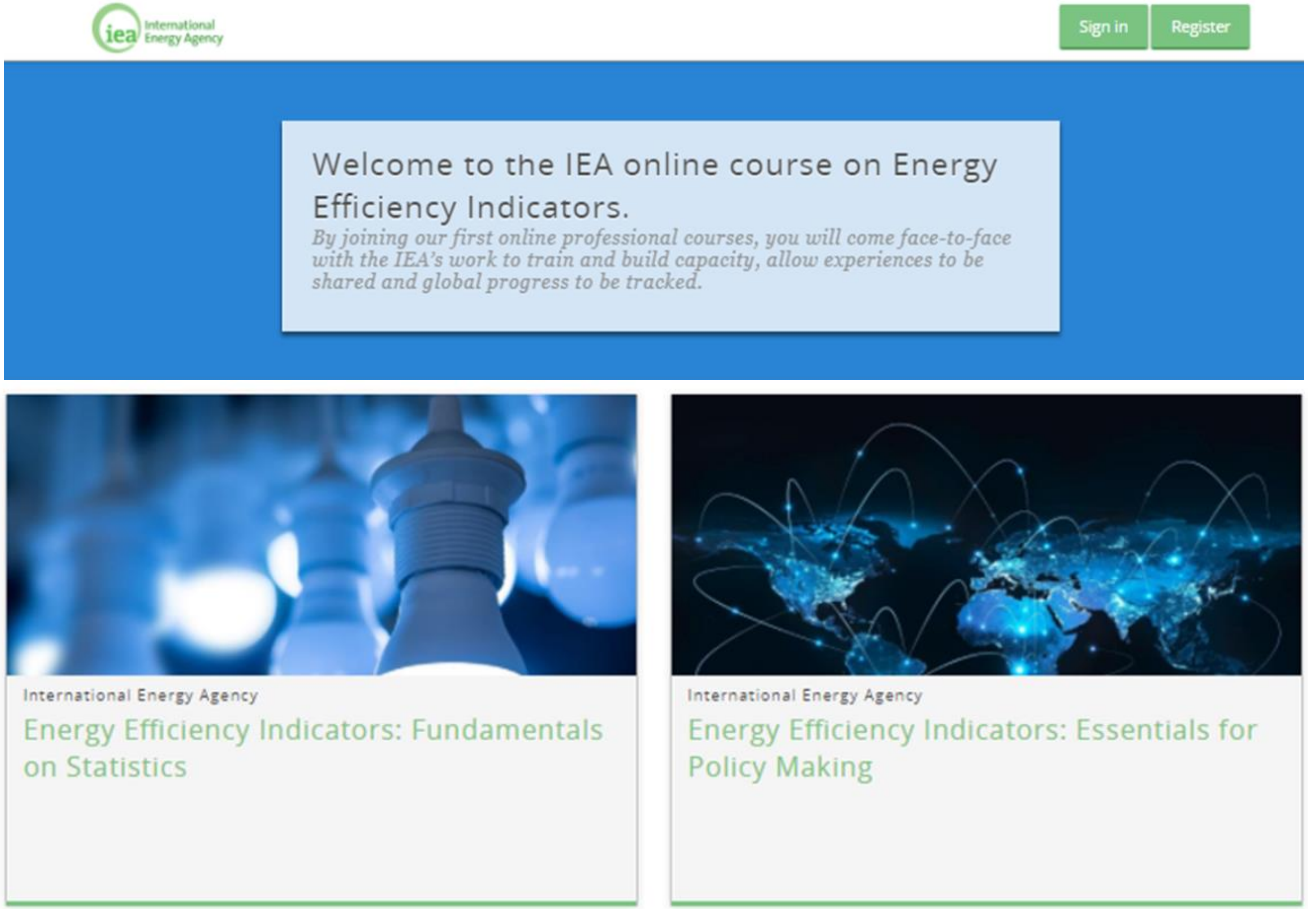
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Energy Efficiency Indicators Online Courses

- Take you step-by-step and sector-by-sector through the fundamental aspects and theories of energy efficiency data.
- Self-paced and interactive.
- Provides the necessary knowledge to develop and use energy efficiency indicators in support of effective policy making.
- No set time limit to complete the course, so that it will easily fit into your professional and personal lives.
- https://edx.iea.org/

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Energy Efficiency Indicators Online Courses



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Energy Efficiency Indicators Online Courses: Expert Videos

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The IEA's Work on Energy Efficiency

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Data Collection Methods: An Overview

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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

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Energy Efficiency Indicators Online Courses: Interactive Exercises

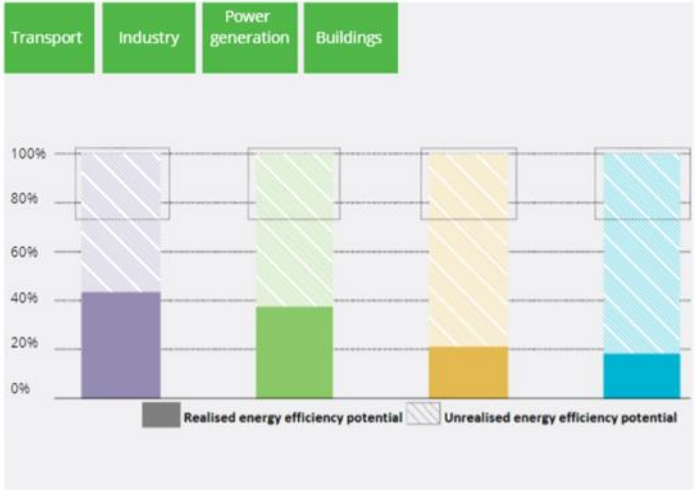
Course Introduction: Energy Efficiency 101 > Lesson > Energy Efficiency Potential In Four Sectors

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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

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Energy Efficiency Indicators Online Courses: Interactive Forums

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Module 3: Discussion Forum

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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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Energy Efficiency Indicators Online Courses: 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

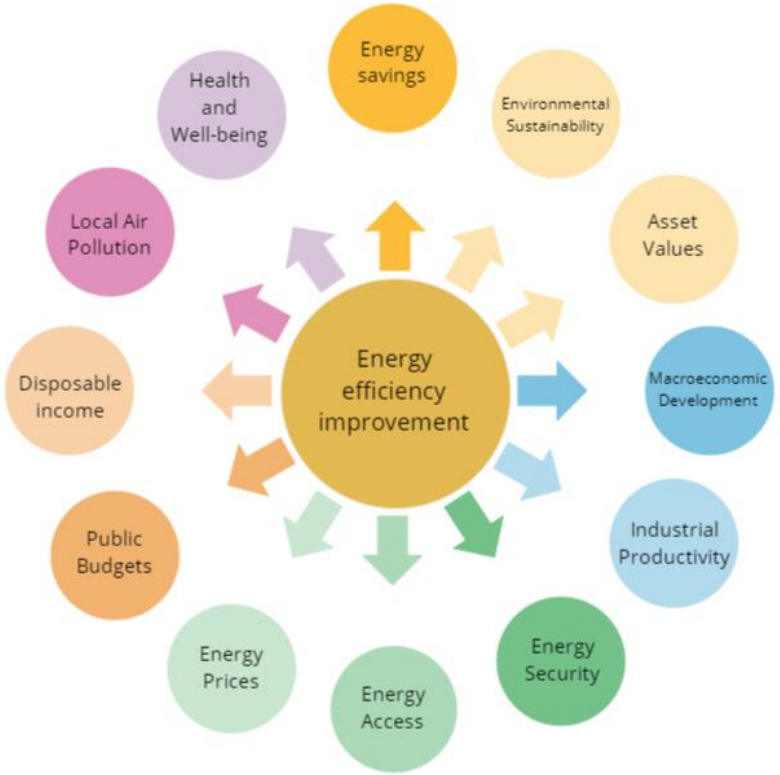
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Course Introduction: Energy Efficiency 101

Short introductory session:

- The rationale for developing energy efficiency indicators and implementing policy reform.
- The work of the IEA on energy efficiency.
- The multiple benefits of energy efficiency.



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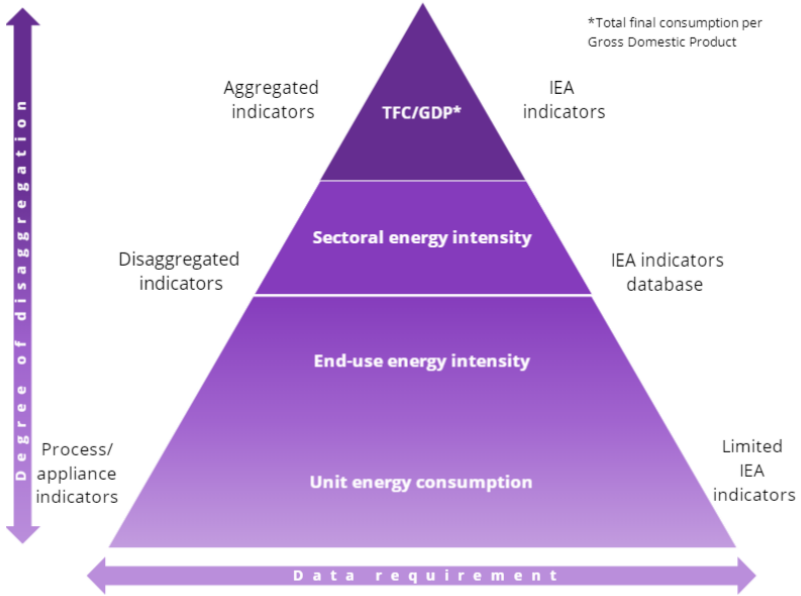
Course Module 1: Why Indicators? A methodological framework

- Methodological framework for identifying and developing disaggregated indicators for effective energy efficiency policies.
- Principles and challenges for effective policy making based on approaches for data collection and energy efficiency indicators development.

The IEA Indicators Pyramid

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Based on data availability, consumption within a sub-sector or an end use could be disaggregated even further. Indicators can be presented following a "pyramid approach", from the most aggregated level down to the most disaggregated one. This hierarchy is important because it helps explain how changes at the lowest level relate to aggregate changes in energy consumption. Navigate the interactive pyramid below to learn more.



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Course Modules 2 – 5: Sector-specific modules

- Module 2: Residential Sector
- Module 3: Commercial and Public Services Sector
- Module 4: Industrial Sector

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Energy Efficiency Indicators Online Courses: Future Plans

- IEA will continue to roll out the courses over the coming 4 years
- Global effort to ensure that policymakers and statisticians understand how to collect and use energy data
- Help countries used energy efficiency indicators to set targets and track progress
- Currently there are plans to translate the courses into into Spanish, Bahasa Indonesian, Portuguese, Chinese and Russian.

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Summary

- Indicators are very important:
  - Used for setting targets
  - Monitoring and tracking progress
  - Used for modelling inputs (for impact assessments)

- High level indicators are increasingly common, and robust
  - e.g. at sector level, TFC/Person

- However, indicators are not yet sufficiently detailed at appliance level
  - at best are estimated stock UEC values (kWh/yr) (Level 3)

- For S&L policy monitoring, the efficiency of products **sold** is most important.
  - Need to separate consumer use and effect of features (change in size).

- Developing S&L indicators will also be useful for explaining higher level indicators

- New IEA - Online courses now available:

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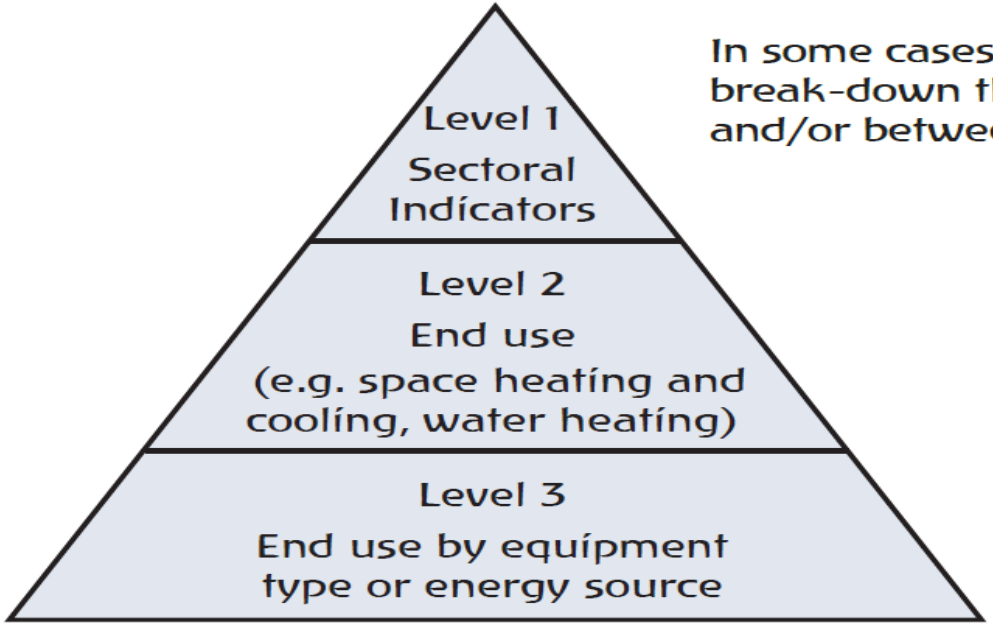


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Indicator pyramid



In some cases it may be required to further break-down this level between urban and rural, and/or between different dwelling type.

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