TRACKING ENERGY EFFICIENCY

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What information is needed to understand energy efficiency?

How to measure energy efficiency

- Energy efficiency can be considered as using less energy for the same or higher output
- So measuring and presenting something that doesn't happen
- Eg replacing a 60watt lightbulb with a 10watt low energy lightbulb means around 100 kWh of electricity are not used.
- But not all energy savings are efficiency (eg the closure of a factory) and energy growth can include more use of energy efficiently
- Need to understand what energy is used for what purpose – requires detailed data
- Often need to look at a counterfactual – what would have happened

The role of energy balances…

Supply

Transformation

Final consumption

World

Million tonnes of oil equivalent

SUPPLY AND CONSUMPTION	Coal & peat	Crude oil	Oil products	Natural Gas	Nuclear	Hydro	Geotherm. solar etc.	Biofuels & waste	Electricity	Heat	Total
Production	3596.04	4069.38	-	2719.10	718.96	295.62	112.02	1277.08	-	1.04	12789.25
Imports	640.82	2295.06	1053.71	817.02	-	-	-	10.78	51.38	0.00	4868.77
Exports	-681.28	-2211.55	-1111.80	-826.35	-	-	-	-9.29	-50.74	-0.01	-4891.01
Stock changes	-79.80	6.49	6.16	17.84	-	-	-	-0.54	-	-	-49.86
TPES	3475.77	4159.37	-51.93	2727.61	718.96	295.62	112.02	1278.03	0.64	1.04	12717.16
Transfers	0.00	-156.64	179.33	-	-	-	-	-	-	-	22.69
Statistical differences	-49.50	11.30	-27.05	-1.68	-	-	0.00	-0.40	1.43	-1.24	-67.14
Electricity plants	-1974.84	-34.63	-201.57	-705.47	-715.67	-295.62	-88.61	-63.40	1671.71	-0.37	-2408.47
CHP plants	-161.19	-0.01	-22.50	-304.76	-3.13	-	-1.06	-35.21	171.56	150.84	-205.45
Heat plants	-103.61	-0.81	-12.92	-90.14	-0.15	-	-0.22	-10.42	-0.34	189.23	-29.38
Blast furnaces	-168.50	-	-0.79	-0.11	-	-	-	-	-	-	-169.40
Gas works	-8.80	-	-3.53	2.81	-	-	-	-0.02	-	-	-9.54
Coke/pat.fuel/BKB plants	-51.08	-	-2.40	-0.00	-	-	-	-0.01	-	-	-53.49
Oil refineries	-	-3964.42	3921.30	-0.80	-	-	-	-	-	-	-43.92
Petrochemical plants	-	30.51	-31.35	-	-	-	-	-	-	-	-0.84
Liquefaction plants	-16.20	7.85	-	-7.10	-	-	-	-	-	-	-15.45
Other transformation	0.01	0.13	-0.17	-2.22	-	-	-	-53.14	-	-0.39	-55.77
Energy industry own use	-86.22	-10.10	-210.37	-275.36	-	-	-0.13	-13.27	-156.15	-40.51	-792.10
Losses	-2.70	-8.23	-0.58	-24.63	-	-	-0.14	-0.15	-153.17	-22.67	-212.27
TFC	853.14	34.34	3535.48	1318.16	-	-	21.87	1102.01	1535.69	275.93	8676.63
INDUSTRY	677.86	12.51	310.02	463.87	-	-	0.46	195.83	636.96	125.43	2422.94
Iron and steel	248.74	0.03	11.36	51.71	-	-	0.01	4.16	87.06	17.48	420.54
Chemical and petrochemical	58.37	2.18	47.73	99.18	-	-	0.00	2.30	95.52	45.11	350.39
Non-ferrous metals	14.47	0.00	6.84	16.16	-	-	0.00	0.11	68.40	2.97	108.96
Non-metallic minerals	176.70	0.07	36.98	50.61	-	-	0.00	7.08	40.97	3.01	315.43
Transport equipment	4.67	0.01	3.19	11.35	-	-	0.00	0.01	18.39	4.22	41.83
Machinery	14.34	0.05	10.04	23.24	-	-	0.00	0.17	67.77	6.78	122.39
Mining and quarrying	6.93	-	16.96	15.93	-	-	-	0.06	23.72	2.52	66.11
Food and tobacco	22.70	0.12	26.68	37.22	-	-	0.00	29.92	34.93	11.20	162.78
Paper pulp and printing	21.66	0.01	8.08	26.06	-	-	0.15	53.10	40.87	10.88	160.79
Wood and wood products	2.71	0.01	4.78	3.30	-	-	0.00	11.58	7.89	5.87	36.14
Construction	6.12	0.05	26.92	6.38	-	-	0.00	0.16	8.00	1.78	49.41
Textile and leather	11.18	0.06	5.59	7.14	-	-	0.00	0.23	23.22	7.01	54.44
Non-specified	89.28	9.93	104.85	115.59	-	-	0.30	86.95	120.21	6.60	533.72
TRANSPORT	3.36	0.04	2195.89	89.06	-	-	-	57.56	23.91	-	2369.81
World aviation bunkers	-	-	153.65	-	-	-	-	-	-	-	153.65
Domestic aviation	-	-	96.42	-	-	-	-	-	-	-	96.42
Road	-	0.03	1666.60	28.52	-	-	-	57.53	0.00	-	1752.68
Rail	3.22	-	28.37	-	-	-	-	0.02	18.04	-	49.65
Pipeline transport	-	-	0.43	59.99	-	-	-	-	2.90	-	63.31
World marine bunkers	-	-	200.72	-	-	-	-	-	-	-	200.72
Domestic navigation	0.12	-	43.98	0.05	-	-	-	0.01	-	-	44.16
Non-specified	0.01	0.00	5.73	0.49	-	-	-	0.00	2.97	-	9.21
OTHER	135.96	6.75	435.64	612.83	-	-	21.41	848.62	874.82	150.50	3086.53
Residential	78.65	0.55	210.54	421.08	-	-	9.42	820.70	426.24	105.72	2072.88
Comm. and publ. services	22.94	0.11	102.97	179.56	-	-	2.01	17.76	358.61	31.52	715.47
Agriculture/forestry	10.90	0.09	101.47	6.07	-	-	0.67	7.43	38.98	3.76	169.37
Fishing	0.01	-	6.23	0.02	-	-	0.06	0.00	0.39	0.05	6.77
Non-specified	23.47	6.00	14.43	6.10	-	-	9.25	2.73	50.60	9.45	122.04
NON-ENERGY USE	35.97	15.05	593.93	152.40	-	-	-	-	-	-	797.35
in industry/transf./energy	35.63	15.05	569.93	152.40	-	-	-	-	-	-	773.01
of which: feedstocks	*2.44*	*14.49*	*362.42*	*149.75*	-	-	-	-	-	-	*529.10*
in transport	-	-	6.63	0.00	-	-	-	-	-	-	6.63
in other	0.33	-	17.38	-	-	-	-	-	-	-	17.71
Electricity and Heat Output											
Electr. Generated - GWh	8697512	27881	961377	4768076	2756289	3437483	449596	331679	-	1573	21431466
Electricity plants	*8091865*	*27864*	*891872*	*3582493*	*2746188*	*3437483*	*446008*	*211248*	-	*827*	*19435848*
CHP plants	*605647*	*17*	*69505*	*1185583*	*10101*	-	*3588*	*120431*	-	*746*	*1995618*
Heat Generated - TJ	5706864	26036	751312	6597541	27357	-	346248	761894	7495	60077	14284824
CHP plants	*2058353*	*216*	*299046*	*3489955*	*20944*	-	*10389*	*434740*	*208*	*24958*	*6338809*
Heat plants	*3648511*	*25820*	*452266*	*3107586*	*6413*	-	*335859*	*327154*	*7287*	*35119*	*7946015*

Energy intensity, Self-sufficiency …

Efficiencies of transformation sector

Shares of energy consumption by sector

But No breakdown by end-use,eg:
Production (for industry)
space/water heating/cooling (Residential and Services)
lighting/appliances (R and Serv)

Understanding energy use from an energy balance

Strengths

- Comprehensive – covers all energy
- Shows importance of all sectors (inc non-energy and energy industry)
- Allows for high level indicators (eg Intensity)
- Allows calculation of efficiency of transformation and distribution

Weaknesses

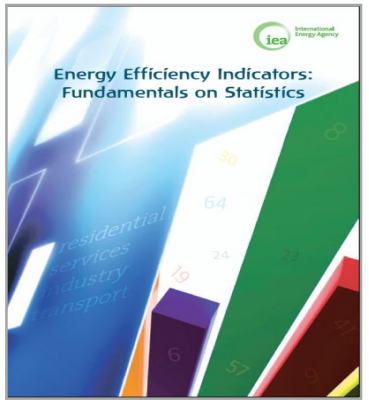
- Too high level, lacks detail on specific use
- So understanding energy use and efficiency requires far more detail

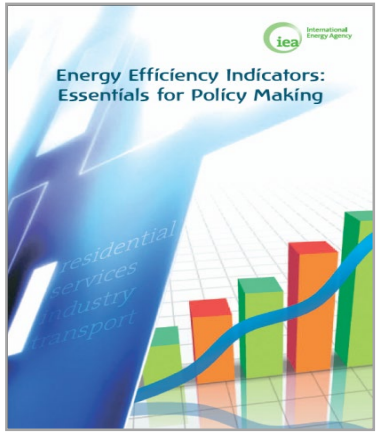
IEA manuals provide a good oversight on the data needed to produce energy efficiency indicators

- Fundamentals on statistics:
  provides guidance on good indicators and information on collecting the data needed for indicators
  - Includes a compilation (on-line) of existing practices from across the world
  - https://goo.gl/Y8QD1G

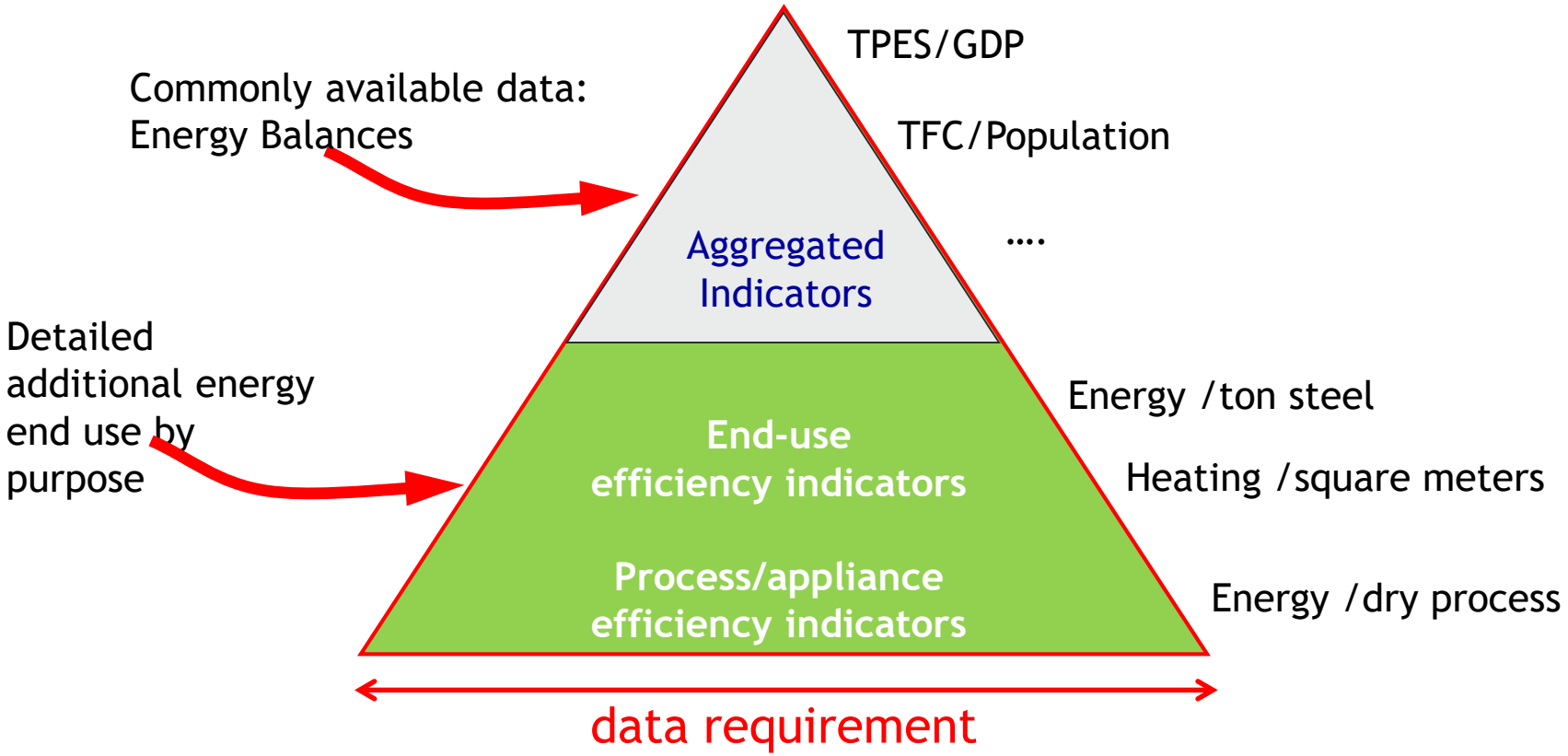
- Essentials for policy makers:
  provides guidance to develop and interpret energy efficiency indicators
  - https://goo.gl/agcNg2

  These are also available as an on-line tools





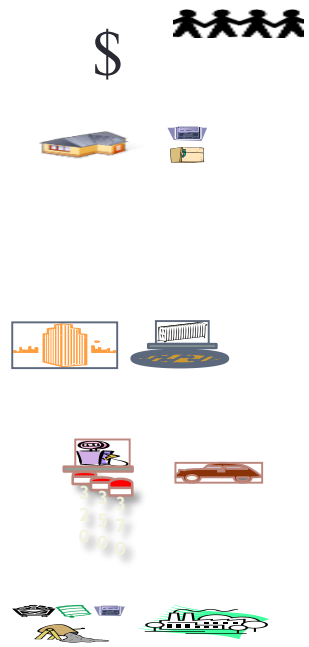
Going beyond the balances: what level of details?



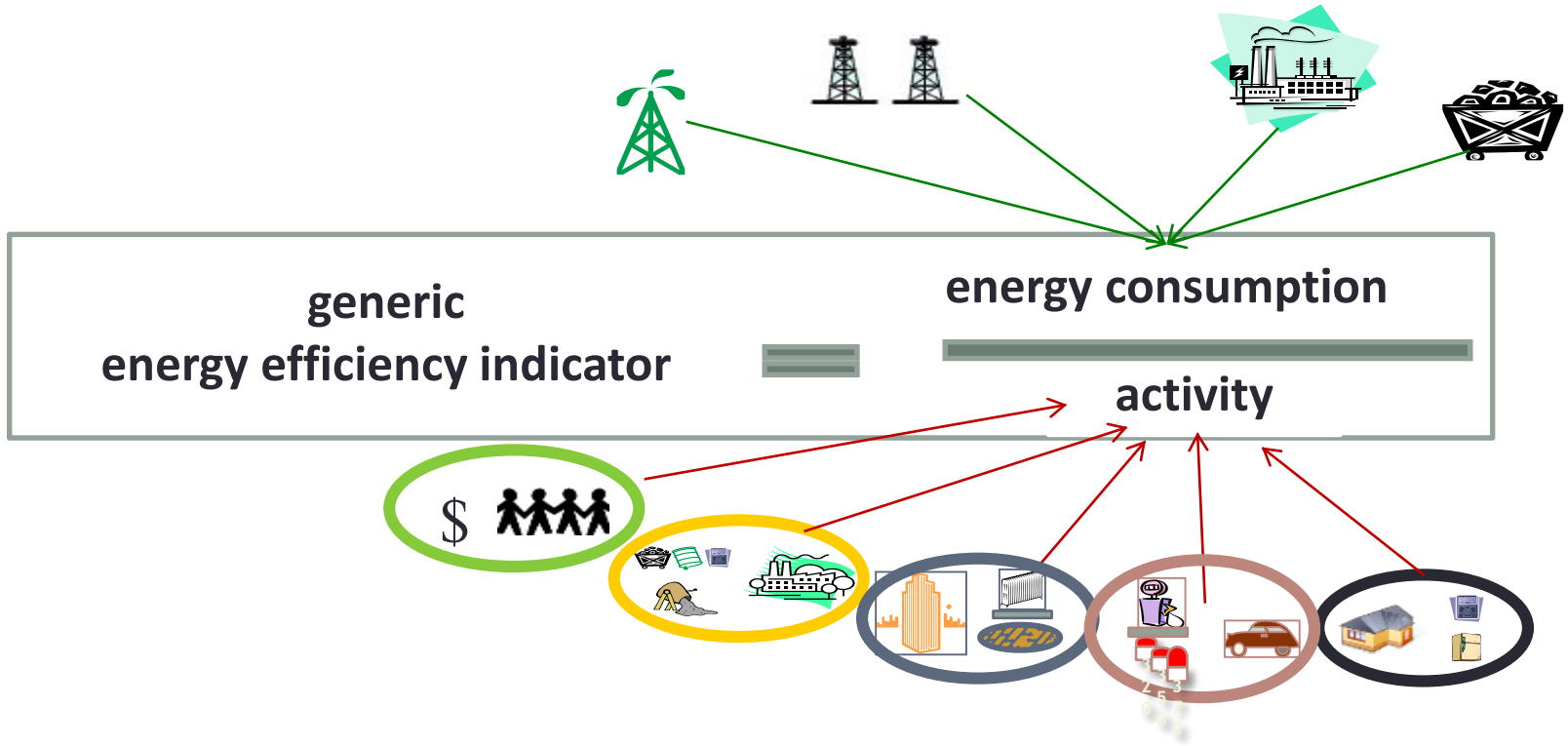
Significantly more data are needed to build a minimum set of disaggregated indicators?

Activity data

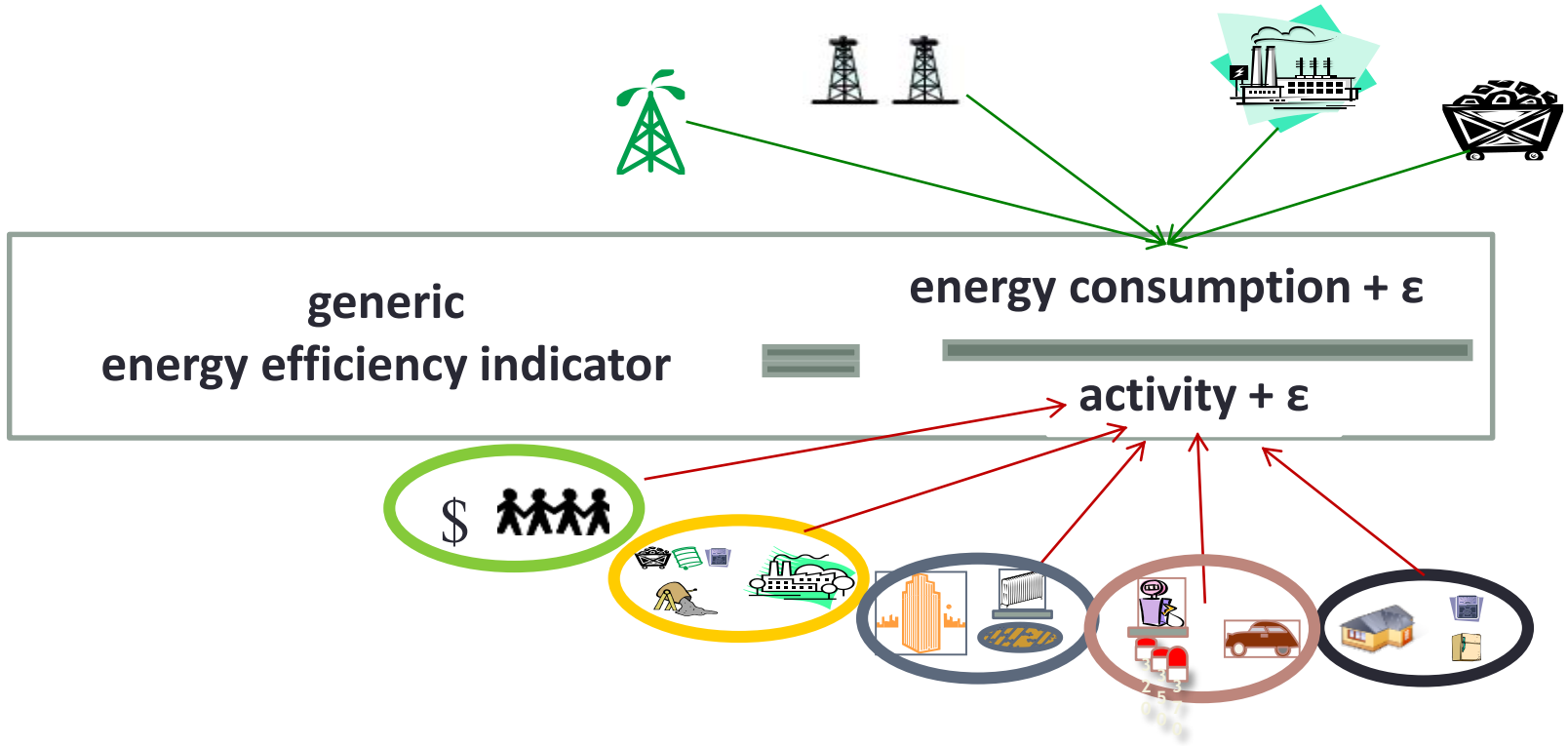
Sector	Activity
Overall	GDP Population
Residential	Population Number of dwellings Floor area Number of appliances
Services (ideally by category)	Value added Number of employees Floor area
Transport	Passenger-kilometer Tonne-kilometer
Industry (by subsector)	Value added Physical production process-level production



Indicators link activity and energy data



Indicators link activity and energy data – the reality



Need to understand the accuracy of both the energy and activity data – are error terms greater than change
Think about data in indicators

How to collect energy efficiency data?

Energy Use data collection

- Maximise the use of administrative data
- Remove barriers to data sharing across gvt (survey and admin)
- Operational policy data can be really effective
- End use surveys likely to be needed covering energy consumption and activity data
- Plan cycles to cover residential, services, industry, transport (what time gap)
- Smaller survey run twice, better than one large one
- Requires funding, but having no data will cost more

Challenges faced by countries

- Cooperation across institutions
- Need for new surveys or estimations
- Ensuring quality and consistency
  - with official energy statistics
  - between energy and activity data
- Delivering timely data

Data “collection”

Producing energy statistics requires some form of data transfer from energy producers and energy users to energy statisticians

Can be via other government ministries (eg Min of Power for elec data) – but they will need to coordinated

Often will be a survey but there can be other options

Business surveys (1/2)

- Pros
  - Importance of large businesses: fewer respondents to survey
  - Timeliness for data and results
  - Easy to acquire (in theory).
- Cons
  - Limiting response burden may result in lack of detail
  - Confidentiality?
  - Response rates
  - Need for legislation
  - Need for a business register/sample frame

Business surveys (2/2)

- Examples of energy sector business surveys
  - UK monthly survey or all major power producers, quarterly survey of major auto generators, annual survey of small generators (all generators in the UK are IPP)

- Examples of end use business surveys
  - China – monthly online consumption survey of 370,000 businesses
  - Annual survey on energy consumption by manufacturing industry (France – 8,500 local units, all with more than 250 employees plus a sample of those having 20-250 employees, internet survey).
  - Survey on energy consumption in services sector (Denmark – 2004 – 5,000 local units surveyed, employing at least 5 full-time employees, stratified by company size and activity - 4,205 answered, but difficult to measure energy consumption as often part of the rent)

Households surveys (1/2)

- Pros
  - Comprehensive information on all fuels used
  - Can be used directly and as input for modelling
  - Energy can be combined with other household surveys (spending) or vital questions in Census
- Cons
  - Resource intensive
  - Expensive
  - Time consuming
  - High respondent burden
  - Need sample frame

Households surveys (2/2)

- Examples of households surveys
  - Philippines : 2011 Household Energy Consumption Survey (HECS), 91.6% response rate, special attention given to local languages and culture
  - Survey of Household Energy Use (Canada, occasional, computer-assisted personal interview, voluntary, 6,500 dwellings, response rate 71%).
  - Austrian household survey, voluntary but linked to mandatory Labour Force Survey
  - Togo Questionnaire d'enquete consummation: The survey is conducted during two seasons (rainy and dry). The survey staff used a scale to measure the quantity of charcoal and wood used in households.

Administrative data (1/2)

- Definition: Data that are held or need to be held to administer a government policy

- The best source if available:
  - No specific survey burden
  - Avoids duplication by making use of existing data
  - Often exhaustive: greater number of records allows more detailed breakdowns
  - Can be designed for precise use (if statisticians are involved from the start)

- Can also assist quality assurance of survey data

Administrative data (2/2)

- But some cons as well:
  - Dependency on third parties
  - Definitions and information may not match statistical needs
  - Often requires substantial effort and time to set up
  - May be legal barriers to use
  - Planning has to happen in advance and needs statisticians involved in policy implementation process

Direct measurement

- Pros
  - Detailed information on individual appliances, information on patterns of use of the equipment
  - High quality of the results
- Cons
  - Invasive: difficulties in finding households willing to participate.
  - High burden (time and human resources)
  - Expensive, so often small samples, and less representative
  - Constraints in monitoring equipment
- For example:
  - In situ monitoring of efficiencies of condensing boilers and use of secondary heating in the UK (60 condensing boilers, 12 months data obtained for 43 of them).

Modelling

- When collecting data is too expensive, or too difficult… modelling can be a solution. For instance:
  - Estimating provinces data based on national sources: finding a way to allocate (using population or GDP figures)
  - Estimating end use consumption by function (heating / cooling / hot water / cooking / lightning…): using number of appliances, total consumption, type of household, time use surveys

SDG’s

The 17 SDGs


TRANSFORMING OUR WORLD:
THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS

Current Goal 7 indicators

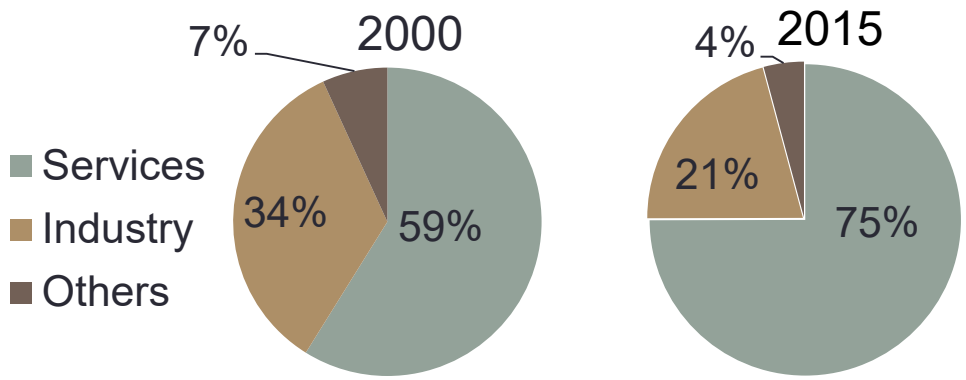
- 7.1.1 Proportion of population with access to electricity
- 7.1.2 Proportion of population with primary reliance on clean fuels and technology
- 7.2.1 Renewable energy share in the total final energy consumption
- 7.3.1 Energy intensity measured in terms of primary energy and GDP

- 7.a.1 Mobilized amount of United States dollars per year starting in 2020 accountable towards the $100 billion commitment
- 7.b.1 Investments in energy efficiency as a percentage of GDP and the amount of foreign direct investment in financial transfer for infrastructure and technology to sustainable development services

A word on energy intensity?

- Intensity = energy/economic output (GDP)
- Nearly universally available so an SDG
- But can change due to size of the country, Climate, Economic structure as well as actual efficiency

Energy intensity MJ/US$PPP	2000	2015
Total	**3.2**	**3.0**
Industry	7.2	10.4
Services	1.0	1.0
Others	2.1	2.9



A decrease in energy intensity is possible without any energy efficiency improvement

Energy data needs

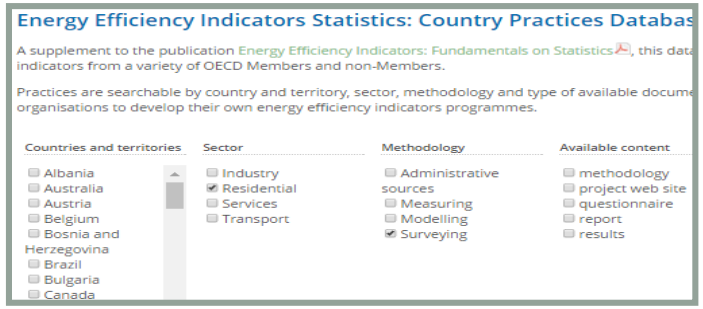
- Countries focus on SDGs can be good for energy as measurement requires:
- An Energy Balance (primary and final energy)
- Comprehensive and complete renewables data – all sectors not just electricity
- Also enhances the need for consistent methodology in countries and historic revisions as methods/ data sources change

Conclusion

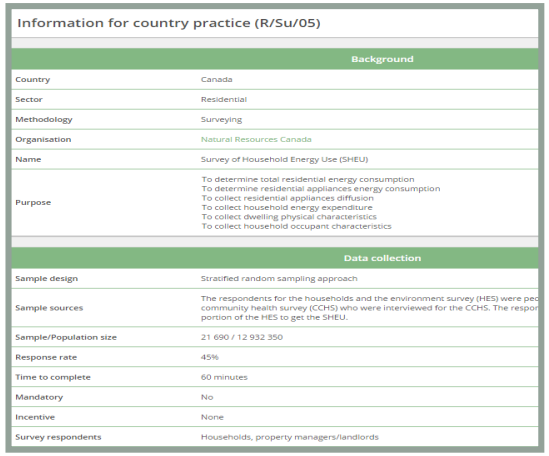
- Energy balances form the basis to understand energy use, but detailed end use information (often from surveys) are needed to get the full picture
- End-use and energy efficiency data are vital
  - Shows by who, where and why energy is being used
  - Creates the means to design cost effective policies
  - Provides the means to monitor and evaluate and thus adapt
  - “You cant control what isn’t measured”

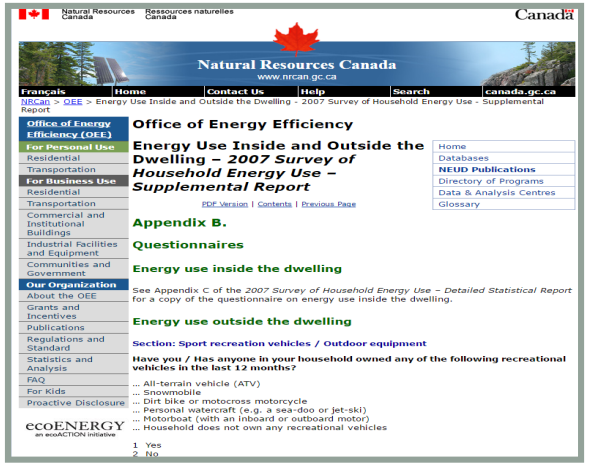
Thank you!

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





https://www.iea.org/eeindicatorsmanual/

Thank you for listening – Any Questions

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