JRC SCIENCE FOR POLICY REPORT

Energy Savings Calculation Methods under Article 7 of the Energy Efficiency Directive

Report for DG Energy

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January 2016

EUR 27663 EN

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JRC Science Hub
https://ec.europa.eu/jrc

JRC99698

EUR 27663 EN

PDF ISBN 978-92-79-54216-9 ISSN 1831-9424 doi: 10.2790/855880 LD-NA-27663-EN-N

How to cite: Labanca, N., Bertoldi, P., 2016; Energy Savings Calculation Methods under Article 7 of the Energy Efficiency Directive; EUR 27663 EN; doi 10.2790/855880

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Abstract:
The present report aims to provide an overview of the main issues at stake with the calculation methods for energy savings generated by measures implemented by EU Member States under Article 7 of the Directive 2012/27/EU on Energy Efficiency (EED).

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Acknowledgements

The authors would like to thank Dr Kiela-Vilumsone Lelde and all other DG ENER representatives who reviewed this report for their valuable contributions.

Introduction

The present report aims to provide an overview of the main issues at stake with the calculation methods for energy savings generated by measures implemented by EU Member States under Article 7 of the Directive 2012/27/EU on Energy Efficiency (EED). Analyses and considerations presented in this document are mostly based on the outcomes of the "Workshop on Common Methods and Principles for Calculating the Impact of Energy Efficiency Obligation Schemes or Other Policy Measures under Article 7 of the Energy Efficiency Directive" organised in Brussels by the authors of this document on behalf of DG ENER on June 10th, 2015. Additional information sources considered have been Member States notifications on EED Article 7 (as submitted by December 2013), the National Energy Efficiency Action Plans (NEEAPs) submitted in 2014[1] and existing analyses of this documentation (see the references included in the final report section).

The structure of the report follows the structure of the above mentioned workshop. General requirements and key principles to be taken into account for energy savings calculation methodologies (as defined in the EED and the Guidance Note on Article 7) are discussed in the first section. This section focuses in particular on additionality and materiality requirements, on how lifetime of savings should be taken into account and on the main correction factors to be considered to calculate the energy savings that have been actually generated at the national level by measures implemented by Member States. Moreover, it provides examples of how these requirements have been fulfilled by Member States and discusses the main related issues.

The second section of the report deals with pros and cons of existing catalogues for standardized actions for which calculation methods relying on deemed savings estimates have or will be used by Member States to assess the amount of energy savings generated by measures. This section also discusses some of the aspects that should be addressed when applying these methods and when documenting their application.

The third report section discusses calculation methods based on scaled savings, metering savings and surveyed savings, whilst the fourth section deals with the difficulties associated with calculation methods related to taxation, information and transport measures. The fifth section discusses then monitoring, verification, sanctions and compliance regimes that can be implemented to fulfil Article 7 requirements. General conclusions on calculation principles and methods that are employed by Member States under EED Article 7 are finally drawn in the sixth report section. Each of the topics mentioned above is generally addressed by first analysing the calculation approaches adopted by Member States as mostly resulting from their Article 7 notifications and NEEAPs and by subsequently discussing the main problems observed and possible ways to overcome them. This is not done by providing extensive overviews of the approaches adopted in each MS, but rather by analysing case studies in given countries which the report authors think can be representative of the situation existing in several other Member States.

The main issues that have been discussed are also mostly derived from the case studies analysed. Wherever information in these documents has been deemed not sufficient to discuss the topics to be addressed, the authors have decided to refer to other information sources (mostly represented by the presentations given by the experts participating in the above mentioned workshop). EED article 7 requirements are also described where necessary and some indications concerning the need for further guidance to be provided to Member States on general principles to be adopted within own energy savings calculation methods or when notifying these methods are also discussed.

[1] Although difficult to establish, some of the situations described in this report might in principle have changed since that time as more information has been submitted by MSs during the following year.

It has to be finally pointed out that the issues and recommendations discussed in this document are solely based on technical considerations concerning the main aspects to be taken into account in the calculation methods and in the documentation to be submitted by Member States in order to ensure that reported energy savings estimates fulfil minimum reliability criteria and that this reliability can be verified. These issues and recommendations should therefore not always be necessarily interpreted as referring to aspects that Member States are or will be obligated to take into account when calculating energy savings associated with measures or when reporting their energy savings estimates to the European Commission.

1. General requirements and key principles to be taken into account for energy savings calculation methodologies

1.1 Additionality & Materiality

Annex V, part 4, point (f) of the EED establishes that, with the exception of taxes, Member States notifications on proposed methodology for operation of possible own energy efficiency obligation schemes shall include details of calculation methodology, including **how additionality and materiality are to be determined** and which methodologies and benchmarks are used for engineering estimates. General principles for establishing additionality are then provided in the EED annex V and in the Guidance Note on Article 7 of the Directive 2012/27/EU [1]. In particular, EED Annex V, part 2, point (a) and part 3, point (a) set out that credit may only be given for savings exceeding the following performance standards and requirements:

a) For products – the requirements established by implementing measures under the Ecodesign Directive;

b) For new passenger cars and light commercial vehicles – the emission performance standards established by Regulations 443/20099 and 510/201110;

c) For taxes – the minimum levels of taxation applicable to fuels as required in Council Directive 2003/96/EC on restructuring the Community framework for the taxation of energy products and electricity or in Council Directive 2006/112/EC on the common system of value added tax.

In addition, Article 7(9)(e) provides that alternative policy measures can include energy labelling schemes but not those which are schemes that are mandatory under Union law.

Moreover, the paragraph 34 Guidance Note on Article 7 specifies that when the above mentioned legal texts are modified or new implementing measures are adopted the new levels will have to be applied.

In addition, EED Article 7(9)(d) establishes that in case of alternative measures (other than taxation), energy savings from standards and norms that aim at improving the energy efficiency of products and services, including buildings and vehicles, that are mandatory and applicable in Member States under Union law cannot be credited. Paragraph 35 of the above mentioned Guidance Note explains that "where the required energy performance is determined by *national policy choices* which are not a result of mandatory and applicable EU requirements, then for the individual actions that are a result of these policy measures all of the resulting energy savings can be attributed to these individual actions".

Concerning materiality, EED Annex V, part 2, point (c) states that "the activities of the obligated, participating or entrusted party must be **demonstrably material to the achievement of the claimed savings**", and paragraph 33 of Guidance Note specifies

that this "materiality test" excludes from eligible measures the automatic rolling out of EU legislation, or autonomous improvements because of, for example, market forces or technological developments. This note also adds that Member States "may not count actions that would have happened anyway" (so called 'free riders'). Further guidance on what has to be intended by "material" is provided by the Note where it is stated that "the activities of the national public sector parties that are implementing the policy measure must be 'material' to the carrying out of the action" and that the "the term 'material' means that the party in question must have contributed to the realisation of the specific individual action in question, and that the subsidy or involvement of the obligated, participating or entrusted party must not have had what is clearly only a minimal effect in the end user's decision to undertake the energy efficiency investment".

Based on these elements, it is possible to conclude that the general requirements and principles on additionality and materiality given by the EED and the Guidance Note on Article 7 concern:

- criteria to be used to establish which *energy savings* can be counted by MSs for Article 7 target achievement (for additionality),
- criteria to be used to select *actions* (mainly related to economic aspects) undertaken by obligated parties[2], participating parties[3] or entrusted parties[4] to contribute to the achievement of the above mentioned savings (for materiality).

These elements also allow establishing that, contrary to what can be concluded for additionality, the above mentioned documents explicitly provide a definition of materiality, or, at least, indicate explicitly to which type of entities the materiality criterion has to be applied to (i.e. these documents establish that the materiality criterion refers to *actions* undertaken by obligated, participating or entrusted parties). In case of the additionality requirement, these texts neither provide a definition for additionality, nor do they mention whether an additionality requirement has to be applied either to energy savings, or to measures implemented to generate the energy savings, or to specific energy efficiency installations/projects implemented under these measures, or to actions undertaken by involved actors to contribute to the achievement of savings[5]. *It is only by acknowledging an implicitly assumed complementarity* between "materiality" and "additionality" that it can be possibly inferred that the additionality requirement has to be applied only to energy savings generated and/or installations or projects implemented under measures and that cannot be referred to *actions* undertaken by involved actors[6].

Given this information background, it is interesting and important to refer to some practical examples that can be found in Member States' notifications in order to try to understand how these Member States have interpreted and applied these general principles to determine additionality and materiality for the measures considered.

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[2] i.e. energy distributors or retail energy sales companies. See the definition provided in the EED.

[3] i.e. enterprises or public bodies that have committed themselves to reaching certain objectives under a voluntary agreement, or are covered by a national regulatory policy instrument. See the definition provided in the EED.

[4] i.e. legal entities with delegated power from a government or other public body to develop, manage or operate a financing scheme on behalf of the government or other public body. See the definition provided in the EED.

[5] Notice that the existing literature applies the term additionality to refer to all these dimensions (see e.g. [2] or [3]). Notice also that by "involved actors" it is meant here: obligated parties, participating parties or entrusted parties as defined in the EED. These actors do not include energy end-users at whose sites individual actions are actually implemented.

[6] It is however worth mentioning that additionality and materiality concepts cannot ever be considered as independent. The amount of existing free-riders e.g. is typically used to estimate the amount of additional savings. This amount, however, is influenced by actions that involved actors undertake to stimulate individual action implementation. Although free-ridership relates to additionality of savings, this aspect will be dealt with a specific and separated report section.

France provides an example under the existing white certificate scheme where the approach used to determine additionality apparently reflects what is stated in the EED. In case of standardized actions related to installations of energy efficient motors, it is indeed possible to observe that EU eco-design minimum requirements are considered to define motors that are eligible for white certificates. The installation of motors not fulfilling the minimum requirements established by eco-design regulation No. 640/2009 (as amended by regulation No. 4/2014 of January 2014) cannot be rewarded by issuing white certificates, i.e. energy savings generated by motors with energy performances below the minimum requirements established in this regulation cannot be claimed under the scheme and thereby for Article 7 target achievement. This information alone, however, does not allow establishing how savings associated with each action have been estimated. Depending e.g. on how the consumption baseline for the calculation of energy savings generated by each single action has been established (e.g. by considering the average consumption of models installed, or the average consumption of models available on market, etc.) the resulting savings and the assumed additionality of the white certificate scheme under discussion might indeed be significantly different[7]. When it comes to materiality, it is then necessary to assess which actions involved actors are supposed to undertake to stimulate the implementation of these standardized actions and whether materiality requirements have been established and have to be fulfilled for actions implementation. In this respect, it has to be mentioned that France has set general materiality requirements (i.e. requirements that apply to all actions rewarded by white certificates) that are supposed to be verified on a project basis. These requirements establish that parties applying for white certificates must document and prove a direct contribution to action implementation. Moreover, they must prove whether the contribution has been directly or indirectly (i.e. by intermediaries) done and whether the contribution has been supplied prior to action installation. Although any assessment of the materiality of the contribution would entail that the magnitude of this contribution would have to be evaluated case by case, the above information allow concluding that materiality requirements are *generally* fulfilled under the French white certificates schemes.

Another interesting example is provided by energy efficiency obligations implemented in Denmark. In this case energy savings additionality is assumed to be guaranteed through the application of the following criteria: a) energy savings cannot be generated before the related contract is issued; b) a contract between distributor system operators (i.e. the obligated parties) and third parties have to be stipulated; c) these parties can count only savings in whose generation they have been directly involved (e.g. by providing energy audits, subsidies, etc.); d) agreements covering the whole chain from obligated parties to energy end-users have to be established[8]. In this case, it should probably be concluded that, although Denmark considers the above mentioned requirements as part of the concept of additionality, these requirements should more properly be considered as materiality requirements as they mostly concern actions to be undertaken by actors to prove their material involvement in the generation of energy savings.

A further interesting example is given by an alternative measure based on saving tenders implemented in Germany[9]. In this case additionality criteria have been established for projects and energy savings by requiring that a) actors participating in

[7] What is meant here is that the exclusion of the motors not complying with the above mentioned eco-design requirements from the French white certificate schemes does not ensure that the EED additionality requirement has been respected. To verify this it would be necessary to establish how the reference consumption baseline for energy efficient motors has been established. Unfortunately this information is not available.

[8] See the update of Danish Article 7 notification and related update as available at http://ec.europa.eu/energy/sites/ener/files/documents/Article7_en_denmark.pdf

[9] See [8] for further information

the tender ask for the minimum possible funding per unit of energy saving generated (in no case exceeding 30% of total project investment and management costs) and that b) projects submitted have a minimum payback time (PBT) of 3 years. Whilst these two criteria are very probably sufficient to prove the material involvement of actors (either of the public authority providing the funding or of the project implementers supposed to generate savings with a rather long and hence not very easy to achieve PBT), it should probably be concluded that PBT requirements such as the ones mentioned above cannot generally be assumed to guarantee energy savings additionality. It may indeed well happen that energy savings with shorter PBT are additional (as happening e.g. when these savings are generated by complex measures implemented in the building sector[10] or when benefits other than energy savings are taken into account in the calculation of the PBT[11]).

A further significant example can be represented by energy advice measures. As also demonstrated by information included in the Article 7 notification provided by Germany for the Federal Advisory Program[12], additionality of these measures is very difficult to be established and it is often not clear whether the impact of these measures are established by using a control group. It has however to be mentioned that, compared to a situation where energy advice measures are implemented alone, the combination of these measures with other measures (e.g. energy audits) can generally prove much more effective in fostering the implementation of energy efficiency improvement actions. The evaluation of additional savings generated by these packages of measures remains however quite difficult, as further discussed in the following report sections.

Whereas the first example referring to France might probably be considered as an example of a best practice[13], the second example (Denmark) represents a case where a MS interprets materiality requirements as part of additionality requirements. The third example (energy saving tender in Germany) represents a case where the requirements adopted can be considered both as materiality and additionality requirements. This last case also gives the opportunity to highlight that benchmark values based on the PBT of generated savings can be assumed to be a good indicator of their additionality only in limited circumstances and for a limited number of energy efficiency improvement actions. Energy advice finally represents a case of a very effective measure (when combined with other measures) but very difficult to be evaluated in terms of additional energy savings generated.

Overall, the three examples show that further guidance should probably be given to Member States concerning what has to be intended by additionality and concerning the difference between additionality and materiality concepts.

[10] It may be worth mentioning that the saving tender implemented in Germany addresses only electricity savings and excludes measures implemented in the heating sector. As such, this measure can be considered as not covering energy efficiency improvement actions implemented in the building sector that might have a short PBT. For this reason, the requirement established for the PBT can probably be considered as a good benchmark to ensure additionality.

[11] Concerning benefits other than energy efficiency, it has however to be pointed that their inclusion in the calculation of the PBT can be very tricky, given the objective difficulties associated with their estimation and the higher uncertainties in the resulting PBT values.

[12] See the information related to the energy savings calculation formula used for the Federal Advisory Programmes M09 as included on page 28 of the German notification available at http://ec.europa.eu/energy/en/topics/energy-efficiency-directive/obligation-schemes-and-alternative-measures

[13] In order to establish if this is actually the case, it would however be at least necessary to know how the reference consumption baseline has been set for the individual action addressed.

1.2 Lifetimes of savings and their contribution to Article 7 target achievement

The EED Annex V, part 2, point (e) establishes how lifetime of savings generated by individual actions have to be taken into account to assess individual actions contribution to Article 7 target achievement. In doing so, it establishes that Member States may adopt what the paragraph 47 of the Guidance Note defines as a straightforward method and thereby "count the savings each individual action will achieve between its implementation date and 31 December 2020" or "adopt another method that is estimated to achieve at least the same total quantity of savings" provided they ensure that the total amount of energy savings calculated with this other method does not exceed the amount of energy savings that would have been the result of their calculation if the straightforward method would be used. The Guidance Note to Article 7 itself indicates three possible alternative methods respectively based on 1) the attribution of an "index value" to each individual action to be used as a multiplicative factor of annual savings in order asses total savings generated by these actions during the relevant time period[14]; 2) the attribution of a "cap" to individual actions lifetimes in such a way that possibly longer lifetimes are reduced to the value of this cap to calculate the contribution of actions to target achievement[15]; 3) discounting future savings attributed to individual actions[16]. As already mentioned, Member States may apply these methods provided they ensure that savings claimed by applying them do not exceed those resulting from the application of the straightforward methodology. The way in which lifetime of savings has to be taken into account is also affected by EED Article 7.2(d) and 7.7(c). Article 7.2(d) establishes indeed that Member States can count "energy savings resulting from individual actions newly implemented since 31 December 2008 that continue to have an impact in 2020 and that can be measured and verified" against the Article 7 target provided the application of this and other flexibilities defined under EED Article 7.2 does not lead to a reduction of more than 25% of the target. Article 7.7(c) states instead that, under energy efficiency obligation schemes, Member States may "allow obligated parties to count savings obtained in a given year as if they had instead been obtained in any of the four previous or three following years"[17].

The first general conclusion that can be drawn based on the above information is that Member States having established national energy saving targets may be very likely obliged to keep a double accounting system in order to estimate a) savings totally generated during individual actions lifetimes an contributing to their national targets and b) savings contributing to the achievement of EED Article 7 target. This however, does not seem a very difficult problem to be dealt with.

Either in case Member States have to assess compliance with national targets different from EED Article 7 target or not, the minimum information needed to estimate the contribution of individual actions to Article 7 target are the year of actions implementation and the lifetime of savings generated by each of this action. In this respect, it may be worth asking whether harmonisation among Member States concerning lifetimes or methodologies for lifetimes estimation to be considered for the various actions could be stimulated by establishing European default values or default estimation methodologies. In case of buildings, for example, the EU standard EN 15495 already provides guidelines for the assessment of lifetimes of actions that can be implemented in this sector.

[14] See paragraph 53 of the Guidance Note.
[15] See paragraph 54 of the Guidance Note
[16] See paragraph 55 of the Guidance Note
[17] Notice that the banking of savings envisaged by Article 7.7(c) cannot outreach the obligation period (2014 – 2020) in line with article 7(1).

Another very relevant aspect to be taken into account in relation to savings lifetimes concerns the issue of energy savings persistence [18]. This issue requires careful investigation and probably additional research activities by policy analysts. If quite standardized individual actions relying on the installation of efficient technologies (e.g. installation of efficient appliances, insulation measures in buildings, etc.) can perhaps be assumed to generate savings whose lifetime can be quite easily and accurately estimated, there are indeed individual actions and measures for which this estimate is not very straightforward and requires a lot of attention. This is the case e.g. of information measures and measures generally aiming at changing energy end-users behaviour for which studies on savings persistence are probably not yet very advanced. This however might be also the case of technical measures like production processes optimisation or installation of efficiency solutions in industry. In these cases lifetimes of savings seem indeed much more dependent on technologies turn-over and reorganizations within industries than on the technical lifetime of efficient solutions installed. Energy labelling schemes, application of standards and norms, taxation, regulations, voluntary agreements of various types, etc. are however also significantly affected by this issue.

1.3 Free-riders and rebound effects

Free riders are commonly assumed to be energy efficiency improvement actions end-users would have implemented anyway in the absence of the measure under question. As such, the number of free-riders can be considered as closely correlated to additionality and materiality of the actions undertaken by involved actors to implement energy efficiency improvement actions. Free-ridership affects in principle all energy efficiency measures and can be estimated ex-ante (i.e. before measures implementation). Nevertheless, a proper and sufficiently accurate free-ridership assessment typically requires also ex-post assessments. In case of measures addressing mass-market products, questionnaires (to be distributed ex-ante and/or ex-post among products end users affected by the measure under evaluation) can be in principle used to estimate free-ridership. Nevertheless, the responses to questionnaires can be highly dependent on how the questions are formulated and on end-users' perception. Therefore, they are often not a very reliable evaluation tool, especially when employed alone. Estimates of future market penetration of products (as provided by innovation theory) can represent another quite effective approach for free-ridership assessment. Market penetration curves obtained by innovation theory need however often to be corrected by considering effects generated by energy performance standards and other energy efficiency measures possibly introduced during the relevant time period under evaluation. Other correction factors to be taken into account may be correlations in the national markets penetrations due to the fact that manufactures typically act at a supranational level. Free-ridership estimations are therefore typically quite challenging. Broadly speaking, it is however generally observed that free-ridership can be particularly high, especially in case the measure supposed to stimulate the installation of efficient products is implemented when the market penetration of these products is already high (e.g. above 40% in case of efficient washing machines)[19]. When evaluating the total savings to be attributed to a measure, estimated free-riders can be taken into account either by reducing the number of individual actions (supposed to have been implemented thanks to the measure) by a percentage factor corresponding to the amount of free-riders, or by increasing the reference baseline consumption of the product under evaluation by this same factor. In case of measures remaining in place for

[18] Strictly speaking, *savings persistence* is the change in savings throughout the functional life of an individual energy efficiency improvement action. Saving persistence may be affected by degradation of installed technical solutions or by changes in the way in which these solutions are used or in the way in which given energy efficient behaviours are reproduced at different times. This concept should generally not be confused with that of *savings lifetime*, referring to the length of time during which an action generates savings. These two concepts are however strictly interrelated, as savings persistence affects savings lifetime.

[19] Information source: [9]

several years, it is usually necessary to periodically update free-ridership estimates. When free-ridership effects are taken into account in the reference consumption baselines of products, these baselines need therefore very frequent updates. In case of mass-market products like refrigerators, washing machines, lamps, etc. baselines update might be needed even on a yearly basis. Needless to say that annual market data on market penetration of products are essential to estimate free-ridership. These data can typically be purchased by governments from private companies producing them. When it comes to measures addressing non mass-market products that are highly specific (and typically generate large amount of savings, as happening e.g. with projects implemented in the industry sector under energy efficiency obligation schemes) the free-ridership estimate can become particularly necessary but very difficult, if not impossible, to perform (how to estimate whether a single industry receiving white certificates for a unique energy efficiency improvement action would have implemented this action anyway?).

As far as rebound effects are concerned, it has to be highlighted that, although not explicitly mentioned in the EED, rebound effects should be estimated and taken into account by Member States within their methodologies in order to produce sufficiently accurate estimates of the generated energy savings (notably in case of deemed savings and engineering estimates mentioned in EED Annex V part 1)[20]. Rebound effects in question here are mostly so-called direct rebound effects[21] generated whenever energy consumption reduction benefits caused by efficient technologies are taken by end-users to increase amenity/comfort generated by these technologies[22]. Whenever the actual energy consumption reduction associated with measures has to be estimated, these effects need hence to be estimated too. In case of measures addressing households and industry, it has been estimated that these effects may respectively cause a reduction of 10-30% and 20-60% in the maximum savings expected from individual actions[23].

1.4 Main issues identified in EED Article 7 notifications and the NEEAPs

Additionality and **materiality** of actions are the most important aspects to be considered when it comes to establish whether energy savings claimed for a measure have actually been caused by this measure and whether the actors involved in Article 7 implementation in a country have actually contributed to this generation. It is hence first of all worthwhile to analyse these aspects both in relation to the information provided by Member States in their Article 7 notifications and in relation to indications included in the EED and Guidance Note on Article 7 implementation concerning what has to be intended by additionality and materiality and how to comply with additionality and materiality requirements.

A first general remark concerning **additionality** relates to the absence of a proper definition of this concept in the EED and in the Guidance Note to Article 7. This

[20] It may be worth highlighting that (direct) rebound effects do not need to be estimated when *metered savings* are considered (direct rebound effects are indeed automatically taken into account when this method is applied). Moreover, they are very difficult, if not impossible, to be estimated by *surveyed savings* as defined by Annex V (due to the large uncertainties affecting this method and the small amount of savings that can be typically expected from measures eligible to surveyed savings).

[21] So called indirect or macroeconomic rebound effects are instead generated when financial savings caused by measures are invested on activities causing energy consumption which are different from those targeted by the measures under evaluation. Indirect rebound effects are usually very difficult to be taken into account, unless top-down methods based on macroeconomic indicators (e.g. total energy consumption in a country or in a sector of the country) are used to calculate the energy savings generated by the measure. These indicators are used e.g. in case of energy taxation measures.

[22] This happens e.g. in case of measures on energy efficient cars when end-users use more energy efficient cars to travel for more kilometres, or in case of measures on energy efficient lighting whenever end-users end up using more efficient lighting for longer time periods because of their lower energy consumption, etc.

[23] Information source: [10].

generates problems when it has to be verified whether Member States have notified how additionality is determined in their calculation methodologies. Moreover, this situation does not allow establishing whether Member States are actually supposed to assess the number of free-riders, rebound effects, or any other measures side effect that is generally supposed to affect measures additionality. A second general connected remark concerns the difficulties arising from the absence of a clear distinction between the notion of additionality and materiality. These difficulties are generated in particular by the fact that the Guidance Note defines "materiality" in terms of characteristics of actions that have been traditionally used to define "additionality"[24]. As happened in case of the Danish notification, this can be a source of misunderstanding and cause that Member States do not provide the expected information to prove additionality or materiality of measures[25]. Another very important point related to additionality concerns the application of EED Article 7(9)(d). This Article establishes, among other things, that Member States cannot claim energy savings from minimum standards and norms that aim at improving the energy efficiency of products and services (including buildings and vehicles) in case these minimum standards and norms are already mandatory and applicable in Member States under Union law. The application of this article implies that savings generated by major renovations or construction of new buildings can be counted only in case they exceed cost-optimal levels of energy performances possibly enforced by Member States under the EPBD[26]. Unfortunately, several Member States did not provide sufficient information in their notifications concerning whether and how they have taken into account cost-optimal levels as reference consumption baseline in case they have claimed savings generated by major renovations or construction of new buildings [5].

A second issue arising for measures related to buildings concerns the application of paragraph 36 of Article 7 Guidance Note where it states that "when there are other alternative policies (such as financing, fiscal, voluntary agreements) that *accelerate* the uptake of, for example, more efficient products, buildings, vehicles, or services, then the full credit of the savings coming from the individual action can be counted[27]". In so far as the EPBD Article 10.(6) establishes that "Member States shall take account of the cost-

[24] For example, the paragraph 33 of the Guidance Note on Article 7 establishes that the so-called "materiality test" serves, among others, to ensure that MSs do not count actions that would have happened anyway for Article 7 target achievement. In this respect, the "materiality test" would have certainly been considered as an "additionality test" for measures implemented under the ESD when the EED was not yet entered into force (see for example [4] at pag. 32 where it is stated that "additionality means that energy efficiency improving measures (and thus also the resulting savings) were induced because of the ESD, i.e. they would not have happened in the absence of the directive". The paragraph 3.2.4.1 of the Guidelines on State aid for environmental protection and energy 2014-2020 [6] provides then another example where it establishes that energy aid has to be considered as having an incentive effect when "the aid induces the beneficiary to change its behaviour to increase the level of environmental protection or to improve the functioning of a secure, affordable and sustainable energy market, a change in behaviour which it would not undertake without the aid. The aid must not subsidise the costs of an activity that an undertaking would anyhow incur and must not compensate for the normal business risk of an economic activity". This condition is commonly meant as an additionality condition whereas the Guidance Note on Article 7 seems to consider it as a materiality condition in so far as it establishes that the term "material" means that the "subsidy or involvement of the obligated, participating or entrusted party must not have had what is clearly only a minimal effect in the end user's decision to undertake the energy efficiency investment".

[25] See what mentioned in the section 1.1 above concerning how Denmark has considered materiality as part of the additionality concept in its Article 7 notification.

[26] Notice that the EPBD does not establish any mandatory deadline for the implementation of cost-optimal levels by Member States. The adverb "possibly" included in the above sentence wants hence to refer to the possibility that some Member States have implemented (or will implement) these levels before 2020. As these levels represent a standard implemented under the Union law, the application of EED Article 7(9)(d) implies that those Member States having implemented cost-optimal levels can count only energy savings exceeding these levels.

[27] The Guidance Note paragraph 36 also states that individual actions listed in Annex V, part 2 point (a) and part 3 point (a) cannot be counted. Whilst Annex V, part 2(a) refers to new passenger cars, light commercial vehicles and products covered by Directive 2009/125/EC, the Annex V part 3(a) refers to taxation measures applicable to fuels. These parts of the Note have not been mentioned in the text above because the reasoning presented above refers to buildings and not to the products mentioned in this footnote.

optimal levels of energy performance when providing incentives for the construction or major renovation of buildings", the application of the previously mentioned paragraph 36 would indeed imply that energy consumption baselines that lie *above* the energy consumption levels defined by cost-optimal levels can be considered for the calculation of the energy savings associated with an alternative measure *only* in case it can be proved that this measure *accelerates* the uptake of efficient buildings. In other words, a reference consumption baseline above cost-optimal consumption levels can be considered only for individual actions for which it can be proved that energy efficient buildings major renovation or new construction has been accelerated[28]. Although a proof of uptake acceleration can be given by Member States, e.g. through an estimation of measures free-riders, the application of paragraph 36 may be not completely clear[29]. During the EED Committee meeting organized on 16 September 2015, the European Commission has orally clarified that Member States can count energy savings, which result from the application of national building codes which are **more stringent than the national cost optimal level** established/calculated under Article 5(2) of the EPBD. Moreover, it has orally provided the further following important clarification concerning how Member States shall calculate the number of energy efficient building renovations which have been *accelerated* compared to the renovation rate that can be expected from the minimum energy performance requirements and cost-optimal levels that Member States must apply according to EPBD Article 4(1) and EPBD Article 5(2):

In case of "(financing) measures that speed up renovation of buildings, Member States can claim full credit if the following has been ensured:

(a) Member States shall establish a number of, or value of, or savings due to renovations they have foreseen in a particular year or period (i.e. baseline – 10 k buildings to be renovated).

(b) This calculation must be based on at least national minimum energy performance requirements.

If the Member State X can then show that, in fact, they achieved more renovations/savings than expected (as baseline per given period, e.g. 15 k buildings) as a result of policy measures, they can then count the 'extra savings' (for 5 k take the full credit). This should be proved ex-post (ideally reported in annual reports)."

Another additionality related issue concerns finally all those cases where the stock average (rather than the market average) [30] has been considered as reference consumption baseline to calculate energy savings generated by the installation of efficient products. In countries like France e.g. public bodies recommend that energy efficiency obligations should evolve to energy savings giving proper signals to households [7], this implying that energy savings observed by the final users should be considered for the issuing of white certificates and that the existing stock (instead of the market average) should be considered as reference baseline for their calculation. This

[28] Paragraph 36 actually states that, besides buildings major renovation and construction, the full credit of savings can be counted also for products and services *not* listed under Annex V, part 2, point (a), and part 3, point (a).

[29] Notice that in case of uptake acceleration, the reference consumption baseline should be the average consumption of the building stock for a number of years for which the uptake has been anticipated whilst cost-optimal levels should still be considered for the remaining years of the lifetime of the efficient solutions installed.

[30] When the stock average is considered as reference consumption baseline for given product categories, this baseline is calculated based on the average consumption of *already installed* products (e.g. at households). In case of market average, the baseline is instead calculated by considering the average consumption of products *currently available on the market*. The market average consumption is typically lower than the stock average because already installed products are typically older and less efficient compared to products available on the market.

approach is, however, highly questionable in so far as the choice of the stock average as the reference baseline implies that an accelerated replacement of products (i.e. a replacement of products that are still functioning) is assumed to be stimulated by measures under evaluation. As long as measures are supposed to just modify end-users decisions at the moment of purchase (i.e. measures are not assumed to cause an accelerated substitution), the market average should indeed be considered as reference baseline. In case measures are assumed to stimulate anticipated substitutions the stock average can instead be certainly considered, but this should be done just for a limited number of years (corresponding to the number of years after which end-users would have anyhow substituted the still functioning and inefficient solution in the absence of any incentive) and not for the whole lifetime of efficient solutions (see the example provided in the box below).

Moreover, not all individual actions benefitting from measures' incentives should be considered for the calculation of total savings generated by measures in this case, unless these measures are designed in such a way that the anticipated substitution must be proved by end-users benefitting from this incentive[31]. All in all, the decision of taking the stock average as reference consumption baseline appears therefore highly questionable for additionality issues, unless anticipated substitution can be proved and the necessary correction factors are taken into account when calculating energy savings generated by measures.

The box below reports an example showing how and when the *stock* average energy consumption should be taken into account when calculating the energy savings generated by a measure addressing mass market products.

Let's take the case of a promotion campaign for efficient washing machines as an example. End-users participating in this campaign might be either end-users who would have bought a new washing machine anyway (i.e. also in the absence of the campaign), or end-users who decided to anticipate (i.e. to accelerate) the substitution of their still working washing machine e.g. because of the economic incentive provided by the promotion campaign. The energy savings generated by the former end-users have to be calculated by the difference between the average consumption of washing machines available on the market (representing what these end-users would have bought in the absence of the campaign) and the consumption of the efficient washing machines promoted by the campaign. The calculation of the energy savings generated by the latter end-users is instead more complicated and requires an estimation of the anticipation/acceleration caused by the promotion campaign. Considering that the lifetime of washing machines is generally assumed to correspond to 15 years, it can e.g. be assumed/demonstrated that anticipated substitutions take place at the year n. 10. Energy savings generated under this assumption by the efficient washing machine should then be calculated by sum of two terms. The first term corresponds to the energy savings generated by this machine during the first 5 years (i.e. the number years during which the latter end-users would have continued using this inefficient machine in the absence of the campaign). The second term corresponds instead to the energy savings generated during the remaining 10 years (i.e. the number of years during which it is assumed the latter end-users would have used the average washing machine they would have bought on the market in the absence of the campaign). The reference consumption baseline to be considered for the first term is the average consumption of the inefficient and early substituted solutions (i.e. the average consumption of the installed stock). The baseline to be considered for the second term is instead the average consumption of the

[31] The author means here that only a part of the participants in a measure can generally be assumed to have substituted in advance their inefficient solutions with the solutions promoted by the measure. See also the previously mentioned example included the oral clarification provided by the European Commission on 16 September 2015.

washing machines available on the market (i.e. the average consumption that would have been generated in the absence of the campaign).

Concerning the **lifetimes** of savings considered to prove compliance with the Article 7 target, existing studies have already pointed out some of the issues identified in the Member States notifications under Article 7 [5]. It may be however worth mentioning that information on lifetime of savings should probably include a description of assumptions made to estimate the lifetime of savings[32], especially when these savings are supposed to be generated by solutions whose lifetime is particularly uncertain (e.g. in case of savings generated by behavioural changes or by solutions whose savings lifetime can be significantly different from their technical lifetime[33]).

Concerning free-riders and rebound effects, NEEAPs and Article 7 notifications do not always allow establishing how and whether these effects have been taken into account when calculating energy savings. UK represents an exception in relation to rebound effects. The number of countries mentioning free riders effects in their notifications and/or taking them into account in their calculations is instead certainly higher (and includes e.g. Denmark, France, Italy, Latvia, UK).

The box below provides a summary of the main issues identified in this section.

Additionality & Materiality

- With the exception of very few Member States[34], Article 7 notifications do not allow establishing whether the Member States that have implemented **cost-optimal levels** under the EPBD (and that claim savings generated by major renovations or construction of new buildings) take these levels as reference consumption baseline in their energy savings calculations and therefore comply with Article 7(9)(d) requirements for alternative measures.

- Member States may have problems in demonstrating the **acceleration** in the uptake of more efficient buildings that has to be proved whenever they count the full credit of savings coming from these individual actions in accordance with paragraph 36 of Article 7 Guidance Note[35]. Moreover, it should be considered that, whenever acceleration is demonstrated, the full credit of savings should generally not be given for the whole lifetime of implemented actions.

- The choice by some Member States of considering the **average consumption of the stock** (rather than the average consumption of the market) as reference consumption baseline for the calculation of energy savings generated by some measures looks generally questionable and difficult to justify for additionality reasons.

Lifetime of energy savings

- Assumptions made by Member States to estimate the lifetime of energy savings should be indicated in their notifications, especially in case of actions where the lifetime is particularly uncertain (e.g. energy savings generated by behavioural changes or by actions implemented in the industry sector).

[32] Or references where information concerning these assumptions can be found should be indicated.
[33] By technical lifetime it is generally meant the theoretical lifetime of the technical solution installed. Energy savings lifetime can differ from technical lifetime due e.g. to unexpected deterioration, anticipated substitution, changes in usage patterns of technologies, etc.
[34] Belgium is the exception mentioned here. The Brussel Capital Region energy efficiency action plan states indeed that only energy savings that go beyond cost-optimal are counted for some of the measures considered to comply with EED article 7 requirements.
[35] The acceleration meant here is an acceleration compared to standards and norms that aim at improving the energy efficiency of buildings that are mandatory and applicable in MSs under Union law (notably EPBD requirements concerning cost-optimal energy efficiency levels of buildings). The oral clarification provided by the European Commission during the EED Committee meeting organized on 16 September 2015 certainly helps address this aspect (see section 1.4 of this report for further information).

Free riders and rebound effects

- NEEAPs and Article 7 notifications do not often allow establishing how and whether these effects have been taken into account when calculating energy savings generated by measures.

2. How to define a catalogue of standard measures and calculate associated deemed savings

2.1 Pros and Cons of approaches adopted for the definition of existing catalogues

Pros and cons of approaches adopted within existing catalogues will be analysed by considering catalogues developed in France, Austria and Denmark as case studies.

The catalogue of standard measures adopted in France is widely employed by actors involved in the existing energy efficiency obligation scheme[36]. The high number of individual actions (304) included in this catalogue cover the sectors of transport, industry, residential and tertiary buildings as well as agriculture and energy network and 193 out of the 304 actions in the catalogue relate to the building sector. A dozen of working groups is employed to update this catalogue quarterly. Standardized actions and related calculation methods are developed through the contribution of all the stakeholders involved in the scheme (obligated and eligible parties, companies, the national energy agency, the technical association ATEE, etc.). Public working documents (i.e. synthesis and explanatory fact sheets) based on not-published methodological and calculation factsheet are produced for each standardized action. Whereas the methodological factsheets provide indications on the data and methodology used to calculate the energy savings, the calculation factsheet specifies the application sectors, actions eligibility conditions (e.g. standards required, possible energy performance criteria to be applied, installation requirements, etc.) and existing national energy saving potential that can be associated with the specific action. Other information in the factsheets include a list of national and EU regulations having an impact on the action, the reference baseline considered, the action operation lifetime, annual energy savings and savings cumulated and actualized over the action lifetime[37].

The French energy efficiency obligation is established on a three year basis and major standard catalogue revisions (including an update of the reference consumption baselines) are implemented on this basis. The latest revisions have been implemented on January 2015 and include, among the others, the adoption of an ex-post control principle and a quality label to be issued for actions implemented at households. Documents submitted by project implementers are not anymore checked ex-ante by the regulator. Implementers declare which actions have been installed and the associated savings and the regulator performs random ex-post checks. When it comes to evaluate pros and cons of the French catalogue, different considerations have to be taken into account. The first criterion to be considered to perform this evaluation concerns how standardized the energy efficient actions included in the catalogue can be assumed to be. In order to be sufficiently reliable, deemed estimates of savings should indeed be performed only for very simple and highly standardized and replicable actions in order to avoid that the ex-ante estimated energy saving deviates significantly from the energy saving amount actually generated by actions. The household sector is the sector where

[36] 91.4 % of the energy savings awarded under the scheme until 2014 have been calculated as deemed savings generated by the standard measures in the existing catalogue. Information source: [10]

[37] Energy savings are cumulated and discounted by 4% over the action lifetime and a number of white certificates corresponding to the total cumulated and actualized amount of savings generated by the action are issued upon action implementation under the French energy efficiency obligation scheme.

most of these types of actions can be identified, and it is probably for this reason that most of the actions included in the French catalogue address this sector. Actions implemented in the transport sectors are instead intrinsically much more difficult to be standardized due to the fact that energy savings are highly dependent on end-users behaviours. It is for this reason that the inclusion in the French catalogue of some actions related to the transport sector raise some concern on the reliability of adopted calculation methods. Broadly speaking, whenever actions like e.g. eco-driving, car sharing, etc. are included in a catalogue, estimates of associated energy savings should generally be highly conservative in order to ensure that these estimates can to the largest extent possible relate to additional savings.

There is indeed always a trade-off between accuracy and costs associated to energy saving estimates. If a catalogue of standardised actions allow lowering costs associated to energy saving calculation, it should be however avoided that this can result in the claiming of energy savings that are not generated. These considerations clearly apply not only to actions that can be implemented in the transport sector. Another very delicate point related to the French catalogue concerns the adoption of the existing stock as reference consumption baseline for actions related to insulation and optimization of existing equipment in the building sector. This decision creates indeed serious concerns for the additionality of savings claimed for these actions. Another important aspect to be taken into account when assessing the pros and cons of existing catalogues relates to the need for periodical and frequent updates of existing calculations due to technological progress and possible market saturation by efficient solutions. In this respect, it can be probably concluded that the update procedures established under the French scheme represent an example of good practice. Another good practice identified in the French scheme concerns finally the estimates available in the catalogue of the remaining energy saving potential that can be exploited by implementing each specific individual action[38]. This type of estimates is rarely found in countries where energy efficiency obligations are in place. Their regular update allows defining reliable energy consumption baselines as well as to have a clearer picture of the still existing potentialities to generate energy savings in a country.

Contrary to what is happening in France, the catalogue for standardized actions developed in Austria is used both for actions implemented under an existing energy efficiency obligation scheme[39] and under alternative measures that this MS considers to comply with EED Article 7 requirements[40]. This catalogue relies on an on-line database where information concerning individual actions and associated deemed savings are registered. It presently includes 40-50 individual actions, but a new regulation whereby the number of actions will be enlarged to 70-80 is expected by autumn 2015. These actions range from comprehensive retrofits of buildings and envelope insulation, to installation of efficient lighting systems (either in the households, or in the public, or in the service sector), efficient heating systems, efficient cooling systems in non-residential buildings, efficient electric appliances (either in the residential or in the non-residential sector), information and advice (including energy audits, eco-driving, installation of smart meters), installation of renewable energy systems (e.g. PV panels).

The associated calculation methods are supposed to allow distinguishing between actions implemented in household and in the non-household sectors in order to allow obligated parties under the energy efficiency obligation scheme to comply with a requirement to generated at least 40% of their savings in the residential sector. Moreover, actions

[38] A total available energy saving potential that can be exploited by the large scale implementation of specific individual actions at energy end-users can be estimated in each Member State. The total energy saving potential available e.g. for LEDs can be estimated by assessing the number of LEDs that can be installed in a country and the amount of energy savings that can be associated with each installation.
[39] This obligation scheme has been implemented following the adoption of the Federal Energy Efficiency Act on 9 July 2014. The first year of obligation for energy suppliers is 2015. See the annual report submitted by Austria in 2015 in the framework of the EED for further information.
[40] For further information see e.g.: [12]

implemented at low income households benefit from a 50% increase in the amount of associated deemed savings. These extra savings can be used by obligated parties to comply with their energy saving obligation but are not counted when actions contribution to Article 7 target achievement has to be evaluated. As in France, reference consumption baselines are estimated depending on the action type either by considering the market average or the installed stock. These baselines are currently being revised in order to comply with EED requirements. Measurement and verification activities are regularly performed for at least 4% of actions totally implemented and consist in random controls based on checks of the received documentation, on a possible requirement for additional documentation from implementers and on on-site controls. Deemed savings are just one of the three energy savings calculation methods employed by Austria. Besides deemed savings for standardized actions, scaled savings (aka analogue methods[41]) and metered savings (aka individual methods) are used in this country. Compared to France, the Austrian catalogue seems to cover a quite limited number of actions. Austria, however, has adopted a more differentiated approach where metered savings and scaled savings will probably play a more relevant role than in France for the calculation of energy savings claimed for EED Article 7 achievement. The on-line database where information on actions and associated savings are registered can in principle facilitate the development and the management of the existing catalogue. It is however probably true that the creation of a catalogue of standardized actions is generally time and resource consuming for implementing bodies, in particular when compared to alternative methods that rely more on data and information to be provided by other involved actors.

Finally, Denmark has adopted a much larger catalogue including 248 standardised actions[42]. This catalogue, however, does not include the actions whereby most of the savings are generated under the energy efficiency obligation in place in this country. Only 18% of the total savings generated in 2013 have been calculated based on deemed savings estimates included in the catalogue. Most of savings generated in this country are indeed generated by actions implemented in the industry sector for which specific and not standardized energy saving calculation methods are employed[43]. Usability is the most important priority for experts involved in the development of the calculation methods included in the catalogue. It is for this reason that the number of deemed savings estimates for buildings envelopes has been recently reduced from 150 to 30-40[44]. Other priorities considered relate to the need to avoid false declarations by obligated parties concerning achieved energy savings as well as to the need to ensure savings additionality and sufficient accuracy in the calculations and to keep costs associated with calculation methods development at a minimum. It is worth mentioning that Denmark has adopted a calculation approach aimed at ensuring that energy savings calculated are highly conservative and therefore additional. Only *first year savings* are indeed taken into account in the calculation for all actions implemented and adjustment multiplicative factors of 1.5 are introduced whereas given actions are considered as a priority for the country[45]. All deemed savings estimates are prepared by the Danish Technological institute and are approved by the Ministry of Science and Technology and the Danish Energy Agency. Calculation methods are public and public hearing sessions are regularly organised in order to allow involved stakeholders to discuss methods and propose possible modifications. Changes in the catalogue are implemented yearly between October and end of December. However, errors, clarifications or changes e.g. related to modifications in the building code can be implemented during the whole year.

[41] See [12] for further information.
[42] Information provided by Mr. Jacob Høg during the "Workshop on Common Methods and Principles for Calculating the Impact of Energy Efficiency Obligation Schemes or Other Policy Measures under Article 7 of the Energy Efficiency Directive" organised by the JRC on behalf of DG ENER on June 10th, 2015 in Brussels.
[43] 64% of total savings generated in 2013 have been estimated in this way. Information kindly provide by Mr. Jacob Høg.
[44] Information source: [13].
[45] Multiplicative factors of 1.5 have been introduced e.g. for energy savings generated by increased insulation of floors, walls, ceilings in oil and gas-heated buildings.

Overall, the Danish catalogue can be considered as an example of best practice for the conservative approach taken when estimating deemed savings associated with actions, for the attention paid to calculation methods usability and accuracy and for having a technological institute specifically committed to produce deemed savings estimates. Lack of sufficiently representative data to produce the estimates is however generally a problem for Denmark as it is probably for all EU Member States.

In general, when designing a catalogue of standardized actions or updating it, it is primarily important to be technologically neutral and to avoid producing deemed savings that my favour very few technologies manufacturers (has might e.g. happen when deemed savings are produced for patented solutions). It is a good practice to produce deemed savings estimates for solutions when these solutions are starting being widely used in a country, when sufficiently accurate studies are available to produce the estimates and when some degree of homogeneity is achieved among end-users (e.g. in relation to how and where these solutions are installed and used) in order to guarantee a sufficient level of accuracy in the estimates. It is also a good practice to avoid that alternative methods can be used to calculated savings generated by actions when deemed savings estimates are available for these actions. It is also worth noticing that involved stakeholders can usually effectively contribute to deemed savings estimates. For this reason, the these estimates can be the result of a gradual process whereby conservative values are produced first and involved stakeholders (e.g. obligated parties under an energy efficiency obligation) are subsequently allowed proving and documenting that higher energy saving values can be attributed to actions.

2.2 Main issues identified in EED Article 7 notifications and the NEEAPs

Information on additionality and materiality of involved actors' contribution to the generation of deemed savings are probably among the most important aspects to be addressed by Member States when notifying the methodologies they have used to determine the energy savings generated by energy efficiency measures. Although not explicitly mentioned in the EED and in the Guidance Note on Article 7, it can be reasonably assumed that in case of catalogues of standardized actions this information should relate at least to the following aspects:

1) how the reference consumption baseline has been determined for each action.

2) how frequently and according to which criteria and data these baselines are being updated.

3) which correction factors have been considered when energy consumption baselines and energy performances of efficient solutions have been estimated.

4) how involved actors have contributed to the implementation of actions for which energy savings are claimed to ensure "materiality" of savings.

Concerning the point 1 above (how the reference consumption baseline has been determined for each action) it has to be stressed that the reference baseline to be considered for deemed savings estimates of actions has usually nothing to do with the reference consumption baseline of the end-users where actions are implemented. Energy savings to be taken into account under Article 7 are indeed not the energy savings generated at end-users sites but just the additional energy savings that can be assumed to have been caused by a policy measure supposed to stimulate the implementation of the energy efficiency improvements. These additional energy savings are typically markedly smaller than savings generated at end-users sites for several reasons. The main reason is that, as already mentioned, measures mostly cause the generation of energy savings by end-users by inducing a change towards more efficient solutions during purchasing decisions (i.e. for purchases that would have happened anyhow) and

not by inducing additional purchases or anticipated substitutions of inefficient solutions[46]. In case of deemed savings estimates related to standardized actions that typically concern mass-market products, the baseline has hence to be mostly set by considering the market average as reference consumption (see what discussed in the report section dedicated to additionality). A second reason is that part of the end-users benefitting from the incentive provided by measures would have anyhow purchased incentivized solutions (they are hence free-riders). A third reason is that baselines used for deemed estimates result typically from an average over different solutions installed or available on the market and cannot therefore represent the actual consumption baseline at energy end-users (for further explanations see the example reported in the box below) . Unfortunately, information related to how baselines are set are often missing in the NEEAP and Article 7 notifications.

The box below reports an example illustrating why *additional* energy savings generated by energy efficiency improvement actions stimulated by a measure are typically markedly smaller than total energy savings generated for the end-users by the same actions.

Let's take the case of the assessment of energy savings generated by the purchase of an energy efficient refrigerator under an energy efficiency obligation scheme as example. Rather than to the energy savings generated by end-users, this assessment refers only to the additional energy savings generated by the scheme (i.e. to the savings that would not have been generated in the absence of the energy efficiency obligation scheme - in other words without EED Article 7). The reasons why these two types of energy savings are typically markedly different are quite straightforward. In the example just mentioned, energy end-users benefitting from the incentive received thanks to the scheme are either end-users that would have anyhow bought a new refrigerator in the absence of the scheme or end-users that decide to anticipate the substitution of a still functioning refrigerator because of the incentive. In the case of the former end-users (typically representing a very large majority among end-users who can decide to participate in the scheme by buying efficient refrigerators), the obligation scheme can only cause a shift of the purchasing decision towards a more efficient model (compared to the model that would have been bought anyhow). In this case, the only (additional) savings generated by the scheme are therefore those savings resulting from the difference between the energy consumed by the average refrigerator available on the market (that end-users would have bought in the absence of the scheme) and the energy consumption of the efficient refrigerator they have decided to buy because of the incentive. Whilst an assessment of energy savings generated at end-users sites has to consider the stock consumption (i.e. the consumption of the inefficient solutions installed at end-users sites) as reference consumption baseline, additional energy savings have to be calculated by considering the market average energy consumption as reference baseline. This is the main reason why the two types of energy savings previously mentioned can be markedly different. It is not difficult to show that additional energy savings are different from and smaller than energy savings generated at end-users sites also for end-users that decide to participate in the scheme by anticipating the substitution of their inefficient refrigerator (see the example and the explanation provided in a previous box).

[46] It is indeed quite difficult that the incentive provided by a measure can induce end-users to anticipate the substitution of an installed solution that is still working. Energy efficiency measures are therefore typically just assumed to change purchasing decisions of end-users that would have anyhow bought a new solution in the absence of the measure.

Baselines regular update is another important aspect affecting the reliability of deemed estimates which is partly correlated with the aspects just mentioned, as the market of standardized products typically assessed by deemed savings estimates evolves quickly. Unfortunately, information on how often and regularly baselines are updated are rarely included in the Member States notifications. As regards the point 3, correction factors to be considered for a fair estimation of savings are another important aspect that is correlated to the ones previously mentioned. Several correction factors should in general be taken into account. These factors range from free riders, spill over effects, rebound effects, geographical factors (e.g. degree days, different buildings performances in different geographical areas, etc.), correlations among national markets, etc. Also this information is rarely included in the Member States notifications. Overall, the issues just mentioned point to a lack of data and studies allowing to regularly perform the deemed estimates needed in the EU Member States. A further aspect to be taken into account in case of deemed savings relates finally to the necessity of regular ex-post verifications that can serve to establish whether deemed savings estimates are sufficiently accurate or corrections need to be introduced.

Concerning **materiality** (see the point 4 above), several criteria can in principle be adopted to assess whether involved actors have actually contributed to the implementation of the energy savings that are claimed. The amount of subsidies made available for energy efficiency investments by end-users is surely a good parameter to take into consideration, although this parameter does not guarantee alone that the subsidies have actually had a part in end-users' investment decisions (as it might happen e.g. in case efficient solutions subsidised have already achieved a very high market penetration and it can be reasonably assumed that all investments considered would have been anyhow performed by end-users). However, the role played by involved actors in actions implementation may in principle be proved also without having the amount of subsidies possibly provided as a benchmark. For example, in case of France, Denmark, United Kingdom, initiatives undertaken by involved obligated parties under energy efficiency obligation schemes and/or agreements to be signed among actors to implement standardized actions can clearly be an important materiality indicator. In case of standardized actions, initiatives like the creation of installation standards for products, information, energy advice and energy audits (when followed by the actual implementation of actions) as well as initiatives aiming at creating economy of scales by pooling small energy efficiency projects can probably be considered as sufficient to demonstrate materiality provided the additionality of energy savings calculated through deemed estimates can be proved[47].

The box below provides a summary of the main issues identified in this section for deemed savings estimates.

- Deemed savings estimates should be considered only in case of **highly standardized** and easily replicable actions.

- It is important that Member States declare whether the average consumption of the **market** or of the **installed stock** has been considered for deemed savings estimates employed under a measure. Moreover, whenever the stock is considered, Member States should prove that an **acceleration** (estimated in number of years and compared to market and technologies autonomous developments) in the uptake of energy efficiency actions has been caused by the measure.

[47] The initiatives mentioned above are generally assumed to be not sufficient to generate additional savings. Additionality of savings should therefore always be proved independently from materiality (e.g. by estimating free riders and the impact of autonomous market developments) in these cases.

- The frequency of **energy consumption baselines updates** is an important factor affecting deemed savings estimates and should be declared by Member States in order to prove the reliability of their estimates.

- **Correction factors** considered to produce deemed savings estimates (e.g. free riders, spill over effects, rebound effects, geographical factors, correlations among national markets, markets autonomous developments, etc.) should be declared by Member States in order to allow assessing whether only additional energy savings generated by measures are claimed.

3. Methods for assessing energy savings generated by measures through metered savings, scaled savings, surveyed savings

3.1 Analysis of methods adopted in the EU Member States based on information reported in EED Article 7 notifications and the NEEAPs

Before entering the details of the analysis presented in this section, it has to be anticipated that this analysis will not tell a lot concerning methods relying on surveyed savings, as a detailed description of these methods is missing in Article 7 notifications and the NEEAPs[48]. According to information reported in these documents, surveys for energy savings calculation are or will be used in Czech Republic, Finland and Spain. Czech and Spanish notifications, however, just mention that these methods will be used, e.g. for education programs as well as information and training campaigns, without providing details on the methods themselves. In case of Finland, instead, surveys do not seem to be actually used for energy savings estimates. In this country surveys seem to be used just for monitoring and verification purposes[49] and to estimate some of the parameters needed to calculate energy savings generated by the installation of heat pumps for single family houses and terraced houses[50].

As far as methodologies relying on scaled savings are concerned, it has to be pointed out that these calculation methods differ from deemed savings estimates in so far as it is assumed that some key parameters used in the formulas for energy savings calculation are highly variable and need to be measured on-field for each individual action (or groups of individual actions) under evaluation. This may happen e.g. in case of measures concerning the installation of energy efficient motors in industry (where energy savings are highly dependent on motors working hours and where working hours are highly variable over the installed stock) or e.g. in case of measures concerning heating and cooling systems in the civil sector (where energy savings depend on the surface and other characteristics of dwellings addressed), etc.. Being dependent on values measured or estimated on-field, it is fundamental that these methodologies are described by clarifying how and by whom (e.g. by qualified and independent evaluators) these values have been determined. It has to be pointed out that in case of methods relying on scaled savings, energy savings calculation costs per individual action are typically higher for

[48] This statement refers to the situation as of August 2015. Although difficult, the situation might in principle have changed since then as more information has been submitted by Member States.
[49] See information included in the notification at page 14 regarding how documentations and methods submitted by industrial companies participating in the energy efficiency agreement activities have been checked.
[50] The Finnish notification mentions at page 25 that annual surveys are used to assess the allocation of heat pumps by building types.

involved actors, but energy savings generated by each single action are typically supposed to be higher compared to actions for which deemed savings can be claimed. The cost-effectiveness of engineering estimates usually produced can therefore be assumed as generally high. Concerning methods accuracy, the reliability of scaled savings estimates depends on the same aspects already illustrated for deemed savings estimates. The way in which the reference consumption baseline is determined and periodically updated represents therefore a key factor for methodology reliability also in this case. The estimate of correction factors like rebound-effects and free riders is highly necessary for scaled savings and can be more difficult compared to the case of deemed savings, due to the fact that the level of standardization of individual actions addressed is lower and due to the higher difficulties linked to the collection of data needed to calculate the values of parameters included in engineering estimates[51].

The highest complexity and implementation costs (per individual action implemented) are however generally achieved by calculation methods based on metered savings. Project specific methodologies are necessary in this case to calculate energy savings and additional costs for project implementers can arise from the possible need to install devices to measure ex-post the energy consumption of the solutions adopted. Additional costs for implementing public authorities are then generated by the need to evaluate and approve each calculation method as submitted by project implementers. Energy savings generated by projects evaluated by metered savings methodologies are however generally large enough to compensate for these additional efforts and complexities. It is nevertheless worth mentioning that complexities generated by the application of these methodologies can be also theoretical (i.e. may not just be related e.g. to lack of data or documentation to be provided by project implementers). These types of complexities relate mostly to the possibility of defining a reference consumption baseline and to the evaluation of energy savings additionality and lifetimes. All these complexities depend ultimately on the unique character of projects that may be considered for metered savings methodologies. Concerning baselines, it can be generally assumed that the reference baseline to be considered should be that that can be estimated from the ex-ante consumption of substituted solutions whenever the more efficient solutions installed do not lead to a change in the outputs produced. Whenever the efficient solutions produce different outputs, the baseline has instead to be estimated by referring to an equivalent inefficient solution (i.e. a solution producing the same outputs by using the same type of energy input) that it can be assumed would have been installed without the incentive received by project implementers through the measure under evaluation[52]. It can be argued that this theoretical exercise can be quite tricky and questionable in some circumstances, especially when projects related to upgrades and improvements of industrial processes have to be evaluated (how to define an equivalent inefficient solution in case of new industrial processes? Which reference technologies should be considered?).

The evaluation of additionality poses same types of challenges in so far as projects which are highly specific do not easily allow establishing which are the technical solutions or processes to consider for the reference baseline. Lifetime of savings in their turn might be difficult to assess because they may be more dependent on internal and quite unpredictable logics regulating technology turnover (e.g. within companies and industries) then on the technical lifetime of solutions. There is then a specific question affecting all calculation methods, but becoming particularly relevant in case of large projects typically evaluated through metered savings. This question relates to how uncertainties concerning baseline and actual consumption can be accurately estimated ex-ante in such a way that energy savings measured ex-post do not differ too much

[51] This might be e.g. the case of engineering estimates related to energy savings generated by actions implemented in the industry sector.

[52] This issue becomes then particularly difficult to solve when e.g. a company decides to install a new and supposedly more energy efficient production system for which no equivalents that can be assumed to represent the energy consumption baseline are available on the market.

from what was expected. Whereas deemed savings and scaled savings depend mostly on factors affecting the energy performances of single technologies under evaluation, the large size of projects evaluated by metered savings makes these savings more dependent on systemic factors[53] (including exogenous factors like the still on-going economic crisis) that may unpredictably and significantly influence energy consumption. The open question is then how these factors will impact on the energy savings that will be assessed under metered savings and whether these savings will significantly diverge from what can be expected by project implementers and Member States implementing agents[54]. It may be finally worth mentioning that, contrary to deemed savings and scaled savings methods, the large scale application of methodologies relying on metering savings can in principle generate an issue of data confidentiality in so far as project implementers might not want that data related to their projects are used to assess consumption baselines and energy savings generated by similar projects implemented by others.

3.2 Main issues identified and recommendations

As already mentioned, the main issues at stake with **scaled savings** are quite similar to those already mentioned for deemed savings estimates and relate mostly to how the reference consumption baseline is estimated and periodically updated and to how correction factors (e.g. free riders, rebound effects, etc.) have been taken into account in Member States notifications. In case of scaled savings, however, Member States should provide in their notifications information concerning which benchmark values have been considered and whether they have been established by independent and qualified experts. Although not specifically stated in the EED and in the Guidance Note to Article 7, scaled savings would also probably require that indications concerning how the value of relevant benchmarks and parameters considered in the methodologies have been estimated would be provided by Member States using these methodologies.

As far as **metered savings** are concerned, the higher level of complexity of individual actions typically evaluated by these calculation methods determines a series of issues that have been partly already described in the previous section. As mentioned above, these complexities are mostly due to the very specific and not standard nature of the projects typically under evaluation. Nevertheless, Member States might certainly provide in their notifications more information concerning the general principles adopted by or recommended to project implementers when these methods are considered[55]. Other important information not always included in the notifications concern criteria adopted by implementing public authorities and evaluators when assessing methodologies based on metered savings (how the reliability of proposed consumption baselines are assessed? How project additionality is evaluated?). Another important remark to be formulated concerns then the significant differences registered in the types of methodologies adopted in the Member States when addressing same sectors and/or technologies and the large differences in the energy savings resulting from the application of these methodologies.

Analyses of **engineering and deemed savings** estimates adopted in the different countries show e.g. that deemed savings estimates for a same individual action may

[53] Systemic factors are generally meant as factors that go beyond the boundaries of the project under evaluation. Energy performances of and energy savings generated by projects might indeed be deeply affected by external and difficult to assess factors. In the industry sector this may happen e.g. when the assumed energy input for the machinery under evaluation depends on industry overall production rates that may change unexpectedly.

[54] Notice that, contrary to e.g. EED Article 3, the additionality requirement for Article 7, implies e.g. that energy savings generated by the economic crisis and, in general, by a reduction in the expected outputs, cannot be claimed for Article 7 target achievement.

[55] IPMVP suggests for example a series of criteria that can be applied in order to establish when scaled savings, metered savings, calibrated simulations, etc. can be considered.

vary greatly among countries[56]. Differences among Member States relates also to the specific type of methodology considered for actions implemented in a same sector. A striking difference between Italy and Denmark relates, for example, to the calculation methods considered for energy savings claimed under the energy efficiency obligation schemes for individual actions implemented in the industry sector. Whereas Denmark seems to extensively use deemed or scaled savings, the methodologies adopted in Italy for actions implemented in the industry sector rely mostly on metered savings. It may be hypothesized that kinds of learning processes take place for some technologies and associated energy saving calculation methodologies. It may be e.g. assumed that these learning processes may cause an evolution from complex methods based on metered savings adopted when technologies implemented are not sufficiently known to simpler methods based on deemed or scaled savings when these same technologies have achieved a larger diffusion and are therefore better known. On the other hand, this difference between methodologies adopted by Member States may also be an indicator of a lack of communication among countries concerning methodologies adopted in same sectors, or may be an indicator of an existing need for a higher harmonisation in the methodologies employed by countries. Establishing whether this is case requires however in depth studies and cross-country comparisons of methodologies being adopted by Member States and of the energy savings resulting from their application.

A final remark that can be formulated concerns methods relying on **surveyed savings**. Although these methodologies are not yet described in Member States notifications, it may be worth mentioning that the EED Annex V part 1(d) restricts their employment to the assessment of energy savings resulting from changes induced in consumers' behaviours and excludes applicability to savings resulting from the installation of physical measures[57]. This restriction, unfortunately, limits the application of these methods to individual actions and measures for which the associated energy savings are the most uncertain and the most difficult to be assessed. Uncertainties affecting energy saving impact evaluations performed for these measures are mainly due to a) the existing difficulties in establishing a cause effect relationship between the implementation of measures and the possibly detected variations in energy consumption at energy end-users addressed by measures[58] and b) estimates of lifetimes or persistence of the annual energy savings possibly detected. These aspects will be discussed in some more detail in the report section dedicated to information measures. Concerning the point a) above, it is however worth stressing that the amount of the energy savings associated with the measures for which surveyed savings can be considered should always be assessed by using statistically representative control samples allowing to accurately define a reference consumption baseline. Notifications of Member States that intend to use surveyed savings do not unfortunately mention how these issues will be dealt with and whether and how control samples will be used for the evaluations.

The box below provides a summary of the main issues and recommendations described in this section.

[56] Studies performed in the past have showed e.g. that deemed savings estimates for the installation of efficient boilers under the Italian energy efficiency obligations are about nine times lower compared to deemed savings considered in France for the same individual action [20].

[57] Strangely enough, however, the EED annex V part 2(d) states that these methods can also be used to determine consumers' response to labelling and certification schemes which are typically used to directly or indirectly assess the quality of physical measures installed.

[58] Provided a sufficiently representative control sample is used, it is indeed generally quite challenging to establish whether changes in consumers' behaviours are the consequence of e.g. information campaigns, smart metering campaigns, etc.

Engineering estimates

- The main considerations and recommendations formulated for deemed savings estimates (concerning stock and market average consumption of products, frequency of baseline updates, corrections factors to be considered to calculate energy savings) apply for engineering estimates.

- Significant differences have been observed in the engineering and deemed savings estimates produced by Member States for a same individual energy efficiency improvement action. These differences point to need for an increased harmonisation in the calculation methods adopted by Member States.

- Being dependent on values measured or estimated on-field, it is fundamental that methodologies based on engineering estimates are described by clarifying how and by whom (e.g. by qualified and independent evaluators) these values have been determined.

Metered savings

- The very specific and not standard nature of the (usually very large) projects typically assessed by metered savings pose important challenges concerning the definition of a reference consumption baseline, the evaluation of materiality as well as of additionality and lifetimes of associated energy savings.

- The above mentioned challenges would require that Member States provide in their notifications more information concerning the general principles adopted by or recommended to project evaluators when these methods are considered (how the reliability of proposed consumption baselines are assessed? How project additionality is evaluated? Which criteria are proposed to estimate savings lifetimes?).

Surveyed savings

- Large uncertainties usually affect the results of the energy savings calculations generated by measures where surveyed savings can be applied according the EED Annex V (i.e. by information measures and measures supposed to induce behavioral changes).

- In order to reduce these uncertainties it is as a minimum necessary that a) energy savings are assessed by using statistically representative control samples allowing to accurately define a reference consumption baseline and that b) energy savings persistence is estimated by dedicated studies.

4. Calculation of energy savings generated by taxation, transport and information measures

4.1 Analysis of methods adopted in the EU Member States based on information reported in EED Article 7 notifications and the NEEAPs

Methods to calculate energy savings generated by taxation, transport and information measures are probably the most difficult to be developed by Member States. This section will discuss methods typically adopted for these three different types of measures in different sub-sections.

Taxation measures

As far as taxation measures are concerned, the main calculation approaches adopted by Member States as described in their notifications are already discussed in [5]. Taxation measures can generally consist in energy taxes, CO2 taxes, tax rebates for the

installation of energy efficient technologies, other tax measures not directly addressing energy consumption but having an indirect effect in terms of reduced energy consumption (e.g. truck tolls and air passengers' duties). Calculations approaches that can be used to estimate associated savings vary depending on the type of taxation measures. Whereas top-down evaluation methods have e.g. to be used for energy and CO2 taxes often affecting several sectors and energy end-uses, calculation methods for tax rebates on specific technologies can be bottom-up. In case of energy and CO2 taxes, the EED sets an energy savings additionality criterion where it states that credit shall be given only to savings generated by taxation measures exceeding the minimum taxation levels established by Directive 2003/96/EC on taxation of energy products and electricity and by Directive 2006/112/EC on VAT [59]. The EED also states that recent and representative official data on price elasticities shall be used for calculation of the impact[60] and that the energy savings from accompanying taxation policy instruments, including fiscal incentives or payment to a fund, shall be accounted separately[61].

The calculation approach adopted in Sweden for savings generated by energy and CO2 taxes can be taken as a case study to discuss the main characteristics of calculation methods that can be produced for these measures[62]. Sweden has a long tradition on energy taxation starting already in 1950s. CO2 taxes were instead first introduced in 1992. Several taxes on energy and CO2 emissions are presently in force and are perceived as policy instruments fostering energy efficiency. The level of taxation applied in this country often exceeds the levels set by the EU tax directive by some orders of magnitude[63]. Dynamics simulation models[64] have been used to calculate energy savings generated by taxes. Energy consumption levels that would result from EU minimum taxation levels have been estimated by considering the relevant energy price elasticities and energy savings have been calculated as the difference between those consumption levels and actual consumption levels registered in Sweden in the relevant time period. Given the magnitude of applied taxation measures, only these types of measures have been considered as contributing to Article 7 target achievement and double counting of savings possibly generated by other types of measures has been so avoided. Price elasticities considered in the calculations applied by Sweden have been both long and short-run elasticities. Different elasticity values have been considered for the different sectors and for the different energy types consumed in these sectors. Overall, most of the savings from taxation measures are expected to be generated in the household and in the transport sector[65].

The calculation method adopted in Sweden can be probably considered as an example of best practice in relation to how double counting has been taken into account [66], in relation to the accuracy of elasticity and energy price levels considered in the calculations and in relation to the level of detail achieved when documenting the calculation method within Article 7 notifications. The main issue at stake with this method lies however with the decision of including both long run and short run

[59] See EED Annex V part 3(a)
[60] See EED Annex V part 3(b)
[61] See EED Annex V part 3(c)
[62] Information source: [15].
[63] Tax rates applied in Sweden in 2015 for natural gas (excepting gas used by vehicles) achieve e.g. 0.29 SEK/kWh when energy taxes and CO2 taxes are summed, whilst tax levels set by the EU energy tax directive just achieve 0.0047 SEK/kWh. In case of coal, Swedish total tax rates achieve 0.44 SEK/kWh to be compared with 0.0047 SEK/kWh set by the EU directive. Taxes on electricity for non-commercial uses achieve instead 0.294 SEK/kWh to be compared with EU directive values corresponding to 0.086 SEK/kWh (see the information source mentioned in the previous footnote).

[64] Dynamics simulation models are models made of non-linear equations that are solved by using numerical methods based e.g. on finite increments. Equations linking energy consumption with energy or CO2 emissions taxes in a country are typically non-linear and may need a dynamic approach to be solved.
[65] Information included in [15] indicate that cumulated savings expected between 2014 and 2020 amount to 37.5 TWh (in the household and service sectors) and to 80.8 TWh (in the transport sector).
[66] It might be worth pointing out that this practice cannot be duplicated in countries where a combination of taxation measures with other measures is being considered to achieve Article 7 target.

elasticities in the calculations. Long run elasticities are indeed supposed to be taken into account whenever taxation measures have been in place for a time span whose length can allow assuming that, besides savings generated by behavioural changes reflected within short run elasticities, also savings associated with substitution of inefficient technologies have been triggered by measures. The seven years period covered by Article 7 target is however generally assumed not to allow that effects due to long-run elasticities can be detected[67,68]. On the other hand, energy taxes seem to have already caused a shift from gasoline to diesel in the transport sector and the installation of heat pumps in Sweden[69]. What remains to be demonstrated is whether these changes are not the result of taxation measures that were in place several years before EED implementation.

Transport measures

Just 3% of the total savings claimed by Member States for Article 7 target achievement are expected to be generated by measures implemented in the **transport sector**[70]. It cannot be excluded that the reasons for the low popularity of these measures among Member States partly depend on the difficulties associated with the calculation of generated energy savings. The main types of measures considered in this sector rely mostly on[71]:

- tax rebates for the purchase of new and energy efficient cars;

- taxes and excises on fuels;

- information and training on eco-driving;

- modal shift for persons and freight;

- mobility reduction for persons and freight (e.g. road traffic charges, etc.);

- car or tyre labelling, speed limits, adoption of alternative fuels, etc.

Energy saving calculation methods for **tax rebates** generally rely on estimates of the reduced amount of CO2 emissions of efficient cars compared to existing EU standards. The total amount of gross savings generated by these measures is then calculated by multiplying the reduced amount of CO2 emissions due to a new car by the number of new cars receiving tax rebates and by the conversion factor representing the amount of cars average energy consumption per unit of CO2 emissions generated.

In case of **fuels taxes**, the related calculation methods usually determine the difference in tax levels compared to the EU minimum tax level and then multiply this difference by

[67] In economics, the short run is generally defined as a period of time over which the capital stock remains fixed. As the typical lifetime of installed capital can vary among economic sectors, energy end uses, and equipment types, there is no single definition that differentiates between short run and long run. Moreover, calculated elasticities result to be different when different price variations are considered in the calculations. It may be useful to observe that the long run for own-price elasticities (i.e. for elasticitieis referring to changes in consumption of a particular fuel when the price of *that* fuel changes) has been estimated to be around 25 years under a model simulating a doubling in the prices of energies used in the residential and the commercial sector between 2015 and 2040. See [21] for further information.

[68] Given the large time span to be considered before the effects of long-run price elasticities can be detected, taxation measures that might generate additional savings due to long-run elasticities should indeed have been implemented long time before 2014 (see information included in the previous footnote for an example of estimate of this time span).

[69] Information provided be Swedish stakeholders attending the "Workshop on Common Methods and Principles for Calculating the Impact of Energy Efficiency Obligation Schemes or Other Policy Measures under Article 7 of the Energy Efficiency Directive" organised by the JRC on behalf of DG ENER on June 10th, 2015 in Brussels.

[70] See information reported in [5]

[71] This categorization is actually based on the experience matured in the Netherlands. Nevertheless, it can be reasonably assumed that it represents the main types of measures implemented in the EU. See in this respect:[16]

the relevant fuel price elasticities and by the amount of fuel totally consumed in the transport sector considered within the relevant time span.

Calculation methods for measures related to programmes for **training and information on eco-driving** are based instead on the determination of the number of participants in the programmes. Average savings (expressed e.g. in terms of litres of fuel saved per kilometre travelled and per participant) are then estimated and total gross savings are assessed as the total number of participants in the programmes, times the average savings per kilometre per participant, times the total amount of kilometre travelled per participant.

In case of **modal shift** the number of persons kilometres (*pkm*) or tons of kilometres (*tkm*) shifted from mode A to mode B is estimated first. The specific energy use for the modes at stake is then evaluated in terms of litres per *pkm* or litres per *tkm* consumed and the total amount of gross savings is calculated as the total *pkm* or *tkm* multiplied by the difference in the specific energy use associated with each mode[72].

When it comes to **mobility reduction measures** (e.g. persons mobility reduction), the number of participants in the relevant measure (e.g. a measure for carpooling or for working at home) is evaluated first. The number of average avoided km (e.g. by car) per participant is then assessed and the total gross savings attributed to measures is calculated as the number of participants times the average avoided km times the energy consumed per km by cars per participant.

A definition of suitable methods for the calculation of gross savings that can be associated with transport measures is not difficult. With the exception of methods where the number of individual actions caused by measures can be estimated (e.g. eco-driving, carpooling, etc.)[73], the methods used for the calculations are mostly top-down[74]. As discussed in the following section, difficulties in the calculations emerge when net savings have to be estimated starting from gross savings and so-called side effects have to be taken into account. It is moreover worth mentioning that not all savings claimed for transport measures can be always technically considered as a result of energy efficiency improvements. Mobility reduction measures, for example, should be often considered as measures aiming at reducing affluence to transport means, whereas modal shifts are often the result of structural changes in the economies of Member States[75]. The problem in these cases lies therefore with establishing whether these measures would not have been implemented by Member States also in the absence of the EED.

[72] The specific energy consumption for cars (kWh/pers-km) is e.g. estimated to range between 0.28 and 0.22 when car occupancy range between 1.92 and 2.4 in the EU-27. The specific energy consumption of airplans (kWh/pers-km) is instead estimated to range between 0.40 and 0.35 when the travelled distance range between 500 and at least 750 km and airplanes occupancy level is at 75% (see http://www.evaluate-energy-savings.eu/emeees/downloads/EMEEES_WP42_15_Modal_Shifts_Final.pdf for further information).

[73] Samples of vehicle owners might be indeed identified and studied in these cases in order to assess behaviour changes caused by measures and related impacts.

[74] Notice that in case of bottom-up methods only individual actions *caused* by the measures under evaluation are counted and taken into account to estimate energy savings. Top-down methods estimate instead energy savings generated by actions *indirectly* because these estimates are derived from the variations observed in given macro indicators once a) all the factors different from energy efficiency improvements caused by measures have been identified and b) observed variations have been corrected for the effects of these factors. The implicit assumption made with top-down methods is that once all the effects due to factors different from energy efficiency improvements have been corrected, the possible variations still observed in the macro indicators used *must* have been caused by energy savings generated by the measure under evaluation.

[75] Modal shift often takes place without the specific intention of saving energy or generating environmental benefits. The point raised here is whether initiatives and changes not taking place as the result of actions/measures aiming at saving energy should be counted against EED targets.

Information measures

Several types of initiatives that Member States can undertake may in principle be considered as information measures. These initiatives may range from large scale and general information campaigns on energy efficiency for energy end-users, to more tailor-made campaigns focusing on energy advice for specific energy end-users categories, to energy audits, to the implementation of energy labelling schemes, to training and capacity building initiatives for installers and/or suppliers of energy efficient technologies and/or energy services, to measures concerning the installation of smart meters and other information technologies, to community-based initiatives, to energy efficiency competitions for specific categories of energy end-users, etc. Each type of measure has its own specificities and requires particular methods for the calculation of the energy savings generated. This being said, it has to be pointed out that the number of Member States that have indicated information measures in their notifications is not low[76]. Descriptions of the calculation methods considered for these measures are however very scant, and assumptions made for these calculations cannot be deduced from indications included in these documents. It seems therefore more useful here to refer to the most common information measures that may have been considered by Member States and try to highlight the main features of the calculation methods that can be considered for these measures whatever the level of detail achieved in the descriptions included in Member States notifications[77]. This will allow describing in the next section of the report the main issues and problems associated with these calculation methods and the possible ways to overcome them.

One typical measure that can be considered by Member States consists in the implementation of large scale programmes providing domestic consumers with customised information and advice on how to improve energy efficiency at home based on simplified energy audits[78]. Recommendations are typically provided to end-users who freely decide to participate in the programmes and may concern installation of energy efficient technologies and/or behavioural changes. Existing literature indicates that the amount of energy saving that can be expected from this type of measure can achieve 2-3% of the total consumption as estimated ex-ante at households and that the number of participants actually implementing recommended measures can achieve around 10% of the total number of participants in the programmes[79]. These quite low amounts of savings require that the total number of programme participants must be high enough in order to allow that energy saving estimates can achieve a sufficient level of accuracy[80]. A data-intensive modelling activity is also required to perform these estimates. This activity is generally accomplished in 2 stages whereby the energy consumption of an equivalent non-participants group is estimated first and is then compared to that of programme participants once the related energy consumption values have been normalized (e.g. for factors like weather conditions[81] in case energy performance of recommended actions are affected by these conditions). Another interesting type of information measure is represented by programmes for the provision of customized information at households based on energy reports relying on information on energy consumption included in households energy bills[82]. Different energy end-uses can in

[76] These MSs are Belgium, Czech Republic, Finland, France, Germany, Greece, Ireland, Lithuania, The Netherlands, Portugal, Romania, Spain, United Kingdom.
[77] This will be done also based on information included in [17].
[78] Simplified energy audits are e.g. energy audits performed by interviews to energy end-users and not by detailed on-site visits and analyses of installed solutions.
[79] Information source: [17].
[80] A program like that described here has been e.g. implemented between 2008 and 2012 in California (US) and addressed about 300,000 households (information source: [17]).
[81] A correction factor for weather conditions may be needed e.g. in case of individual actions addressing heating and/or cooling systems whenever weather conditions that have affected the energy consumption within the non-participants control group are assumed to be significantly different from those registered for the participants.
[82] Data on historical energy consumption and customized benchmark energy consumption values are typically used within these reports to recommend possible energy efficient improvement solutions.

principle be targeted by this measure (e.g. electricity end-uses and/or gas end-uses), and different time frequencies can be considered for energy consumption monitoring and reporting to energy end-users. Also in this case, however, large scale programmes must be implemented and a sufficiently large randomised control samples must be identified in order to produce sufficiently credible energy saving estimates. Weather normalizations may have to be performed also for this type of measure, especially when results are used for forecasting the expected energy consumption over more than one year. It is usually possible to prove that energy savings generated by these measures increase progressively during the years while the measure is in place and can endure after programmes end (although it is very hard to establish for how long)[83]. This type of information programme is also generally assumed to increase households' participation and uptake of other energy efficiency programmes possibly in place. Moreover, energy reports can be used to provide alerts that can serve to reduce energy consumption during critical energy consumption peak periods.

Other types of information measures are represented e.g. by television programmes oriented to houses improvement. These programmes can generally cover topics ranging from energy basics, to energy efficient buildings retrofits, to renewable energies, to energy efficient appliances. Related energy saving calculation methods require surveys among statistically representative samples of viewers and non-viewers and statistical techniques to estimate the amount of attributable savings. Also in this case, the amount of generated energy savings results generally quite low[84] and large scale programmes are necessary to ensure that a significant amount of savings can be generated and detected.

Compared to the measures so far described, information measures based on initiatives aiming at training and capacity building (for installers and/or suppliers of energy efficient technologies and/or energy services) are more oriented to specific technologies. The amount of savings that can be expected from these types of measures is highly dependent on the frequency of training initiatives undertaken, on the number of persons targeted during these initiatives, on the number of the energy end-users finally benefitting from these initiatives, on the type of training and building capacity activities envisaged, etc.. Although some of these parameters and aspects are or can be known ex-ante, any sufficiently reliable energy saving calculation method has to be based on on-field verifications of the additional energy savings that can be generated by the persons trained and requires the creation of control samples[85].

In case of information measures like energy labelling schemes, the calculation methods can be simpler to some extent. Time series of the energy consumption of addressed technologies and top-down analyses based on possibly available market data can in principle allow estimating the generated energy savings in case technologies addressed are not too complex mass market products (e.g. domestic appliances). In case of more complex technologies (e.g. buildings) some modelling and engineering estimates are needed to produce sufficiently reliable estimates.

Individual actions implemented under community-based initiatives and competitions on energy efficiency may be finally easier to assess in terms of gross savings generated per action given the more limited amount of participants. Spill-over effects due to actions implemented by energy end-users who are influenced but not directly targeted by these initiatives can be particularly relevant for these measures and have to be carefully estimated.

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[83] Information source: [17]
[84] Information source: [17]
[85] What stated here is that in case of e.g. a training course for installers of efficient boilers, energy savings to be attributed to this course have to be estimated by comparing the energy performance of boilers installed by the trained installers with the energy performances of boilers installed by a representative control group made of installers who have not participated in the training.

All in all, energy savings generated by information measures are typically highly uncertain and the difficulties linked to energy saving calculation vary highly depending on whether these measures focus on technological improvements or on changing behaviour and depending on whether these measures are linked to the installation of concrete energy efficiency improvement actions or not. Needless to say that, despite these calculation difficulties, these measures are highly needed and necessary in Member States.

4.2 Main issues identified and recommendations

Taxation measures

The main general issues at stake with taxation measures have been already illustrated in [5]. What may be worth stressing here relates to issues that are strictly inherent to the calculation methods used for taxation methods. These methods are typically top down and rely on time series[86] concerning the energy consumption in the sectors addressed by measures or time series of relevant indicators from which this energy consumption can be inferred. Econometric methods are typically employed in order to estimate the energy savings that can be associated with measures. The most used econometric methods are based on the possibility of capturing a trend in the relevant indicators before the implementation of the measure in such a way that this trend can be considered as the reference against which energy savings can be estimated during and after measure implementation[87]. Other elements of these methods are price elasticities, energy prices (before and after taxation), other macro-economic variables capturing the impact of the business cycles (e.g. GDP) and related elasticities. Structural factors that may have had an impact on national economies (e.g. factors beyond fuels taxation that have produced a change in the transportation system and in the relevant indicators)[88], possible price-induced energy efficiency progresses linked to an increase in international markets prices, autonomous energy efficiency progresses (e.g. autonomous technical trends that would have taken place even in the absence of the measure), earlier policies and other policies that may have had an impact on the indicator are other factors to be taken into account. There is therefore a data-intensive modelling activity involved in the calculation methods used for taxation measures and it is necessary that the values of the all the parameters used and all the factors taken into account in the calculations are duly documented in order to assess the reliability of the estimates that can be performed. Elasticities are certainly one of these parameters and the EED rightly requires that recent and representative official data on price elasticities are used in the calculations and notified. A same relevance should however be probably acknowledged to all the parameters and factors that have to be considered in the calculations.

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[86] A time series is a sequence of data points typically consisting of successive measurements of a same quantity made over a time interval.

[87] Implementation of energy efficiency measures is indeed generally expected to change the trend (i.e. the expected variation over time) of relevant indicators. Let's assume, for example, that the energy savings generated in a country by an energy tax in force as of 2014 has to be evaluated over the period 2014-2020 by applying econometric methods to the variation of the total energy consumption in this country. This requires that the trend in the total energy consumption has to be evaluated over a significant time span immediately before 2014 and has then to be extrapolated over the period 2014-2020. Broadly speaking, econometric methods allow in principle estimating energy savings generated by the energy tax by analysing the difference between this extrapolated trend and the actual trend registered for the total energy consumption over the period 2014-2020, when all the corrections due to all the possible factors (other than the energy tax) that may have affected this latter trend have been introduced.

[88] Typical structural factors to be considered for top-down methods applied to passenger transport measures are the number of km per passenger and the number of passengers per transportation mean under assessment (e.g. cars, buses, rail, etc.). Examples of structural factors to be considered for top-down methods applied to e.g. measures for space heating are the floor area per capita or the number of persons per household. These are typically exogenous factors depending on changes occurring in the economies of countries.

Transport measures

The main problems with the calculation methods described in the previous section for the transport sector will be briefly discussed here for each of the main measure types considered.

Calculation methods for *tax rebates* on the purchase of new cars are generally affected by problems of complying with additionality and double counting. It is indeed generally quite difficult to establish whether associated savings are additional to existing EU standards on emission performance and whether these savings have not to be attributed to other measures in place possibly addressing efficient new cars. Methods for *fuel taxes* may also often be affected by issues related to double counting. Reliability of elasticities values considered is another frequent problem in this case. Moreover, fuel taxes are often implemented for reasons that have not very much to do with energy efficiency. Concerning measures on *driving styles,* the main problem is that savings persistence is usually not very well known.

In case of *modal shift* and *mobility reduction* measures it has to be taken into account that also these measures might have been implemented for reasons different from energy efficiency improvement[89]. In addition, modal shift can also be due to structural changes in national economies that happen without the specific intention of Member States. Overall, the problems mostly affecting the calculation methods that can be adopted for the measures mentioned above are linked to the estimate of correction factors needed to pass from gross savings to net savings. It may be worth mentioning that direct rebound effects may be particularly high for measures implemented in the transport sector in so far as energy efficiency improvements can stimulate higher affluence (e.g. more people can be induced to use cars because carpooling is a cheap option or because more affordable and energy efficient public transport means are made available) or more intensive usage (e.g. people travel for more kilometres because their cars consume less). What might be defined as a *substitution effect* has been instead observed in case of persons' mobility reduction measures in so far as mobility reduction may cause additional energy end-uses (e.g. when people telework they consume additional heating at home)[90].

Information measures

The most common issues arising with energy savings calculation methods associated with information measures concern additionality, double counting, energy savings persistence and, in general, correction factors to be taken into account to estimate the net savings generated. Large scale information campaigns are typically affected by selection biases (i.e. participants would often have anyhow generated attributed savings) and by double counting issues (i.e. attributed energy savings can be often due to other energy efficiency measures, if other measures are in place[91]). Moreover, the low amount of savings that can be typically generated per participant requires that these campaigns target a very high number of energy end-users in order to ensure that energy savings attributable to each participant can be estimated. Suitable control groups have also to be created in order to perform the calculations needed. An inventory of behaviour and technologies addressed is also generally needed in order to calculate savings, given the high diversification of solutions that can be addressed by these measures.

Either large scale or small scale, information initiatives are generally affected by a problem of energy savings persistence in case these initiatives relate to behavioural

[89] This also applies to measures aiming at modernize road and rail infrastructures.

[90] Although quantitative estimates are not available, relevant effects of this kind have been observed e.g. in France (information provided by Ms. Elodie Trauchessec during the "Workshop on Common Methods and Principles for Calculating the Impact of Energy Efficiency Obligation Schemes or Other Policy Measures under Article 7 of the Energy Efficiency Directive" organised by the JRC on behalf of DG ENER on June 10th, 2015 in Brussels).

[91] Consider for example the case of an information campaign addressing efficient heating systems for whose installation some type of economic incentive is made available by the government.

changes only and savings to be estimated do not hence result from the installation of technologies. It is hence necessary that the values considered for energy savings lifetimes in the calculations methods are duly justified. This can be done for example by undertaking measures follow-up activities aiming at establishing actual energy savings persistence once measures implementation is completed. Free riders effects are then particularly high for information measures and should always be estimated. On the other hand, spill over effects are also usually very relevant for these measures and should also be taken into account. Information measures typically generate wider benefits and additional savings by changing the way in which people think about energy, by increasing the possibilities of engagements in future measures. Moreover, and may be most importantly, information can spread autonomously among persons and the number of persons affected by these measures can therefore be much higher than the number of persons directly targeted.

A clear distinction has finally to be made between calculation methods that can be used for information measures within packages of measures addressing the physical installation of technologies and information measures implemented as stand-alone and generally aiming at raising awareness and informing about existing energy savings opportunities. Energy savings that can be expected per participant from the former measures are unquestionably higher even when the only impact of the information component of the package is considered. The link and the correlation that is possible to establish with the installation of technologies allows indeed generally achieving this conclusion.

Nevertheless, it is also true that every measure targeting the installation of energy efficient technologies include an information component. Whenever additional savings are attributed to accompanying information initiatives, it is therefore highly necessary to demonstrate that these initiatives represent an additional information effort by involved actors compared to what is usually done when implementing a measure.

The box below provides a summary of the main issues and recommendations described in this section.

Taxation measures

- **All** main correction factors needed and used to estimate additional savings generated by taxation measures should be duly documented in Member States notifications.

- Considering that only savings generated between 2014 and 2020 can be claimed by Member States notifications, the usage of **long-run elasticities** to estimate energy savings generated by taxation measures remains questionable. The usage of these elasticities should be therefore duly justified by Member States.

Transport measures

- Double counting and additionality of **fuel taxes** and **tax rebates** in the transport sector are often very difficult to be estimated and may require detailed analyses. Member States should therefore refer to these detailed analyses when notifying energy savings associated with these measures.

- Persistence of savings generated by measures addressing **driving styles** needs to be estimated and declared values need to be proved by supporting studies.

- **Modal shift** and **mobility reduction** may be caused by measures and factors not aiming at or not related to energy efficiency improvement. The additionality of savings generated by these measures should therefore be duly proved.

- **Direct rebound effects** and so-called **substitution effects** might not be negligible and may require to be carefully estimated for some transport measures.

Information measures

- General information measures may often be affected by **double counting** and **selection biases** (i.e. participants would often have anyhow generated attributed savings) in important ways, especially when they do not accompany measures promoting the physical installation of specific actions (e.g. an incentive campaign for the installation of energy efficient boilers). Member states should therefore clearly explain how they have avoided double counting and selection biases in their notifications.

- **Persistence and lifetime of savings** generated by information measures need to be carefully estimated and declared values need to be proved by supporting studies, especially in case these measures relate only to behavioural changes and savings to be estimated do not result from the installation of technologies.

- **Spill over effects** may be very relevant for information measures and should also be taken into account in the calculation of associated energy savings.

- Given the low amount of savings that can be typically generated per participant by information measures, these measures have typically to target a very high number of energy end-users and suitable **control groups** have also to be created in order to perform the needed calculations with sufficient accuracy.

5. Implementation of Monitoring, Verification, Sanctions and Compliance Regimes

5.1 Analysis of regimes adopted in the EU Member States

Monitoring, verification, sanctions and compliance regimes represent an integral part of energy savings calculation methods in so far as these regimes 1) allow verifying whether energy savings expected from measures have been actually generated, 2) create the conditions whereby it can be assured that relevant data and information for the calculations are duly provided by actors involved in measures implementation, 3) allow assuring that calculations are performed by unbiased and independent actors.

EED Articles dealing with monitoring, verification, sanctions and compliance regimes to be enforced by Member States are the Article 7(6), the Article 7(10)(i) and the Article 13. The former article establishes that Member States implementing energy efficiency obligations shall put in place measurement, control and verification systems under which at least a statistically significant proportion and representative sample of the energy efficiency improvement measures put in place by the obligated parties is verified and that measurement, control and verification shall be conducted independently of the obligated parties. Article 7(10)(i) addresses alternative measures and states that for these measures a control system must be put in place that also includes independent verification of a statistically significant proportion of the energy efficiency improvement measures. Concerning sanctions, the Article 13 establishes that "Member States shall lay down the rules on penalties applicable in case of non-compliance with the national provisions adopted pursuant to Articles 7 to 11 and Article 18(3) and shall take the necessary measures to ensure that they are implemented". The Article 7 Guidance Note F, paragraph 58 specifies that Member States "have to lay down rules on effective, proportionate and dissuasive penalties applicable in case of non-compliance with the national provisions adopted pursuant to Articles 7 and 18(3) and must take the necessary measures to ensure that they are implemented." Moreover, EED Annex V, part 4(j) and (k) state that Member States need to notify the Commission of "their proposed detailed methodology for operation of the energy efficiency obligation schemes and for the purposes of Article 7(9) […] and that, except in the case of taxes, such notification shall include details of […]:

(j) monitoring and verification protocols and how the independence of these from the obligated, participating or entrusted parties is ensured;

(k) audit protocols.

Despite these notification requirements, in most Article 7 notifications and NEEAPs there is either not enough or no information to perform a proper analysis of the regimes adopted by Member States[92]. The authors of this report have therefore decided to present here a short overview of the regimes implemented under the Energy Company Obligation (ECO) in UK. This decision has been due to the fact that this overview allows highlighting the problems at stake under the UK ECO that to some extent can be considered as representative of the situation existing in the several other Member States. Moreover, it must be admitted that the UK ECO is the only case for which it has been possible to collect sufficiently detailed information by referring to sources other than UK Article 7 notification and NEEAP [18].

The body in charge of monitoring, verification, sanctions and compliance regimes under the UK ECO is Ofgem (Office of Gas and Electricity Markets)[93]. Ofgem apportions the overall target among obliged energy suppliers, monitors their progresses against their individual targets and works with suppliers to complete audits, ensure compliance, prevent and detect fraud. These objectives are mostly achieved through a) a so-called technical monitoring; b) the monitoring and verification of energy savings attributed to individual actions; c) the implementation of audits to verify that savings claimed by obligated parties have been actually delivered; d) the undertaking of specific activities aiming to preventing fraud and double counting. Concerning the technical monitoring, obligated parties are requested to monitor 5% of measures installed per each quarter, per action type (e.g. 5% of cavity wall insulation actions implemented at households) and per installer. The main aim of the technical monitoring is to assess that the installation fulfils standard requirements. This activity consists of inspections by independent monitoring agents and is based on standard questions prepared by Ofgem[94]. Technical monitoring results have to be reported to Ofgem and are made public every quarter. Any failure identified in an implemented individual action must be remediated within 6 months, otherwise this action is not considered as eligible.

The monitoring sample is selected by independent agents and these agents have to be in their turn selected by obligated parties according to selection criteria that can ensure their qualification[95]. Interestingly, failures detected during the monitoring may also concern end-users behaviours (e.g. they may relate to end-users not using properly boilers or heating controls). Energy savings claimed for 5% of total individual actions

[92]As also mentioned in [5], information reported in Member States Article 7 notifications allow establishing the credibility of monitoring, verification, control and compliance regimes implemented by Member States only in case of Belgium and Sweden. Belgium and Sweden, however, are not considering implementing an energy efficiency obligation to comply with Article 7 requirements. Therefore they do not have to comply with EED Annex V part k(4) requirement concerning the obligation to provide details about audit protocols implemented. In addition, it is not easy to get a comprehensive picture of the situation in Belgium, because this country has adopted diversified regimes depending on the different characteristics of the several measures implemented in each of its three regions. Moreover, its Article 7 notification states that Belgium has no obligation to describe sanctions regimes because an approach that is alternative to energy efficiency obligations has been adopted to comply with Article 7. Sweden, on the other hand, intends to comply with Article 7 requirements by implementing *only* energy and CO2 taxes and information provided in Article 7 on monitoring, verification , sanctions and compliance regimes are not very detailed and representative of the regimes that are supposed to be implemented in other Member States. For these reasons, the case of Belgium and Sweden is not analysed in this section.

[93] Information reported in the reminder of this section is mostly taken by [18].

[94] Questions answers have to be returned to Ofgem first and are then sent to obligated parties. Inspections are mainly performed ex-post. In case of some individual actions (e.g. external wall insulations) monitoring agents perform their inspections while actions are being implemented.

[95] Audits at obligated parties are periodically organized to ensure this.

implemented per supplier, per action type and per installer are also monitored[96]. It has to be pointed out that energy savings are calculated under the ECO by using standard assessment procedures (SAP) consisting in engineering estimates based on on-field measurements of key parameters performed for each individual action implemented[97]. Energy saving monitoring is performed after actions implementation and consists in the verification of the accuracy of the values used as input to the SAP[98]. Energy saving monitoring agents must be qualified and whenever an action fails the monitoring, savings for the individual action have to be recalculated. Energy savings are also verified by Ofgem based on desktop activities. Dedicated Ofgem experts perform verifications and in case values that are higher or lower than expected are identified, further information is requested from the obligated parties. Following this request, the energy savings may have to be recalculated or the action that has generated these savings may have to be rejected.

Audits are instead performed by Ofgem as a prevention strategy in the areas with risks associated. They can be either site-based or desk-based and are carried out by independent auditors focusing on particular action types or eligibility criteria. Concerning frauds, a dedicated counter fraud team is in force in Ofgem in order to investigate cases of suspected fraud including accuracy of savings and reporting. In addition, obligated parties are requested to implement fraud prevention strategies. Notifications for actions implemented are received by Ofgem on a monthly basis and installers are not paid until these actions are approved. In case irregularities are detected, obligated parties are requested to provide further information and in case a breach of legislative requirements is identified sanctions are applied up to 10% of their annual turnover. Sanctions and the regular publication of performances by obligated parties are supposed to be effective deterrent against fraud and non-compliance with the obligations.

Concerning double counting (aka duplication of savings), actions counted twice can be identified by relying on Ofgem IT systems where all information concerning actions implemented under the ECO and other energy efficiency schemes (e.g. the Green Deal Home Improvement Fund) are registered. Thanks to these systems, it is possible to verify whether a same action has been claimed twice under a scheme or under different schemes. In case duplications are identified, one of the duplicates is rejected[99]. Duplication is assumed to be mitigated under the ECO also thanks to the employment of auditors making on site visits and recommending specific energy efficiency improvement actions (it is indeed assumed that auditors will not recommend an action that has already implemented in the past at a site).

The experience matured under the UK ECO and the brief information provided above show that the definition and implementation of monitoring, verification, sanctions and compliance regimes can be highly data-intensive, entail the involvement of several different actors (scheme administrator, obligated parties, actions installers, etc.) and a relevant amount of administration costs. The administrative burden associated with the implementation of these regimes is probably higher under the UK ECO than in other Member States where an energy efficiency obligation scheme is in place, due to the fact that the UK scheme has recently moved from deemed savings to scaled savings requiring on-filed estimates of the values of the parameters considered to calculate

[96] The order of magnitude of the number of savings assessments typically monitored can be estimated by considering e.g. that 1.3 million actions were notified to Ofgem by obligated parties during the 26 months preceding June 2015 and that 5%*1.3 million = 0.065 million assessments.

[97] Individual actions eligible under the ECO are actions that can be implemented in the residential sector only. Reduced SAP where default values are considered for some parameters are however also employed for some individual action.

[98] Typically input values verified in case of actions related to heating may concern e.g. insulation levels existing before and after action implementation, floors areas of dwellings, heating systems and fuel types used.

[99] This means that in case Ofgem verifies that e.g. a same solid wall insulation action has been claimed both under the ECO and the Green Deal Improvement Fund, Ofgem has to decide whether this action has to be counted under the ECO (and rejected under the Green Deal Improvement Fund) or vice-versa.

energy savings associated with each individual action implemented. Moreover, energy efficiency obligation schemes typically entail a plenty of different energy savings delivery methods and involve several different actors that can be quite difficult to monitor[100]. Data sharing with external bodies directly involved in the monitoring and verification activities can also be an issue. On the other hand, the UK experience also shows that after an initial learning phase, the administrative burden associated with these activities can be sensibly reduced e.g. thanks to the introduction of standardized procedures[101]. It has also to be considered that these activities allow a progressive improvement in the quality of the solutions installed and in the accuracy of the estimates of the energy savings generated by them[102]. They can indeed mobilize a variety of market actors (e.g. external bodies responsible for the accreditation of installers and assessors) that can contribute to improve energy efficiency market delivery quality standards.

5.2 Main issues identified and recommendations

Issues concerning information to be included in Article 7 notifications in relation to the aspects previously described have been already analysed in [5] and will not be discussed here. This section will rather focuses on typical problems arising when monitoring, verification, sanctions and compliance regimes have to be implemented.

The main problem arising when these regimes have to be enforced derives from an existing trade-off between associated costs and benefits. Monitoring activities for energy efficiency obligation schemes and alternative measures that can be implemented under Article 7 can indeed represent a complex and costly[103] task. In this respect, it has to be mentioned that the highest cost-effectiveness of existing energy efficiency obligation schemes (compared to alternative measures) has been proved in countries where schemes address very simple and standardised actions that are easy and cheap to be implemented and assessed (e.g. installation of faucet aerators, energy efficient lamps or boilers, insulation measures like cavity and solid wall insulation, etc.)[104]. Deemed savings have been the preferred calculation option under these schemes given, among others, the lower costs associated with monitoring and verification of energy savings. Whether the monitoring and verification (M&V) of the massive installation of more complex actions (e.g. energy efficiency improvement actions that can be implemented in industry) can be as cost-effective is still an open question. Also in these cases, however, it has to be recommended that, if not the energy savings M&V methods, at least the associated procedures (e.g. for data reporting, quality evaluations and assessment, etc.) are as standardized as possible, the physical installation of energy saving monitoring systems and on field verifications of actions remaining however the most important cost component.

Another very common issue concerns sanctions definition and enforcement. It is indeed highly necessary that applied penalties are very clearly defined and known ex-ante to

[100] Hundreds of different individual actions may in principle be included in the catalogues and hundreds or thousands of involved actors (including obligated parties, actions installers, ESCOs, etc.) may typically have to be monitored.
[101] The procedures relate e.g. to the definition of a standard formats for the data to be provided. Once these formats have been introduced and obligated parties have been trained in the use of these format, the administrative burden represented by these procedures has been markedly reduced (information provided by Ms. Cassie Sutherland during the "Workshop on Common Methods and Principles for Calculating the Impact of Energy Efficiency Obligation Schemes or Other Policy Measures under Article 7 of the Energy Efficiency Directive" organized by the JRC on behalf of DG ENER in Brussels on June 10th, 2015).
[102] For example, monitoring and verification activities allowed detecting a 20% failure rate in loft and wall insulation actions under the ECO and that this rate was probably most due to problems with loft hatches and patterns of drilled holes (information provided by Ms. Sutherland, see the previous note).
[103] The text makes here reference both to costs borne by implementing public authorities and by agents charged of monitoring and verification activities (e.g. independent agents, obligated parties under energy efficiency obligation schemes, etc.).
[104] Information source: [19].

involved actors. Whenever this is not the case the efficacy of measures implemented can in principle be compromised or sensibly reduced. In case of energy efficiency obligations, transparency about existing cost-recovery mechanisms applied by obligated parties (e.g. which amount of the obligation costs is recovered by energy suppliers by energy tariffs?) and regular publication of obligated parties' data concerning their performances against their obligation are other important leverage factors.

When it comes to audits and checks performed on field, it is then necessary that the criteria used to define and select a representative sample are clarified. It is indeed very rare that Member States can explain how and why they have defined the sampling criteria they have adopted.

Double counting is finally a very important aspect to be taken into account in countries where more than a single measure as be considered to comply with EED Article 7 requirements. Double counting can relate to actions that are counted twice under a same measure or to actions receiving incentives from two different measures. Data concerning actions implemented must achieve a sufficient level of detail in order to avoid double counting (e.g. it is quite difficult to detect double counting if only data concerning the geographical area where actions have been implemented are included in the national registers that Member States and involved parties are supposed to keep updated in order to perform monitoring and verification activities associated with measures). Double counting can be particularly relevant when measures that are intrinsically cross-sectoral (e.g. energy taxes) are implemented in conjunction with measures which are more sector or technology specific.

The box below provides a summary of the main issues and recommendations described in this section.

- Achieving a higher **standardization** in the implemented actions may effectively serve to reduce the high costs typically associated with monitoring and verification activities. There is however a trade-off between the level of standardization achieved and the accuracy in the outcomes of the calculations of the energy savings generated by actions. Member States and parties involved in the evaluation of actions should therefore pay attention to this trade off in order to ensure sufficient accuracy in energy savings evaluation while reducing costs associated with monitoring and verification.

- **Penalties** have to be very clearly defined and known ex-ante to involved actors in order to avoid reducing the effectiveness of measures.

- In case of energy efficiency obligation schemes, the **regular publication** of obligated parties' data concerning their performances against their obligation are other important leverage factors. Member states should therefore ensure that these data are published in accordance to EED Article 7.8.

- Criteria applied to define and select a **representative sample** where to perform monitoring and verification activities have to be clarified by Member States and parties involved in these activities.

- Data to be provided by involved actors concerning actions implemented (as a result of the EEOS and alternative measures) must achieve a sufficient level of detail in order to **avoid double counting** (e.g. it is quite difficult to detect double counting if only data concerning the geographical area where actions have been implemented are requested and made available in the national registers that Member States and other involved parties are supposed to keep updated in order to perform monitoring and verification activities associated with measures).

Discussion and conclusion

The main points addressed in the sections above will be briefly re-addressed and some general conclusions on calculation methods that can be adopted and notified by Member States under EED Article 7 will be drawn here.

One general and very relevant aspect concerns the concepts of additionality and materiality as introduced in the EED and defined (in case of materiality) in the Article 7 Guidance Note. The main question arising in this case is whether and to what extent the concept of materiality can be distinguished from that of additionality. Answering this question is not an easy task, as a definition of additionality is not provided in the EED and in the Guidance Note to Article 7. Based on how the concept of additionality has been traditionally defined and on information included in the Guidance Note concerning how materiality has to be intended[105], the only general conclusion that can be drawn is that materiality should probably serve to characterize actions (mainly economic) undertaken by involved actors to contribute to energy efficiency improvement actions implementation, whereas additionality should serve to assess the amount of energy savings caused by a measure (i.e. the amount of savings that would not have been generated anyhow in the absence of the measure) . If this is the case, the general question arising here relates to the reasons that may have led to introduce the concept of materiality for measures implemented under EED Article 7. The material contribution of involved actors to the implementation of measures does not indeed guarantee energy savings additionality (i.e. materiality does not necessarily imply additionality). On the contrary, whenever some part of the energy savings generated by measures is additional, it can be always assumed that actors involved in measure implementation have materially contributed to the generation of these savings [106] . Additionality requirements alone should therefore be sufficient to prove the material contribution of involved actors.

Concerning additionality of energy savings, it should be then considered that a proper definition of this concept can only be given once the concepts of gross energy savings generated by measures, net energy savings generated by measures and the main correction factors allowing estimating net energy savings from gross energy savings are defined. As the nature of these correction factors varies depending on whether the calculation methods used to evaluate savings are top-down or bottom-up, these factors should then be defined separately for bottom-up and top-down methods. It has to be pointed out that the estimate of correction factors linked to free-riders, direct rebound effects, double counting of actions typically serves to assess additional savings under bottom-up methodologies, whereas corrections factors allowing calculating autonomous energy efficiency improvement trends, energy consumption changes due to other policies and structural changes in the economies serve typically to estimate additional savings under top-down methodologies.

The general conclusion that can be drawn from these observations is therefore that a definition of additionality and more guidance on how additional energy savings can be estimated could be provided to Member States and that this cannot probably be done without entering the details of the calculation methods that can be adopted to calculate the energy savings generated by measures and of the correction factors to be used to pass from gross to net energy savings[107].

A final remark related to additionality (and probably to materiality) concerns measures that can be eligible for Article 7 target achievement. Considering that the EED does not pose any explicit limitation on the types of measures that can be considered by Member

[105] See paragraph 34 of the Guidance Note.
[106] In other words, the additionality of energy savings implies the materiality of involved actors' contribution but not vice versa.
[107] It is indeed probably not possible to produce an operative definition of (or to prove the) additionality of measures without referring to the main correction factors needed to pass from gross to net energy savings. As mentioned in the previous paragraph, the correction factors to be considered depend however on whether the calculation methods adopted are top-down or bottom-up.

States to comply with Article 7 requirements, the question is whether measures not expressly designed to achieve energy efficiency improvements can be counted for Article 7 target achievement[108]. The common sense[109] would suggest that these measures should not be counted for additionality and materiality reasons. The common sense suggests indeed that a) these measures would probably have been implemented also in the absence of the EED and that b) eligible measures should only be those implemented by Member States because of EED enforcement. In any case, it would probably have been better if eligibility criteria for measures would have been defined in the EED or in the Guidance Note on Article 7.

When it comes to the different methods that Member States may use for calculating energy savings, it may be the case to reassert here that energy savings calculated and claimed by Member States for the implementation of individual actions cannot be assumed to correspond to energy savings generated by energy end-users implementing these actions. Whenever Member States make this assumption in their calculations it is highly probable that at least a part of the energy savings they are claiming is not additional. Concerning the specific methods that can be adopted, deemed savings and scaled savings estimates require typically detailed preliminary studies to assess existing savings potentials in a country. Data gathering is probably the main issue for implementing authorities having to perform these studies. In this respect, it may be worth mentioning that the provision of EU default values for deemed savings associated with the installation of technologies which are very standardized across the EU countries (e.g. domestic appliances) could perhaps contribute to alleviate this problem. EU default values might indeed be defined and regularly updated by adopting a conservative approach and Member States might be allowed choosing between these default values and own values provided they could document how they have estimated that latter values. This approach would, among others, contribute to increase harmonisation among Member States concerning the way in which deemed savings are calculated and the amount of savings that can be claimed for same individual actions. It has also to be mentioned that the creation of EU databases including energy consumption data of products sold on the EU market can contribute to ameliorate the just mentioned data scarcity situation while facilitating the introduction of EU default values for deemed savings estimates associated with specific actions[110]. Deemed savings and scaled savings estimates require regular data-intensive revisions due to the evolution of technologies addressed and the need to periodically revise energy consumption baselines.

Most of the problematic affecting methods based on metered savings can instead be ultimately related to the specific character of the individual actions and projects these methods are applied to. Statistics cannot help a lot to evaluate the amounts of savings actually generated in this case. Moreover, the scarce replicability of these actions makes the estimation of their additionality quite problematic. Additional savings have indeed to be typically estimated by methods and assumptions that are action specific. In addition, individual actions evaluated by these methods are usually much larger (both in terms of involved investments and energy savings generated) compared to actions evaluated by

[108] Examples of this type of measures are given by policies generally aiming at increasing taxation. It can indeed been argued that, although not explicitly designed to reduce energy consumption, these policies generate energy savings. Other examples might be represented by measures aiming at improving transportation systems and infrastructures in countries.

[109] By common sense it is meant a sound and prudent judgment based on a simple perception of the situation or facts related to EED Article 7 implementation.

[110] It is worth mentioning that the Article 8 of the Commission Proposal COM(2015) 341 (adopted on 15 July 2015 and setting a framework for energy efficiency labelling and repealing Directive 2010/30/EU) states that the Commission shall establish a publicly available product database including, among others, information on the energy consumption of products subject to energy labelling requirements. This database will be available after 2018 and might certainly contribute to achieve the objectives described in the paragraph above.

deemed of scaled savings estimates. This implies that the contribution provided by the measure under question to the implementation of the former actions must generally be very substantial in order to make generated energy savings additional[111]. Monitoring and verification of metered savings by independent actors can be difficult for the same reasons mentioned above. Competencies required for these activities are indeed often highly project specific. This situation implies that a lot of documentation has to be typically provided by actions implementers to prove their savings and that monitoring and verification activities have to be performed by highly specialised personnel. As the amount of information needed to notify calculation methodologies is also usually very burdensome in this case, it may be perhaps more useful to consider the possibility that, rather than on explanations on the calculation methodology, notifications were more focused on the description of the instruments put in place by Member States in order to ensure a) that calculations are performed according to EED requirements and b) that energy savings are duly monitored and verified by independent and qualified actors.

The main remark that can instead be made on the last calculation method proposed by EED Annex V part 1 (surveyed savings) relates probably to the fact that information on this method is practically null in the notifications of Member States intending to use it to comply with Article 7 requirements. Highly sophisticated statistical calculations and very wide samples are generally required to use it, given the fact that energy savings generated by individual actions that can be evaluated are considerably small and uncertain. The lack of information included in Member States notifications generates therefore some concern in relation to the possibility that energy savings claimed by this method have been or will be accurately estimated.

A series of general considerations can then be done for energy savings to be calculated for taxation, transport and information measures. As mentioned in the previous sections of this report, the calculation methods that can be used for taxation measures (like energy or CO2 taxes) are usually top down and require the accurate evaluation of several correction factors in order to be sufficiently reliable. It would hence be probably necessary that Member States would provide more information on how they have estimated and taken into account these factors.

In case of transport measures, the calculation of generated gross savings is generally not very troublesome. The problems arise when gross savings have to be corrected in order to estimate net savings. Savings claimed by Member States under transport measures need indeed typically to be corrected because not totally additional, because of double counting, because of rebound effects and so called substitution effects (taking place when people consume additional energy of different type by reducing transportation e.g. by teleworking). Direct rebound effects can be particularly relevant in the transport sector. Moreover, transport measures included in Member States notifications seem sometimes to not have been expressly designed and implemented to improve energy efficiency, this making the additionality of total savings claimed questionable. Information measures are then probably the most troublesome measures when associated energy savings have to be calculated. The problems associated with these calculations become particularly relevant when it is considered that these types of measures are widely used by Member States and play in generally a very relevant role to foster energy efficiency improvement actions implementation. Additionality, double

[111] What is meant here is that additional energy savings generated by a measure (e.g. an energy efficiency obligation scheme or an energy taxation scheme) in case of large projects (e.g. a project implemented in the industrial sector and involving investments of millions euros) have generally to be assumed to be very low (compared to total energy savings generated by the project) unless the measure under question provides a substantial contribution to project implementation (e.g. in terms of economic incentives or in terms of avoided additional energy costs).

counting and persistence of savings after measures implementation are probably the most difficult aspects to be treated by related calculation methods. Nevertheless, spill-over effects may also be very relevant and difficult to assess. Given the difficulties in estimating associated savings, indications concerning whether and how control groups have been considered for the estimates should always be produced. Energy savings generated by information measures accompanying the measures fostering the installation of technologies should be in principle less difficult to be evaluated, although evaluation uncertainties remain generally high.

Based on the considerations so far reported, it can be concluded that more guidance to Member States is needed in order to allow establishing a same level playing field in relation to how energy savings generated by measures have to be calculated. It will never be sufficiently stressed that a) a definition of the concept of additionality is key in this respect and that b) a definition of the main correction factors to be considered to pass from gross to net energy savings under top-down and bottom-up methodologies possibly used by Member States have to be provided in order to ensure that Member States can estimate additional energy savings with sufficient accuracy and according to same calculation principles.

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LD-NA-27663-EN-N

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doi: 10.2790/855880

ISBN 978-92-79-54216-9