Principles of developing energy efficiency indicators

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

Beijing, 23rd to 25th May 2018

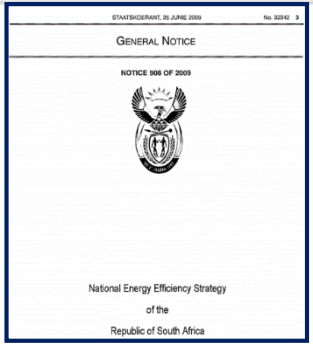
IEA

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?

Indicators: key to set targets and monitor impacts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National Energy Efficiency Strategy

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Energy Efficiency Act (S.C. 1992, c. 36)

Full Document: HTML | XML [61 KB] | PDF [250 KB]

Act current to 2014-09-01 and last amended on 2009-09-21. Previous Versions

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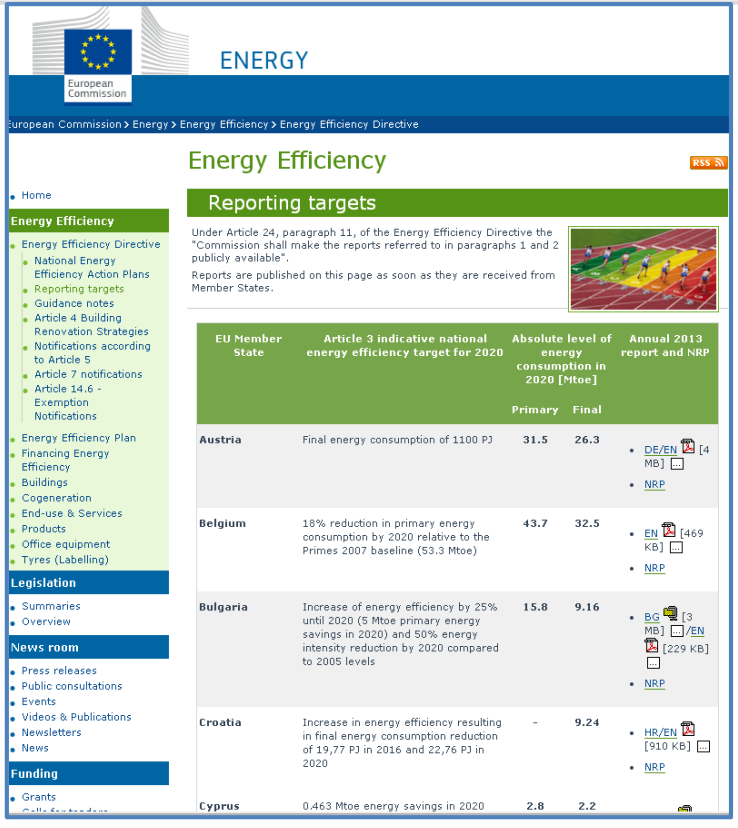
Energy Efficiency Act

S.C. 1992, c. 36

Assented to 1992-06-23

An Act respecting the energy efficiency of energy-using products and the use of alternative energy sources

Her Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows: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ENERGY

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Funding

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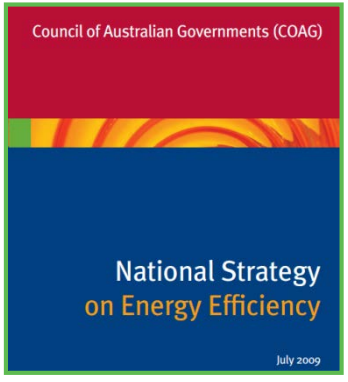
Reporting targets

Under Article 24, paragraph 11, of the Energy Efficiency Directive the "Commission shall make the reports referred to in paragraphs 1 and 2 publicly available".

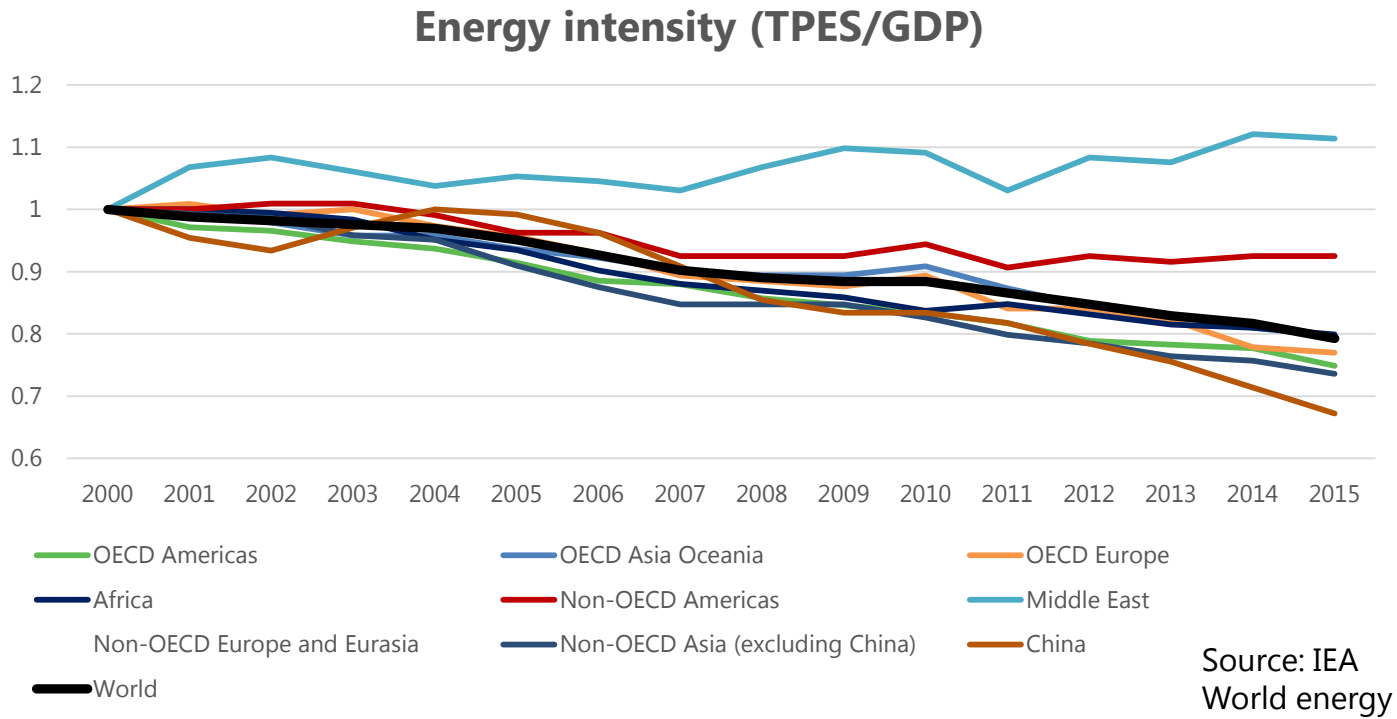
Reports are published on this page as soon as they are received from Member States.

EU Member State	Article 3 indicative national energy efficiency target for 2020	Absolute level of energy consumption in 2020 [Mtoe]		Annual 2013 report and NRP
		Primary	Final	
Austria	Final energy consumption of 1100 PJ	31.5	26.3	DE/EN [4 MB] ... NRP
Belgium	18% reduction in primary energy consumption by 2020 relative to the Primes 2007 baseline (53.3 Mtoe)	43.7	32.5	EN [469 KB] ... NRP
Bulgaria	Increase of energy efficiency by 25% until 2020 (5 Mtoe primary energy savings in 2020) and 50% energy intensity reduction by 2020 compared to 2005 levels	15.8	9.16	BG [3 MB] .../EN [229 KB] ... NRP
Croatia	Increase in energy efficiency resulting in final energy consumption reduction of 19,77 PJ in 2016 and 22,76 PJ in 2020	-	9.24	HR/EN [910 KB] ... NRP
Cyprus	0.463 Mtoe energy savings in 2020	2.8	2.2	



But what indicators help us track energy efficiency?

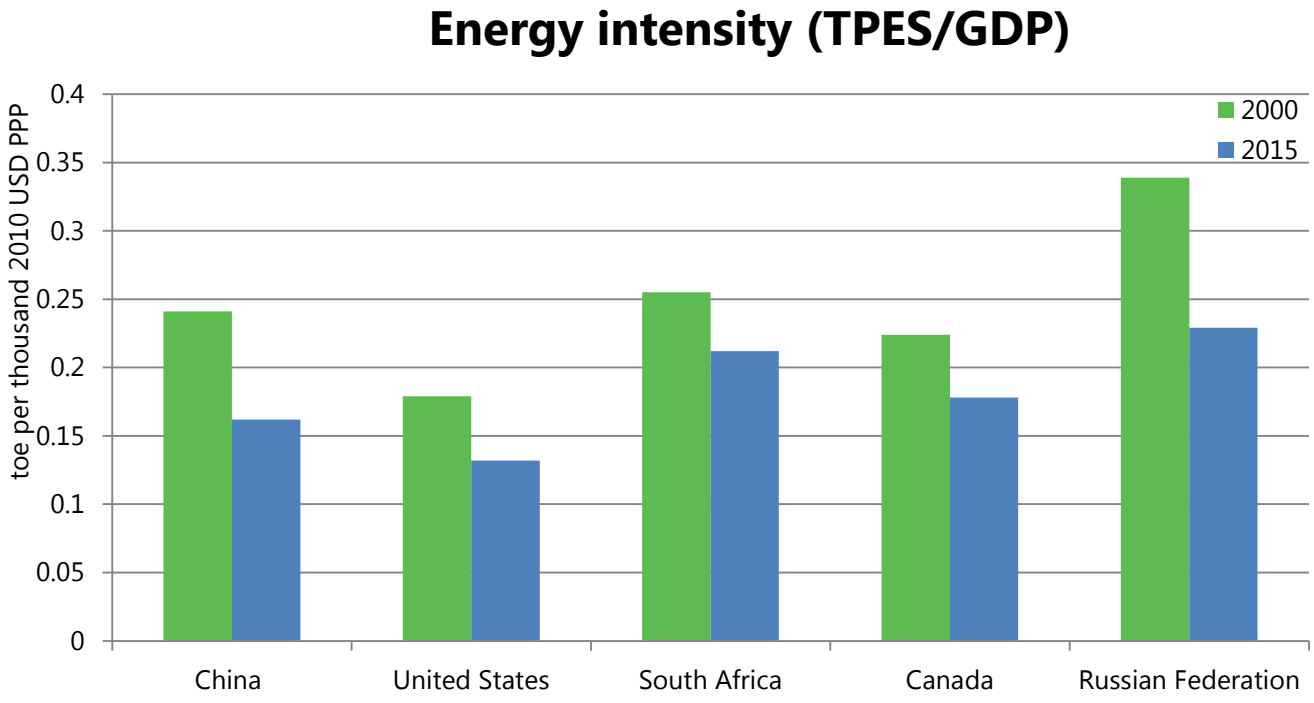
Does energy intensity track energy efficiency?



Source: IEA
World energy balances, 2017

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

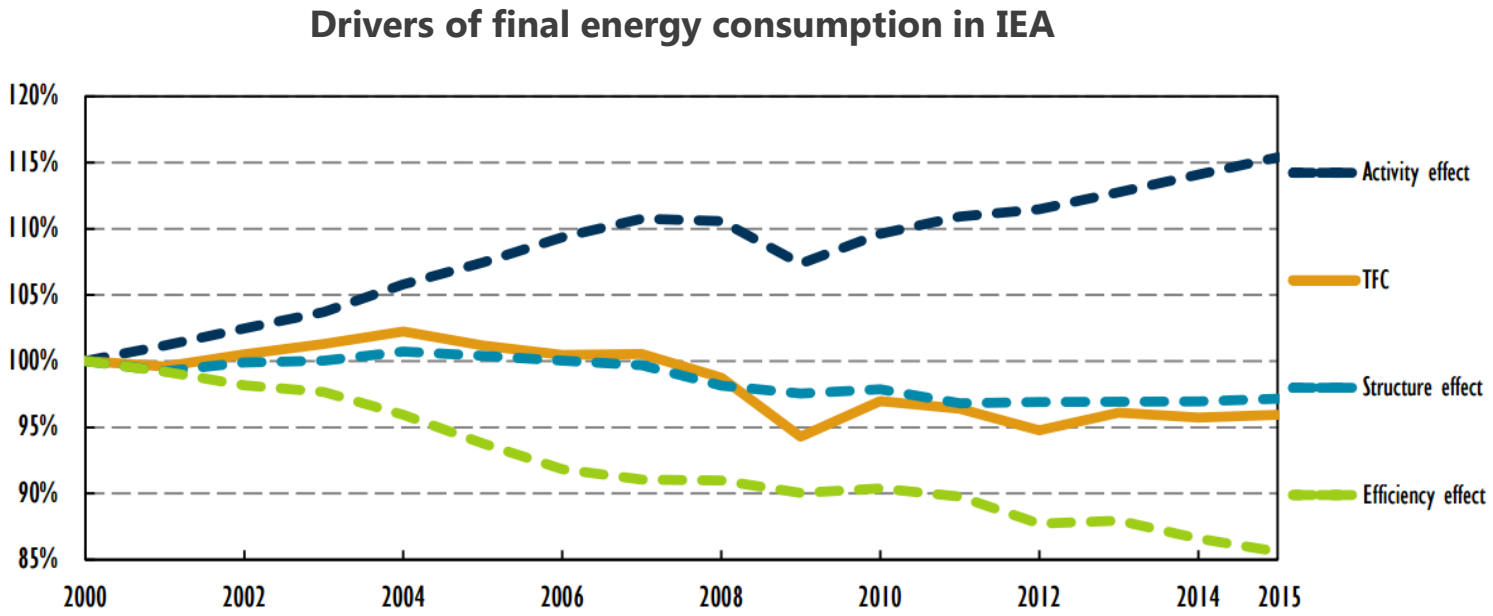
What drives energy intensity trends?



Source: IEA World energy balances, 2017

Efficiency progress and also other factors (mainly structural changes)

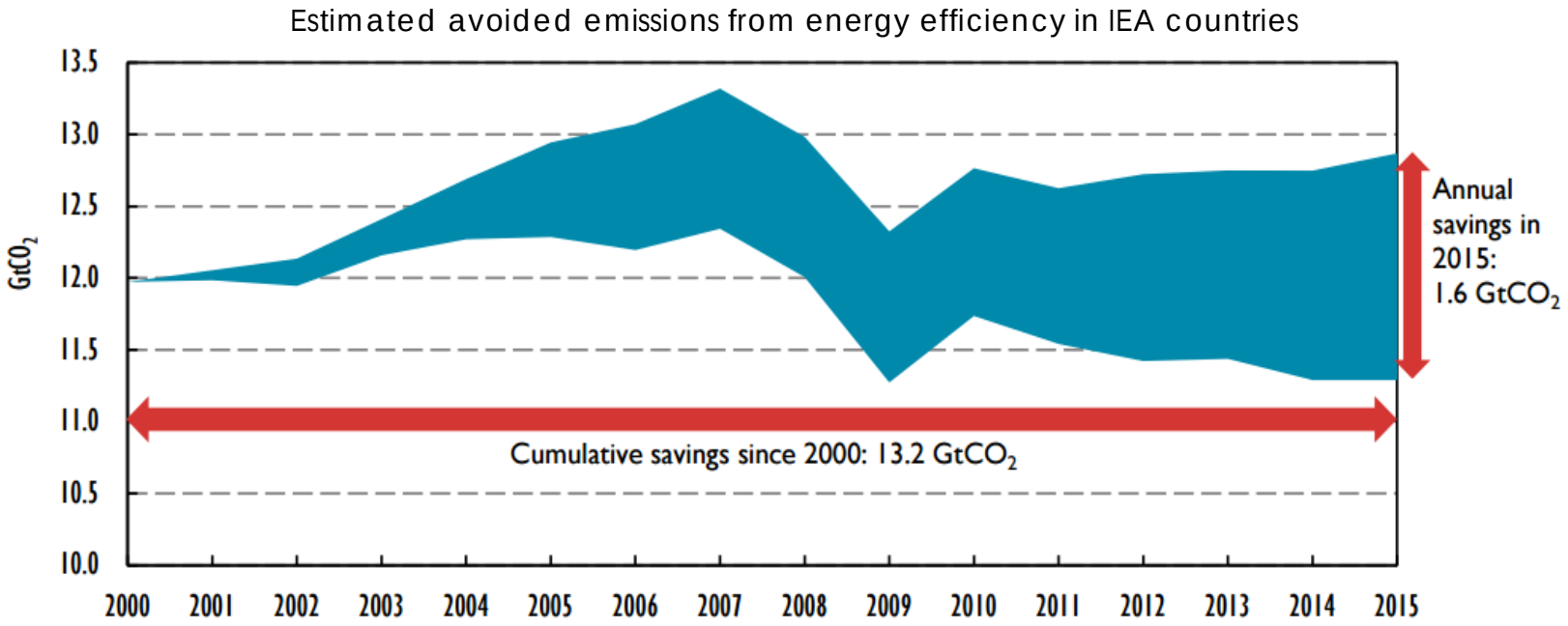
How to disentangle efficiency from other drivers?



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.

Source: IEA (2016), *Energy Efficiency Market Report*, OECD/IEA, Paris, based on IEA Energy efficiency indicators database.

How to quantify emission savings due to efficiency?



Efficiency estimated to have reduced IEA CO_2 emissions from fuel combustion by 13% in 2015

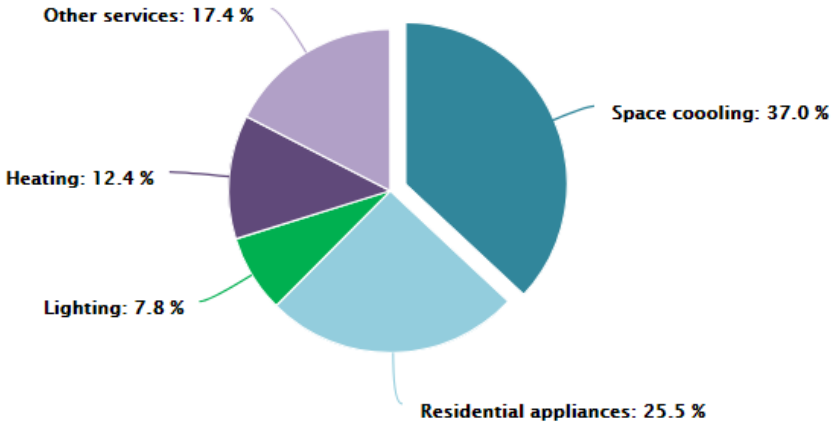
Source: IEA (2016), *Energy Efficiency Market Report*, OECD/IEA, Paris based on IEA Energy efficiency indicators database.

How to project energy demand?

Cooling is the fastest growing use of energy in buildings

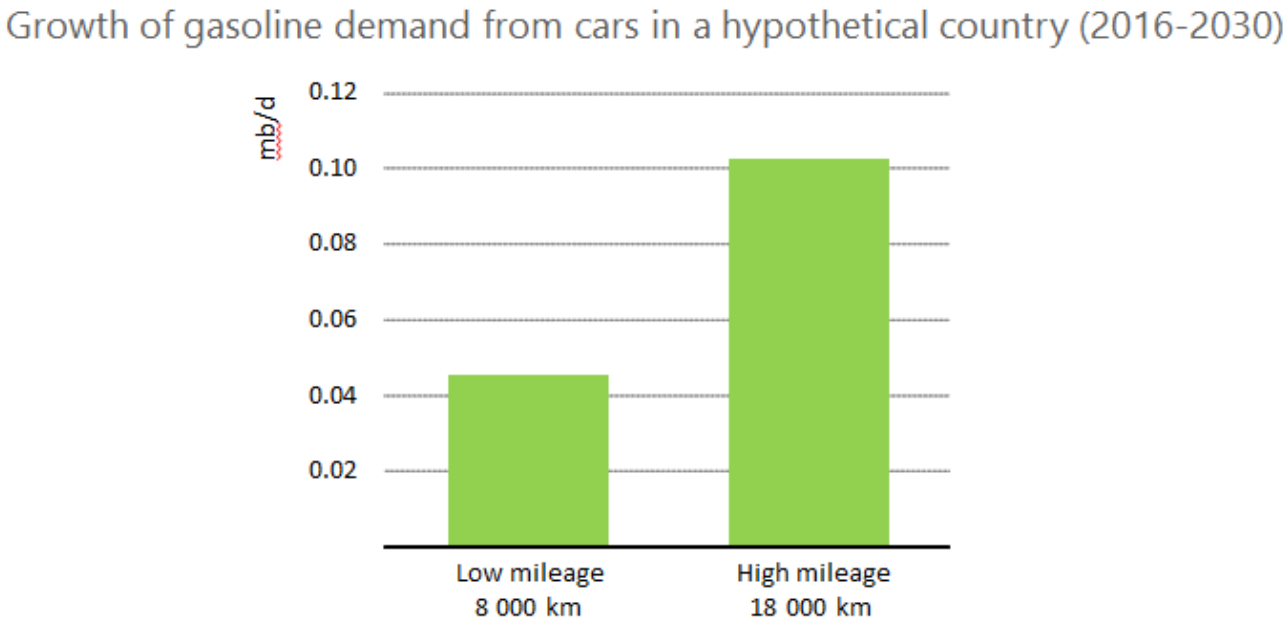
Without action to address energy efficiency, energy demand for space cooling will more than triple by 2050 – consuming as much electricity as all of China and India today.

Share of final electricity demand growth to 2050



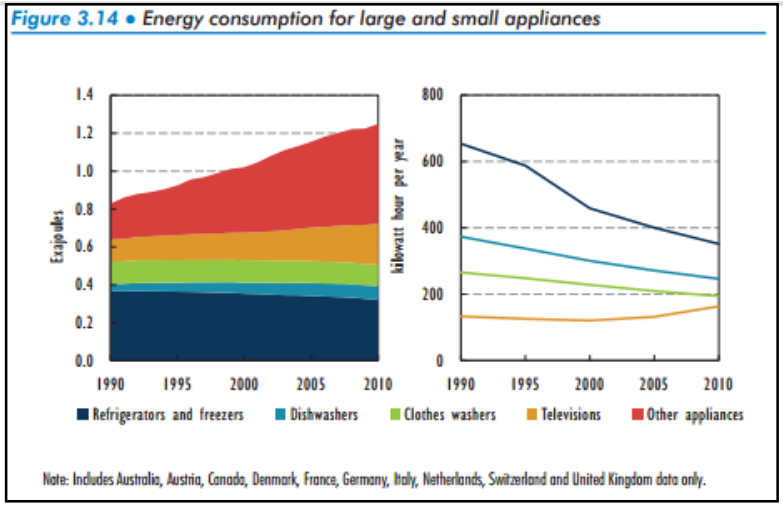
Source: IEA, The future of cooling, 2018

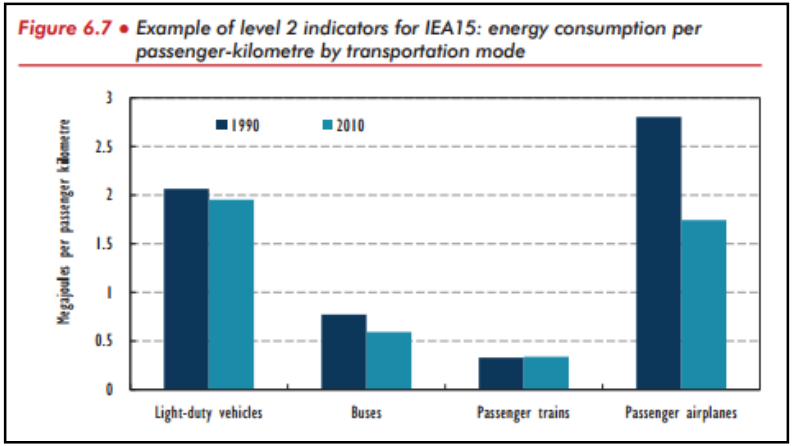
How to estimate potential energy demand policy impacts?

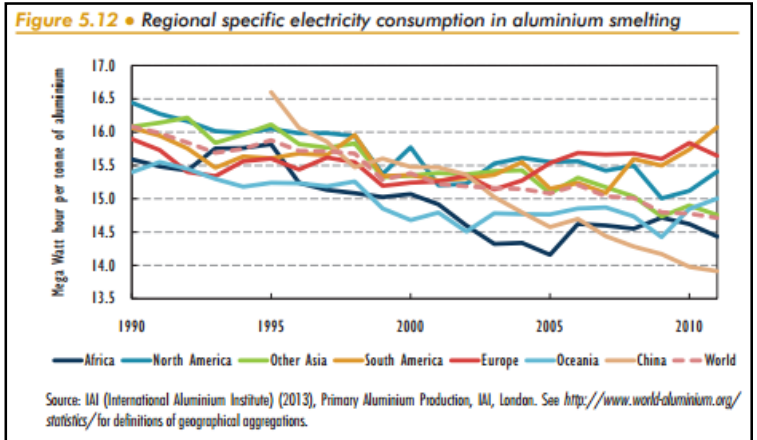


Historical annual vehicle mileage and fuel efficiency are key indicators for forward-looking analysis, affecting both expected demand growth and possible policy impacts

End-use data and indicators are the answer



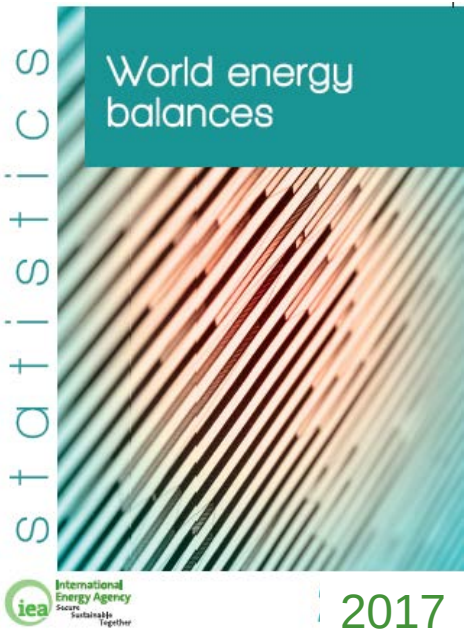




IEA Energy Efficiency Indicators:
Essentials for Policy Makers manual

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

World

2014

Million tonnes of oil equivalent

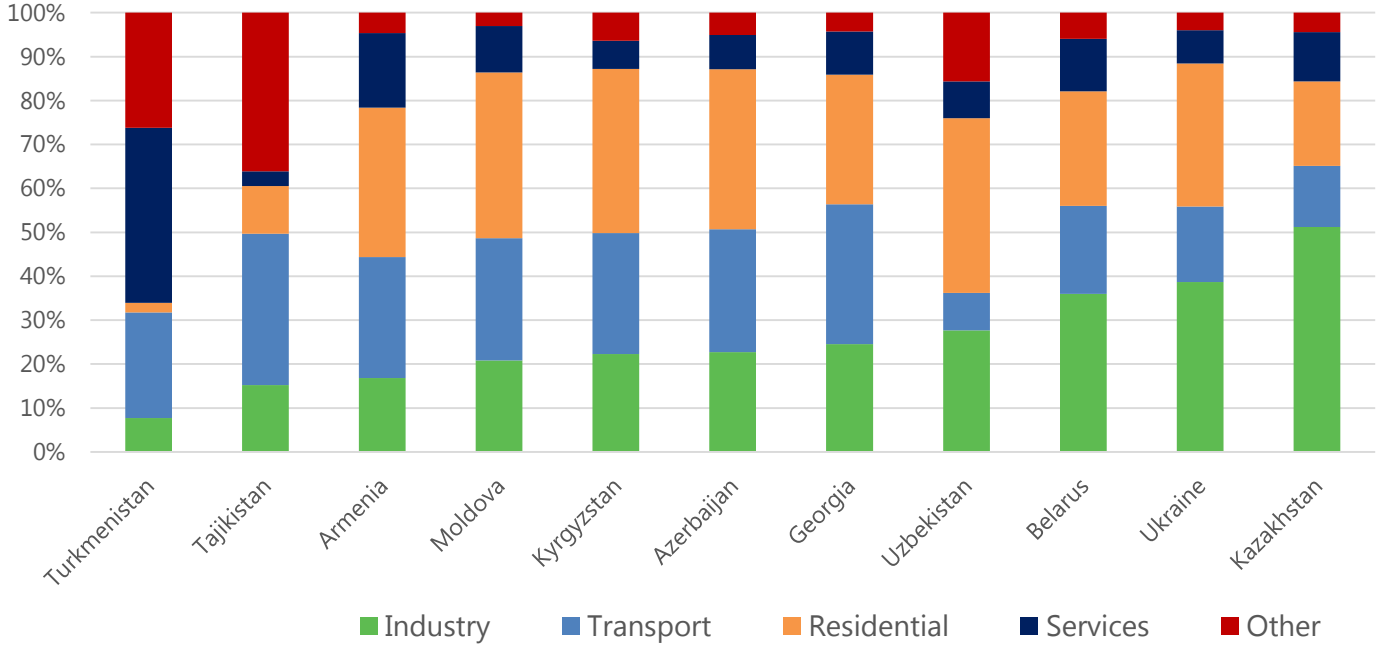
SUPPLY AND CONSUMPTION	Coal[1]	Crude oil[2]	Oil products	Natural gas	Nuclear	Hydro	Geotherm./ Solar/ etc.	Biofuels/ Waste	Electricity	Heat	Total
Production	3976.14	4308.45	-	2928.32	661.35	334.94	181.07	1413.06	-	2.10	13805.44
Imports	842.15	2213.37	1193.32	844.32	-	-	-	20.22	61.73	0.01	5175.12
Exports	-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**	**294.67**	**548.54**	**-**	**-**	**0.78**	**193.52**	**725.37**	**123.00**	**2751.17**
Iron and steel	329.62	-	7.71	56.34	-	-	-	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	9.07	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	-	7.89	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	106.89	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	**5669.47**	**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*

Energy intensity, Self-sufficiency …

Efficiencies of transformation sector

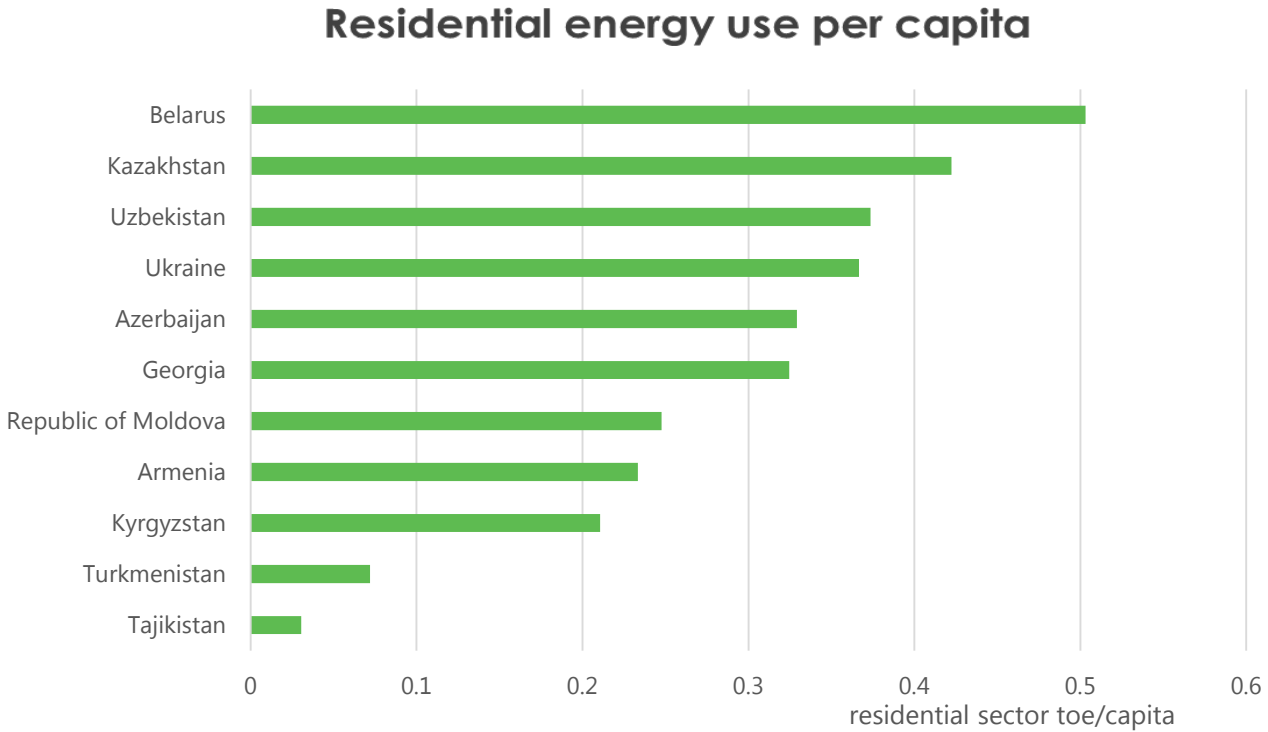
Shares of energy consumption by sector

For example, shares of sectors in total final consumption



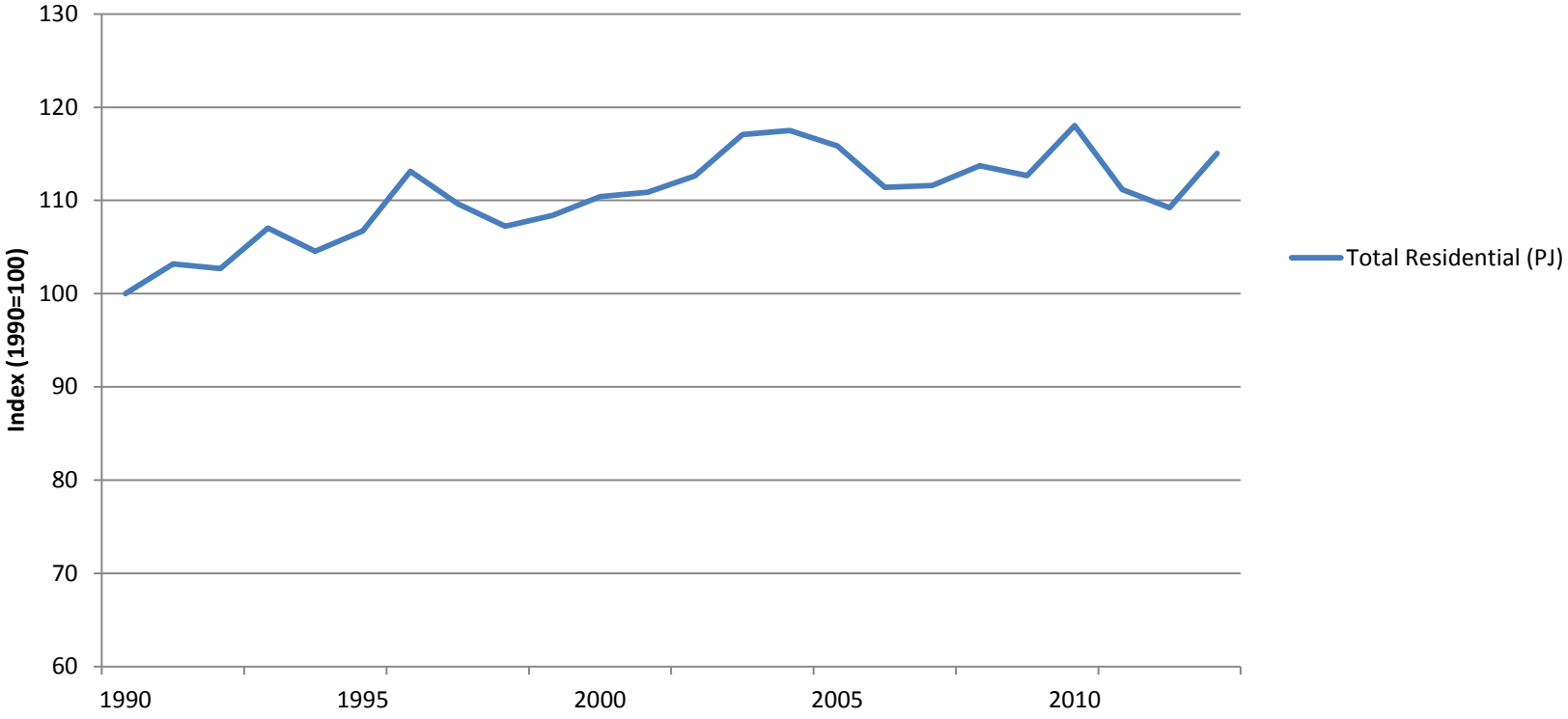
Key to understand where energy is used and to define policy priorities

And more specific sectoral indicators



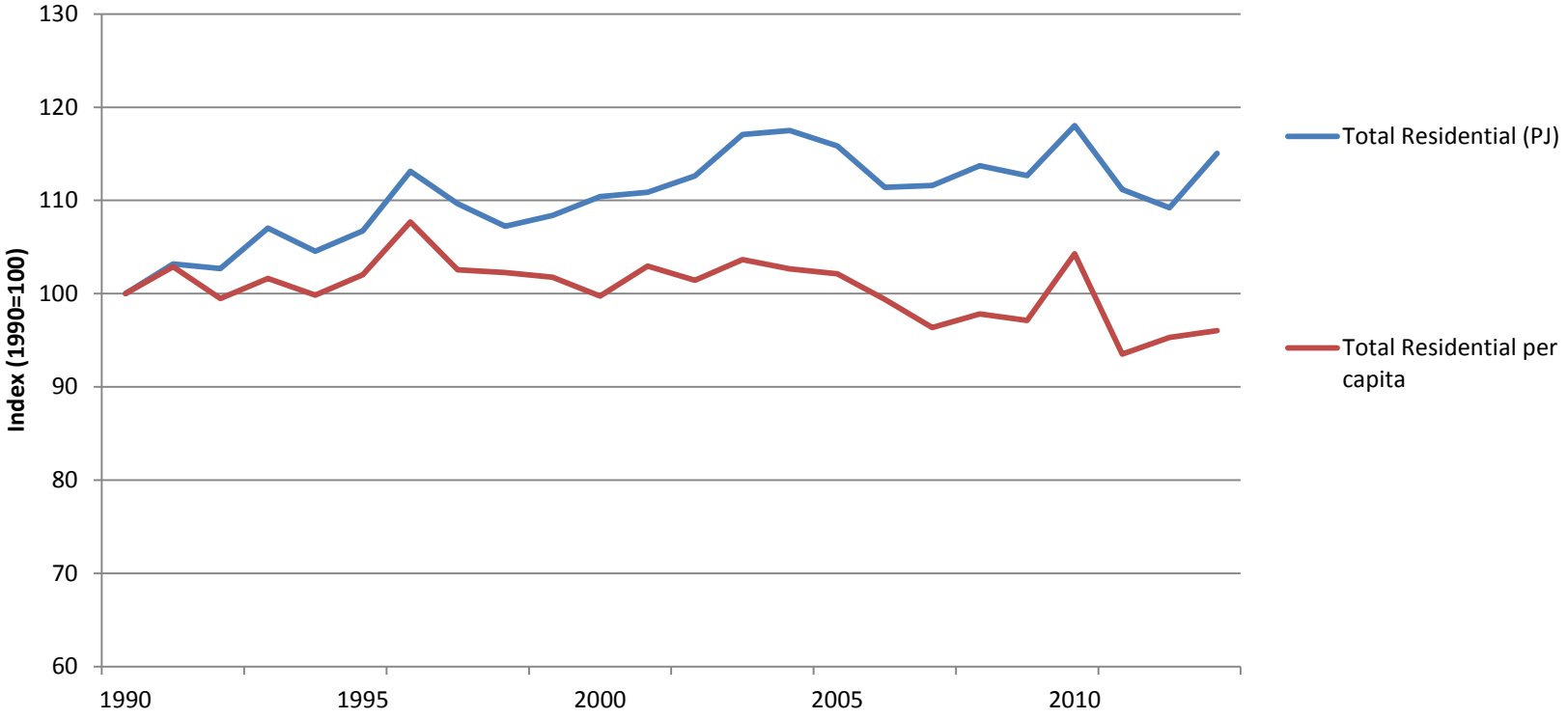
Coupling sectoral demand data with socio-economic data

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.

But do aggregated indicators tell us the full story?



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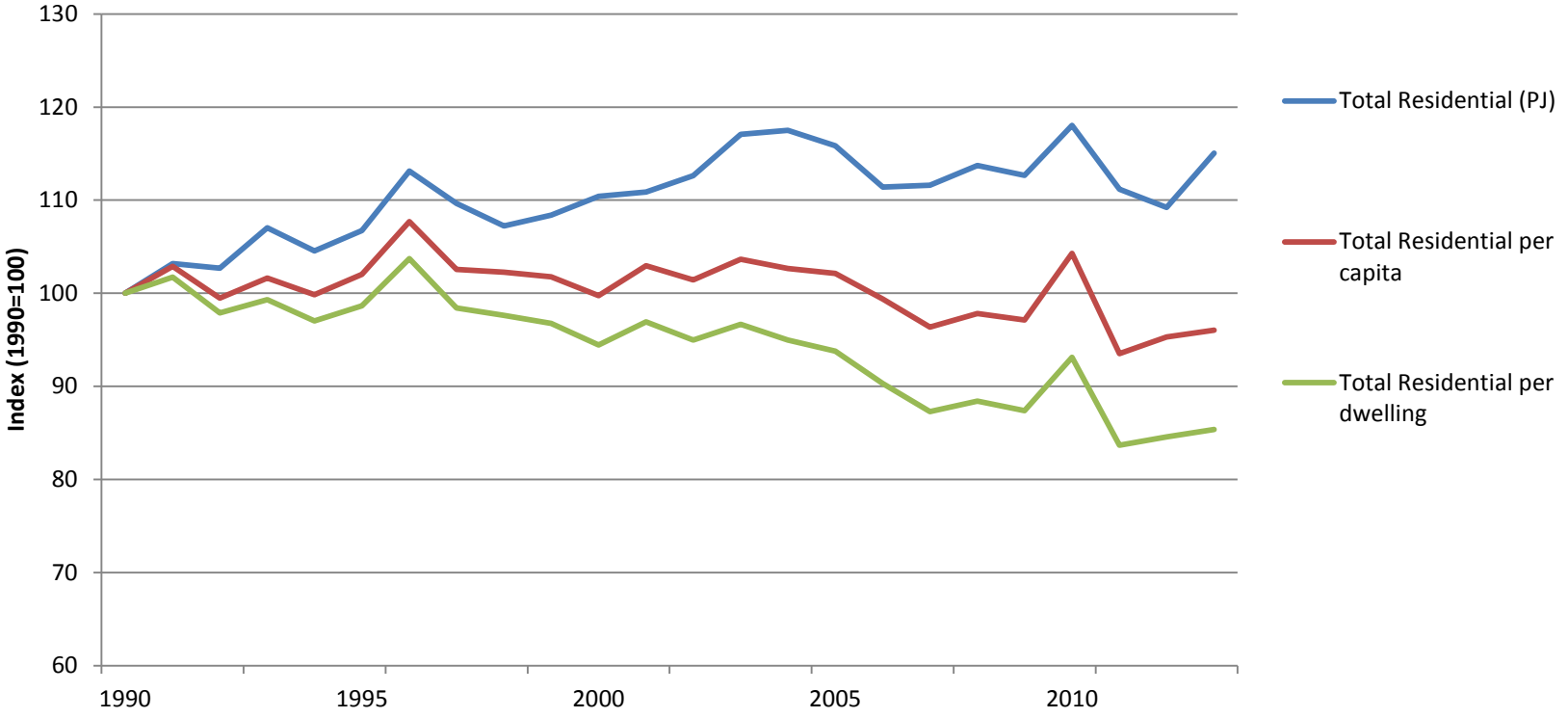

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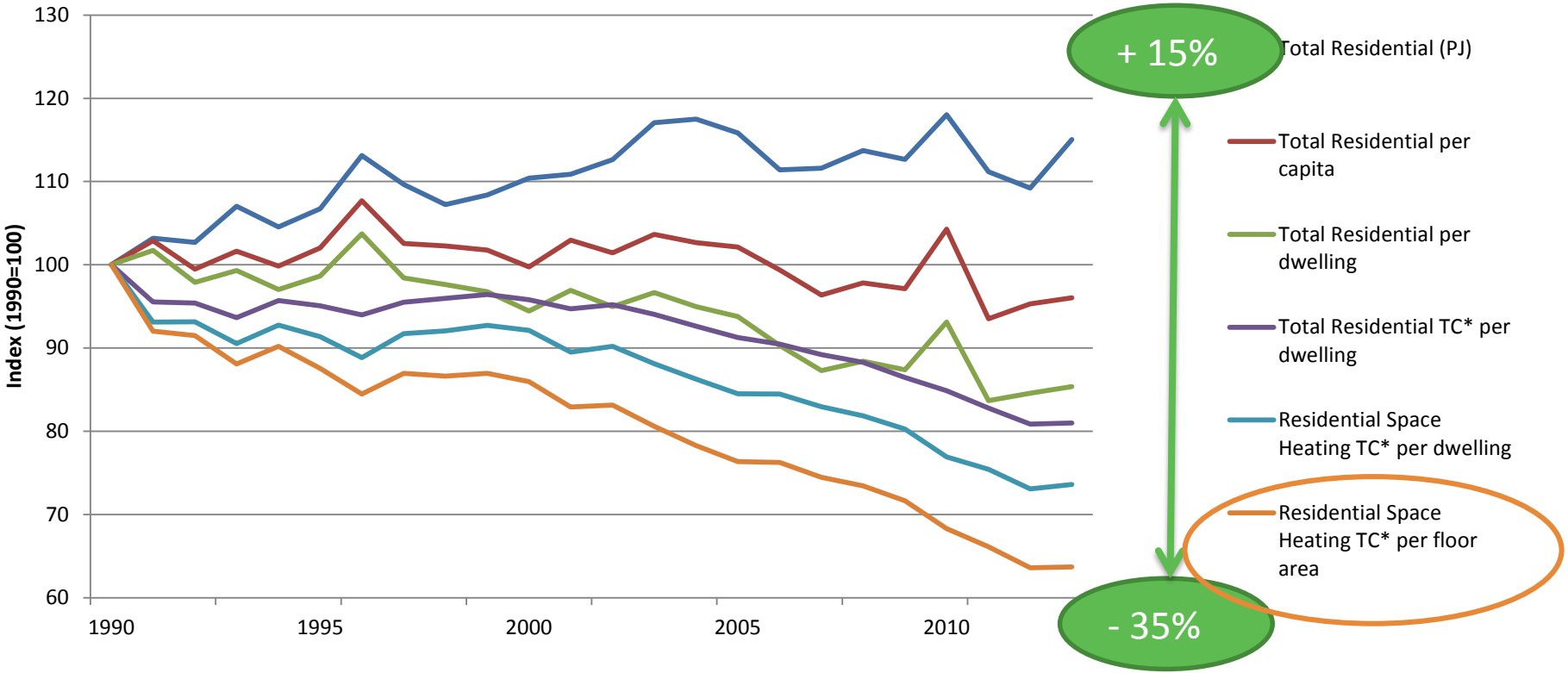
* Temperature correction using heating degree days
Data source: IEA, Energy efficiency indicators.

Choosing the most appropriate indicators is essential



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* Temperature correction using heating degree days
Data source: IEA, Energy efficiency indicators.

Balances are very useful but do not track end-uses

ENERGY BALANCE

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

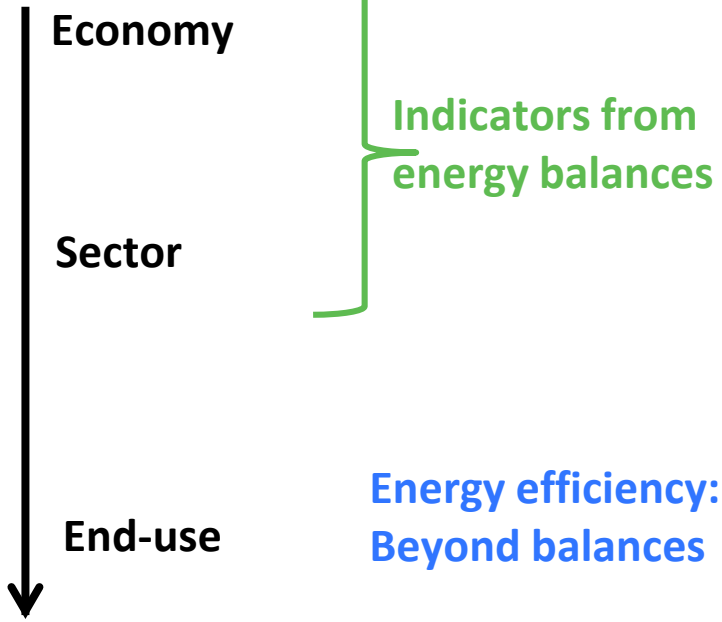
Residential:
no breakdown by end-use

- 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

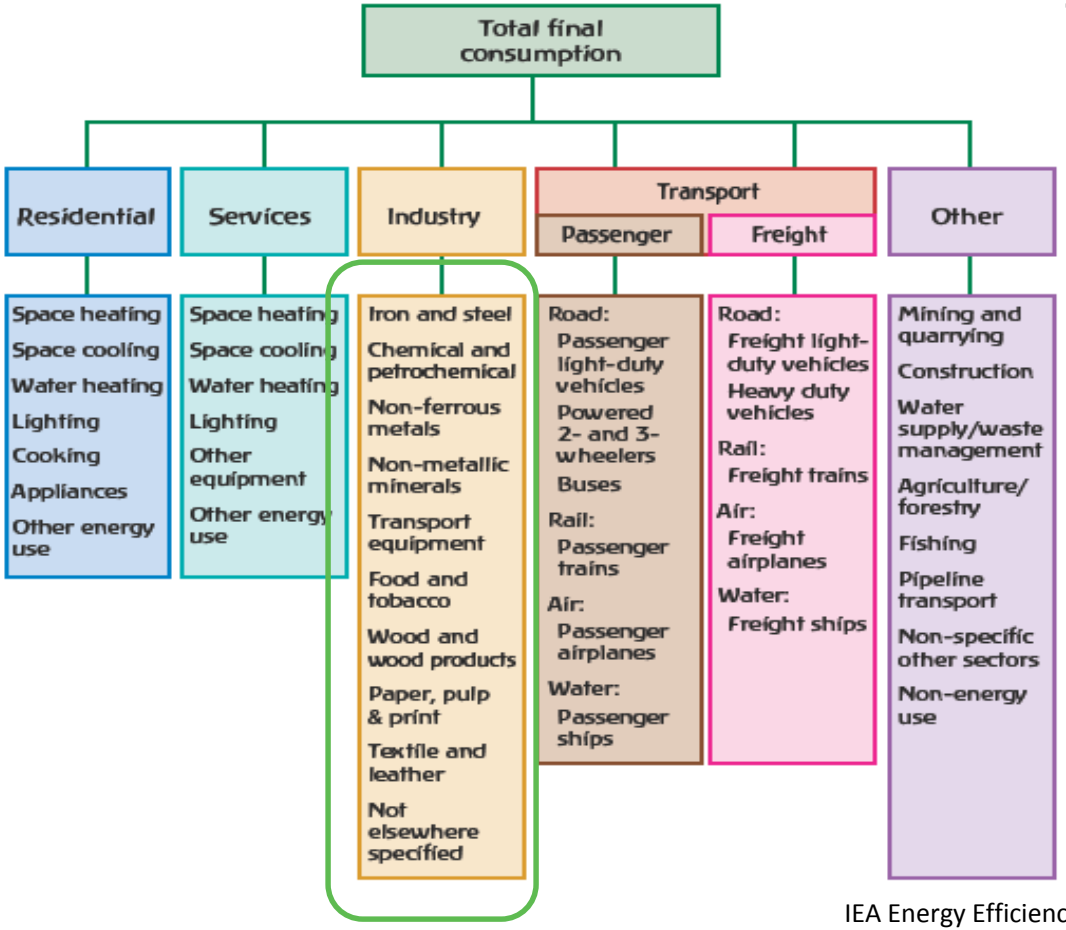
Beyond the energy balance: energy efficiency indicators

Analysing energy end-uses

Understanding end-uses across sectors

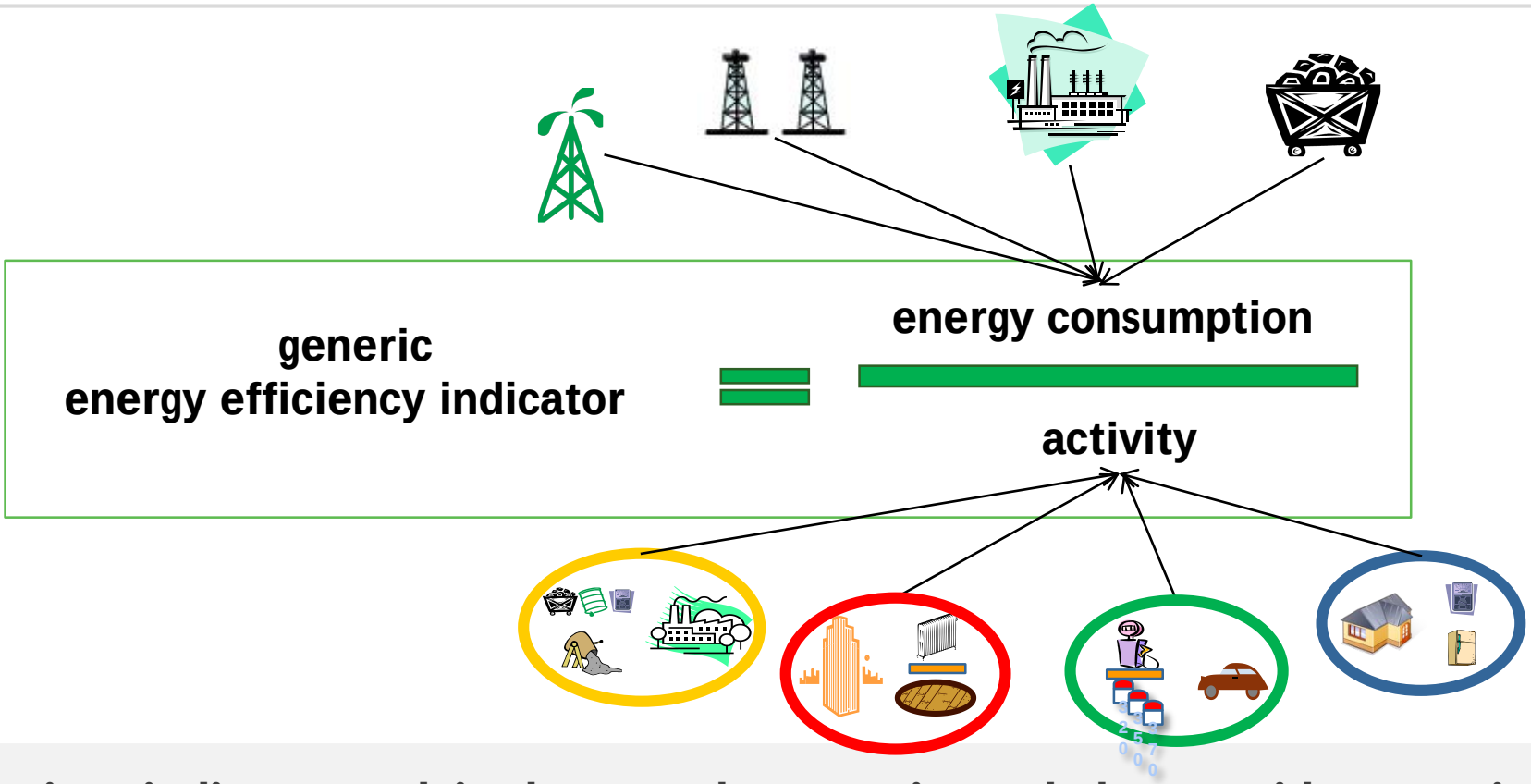
Energy balances:
Sectoral consumption

Energy efficiency:
End-use consumption



IEA Energy Efficiency Indicators: Fundamentals on Statistics, 2014

Efficiency indicators link energy to activity across 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

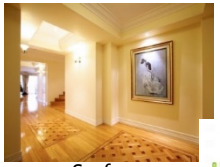
* Temperature corrected, using HDD & CDD

Activity data:

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

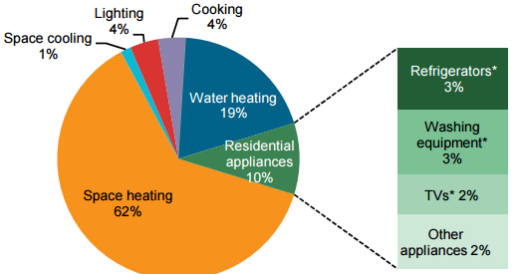
 # of people

# of dwellings

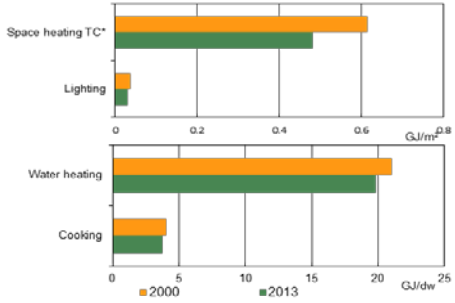


Surface

# of appliances



Energy consumption by end-use, country B



Selected energy intensities, country B

Data and indicators for the transport sector

Energy consumption data:

- Transport segment
  - passenger / freight
- Transport modes
  - road, rail, air, water, etc.

Activity data:

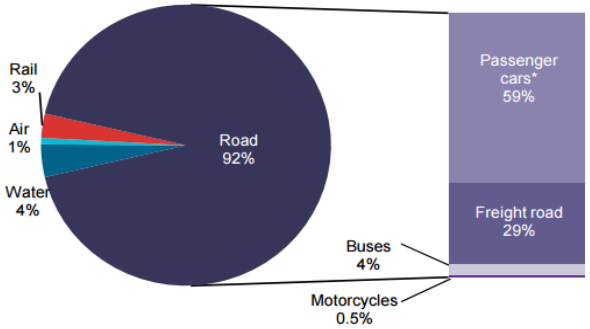
- Vehicle stocks
- Passenger-kilometers
- Tonne-kilometers

Vehicle stock

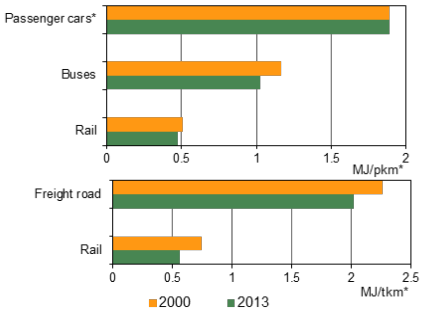
Distance travelled

Occupancy

Load



Energy consumption by mode/vehicle type, country D



Selected energy intensities, country D

Data and indicators for the industry sector

Energy consumption data

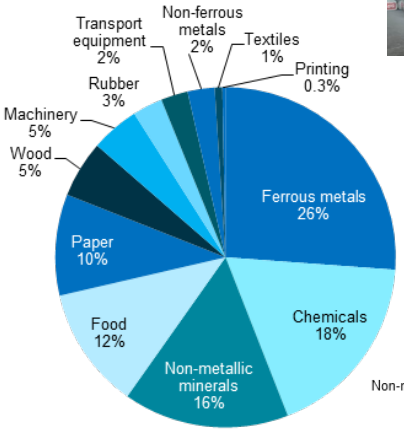
- (major ISIC sub-sectors):
- Chemical
- Iron and steel
- Non-ferrous metals
  - Aluminum
- Non-metallic minerals
  - Cement
  - Clinker
- Pulp and paper
  - Pulp
  - Paper
- …. etc.

Activity data:

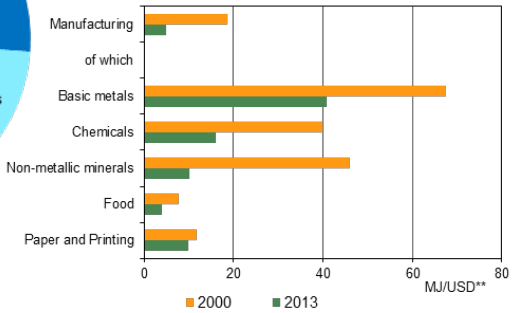
- Value added
- Physical production

Volume

Value



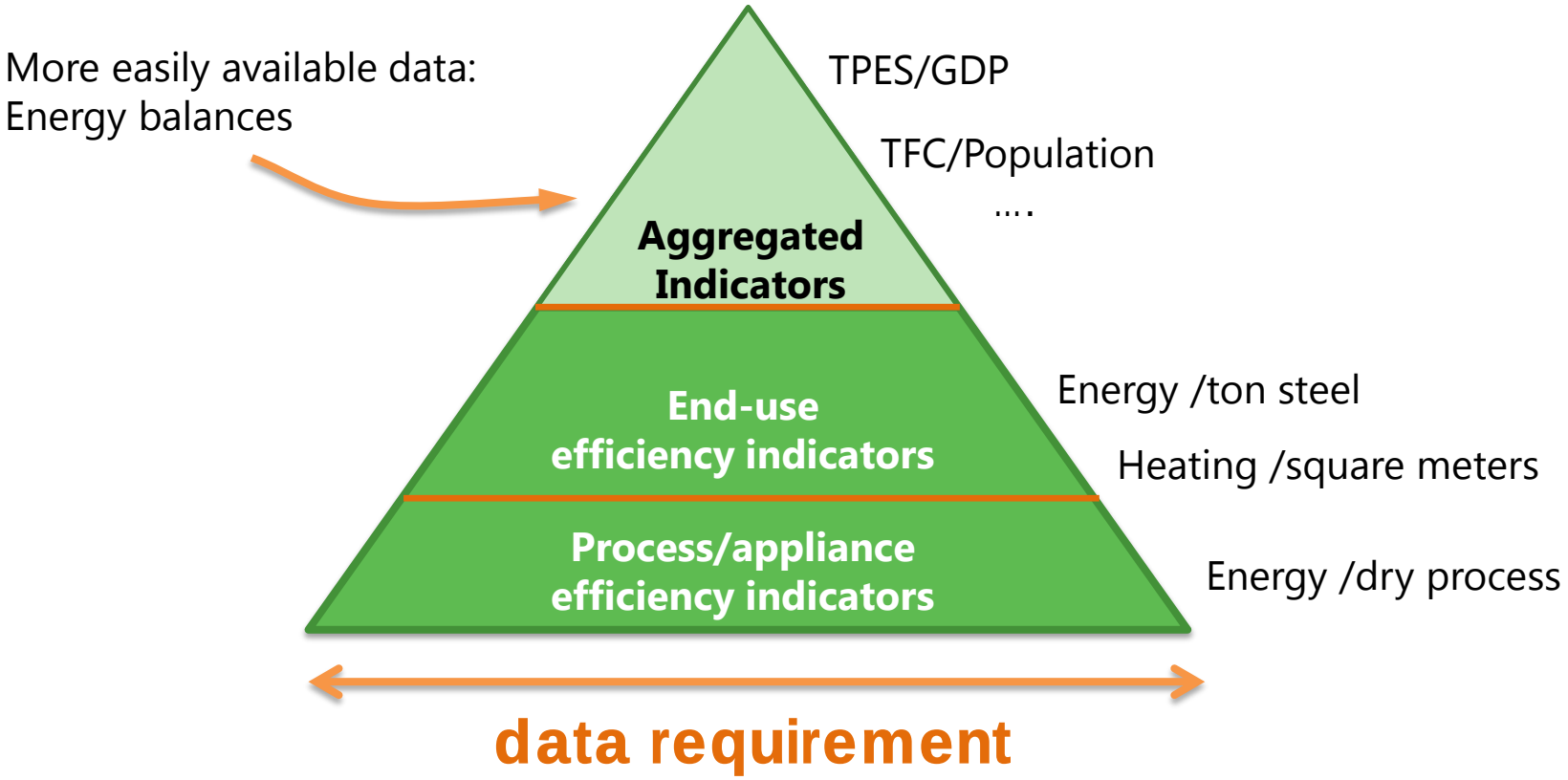
Energy consumption by end-use, country A



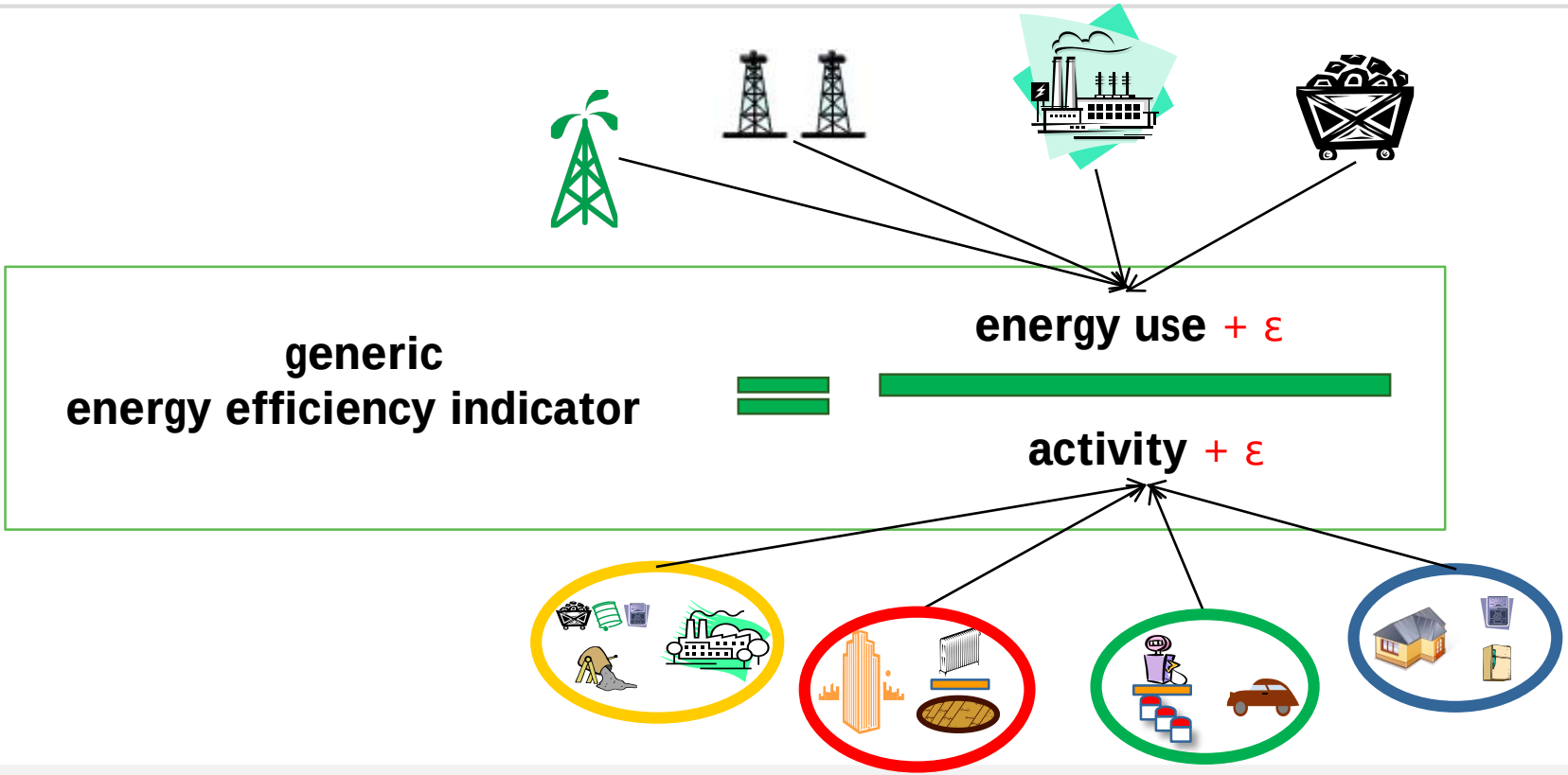
Selected energy intensities, country A

How to collect energy efficiency data?

Energy efficiency indicators: stronger data requirements



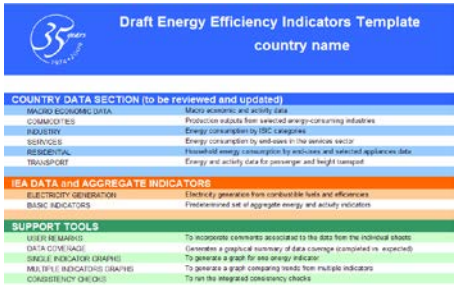
and also… higher data accuracy requirements

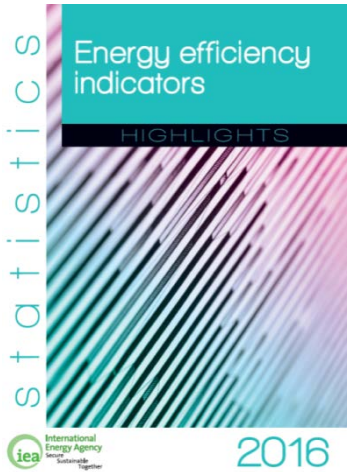


Understand the accuracy of energy / activity data – and match boundaries

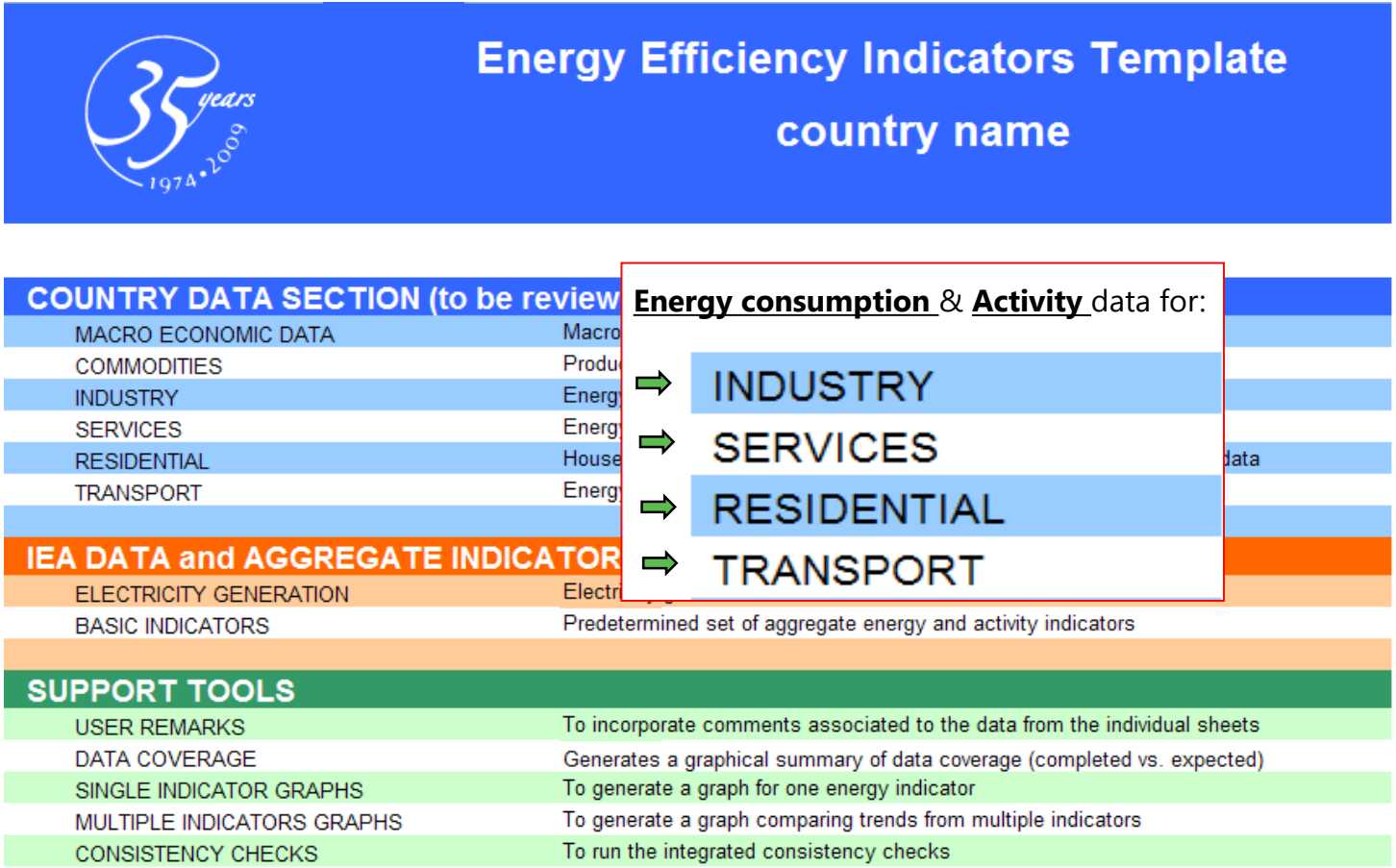
Addressing the challenge: the IEA experience

- 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

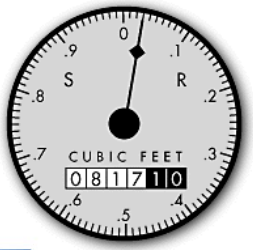


Methods used by countries to collect data for indicators

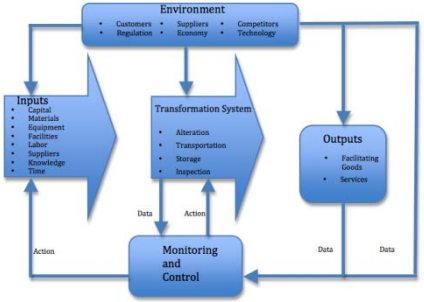
- Administrative sources
  - before starting new data collection

- Surveys
  - representative sample
  - possibly expanding existing surveys

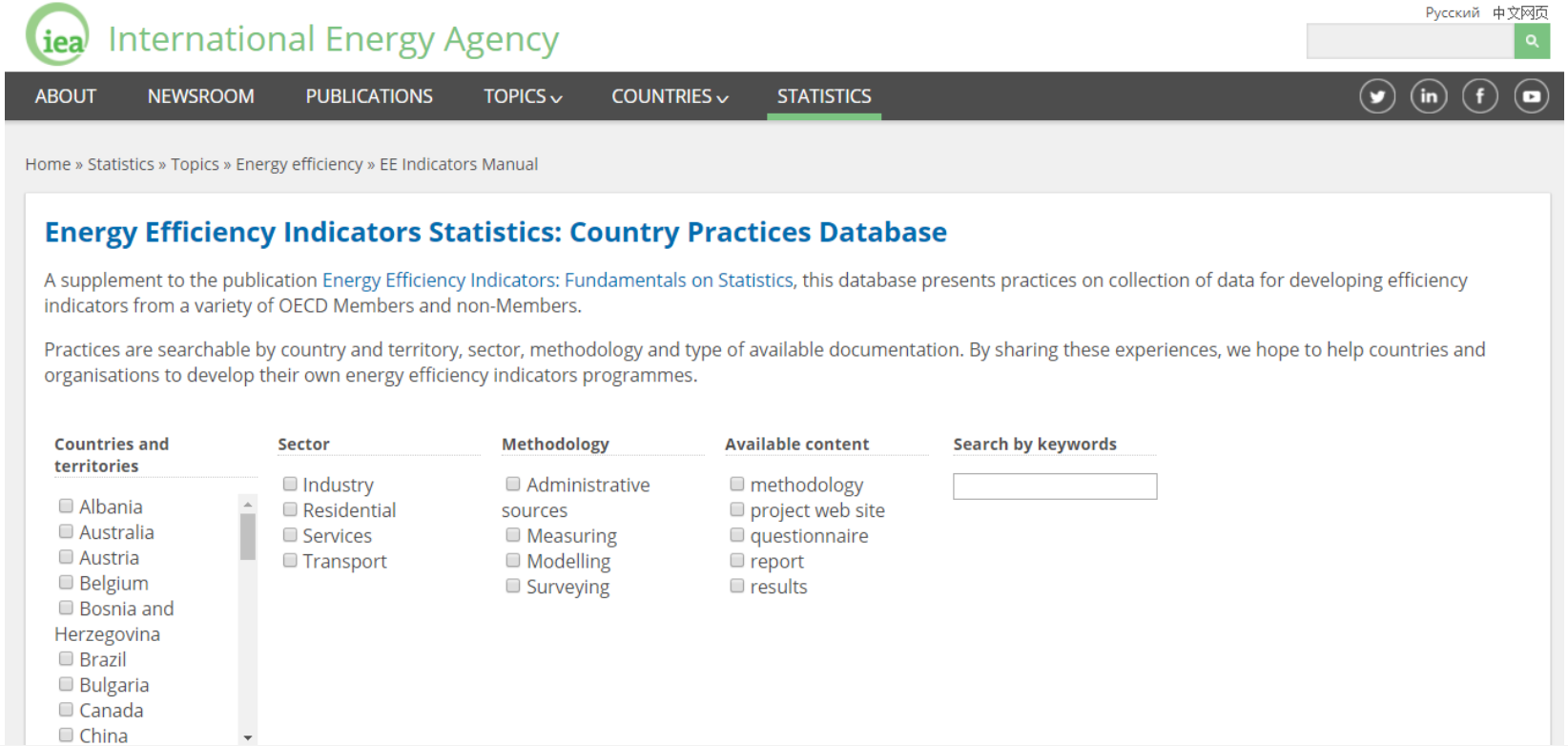
- Metering and measuring
  - costly but very effective for monitoring specific equipment efficiency



- Modelling
  - complementary to surveys or stand alone



IEA country practices database

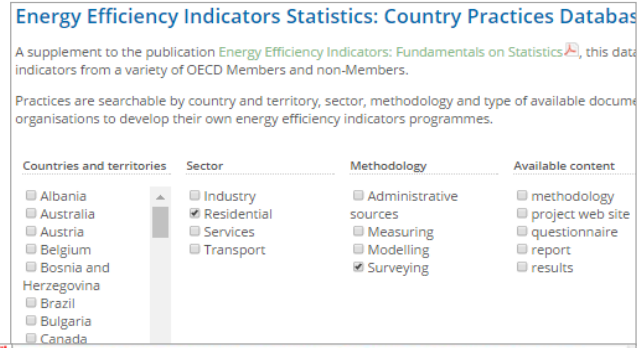


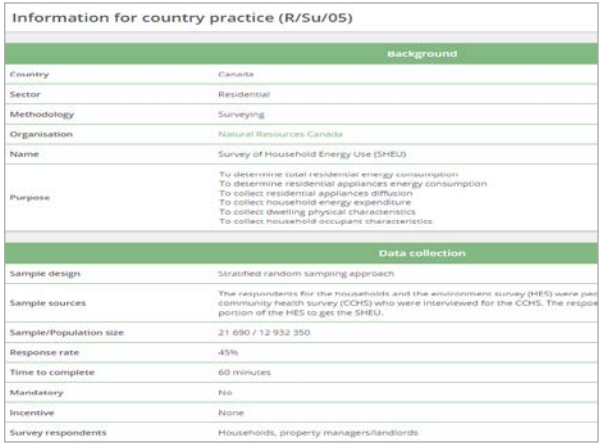
An example of how to benefit from each other's work

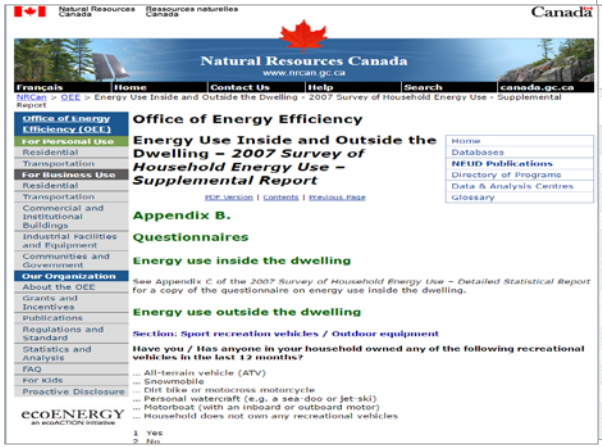
http://www.iea.org/eeindicatorsmanual/

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



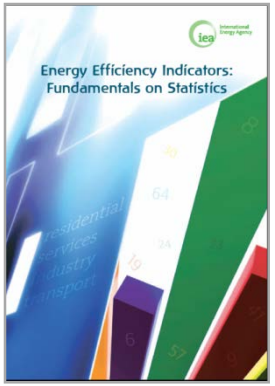




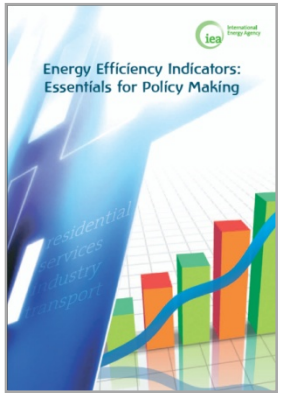
Feel free to share your practice with us!

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



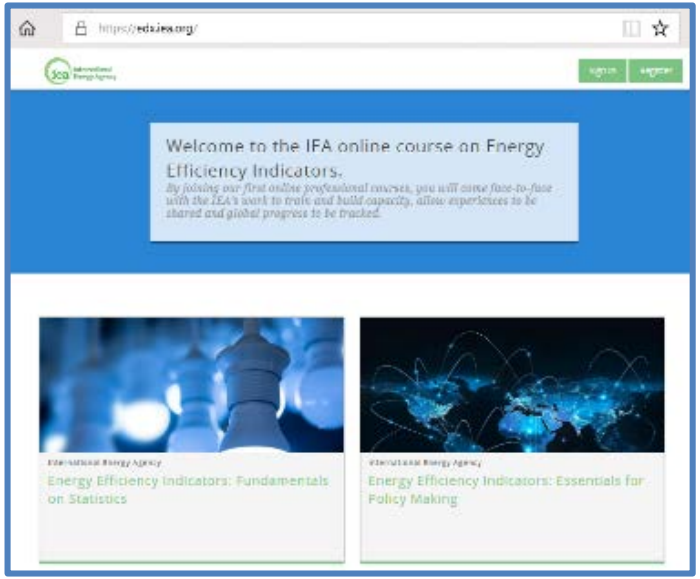
- Essentials for policy makers:
  - to provide guidance to develop and interpret energy efficiency indicators
  - https://goo.gl/agcNg2

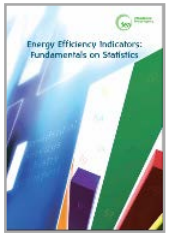


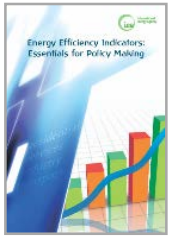
Both available also in Chinese

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





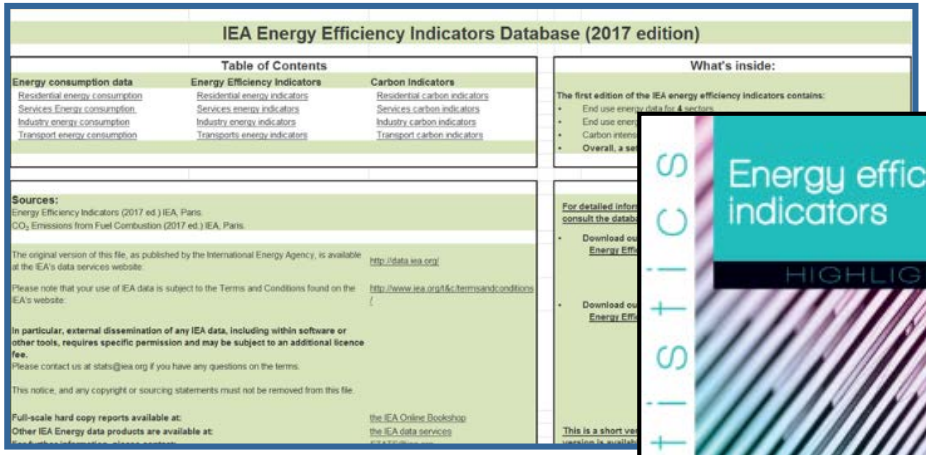


https://edx.iea.org/

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

www.iea.org

IEA

Services sector

Energy consumption data:

- Space heating*
- Space cooling*
- Lighting
- Other building use
- Non-building use

* Temperature corrected, using HDD & CDD

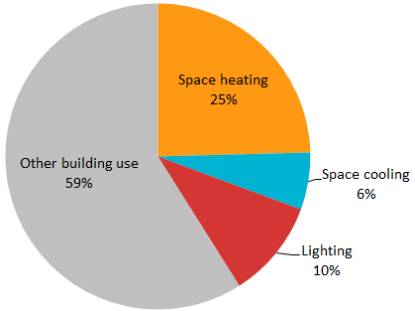
Activity data:

- Value added
- Number of employees
- Services floor area

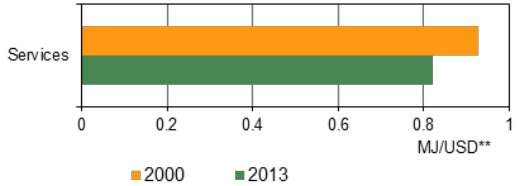
Value

# of people

Surface



Energy consumption by end-use, country C



Selected energy intensities, country C