Application of Energy Intensity Changes as a Proxy for Energy Savings

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Abstract

Energy savings can be calculated, using the change in the value of indicators, such as the average energy consumption per dwelling for space heating. The results per indicator can be aggregated to savings at sector level. A problem is that statistical data needed become only available one year later or even more. Moreover, some data might not be available. Therefore, there is a need for an alternative that provides timely information on recent savings trends, also when not all data are available. The paper describes how sectoral energy intensities can serve as a proxy for realized energy savings in end-use sectors. The intensities relate sectoral energy consumption to performance quantities, such as number of households or total industrial production, which are readily available. For past years the year-to-year changes in intensity figures have been compared with the change in yearly sectoral savings, calculated in the European Odyssee project on energy indicators, and covering both autonomous trends and the effect of policy. Based on the fit suitable intensities are selected. It proves that in the majority of countries and sectors an intensity can be found that give a reasonable fit with savings. However, which intensity is the most suitable can vary between countries.

Introduction

Energy savings for end-use sectors can be calculated using various indicators for targeted energy uses, such as average energy consumption per dwelling for space heating. These so-called top-down or total savings include both the autonomous trends and the effect of policy to stimulate energy efficiency. It is also possible to calculate so-called bottom-up savings that show the effect of policy measures on energy efficiency. Generally, bottom-up calculation combine an implementation effect of a policy measure (number of high-efficiency boilers installed due to a subsidy scheme) and unitary savings (estimate of the savings per boiler, compared to a reference boiler). Possible top-down and bottom-up savings methods for sectors and targeted end-uses have been extensively analysed in (EMEEES, 2009), (Vreuls et al, 2008), (Lapillonne, 2009) and (Boonekamp, 2009). The European Commission has defined a selection of these methods in (DG-TREN, 2010) that countries can apply in their savings evaluation for the Energy Service Directive (ESD, 2006).

In the following the focus is on calculation of total/top-down savings. For Europe this is accomplished every year in the Odyssee/MURE project that includes a large set of energy indicators for all end-use sectors (Enerdata, 2008). The results for the individual indicators are aggregated to calculate savings at sector level and national level. For instance, Household savings are derived from indicators that show the change in average energy consumption for space heating, for hot water use and for electric appliances. However, the statistical data needed for some individual indicators become only available after up to two years. A delay for one indicator means that the calculation of aggregated savings is also delayed. In order to provide timely information on recent savings trends at aggregated level there is a need for so-called short-term indicators. These indicators do not replace the savings indicators but function as a proxy for the savings in a recent year.

Possible short term indicators are energy intensities for end-use sectors, and at the national level. The intensities relate sectoral energy consumption to performance quantities, such as number of households or total industrial production. Data on these aggregated quantities are more readily available, often one year earlier than (some) detailed data underlying the savings calculations. In (Boonekamp, 2012) it was analysed whether intensities can serve as a proxy for savings, by comparing the year-to-year changes in intensity values and calculated savings. If there is a fit for most years the intensity value for the most recent year can be used to estimate the savings at aggregated level for that year. Intensities can also be used as a proxy when part of the data for the calculation of the indicators is missing.

In literature many studies on energy intensities can be found, e.g. (Ramirez, 2005) and (Schipper, 2001). Together with the activity and structure effect, the energy intensities explain the trends in energy consumption for sectors or countries. On energy savings countless studies have been published, especially on the calculation of bottom-up savings. However, the number of studies for the calculation of top-down savings at aggregated level is limited because here large databases are needed. Next to the references mentioned above also (IEA, 2010) should be mentioned. As to the relation between intensities and savings, literature sources are sparse. No study has been found so far that systematically analyses the relation between decreasing energy intensities and energy savings.

Regression analysis is often used to analyse the relation between quantities that develop over time. However, regression results apply for the whole period, while here the issue is how year-to-year changes for intensity and savings are related, in order to "predict" the lacking savings in the most recent year. This methodological choice is discussed in the section on defining a quantitative relation between year-to-year changes in savings and intensity.

Finally it must be stressed that the intensities do not replace the savings indicators but function as a proxy for the savings figure at aggregated level. This proxy value is faster available, also in case not all data are present, but will be less accurate than the saving indicators themselves. The changes for intensities have to be checked regularly with that for the aggregated top-down savings , in order to see whether they can function still as a proxy.

The following section describes the calculation of indicators, aggregated indices at sector level and savings. Then the intensities found for the various sectors in the Netherlands are presented. In the third section the intensities are compared with the aggregated savings indices per sector as to their yearly fit. In section four results are presented for France and Germany as well. Finally, conclusions are drawn about the use of intensities as proxy for savings.

Energy indicators and savings

Energy indicators in the Odyssee database

Energy indicators relate energy consumption to a chosen quantity, e.g. a physical output (ton of steel), a performance (person-km driven per car) or number of energy using devices (refrigerators). Indicators provide insight into energy trends. For instance average electricity consumption per refrigerator can help to explain the trend for electricity consumption in households.

Unit consumption indicators show trends for a chosen targeted energy use, such as energy use for space heating. The unit consumption per m^2 floor area in dwellings is calculated from total yearly energy consumption for space heating and the number of dwellings times their average size.

Variations in yearly climate can distort the real trend for unit consumption; therefore, energy consumption figures are corrected for the deviation from average temperature during the heating season and for the severity of winters in the different countries.

A decrease in the indicator value is interpreted as an increase in energy efficiency, from which an amount of energy savings is calculated. A large set of indicators is available in the Odyssee database (www.odyssee-indicators.org), that has been set up to enable the monitoring and evaluation of realised energy efficiency improvements and related energy savings. The database covers the 27 EU countries as well as Norway and Croatia. Data on energy consumption, socio-economic quantities, energy using systems and the indicators values and realized savings are available from 1990 on.

Aggregated indices and savings

The trend for unit consumption is expressed as an index, with a value of 100 for the base year. In this way the trends for all indicators can be shown in a comparable fashion. Moreover, trends for various indicators can be aggregated to provide overall efficiency indices per sector and the whole economy. With these so-called ODEX (ODyssee indEX) the overall energy efficiency progress can be evaluated. The trend for ODEX Households is shown in Figure 1 for all EU countries, accompanied by the underlying trends for space heating, appliances and hot water use.

The total energy savings, expressed in Joule or Mtoe, are found by multiplying the relative change in the indicator or aggregated index with the energy consumption that is connected to the indicator or index. The energy consumption can be taken from the base year or the most recent year.

Energy intensities (per sector)

Available intensities

Intensities relate energy consumption to socio-economic quantities, e.g. at notional level Total Primary Energy Consumption (TPEC) against Gross Domestic Product (GDP). Generally these quantities are readily available from national statistics. Often more than one quantity is available for defining the intensity. At the national level the quantities available are:

- GDP (Gross Domestic Product)
- Population (number of inhabitants).

The intensity per sector is the ratio between total energy consumption and a sector-specific quantity. The following quantities are normally available per sector:

- Households: number of people or number of households
- Industry: value added or production volume
- Services: number of employees or value added
- Transport: GDP or transport activity (person-km/tonne-km).

The Odyssee database contains statistical data on all quantities mentioned above. Therefore, different intensities can be calculated for the same category of energy consumption, e.g. for industry energy consumption per unit of value added or per unit of production. The availability of multiple intensities enables to analyse which intensity functions best as proxy for energy savings (see next section).

Calculated energy intensities

Here calculated intensity values are shown for the Netherlands. It regards the sectors Households, Industry and Transport and the national level. Intensities for Services can be calculated, but cannot be compared with indicator based savings because these are not calculated due to lack of detailed data. The values are given for the years 1990 to 2009 (the latest year at the time of the study). The longest possible period (for calculated savings) has been taken in order to detect a structural relationship between trends for intensities and trends for savings.

Household sector

For the sector Households two intensities have been calculated:

- Final energy consumption per person ("Final/capita")
- Final energy consumption per household/dwelling. ("Final/HH")

Energy consumption for space heating is influenced by yearly variations in climate. To highlight this effect both intensities have been calculated without ("Final") and with ("Final T-corr") correction for climate (see Figure 2). It can be observed that the intensity trend is much more stable with correction for climate.

Industry sector

For the sector Industry the calculated intensities are:

- Final energy consumption per unit of Value Added ("Final/VA")
- Final energy consumption per unit of Production volume. ("Final/PV")

Figure 3 shows that the intensity based on Value Added decreases faster, but the year-to-year trend is often the same.

Transport sector

For the sector Transport the calculated intensities are:

- Final Energy consumption including air transport per unit of GDP ("Total/GDP")
- Final Energy consumption excluding air transport per unit of GDP ("Final/GDP")
- Final Energy consumption excluding air transport per unit of transport performance, expressed in a combination of person-km and tonne-km ("Final/Trsp")

In the Netherlands energy consumption for air transport is almost fully connected to international air traffic, which is often considered as "bunkers" and not as part of the national energy consumption. Therefore, intensities with and without air transport have been calculated. From Figure 4 it can be seen that the intensity with air transport shows a slower decrease because the relatively large increase in fuel use for international air traffic (growth rate beyond that for GDP).

For the third intensity energy consumption is related to the transport performance, which is a mixture of person-km travelled and tonne-km transported, weighted with their (base-year) fractions in total transport energy consumption. Remarkably, the intensity value increases with time. Given the fixed weighting factors this cannot be due to a shift between passenger and freight transport.

However, it can be due to a shift to more energy-intensive modes of transport, both for passengers (bigger and heavier cars) and freight (more small scale transport with vans).

National level

At the national level the calculated intensities are:

- Primary energy consumption per unit of GDP ("Prim/GDP")
- Primary energy consumption per inhabitant ("Prim/capita").

The figures for primary energy consumption differ for the calculation of intensities (based on Eurostat figures) and the calculation of national savings (based on consumption data according to Odyssee database). Therefore, the intensity with GDP has been calculated with both consumption figures ("Eurostat" and "Odyssee"). Figure 5 shows that the overall trend is almost the same, but year-to-year changes can be different. The population based intensity shows an increase, while the GDP based intensity shows a decrease. This is due to GDP growing much faster than population.

Comparison of trends for intensities and savings indicators

Method of comparison

It cannot be expected that intensities and total savings show exactly the same pattern, because intensities also incorporate structural effects (which are eliminated as much as possible in the Odyssee calculations). Structural effects encompass all factors (other than the quantity connected to the intensity) that influence energy consumption. For example in Households structural effects regard larger dwellings, more appliances per household, less people per household and lower occupation rates due to working elsewhere.

On the other hand, higher energy prices and autonomous technological developments will contribute to more savings, but also help to decrease the energy intensities. Therefore, it is plausible that a change in the amount of total savings works through in the intensity value. An increase in savings, meaning a decrease in the value of ODEX, should show up as a decrease for the intensity value, and vice versa. In order to check whether the sectoral intensities are a good proxy for sectoral savings, represented by the ODEX, the direction of the year-to-year changes (increasing or decreasing) in both quantities are compared. If the direction of change is the same for most years it can be concluded that the intensity change is a proxy for increasing or decreasing savings from one year to the next.

A comparison is presented for the case of the Netherlands (see Table 1). Later, results for other countries are shown as well.

Comparison for Households

The changes in the ODEX value have been compared with that for the person based intensity and the household based intensity (see Table 1). A rating "F" denotes a fit, meaning that the sign (direction of change from year to year) is the same for ODEX savings and the intensity. It can be concluded that the intensity based on number of households fits exactly as good with the ODEX changes as the intensity based on number of inhabitants.

Earlier intensities have been presented with and without correction of energy consumption for yearly deviations in the average temperature during the heating season. If no temperature correction is applied, this results in much less fits than for the cases with correction. Therefore, only the cases with corrected energy consumption are presented here.

Comparison for Industry

For industry the trends for savings (ODEX-index) and the intensities, based on production volume (PV) or Value Added (VA) are compared. From the number of fits ("F") between ODEX and intensity in Table 1 it can be seen that intensity based on PV provides a better fit with the ODEX savings than the intensity based on VA.

Comparison for Transport

The yearly changes for ODEX have been compared with that of the intensities based on GDP or transport performance (see Table 1). It proves that the intensity based on transport performance (person-km driven and tonne-km transported) provides a much better fit with ODEX savings than the intensity based on GDP, especially in recent years.

Although the data to calculate intensity values are often readily available, this is not always the case for transport performance. Therefore another alternative is used, namely the specific fuel use of cars, trucks and buses, which is also calculated in the Odyssee database on indicators. In order to aggregate these specific uses, the number of trucks and buses have been expressed in equivalent cars. The year-to-year change in specific fuel use per equivalent car could be a good proxy for year-to-year savings because technical efficiency gains provide most of the savings in transport. Table 1-C (lowest line) shows that the fit for intensity, based on specific fuel consumption of vehicles (equivalent car), scores better than that for transport performance.

Comparison at national level

The changes for the aggregated ODEX at national level have been compared with that of the national intensities, based on inhabitants or GDP. From Table 1 (see "National") it can be seen that the intensity based on GDP shows a rather good fit with the national ODEX savings. However, the fit with the intensity based on population is almost absent.

Intensities as proxy for savings for other countries

Standard and alternative proxy

The comparison between savings indices and intensity values has been extended to the countries France and Germany. In the following these results are combined with that for the Netherlands, in order to draw general conclusions on using intensities as a proxy for energy savings.

In the previous section different intensities per sector and at national level have been tested for the Netherlands. Based on the best fit between ODEX and intensity trends the following intensities have been chosen as the standard proxies for yearly savings:

- Households: final energy consumption per household
- Industry: final energy consumption per unit of production volume (PV)
- Transport: final energy use per unit of transport performance (person-km/tonne-km)
- National: total primary energy consumption per Euro of GDP.

The other intensities function as alternative proxy, in case the standard proxy does not deliver satisfying results for Germany or France.

Intensities as proxy for Germany

The fit between year-to-year changes for ODEX and chosen intensities is shown in Table 2. The fit for households with intensity based on number of households is quite good. Remarkably the fit is also the same for intensity based on number of inhabitants.

The fit for industry using PV for the intensity is also very good (without 2009, for which no values could be calculated due to data not yet available). The fit for the alternative intensity based on VA is less pronounced.

The fit for transport using an intensity based on transport activities is modest, especially for the nineties. The fit is slightly better for an intensity based on GDP and slightly worse for an intensity based on vehicle performance (specific fuel consumption per equivalent car).

Finally, the fit at national level using GDP for the intensity is very good. The alternative intensity, based on per capita total energy consumption, scores less good.

Intensities as proxy for France

The results on the fit between year-to-year changes for ODEX and intensities for France are shown in Table 3. The fit for households defined intensity is reasonably good, but the fit is also good for the intensity using the number of inhabitants. Remarkably the fit is even better for an intensity based on energy consumption without temperature correction, which is not used in the analysis. The fit for industry using PV based intensity is very good (without 2009, for which no data were available). But the fit for the alternative VA based intensity is also reasonably good. The fit with the transport activity intensity is reasonably good (without 2009 when data lacked at that moment). Remarkably, the fit for an intensity based on GDP is almost as good, taking into account the longer period (including 2009). However, the fit for the other alternative, intensity based on specific fuel use per equivalent car, is much worse. At national level the fit for GDP is reasonably good, and much better than the fit for per capita intensity.

Overview for standard proxies in all countries

Table 4 shows for the three countries the year-to-year fitting results, per sector and for the standard proxies (intensities), The amount of year-to-year fits (see “F” in table 1, 2 and 3) is expressed as a percentage of maximum number, i.e. all years in the period 1990-2009. It proves that Germany performs best overall; the Netherlands is second with the exception of transport, and France scores lowest, except for transport.

Further, it can be concluded that the standard proxies can be used for all sectors and all selected counties, if a fit for two-thirds of all years is assumed as sufficient. If the minimum score is raised to three-quarters, only the standard intensity for industry suffices for all countries.

Acceptable alternative proxies per country

In a number of cases there is an alternative for the standard proxy (intensity) that scores the same or slightly worse as to the fit with the ODEX savings (see previous sections). Acceptable alternatives are defined as:

- A score of at least 80% of the score for the standard intensity.
- A fit for at least two-thirds for all year-to-year changes.

The resulting alternatives are shown in Table 5. It can be concluded that for households there is a reasonable alternative intensity in the form of per capita energy consumption. For transport there is either the alternative of energy consumption per unit of GDP or specific fuel use per equivalent car. For industry the alternative intensity based on VA is possible, but the score for the Netherlands is slightly below the threshold of two-third. At national level there is no alternative intensity as per capita total energy consumption only scores above the minimum thresholds as defined above for Germany.

From fit to quantitative relation

Possible methods

The preceding analysis only regards the direction of the year-to-year changes in the intensity and the ODEX savings. No attention was paid to the strength of the relation between intensity changes and changes for savings, as represented by ODEX.

Often regression analysis is used to analyse the correlation, the strength of the relation, between two quantities that both develop in time. However, regression analysis, performed on the values for the period 1990-2009, provides average values for the correlation over the whole period. The focus of this study is not on general trends but on the relation for the most recent year. For this year circumstances will often differ from the trend for the whole period. Therefore, the quantitative analysis should concentrate on the relation for the separate year-to-year changes.

In the following the separate year-to-year changes for intensities and ODEX savings are related to each other, and the results summed over the whole period. The overall score is compared with the number of fits from the qualitative approach presented earlier. This approach enables to estimate the amount of savings from the size of the change for intensities. It also provides an extra check on the reliability of intensities as short term indicator for savings.

Quantification of the fittings

For each case for which there is a fit between intensity and ODEX savings, the ratio between the change in the ODEX savings and the change in the intensity is calculated. The ratios are summed up and divided by the number of fits, thus providing the average ratio between the changes in value for both quantities. These average ratios are used to provide an estimated value for the savings on basis of the known value for the intensity in the most recent year.

Two remarks must be made:

- For cases without a fit no rate is calculated because here the ratio is negative (due to different directions of both changes). The sum over, positive or negative, ratios will not provide useful information on the strength of the fit.
- In a few cases the change in the intensity value is close to zero and a very high ratio is found that has substantial influence on the average ratio. This distorting effect has been avoided by capping individual ratios. Capping the ratio at 3 proves to be best, because the number of capped cases is small, while the effect of the capped case on the average value is limited.

Table 6 shows the average ratio per sector and intensity, for the three countries. In most cases the average ratio lies between 0.9 and 1.6 which shows modest differences in the relation between intensities and savings. The value mostly above 1 indicates that changes in savings are relatively stronger than changes in intensity.

Consistency between fits and ratios

Table 6 also shows the fraction of fits which can be compared with the average ratio. On the consistency between fits and ratios the following can be observed:

- For about the same level of fits different ratios are found, and the other way around. This indicates that the strength of the relation (number of fits) and the quantitative value (how changes in intensities relate to that of savings) are different things.
- On the other side, when comparing all intensities, a higher fraction of fits often means a higher average ratio. This is true for Germany and the Netherlands but not for France showing contradictory results.

An explanation for these contradictory findings may be the following. For relative minor changes in savings the changes for intensities will also be smaller. Given the margins in statistical data there will be a higher probability that the direction of change for the intensity switches, thus leading to less fits. For relative large changes in savings (and probably large changes in the intensity) statistical margins will play a much smaller role, thus resulting in more fits. Therefore, the most appropriate intensity must be selected on basis of the number of fits and not on the value of average ratios.

Estimation of recent savings

The savings for the most recent year can be estimated as soon as data become available for the proper intensity. The proper intensity is found from the results for the best fit between intensities and the ODEX-savings, as described for example countries earlier. The estimated savings are calculated from the change in the intensity (for the most recent year) and the value of average ratio. For each case a separate ratio must be used, based on historic analysis for each country, sector and possible intensity, as described earlier.

It must be stressed that the saving figures are estimates which could be found wrong later. When all data have become available the analysis will not always show a fit (positive ratio) and the applied value for the average ratio is not by definition valid for each year-to-year case. This is especially true if there are large changes in the factors that define savings and/or intensities. For instance, in times of a sudden economic crisis, large changes in intensities are possible due to structural changes in the economy. The relation with savings development will be less clear than in times of stable economic development.

Summary and conclusions

In the evaluation of realized energy efficiency and savings few recent figures can be provided due to the late availability of detailed data, needed for calculating indicators on savings. There is a need for a more readily available quantity that can serve as a proxy for the savings in recent years, at least at sectoral and national level. Moreover, for some indicators detailed data lack, which also prevents the calculation of savings at the level of sectors or country as a whole.

Energy-intensities per sector or at national level, such as total energy consumption per unit of production for Industry, are based on readily available aggregated statistical data. Therefore, it has been investigated whether intensities can function as proxy for savings at the sectoral or national level. The analysis is based on data from the Odyssee/MURE project on energy indicators, that are also used by European countries and Eurostat.

In the Odyssee/MURE project so-called ODEX savings at sector and national level are calculated, regularly, based on an aggregated set of energy indicators per sector. For the investigation several intensities have been calculated for each sector and the direction of the year-to-year changes has been compared with that for the ODEX. The number of fits, meaning a lower intensity in combination with more savings, or vice versa, was used to rate intensities as a useful proxy for savings.

For the Netherlands it proved that for every sector at least one appropriate (80% yearly fits over the period) intensity is available. At the national level the fraction of fits is lower. When including Germany and France more or less the same results are found.

The fits have been converted to an overall quantitative ratio between changes in the intensity and changes in the ODEX savings. With the fractions an estimate can be made of the savings in the most recent year, based on the known intensity change. In general the ratios are consistent with the number of fits for the different cases (country, sector, chosen intensity).

Overall it can be concluded that there are suitable intensities available to serve as a proxy for savings in cases that calculated savings are not available. What is a suitable intensity can sometimes differ per country and sector. However, it is always possible that the preliminary (estimated) savings diverge from the final savings based on the statistics (when available). Especially in dynamic situations, like a sudden economic crisis, intensities may be less useful. Finally, it must be remarked that this analysis must be repeated every number of years in order to check that each chosen intensities is still a good proxy for sectoral or national savings in a country.

Tables

Table 1. Year-to-year fit between ODEX savings and intensity values (Netherlands)

Household	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09
Intensities																			
Capita	F	F	F				F	F	F	F	F	F	F	F	F	F	F	F	F
Household	F	F	F				F	F	F	F	F	F	F	F	F	F	F	F	F
Industry	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09
Intensities																			
PV	F	F	F	F	F	F	F		F	F	F	F		F	F	F	F	F	F
VA		F	F	F	F	F	F			F		F		F	F	F	F		
Transport	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09
Intensities																			
GDP				F	F	F	F	F	F	F	F	F							
Activity				F	F	F	F	F				F	F	F	F	F	F	F	
Equiv.car	F	F	F		F		F	F	F	F	F		F	F	F	F			F
National	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09
Intensities																			
GDP	F		F	F	F	F	F	F		F		F		F	F	F	F		F
Capita	F		F	F		F	F								F	F			

Table 2. Fitting results standard proxies for Germany

	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09
Households																			
Number	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F
Persons	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F
Industry																			
PV	F	F	F	F	F	F	F	F	F	F		F	F	F		F	F	F	-
VA	F	F	F	F			F	F	F	F			F	F		F	F	F	-
Transport																			
Activity			F	F			F	F		F	F	F	F	F	F	F	F	F	-
GDP	F		F	F		F	F	F		F		F	F	F	F	F	F	F	-
Equiv.car		F		F		F	F			F		F	F	F	F	F	F	F	-
National																			
GDP	F	F		F	F		F	F	F	F	F	F	F	F	F	F	F	F	-
Capita	F	F	F	F			F	F	F		F	F	F	F	F		F		-

Table 3. Fitting results standard proxies for France

	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09
Households																			
Number	F	F	F	F			F	F	F	F		F			F	F	F		F
Persons	F	F		F			F	F	F	F		F			F	F	F		F
Industry																			
PV			F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	-
VA			F	F		F	F	F	F	F	F	F		F	F	F	F	F	-
Transport																			
Activity	F		F	F	F	F	F	F	F	F			F	F		F	F	F	-
GDP	F		F	F	F	F	F		F	F			F	F	F	F	F		F
Equiv.car				F		F	F			F		F	F	F	F	F	F		
National																			
GDP				F	F		F	F	F	F	F		F	F	F	F	F		-
Capita				F			F				F		F		F	F	F		-

Table 4. Overview of fitting results for the countries

	France	Germany	The Netherlands
Households (number)	68%	95%	84%
Industry (PV)	89% (*)	89% (*)	89%
Transport (Activity)	78% (*)	72% (*)	63%
National level (GDP)	67% (*)	89% (*)	74%

(*) based on the period 1990-2008, without 2009

Table 5. Acceptable alternative proxies for the countries

Sector	France	Germany	The Netherlands
Households	Capita	Capita	Capita
Industry	VA	VA	VA?
Transport	GDP	GDP / Equivalent car	Equivalent car
National level	x	Capita	x

(x = no alternative meeting the thresholds available)

Table 6. Qualitative fit and quantitative ratio for intensities and savings

	France		Germany		Netherlands	
	Fraction fits[1]	Average ratio	Fraction fits	Average ratio	Fraction fits	Average ratio
Households						
HH	68%	0.89	95%	1.28	84%	1.20
Capita	63%	0.74	95%	1.48	84%	1.63
Industry						
PV	89%	0.91	89%	1.17	89%	1.37
AV	78%	1.28	72%	1.26	63%	1.91
Transport						
Activity	78%	1.11	72%	1.00	63%	0.63
GDP	74%	1.18	78%	1.41	47%	0.42
Equivalent car	53%	1.95	67%	1.00	74%	0.91
National						
GDP	67%	0.90	89%	1.00	74%	1.69
Capita	39%	2.42	72%	1.56	37%	1.35

Figures

Figure 1. Aggregated efficiency indices and ODEX for Households

1 Number of year-to-year changes in ODEX savings indicator fitting with changes in the intensity, compared to total number of year-to-year observations in the period

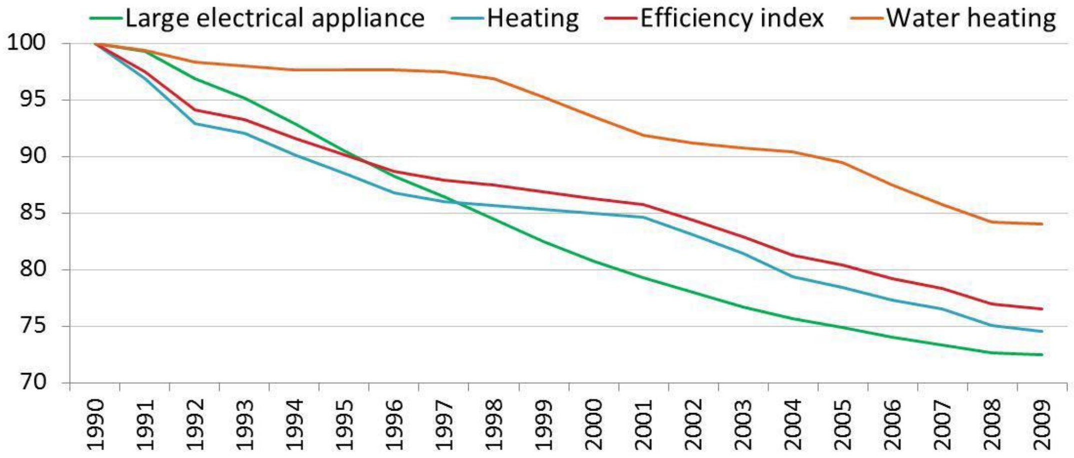


Figure 2. Energy intensities for Households

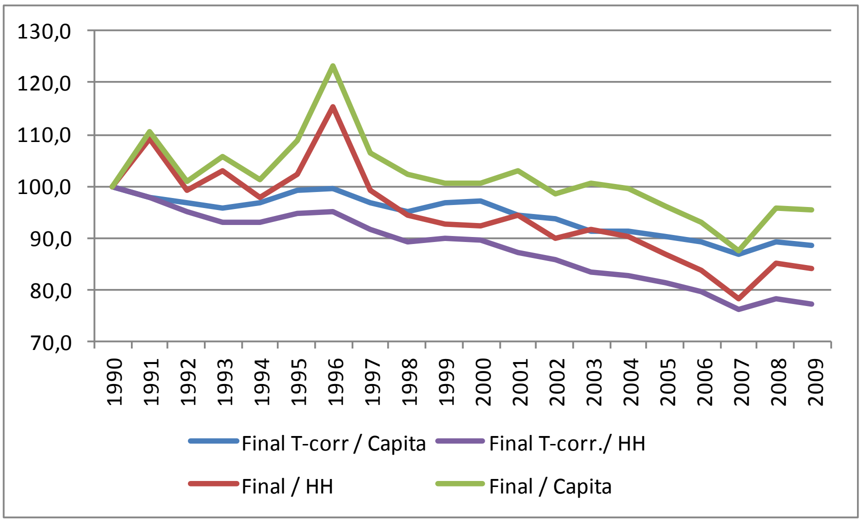


Figure 3. Energy intensities for Industry

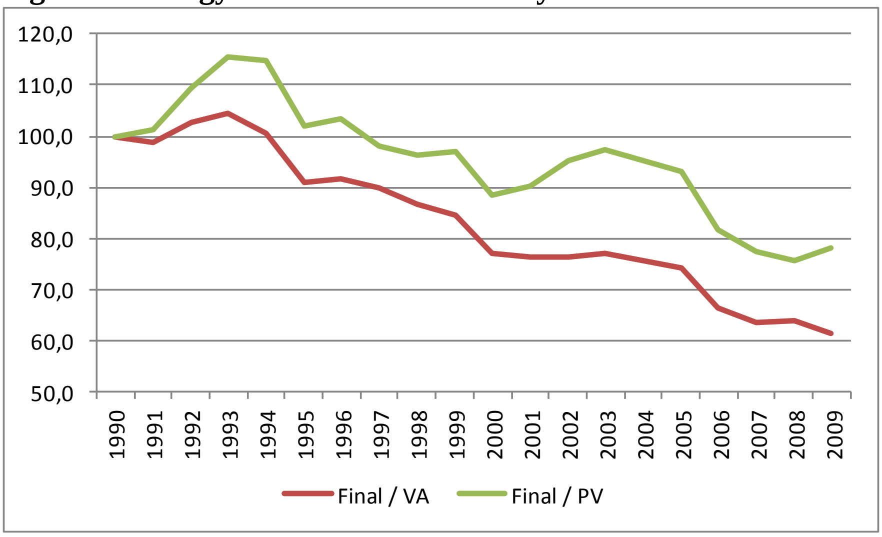


Figure 4. Energy intensities for Transport

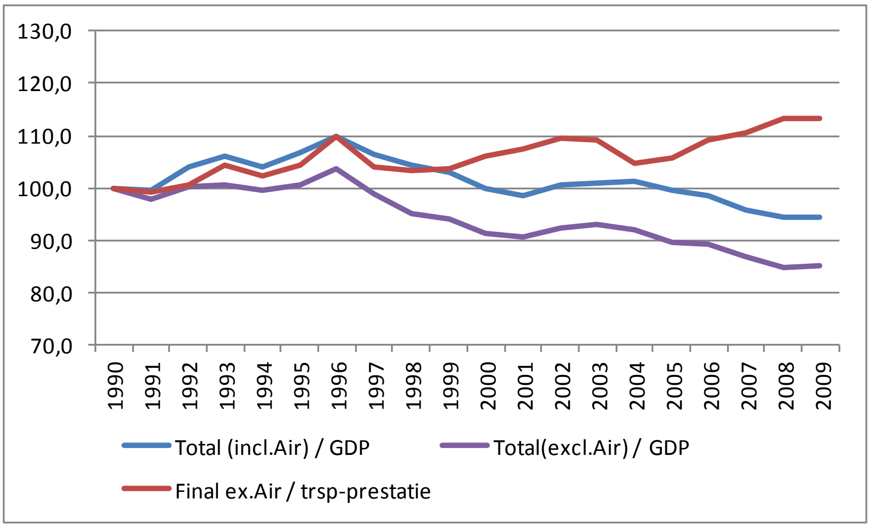
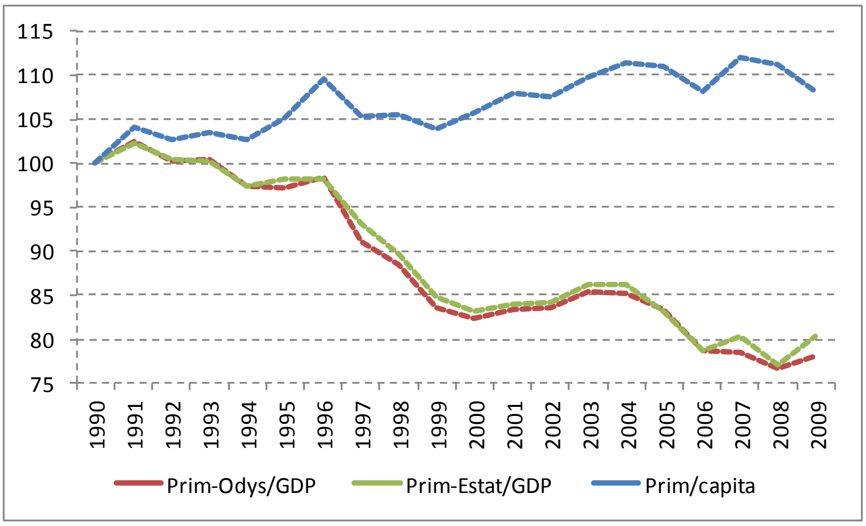


Figure 5. Energy intensities at national level



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