EPMI
Energy Performance Measurement Institute

Basic European Energy Performance, 2005–2015

The European Union (EU) has several energy performance goals, and they have changed some over time, but this short paper looks only at one basic energy performance value: reduction in total energy use from 2005 through 2015. A few additional background indicators are also provided. If energy performance is defined simply as reduction in total primary energy consumption ("gross inland") relative to 2005, then the results here provide the energy performance values through the year 2015 for several individual countries and the EU-28. A 100% reduction (–100%) means zero-energy has been achieved.

EU targets tend to be difficult to understand. Evaluation of progress towards target goals is usually complicated, and evaluation studies tend to be complex as a result. The presentation here is aimed at understanding the simple energy performance value indicated. No modeling or complicated evaluations are required, only a simple calculation.

Complications could be introduced, if consideration of alternate ways of including or not including hydro, wind, and photovoltaic electricity, as well as biomass, is desired. Consideration of the use of some combined indicator involving both "gross inland" and "total final" consumption could also introduce another complication. All state-specific energy values for consumption (e.g., gross inland is database id B_100900, product id 0000) are from the official Eurostat data for 2015 (June 2017 release).

The simple performance value here does not look at end-use sectors, only overall total energy.

EU Member States are expected to set energy efficiency targets at the national level, but those state-specific targets are not covered here.

Geographic Entities

Eurostat tracks data for more than just the EU, including possible future members of the EU. Of the EU28 member states in 2015, energy performance of the 20 states with gross inland energy consumption in 2015 greater than 0.5 EJ will be presented. Energy performance of Norway, Serbia, Turkey, and Ukraine will also be covered. Energy data for Switzerland are not included in the data file used.

Total 2015 Gross Inland Consumption

Total gross inland energy consumption is the most direct energy link to air emissions, so a list of totals in 2015 is presented. Biomass energy sources in Europe are significant, including biomass that is not obtained as part of a commercial transaction. Total world primary energy consumption (mostly equivalent to gross inland), without including biomass that is not obtained as part of a commercial transaction, is about 580 EJ in 2015. EU28 gross inland consumption is 68.1 EJ in 2015, a little over 10% of world consumption (10+% with or without the non-commercial transaction biomass).

The 20 EU28 member states with 2015 gross inland consumption greater than 0.5 EJ account for 97.6% of the EU28 total of 68.1 EJ. Seven member states: France, Germany, Italy, Netherlands, Poland, Spain, and the United Kingdom; that used more than three EJ, account for three-fourths of EU28 2015 gross inland consumption (74.2%).

Gross inland consumption for the 20 member states plus Norway, Serbia, Turkey, and Ukraine, adds to 77.6 EJ in 2015, about 14% higher than the EU28 by itself.

The table here lists the 24 countries and the 2015 gross inland energy consumption values, as well as the ratio of gross inland to total final consumption for 2015. If a 2005 baseline is used, total EU28 gross inland consumption in the year 2015 is –11% from 2005.

The ratio of gross inland to total final consumption is affected by the relative dominance of the end-use sectors and energy product mix. For example, increased fossil-fuel consumption in the transportation sector will lower the ratio of gross inland to total final.

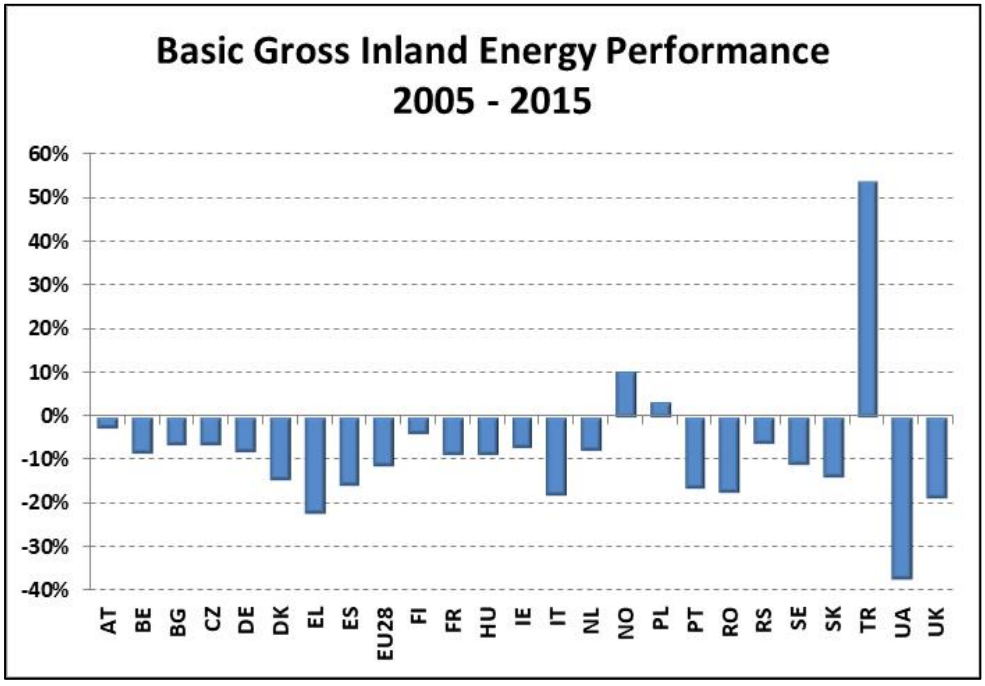
Industrial activity for the EU28 reduced slightly during this period of 2015 re 2005, and reduced for most of the countries shown, except for Austria, Belgium, Germany, Hungary, Ireland, and Slovakia.

Country or EU	2015 Gross Inland Consumption EJ/yr	Ratio of Gross Inland to Total Final 2015
EU28	68.14	1.50
Austria, AT	1.39	1.21
Belgium, BE	2.27	1.52
Bulgaria, BG	0.78	1.95
Czech Republic, CZ	1.78	1.75
Denmark, DK	0.70	1.20
Finland, FI	1.39	1.37
France, FR	10.58	1.75
Germany, DE	13.16	1.48
Greece, EL	1.02	1.48
Hungary, HU	1.06	1.46
Ireland, IE	0.59	1.26
Italy, IT	6.54	1.34
Netherlands, NL	3.25	1.60
Poland, PL	4.00	1.53
Portugal, PT	0.96	1.43
Romania, RO	1.36	1.48
Slovakia, SK	0.69	1.63
Spain, ES	5.08	1.51
Sweden, SE	1.90	1.43
United Kingdom, UK	7.99	1.45
Norway, NO	1.26	1.60
Serbia, RS	0.62	1.80
Turkey, TR	5.52	1.41
Ukraine, UA	3.72	1.70

Basic Energy Performance, 2005–2015

First the basic performance for all 24 countries and the EU28 will be presented. The figure below shows the basic energy performance metric: change in total gross inland consumption for each in 2015 relative to 2005, as a percentage change. Also see data table at end.

Almost all entities have achieved reductions relative to 2005, and the EU28 may be on a path to reaching a 20% reduction in gross inland consumption by 2030, from 76.65 EJ in 2005 to 61.3 EJ in 2030 (1831 Mtoe in 2005 to 1465 Mtoe in 2030). (All 2015 and 2005 data directly from the data base file, ktoe converted to Mtoe, and TJ converted to EJ.)



Gross Inland vs Total Final

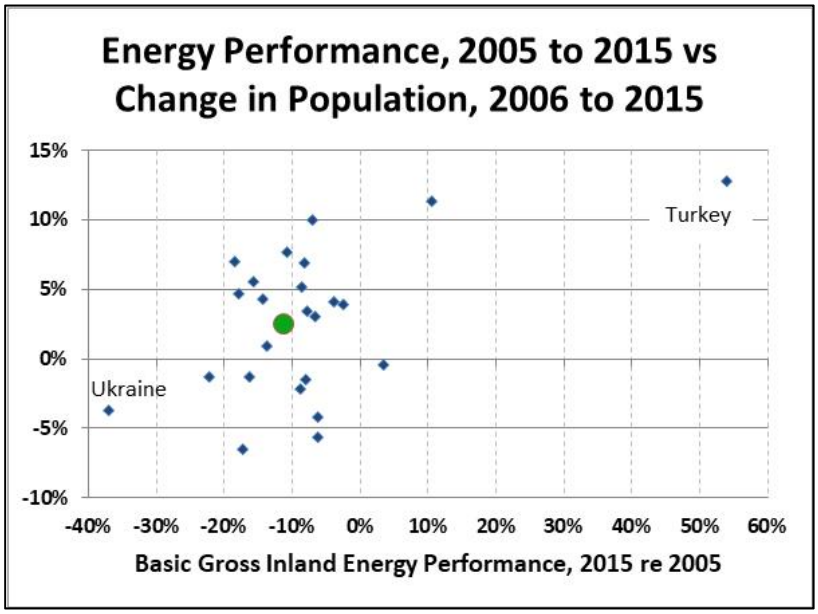
Energy performance could also be defined in terms of reduction in total final energy consumption (data id B_101700, product = 0000). Eight out of the 24 countries had a larger percentage reduction in total final consumption compared to the percentage reduction in gross inland consumption (Poland had a larger increase.). Instead of showing another graph, the ratio of percent change in total final to percent change in gross inland consumption is shown in the table here. Over half of the ratios are less than one. A ratio less than one means the energy performance using gross inland consumption is better (larger reduction from 2005 to 2015) than performance using total final consumption for all countries that had a reduction. For the three countries that had an increase, the ratio lower than one means total final consumption increased less on a percentage basis than gross inland consumption increased. Poland had a small increase in both, although total final increased almost twice as much as gross inland on a percentage basis. Norway had a small increase in total final but a much larger increase in gross inland consumption.

Country or EU	Ratio of Total Final to Gross Inland Energy Performance
EU28	0.82
Austria, AT	0.65
Belgium, BE	0.27
Bulgaria, BG	1.06
Czech Republic, CZ	1.24
Denmark, DK	0.70
Finland, FI	1.02
France, FR	1.20
Germany, DE	0.36
Greece, EL	0.96
Hungary, HU	0.58
Ireland, IE	1.54
Italy, IT	0.85
Netherlands, NL	1.34
Poland, PL	1.86
Portugal, PT	0.96
Romania, RO	0.66
Slovakia, SK	0.94
Spain, ES	1.12
Sweden, SE	0.52
United Kingdom, UK	0.75
Norway, NO	0.07
Serbia, RS	2.39
Turkey, TR	0.86
Ukraine, UA	0.94

Energy and Population

Worldwide, over time, the correlation of energy use to population is very strong (see for example, EPMI technical note, *Energy and GDP*, http://epminst.us/states/Energy_and_GDP.htm). A strong trend for individual states in the United States has also been found.

In Europe there is little correlation over this time period. The figure here shows, for the 24 countries covered, the scatter of basic energy performance (percentage change in energy consumption from 2005 to 2015) vs percent change in population from 2006 to 2015 (the larger circle data point is for the EU28). Population change is notable in that there are so many countries where population declined (Ukraine is one of these, and 2015 population for Ukraine was not available from Eurostat and was estimated. based on the Google estimate for 2017). The issues related to migration and armed conflicts may also have an influence but will not be considered here. The bottom line is that energy performance in Europe is erratic with respect

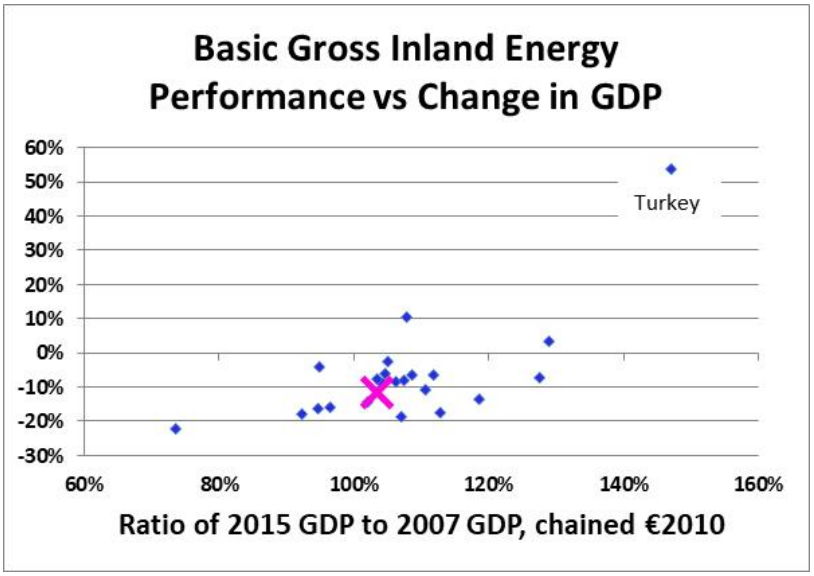


to population change. The data scatter is just as pronounced for total final consumption. (Eurostat population data only readily available back to 2006.)

The R-square for these data without the EU28 is 0.27, and this is artificially high, since Turkey is so far out (also see GDP below) and has too much influence. The R-square of these data without Turkey or the EU28 is 0.12. Even though this is a cross-sectional correlation, energy performance, when defined as percentage change in energy use over a time period, is barely correlated to population change in European countries for this time period, noticeably different than for the United States. Change in population will not be tabulated in the data table at the end.

Change in GDP

A more pronounced trend for energy performance is seen with change in GDP from 2007 to 2015, and one important reason for the increased energy use in Turkey is the large increase in GDP. The largest increase in GDP and the largest increase in population occurred in Turkey, indicating part of the cause of the largest increase in energy use over this time period. Also of note, the large decrease in energy use in Greece appears strongly related to the large drop in GDP. Similarly, four other countries have energy use decreases associated with drops in GDP over this time period (see table at end). More importantly, energy performance of –5 to –20% was achieved for several countries having GDP increases of 5% or more.



The figure here shows the more definite trend of increasing energy use (decreased energy performance) with increase in GDP. The magenta '**X**' is the EU28 data point. Eurostat GDP data are only readily available back to 2007.

The R-square for these data is 0.51 without the EU (and data for Ukraine are not available). For a cross-sectional correlation, this indicates a fairly strong trend. In this case Turkey also has a large influence, but the trend line is also in the direction of the data point for Turkey (removing Turkey reduces the R-square to 0.23, but still a much stronger trend than for population).

Percent Renewables

The percent of total final consumption provided by renewable energy sources is estimated at almost 17% for the EU28 by Eurostat. Basic energy performance could be complicated further by trying to include some type of adjustment for renewable energy, but that will not be attempted here. There is a slight trend in the data toward less percent reduction in total final consumption as percent renewables increase, mainly driven by the Scandinavian countries, but the trend is small and there is a lot of scatter in the data (R-square = 0.1). Adjustments to the definition of energy performance could attempt to deal with this trend. Eurostat percent renewables values are tabulated in the data table at the end.

Tracking Energy Performance

The available data allow changes in consumption to be tracked over time, and the initial results here show basic energy performance as the percent change in gross inland consumption from 2005 to 2015. For this definition, the results here provide energy performance results for 24 countries and the EU28 as of the year 2015. As stated before, a 100% reduction (–100%) means zero-energy has been achieved.

The method of tracking energy performance presented here should be both a support to understanding how consumption is changing over time and whether this type of performance is useful for helping to track other types of goals. If climate protection requires that total gross inland consumption be reduced, then such energy performance results may assist in tracking climate goals.

EPMI will plan to update these data intermittently, possibly depending on the nature of current events. EPMI is independently presenting these basic energy performance results for Europe to foster a more understandable assessment of progress toward energy goals, without having to understand multi-level lemmas or complicated computer models or evaluation methods.

Data Table

The following data table presents the key data discussed in this paper. Energy performance is as described above, and energy performance is provided for both gross inland and total final consumption for the 24 countries and the EU28.

The absolute change in industrial energy fraction is the change in percentage points from 2005 to 2015 of the ratio of total final industrial consumption to the sum of total final consumption for all sectors. This industrial energy fraction is also displayed for the year 2015, as a percentage. As an example, Italy in 2015 is shown to have 22.3% of national total final consumption in the industrial sector. The "absolute" change for Italy from 2005 to 2015, is –6.71%. This absolute change means the 22.3% fraction in 2015 is –6.71 percentage points less than in 2005. The fraction in 2005 could be determined, if needed, by calculating: 22.3 + 6.7 = 29.0. Thus, the fraction of total final consumption for Italy in 2005 in the industrial sector was 29%.

The industrial sector accounts for 25% of total final consumption for the EU28 in 2015, which is a reduction of about 2 percentage points from 2005.

Change in GDP is the ratio of 2015 GDP to 2007 GDP, measured in chained €2010, as a percentage.

The percentage of total final consumption provided by renewables in 2015 is directly from Eurostat (data table nrg_ind_335a, data id 119800).

Eurostat data were downloaded in July 2017, after the June update for energy.

Data Table for Basic European Energy Performance 2015

Country or EU	2015 Gross Inland consump-tion	Gross Inland energy perfor-mance	Total Final energy perfor-mance	Absolute change in industrial fraction	Percentage of total final by renew-ables	Ratio of 2015 to 2007 GDP, Chained €2010	2015 Industrial fraction of total final
	2015 EJ	Percent	Percent	points	2015	percent	percent
AT	1.392	-2.57%	-1.68%	1.91	33	105%	33.3%
BE	2.270	-8.20%	-2.19%	1.22	7.9	106%	33.2%
BG	0.775	-6.29%	-6.66%	-11.11	18.2	112%	28.5%
CZ	1.777	-6.57%	-8.14%	-5.87	15.1	109%	30.9%
DE	13.155	-8.11%	-2.90%	1.68	14.6	107%	28.7%
DK	0.702	-14.27%	-10.02%	-3.23	30.8	102%	15.1%
EL	1.024	-22.16%	-21.26%	-0.90	15.4	74%	19.0%
ES	5.084	-15.81%	-17.70%	-8.18	16.2	96%	23.5%
FI	1.388	-3.91%	-3.99%	-2.91	39.3	95%	44.2%
FR	10.576	-8.60%	-10.35%	-0.96	15.2	104%	19.9%
HU	1.055	-8.73%	-5.05%	5.92	14.5	104%	24.5%
IE	0.594	-7.12%	-10.97%	1.03	9.2	127%	21.5%
IT	6.538	-17.84%	-15.10%	-6.71	17.5	92%	22.3%
NL	3.247	-7.79%	-10.47%	-2.00	5.8	103%	29.4%
NO	1.257	10.53%	0.71%	-4.92	69.4	108%	31.6%
PL	3.996	3.48%	6.47%	-2.02	11.8	129%	24.2%
PT	0.963	-16.30%	-15.63%	-2.74	28	95%	27.8%
RO	1.357	-17.33%	-11.42%	-10.93	24.8	113%	29.6%
RS	0.617	-6.15%	-14.67%	-8.42		105%	28.2%
SE	1.904	-10.82%	-5.65%	-1.23	53.9	111%	36.3%
SK	0.688	-13.68%	-12.84%	3.16	12.9	119%	43.9%
TR	5.515	53.95%	46.64%	-4.61	13.6	147%	30.9%
UA	3.720	-36.95%	-34.78%	-8.01			40.4%
UK	7.986	-18.54%	-14.00%	-2.99	8.2	107%	18.8%
EU28	68.139	-11.11%	-9.09%	-2.17	16.7	103%	25.3%