Motiva

Energy Efficiency: Can We Easily Compare Countries?

2019

Background

Recent country comparisons and their mixed results prompted the need to have a closer look. Therefore, the Technical Research Centre of Finland (VTT) carried out a study:
Energy Efficiency: Can We Easily Compare Countries?

The report can be downloaded from:
https://www.motiva.fi/files/15910/VTT_R_07000_18.pdf

The study was financed by the Energy Authority of Finland through Motiva Oy.

Can we easily compare countries?

- Let's look at some research results presented recently

- Joint Research Centre (JRC), International Energy Agency (IEA) and the ODYSSEE-Mure Project have studied changes in energy efficiency based on decomposition analyses.

- ODYSSEE also presents country comparison scoreboards based on energy efficiency level, energy efficiency trend, policy and their combination (Combined Scoreboard).

Decomposition

Decomposition analyses - sources

- JRC. Economidou M. 2017. Assessing the progress towards the EU energy efficiency targets using index decomposition analysis, EUR 28710 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-71299-9, doi:10.2760/675791, JRC106782.

- ODYSSEE 2018. Decomposition tool. Interactive web site, last visited 30.11.2018. http://www.indicators.odyssee-mure.eu/decomposition.html

- IEA 2017. Energy Efficiency Indicators: Highlights. OECD/IEA 2017. *NB! IEA cumulative lifetime energy savings are estimated from graph, and annual saving for the last year is estimated assuming a linear increase.*

Energy saving results by JRC, IEA and ODYSSEE

	Energy savings ktoe	Finland	Sweden	Germany	Italy
Ind+serv.*	**FEC** 2015 (as by JRC)**	**13,972**	**15,381**	**95,305**	**44,155**
Ind+serv.*	IEA 2000-201(5)	700	4,100	7,300	
Ind+serv.*	JRC 2005-2015	-221	3,251	8,704	11,125
Industry	ODYSSEE 2000-2015	1,425	2,548	8,240	9,115
House-holds	**FEC 2015 (as by JRC)**	**4,898**	**7,197**	**53,171**	**32,495**
	IEA 2000-2015	300	2,500	27,000	
	JRC 2005-2015	1,018	1,307	15,980	-768
	ODYSSEE 2000-2015	471	4,365	23,310	3,546

*Ind.+serv. = Industry branches and the service sector are combined

**FEC = Final Energy Consumption is given as reference of consumption level

Can we easily compare countries?

Methods

- **There is large variation in energy savings between the methods. Is the large variation based on the use of different data and partly different timespans, 2000-2015 versus 2005-2015?**
  - Let's look at JRC and ODYSSEE data. As ODYSSEE is an interactive tool, we can set it to the same timespan as JRC, 2005-2015
  - What more, for the transport sector JRC uses ODYSSEE data, so the data should be exactly the same.

JRC vs ODYSSEE energy savings* 2005-2015

	Households		Industry	Services	Commer-cial	Transport			
						Passenger		Goods	
	ODYSSEE	JRC	ODYSSEE	ODYSSEE	JRC	ODYSSEE	JCR	ODYSSEE	JCR
AT	13 %	7 %	10 %	23 %	16 %	4 %	-1 %	8 %	10 %
DK	18 %	23 %	19 %	4 %	22 %	7 %	5 %	6 %	11 %
CY	24 %	20 %	29 %	39 %	-6 %	10 %	-11 %	0 %	-43 %
FI	5 %	20 %	6 %	4 %	-2 %	4 %	-5 %	0 %	-26 %
FR	18 %	21 %	7 %	9 %	13 %	5 %	6 %	4 %	8 %
BE	22 %	37 %	14 %	0 %	7 %	9 %	2 %	16 %	-10 %
EL	20 %	15 %	11 %	8 %	-8 %	26 %	33 %	0 %	-8 %
DE	23 %	25 %	9 %	7 %	9 %	10 %	5 %	13 %	6 %
IT	6 %	-2 %	15 %	1 %	19 %	13 %	17 %	4 %	-37 %
IE	37 %	37 %	20 %	23 %	26 %	8 %	29 %	2 %	-159 %
LU	13 %	43 %	1 %	36 %	3 %	3 %	13 %	0 %	-60 %
NL	30 %	28 %	20 %	14 %	19 %	9 %	-1 %	0 %	-1 %
PT	28 %	27 %	17 %	23 %	16 %	15 %	-9 %	8 %	3 %
ES	27 %	11 %	15 %	23 %	19 %	11 %	-20 %	12 %	19 %
SE	27 %	18 %	5 %	41 %	19 %	11 %	8 %	5 %	-10 %
UK	34 %	35 %	16 %	26 %	19 %	11 %	-3 %	0 %	-3 %

Different data set or timespan is not the explanation.

Both ODYSSEE and JRC use ODYSSEE data for transport!

*ODYSSEE percentages are calculated as ODYSSEE energy savings per energy consumption 2005, and JRC as 100% – Energy intensity-% in 2015, so the levels are not an exact match.

Can we easily compare countries?

Data issues

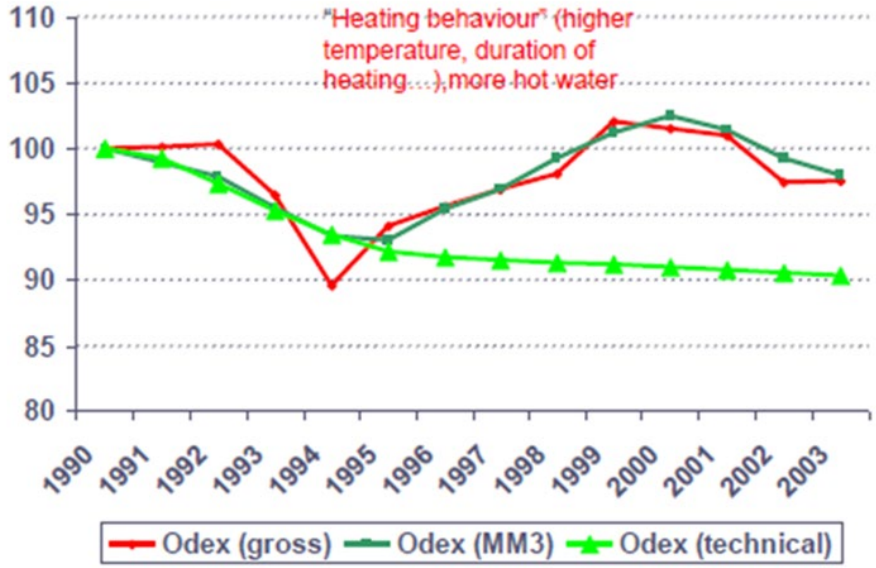
- For households, the results differ quite remarkably. OK, use of different data might explain that?
- Industry and service sector might be different because the setup is so different.
- But as the transport sector shows, using the same timespan and the same input data, the results are miles apart!

- ==> It is not easy to compare countries, when the same methodology (decomposition), the same timespan (2000-2015) and the same data give so vastly differing results

Explanations for the large differencies?

Well, ODYSSEE and "technical ODEX"

- **ODYSSEE:**
  - uses a technique more like composition than decomposition, and it contains a significant residue term, named "Other"
  - the energy efficiency component is based on their technical ODEX-indicators, which only allow for improvements, see light green graph.



Source: Odyssee 2018. Definition of data and energy efficiency indicators in ODYSSEE data base. Documentation at website, last downloaded 27.11.2018.

Methodological issues:

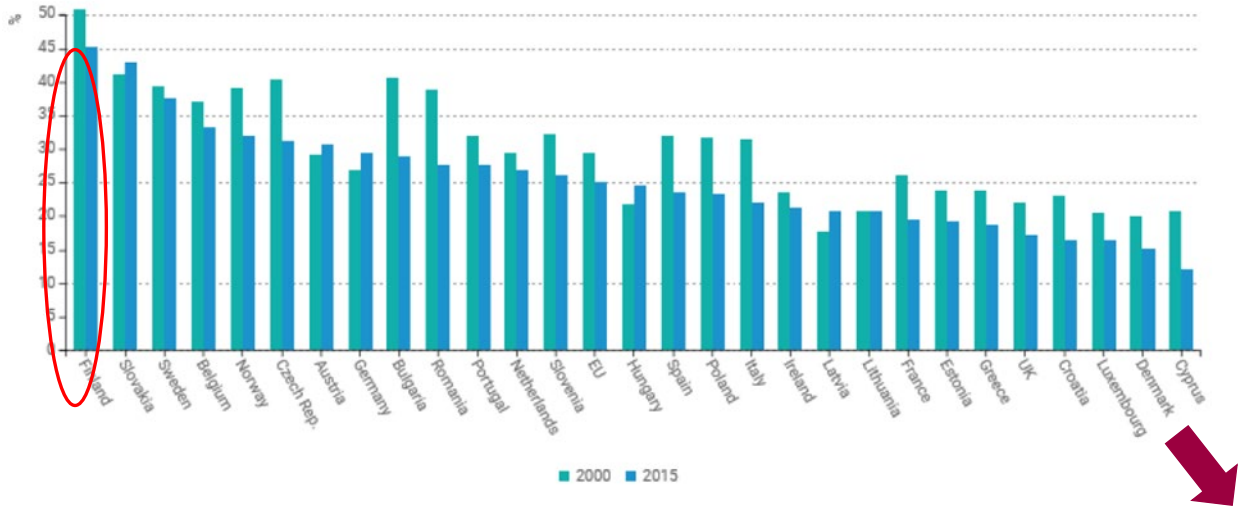
Energy intensity as proxy for energy efficiency 1/2

- **IEA notes that energy intensity as measured by energy consumption per value added or GDP is often used as a proxy for energy efficiency and exclaims that**
  - "This is a mistake, however, since a given country with a low energy intensity does not necessarily have high efficiency. For instance, a small service-based country with a mild climate would certainly have a much lower intensity than a large industry-based country in a very cold climate, even if energy is more efficiently consumed in this country than in the first. "
- **According to IEA, efficiency is a contributing factor in intensity, but many other elements – often more significant – also need to be considered. These include: the structure of the economy (presence of large energy-consuming industries, for instance); the size of the country (higher demand from the transport sector); the climate (higher demand for heating or cooling); and the exchange rate.**

IEA 2014. Energy Efficiency Indicators: Fundamentals on Statistics. OECD/IEA.

Methodological issues:
Energy intensity as proxy for energy efficiency 2/2

- **It must be noted, that Finland fulfils the circumstances IEA describes to a dot.**
  - Finland is the EU-28 country with the highest share of industry energy consumption of the final energy consumption, around 45%.



Share of industry in final energy consumption
(Source: Sectoral Profile - Industry. Pamphlet on ODYSSEE web site. Last visited 26.11.2018.)

- Finland is by far the coldest of the EU-28 countries (Eurostat)
- Finland is a vast country with long distances

Energy intensity based country comparisons are especially unfair for Finland

Explanations for the large differences?

Well, use of value added for industry

- **Even though generally acknowledged that value added is not the best tool against which energy use is measured, energy intensity is still used in decompositions and scoreboards, because it is easy**
  - ==> energy intensive branches that depend on global market prices of both inputs and outputs are especially vulnerable to give wrong energy efficiency signals
  - ==> Finland, with a large share of energy use in both pulp and paper as well as steel manufacturing, is especially maltreated by using energy intensity
- **Better alternative to value added would be to use production indices or product tons for energy intensive branches, as ODYSSEE does**

Indicators for pulp and paper

	ODYSSEE Energy consumption of **pulp&paper** per **paper tons**, MWh/t	Why doesn't ODYSSEE use this, they have the data? Energy consumption of **pulp&paper** per **pulp&paper** tons, MWh/t	IEA, JRC approach Energy intensity of pulp, paper and **printing**, MWh/1000€
Finland	6.61 (0.9%)	3.41 (- 1.8%)	20.66 (- 8.7%)
Sweden	7.47 (4.3%)	3.61 (4.3%)	17.80 (62.9%)
Italy	3.08 (- 9.4%)	3.08 (- 3.4%)	2.87 (- 3.7%)
Lithuania	2.48 (-73.2%)	2.48 (-73.2%)	1.00 (-80.8%)
UK	6.18 (43.5%)	6.18 (43.5%)	2.10 (7.7%)

Change of unit consumption/ energy intensity; 2000-2015 in brackets

Minimum disaggregation level in industry

- To mix services with industry is not good because services is so many times bigger in regard to value added (and less energy intense)

- Only ODYSSEE tries to handle energy intensive industry based on physical production, but even then sub-sector disaggregation level is not enough; we need to go deeper:
  - Mechanical pulp, chemical pulp, newspaper, fine paper, soft tissue
  - Oxygen combustion conversion, electric arc furnace
  - Clinker, cement
  - Share of recycled material: paper, scrap steel etc.

Explanations for the large differences?

Well, missing data issues?

- Assumptions for missing series?
  - JRC informs of actions taken, others not. Using other countries data.
  - Actions taken or not taken can have a severe impact on results and country comparisons.

- Assumptions for missing values?
  - JRC informs on actions, but are using another country's data
  - JRC household heating data only for a few or even one year => trends will be very different
  - IEA shortens decomposition period to 2014 if no 2015 data available, and sometimes estimate the values.
  - ODYSSEE? No information given!

Data used in the decomposition analyses

	IEA	JRC	ODYSSEE
Timespan	2000-2014/5	2005-2015	2000-2014/15
Countries	IEA MS, including several EU MS	EU28	EU28 and Norway, Serbia
Data source	Data provided state wise, with several EU member states providing ODYSSEE data.	Main data source: Eurostat. From ODYSSEE floor area per dwelling and all transport data.	ODYSSEE database
Missing data	Not all data, especially for 2015 available.	Breakdown of FEC by household end use only for 2010-2015, and badly missing even as such with 10 MS having only 2015 and 4 MS nothing. Road FEC missing from 1/3 of MS, air and water activity likewise	Transportation disaggregate data missing, see analysis of JRC on the left. Household appliance level data missing
Action to correct missing data	IEA Secretariat made estimates for missing data.	Use of similar country data. Assumptions to fill data gaps. Year 2015 data missing for several countries, filled by assumptions.	?

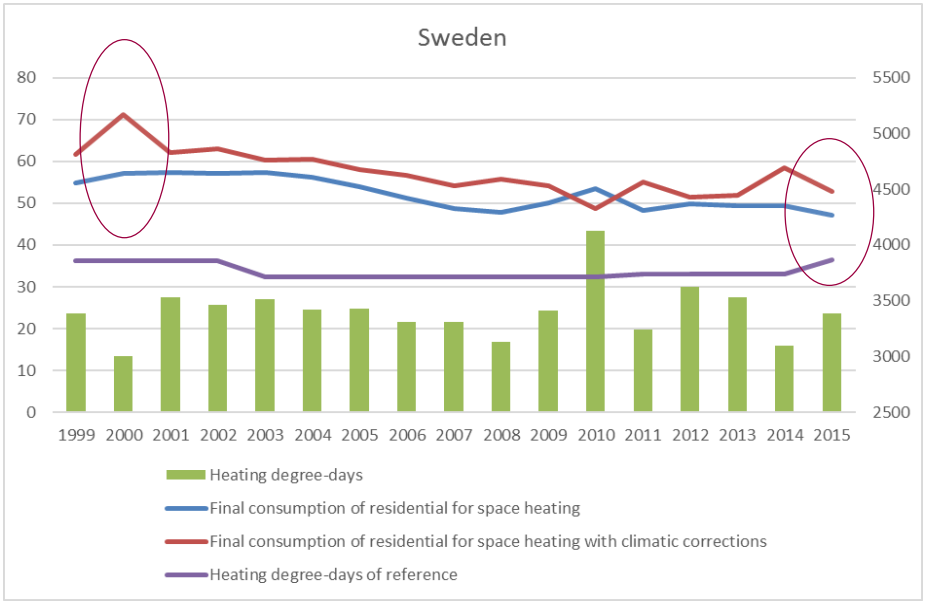
Other data issues affecting comparisons

- **Incorrect data. E.g. Sweden's basic heating energy is already normalized in ODYSSEE, so the normalization done by ODYSSEE is a re-enforcement.**
- **Direct use of on-site RES: Guidelines? Practically none found in sources, but has tremendous impact on households, for example, with the massive penetration in recent years of PV, solar heat and heat pumps.**
- **Calculation and use of heating degree days should be the same for all countries, but isn't in ODYSSEE. This skews country comparisons.**
- **Breaks induced by changes in data definitions and gathering methodologies in time series are not similar in all countries and databases, and this makes country comparisons difficult.**
  - Methodological data changes (NACE etc.) which are or are not changed backwards
  - Correction of historical erroneous data, is it done or not?

Data issues -specifics

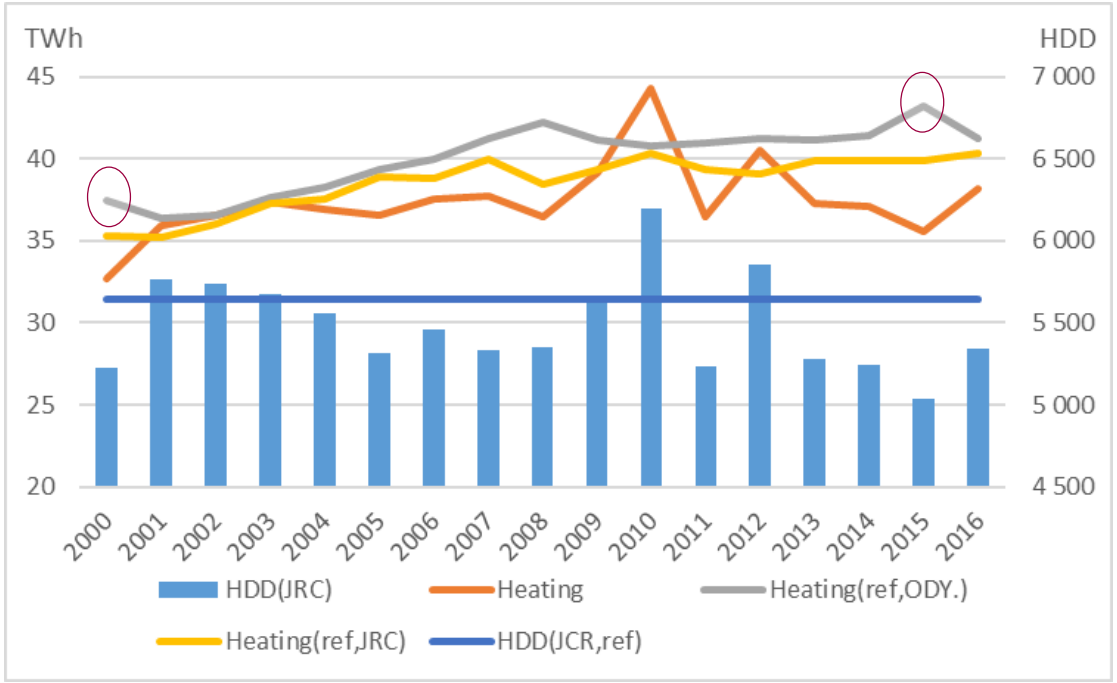
- ODYSSEE/Sweden: basic heating data already temperature corrected, climatic corrections do it again. This gives warm year 2000 a "good" starting point for trend.

- Reference heating degree days in Sweden (and some other countries) are not constant but variate over the years.



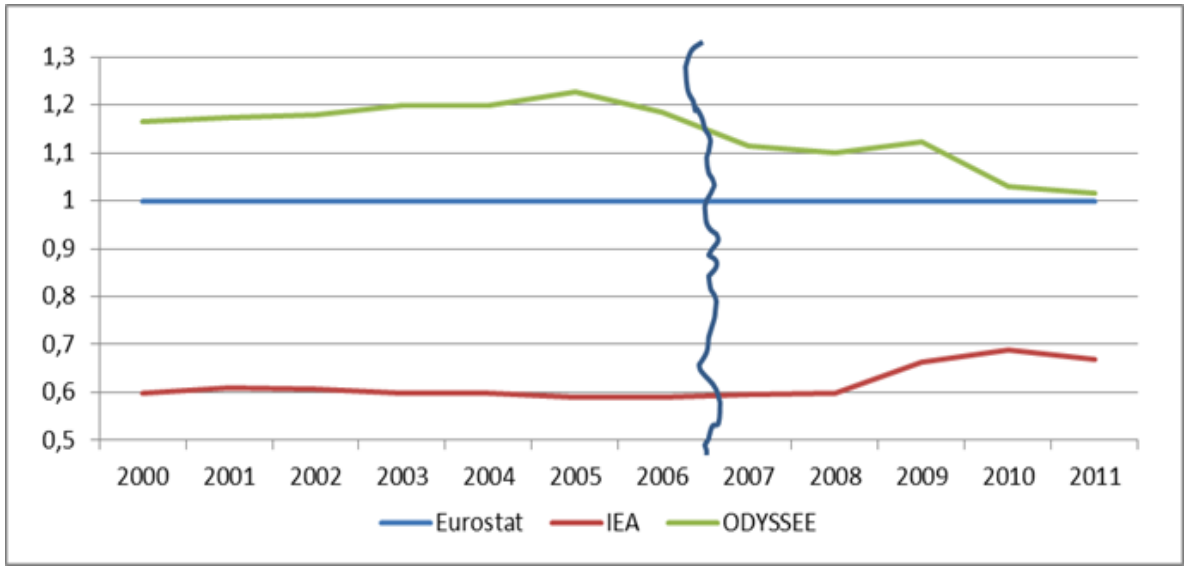
Heating Degree Days (HDD): Case Finland

- ODYSSEE HDD's differ from JRC HDD's
  - Overcompensation by HDD larger for ODYSSEE (grey line) than for JRC (yellow line)
  - In ODYSSEE, year 2015 more overcompensated than 2000 => is seen as energy inefficiency in indicators



Steel sector energy use in Finland as by ODYSSEE and IEA related to Eurostat

The use of different sources gives different results



Source: Koreneff, G., Grandell, L., Lehtilä, A., Koljonen, T. & Nylund, N-O. 2014. Energiatehokkuuden kehittyminen Suomessa. Arviot menneisyydestä ja tulevaisuudesta. [In Finnish; The development of energy efficiency in Finland. Assessments of the past and the future.] Espoo 2014. VTT Technology 180. 70 p. + app. 16 p.

ODYSSEE-Mure Scoreboards

Are ODYSSEE scoreboards better?

- **Short answer: no**
- **They are behefted with many of the flaws already described**
  - Use of technical ODEX in industry trend
  - Only counting paper tons for pulp and paper energy use
  - Using indicators that have no data in many country, e.g. household equipment, and not divulging how missing data series are managed
- **Biased indicators**
  - In individual indicator scoring, outlier countries can really skew the relative ratings of other countries
  - For households, the rate of installed solar heating but not heat pumps (South Europe bias)
  - Services: energy use per employee and not per m^2? This tells more about automation and wage levels?
- **Combined Scoreboard based on energy efficiency level, trend and policies, all having equal weights. Not every statement is equally valid!**
  - Trend does not recognise initial energy efficiency level
  - Policy is based on quite vague and seemingly arbitrary input in MURE

MURE Scoreboard

- **Data on the policy measures controversial**
  - Measures looked at in database have a strong energy production or primary energy bias and relation to energy efficiency (EE) is small (DK10, DK5, IRL8)
  - Numbers influenced by user
    - Energy efficiency impact: RES or CO_2 impact used as EE impact etc. (DK5, IRL8)
  - Calculation of numbers
    - MA10, RO12 (lifetime cumulative?)
  - Power system balancing: IRL9

Conclusions

Can we easily compare countries?

Conclusions

- Data is not good and data quality does vary between countries and in time
- Data errors and misjudgements
- Handling of missing data time series and data points is not revealed or does not support country comparisons
- Decomposition/scoreboard is not disaggregate enough
- Indicators do not take all major factors into account or correct for them on a fair basis (e.g. climate conditions for heating)
- Money is a bad measure of energy efficiency
- Selected structures are not always the best or most logical indicators
- Methodology weaknesses
- => Do not rank countries based on these results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