Measuring savings target fulfilment in the proposed Directive on energy end-use efficiency and energy services (COM(2003)0739) Developing a framework for a harmonised measurement scheme for energy efficiency improvements in the EU

Randall Bowie and Håvard Vaggen Malvik
European Commission
DG for Energy and Transport
B-1049 Brussels
randall.bowie@cec.eu.int
havard.malvik@cec.eu.int

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Abstract

The proposal for a Directive on Energy End-Use Efficiency and Energy Services sets forth savings targets to be achieved by improved energy end-use efficiency. While most of the issues in the proposal have now been resolved, the proposed savings targets, their precise nature and how to measure them remain to be agreed. This paper presents concepts for a target measurement system that can be further developed into a common, harmonised methodology.

The purpose of this paper is to look at what we are measuring in the way of energy efficiency improvements, to consider the available tools and methods, and to propose common structures and concepts for a possible common methodology. Such a methodology should still allow for national methodological differences and for the use of existing national measurement systems to the extent possible.

We will consider current techniques being used in the Member States and elsewhere for measuring and verifying energy efficiency improvements. We will also look at their limitations and propose ways to overcome these.

Introduction

SUMMARY OF CONTENT OF THE EE&ES DIRECTIVE

The proposal for a Directive on Energy End-Use Efficiency and Energy Services (EE&ES Directive) was adopted by the European Commission on 10 December 2003. This Directive proposal, presently under discussion in the European Parliament and Council, sets forth savings targets to be achieved by improved energy end-use efficiency. The need for mandatory energy efficiency targets has been underscored by the Commission and by the European Parliament. An indicative energy intensity target has already been adopted in a Council Resolution, but has not had the desired effect[1]. The development of a reliable system for measuring energy efficiency is for the purpose of measuring fulfilment of a measurable cost-effective savings target. The savings target should therefore be quantifiable and met with cost-effective measures ensured by the Member State. A measurement system with a fair share of bottom-up measurements and a target of a more binding nature can promote this objective. Soft energy efficiency measures, such as those set forth in Directive 93/76 (the "SAVE Directive") have already been tried and have shown not to lead to acceptable results.

The proposal for a Directive on Energy End-Use Efficiency and Energy Services sets forth an energy savings target of 1% annually, accumulated for a fixed period of six years, as illustrated in the figure below.

1. The Council, in its Resolution of 7 December 1998 (OJ C 394, 17.12.1998, p. 1) accepted an indicative target for energy intensity improvement of final consumption by an additional 1 percentage point per year, up to the year 2010, as useful guidance with which to increase efforts in this field.

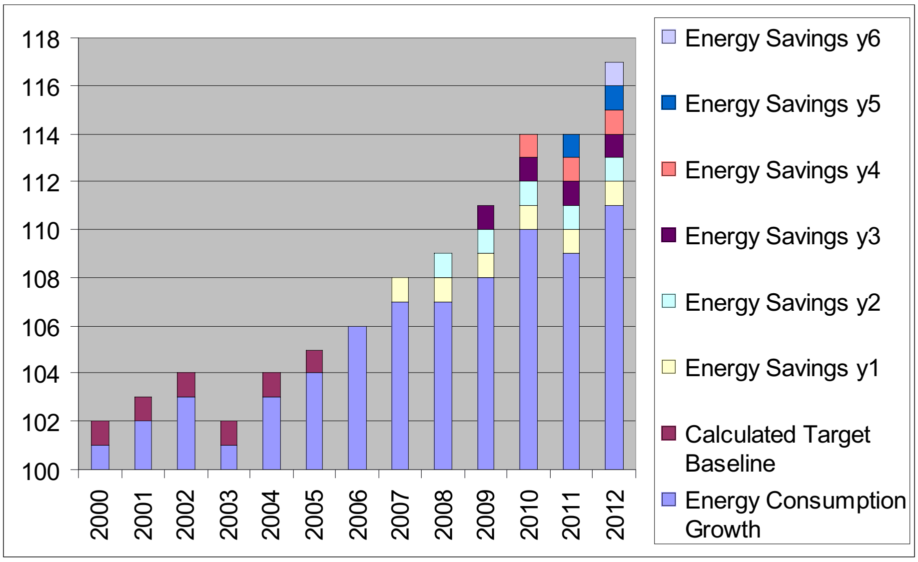

Figure A.

The baseline for the energy saving target is calculated using the average energy consumption during the years 2000-2005[2]. If the average 6 year energy consumption in Member State A is 103.2 TWh, 1% of this constant amount of energy (1.032 TWh) will then have to be saved cumulatively during the implementation period of the EE&ES Directive (2007-2012). This process builds on the fact that measures taken in 2007 will continue to have the same impact on energy consumption – in absolute terms – during each year in the implementation period, allowing the effect to accumulate. If a measure that starts in 2007 has a life-time that is shorter than 6 years, then a new measure with the same impact would need to be launched when the first measure expired.

It should be pointed out that, as shown in the diagram, energy consumption:

(1) can continue to increase during the target years in spite of the savings target. The target may have only a dampening effect on total energy consumption if consumption increases more in absolute terms than the energy that is saved.

(2) The size of the increase in energy consumption during the target years (due e.g. to increased rates of GDP growth), does not have any effect on the size of the target during the target years. This is because the size of the target is established (once and for all) for the entire length of the target period and thereafter remains constant throughout the target period[3].

The rest of the proposed EE&ES Directive includes a sub target on the Public sector of 1.5% measured the same way as above and a set of obligation for companies that distribute or sell energy within a Member State. Other ways the Directive proposal also includes a toolbox of measures to help Member States to save energy (e.g. energy fund, energy audits, informative billing etc.). However, in this paper we will only look at issues related to Article 4, Annex I and Annex IV.

NEED FOR MEASURING ENERGY SAVINGS AND SETTING TARGETS

The interest internationally in quantifying and verifying energy savings has increased in recent years, attributable mainly to international, multinational, and national energy and environmental agreements and targets that require energy savings to be measured.

EU Member States support the idea that an energy-efficient economy has environmental, budgetary, competitiveness, employment and other advantages. Many Member States have also recognized the value of savings targets against which to measure progress toward improved energy efficiency and saved energy.

Monitoring of trends is important if we are to know what we are actually accomplishing in the way of improved energy use. We need to know where we have been, where we are in relation to others, in which direction we are going and how far we can go in a cost-effective manner. Ideally, we also need to know which measures have led to the improvements. In a more global sense, we need to ensure that all Member States contribute to the common goal of improved energy efficiency that will realize fully the existing savings potential.

THE DIFFICULTY OF MEASURING ENERGY EFFICIENCY IMPROVEMENTS

Measuring energy production is a relatively easy and straightforward process. One can, for example, meter or estimate how much energy is produced by a wind turbine under various conditions. Energy savings caused by energy efficiency improvements, on the other hand, are more diffi-

2. Please note that this target is not shown to scale, but has been made larger (starting with 100 TWh) to increase visibility.
3. In the diagram, the year 2006 is not included, neither in the calculated target base line nor in the target period. This is because of statistical lag, i.e., the time required for Eurostat statistics to be made available after they have been received from the Member States.

cult to measure and even more difficult to visualise. This is because we are measuring energy that is not produced, the amount of energy that would have been consumed had we not undertaken energy efficiency measures.

Generally speaking, energy savings (ES) can be measured by metering or estimating energy consumption (EC) before and comparing it to the consumption after the implementation of one or more energy-efficiency improvement measures (where the change in energy consumption due to energy efficiency measures (**Δ**ECm) is thus equal to ECm0 minus ECm1). We should always adjust for extrinsic factors e.g. occupancy levels, level of production etc. (**Δ**ECe). We could, in principle, also adjust for energy consumption changes caused by behavioural and life-style changes (**Δ**ECb) and changes in products that deliver the same energy-services (**Δ**ECp), e.g. information from internet instead of on paper. Combining all the possible causes of energy savings, we have, ES = **Δ**ECm + **Δ**ECe + **Δ**ECb+ **Δ**ECp. Thus energy savings, in addition to being the result of energy efficiency measures, can be caused by changes in behaviour and life-style and the products/installations used – which may or may not mean changing the level of service provided. With today's energy-efficient technology, it is possible to save energy and at the same time maintain or improve standards and levels of service. A vast array of cost-effective energy efficiency improvements is available that allows energy savings to be accomplished without reduced levels of service or comfort.

However, to simplify , in cases dealt with in this paper, measuring energy savings is a question of metering or estimating energy consumption before the implementation of an energy-efficiency measure and comparing it to energy consumption after the measure has been implemented, taking into account certain extrinsic conditions (ES = DECm + DECe). Which extrinsic factors that should be taken into account is a matter to be agreed upon on at Member States level[4]. Once agreement is reached on methodology, energy efficiency improvements can then be estimated with considerable accuracy, provided data are available on the technical specifications and energy-consumption characteristics of the technologies and techniques in question.

TECHNICAL AND ECONOMIC ENERGY SAVINGS POTENTIALS

Technical and economic energy savings potentials can provide valuable guidance in determining the limits for improving energy efficiency. With today's rising energy prices, this cost-effective savings potential has been increasing, but is estimated roughly to be at least 20% of total energy consumption, realisable within 10 years[5]. This means that 2% per year could be saved for the EU as a whole. In addition, it has been shown that this potential for improvement is at least 1% per year in all Member States[6]. So we do have an idea of how far we can go in a cost-effective way.

The Case for Bottom-up Measurement

THE NEED FOR ACCURATE MEASUREMENTS

Besides security of supply, the growing global environmental problem is one of the driving forces for improving energy efficiency. The entry into force of the Kyoto Protocol in February 2005 highlights the importance of actions in the field of energy efficiency. By most estimates, about half of the EU Kyoto commitment for 2008 -2012 will be met by improved energy efficiency[7]. It is also clear that this large contribution will continue into the post-Kyoto period because new energy-efficient technology will continue to raise the available potential.

FLEXIBILITY MECHANISMS

The Kyoto Protocol contains three market-oriented instruments, known as "flexibility mechanisms". They are all designed to promote emissions reductions at the least possible cost. These are emissions trading (ET), which enables countries with binding emissions targets to buy and sell emission reductions among themselves; the Clean Development Mechanism (CDM), allowing credit for projects undertaken in developing countries, and Joint Implementation (JI), under which one country with a target may receive an emission credit for performing an emissions-reduction project in another such country. JI starts in 2008.

For JI and CDM trading of (*ex-ante* determined) emission reduction by means of energy efficiency will require that there is (1) a way to set a price tag on the measures and (2) a way to calculate and accurately measure the energy-reducing effect (or energy efficiency improvement) of the measures.

Within the EU, ET covers more than 12 000 installations in the 25 Member States. Under the scheme, a company that owns one of these installations must calculate the cost of reducing its emissions compared to buying the necessary emission allowances (issued by the Member State). This means that the costs of different CO_2 reduction measures need to be identified. These measures will in some cases be end-use energy efficiency improvement measures, meaning that the effect of such measures will be internally calculated by the owners of the installation covered by ET. This will be done even if in the ET system itself does not require the calculation of realized energy savings due to the fact that only CO_2-rights are traded, being the (ex-post) difference between the allowed amount and the actual emission.

WHITE CERTIFICATES

Today we see a growing interest in white certificates. Italy and France are developing such systems, independently of one another. The UK has a measurement protocol and programmes in the area that would permit white certificates trading.

4. The following list is indicative: Occupancy levels; opening hours for non-domestic buildings; installed equipment intensity (plant throughput); product mix; plant throughput, level of production, volume or added value, including changes in GDP level; using schedule for installation and vehicles; relationship with other units and maybe also weather conditions, such as degree-days.
5. The technical potential for energy savings is even higher - about 40% (EC 2000). Calculations based on reports from MURE database (2000), Wuppertal Institute (2005). ECOFYS (2000), ODYSSEE (2004) and European Commission (2005).
6. Explanatory Memorandum to the proposed Directive on energy end-use efficiency and energy services (COM(2003)0739.
7. Action Plan for Energy Efficiency, 2000.

White certificates serve two purposes. They are **accounting tools**, which attest to the fact that a required amount of energy savings has been realized within an agreed timeframe. The possessor of white certificates will use this accounting system to declare his savings in an energy value after surrendering the white certificates to the responsible authority, for meeting an agreed target. In addition, white certificates can be traded, either bilaterally or in a white certificate market (Pavan, 2002).

In Italy, compulsory targets for increased efficiency of energy use are now defined. The system requires gas and electricity distribution companies to comply with this obligation by delivering "Energy Efficiency Titles" in proportion to the gas or electricity they distribute.

In the UK, trading of white certificates (called obligations) can be performed by means of bi-lateral contracts based on saved TWh[8]. Cross-border trading of white certificates can in the future help steer investments to the most cost-effective projects. Such trade between Member States would of course require a harmonised measurement and methodology. Each participating country would need to make sure that what it buys from another country is measured the same way using the same methodology.

DEMAND SIDE MANAGEMENT

For decades monitoring of energy savings has also been part of Demand Side Management (DSM) that aimed at influencing the pattern of electricity use, often to save on peak production capacity in electricity supply. Especially in the USA extensive programmes have been running and various methods for monitoring have been developed.

THE NEED FOR BOTTOM-UP MEASUREMENTS IN TRADING SCHEMES

JI and CDM and white certificate systems require bottom-up measurements. ET also indirectly favours a bottom-up system because each installation covered by ET will have to calculate the costs and results of different CO_2 reduction measures. A bottom-up measurement system means that savings (and emissions), obtained through the implementation of energy efficiency measures, are expressed in relevant quantities and common units (or emissions) and then aggregated with results from other implemented or planned measures. Such aggregation of results can be done at company, local, regional and national level, a task handled very well with standardised templates, websites, databases etc., using standardised lists of measures and assumptions on their average lifetimes, estimates of the average energy saving impact and calculations of the total expected or deemed (technical calculation, often ex ante) energy savings. These measures may consist of all types of activities such as wall cavity insulation in a building, the installation of CFLs, etc. It could also be done at the level of policy measures, such as subsidy programmes for high-efficiency appliances, focused information campaigns, etc[9].

In a bottom-up system, the impact of measures can usually be estimated before the impact is actually implemented or metered, using deemed savings. In fact, metering is required only to calibrate the real effect of such measures and, when necessary, to verify. This can often be done using representative samples. This is an important characteristic of bottom-up measurements because it means the results can be known without waiting several years to receive statistics on energy consumption. An additional advantage of using bottom-up measurements is the additional information obtained on exactly which policies and measures deliver the savings.

Top-down calculations often lack the possibility to measure *ex ante*[10]. The long time required for collecting statistics from the Member States adds to the problem of using top-down methods to obtain rapid feed-back for making policy decisions. Top-down calculations are also often less accurate than bottom-up systems because aggregations of sometimes heterogeneous sector statistics are used in such calculations.

OTHER APPLICATIONS OF BOTTOM-UP MEASUREMENT SCHEMES

Besides planned trading or white certificate schemes and markets, many countries today use bottom-up calculation models to keep track of energy savings. These include e.g. UK, Belgium (Flanders), Denmark, Ireland and Norway. Others have partial systems that cover individual private and government programmes. The energy savings results from some of these countries provide extensive data on savings and costs, allowing cost effectiveness rates of policy measures to be easily calculated, as well as the total energy saved.

In the UK e.g. the "Home energy programme" is a programme operated by the Energy Saving Trust (EST). It has been calculated, on the basis of bottom-up measurements of energy efficiency measures such as wall cavity insulations taken in the domestic sector, that the programme achieved 990 GWh of energy savings in 2003 and 2004, costing 23.78 M Euro, or 2.4 Euro cent per kWh saved[11].

In Denmark energy efficiency advice to industry and the public sector carried out by the utilities in 2003 resulted in 105 GWh in energy savings. The costs were 9.3 million Euro. This gives for the 8-year average lifetime of the saving effect a programme cost of 1.1 Euro cent per kWh. An evaluation of the Danish Electricity Saving Trust shows that their measures cost less than 1 Euro cent per saved kWh, calculated over a 10 year period.[12]

In Flanders, a performance obligation for the electricity grid companies was introduced in January 2003. An annual energy savings target of 1% was set for 2003. In 2003,

8. Such trading has been carried out in the U.K. in a limited pilot project.
9. A workshop on Member State measurement and verification practices was held on 3 March 2005, sponsored jointly by the European Council for Energy Efficient Economy, the European Parliament and the European Commission. This workshop, attended by representatives from most Member States, focused on the practical issues of bottom-up measurement systems, their usefulness, accuracy, costs and limitations. Among the conclusions were that an element of bottom-up methodology is possible and practical in a future EU-harmonised measurement and verification scheme. Summary of Workshop, Final Version 19 March 2005. Eoin Lees Energy, Oxon, U.K.
10. Forecasting of developments in energy intensity indicators is, in fact, possible using time-series analysis. These can be interesting to use as a rough approximations when deemed savings are not available.
11. Energy Saving Trust, 2005.
12. P. Bach, DEA, 2005.

763 GWh was saved by measures undertaken by the grid companies. The cost of the programme to stimulate savings was 11.8 M Euro, or 1.5 Euro cents per kWh saved yearly (Collys 2005)[13]. The programme cost for reaching the target is covered by the electricity grid tariffs. For low voltage clients (<1 000 V) a target of 2% was set for 2004[14].

In Norway energy savings results from all programmes and activities run by the national energy agency, Enova SF, are aggregated and reported annually to the responsible ministry. In 2003, 12.6 million Euro was spent on different energy efficiency programmes in the household, industry and service sectors, resulting in 424 GWh energy saved. On average this means an investment of 3 Euro cents per kWh (or 0.3 ct per kWh with a 10 year life time of the savings effect). In 2004, the same programmes delivered 646 GWh, costing 17 million Euro. On average the programme cost per kWh was reduced to 2.6 Euro cents (Enova 2005).

As shown above, bottom-up measuring systems for energy savings already exist in several European countries today. If a harmonised European system that is partially bottom-up is agreed, one should of course build on the considerable experience already gained in these Member States. However, more information is needed on the accuracy of the figures displayed above. These energy savings results can not be directly compared today.

The Case for Top-down Measurement

THE NEED FOR TOP-DOWN MEASUREMENT: LIMITATIONS OF THE BOTTOM-UP SYSTEM

While bottom-up measurements could have a high degree of precision for most measures, they are difficult to apply to certain types of measures, especially those taken in the past and lacking data, and for certain types of more cross-cutting measures such as taxes. Bottom-up calculations often fail to capture multiplier effects or market transformation, "autonomous" market development and miss "rebound effects", "free-riders" and "free-drivers".

DEFINITION OF TOP-DOWN SYSTEMS

A top-down measurement system is one in which the amount of energy saved is calculated using more aggregated sectoral levels of energy consumption and savings as the starting point. Adjustments of the annual data are then made for a number of extraneous factors such as degree days, structural changes, product mix, purchasing power parity, etc. to derive a measure that gives a fair indication of e.g. total energy used per unit of GDP, energy used per square meter of housing space or energy per person-kilometre. Structural changes, such as decreased production in a Member State's energy-intensive aluminium industry, needs to be adjusted. If no adjustment were made, such structural changes would appear as an improvement in energy efficiency. Top-down indicators can, in principle, be adjusted for structural changes to a fairly satisfactory degree. This means that energy consumption has to be disaggregated unto the level where the reference energy consumption (without savings) can be coupled to the trend for an appropriate production or consumption variable. A standardised method for carrying out such adjustments is possible and can be agreed, although generally, adjustments for structural changes in top-down indicators need further improvement.[15]

TAXES

Energy taxes steer energy consumption by raising or lowering the price of energy, prompting the consumer to seek ways to mitigate the effects on his budget of the price change. Quite often the consumer will seek measures that are already being promoted or subsidized through other programmes or policies. This, of course, introduces a risk for double counting because it becomes difficult to distinguish between the effect of the tax and the effect of the other measures that have been measured bottom-up at the same time. Regression analysis, the use of price elasticities[16] and similar tools, used together with top-down calculations, help reduce the risk of double-counting. Harmonised methods for using these tools and methods, together with bottom-up calculations can be agreed.

PREVIOUS MEASURES OR "EARLY ACTIONS": BOTTOM-UP OR TOP-DOWN?

An area that may create measurement difficulties is that of actions taken in the past. Some measures, such as improvements in national building codes put in place a number of years ago can continue to have a positive impact on energy efficiency. For these there is often enough information available to use a bottom-up calculation: this savings can be estimated by comparing energy consumption without the improved building code to energy consumption with the improved codes and scaling the difference up to the square meters in the building stock covered. The calculation should, of course, reflect the fact that normal technological development will produce possible new measures for improvement that are not used because the existing building code may not require it. This means that in some cases old building codes that have not been revised for many years may actually be having a negative or detrimental effect on improving energy efficiency. If data is available for a number of years in the past, bottom-up calculations on the building stock can be carried out. If such data are not available, top-down calculations will be necessary to capture some of the improvements in the building sector. Generally speaking, for individual measures launched in the past for which technical and impact data are missing, top-down calculations will be necessary.

13. These are primarily household customers, with a wide use of CFL lighting campaigns. Energy-intensive industry is not included because high voltage distribution (>70 kV) is regulated at the federal level in Belgium.

14. These costs can be compared with the production cost of electricity at wholesale level, which is now almost 5 euro cents (off-peak) and over 10 euro cents (peak price). In the heating sector the relationship between the cost of end-use saving and the wholesale price of (non-electric) heating is similar.

15. If an industrial sector is very heterogeneous in its product mix and energy intensities, the adjustment may require looking at a relatively disaggregated level of statistics on industrial production and at a large number of groups. If a sector is judged to be homogeneous the adjustment can be done on a higher level of aggregation.

16. Most studies indicate relatively low price elasticity for energy, often around 0.2. This means that a 10% energy price increase will lead to a 2% reduction in energy consumption.

MULTIPLIER EFFECTS AND MARKET TRANSFORMATION

Many energy efficiency measures that are implemented will continue to impact on and transform the market in both direct and indirect ways, like "rings on water". The effect of energy-efficiency labels, e.g., is not only on the buyer of appliances, but on the manufacturer as well. The manufacturer observes the increased market share for high-efficiency models and increases his production of these models thereafter. This often leads to lower unit costs and lower prices. **Public procurement** of energy-efficient technology has also been shown to have very strong multiplier effects because of its high visibility and large volume. Multiplier effects on the market can be estimated and standardised methods to do so can be agreed. These can be applied to bottom-up calculations. However, until agreement is reached, one has to rely on top-down methods where this effect is part of the calculated total savings effect.

REBOUND EFFECTS

In some cases, part of an improvement in energy efficiency may be "taken back" in the form of increased energy consumption or a higher level of performance. Examples of this are seen in transport, where the knowledge that one now has a car that is, for example, 20% more energy efficient leads to increased use of the car. While this effect is usually small – with 5% to 10% of the savings being used up, it has been shown to be as high as 25% or higher in certain sectors, including parts of the transport sector. It is estimated, e.g., that the re-bound effect of energy efficiency measures taken in the building sector in some parts of the EU that have low comfort and service levels may be significant. A sizable share of the savings will probably be used to finance increased levels of comfort. This effect is difficult to capture in bottom-up calculations, although it can be estimated and the rebound can be deducted from the savings. With top-down measurement it will be manifested *ex post* as higher-than-expected energy consumption. While the size of the rebound effect will vary between different measures and between different Member States, it is possible to harmonise the methods used to calibrate and to calculate the effect. One should remember, however, that the size of rebound effects is a topic for which there are many diverging opinions.

FREE-RIDERS AND FREE-DRIVERS

Another measurement difficult that arises when attempting to ascribe impacts to measures carried out, as is done in bottom-up calculations, is the problem of "free-riders" and "free-drivers". Free-riders are participants that benefit from an energy-efficiency measure in a programme targeting them but would have carried out the measure themselves anyway, without any subsidy or programme. This phenomenon leads to unnecessary costs and to miscalculations of impact assessments, unless estimates are available of the size of the free-rider effect. In bottom-up calculations, standardised calculation methods can be agreed for the free-rider effect, and can form part of a harmonised measurement system. Free-drivers are a similar phenomenon, although they make a positive contribution to improving energy efficiency by taking initiatives where it is not expected from rational considerations. Standard calculation methods and assumptions can also be developed for free-drivers in the bottom-up approach. With both free-riders and free-drivers, top-down indicators capture automatically the net impact on the improvement in energy efficiency and on energy consumption. As the free driver effect is not a result of policy, it is a matter of correcting for added activity.

MEASURING THE EFFECT OF FOCUSED INFORMATION CAMPAIGNS

In the case of general, untargeted information campaigns, it becomes difficult to calculate the energy savings that result from the behaviour changes induced by the information made available. Top-down calculations are therefore often used. However, if information campaigns are focused on certain technologies, bottom-up measurement may well be used. A certain increased uptake of this technology can be measured or assumed. This calculation allows a "premium" to be estimated – e.g. 5% – for the effect of information on an associated measure promoting the technology. Thus, bottom-up calculations work for information measures.

ODYSSEE/ODEX: A Top-down Measurement System with Adjustments

A HARMONISED TOP-DOWN/BOTTOM SYSTEM FOR THE MEMBER STATES?

A top-down system is thus a necessary part of any system for measuring energy efficiency improvements, not only during the time a harmonised bottom-up system is being developed, but even afterwards. While a reliable top-down system will be especially important in the initial phase of the measurement system, limitations on bottom-up measurement systems will also make a permanent element of top-down measurement necessary even afterwards.

The Odyssee Energy Efficiency Indicators project is a good example of a top-down system. It has been running since 1992. It includes the EU 15 and Norway and has recently been expanded to include the new Member States. However, data for the new Member States will, in many cases, not extend further back than 1995.

ODYSSEE is illustrated in Figure 1. In the figure, based on ODYSSEE data, no adjustments have been made to energy intensity except for climate correction. It can therefore be considered a first rough approximation of energy efficiency improvement.

According to Figure 1, energy intensities decreased in most EU-15 Member States between 1990 and 2002. They seem to have decreased sharply in Luxembourg and Ireland (between 3 and 4 % per year); and between 2.5 and 1.5 % per year in Norway, Sweden, UK, and Denmark. In the southern European countries, however, intensity increased regularly since 1990[17].

The reason behind the changes in energy intensity in a number of Member States is clearly not completely attributable to changes in energy efficiency. The development in

17. Portugal (+2.1 % per year), Spain (+0.7 % per year) and Greece (+0.1 % per year until 1998).

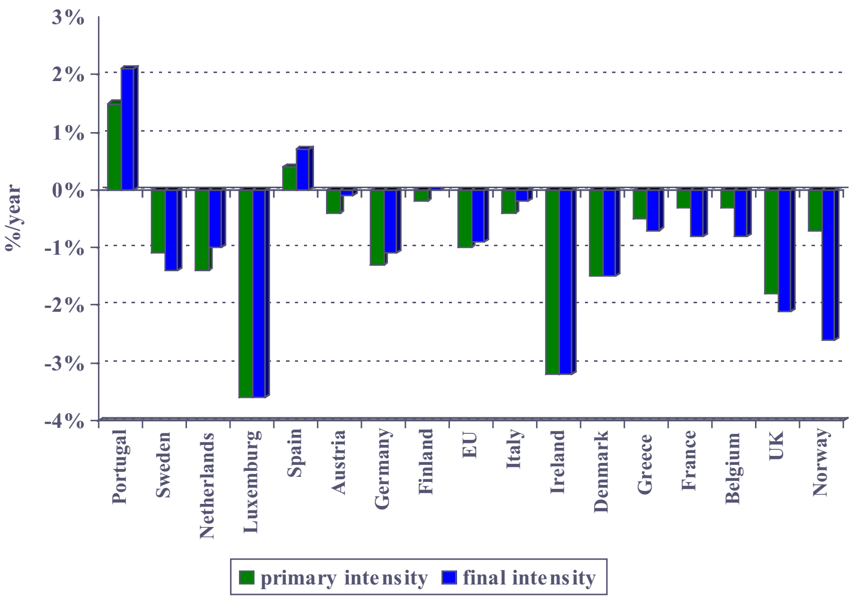

Figure 1: *Variation of energy intensities in the EU-15 countries and Norway 1990-2002*.*
*Under normal climate conditions.

Luxembourg, for example, is mostly the result of statistical weighting effects due to the closing down of an aluminium plant. In Ireland, the rapid growth in GDP with only a small increase in energy consumption is explained by productivity gains in the service sector, also creating weighting effects. In both cases, the impression is given that energy efficiency has improved much more than can be explained. Fortunately, methods have been developed to correct for such discrepancies, mainly by using improved index calculations, weighting, structural change corrections and similar adjustments. This increases the reliability of these calculations. There is scope to continue improving these indicators. Member State experts participate actively ODYSSEE and ODEX group (see below) and provide a link to Member State governments.

ADJUSTMENTS TO ODYSSEE AND ODEX[18]

Three types of adjustments are quantified in the ODYSSEE database and are normally used to try to correct energy intensity in order to obtain a measurement that approximates energy efficiency improvements. These are shown in Figure 2. They are:

- adjustment of GDP in purchasing power parities to account for differences in the general price level;
- adjustment for heating requirements to account for degree-day differences;
- and finally, adjustment in the "economic structure" to account for differences in the nature of the economic and industrial activities of the countries concerned. This includes the use of indices that correct for weighting factors.

In general, these adjustments correct for many of the non-energy efficiency developments in energy consumption. If care is taken with such adjustments, such indices can give a reasonably accurate picture of the development of energy efficiency improvement and, somewhat less reliably, a picture of the relative position of countries with regard to energy efficiency improvements. These adjusted indicators are better than using intensity indicators calculated from raw statistics at an aggregated level without adjustment, as in Figure 1.

For countries with a lower general price level (e.g. Portugal, Greece or Spain), the price adjusted value is below the actual or observed intensity, as can be seen in Figure 2.

A Way Forward?

CONCLUSIONS ON BOTTOM-UP AND TOP-DOWN MEASUREMENT SYSTEMS

It can be argued that we should try to develop a harmonised measurement system that allows the use of as large a share as possible of bottom-up measurement, while still allowing for the use of acceptable top-down measurements where it is appropriate or necessary. In the transition period during which a harmonised system is being developed, top-down calculations will be especially important because they are already more developed in an EU-harmonised fashion thanks partly to the ODYSSEE project. The use of measurements such as ODEX -which today relies on only 30 different indicators- will require some additional improvements. The three above-mentioned adjustments carried out in ODYSSEE manage to correct for many of the factors that are not related to improvements in energy efficiency as we have de-

18. ODEX is sometimes referred to as a "bottom-up" calculation. While parts of ODEX are based on disaggregated energy efficiency improvements, such as a selection of technologies (e.g., 8 household appliances are weighted together for the domestic sector), the calculation still contains top-down measurements.

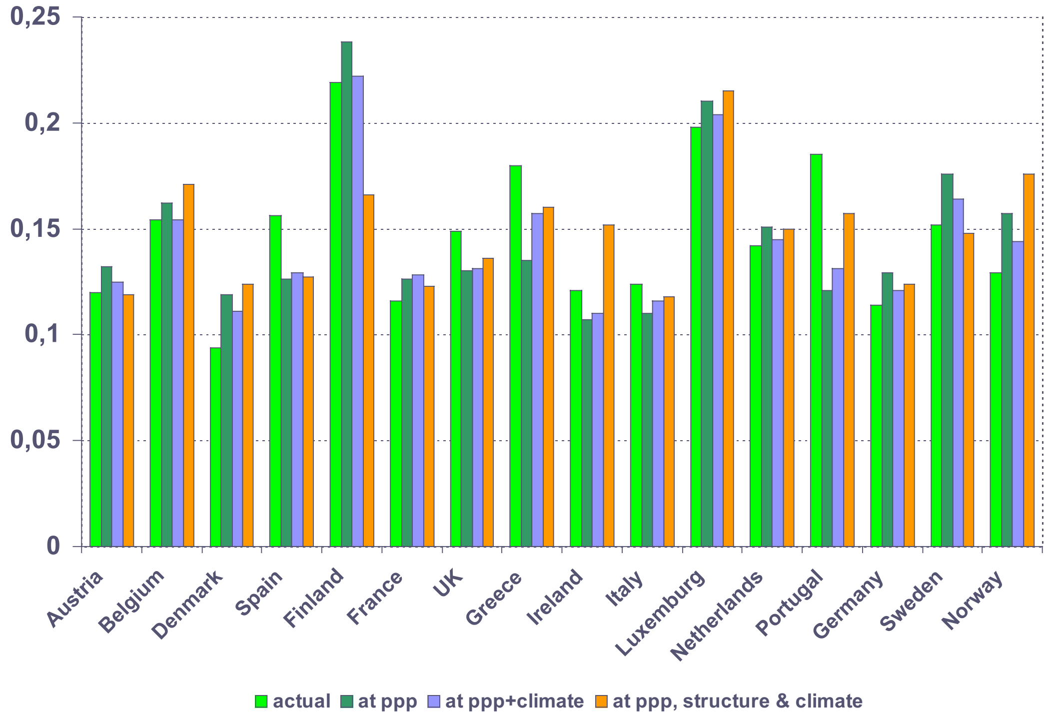

Figure 2. *Final energy intensities: the different adjustments (MJ/Euro, 2002).*

fined it, but in some cases they still fail to give completely reliable and detailed measurements of energy efficiency performance.

ODYSSEE and ODEX energy efficiency indicators can be improved fairly quickly. It will then take a little more time to develop a first generation of harmonised bottom-up measurements, even though we will be able to build on a number of existing systems from Member States. A goal could be to develop harmonised systems that would allow Member States to use a share of 50% harmonised bottom-up measurements, depending on costs and availability of data. During the time this is under development, top-down measurements could be used and would, of course, continue to be improved. It is not inconceivable that the improved reliability of top-down measurements might lead to a wider use of them than now seems possible. A committee of experts should be able to judge the relative merits and appropriateness of the two systems once they are harmonised. These experts could then recommend an optimal mix of the two systems, taking into account their relative accuracy and their relative costs.

It is a widely held belief that top-down indicators, irrespective of how sophisticated they are, will never be able to replace a bottom-up measurement system because of the accuracy needed to form the basis for white certification schemes and trading with energy savings measures. Establishing a common methodology based partially on a bottom-up system will therefore be necessary and will help speed up a process that is already underway. The Energy End-Use Efficiency and Energy Services Directive could thus play an important role in the future development of European energy saving trading schemes. A certificate system that includes both green and white certificates and perhaps also black and blue certificates (CDM & JI and CHP) are possible to imagine in the not-too-distant future.

Nevertheless, top-down methods will always be needed, especially to measure the impact of certain measures (e.g. taxes) and additional effects (rebound, multiplier, etc.), even if bottom-up alternatives should be sought when costs and data allow it.

The solution thus appears to be to combine the use of bottom-up and top-down methodologies without now proposing the exact share of the uses of the models or of proposing a forced marriage between the two. Once the Proposed Directive on energy end-use efficiency and energy services are adopted, committee procedures and future development of the two models should determine how the two will complement each other.

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