IV REFERENCES

Buildings renovation

Center for Climate Change and Sustainable Energy Policy, *Employment Impacts of a Large-Scale Deep Building Energy Retrofit Programme in Poland*, Central European University, Budapest, 01.2012.

Copenhagen Economics, *Multiple benefits of investing in energy efficient renovation of buildings*, 05.10.2012.

Ecofys, *Renovation Tracks for Europe up to 2050 - Building renovation in Europe - what are the choices?*, 10.2012.

Jülich Research Centre, *Impact on public budgets of KfW promotional programmes in the field of 'Energy-efficient building and rehabilitation'*, KfW Bankengruppe, 10.2011.

Residential energy roadmap 2050, Sustainable Energy Authority of Ireland (SEAI), 2010.

Energy Audits

Commission Recommendation concerning the definition of micro, small and medium-sized enterprises (2003/361/EC). OJ L 124, 20.05.2003, p. 36.

Energy Savings Toolbox – An Energy Audit Manual and Tool, Canadian Industry Program for Energy Conservation (CIPEC) and the Office of Energy Efficiency of Natural Resources Canada, 2007.

European Commission, *The New SME Definition: User guide and model declaration*, 2005.

Hasanbeigi, A. and Price, L., *Industrial Energy Audit Guidebook: Guidelines for Conducting an Energy Audit in Industrial Facilities*, Ernest Orlando Lawrence Berkeley National Laboratory, 10.2010.

The International Organization for Standardization, *EN ISO 50001, A Standard for energy management systems*, 2012.

Supply side efficiency and demand response

European commission webpage on CHP with direct access to national report on CHP potential: http://ec.europa.eu/energy/efficiency/cogeneration/cogeneration_en.htm

Intelligent Energy Europe projects in the field of CHP:

CODE and CODE2 http://www.code-project.eu

CHP Goes Green (bio-CHP) http://www.chp-goes-green.info/

ene.field (micro-CHP fuel cell) www.enefield.eu/

International Energy Agency, *Cogeneration and District Energy: Sustainable energy technologies for today…and tomorrow*, 04.2009.

International Energy Agency, *Cogeneration and Renewables: Solutions for a low-carbon energy future*, 05.2011.

International Energy Agency, *Combined Heat and Power: Evaluating the benefits of greater global investment*, 03.2008.

ANNEXES

A. Timeline of the Energy Efficiency Directive obligations

Deadline	**Article**	**Obligation**
31 December 2012	Article 24 – Review and monitoring of implementation	Commission provides template as guidance for NEEAPs
30 April 2013	Article 3 – Energy Efficiency Targets	MSs shall set indicative national energy efficiency target
5 December 2013	Article 7 – Energy Efficiency Obligations	MSs opting for alternative approach shall notify Commission of policy measures.
5 December 2013	Annex V	MSs shall notify the Commission of proposed detailed methodology for Energy Efficiency Obligation Schemes and for purposes of Articles 7.9 and Article 20.6
31 December 2013	Article 5 – Exemplary Role of Public Bodies' Buildings	Inventory of eligible heated and/or cooled central government buildings
31 December 2013	Article 5 – Exemplary Role of Public Bodies' Buildings	For MSs opting for alternative approach instead of renovations, notification of alternative measures
31 December 2013	Article 14 – Promotion of efficiency in heating and cooling	Notification of exemptions under paragraph 6
1 January 2014	Article 5 – Exemplary Role of Public Bodies' Buildings	3% of total floor area of heated/cooled buildings owned and occupied by central government is renovated each year
30 April of each year from 2013	Article 24 – Review and monitoring of implementation	MSs report progress on achieving national energy efficiency targets
Before 30 April every year	Article 24 – Review and monitoring of implementation	Submit statistics on national electricity and heat production from high and low efficiency cogeneration.
30 April 2014 and updated every 3 years thereafter	Article 4 – Building Renovations	Building Renovation Strategy - first version of strategy published by MSs and submitted as part of the NEEAPs
30 April 2014	Article 19	MSs shall evaluate barriers and take measures to remove barriers to energy efficiency, and notify the Commission in the first NEEAP
30 April 2014 and every three years thereafter	Article 24 – Review and monitoring of implementation	Submit NEEAPs
5 June 2014	Article 7 – Energy Efficiency Obligations	MSs making use of paragraph 2 shall notify Commission
5 June 2014	Article 13 – Penalties	MSs to lay down rules on penalties for non-compliance for Articles 7 to 11
5 June 2014	Article 14 – Promotion of efficiency in heating and cooling	Cost-benefit analysis (paragraph 5)

5 June 2014	Article 27 – Amendment and repeals	Various repeals and amendments
5 June 2014	Article 28 – Transposition	MSs bring into force necessary laws, regulations and administrative provisions
30 June 2014	Article 24 – Review and monitoring of implementation	Commission submits assessment referred to in Article 3.2 to EP and Council (national targets)
31 December 2014	Article 10 – Billing Information	For final customers without smart meters, MSs shall ensure billing information is accurate and based on actual consumption
31 December 2014	Article 14 – Promotion of efficiency in heating and cooling	Commission empowered to review the harmonised efficiency reference values
31 December 2014	Article 16 – Availability of qualification, accreditation and certification schemes	MSs shall ensure certification and accreditation schemes or equivalent if existing ones are considered insufficient
30 April of each year	Article 24 – Review and monitoring of implementation	MSs report progress on achieving national energy efficiency targets
30 June 2015	Article 15 – Energy transformation, transmission and distribution	MSs undertake assessment on energy efficiency potential of their gas and electricity infrastructure (paragraph 2)
9 July 2015	Article 5 – Exemplary Role of Public Bodies' Buildings	Threshold for buildings to be included in public sector renovations reduced to 250 m^2 from 500 m^2
5 December 2015, and at least every four years from the date of the previous energy audit	Article 8 – Energy Audits	National legislation by MSs to ensure that enterprises (non-SMEs) are subject to energy audit, implemented and supervised by public authorities
5 December 2015	Article 24 – Review and monitoring of implementation	Commission shall review the effectiveness of implementation of Article 6 (Purchasing by public bodies)
31 December 2015, and upon request of Comm. every five years thereafter	Article 14 – Promotion of efficiency in heating and cooling	Comprehensive assessment by MSs of potential of high-efficiency cogeneration and efficient district heating and cooling
30 June 2016	Article 24 – Review and monitoring of implementation	Commission report to EP and Council on implementation of Article 7 (Energy Efficiency Obligation Schemes)
31 December 2016	Article 9 – Metering	In multi-apartment and multi-purpose buildings with central heating or from DH system, individual meters to be installed
30 June 2018	Article 24 – Review and monitoring of implementation	Commission assessment of progress in removing regulatory and non-regulatory barriers referred to in Article 19(1)

B. Eligibility of measures and savings to count towards the energy end-use savings target

NEW AND ADDITIONAL ENERGY SAVINGS FOR THE EED

This note explores the issues around how energy savings will be counted towards the target outlined in Article 7.1 "equivalent to achieving new savings each year from 1 January 2014 to 31 December 2020 of 1.5% of the annual energy sales to final customers". The energy savings can be determined through Energy Efficiency Obligations on energy providers or through the option in Article 6.9 of setting up equivalent policy measures – both will follow the same methodology of determining new and additional energy savings.

Annex V in the EED clearly explains the various options that may be used to determine energy efficiency savings: deemed savings, metered savings, scaled savings and surveyed savings. In what follows, the issues discussed relate primarily to deemed and scaled engineering estimates of determining energy savings. Historically these are the most commonly used methodologies in EU Energy Efficiency Obligations.

MSs will need to decide the eligible energy efficiency measures for which there are either independently proven or well-established energy saving norms; all others will need their energy savings to be metered or surveyed to determine their exact values. For all deemed and scaled engineering estimates, it is recommended that MSs publish such information to ensure that all stakeholders have access to a common database.

However, as discussed below, there are various factors which need to be addressed in order to determine whether the anticipated energy savings are fully realised and to what extent there is an additionality or materiality associated with the involvement of the obligated, participating or entrusted parties. In a few cases, there will be a difference between the best practice of determining new and additional energy savings for Energy Efficiency Obligations (or equivalent options) and for MSs meeting the 1.5% target.

Inevitably there are overlaps between the issues that need to be addressed, but these have been gathered under the following headings: gross energy saving adjustments, baseline considerations and attribution of energy savings.

1. Gross energy saving adjustments

There are a series of adjustments that need to be made and these depend on the nature of the energy efficiency measure installed and any subsequent impact it may have on other energy usage in the property or industrial site. They are particularly important for deemed energy savings or scaled engineering estimates. Additionally, energy efficiency measures which save heat or produce heat efficiently will produce energy savings which clearly depend on the climatic zone of such installations. For example, in France, they have divided the country into three climate zones with different energy saving values. The French accommodate this flexibility by setting the target with a mix of measures across all three climatic zones and building those into the energy saving target.

The following are typical energy saving adjustments that will need to be addressed by MSs:

- Technical corrections and rebound effects

The energy efficiency measures will only save their full potential if they are both quality and installed correctly. The EED refers to the importance of monitoring measures on a sampling basis. However, even high-quality installations may not result in full energy savings because of unforeseen technical factors. For example, it may not be possible to insulate the entire loft, roof or external walls because of accessibility problems.

From experience monitoring the actual energy savings achieved, a technical correction can be derived to apply to the energy savings which are often set from either modelling calculations or paired test houses which have the benefit of no human involvement[1].

The rebound effect is often factored in along with the technical corrections. The rebound effect, also known as the comfort factor or increased amenity, can be best explained by giving the example of an insulation measure that will make it easier and cheaper to heat a property. It is likely that, particularly in low-income households, a portion of the benefit may be taken as increased comfort if that property was not heated to desired temperatures beforehand because of cost considerations.

Disentangling the two effects is difficult. Attempts to do this in UK and the USA have produced similar reduction factors. For the UK, because of the historically much lower indoor temperatures than in mainland Europe, a combined reduction factor of 50% gave the energy saving values used in their CERT obligation. In the USA, compared to the results from the computer simulation models, the reduction was 35% of the expected energy savings.

- Heat replacement effect

At times when space heating is required, internal gains from inefficient lights, appliances or pumps make a useful contribution to meeting the heating load. Conversely, at times when space cooling is required, such internal gains result in the cooling system working harder than necessary. A shift to more energy efficient equipment will therefore reduce internal gains and reduce the net savings from the energy efficient measure during the heating season.

To allow for this, the savings from the more efficient product should be amended, accounting for the duration of the useful heat provision from the inefficient products and/or if cooling is required, the reduction of the load on the air conditioning plant and hence increased energy savings.

2. Baseline considerations

Because energy savings under the EED can only be counted if they are new and additional, it is important to set the baseline from which the energy savings are accredited. Of the factors governing the use of baselines, the ones explored here are regulatory requirements, the average energy efficiency in the market place for certain products, early replacement of products or equipment and historic energy efficiency activity.

- Regulatory requirements

Perhaps the easiest examples to understand are whether there are clear regulatory requirements on either buildings or products. For example, if national or regional building regulations require that all new buildings meet a certain level of energy efficiency and they also meet cost-optimality requirements that are calculated as set out in Commission Delegated Regulation (EU) No 244/2012, then only improvements above that level of efficiency can be taken into consideration in claiming additional and new energy savings.

Minimum energy performance improvements are also required by the Energy Performance of Buildings Directive. These are to be set by the MSs for new buildings and for major renovations in all property sizes, as well as for building elements. All building energy performance requirements shall be benchmarked in accordance with the cost-optimal calculation methodology[2].

When applied in the context of Article 7 of the EED, this will mean that only energy performance requirements in building codes more stringent than requirements set in accordance with the cost-optimal methodology may be credited as energy savings. However, policy measures that increase the rate of new build or renovation, including financial and fiscal

[1] The range of energy savings achieved by individual households is known to be amazingly wide even for identical properties with the same energy efficiency measures installed. Many factors contribute to this, such as indoor temperature preferences, the number of people in the household, whether they are in the property all day or not, elderly relatives moving in or out or childbirth. For this reason, energy saving studies require significant sample sizes to correct the theoretical energy saving values.
[2] OJ L 81, 21.03.2012, p. 18-36.

instruments, may be eligible to be counted as delivering energy savings even if they are based on building code energy performance requirements that simply meet the cost-optimal level, in so far as they would trigger activities above the baseline.

In the field of energy efficient appliances and products, the Ecodesign Directive sets minimum energy performance standards in a variety of applications. In all cases, only energy efficiency improvements encouraged beyond these minimum requirements may be counted for additional and new energy savings unless higher standards exist already in the marketplace.

- Using the average energy efficiency of new equipment in the marketplace

For many products, the minimum energy performance required by the Ecodesign regulations is considered lower than the actual products available in the marketplace. For example, the Ecodesign in refrigeration products permits refrigeration products of energy efficiency class B to be sold, though the market average for such products encompasses better performing A, A+, A++ classes of product. The baseline in such situations should be the average efficiency of the product sold in the market place. For household appliances and lighting, such data is available from sources such as GfK and frequently used by governments, among others, to track the performance of energy efficiency as part of their market transformation programmes.

- Early replacement of products and equipment

For example, for boilers (which last approximately fifteen years), the net present value of replacing a twelve-year-old boiler three years early is very positive because of the tremendous improvement in energy efficiency over those three years. However, it would not be correct to claim energy savings in such a situation for more than three years, because the boiler is likely to fail and the owner might replace it with a market average efficiency or minimum energy performance requirement energy efficiency boiler. For the remainder of its lifetime, in addition to the three year advancement of significant energy savings, there should an added value reflecting savings from the rest of the new boiler's twelve year lifetime compared to the market average or minimum energy performance requirement as appropriate.

- Increases on previous energy efficiency activity

One way to view the effectiveness of any Energy Efficiency Obligation is to determine whether it has brought about a dramatic upturn in the rate of activity for that particular energy efficiency measure. The secondary consideration of dealing with free riders (those end users that would have invested in the measure anyway) is discussed below.

Trade bodies in MSs will usually have a good idea of the market activity relating, for example, to new insulation measures in their country. One way of determining the baseline for such activities would be to extrapolate historical activity from the underlying trend prior to the introduction of the Energy Efficiency Obligation or equivalent new policy.

3. Attribution of energy savings

This section covers the topics that are necessary to ensure that energy savings claimed towards EED targets are additional and that the activities of the obligated or entrusted parties have made a material difference to the end-use consumer's decision to invest in the energy efficiency measure. Clearly all the net energy savings that are additional to the prevailing or business as usual conditions may be counted.

- Free riders or deadweight

It is necessary to account for those end users that benefit from energy efficiency funds though they would have undertaken the investment anyway, known as free riders or deadweight. This depends on whether the energy efficiency measure being installed was a natural change in a purchase decision (e.g. new appliances, light bulbs, boilers, etc.) or the creation of a purchasing decision such as insulation or early replacement of products or equipment.

When starting Energy Efficiency Obligations on a small scale, it is possible to design the system to minimise free riders. For example, solid wall insulation is not a common occurrence in the existing housing stock (less than 1% per annum) and by targeting a defined geographical region, a successful programme which stimulates significant activity will have few free riders.

However, as such obligations become larger in scope, it is inevitable that they will pick up free riders. For example, Danish energy distributors are expected to reach a target 15% higher than the normal expected savings to account for a proportion of the savings that will not be additional. In other words, obligated distributors must achieve 115% of the nominal target. A different approach has been adopted in the United Kingdom where the government has built an estimate of likely free riders into the target that energy retailers must meet. When reporting the energy savings, the government removes the deadweight estimates but the energy retailers are credited for the full energy savings for the measures delivered.

In both cases, an estimate was made of the extent of free riders based on the best data available (ex ante or ex post) and deducted from the achieved savings to deduce the real additional energy savings above those that would have happened anyway.

- Co-funding of installation measures

Determining to what extent the obligated or entrusted parties should be accredited with energy savings in the case of co-promotion with other funding sources is an issue which has been addressed through a variety of approaches. In France and Italy, the availability of tax breaks for installing energy efficient boilers has been widely utilised by the obligated parties without any reduction of the energy saving values. In contrast, in the United Kingdom, if the obligated party is funding measures in conjunction with another national government programme, then the energy savings are delivered in proportion to the funding provided. However, any local government, other third party or end user financial support is not taken into account and the full energy savings are awarded to the obligated party.

Nevertheless, for the purposes of meeting the EED's 1.5% energy savings target, it is not necessary to reduce the energy saving value for other national or local governments' involvement, though MSs may wish to do so for their own particular obligation activities to ensure as much energy saving as possible is achieved through such schemes.

Although not yet applied in European Energy Efficiency Obligations, the concepts of free drivers and multiplier effects have been determined in the United States, when publicity for a scheme created by marketing or raised awareness creates purchases by those who invest in the energy efficiency measure but do not directly take advantage of any subsidy offered. Naturally, the case for applying free drivers needs to be examined carefully if the obligated party has not made a direct financial contribution to equipment sales. There is European evidence that this free driver effect occurs. In the Dutch EMAP programme, which subsidised condensing boiler sales, only 50% of the subsequent condensing boiler sales were subsidised by the government driven programme. Similarly in the mid 1990s, the UK's Energy Saving Trust condensing boiler cashback schemes only funded 50% of condensing boiler sales.

- Materiality of obligated or entrusted party to the energy efficiency measure

It is important to ensure that any subsidy or involvement of the obligated or entrusted party has a clear material effect on the end user's decision to undertake the energy efficiency investment. For example, an obligated party contributing €1 and/or no promotional activity to the purchase of an energy efficient appliance costing €400 has not made a "material contribution" to the purchasing decision. In other words, simply buying electronic point of sale data on energy efficient appliances from appliance retail outlets should not be allowed to count towards the target.

If the other contributions are coming from national government, then this causes no concern in terms of meeting the target. The key determinant is the extent to which the subsidy or the involvement of the obligated or entrusted party had an impact on the end user's decision to invest in energy efficiency.

4. Further reading

Greater detail on specific energy efficiency measures in residential, commercial, public and industrial buildings can be found in the eceee and RAP Report "Determining Energy Savings for Energy Efficiency Obligation Schemes"[3]. The report has examined best practices in determining energy savings in EU Energy Efficiency Obligations and their alignment with common practices in North America. Chapter 8 contains recommendations on how to determine energy savings measure by measure.

[3] Lees, E. and Staniaszek, D., *Determining Energy Savings for Energy Efficiency Obligation Schemes*, European Council for an Energy Efficiency Economy and the Regulatory Assistance Project, 04.2012.

MONITORING AND VERIFICATION

(QUALITY STANDARDS, COMPLIANCE, SAMPLING PRECISION)

It will be important for MSs to ensure that the claimed energy savings from Energy Efficiency Obligations or equivalent policies meet the EED requirement to deliver new and additional energy savings. This section outlines the monitoring and verification (M&V) requirements to ensure that the claimed energy efficiency measures have actually been implemented and that the measures are delivering the expected energy savings. There are well established international protocols[4] to govern this process.

In this section, the M&V process has been split into three steps: quality standards for installations of energy efficiency, compliance methodologies to ensure savings claimed are eligible and valid and an indication of the sampling techniques which are used to deliver a reasonable degree of confidence in the validity of the achieved energy savings.

1. Quality standards

MSs need to be satisfied that the energy efficiency measures that have been installed conform to the relevant quality standards. This involves ensuring that the energy efficiency measure meets the energy performance requirements and that (if appropriate) it has been installed to the prevailing best practice guidelines. These monitoring aspects serve to ensure that energy efficiency is delivered properly and that end users see it as a positive experience.

The quality standards can be achieved in a variety of ways, for example:

- Technically monitoring a sample of recipients of energy efficiency measures (common for insulation installations);
- Customer satisfaction monitoring, often required of energy providers for heating and insulation installations in properties;
- Customer utilisation monitoring, which ensures that the measures are being used and that energy savings are actually being realised. This is historically required for certain measures such as free compact fluorescent lamps (CFLs), low flow shower heads or consumer electronics;
- Using an approved list for specific energy efficiency measures, for example, the European lighting standard for minimum energy performance requirements in terms of energy saving and lifetime for CFLs;
- Appliances and products carrying an energy label. Most Energy Efficiency Obligation schemes in Europe have placed restrictions on the energy label that may be promoted by obligated and entrusted parties; as the appliance retailers are subject to the European Union energy labelling scheme, it is not usually necessary to undertake any technical monitoring of such products;
- Products with specifications for performance. Using the example of insulation, it could be required that products have U-value or lambda performance which are compliant with the national or European standards; and
- Where applicable, ensuring that installers use national best practice guides regarding the installation of energy efficiency measures like insulation and heating.

In all cases, international best practice recommends using a sampling procedure to physically monitor the quality of installations after completion.

2. Compliance

To ensure that savings are new and additional and that the energy efficiency measures claimed have actually been installed and are not being double counted, common practice in Europe and elsewhere is to carry out a random sample of the end users that have received energy saving measures. This can be in conjunction with the quality standard sampling discussed above.

[4] Efficiency Valuation Organization, *The International Performance Measurement and Verification Protocol*, 2007.

Effectively this is the equivalent of a financial "dip check" familiar for accountancy audits. Best practice is a trade-off between the level of precision required and the costs of attaining that precision. Typically, the audit would be on a standard sampling basis.

Audits can be carried out by a scheme administrator or by a recognised, independent third party. For example, in Denmark an annual audit of documentation and guidelines is required from the obligated parties and from an independent third party every second year.

Double counting can be addressed by maintaining a central register or database of all efficiency improvements by physical location. Such databases are also helpful in identifying localities which seem to be missing out on energy efficiency activities.

The costs of monitoring and verification and the associated auditing process are not large especially if the deemed savings approach is the dominant methodology for recording the energy savings. In the United Kingdom, the cost to the Office of the Gas and Electricity Markets (Ofgem) for administering (including monitoring, verification and auditing) the Carbon Emissions Reduction Target (CERT) programme totals €1.5 million per year, equivalent to around 0.1% of what the annual energy retailer spends on energy efficiency measures.

3. Sampling precision

Whether in connection with quality standard monitoring or compliance monitoring, the size of the sample is inevitably a compromise between high precision and cost. Additionally, certain energy efficiency measures may need to be monitored for quality standards to a greater extent than others. The box below illustrates a typical good practice sampling requirement by the energy regulator Ofgem for technical monitoring.

CERT Monitoring Requirements (Source: Ofgem Supplier Guidance Manual)

1% customer utilisation monitoring for electrical items, do-it-yourself (DIY) loft insulation and DIY radiator panels provided to householders for free

5% technical monitoring for professionally installed insulation and heating measures

1% customer satisfaction monitoring for professionally installed insulation, heating measures and micro-generation measures

5% or a statistically significant sample (whichever is smaller) utilisation and evaluation monitoring of behavioural measures (CFLs, advice and smart metering)

Some obligations require that a certain fraction of the energy saving target be met by energy efficiency measures in low-income households. Because promotions of appliances, CFLs and information or communication technologies often appear in retail outlet or internet sales, it is difficult to reliably establish whether the customer is part of a low-income household. Subsequent determination of the percentage of low-income households who purchased the energy efficient product is determined via a sampling approach. Standard statistical calculations can be used to derive an appropriate sampling base to give a confidence level of 95%. Typically this would require sampling 5% or less of the customers.

ANALYSING PRICE ELASTICITIES IN VARIOUS SECTORS

Transport

The best known review (Goodwin, Dargay et al. 2004) concludes that the short run price elasticity of demand is -0.25 (+/- 0.15). A more recent review (Brons, Nijkamp et al. 2008) reports a number of studies with a very similar central estimate (Espey 1998; Graham and Glaister 2002). There is therefore a strong case to use -0.25 as the price elasticity of energy in the transport sector.

Residential

Analysis of the residential sector is a little more complicated, as there is a broader range of fuels, including electricity. Analyses of the long run price elasticity of a single fuel may be misleading, as the cross-price elasticities with other fuels need to be considered to address fuel switching. However, for the short run elasticity, measures of the fuel's own price elasticity are probably sufficient.

There is more significant literature on electricity than other household fuels. A recent review of electricity price elasticities (Fan and Hyndman 2011) found a range from -0.2 to -0.4, but also found a significant variation by income and time of year, presumably reflecting different elasticities for different energy services (which would be expected). Another review (Alberini and Filippini 2011), limited to the United States, has similar results for electricity price elasticities of demand of -0.2 to -0.35.

Of the other household fuels, gas is the only one studied. A recent analysis in California (Lavín, Dale et al. 2011) tends to confirm the findings for electricity reporting a value of -0.28, but finds a significantly lower value of -0.11 for gas and reports other findings well below -0.2.

In the UK, DECC's economists in 2012 used for households an electricity demand elasticity with respect to price of -0.196 and with respect to disposable income per head +0.196. (Danskin, private communication).

In conclusion, it seems likely that electricity has significantly higher price elasticity of demand than direct use of fossil fuels in this sector, with the former larger than -0.2 and the latter smaller. On average, if a single value is required, an assumption of -0.2 is supported by the available literature. Ideally there should be some differentiation by fuel or energy service.

References

Alberini, A. and M. Filippini (2011). "Response of residential electricity demand to price: the effect of measurement error". Energy Economics 33(5): 889-95.

Brons, M., P. Nijkamp, et al (2008). "A meta-analysis of the price elasticity of gasoline demand: a SUR approach". Energy Economics 30(5): 2105-22.

Espey, M. (1998). "Gasoline demand revisited: an international meta-analysis of elasticities". Energy Economics 20(3): 273-95.

Fan, S. and R. J. Hyndman (2011). "The price elasticity of electricity demand in South Australia". Energy Policy 39(6): 3709-19.

Goodwin, P., J. Dargay et al (2004). "Elasticities of road traffic and fuel consumption with respect to price and income: a review". Transport Reviews 24(3): 275-92.

Graham, D. and S. Glaister (2002). "Review of income and price elasticities of demand for road traffic". Centre for Transport Studies.

Lavin, F., L. Dale, et al. (2011). "The impact of price on residential demand for electricity and natural gas". Climatic Change 109(1): 171-189.

C. Building renovation concepts

Comprehensive renovation: The concept of "comprehensive renovation" should be understood as a renovation undertaken with the objective to bring a building to a very high energy performance level, incorporating best available technologies. Comprehensive renovation should also be linked to the economic, environmental and social co-benefits of deep renovations, while calculating the net present value of the investments.

Deep renovations or staged deep renovation: Deep renovations or staged deep renovations are not specifically defined in the EED; however Recital 16, which addresses the long-term strategies referred to in Article 4, states that deep renovations "lead to a refurbishment that reduces both the delivered and the final energy consumption of a building by a significant percentage compared with the pre-renovation levels leading to a very high energy performance".

Recital 16 also states that "such deep renovations could also be carried out in stages". "Staged deep renovation" should be understood as a "deep renovation" that reduces the final energy consumption of a building or group of buildings in stages to achieve a very high energy performance or nearly zero-energy level. The successful implementation of a staged renovation requires the definition of a holistic renovation plan which defines the sequence of the renovation stages with a view to reach the final goal of significantly reducing energy consumption. This renovation plan will look at the building as a whole (including envelope, control systems and technical systems and equipment). Establishing this plan will avoid increasing significantly the costs of individual stages or precluding subsequent stages in the course of the standard renovation cycle.

In poorly performing buildings, deep renovation has been shown to improve the energy performance by an average factor of four or within a range between 65%-95% compared with pre-renovation levels, primarily by reducing final energy consumption. This should bring the energy performance level of the renovated building as close as possible to requirements for new built or nearly-zero energy buildings. A study from the German Energy Agency (Dena) evaluates 350 deep retrofit projects of different types of buildings with cost effectiveness criteria. The energy consumption in every retrofitted building analysed was reduced on average by 85%[5].

Normally, deep renovation is undertaken in conjunction with a major renovation of the building or buildings and/or as part of the standard 30-40-year renovation cycle, using a cost-optimal approach. Deep renovation can be applied to an individual building or to a group of buildings.

Given the current poor performance of buildings in all MSs, it is estimated that a large proportion of buildings will require a deep or staged deep renovation in order to be brought to a very high energy performance or "nearly zero-energy" level. This will depend on the overall national target for reduction of energy consumption for the building stock by 2050, the overview of the national building stock and the results of the individual audits for buildings.

Energy savings: in Article 2.5, energy savings is defined as "an amount of saved energy determined by measuring and/or estimating consumption before and after implementation of energy efficiency improvement measures, whilst ensuring normalisation for external conditions that affect energy consumption".

[5] dena, 'Part 1: Economic viability of upgrading the energy efficiency of the rental housing stock', *dena Renovation Study*, 01.2013.

D. Good practices in practice: boosting the energy services market

One example of national schemes that enhance a development of energy services is "Grenelle de l'environnement" which is the French action plan invented through a dialogue between business, communities, unions and associations. The action plan encompasses policy objectives, information campaigns and financial instruments. Policy objectives for residential sector include the reduction of existing buildings' energy consumption by 38% by 2020 in comparison to 2008 and buildings' refurbishment. Regional offices of the National Energy Agency (ADEME) make funding available under public-private partnerships for state-owned buildings which create a market for energy services, especially in the public sector.

In Spain, there are two different "models" recommended by the Spanish Ministry of Energy (jointly elaborated by the public sector and the professionals) for contracting energy efficiency services with public administration:

- A "Services and Supply Contract" with a recommended contract: "CONTRATO DE SUMINISTRO DE ENERGÍA Y GESTIÓN ENERGÉTICA EN EDIFICIOS PÚBLICOS CON GARANTIA TOTAL DE LAS INSTALACIONES TÉRMICAS Y DE ILUMINACIÓN INTERIOR LOS EDIFICIOS DE LAS ADMINISTRACIONES PÚBLICAS"
- A Public-Private Partnership (CCPP) with a recommended contract: "CONTRATO DE COLABORACIÓN ENTRE EL SECTOR PÚBLICO Y EL SECTOR PRIVADO PARA LA PRESTACIÓN DE SERVICIOS ENERGÉTICOS".

In Finland, in the framework of the National Energy and Climate strategy, companies and communities apply energy efficiency solutions that can be subsidised by the state.

In Austria, energy agencies create demand for energy services, initiate pilot projects and act as independent advisors. Municipalities and federal state organise EPC tenders for their building stock and street lighting.

Cooperation between public institutions and the private sector has also been established in Denmark, where promotion of the ESCOs concept is mainly achieved through projects by research institutes, industry associations, the Danish Energy Agency (DEA) and the Danish Enterprise and Construction Authority.

In countries juggling rising energy prices, high energy efficiency potential and limited financial resources and experience, a strong legal framework is necessary to bolster the growth of ESCOs. For example, in Bulgaria the Energy Efficiency Law has created a better environment with increased security for the development of ESCO projects, particularly in the municipal sector[6].

[6] Bertoldi, P., Boza-Kiss, B., Marino, A. and Rezessy, S., *Energy Service Companies Market in Europe - Status Report 2010*, Joint Research Centre, European Commission, 2010.

E. Case studies: innovative use of Structural Funds for EE financing

The JESSICA Holding Fund in Lithuania: In June 2009 a tripartite agreement between the Ministry of Finance and the Ministry of Environment of the Republic of Lithuania and the EIB was signed, establishing the JESSICA Holding Fund for the modernisation of residential apartment houses. The EIB-managed JESSICA Holding Fund will invest in energy efficiency projects for multi-apartment housing via the Lithuanian banking sector. Funds have been contributed from the European Regional Development Fund (ERDF) alongside national match funding. Intermediary banks will act as energy efficiency-focused JESSICA Urban Development Funds (UDFs) in providing long-term preferential loans with a fixed interest rate not exceeding 3%. The loans will be offered to homeowners in multi-apartment buildings with tenant associations acting as representatives and managing the implementation process of chosen energy efficiency projects. The contribution invested in the Holding Fund is €227 million, which consists of ERDF funds (€127 million) and national funding (€100 million). The expectations are that commercial banks step in with an additional €20-40 million.

Revolving fund for energy refurbishment in housing in Estonia: This revolving loan fund combines ERDF grant funding with loans from European banks like the CEB or the EIB. It also combines funds from the Credit and Export Guarantee Fund KredEx (national guarantee fund) to provide long-term (up to 20 years) low-interest loans (currently 4.5% compared to the 7% market minimum) through local commercial banks to multiple-unit residential buildings built before 1993. Homeowners contribute 15%. This lending scheme, which was set up by KredEx with the help of technical assistance provided by KfW Bankengruppe, targets energy efficiency investments that have been defined as priority measures in an energy audit. The objective is to reach minimum 20-30% savings in the building's energy consumption.

Grants for energy efficiency in housing in France: The French government has chosen to use the ERDF in a grant scheme as an additional resource to reach its objectives of retrofitting 800,000 very energy inefficient dwellings. In many cases, like in the Nord-Pas de Calais region, the ERDF will release the extra investment needed to improve the energy performance of buildings. Each French region is therefore permitted to use up to 4% of their Operational Programme funding for energy efficiency investments and greater use of renewable energy in existing housing. Operations must target a significant number of homes, mostly energy inefficient buildings or most effective energy saving refurbishment actions. Two types of housing are eligible: social housing and run-down co-ownership with social occupation, within the framework of an operation supported by ANAH (national housing agency). For the most recently constructed buildings, the eligible actions are the ones that achieve at least a gain of 8 kWh/m^2 and reach an energy consumption of less than 150 kWh/m^2.

F. Overview of main EU energy efficiency legislation

Framework legislation

Energy Efficiency Directive: Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, OJ L 315, 14.11.2012, p.1. Adapted by Council Directive 2013/12/EU of 13 May 2013 by reason of the accession of the Republic of Croatia.

Sectoral and procedural requirements

Energy efficiency in buildings: Directive 2010/31/EU of the European Parliament and of the Council of 17 May 2010 on the energy performance of buildings, OJ L 153, 18.6.2010, p. 13 (recast of the Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002). Directive 2010/31/EU entered into force in July 2010; Directive 2002/91/EC was repealed beginning 1 February 2012.

Delegated Regulation on cost-optimal energy performance requirements for buildings: Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements, OJ L 81, 21.3.2012, p. 18.

Energy Services Directive: Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC, OJ L 114, 27.4.2006, p. 64, as amended. Directive 2006/32/EC will be repealed from 5 June 2014 except Articles 4.1-4.4 and Annexes I, III and IV, which will be repealed from 1 January 2017.

Cogeneration - Combined Heat and Power (CHP): Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC,, OJ L 52, 21.2.2004, p. 50, as amended. Directive 2004/8/EC will be repealed from 5 June 2014.

EU product legislation

Labelling of energy-related products: Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products, OJ L 153, 18.6.2010, p. 1 (recast of Council Directive 92/75/EEC of 22 September 1992).

Ecodesign of energy-related products: Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products, OJ L 285, 31.10.2009, p. 10 (recast of Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005).

Consumer information on fuel economy and CO2 emissions of new passenger cars: Directive 1999/94/EC of the European Parliament and of the Council of 13 December 1999 relating to the availability of consumer information on fuel economy and CO2 emissions in respect of the marketing of new passenger cars, OJ L 12, 18.1.2000, p. 16, as amended.

Emissions from motor vehicles: Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO 2 emissions from light-duty vehicles, OJ L 140, 5.6.2009, p. 1.