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RAP Energy solutions for a changing world

Determining Energy Savings for Energy Efficiency Obligation Schemes

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1. Introduction

This report on determining energy savings for Energy Efficiency Obligation (EEO) schemes was researched by Sustainability Consulting Ltd in conjunction with eceee[1] and has been built upon by RAP Europe[2] in response to the publication by the European Commission of the draft Energy Efficiency Directive (EED). In particular, the report addresses Article 6 on *energy efficiency obligation schemes* and the accompanying Annex V (both of which are reproduced as Appendix 1 to this report).

The aim of this report is to help ensure that EEOs on energy distributors or retail energy sales companies are established by Member States in a transparent, consistent, and coherent manner when it comes to evaluating the energy savings from such obligations.

RAP identified several shortcomings with the original approach proposed by the Commission for determining energy savings from individual measures in Annex V, including:

- Not all the measures are covered;
- Differences across the region in climate, building types and construction practices, and other baseline conditions will result in many of the measures installed as a result of the EEO saving different amounts of energy in different locations; and
- Insufficient clarity on the common principles that should be applied when determining energy savings.

This report is based on a review of the processes that currently exist in a number of Member States, as well as territories outside the EU for determining energy savings from energy efficiency measures using EEOs. From this review, best practices are identified that should be used to derive high level guidelines and procedures on how energy saving should be determined. Guidance on the monitoring and verification procedures that would need to be in place to ensure that the energy companies meet their obligations is also provided. This report also presents the approach to determining energy saving values for the main classes of energy efficiency measures in buildings (such as upgrades to heating equipment, insulation, lighting, appliances), including individual measures within each class. The importance of sampling, and appropriate sample sizes, is also discussed.

Section 2 of this report identifies the schemes and other source material reviewed as part of this report. Section 3 provides an overview of key issues to consider when designing an EEO. Sections 4-6 describe the principles or general approach to specifying energy savings in three countries: Denmark, France, and the United Kingdom (Great Britain[3] only). Sections 7 and 8 examine issues that should be considered in defining energy savings, the high level principles to apply in determining energy saving values, and the energy saving methodology by measure type. Section 9 briefly discusses monitoring, verification, and auditing arrangements. This report also contains four appendices that cover (1) selected extracts from the draft EED; (2) a proposed revision to EED, Annex V; (3) a brief description of EEO arrangements in South Australia, Italy, and Poland (planned); and (4) conclusions about the EuroWhiteCert[4] Intelligent Energy Europe (IEE) Project concerning energy saving methodology.

1 The European Council for an Energy Efficient Economy (www.eceee.org)

2 The Regulatory Assistance Project (www.raponline.org)

3 Great Britain = England, Scotland, and Wales. Northern Ireland, which is part of the UK, is regulated separately and covered by a different EEO scheme, although it bears many similarities to its GB counterpart.

4 For more information see http://www.ewc.polimi.it/index.php

2. Source Material

This report draws heavily on the operational framework of the following three EEO schemes, including: (1) the **energy companies' conservation efforts (Energiselskabernes spareindsats)**, a Danish scheme for savings delivered by the grid and distribution companies in the electricity, natural gas, district-heating, and oil sectors[5]; (2) the **White Certificate Scheme (certificats d'économies d'énergie or CEE)**, which operates in France and applies to suppliers of electricity, gas, heat, cold, heating oil, and vehicle fuels for passenger cars[6]; and (3) the **Carbon Emission Reduction Target (CERT)**, which applies to retail suppliers of electricity and gas serving residential customers in Great Britain.[7]

In addition, the results of three IEE projects have been reviewed and are utilised in the report—the **EuroWhiteCert**[8], the **EMEEES**[9] project, and the **Concerted Action for the Energy Services Directive**[10] (CA ESD). The EuroWhiteCert project (completed 2007) involved a critical evaluation of the experiences with already established certificate schemes in the energy sector and also addressed the development of a uniform measurement and verification methodology. The EMEEES project (completed 2009) was concerned with measuring and reporting energy savings for the Energy Services Directive (ESD).[11] Finally, the CA ESD aims to provide a structured framework for the exchange of information between the 27 Member States and Croatia during their implementation of the ESD.

Information on EEOs in other territories and from other sources has also been reviewed, including the presentations and discussions at a workshop on EEOs organised by eceee on behalf of the Commission and held in Brussels on 30th September 2011.[12]

5 For more information on Energiselskabernes spareindsats see: http://www.ens.dk/da-dk/forbrugogbesparelser/energiselskabernesspareindsats/Sider/Forside.aspx

6 For more information on the White Certificate Scheme see: http://www.developpement-durable.gouv.fr/-Certificats-d-economies-d-energie,188-.html

7 For more information on CERT see: http://www.ofgem.gov.uk/Sustainability/Environment/EnergyEff/Pages/EnergyEff.aspx

8 For more information on the EuroWhiteCert see: http://www.ewc.polimi.it/index.php

9 Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services (EMEEES). For more information on the EMEEES see: http://www.evaluate-energy-savings.eu/emeees/en/the_project/project_description.php

10 For more information on CA ESD see: http://www.esd-ca.eu/

11 For more information see http://www.evaluate-energy-savings.eu/emeees/en/home/index.php

12 See eceee website for details, including presentations: http://www.eceee.org/eceee_events/energy-efficiency-obligations

3. Key Features of Energy Efficiency Obligation Schemes

At its simplest, an EEO is a requirement on a group of market actors in one or more sectors of the energy industry in a given territory to achieve a specified energy saving target.

A variety of issues should be considered when specifying a target, including:

Who should the target apply to?

- Should it apply to energy distribution companies or retail energy supply businesses, or both?
- Should certain market actors be excluded, for example, by virtue of size (de minimis exclusion) or constitution (e.g., municipally owned non-profit distributing), or because of the market they serve (e.g., specialist supplier for street lighting)?
- Should new market entrants be given a partial or full derogation, to reduce barriers to entry?

What is the size of the target and how should it be apportioned?

- How should the target be apportioned between different sized companies?
- How large should the target be, balancing the need for savings against likely costs and benefits to the relevant end-use consumers?

How should the target be constructed?

- What metrics should be used to specify the target, e.g., energy (delivered or primary) or carbon dioxide; absolute or percent reduction of relevant consumption; expressed in annual or lifetime savings of the measures?
- What is the cost recovery mechanism? If the obligated companies are regional monopolies (e.g., distribution companies or retailers in a price regulated market), a levy might be appropriate. For companies operating in a competitive market (e.g., retail supply businesses), a commercial approach would see companies seeking to deliver their targets at lowest cost, to reduce the impact on energy tariffs.
- Over what period should the target be set? Examples include a fixed period, say three to four years, or a rolling annual target.
- Should obligated companies be restricted to achieving savings among their own consumers?
- Should non-obligated companies be permitted to deliver qualifying savings, and if so, how should this work (e.g., through an open market in certified savings or bilateral contracts with obligated parties)?
- Should savings from renewable energy deployment be permitted alongside energy efficiency measures, and if so, what conditions should apply (e.g., only renewables deployed within the property boundary would qualify)?
- Who should administer the target? Clearly the administrator needs to be independent and trustworthy. Historically this role has been given to the energy regulator if the target addresses the regulated companies, to a government body such as an energy agency if addressing a wider group of operators, or directly to a government department.

How should energy end-uses and institutional issues be addressed?

- Which energy end-uses should qualify?
- Which end-use sectors should the target address—residential, commercial, public sector, industrial (small/large), transport?
- How should interaction with other schemes be dealt with? How should overlap with other schemes (e.g., EU Emission Trading Scheme (ETS) or national schemes) be addressed?

- Should banking and/or borrowing be permitted between different trading periods?
- Should trading between obligated companies be permitted?
- Should trading outside of the obligated companies (e.g., with the EU ETS or national schemes) be permitted?
- Should savings be specified in tradable units (i.e., certificates designated in savings of the target units)?

Whilst these are essential issues to consider in the design of a scheme, they are not explored further in this report except for those that have a direct bearing on the methodology for defining energy savings.

4. The Danish Energy Savings Calculation Methodology

This and the next two sections briefly discuss the energy savings methodology in the EEOs operating in Denmark, France, and the UK. As the principles are generally quite similar, only the Danish methodology is described in detail. The next two sections highlight only some of the specific features of the French and British systems, respectively.

The Danish obligations for energy savings have existed for many years, especially within the electricity grid companies. In 2006, the obligations were increased and the obliged parties were allowed to search for energy savings in all energy types and all over Denmark. The obligations are legally binding on electricity, gas, and heat providers but are the subject of a voluntary agreement with the heating oil sector. Earlier the utilities had only worked with their own end-users. For natural gas, electricity, and heating oil, the obligation is negotiated with the sector trade organisation, whereas for district heating the obligation is put on the individual company.

Energy savings in the Danish EEO are based on *standard values* for smaller, standardised activities (typically in homes and other buildings).[13] If a standard value is available for a given measure, then this must be used. *Specific calculations* are used in areas where there is no standard value, typically larger and integrated projects in business enterprises or public institutions. If a specific calculation is used, then the entire project must be calculated specifically, including the effect of initiatives where standard values exist.

Standard Values

Standard values reflect an average saving, and it is therefore not allowed to choose a specific calculation when the saving is greater than the standard value. These values are based on proven technology for which the savings have been independently verified. Only those energy savings that would not have been realised without the companies' efforts can qualify. Savings from advice and behavioural measures are non-qualifying.

The following principles were incorporated in setting the standard values:

a) To ensure maximum savings and promotion of technology development, standard values should focus on the most cost-effective solutions using best available technology. Account must be taken of profitability etc, however, so as to avoid blocking the implementation of sensible savings and so other standard values may be required.

b) If the lifespan of a given measure is estimated to be less than one year, no standard value can be set, and therefore the savings cannot be included. Savings for measures with lifetimes greater than one are adjusted by the factors[14] illustrated in Figure 1.

c) In areas where a large part of the improvement is implemented in connection with natural replacement (i.e., typically after the technical lifespan), then the standard value is set as the difference between the average efficiency of the products sold (standard

13 For more information on Energiselskabernes spareindsats see: http://www.ens.dk/da-dk/forbrugogbesparelser/energiselskabernesspareindsats/Sider/Forside.aspx

Figure 1

Lifetime (years)	Factor
1-4	0.5
5-15	1
Over 15 (for measures outside the ETS saving oil, coal and gas)	1.5
Over 15 (all other measures)	1

technology) and the efficiency of the specific product. It is therefore only possible to include an effect if the products chosen are better than the average sold. If, in the absence of a market average figure and in accordance with Danish and EU legislation, efficiency standards have been adopted, then these may be used as a basis for determining the efficiency of the average product sold. If part of the replacement is forced (see point d below), then account should be taken of this when determining the standard value.

d) Where there is a forced replacement, or a saving that would not be implemented at this stage without the obligated companies' efforts, then the standard value is calculated as the difference between the existing product and the new product for the remaining life of the product being replaced.

e) Standard values should be adjusted for specially selected areas where it is obvious that savings will occur naturally. For example, no standard value is allocated to CFLs and "white and brown" appliances (e.g., refrigeration, washing, home entertainment), as efficient products already have a high market share and there is little or no additionality.

In order to ensure true and credible standard values, there must be openness about the standard values and their preparation. Documentation of the standard values must be available. A technical working group undertakes an annual assessment as to whether there is reason to adjust the various standard values, due to, amongst other things, technological developments. Any changes will only affect future efforts.

Specific Calculation

A specific calculation is used in areas where there is no standard value. This will typically be used for larger, integrated projects in business enterprises or public institutions. For specific calculations, the objective is that efforts should promote the use of best available technology or practices, while taking into account financial considerations.

The level of detail on the specific calculation must be adapted to the specific project. The larger the project, the greater the detail required for the calculation. There is no general requirement for the measurement of consumption before and after, but this may be relevant, particularly for larger projects. If using a specific calculation, the entire project must be calculated, including the impact of initiatives for which there are standard values. In order to calculate the effect of an integrated project consisting of various sub-projects, account must be taken for any possible overlap between the effects of the various sub-projects. A specific calculation may include a calculation of the savings on the "main meter," assuming the use of a method that corrects for changes in production volume and/or the nature of the product.

14 Because the total energy savings are critically dependent on the lifetime of the measure, it is important to recognise the duration of the savings. Unlike the French and British schemes (see next sections) that apply the actual measure lifetime, the Danish EEO scheme moved in January 2011 from first-year energy savings only being considered to one that operates on lifetime bands. These have been set by the scheme administrator as a pragmatic approach, based on their experience in which the average industrial energy saving measures last for seven years. Only building fabric measures and windows are ascribed lifetimes in excess of 15 years. The bandings have the effect of favouring shorter lifetime measures. For example, a measure with a lifetime of 20 years generates 10 times the total energy saving as an equivalent measure with a lifetime of just two years, yet only receives three times the credit under the Danish scheme (1.5 uplift factor instead of 0.5). Note that the French scheme applies a discount rate of four percent to energy savings, which reduces the savings for longer life measures. The British scheme target metric is in lifetime carbon savings, which are not discounted.

5. The French Energy Savings Certificate Scheme

The French Energy Savings Certificates (ESC) Scheme was established by the Energy Strategy law of 13th July 2005 and formally launched a year later, in July 2006. Its main objective is to reach the diffuse potential sources of energy savings, especially in existing buildings, by means of an obligation on energy suppliers to achieve energy savings in proportion to their energy sales. The first three-year period was seen as a learning phase, with the target set deliberately low. After a transition period to 2011, when no target was in operation, a second, more ambitious phase was introduced for the period 2011 to 2013 with a headline target more than six times greater than in the first phase.[15]

The key players in the French ESC Scheme are:

- DGEC (Energy and Climate General Direction) within the Ministry of Ecology, Sustainable Development, Transport and Housing sets the scheme rules and level of the obligation;
- ATEE (Energy Environment Technical Association) is a forum in which actors in the energy savings market (e.g., energy suppliers, manufacturers, retailers) work together to propose new standardised actions to the ministry based on the consensus of all actors. ATEE develops feedback on the ESC system and contributes to the adaptation and the evolution of the system over time;
- ADEME (Agency for Environment and Energy Management) provides "back office" functions on behalf of the DGEC, including technical analysis, expert advice, and evaluation. ADEME also runs information campaigns as well as numerous other government-funded energy saving activities;
- A national administrative centre ("PNCEE")[16], under the control of DGEC, awards and records the ESCs and controls the projects;
- The obligated parties, namely suppliers of electricity, natural gas, liquefied petroleum gas, district heating and cooling, heating oil, and (in the second phase only) vehicle fuel suppliers; and
- The "eligible" parties. This category of players was modified in the second phase and refers to organisations that are not an obligated party but can earn energy saving credits in their own right.

Eligible parties are:

- Local authorities for actions on their own buildings or toward third parties in their territory;
- The National Agency for Housing (ANAH); and
- Social housing agencies or social landlords

The target is denominated in energy savings over the lifetime of the project, discounted at a rate of four percent. The metric is termed "kWh cumac."[17]

Obligated energy suppliers have a variety of options for meeting their commitments. They may:

- implement energy saving programmes (within their customer base);
- buy certificates on the ESC market;

15 In reality, with the expanded scope of the obligations and the 18-month lapse between schemes when the obligated parties continued to save energy, the increase for EDF and GDF Suez was closer to a factor of 4. For more information on the White Certificate Scheme see: http://www.developpement-durable.gouv.fr/-Certificats-d-economies-d-energie,188-.html

16 Le Pôle National des Certificats d'Economie d'Energie, National Centre of the Energy Savings Certificates.

17 CUMulated ACtualised saving over the lifespan of the action or equipment

Figure 2

	Building Envelope	Heating/ Cooling	Lights & Appliances	Other Equipment	Services	Total
Residential	7	48	6	0	4	65
Commercial buildings	14	55	19	0	1	89
Industry	2	0	6	18	0	26
Networks	0	5	5	1	0	11
Transport	0	0	0	13	3	16
Agriculture	0	3	0	3	1	7
TOTAL	**23**	**111**	**36**	**35**	**9**	**214**

- pay the penalty (this is set at €c2/kWh cumac (i.e., far higher than the cost of delivering savings, which equated to €c0.4/kWh cumac during the first period); or
- some combination of the above.

Energy savings that qualify for white certificates are specified in individual sheets (known as "fiches"). Savings are categorised into six end-use sectors, each of which is subdivided into up to five different categories of measure – (see Figure 2).

Each (usually one-page) sheet specifies the following parameters for that measure:

- Eligible end-use application;
- Brief description of the measure, its applicability, and any relevant technical standards;
- Requirements concerning installation of measure;
- Measure lifetime; and
- Energy saving (e.g., per unit, m^2), including any variations between the three French climatic zones.

Example sheets are provided on the next page for high efficiency motors in industry and also for the installation of a condensing boiler in an existing residential building.

The sheets are applicable to buildings up to 5,000 m^2 area. Anything with a larger area uses separate sheets. Tertiary[18] buildings use distinct parameters unique to this particular sector. Measures that do not fit within the standard sheets are also permissible – these are calculated individually.

The full list of energy saving sheets is available on the Ministry website: http://www.developpement-durable.gouv.fr/Secteur-du-batiment-residentiel.html

All certificates are maintained on the National Register of White Certificates: http://www.emmy.fr/

18 Tertiary covers the public and commercial sectors.

Figure 3

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RÉPUBLIQUE FRANÇAISE

Certificats d'économies d'énergie
Opération n° **IND-UT-01**

Moteur haut rendement EFF1

1. **Secteur d'application**
   Industrie
2. **Dénomination**
   Mise en place d'un moteur haut rendement appartenant à la classe de rendement européenne EFF1.
3. **Conditions pour la délivrance de certificats**
   Seules les actions engagées avant le 16 juin 2011 donnent lieu à la délivrance de certificats d'économies d'énergie.
4. **Durée de vie conventionnelle**
   15 ans
5. **Montant de certificats en KWh cumac**

Montant en kWh cumac en fonction de la puissance nominale du moteur Pn en kW	
Application	
Pompes, ventilateurs, compresseurs, convoyeurs	**Autres moteurs**
720 x Pn + 4 700	440 x Pn + 3 200

Figure 4

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RÉPUBLIQUE FRANÇAISE

Certificats d'économies d'énergie
Opération n° **BAR-TH-06**

Chaudière individuelle de type condensation

1. **Secteur d'application**
   Bâtiments résidentiels existants.
2. **Dénomination**
   Mise en place d'une chaudière individuelle de type condensation.
3. **Conditions pour la délivrance de certificats**
   L'action n'est applicable que sur des installations dont les émetteurs sont dimensionnés de façon à permettre à la chaudière de condenser.
   Mise en place réalisée par un professionnel.
4. **Durée de vie conventionnelle**
   16 ans
5. **Montant de certificats en KWh cumac**

Pour une maison individuelle:				
Zone climatique	**Montant unitaire en kWh cumac**		**Facteur correctif**	**Surface habitable en m2**
H1	120 000	**X**	0,2	< 35
H2	110 000		0,4	35-60
H3	74 000		0,7	60-80
			0,9	80-100
			1,1	100-130
			1,4	>130

Pour un appartement:	
Zone climatique	**Montant unitaire en kWh cumac**
H1	61 000
H2	53 000
H3	40 000

6. The British Carbon Emissions Reduction Target

The British Carbon Emissions Reduction Target (CERT), which runs from 2008 to 2012, can trace its roots back to 1994 when the first Energy Efficiency Standards of Performance (EESoP) on 12 electricity retailers in England and Wales were introduced by the electricity regulator in response to a duty *"to promote the efficient use of electricity among customers."*

Around 40 times bigger than its earliest ancestor, CERT retains essentially the same principles as the original scheme nearly 20 years earlier. As the scheme has grown, however[19] (in terms of its size, geographical spread, fuels covered, and eligible end-uses), additional layers of complexity and sophistication have been added, as detailed in the scheme rules published by the energy regulator, Ofgem.[20] The Department of Energy and Climate Change (DECC) sets all licensed retailers of electricity and gas[21] specific obligations to save energy from GB households (not necessarily their own customers) within a certain time period (usually three years). The latest phase has moved from energy savings to lifetime carbon dioxide savings, which are calculated from the energy savings achieved multiplied by the carbon dioxide content of the energy source saved. This change reflected the environmental priority of the programme, although it also makes important contributions to aspects of fuel poverty. There are exemptions from the obligation for companies with less than 50,000 customers, and more than 99 percent of the overall target is shared between the major six energy retailers in proportion to their market share of customer numbers. There are specific requirements that 40 percent of the energy retailer's target must come from energy saving measures carried out in low-income households.

The main CERT documentation comprises:

- supplier guidance covering issues on compliance, reporting, and other administrative arrangements;
- a technical manual describing how different energy savings measures should be determined; and
- a submission spread sheet with predetermined energy saving values for specific measure/property combinations.

These are augmented by various other documents, such as a combined heat and power (CHP) calculation spread sheet, and pro formae for customer satisfaction monitoring.

The vast majority of savings arise from deemed or ex ante measures whose energy savings have been adjusted and validated over years of monitoring and evaluation. These were originally determined through the research, demonstration, and dissemination activities of the Government's Best Practice Programme, which then fed into BREDEM[22], a model of residential energy consumption by end-use. This provided the basis for deriving the original energy savings. A programme of physical monitoring and evaluation of installed measures was then undertaken by the Energy Saving Trust, the original scheme administrator on behalf of the regulator, which resulted in adjustments to

19 One exception to the generally expansive nature of the obligation is a contraction in coverage. The first EESoP scheme (1994-1998) applied to non-residential electricity consumers with peak demands of up to 100 kW, in addition to residential customers. The non-residential component was removed in 2000 and the scheme has been focused exclusively on the residential sector since then.

20 For more information on CERT see: http://www.ofgem.gov.uk/Sustainability/Environment/EnergyEff/Pages/EnergyEff.aspx

21 For the residential sector in GB, all obligated retailers offer both electricity and gas where available.

22 Building Research Establishment Domestic Energy Model

both the gross energy saving and the comfort factor.[23] Since 2003, the Government has funded periodic research to ensure that energy saving values continue to reflect reality.

Energy suppliers submit details of completed schemes with pre-entered savings for a comprehensive spectrum of measures, varying according to property typology and specific circumstances. Figure 5 illustrates an example for a single measure (loft insulation top up). The savings vary depending on the previous level of insulation and the final level after top up – four of the six possible combinations are illustrated. The big difference in savings between the first two columns, where the prior level of insulation was less than 60mm, and the last two columns, where the prior level was between 60 and 160mm, demonstrates the importance of establishing the particular circumstances of the measure being installed. Ex ante lifetime carbon savings (the metric used for the CERT target) are prescribed for 18 dwelling type/size combinations, representing the vast majority of the housing stock in Britain.[24] If the property size is significantly different from the average value used in the calculation below, then the energy supplier may use a value derived from an energy saving value per square meter, again taking into account the starting thickness value.

Please note that the Government has announced its intention to introduce a new Energy Company Obligation (ECO) in 2013, along with a new "Green Deal,"[25] to replace CERT.[26]

23 For example, a comfort or increased amenity factor reflects the fact that after a property is insulated, the average householder takes some of the potential energy savings of heating fuel in the form of higher indoor temperatures or increased comfort. Historically in GB households a comfort factor of 30 percent was discounted from the expected BREDEM energy savings.

24 For properties that are 15 percent or more larger or smaller than the average property size, an adjusted saving figure must be used.

25 Green Deal is a new financial mechanism that eliminates the need to pay upfront for energy efficiency measures and instead enables costs to be recovered through energy bills.

26 Further details on the Green Deal are available at the DECC website: http://www.decc.gov.uk/en/content/cms/tackling/green_deal/green_deal.aspx

Figure 5

Loft Insulation Top Up	From Less Than 60mm to 200mm	From Less Than 60mm to 270mm[3]	From Between 60mm and 160mm to 200mm	From Between 60mm and 160mm to 270mm
Dwelling Type	**Lifetime Carbon Reduction ($kgCO_2$)**			
1 Flat, 1 bedroom	10,520	10,954	3,022	3,123
2 Flat, 2 bedrooms	15,279	15,909	4,389	4,536
3 Flat, 3 bedrooms	22,292	23,212	6,403	6,618
4 Mid-Terrace, 2 bedrooms	7,642	7,951	2,256	2,328
5 Mid-Terrace, 3 bedrooms	9,583	9,971	2,829	2,919
6 End-Terrace, 2 bedrooms	8,137	8,459	2,428	2,503
7 End-Terrace, 3 bedrooms	10,204	10,608	3,045	3,139
8 Semi-detached bungalow, 2 bedrooms	16,370	17,046	4,906	5,063
9 Semi-detached bungalow, 3 bedrooms	19,077	19,865	5,717	5,900
10 Detached bungalow, 2 bedrooms	17,000	17,720	5,188	5,355
11 Detached bungalow, 3 bedrooms	19,791	20,629	6,040	6,235
12 Detached bungalow, 4 bedrooms	22,835	23,803	6,969	7,194
13 Semi-detached house, 2 bedrooms	9,863	10,256	2,935	3,026
14 Semi-detached house, 3 bedrooms	11,400	11,854	3,393	3,498
15 Semi-detached house, 4 bedrooms	13,065	13,586	3,888	4,009
16 Detached house, 2 bedrooms	11,728	12,219	3,633	3,747
17 Detached house, 3 bedrooms	13,553	14,119	4,198	4,330
18 Detached house, 4 bedrooms	15,638	16,291	4,844	4,996

7. Issues to Consider in Defining Energy Savings

The next level of consideration after the high level scheme objectives described in Section 3 is that of the administrative arrangements. For the purposes of this report, the focus is on those areas specifically affecting energy savings. Issues such as administrative arrangements, reporting requirements, target setting, trading, property rights for the ESC, penalties, and many others are vital for the effective management and operation of an EEO, but are not directly of relevance to calculating and evaluating energy savings and hence not covered in this report.

In what follows, we examine the key considerations that need to be considered in determining energy savings under the headings of (1) Baseline Issues; (2) Gross Savings Adjustments; (3) Attribution of Energy Savings; (4) Reporting & M&V; (5) Encouraging Innovation; and (6) Policy Issues.

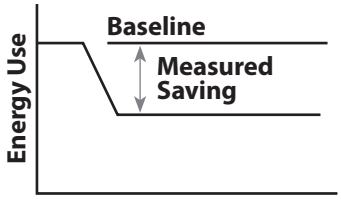
7.1 Baseline Issues

Specifying the energy saving of specific measures. The actual measure saving should be calculated or estimated as accurately as possible for the particular application, but with due consideration to keeping the cost of calculation to a reasonable level. The main calculation methodologies are described below.

Calculation method(s) used.

Three basic approaches are:

1. ***To calculate the actual savings achieved as a result of the measure.*** This is termed "ex post" and would entail before and after monitoring or billing analysis, as illustrated by this simplified schematic.



A simple equation for quantifying the savings would be: **Savings = baseline period energy - reporting period energy ± adjustments**

The adjustments are critical to ensure that a reasonable comparison is made between the before and after period, as many things could change between the two periods – e.g., the weather, occupancy, usage patterns, and production levels. Also, the length of the monitoring period should be sufficient to provide a representative measurement. If the period is too short, the error risk is greater and there may be a "novelty" factor as users temporarily adjust their behaviour in response to the installation. The main downside of the ex post methodology is the time delay between installation of measure and validation of savings, and for measures that save smaller amounts of energy, the savings may not show up in bill analysis unless sub-metering is present – unlikely in residential or small business situations.

2. ***To specify savings from a particular measure in advance,*** by reference to engineering estimates or the results of previous monitoring. The generic approach is termed "ex ante" or "deemed savings" and has the benefit of providing certainty in advance to market participants as to the contribution to the target from particular measures. It also does not suffer the time delay of the ex post methodology or from the need to inconvenience the end-user with the ongoing metering. Conversely the downside is that the estimated ex ante savings may not reflect the true savings achieved in practice, though for large number of installations, the average value will be representative. The validity of the deemed energy savings can be addressed by monitoring (see Section 9).

In some cases an intermediate approach between deemed savings and actual measured energy savings is appropriate. The method is variously known as engineering estimates of savings (also known as deemed savings algorithms) in which existing robust measured data from similar applications are available but it is difficult or disproportionately too expensive to directly monitor (e.g., replacing a compressor or electric motor with a different kWh rating than that for which independent information on savings has been measured at a different kWh rating). This is similar for office HVAC equipment.

3. To undertake a survey. If behavioural or advice measures qualify toward the target, or in the case of measures with a small impact that would be difficult to measure accurately, it may be appropriate to undertake a survey of the energy savings subsequently attained by scheme participants; it is good practice to have a control sample of those who did not receive the behavioural and/or advice measures to discount any behavioural changes occurring naturally or for other reasons in the wider population. A survey may be appropriate also for energy audits, to determine the measures undertaken as a result of the audit.

From the review of EEO schemes undertaken, ex ante or deemed savings are by far the preferred option for most standard measures, particularly in the residential sector where there are large volumes of similar properties/measures. Ex post monitoring is generally reserved for larger, low-volume, and more complex applications. This is also the conclusion of the EuroWhiteCert IEE project (see Appendix 3).

New Build or Major Renovation

For any measures installed in a newly built property, only the savings over and above the prevailing building regulations or codes for the property can be included. For particular categories of buildings that are normally constructed to a higher standard than the national or regional building regulations (e.g., in social housing or public buildings), the baseline standard to apply is the higher level. Similarly, if a major renovation to the building is covered by building regulations, then only energy savings are awarded for those measures saving energy above that required by the building regulations.

New Equipment (e.g., HVAC plant, lighting, appliances, motors and drives, compressors)

Only the difference between the high-efficiency equipment and the market average should be counted.

Early Replacement of Products or Equipment

Where measures result in the accelerated replacement of equipment, products, or building components, due account shall be taken of the duration of the energy savings compared to the energy consumption of the original equipment, but only for the remaining lifetime of the original equipment.

7.2 Gross Savings Adjustments

Rebound Effect/Comfort Factor/ Increased Amenity

Deemed energy savings should be net of any change in consumption due to the installation of the measure. For example, insulation measures will make it easier and cheaper to heat a property, and hence there is a significant likelihood that a proportion of the benefit may be taken as increased comfort. Equally, if energy bills are lower as a result of a package of measures, there may be a tendency to increase consumption generally due to its greater affordability.

Normalisation Factors

Deemed energy savings should be normalised to a standard value. For example, if there are significant weather variations within a territory, the savings from heating and/or cooling measures should be standardised to a representative norm for that territory. An alternative approach would be to count the "true" savings in different parts of the territory, but to adjust the target accordingly prior to the start of the obligations. This alternative might be appropriate for regionally-based companies but would be less effective for companies operating across an entire territory with markedly different climatic zones. The former approach is used in CERT in Britain, whereas the latter is used in the French White Certificate Scheme.

Conversion Factors

Savings from different fuels need to be converted into a standard form. If the overall target is expressed in terms of carbon, the conversion should be on the basis of carbon equivalence from the carbon content of the input fuel on a kWh basis.

Fuel Switching/Carbon Content of Fuels

This is particularly important where there is an increase in one energy source at the same time as a decrease in another. This might occur, for example, when converting from coal-fired heating to gas,[27] or when installing a gas-fired CHP unit, which increases gas consumption but reduces primary electricity consumption, or with heat recovery ventilation in which heating fuel is saved, although there is a parasitic electricity use for operating the ventilation unit. In a programme in which the emphasis is to tackle climate change rather than to deliver energy savings, due account should be taken of the carbon content of both the energy saved and the new type of energy that will be consumed.

Measure Lifetime

A realistic lifetime, ideally based on recognised market data (e.g., derived from recent annual replacement figures for the measure), should be applied to the measure.

Heat Replacement Effect

At times when space heating is required, internal gains from lights, appliances, pumps etc., make a useful contribution to meeting the heating load. A shift to more energy efficient equipment will reduce internal gains and thus require the heating system to compensate for this reduction. To allow for this, the savings from the more efficient product should be amended, taking due account of the duration of useful heat provision and conversion factors between electricity and the primary heating fuel. The converse is true in situations in which cooling is required – more efficient products reduce the load on the air conditioning plant and hence increase energy savings.

Technical Interaction Between Measures

This may occur when two or more actions overlap (e.g., improving both the insulation and the heating system of a building). Only the net impact of the package of measures should be counted. In some instances this type of interaction may be difficult to spot or eliminate, for example, if a customer takes a heating measure from one actor and an insulation measure from another.

7.3 Attribution of Energy Savings

Additionality

Only the net savings that are additional to the prevailing or "business as usual" (BAU) conditions should be counted. Establishing a baseline for BAU purposes requires a good understanding of the current energy use for the particular application, the market dynamics, including the direction of travel of prices and sales, etc. Where national or EU regulations set a minimum efficiency threshold for a particular product or end use, only savings over and above that threshold, or the market average (whichever is more appropriate), can be considered as additional.

Where the market share of the energy efficient measure is already high, it may be appropriate to exclude it from the list of qualifying measures, as has been done in the case of Denmark with CFLs and white/brown appliances. The Danish scheme has set a target 15 percent higher than the nominal expected savings, to recognise the fact that a proportion of the savings implemented by obligated parties will not be additional. In other words, obligated suppliers must achieve 115 percent of the nominal target.

Free Riders or Deadweight

The British scheme originally focused on careful scheme design to minimise free riders or deadweight – a specific case of additionality in which customers who were planning to install the energy saving measure anyway take advantage of a subsidy. When the scheme grew in size, however, it effectively subsumed the previous markets for most energy efficiency measures. Unlike the Danish scheme, obligated suppliers in Britain receive the full credit for all measures delivered. The net carbon impact of CERT is assessed by the

27 Converting from a coal-fired heating system to gas would have a double benefit – firstly, the gas system has a higher efficiency, so delivered energy is reduced, and secondly, the carbon content of the fuel used is lower.

Government[28] by removing the deadweight energy savings and other considerations. This does not affect the target that the energy retailers must meet, however, which is set assuming a certain level of deadweight (i.e., estimates of deadweight are built into the target).

Additionality remains an important criterion in CERT. For example, if a supplier is funding measures in conjunction with another Government programme, then the carbon savings accredited to the supplier will be in proportion to the funding they have provided. Suppliers are also required to minimise free riders, to the extent possible, within scheme design.

It is important to recognise that markets are not static and that prices, fiscal incentives, standards, etc change over time. The savings attributable to a given measure therefore need to be periodically appraised, ideally in a pre-scheduled timeframe so that all actors within a scheme can plan for a changing landscape.

Free Drivers/Multiplier Effects

The opposite of free riders are free drivers, that is, programme participants who are stimulated into action by the existence of the scheme (e.g., a subsidy), perhaps due to the marketing or raised awareness it creates, but who do not take advantage directly. The case for applying free drivers needs to be examined very carefully if the obligated party has not made a direct financial contribution to equipment sales. In practice, this has rarely been used in awarding energy savings in Europe, although some evaluations of EEOs in other parts of the world (e.g., many jurisdictions in North America) have included free driver impacts where they have been clearly documented.

Materiality

Whilst EEO schemes should work with the grain of the market, and sometimes in conjunction with existing market initiatives (e.g., tax incentives, preferential loans), it is important to establish that the obligated company has made a measurable contribution to any installations benefitting from two or more means of support. Depending on the circumstances, it may be appropriate to apportion a share of the total savings in accordance with the proportion of effective support provided by the obligated party compared to that from the other policy measure.

Market Transformation

Market transformation is a special type of multiplier effect in which the actions of (typically all, or a group of) obligated parties result in new markets for particular products, or a significant shift in market dynamics. Such initiatives could have significant long-term benefits in terms of energy savings and should therefore be encouraged, although a cautious approach to apportioning savings should be taken – sales beyond the obligation period should not be permitted. It can be useful to have a "sunset" clause for rapidly moving markets such as appliances (e.g., once an energy efficient market product has reached 30 percent market penetration).

7.4 Reporting and Monitoring and Verification (M&V)

Quality Standards

Energy efficiency measures have to fulfil their promise of energy savings and be a positive experience for the end-users to avoid a backlash against the concept of energy efficiency. This is often down to ensuring that the installation of energy efficiency measures is done to the highest prevailing quality standards. Similarly, as substandard installations are unlikely to achieve the expected energy savings in the case of deemed energy savings, then awarding the full energy savings values for such installations is not justified. To minimise such occurrences, measures should meet the prevailing national, regional, or local standards for quality and performance. Where installed professionally, this should be done in accordance with recognised industry standards. Where nationally or regionally recognised accreditation, certification, or quality mark standards exist, for materials or labour, these should be mandated.

Deemed energy savings should be net of any change. Equally, if energy bills are lower as a result of a package of measures, there may be a tendency to increase consumption generally due to its greater affordability. These are direct

28 The responsible body is the DECC. Further information on CERT can be found at the DECC website: http://www.decc.gov.uk/en/content/cms/funding/funding_ops/cert/cert.aspx

rebound effects that are usually easy to measure and larger than the macro-economic rebound effects. The latter are the subject of much debate and have not been taken into account in energy efficiency obligations in the past. Care must be used in establishing such clauses and determining when they should apply, however, as the market share for some products will not necessarily grow quickly once the 30 percent (or any other benchmark) has been reached.

Double Counting

Double counting may occur when two measures overlap (e.g., grants and energy audits schemes for industrial companies), or when an end-user is able to take advantage of two offers (from the same or different companies) for the same measure. Careful attention to scheme design can help reduce or eliminate double counting. Denmark uses an arbitrator in the case of disputes over the apportionment of savings. In Britain, the Energy Saving Trust has a Homes Energy Efficiency Database[29] capable of storing all energy measures installed by energy companies and others, and the use of this database by energy suppliers eliminates double counting.

7.5 Encouraging Innovation

Encouraging Technical Innovation

It may be desirable to speed up the move to new products or technologies that represent a significant improvement over existing technologies and have significant energy savings potential but at present cost significantly more than most of the market is prepared to pay. Provided the energy savings have been independently verified, an uplift factor that multiplies the real energy savings for that product or technology can be awarded for a limited time. If done sensibly and by inclusion of a sunset clause (see earlier), the energy savings gained from the advancement of the new product or technology can be far greater than the "loss of energy savings" due to the artificial uplift.

New Measures

Over the duration of a compliance period, which may be one year or more, it may be the case that new measures or products enter the market. Such products must have achieved the CE marking to qualify for sale onto the European market, but may not yet have independent verification of their savings. If ex post monitoring is not feasible within the timescale of the obligation, it may be appropriate for the scheme administrator to apply a conservative figure for deemed savings, although it is essential that in situ field trials be undertaken to inform the energy savings for future schemes.

Technical Advisory Group

Given that it is not possible to define every potential energy saving measure or particular application in advance, there may be a role for an independent technical group in dealing with complex issues. The group should comprise the scheme administrator, representatives from the obligated companies, and independent technical experts. Its recommendations to the scheme administrators should be taken independently of the obligated companies. As noted earlier, such an advisory group operates within the scope of the Danish scheme and in France.

7.6 Policy Issues

Quotas or Adjustment Factors

The cost of achieving a given quantity of energy savings will depend on the type of measure. For example, insulation measures may be less cost effective for obligated companies to achieve than, say, appliance or lighting measures. If there is a desire to support all end uses, quotas for saving energy in each main category (i.e., heating, insulation, appliances, and lighting) could be set. For example, in the latest extension of GB CERT, 68 percent of savings have to be delivered by professionally installed insulation measures. An alternative is to apply a weighting factor to reduce the differential in cost effectiveness.[30] Conversely, if the sole objective is to achieve the maximum savings at lowest cost, no quotas or adjustment factors should be applied.

29 For more information on the Homes Energy Efficiency Database see: http://www.energysavingtrust.org.uk/Professional-resources/Existing-Housing/Homes-Energy-Efficiency-Database

30 Such an approach was tried in the pilot UK scheme, called the Community Energy Saving Programme, but at the time of writing, it is not clear that this extra layer of complexity has delivered its objectives.

Social Objectives

Another form of quota or ring fencing would be the requirement to deliver a minimum proportion of the target among specified customer groups, for example, those on low incomes, the disabled, elderly, or otherwise vulnerable consumers, or rural customers. Such social requirements have existed for a long time in the Flemish and GB obligations. Equally, there might be a desire to ensure that each end-user category (e.g., residential, tertiary) receives a prescribed share of the benefits, perhaps in proportion to their collective financial contribution to the scheme.

Only the net impact of the package of measures should be counted. In some instances this type of interaction may be difficult to spot or eliminate, for example, if a customer takes a heating measure from one actor and an insulation measure from another or if the two measures are installed at different times.

For any measures installed in a newly built property, only the savings over and above the prevailing building regulations or codes for the property can be included. Further details of the specific means for determining energy savings for individual measures are provided in the next section.

8. Determining Energy Saving Values by Measure

This section provides a brief description of the methodology for specifying energy saving values for each measure type commonly deployed in buildings. It does not discuss the important challenge for policy makers to align the inherent incentives for obligated companies to deliver targets at the lowest cost to the companies with the societal aim of achieving cost optimality through such adjustment factors that were described in the previous section.

For every measure, the aim should be to achieve the maximum, realistic energy or carbon savings consistent with the specific scheme objectives and criteria. Doing this requires rigorous definition of the energy savings, clear specification of quality standards to achieve them, and monitoring to ensure that these are attained in practice.

Figure 6 covers most types of energy use typically found in residential, commercial, public sector, and industrial buildings.[31] For non-standard measures, specific calculations or direct measurement of the energy savings should be undertaken to quantify the actual energy savings.

As a general principle, retrofit or replacement measures fall into two main categories that determine the baseline for determining savings:

- ***Retrofit building fabric measures*** (e.g., insulation, windows/doors) – due to different construction standards over time, the performance of the existing fabric element may vary according to the age of the property as well as the construction type. The use of housing survey data can be used to determine the average energy performance of the existing fabric element for that property type, age, and construction; this would then serve as the baseline for determining the energy savings. Alternatively, the improvement in the energy performance of the fabric element being replaced can be estimated based on the improvement in the thermal conductivity of the replacement fabric and the area treated if good estimates are available for the existing fabric. Under some circumstances, the baseline would be the energy performance of current mandatory code or regulation, as discussed above.

- ***Product measures*** (e.g., lighting, appliances, HVAC systems, motors, and drives) – the baseline would be set at the market level of sales for that product, taking due account of changing market share, which is particularly important in rapidly evolving markets such as consumer electronics ("brown goods") and, to a lesser degree, kitchen and laundry appliances ("white goods"). The appropriate baseline may be the energy performance associated with a current mandatory code or regulation. There is also a need to address issues such as free riders as discussed in section 7.3.

31 Savings from transport applications, and from grid/network operation, are not covered, although these are eligible energy savings in some schemes, for example, the French white certificate scheme, but less than 0.4 percent of the target has been delivered by such measures.

Figure 6

Measure	Energy Saving
	Building Fabric Measures
Insulation	The main objective is to reduce the thermal transmittance (U-value) or increase the thermal resistance (R-value) of the surface in question – wall, floor, foundation, roof, or loft space. Due to different construction practice over the years, and in different regions, the thermal performance of building elements will vary. Added to this might be the impact of post-construction retrofit measures, in particular insulation of accessible loft spaces. The energy saving is the difference between the baseline heat loss per m^2 for that particular building element (e.g., wall, roof) before and after application of the insulation measure. Due to the variable nature of the existing building fabric, two alternative approaches can be adopted with either deemed or deemed algorithm savings for determining its baseline thermal performance (unless a code standard is the baseline). The actual choice will be determined by balancing the accuracy in determining energy savings (building specific approach) and the extra cost to achieve this versus using weighted averages of energy savings determined from modelling and surveys of house conditions. The final decision is likely to reflect local circumstances, particularly the extent to which a finite number of property classifications can be used as representative of the country or region. ***a) Stock Average*** – The weighted average thermal performance across the building stock. This approach is appropriate where the costs and practicalities of determining the actual thermal performance in each case are disproportionate. ***b) Building Specific*** – The thermal performance of the particular building element being insulated. This approach is appropriate where it is relatively easy to determine the construction type based on the building typology or its age.
Glazing	Provided the building regulations in that country or region do not require a minimum energy performance for replacement glazing, then the saving is the difference between heat loss per m^2 for the existing glazing and the new high performance glazing. Wherever possible, standard heat loss figures should apply for different types of existing glazing, with due allowance for the reduction in air infiltration from older window types.[32] In certain replacement situations, the solar gain can be reduced, which can have additional energy savings or increased energy consumption, depending on the regional climate. If the Building Regulations specify a minimum performance for replacement windows, then only energy savings from the new windows above that minimum specification are counted. In both cases, there is also a need to address issues such as free riders as discussed in section 7.3.

32 In the French ESC scheme, the average heat loss across all existing glazing is used.in some schemes, for example, the French white certificate scheme, but less than 0.4 percent of the target has been delivered by such measures.

Measure	Energy Saving
Draught-proofing/air infiltration	When calculating the reduction in air infiltration rate, the savings is the reduction in energy required to heat/cool the reduced volume of air exchange from baseline. This measure has historically focussed on properties with poorly fitting windows and doors, but with improving insulation measures, heat losses from reducing air infiltration from a wider range of sources become proportionately more important (e.g., skirting boards, ceiling/wall junctions).
	Heating and Cooling Measures
New boiler or HVAC plant	(Applicable to first time installation of plant, or replacement of plant due to mechanical failure.) The savings are the difference between the prevailing market average plant (unless a code standard is the baseline) and the high-efficiency product installed.
Boiler or HVAC plant upgrade	(Applicable to replacement of working but inefficient boiler/HVAC plant). The savings are the difference between the existing plant efficiency (or a representative average) and the new plant, to be counted over the remaining lifetime of the plant. For example, if the plant has a 15-year lifetime and it is upgraded after 10 years, the applicable lifetime is five years. There of course will continue to be savings after this five-year period, but those will be against the likely market average efficiency of the plant in five years time. Where it is not possible or is impractical to verify the age of the existing plant, default lifetimes can be applied based on realistic estimates.
Heating controls	There is a wide range and type of heating control, from basic time and temperature control through to weather and load compensation, delayed start, sensor control, and thermostatic control of individual radiators/heat emitters. The savings attributable will depend on the particular mix of controls installed, and how this compares with prevailing practice or standards for the particular application.
High-efficiency hot water cylinders	High-efficiency cylinders have larger heating coils and/or thicker insulation. The savings are based on reduced heat loss in the pipework from the boiler, due to shorter boiler operating time, and from reduced standing losses, compared with a standard efficiency cylinder.
Solar hot water systems	Savings will depend on the size of the panel, its location and orientation, the existence of any overshadowing, and also the end-use requirements for hot water. All these factors should be considered when quantifying savings for specific installations. Alternatively, a representative average can be used. Systems should be sized to not exceed the peak hot water requirements, so that all the hot water generated is utilised. The savings are then the total production from the solar hot water system, less any parasitic losses. This could be derived by direct calculation of usage and temperature, or by using engineering calculations based on insolation levels for the specific location, with due allowance for orientation, overshadowing, or other factors that might affect output.

Measure	Energy Saving
Heat pumps	When calculating the energy/carbon savings from replacing an existing heat generator with a heat pump, or when installing a heat pump system instead of a conventional heating system, it is necessary to compare the total energy/carbon balance of the two options. For the heat pump system, it is important to consider the coefficient of performance (COP) over a full annual cycle of usage and weather conditions. Another consideration is the different operating temperature of the two heating systems, which may have a bearing on energy use and parasitic loads for pumping, etc. A simplified formula for deriving the energy saving is provided below. Energy saving = (consumption of original heating system + its parasitic electrical loads) - (consumption of heat pump system + its parasitic electrical loads) In order to take account of the carbon content of different fuels or their primary energy (depending on the metric in which the target is denominated), each of the four items in the above formula needs to be multiplied by the relevant carbon emission or primary energy factor.
Other renewable systems for heating and/or hot water	(e.g., biomass boilers) The savings are the total production from the renewable energy system, less any parasitic losses, and taking into consideration the energy or carbon content in growing, drying, and/or transporting the renewable fuel. To avoid unnecessary over sizing (and cost) of the renewable heating system, some countries require the property to possess minimum standards of insulation.
Connection to district heating and/or cooling system	Primary Energy Savings equal the difference between the current energy consumed for heating and/or cooling and that provided by the district heating/cooling system, taking due account of system losses and the relative conversion factors to primary energy. Alternatively, an equivalent calculation can be undertaken, taking into account the carbon content of the respective heat/cooling supply options.
Heat recovery system	Savings equal the energy recovered by the system, less parasitic losses, taking due account of the carbon content of the fuel saved and that of the electricity used in pumps and fans. If this is a replacement ventilation system, only the improvements in heat recovery performance and the energy savings from the lower parasitic losses can be counted. If this is a new installation, then it will increase energy consumption, but if this is being carried out as part of Government policy to improve living conditions for health or condensation reasons, it may be included as an eligible energy saving measure. In this case, it would be treated as a replacement product for estimating the energy savings i.e. equal to the savings between the performance of the installed unit and the average energy performance of similar units on the market place.

Measure	Energy Saving
Heating system replacement with fuel switching	This would normally occur when an inefficient and/or high carbon content heating system is replaced with an efficient, lower carbon system. The benefits are two-fold: firstly, the reduced system losses of the more efficient system, and secondly, the primary energy or carbon saving from fuel switching. If there are large numbers of such conversions, for example, for housing of a particular type, age, and fuel supply, it would be possible to derive standard savings for each conversion. Otherwise, ex ante engineering calculations for each conversion, or ex post monitoring, will be required to determine savings.
Cogeneration (CHP) plant or tri-generation (heating, cooling, and electricity) plant	Saving = (net electricity generated) + (useful heating/cooling generated by the CHP or tri-generation plant) – (fuel consumed) – (the fuel consumption to provide an equivalent amount of heating/cooling from the most likely alternative boiler/chiller plant)
	Lights, Appliances, and Other Equipment
Cold appliances (e.g., fridges, freezers) and wet appliances (e.g., dishwashers, washing machines)	There are two principal delivery routes relevant to cold and wet appliances: • an incentive to purchase a more efficient appliance,[33] and • a trade-in of a working appliance. It is important to ensure the old appliance is destroyed (in accordance with the WEEE[34] directive and other prevailing environmental local conditions) to prevent its reuse elsewhere. Savings for incentive schemes are the difference between the sales-weighted average energy consumption (unless a code standard is the baseline) for the particular type of appliance and that of the promoted appliance. Under trade-in schemes, a working appliance is traded in for a new high-efficiency appliance. Savings are the difference in consumption between the existing working appliance and the new one, for the remainder of the traded-in appliance's working life.[35]
High-efficiency lighting replacement (e.g. CFLs, LEDs)	Savings equals the difference in wattage between the original lighting and the new lighting, multiplied by the annualised hours of use. A distinction may be made between high usage and lower usage lighting points. Again, due recognition of any legislation on minimum performance standards for replacements will form the baseline for calculating energy savings (e.g., CFLs are no longer eligible in most energy saving obligations schemes within the EU).

33 Due consideration needs to be made for situations in which the customer retains the old but working refrigerator (e.g., as a beer/wine chiller). A customer survey could establish the prevalence of this, and a proportion of the savings netted off accordingly. The trade-in alternative removes this issue.

34 WEEE – Waste Electrical and Electronic Equipment

35 For a more accurate measure of savings, one could add the savings after the normal end of life of the traded-in product, on the basis that a high-efficiency product, rather than the market average, is in operation. For example, if an appliance with a 15-year life is traded in after 10 years, for the first 10 years the saving = difference in consumption between the traded-in appliance and the new one. Then for the next five years, saving = difference between high-efficiency and market average product. Clearly there are challenges in knowing the market average efficiency levels 10 years in the future.

Measure	Energy Saving
Lighting controls	Where established savings from particular lighting controls (based on time, occupancy, and/or ambient lighting levels) in a similar end-use application are available, these should be used. Otherwise ex post monitoring should be used to determine actual savings, taking due account of differences before and after installation.
Other (e.g., motors, drives, compressors, transformers)	Savings equals the difference in annualised energy use between the original equipment (or based on a representative average) and the new equipment. Scaled engineering savings is commonly used for such standard equipment measures.
	Other
Photovoltaic, micro-hydro, wind turbines, or other renewable electricity generation system	Savings equals the quantity of electricity generated, less any parasitic losses. Depending on the scale of the installation, the energy savings can be directly metered or (often for small installations) an estimate made based on physical location and size and nominal efficiency of the installation. Note that, as many EU countries offer feed-in tariffs for renewable electricity generation, it is important to examine the "double subsidy" issues and how the "double counting" of the energy savings are addressed in the evaluations of both policy initiatives.
Comprehensive building or plant renovation	Savings equals the difference between the energy consumption of the existing building or plant and the consumption post-renovation. Due to the specific nature of such a renovation, it is recommended that savings be measured on an ex post basis rather than using ex ante figures.
Energy performance contracting or other energy service	Savings equals the total reduction in energy use as a result of the contract/service, suitably adjusted for any changes in factors affecting consumption (e.g., weather, occupancy, production levels). Due to the specific nature of each contract/service, it is recommended that savings are measured on an ex post basis rather than using ex ante figures; this is relatively straightforward because energy performance contracts usually require such measurements to be in place anyway.
Industrial process energy use	Due to the wide variety, scale, type, and operating parameters of industrial processes, it is not always possible to specify a comprehensive list of savings. Savings would need to be established by reference to industry norms and prior experience, if available. Otherwise ex post monitoring is required to establish the actual savings achieved, taking due consideration of changes in utilisation/production.

9. Monitoring, Verification, and Auditing

In addition to specifying how energy savings should be defined, there is a need to ensure obligated parties are performing in accordance with the scheme rules, that the claimed measures have actually been implemented, and that the measures are delivering the expected energy savings (assuming an ex ante or deemed approach is adopted).

A random sample of properties receiving energy saving measures should be monitored to ensure the measures have been implemented in accordance with the claims of the obligated party and in accordance with the required technical specifications. It is recommended that a statistically significant number of installations be inspected. The box below summarises the monitoring requirements set by Ofgem for different measures under the CERT as an example of how the GB system has tackled this problem.

Periodic audits of obligated companies are necessary to provide independent verification of company claims. This could be carried out by the scheme administrator or by a recognised independent third party (as done by Ofgem in Britain). In Denmark, an annual audit of documentation and guidelines is required, while every second year this audit must be carried out by an independent third party, for example, as part of a certified quality management system.

Customer satisfaction and quality issues should also be monitored on an ongoing basis. Any shortcomings need to be promptly addressed in order to maintain the scheme credibility.

The costs of monitoring, verification, and auditing are not large, especially if the deemed savings approach is the dominant methodology for recording the energy savings. The audit reduces to a sample of the claimed energy savings being verified by the auditors – analogous to a financial "dip check." In GB, the costs to Ofgem for administering (including monitoring, verification, and auditing) the CERT programme are ~€1.2 million per year, equivalent to 0.1% of the annual energy retailer spend.

CERT Monitoring Requirements

(source: Ofgem Supplier Guidance Manual)

- 1% customer utilisation monitoring for electrical items, DIY loft insulation, and DIY radiator panels provided to householders for free.
- 5% technical monitoring for professionally installed insulation and heating measures. NB technical monitoring is not required for microgeneration measures installed under the Government's Microgeneration Certification Scheme.
- 1% customer satisfaction monitoring for professionally installed insulation, heating measures, and microgeneration measures.
- 5% - or a statistically significant sample,[36] whichever is smaller - utilisation and evaluation monitoring of behavioural measures (e.g., advice and smart metering)

36 See link for more details on sampling requirements: http://www.ofgem.gov.uk/Sustainability/Environment/EnergyEff/Documents1/CERT%202008-2011%20Supplier%20guidance.pdf

Appendix 1.
Selected Extracts from the Draft Energy Efficiency Directive

Article 6
Energy efficiency obligation schemes

1. Each Member State shall set up an energy efficiency obligation scheme. This scheme shall ensure that either all energy distributors or all retail energy sales companies operating on the Member State's territory achieve annual energy savings equal to 1.5% of their energy sales, by volume, in the previous year in that Member State excluding energy used in transport. This amount of energy savings shall be achieved by the obligated parties among final customers.

2. Member States shall express the amount of energy savings required from each obligated party in terms of either final or primary energy consumption. The method chosen for expressing the required amount of energy savings shall also be used for calculating the savings claimed by obligated parties. The conversion factors in Annex IV shall apply.

3. Measures that target short-term savings, as defined in Annex V(1), shall not account for more than 10% of the amount of energy savings required from each obligated party and shall only be eligible to count towards the obligation laid down in paragraph 1 if combined with measures to which longer-term savings are attributed.

4. Member States shall ensure that the savings claimed by obligated parties are calculated in accordance with Annex V(2). They shall put in place control systems under which at least a statistically significant proportion of the energy efficiency improvement measures put in place by the obligated parties is independently verified.

5. Within the energy efficiency obligation scheme, Member States may:
   (a) include requirements with a social aim in the saving obligations they impose, including by requiring measures to be implemented in households affected by energy poverty or in social housing;
   (b) permit obligated parties to count towards their obligation certified energy savings achieved by energy service providers or other third parties; in this case they shall establish an accreditation process that is clear, transparent, and open to all market actors, and that aims at minimising the costs of certification; and
   (c) allow obligated parties to count savings obtained in a given year as if they had instead been obtained in any of the two previous or two following years.

6. Member States shall publish the energy savings achieved by each obligated party and data on the annual trend of energy savings under the scheme. For the purposes of publishing and verifying the energy savings achieved, Member States shall require obligated parties to submit to them at least the following data:
   (a) the energy savings achieved;
   (b) aggregated statistical information on their final customers (identifying significant changes to previously submitted information); and
   (c) current information on final customers' consumption, including, where applicable, load profiles, customer segmentation, and geographical location of customers, while preserving the integrity and confidentiality of private or commercially sensitive information in compliance with applicable European Union legislation.

7. Member States shall ensure that market actors refrain from any activities that may impede the demand for and delivery of energy services or other energy efficiency improvement measures, or hinder the development of markets for energy services or other energy efficiency improvement measures, including foreclosing the market for competitors or abusing dominant positions.

8. Member States may exempt small energy distributors and small retail energy sales companies, namely those that distribute or sell less than the equivalent of 75 GWh of energy per year, employ fewer than 10 persons, or have an annual turnover or annual balance sheet total that does not exceed EUR 2 000 000, from the application of this Article. Energy produced for self-use shall not count towards these thresholds.

9. As an alternative to paragraph 1, Member States may opt to take other measures to achieve energy savings among final customers. The annual amount of energy savings achieved through this approach shall be equivalent to the amount of energy savings required in paragraph 1. Member States opting for this option shall notify to the Commission, by 1 January 2013 at the latest, the alternative measures that they plan to adopt, including the rules on penalties referred to in Article 9, and demonstrating how they would achieve the required amount of savings. The Commission may refuse such measures or make suggestions for modifications in the three months following notification. In such cases, the alternative approach shall not be applied by the Member State concerned until the Commission expressly accepts the resubmitted or modified draft measures.

10. If appropriate, the Commission shall establish, by means of a delegated act in accordance with Article 18, a system of mutual recognition of energy savings achieved under national energy efficiency obligation schemes. Such a system shall allow obligated parties to count energy savings achieved and certified in a given Member State towards their obligations in another Member State.

Annex V
Energy efficiency obligation schemes

1. Measures that target short-term savings

The following measures shall be considered as targeting short-term savings:

a) distribution or installation of energy efficient compact fluorescent light bulbs;
b) distribution or installation of energy efficient shower heads;
c) energy audits; and
d) information campaigns.

2. Calculation of energy savings

The calculation of energy savings in national energy efficiency obligation schemes shall take into account the lifetime of measures. Where no national values for lifetimes are fixed the default values in point 4 shall apply.

Obligated parties may use one or more of the following methods for calculating energy savings for the purposes of Article 6(2):

(a) engineering estimates;
(b) metering;
(c) standard values and lifetimes that Member States have adopted on a clear and sound basis. Such values shall be notified to the Commission. The Commission may request that such values are modified, where they are likely to distort competition or where they show less ambition than the default values and lifetimes in points 3 and 4; and
(d) the default values and lifetimes in points 3 and 4 where no national standard values and lifetimes have been established.

3. European default values according to equipment type

3.1. Household appliances

a. Freezers and Refrigerator-Freezers Distinguished

Freezers And Refrigerator-Freezers Distinguished

	Refrigerator-freezers	Freezers
*Class A+ Deemed savings (kWh/year)	64	62
** Class A+ Deemed savings (kWh /year)	76	73
Class A ++ Deemed savings (kWh/year)	129	123
Class A+++ Deemed savings (kWh/year)	193	185

b. Freezers and Refrigerator-Freezers Not Distinguished

Freezers And Refrigerator-Freezers Not Distinguished

	Refrigerator-freezers and Freezers
*Class A+ Deemed savings (kWh/year)	64
** Class A+ Deemed savings (kWh /year)	75
Class A ++ Deemed savings (kWh/year)	128
Class A+++ Deemed savings (kWh/year)	191

c. Domestic Washing Machines

Domestic Washing Machines	
***Until 30 November 2013**	
Class A+ Deemed savings (kWh /year)	26
Class A ++ Deemed savings (kWh/year)	46
Class A+++ Deemed savings (kWh/year)	63
***From 1 December 2013**	
Class A ++ Deemed savings (kWh/year)	20
Class A+++ Deemed savings (kWh/year)	37

**From 1 December 2013 for household washing machines with a rated capacity equal to or higher than 4 kg. the Energy Efficiency Index (EEI) shall be less than 59 (See Annex 1 of Commission Regulation (EU) No. 1015/2010).*

d. Domestic Dishwashers

Domestic Dishwashers	
****Until 30 November 2013**	
Class A+ Deemed savings (kWh /year)	37
Class A ++ Deemed savings (kWh/year)	69
Class A+++ Deemed savings (kWh/year)	97
****From 1 December 2013**	
Class A ++ Deemed savings (kWh/year)	32
Class A+++ Deemed savings (kWh/year)	60

*** From 1 December 2013. For household dishwashers with a rated capacity equal to or higher than 11 place settings and household dishwashers with a rated capacity of 10 place settings and a width higher than 45 cm, the Energy Efficiency Index (EEI) shall be less than 63 (see Commission Regulation (EU) No. 1016/2010 Annex I)*

3.2 Residential Lighting

Residential Lighting	
Unitary energy savings GLS to CFL	16 kWh/year
Unitary energy savings GLS to LED	17 kWh/year

4. Default Lifetimes

Default lifetimes	
Energy efficiency improvement measure through replacement of component	**Default lifetime in years**
Boiler-condensing	20
Boiler- direct evacuation	20
Burners, oil and gas	10
Control equipment	15-20
Control system—central	15-25
Control system—room control	15-25
Heating control: Control valves, automatic	10
Meters	10

Appendix 2
Proposed Revision to Energy Efficiency Directive, Annex V

Annex V
Energy efficiency obligation schemes

The following are the guiding principles which shall be used by Member States when determining energy saving above those which would have occurred naturally.

1. Energy efficiency measures that target short-term savings

The following measures shall be considered as targeting short-term savings:

(a) distribution or installation of energy efficient shower heads;

(b) energy audits; and

(c) information campaigns.

{Alternative text for paragraph 1:

Measures used in such obligations must have a lifetime of at least six years (or in the case of lighting improvements at least a rated life of 6,000 hours)}

2. Energy saving methodology

Obligated parties shall use one or more of the following methods for calculating energy savings for the purposes of Article 6(2):

(a) Deemed savings, by reference to the results of previous independently monitored energy improvements in similar installations. The principles set out in point 3 shall apply when determining deemed savings. The generic approach is termed "ex ante";

(b) Metered savings, whereby the savings from the installation of a measure, or package of measures, is determined by recording the actual reduction in energy use, taking due account of factors such as occupancy, production levels, and the weather, which may affect consumption. The generic approach is termed "ex post";

(c) Scaled savings, whereby it may be appropriate to use engineering estimates of savings where establishing robust measured data for a specific installation is difficult or disproportionately too expensive (e.g., replacing a compressor or electric motor with a different kWh rating than that for which independent information on savings has been measured); and

(d) Surveyed savings, where consumers' energy savings in response to advice, information campaigns, or smart metering is determined. This approach may only be used for savings resulting from changes in consumer behaviour. It may not be used for savings resulting from the installation of physical measures.

3. Principles to apply in the calculation of energy savings

In determining the energy saving for an energy efficiency measure, the following principles shall apply:

(a) Only savings that are additional to those that might otherwise have reasonably been expected to have been achieved can be counted. Due account of the following shall be taken in determining the additional energy savings:

i. the prevailing energy performance of fabric measures (walls, roofs, floors, windows, and doors) in the existing building stock;

ii. prevailing regulations relating to minimum energy performance requirements of new buildings or major renovations or the removal of certain products (e.g., the banning of certain incandescent light bulbs meaning that compact fluorescent light bulbs are the norm for that application);

iii. EU minimum energy performance requirements for energy related products as defined by the EU Ecodesign Directive; and

iv. prevailing market sales, and sales trends, of energy-consuming products in the Member State where

EU energy labelling criteria exist;

(b) the activities of the obligated party must be demonstrably material to the achievement of the claimed savings;

(c) due allowance shall be taken of the increased amenity, or direct rebound effect, resulting from the installation of measures, for example, increased comfort arising from insulation measures;

(d) savings may not be claimed by more than one obligated party;

(e) savings achieved as a result of other local, regional, national, or international policies may not be included (e.g., prevailing building regulations);

(f) to account for climatic variations between regions, Member States may choose to adjust the savings to a standard value or to ascribe different energy savings in accordance with the temperature variations between regions;

(g) where measures result in changes in consumption of more than one fuel type, due account shall be taken of the primary energy content of that fuel as specified in Annex IV;

(h) calculation of energy savings shall take into account the lifetime of measures;

(i) where measures result in the accelerated replacement of equipment, products, or building components, due account shall be taken of the duration of the energy savings compared to the energy consumption of the original equipment, but only for the remaining lifetime of the original equipment;

(j) actions by obligated parties, either individually or together, which aim to result in lasting transformation of products, equipment, or markets to a higher level of energy efficiency are permitted;

(k) in promoting the uptake of energy efficiency measures, Member States shall ensure that quality standards for products, services, and installation of measures are maintained. Where such standards do not exist, Member States shall work with obligated parties to introduce them.

The calculation of energy savings shall be revised at least every three years to take account of regulatory and/or technological developments.

4. Notification of methodology

Member States shall notify the Commission of their proposed detailed methodology for operation of the energy efficiency obligation schemes. Such notification shall include details of:

(a) obligated parties;

(b) target sectors;

(c) the level of the energy saving target;

(d) the duration of the obligation period;

(e) eligible measure categories;

(f) calculation methodology, including how additionality and materiality are to be determined;

(g) measure lifetimes;

(h) approach taken to address climatic variations within the Member State;

(i) treatment of fuels with different carbon or primary energy content;

(j) quality standards;

(k) monitoring and verification protocols and how the independence of these from the obligated parties is ensured; and

(l) audit protocols.

The Commission may request that methodologies are modified, where they are likely to distort competition or where they are less rigorous than equivalent schemes in other Member States.

Appendix 3
Brief Description of EEO Arrangements in South Australia, Italy, and Poland

South Australia - Residential Energy Efficiency Scheme

The Residential Energy Efficiency Scheme (REES) is designed to assist households achieve greenhouse gas reductions. Under the REES, energy retailers with 5,000 or more electricity or gas residential customers will be required to provide incentives for South Australian households to achieve greenhouse gas reductions and potentially lower their energy bills through reduced energy consumption. It does this through establishing obligations to be met by electricity and gas retailers.

The Essential Services Commission is the administrator of the REES. As scheme administrator, the Commission ensures energy retailers comply with the REES. The Commission is also responsible for reporting to the Minister for Energy annually on retailers' progress in achieving the required targets.

For detailed information on the methodology for setting savings for individual measures, please see:

http://www.escosa.sa.gov.au/library/110705-REES-EnergyActivitiesReview-Phase3-EnergyConsult.pdf

Italian White Certificate Scheme

In Italy, the system was introduced in 2002 and started in 2005. The obligated parties (target group) are electricity and gas distributors serving more than 100,000 clients (as of 31 December 2001); this includes 22 gas distributors (covering about 60 percent of the customers) and eight electricity distributors (covering almost 98 percent of all customers). This threshold was subsequently lowered to 50,000 customers in 2010.

The obligation plan has a target of 243 PJ (5.8 MTOE) of primary energy saved over the 2005 to 2009 period, which would imply an average 0.5 percent annual reduction of energy demand. This obligation is adapted every year on the basis of the achievements of the previous year.

There are three methodologies for determining energy savings:

1. Deemed savings (no on-field measurement; pre-defined annual energy savings/installed unit = toe/year/unit);
2. Engineering estimates (partial on-field measurement; pre-defined evaluation algorithm, with pre-defined values for some parameters while others have to be measured case by case); and
3. Complete energy monitoring plans (subject to pre-approval).

The scheme operates on the basis of tradable white certificates. One White Certificate is equivalent to one saved TOE/year of primary energy. Every certificate lasts for five years for all implemented measures, with the exception of building insulation and other measures in bioclimatic architecture, lasting eight years. Certificates can be traded both between the obligated parties and among external parties, such as ESCOs.

Where the energy efficiency measures to be implemented draw upon technical standards, the value of primary energy to be saved is calculated using coefficients based on the average efficiency of the Italian energy system (electrical and thermal energy production); such coefficients are regularly updated so as to take into account technology improvements.

Polish White Certificate (Energy Efficiency) Scheme[37]

The Energy Efficiency Law, passed on 15 April 2011 by the Polish Parliament, introduces into the legal order the so-called "white certificates" (i.e., energy efficiency certificates), which will be issued by the Polish energy regulatory authority (URE, Urząd Regulacji Energetyki[38]). Energy efficiency certificates will incorporate tradable rights and will be evidenced by entries in the registry established by the commodity exchange or regulated market. The newly passed provisions will enter into force after three months from the publication in the Polish official journal and will be binding until 31 December 2016.

Energy efficiency certificates will be issued in exchange for realised undertakings serving the improvement of energy efficiency. URE will choose the eligible undertakings by way of a public tender, which will be announced at least once a year.

The new rules impose on certain entities the obligation to acquire and surrender in URE energy efficiency certificates of a specified value or to pay the substitute fee.

The entities charged with the new costs are:

1. undertakings selling electricity, heat, or natural gas to the final customers connected to the network on the territory of Poland;
2. final customers connected to the network on the territory of Poland, being the members of the commodity exchange in relation to the transactions entered into on their own behalf on the commodity exchange; and
3. commodity broker firms as regards transactions carried out on the commodity exchange on account of final customers connected to the network on the territory of Poland.

The Polish Minister of the Economy was given the competence to issue a delegated act on the particulars of the matters regulated by the new provisions, among others on the specific conditions and procedure of the public tender, and the concrete amount of the substitute fee.

37 For more information on energy efficiency in Poland see: http://www.climatechange.pl/index.php?option=com_content&view=article&id=10:the-new-rules-on-energy-efficiency-and-new-opportunities-for-business-in-poland&catid=2:energy-efficiency&Itemid=4

38 For more information see the Polish Energy Regulatory Office website: http://www.ure.gov.pl/portal/en/

Appendix 4
Main Conclusions From the EuroWhiteCert[39] Project

For measures for which their performance is well understood, develop an ex ante M&V approach:

Whenever possible, an ex ante M&V approach appears to be a cost-effective way of accrediting energy efficiency measures. This approach entails simplified estimations; savings and thus baselines are agreed in advance; there is limited provision of documentation and reduced monitoring and certification procedures. It applies to measures for which the performance is well known, however, there is an inherent level of uncertainty. An ex ante approach, also called "deemed saving" or "default" approach, requires no field measurement and works effectively for energy saving measures for which technical performance is well understood. For "proven" technologies, energy savings granted beforehand should be applicable. Reference scenarios and baselines must be kept updated.

For a mix of known and unproven measures, establish a hybrid M&V approach:

A hybrid method is a combination of an ex ante and an ex post M&V approach. It can be more accurate than a pure ex-ante methodology (with updated reference scenarios or baselines), without the financial burden of a full ex post approach. To avoid a large increase in the M&V costs, only the smallest and uncertain part of energy savings realised through saving Stepwise toward European energy efficiency policy portfolios involving White Certificates measures implemented can be analysed through an ex post methodology. The most predictable or certain part of savings realised must be evaluated through an ex ante approach. This kind of approach requires the preapproval of the proposed methodology.

39 For more information on the Euro White Cert project see: http://www.ewc.polimi.it/index.php

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts focused on the long-term economic and environmental sustainability of the power and natural gas sectors. We provide technical and policy assistance on regulatory and market policies that promote economic efficiency, environmental protection, system reliability and the fair allocation of system benefits among consumers. We have worked extensively in the US since 1992 and in China since 1999. We added programs and offices in the European Union in 2009 and plan to offer similar services in India in the near future.
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