Five actions fit for 55: streamlining energy savings calculations

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Abstract

The "energy efficiency first principle" is key when defining energy policies and making relevant investment decisions within Europe to encourage actions in energy efficiency and energy demand management. In a first round, the H2020 project streamSAVE targeted five Priority Actions or measures with high energy savings potential and being considered as priority issues by the Member States. The project streamlines energy savings calculations, in frame of Article 3 and 7 of the Energy Efficiency Directive (EED) covering energy efficiency targets and national energy savings obligations, respectively. Given the importance of deemed savings approaches in Member States' EED reporting, streamSAVE focuses on bottom-up calculation methodologies of standardized technical actions.

Despite their high energy savings potential, policy officers indicated that a lack of experience, practices and reliable data sources is hindering the adoption of the following Priority actions by several Member States: Heat Recovery; Building Automation and Control Systems (BACS); Commercial and Industrial Refrigeration Systems; Electric Vehicles and Road Lighting. The project developed standardized calculation methodologies and provided EU-wide indicative values for each of these Priority Actions. These bottom-up approaches for calculating energy savings consider all essential impacts on the energy consumption of an appliance or system (e.g., equipment efficiency, operating hours) and compare the baseline scenario with the situation after implementation. This paper presents the developed methodologies, considering Article 3 and Article 7 reporting requirements as well. Moreover, lessons learned, collected during the testing and validation of the methodologies when translating the streamSAVE methodology guidance into Member States' EED practices, are explained to illustrate the role of standardized calculations in supporting energy efficiency policy.

Introduction

In July 2021, as part of the 'fit for 55'-package "Delivering on the European Green Deal", the European Commission proposed a recast of the Energy Efficiency Directive (EED). Not only does it underline the importance of the "energy efficiency first" principle by providing a legal basis for it, but the proposal also introduces higher targets for reducing primary and final energy consumption by 2030. Whereas the previous target was set at a reduction of at least 32.5 % in both primary and final energy consumption, the proposal is made to increase the reductions to 39 % and 36 % for primary and final energy consumption, respectively. However, according to the European Commission's 2020 report, the national contributions to the 2030 EU target, as reported in the final National Energy and Climate Plans (NECPs), fall short of the ambition currently set at 32.5 %. To further increase the level of ambition, therefore, requires that most Member States (MS) will tap under-used energy savings opportunities.

The aim of the H2020 streamSAVE project is to provide support to Member States to increase their chances of successfully and consistently meeting those energy efficiency targets, by streamlining energy savings calculations. The project specifically focuses on Article 3 and Article 7 of the EED, which are dedicated to energy efficiency targets and national energy savings obligations, respectively. Annex V of the EED allows various approaches to calculate energy efficiency savings, namely deemed savings, metered savings, scaled savings, or surveyed savings. Nevertheless, in the context of calculating Article 7 savings, the deemed savings approach is the one most commonly used, in addition to energy savings calculated using standardized methodologies. Therefore, streamSAVE focuses on bottom-up calculation methodologies of standardized technical actions. During October–November 2020, a stakeholder consultation was held by the consortium to identify available methodologies for calculating energy savings and hurdles or needs Member States are facing. This survey indicated two issues, namely that savings potentials exist that might not have been covered extensively by existing bottom-up methodologies due to a lack of experience, practices and reliable data sources, and that where methodologies are available, Member States are not always certain about compliance with the EED framework.

The streamSAVE project aims to take away these hurdles by streamlining calculation methodologies for actions that have a high potential for energy savings, and that were indicated as priority issues by the Member States, the so-called Priority Actions (PA). Over the course of the project, streamSAVE will target ten Priority Actions in two cycles. The first round comprised the following five PAs:

- Heat Recovery: heat recovery from industrial processes for on-site use in industry, either fed back into a process or used for on-site applications, and heat recovery for feed-in to a district heating grid;
- Building Automation and Control Systems or BACS: all products, software and engineering services for automatic controls, including interlocks, monitoring, optimization for operation, human intervention and management to achieve energy-efficient, economical and safe operation of building services;
- Commercial and Industrial Refrigeration Systems: new installations of air- or water chilled compression refrigeration units with compressors powered by electrical energy;
- Electric Vehicles: fuel switching between conventional and electrical vehicles in private or public transportation;
- Road Lighting Systems: replacement of existing road lighting systems for more energy efficient technologies, such as more efficient LED light sources and lighting control technologies.

These Priority Actions form the red thread throughout the project's set-up. In the Knowledge Facility, the existing practices in the Member States were explored and standardized calculation methodologies were developed for the first five PAs. The methodologies are developed in a bottom-up way, taking into account all essential influences on the energy consumption of an appliance or system. The baseline situation is then compared to the situation after the PA's implementation. This information is bundled in a Guidance document[1] (streamSAVE, 2021), which additionally comprises other aspects such as indicative calculation values per parameter based on EU-wide data, reference consumption or baseline, correction factors for behavioural or regional effects, costs and benefits, next to calculation formulas and related indicative values for estimating CO2 savings. This document also aims to remedy the observed lack of reliable data on a national scale, by detailing which type of data is needed, which method can be used to gather the needed data and in case no data is available, which indicative values on an EU-level could be used instead. The Guidance is available via the project's collaborative platform, which also includes a Training Module, where members can use these methodologies as an online tool or download an excel file to make first estimates of energy savings delivered by one of these PAs.

Another pillar of the streamSAVE project consists of the peer-to-peer dialogue groups, which aim at fostering transnational dialogue and knowledge exchange by bringing together key stakeholders, such as public authorities, technology experts and market actors. After a more general dialogue group to introduce the project and the five PAs, two content-specific dialogue meetings have been organised per PA. During these meetings, the draft methodologies developed in the Knowledge Facility have been discussed, as well as existing practices in Member States. In the third pillar of the project, the Capacity Support Facility, one-to-one technical support is provided by consortium experts to address needs from individual, partner Member States on energy savings calculations regarding one of the five PAs. In this way, 10 cases have been developed where support has been offered on concrete issues the Member States are facing regarding on of the five PAs. In addition to making calculation methodologies transparent and streamlined across EED articles, this approach aims at streamlining methodologies between Member States. The more the energy savings calculations become transparent, and the more the energy savings calculation skills of key stakeholders improve, the higher the probability that streamSAVE will contribute to enhanced implementation of and reporting on energy savings actions and that these results will be replicated across European Member States.

Standardised savings methodologies for Priority Actions

In the following section, the different aspects of the standardized savings methodologies that have been developed in the guidance documents, will be treated. Before diving into the components, the difference between savings in the frame of Article 3 and Article 7 of the EED will be described, considering the cumulative aspect of savings as well under Article 7 of the EED. Then, the formula for estimating energy savings will be treated, the indicative calculation values, the indicative values for the baseline situation and behavioural effects. As a last aspect, the estimation of greenhouse gas savings will be covered shortly. The last section aims to make this technical part more

1. https://streamsave.eu/wp-content/uploads/2020/09/D2-2_PracticalGuidance_IntermediateVersion-5.pdf

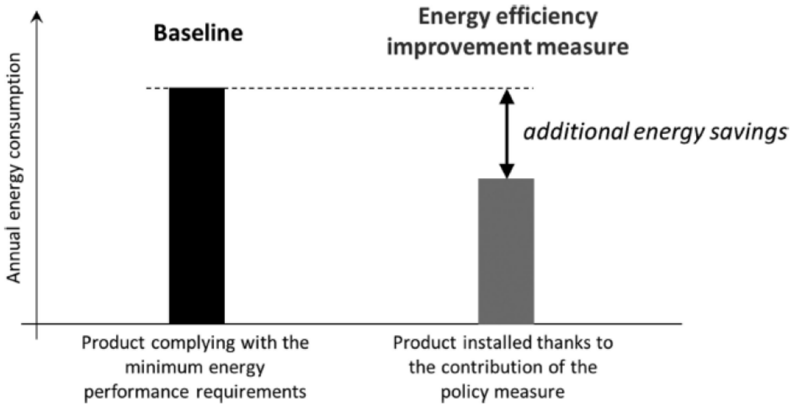

Figure 1. Baseline defined on the basis of the Ecodesign Directive (European Commission, 2019).

concrete, by providing two cases that were addressed in the Capacity Support Facility of the project. It will put forward lessons learned from Member States' EED practices.

DIFFERENCE BETWEEN ARTICLE 3 AND ARTICLE 7 SAVINGS

The amended EED 2018/2002 stipulates in Article 3(5) that by 2030, the Union's energy consumption shall be no higher than 1,128 Mtoe of primary energy consumption or 846 Mtoe of final energy consumption. Furthermore, Member States shall set indicative targets to reduce their energy consumption, based on either primary or final energy consumption, primary or final energy savings, or energy intensity (European Commission, 2018). The energy consumption of Member States is reported yearly via energy balances, according to the Regulation (EC) 1099/2008 on energy statistics. In addition to the definition of energy products, it contains details on the balance aggregates (including final energy consumption) to be reported. For each balance aggregate, the main consumption sectors and energy conversion activities are listed. As Article 3 focuses on reducing the total energy consumption according to the energy balances, also primary energy savings are considered in streamSAVE. Therefore, every effect on energy consumption can be considered saving for Article 3, regardless of what caused this reduction.

In contrast, Article 7 is about considering additional final energy savings at the level of policy action. The energy savings obligation in Article 7 of the amended EED 2018/2002 states that Member States shall achieve cumulative end-use energy savings of 0.8 % of the annual final energy consumption, for each year of the period 2021 to 2030. Further, it is mentioned that Member States shall establish their own calculation baseline. Calculated savings are the result of comparing the energy consumption of a more efficient product or service to the energy consumption of the normal situation, i.e., the baseline, as presented in Figure 1. Moreover, when calculating savings in the frame of Article 7 EED, Member States should demonstrate that energy savings are not double counted (Article 7(12)), as well as additional to what would have occurred anyway (e.g. existing EU legislation) (Annex V of EED). It is namely important that these savings are additional to the savings generated from actions that would have occurred under normal circumstances. Annex V(2) points (a) and (b) explain that savings emanating from actions that have been implemented due to mandatory Union law cannot be considered additional. Therefore, when defining the baseline for savings actions that are reported in the frame of Article 7, the effects of actions required by EU law are taken into account. In this way, only the savings beyond what is demanded by EU legislation are eligible.

Almost all countries set their 2030 Article 3 contributions to match their "With Additional Measures' (WAM) projections (Economidou et al., 2020). The savings of these additional measures or actions to reach the target can be counted on top of the baseline or a "with existing measures" (WEM) scenario. The WEM scenario already takes into account existing measures, such as minimum standards for new appliances, as well as autonomous evolutions, such as the necessary replacement of outdated appliances, population growth and economic growth. Therefore, only savings from energy efficiency actions exceeding the WEM scenario are additional and can, therefore – at the action or technology level – be considered as savings relevant to estimate the Article 3 target setting. In the context of Article 7, Member States should demonstrate that energy savings are not double counted when the impact of policy measures overlaps (Article 7(12)), as well as additional to what would have occurred anyway (e.g. existing EU legislation) (Annex V of EED). As the concept of the WEM-scenario is generally in line with the baseline definition for Article 7 saving calculations, the annual energy saving calculations for Article 3 and Article 7, as suggested in the guidance by streamSAVE, are similar for most of the energy saving actions. In the streamSAVE project, it is therefore assumed that savings exceeding the assumptions of the WEM scenario are in line with the Article 7 target achievement, i.e. being additional and without double counting. However, when implementing the streamSAVE methodologies and related baselines within a MS, it is recommended to take country specificities into account, such as policy developments and the current performance of the market or stock. Moreover, it should be noted that while Article 7 only focuses on final energy, for Article 3, both final and primary energy consumptions are relevant.

CUMULATIVE ASPECT

In EED Annex V(2), which stipulates the principles that apply when determining energy savings for an energy efficiency measure for the purpose of Article 7, point (i) indicates that the calculation of energy savings shall take into account the lifetime of the actions and the rate at which the savings decline over time. When actions are implemented, they will not only generate savings at the time of implementation, but instead, they are likely to continue to deliver savings in the following years. Hence, it is important to determine the lifetime of a savings action. Possible sources comprise the Commission Recommendation (EU) 2019/1658, which lists indicative average lifetimes of energy efficiency improvement measures (European Commission, 2019), the EU standard EN15459-1:2017 (European Standards, 2017), legal depreciation periods or empirical studies; the latter being interesting especially in case of actions generating behavioural changes. When the lifetime of the savings action is determined, the yearly savings of that action from the date of implementation until the end of its lifetime can be calculated. One remark in this regard is that during the current Article 7 period (from 2021–2030), savings are only accountable until 31 December 2030.

As EED Annex V(2)(i) leaves room for Member States to decide the method they use to calculate cumulative savings, the methodologies that were prepared for the first round of PAs only calculate first-year savings. However, in the Capacity Support Facility, where streamSAVE reached out to public authority officials in partner countries and supported them with the questions and hurdles they face in implementing measures of one of these five PAs, exemplary calculations have been made on how to cumulate yearly savings.

FORMULA TO ESTIMATE ENERGY SAVINGS

For every PA, a bottom-up formula was developed, covering all essential impacts on the energy consumption of an appliance or system (e.g., equipment efficiency, operating hours) and comparing the baseline scenario with the situation after implementation. Hence, although the formula's parameters differ from PA to PA, the basic principle remains the same.

For commercial refrigeration, for example, the formula is shown in **Equation 1**:

$$TFES = n \cdot Pc \cdot h_{FL} \cdot \left(\frac{1}{\mathrm{SEPR}_{Ref}} - \frac{1}{\mathrm{SEPR}_{Eff}}\right) \cdot f_{BEH}$$

Where Total Final Energy Savings (TFES) equal the product of the number of cooling systems installed at a specific cooling power (n), the installed cooling power of the cooling system (P_c), the full-load hours related to the maximum installed cooling power (h_{FL}) and the difference between the seasonal energy performance ratio of the reference compression refrigeration system ($SEPR_{ref}$) and the SEPR of the more efficient compression refrigeration system ($SEPR_{eff}$). A factor f_{BEH} is foreseen to take into account behavioural effects.

INDICATIVE CALCULATION VALUES

For some of the formula parameters, indicative calculation values have been provided. These values are based on EU-wide data and should preferably be adjusted to national circumstances.

Looking at the example of heat recovery for feed-in to a district heating grid, the formula is shown in Equation 2 and explained in Table 1.

For most parameters, even for the reference heating system and new heating system (i.e., the baseline comparison), calculation values have been provided, as presented in Table 2.

As a first example, the estimation of the indicative value for heat losses in the district heating grid (HL_{DHG}) is explained in more detail. The heat losses for the EU27 were derived from the complete energy balances (Eurostat, 2021a). In the energy balances, district heating corresponds to the standard international energy product classification "heat". Therefore, to obtain the heat losses, the distribution losses must be divided by the sum of the final energy consumption and the distribution losses. Since the recovered heat quantities can be collected precisely for a specific project, it is advised to collect data on heat losses by the action implementer for the specific heat distribution network.

A second example constitutes the value for the conversion efficiencies of the reference heating system ($eff_{baseline}$). The preferably seasonal efficiencies are to be weighted over the energy consumption of the technologies used, before the implementa-

Equation 2. The formula of the example of heat recovery for feed-in to a district heating grid.

$$TFES = Q_{EH} \cdot (1 - HL_{DHG}) \cdot \left(\frac{1}{eff_{Baseline}} - \frac{1}{eff_{Action}}\right) \cdot (1 - f_{ei}) \cdot (1 - f_{BEH})$$

Table 1. The parameters in Equation 2 are explained as:

TFES	Total final energy savings [kWh/a]
Q_{EH}	Excess heat fed into the district heating grid [kWh/a]
HL_{DHG}	Heat losses in the district heating grid [dimensionless]
$eff_{Baseline}$	Conversion efficiency of the reference heating systems [dimensionless]
eff_{Action}	Conversion efficiency of the district heat consuming heating systems [dimensionless]
f_{ei}	Factor to calculate extrinsic incentives[2] [dimensionless]
f_{BEH}	Factor to calculate rebound effects [dimensionless]

2. The factor of extrinsic incentives is used to subtract those installations that were implemented through other incentives (e.g. district heat pipeline expansion, subsidy programs on district heat connections) or would have been installed in any event.

Table 2. Indicative values for the reference and new heating system.

Heat losses in the district heating grid (HL_{DHG})	0.106
Efficiency of the reference heating system ($eff_{Baseline}$)	0.734
Efficiency of district heating (eff_{Action})	0.827
No other incentive in force ()	0
Heat recovery in the industry : Lifetime of savings	10 years
Rebound effects (f_{BEH})	0.20

tion of the action, in the district heating supply area. For the indicative calculation values on an EU-level, this implies that, first, the conversion efficiencies of space heating are taken from the latest year of the tables of the Integrated Database of the European Energy System of the Joint Research Center (Mantzos, 2018). Then the conversion efficiencies per energy carrier are weighted by the final consumption of both sectors which were extracted from the same source. This data is based on EU averages of heating systems installed, which is why Member States are highly recommended to adapt these values to national shares of reference heating systems in the respective district heating supply area.

In conclusion, the values provided by streamSAVE are mostly based on EU-wide data, which is recommended to be further adapted to national circumstances.

INDICATIVE VALUES FOR THE BASELINE SITUATION

Throughout the previous sections, it has already been indicated that the calculated savings are the result of comparing the energy consumption of a more efficient product or service to the energy consumption of the normal situation, i.e. the baseline. Several approaches are possible for defining the baseline for newly installed appliances (European Commission, 2019). Starting with the strictest approach[3], the market average could be used, taking into account the normalized energy consumption of all appliances available at the market. In terms of additionality, only those appliances that are more efficient than the market average can be considered. Second, and indicated above, the baseline could be composed on the basis of legal requirements. This refers to Annex V to the EED only allowing savings going beyond standards defined in the EU law. Examples of those standards are set by, for example, the Energy Performance of Buildings Directive (EPBD) (Directive 2018/844), the Ecodesign Directive (Directive 2009/125/EC) and the Union emission performance standards for new passenger cars & new light commercial vehicles following the implementation of Regulations (EC) No 443/2009 and (EU) No 510/2011. A third approach is called 'going beyond most economical decision' and can be used when there are no homogenous solutions suitable, and comparison to similar actions is hard to achieve. It has to be shown then that although not the most cost-efficient option is chosen, energy efficiency was considered in the decision.

3. The market average is considered the strictest approach in terms of attributable savings.

When making use of the market average approach or the legal requirements approach, the baseline must be updated regularly. Regarding the latter, it is logical to adapt the baseline to take into account changes in EU and/or national legislation (for example, emission performance standards for passenger cars that become stricter over time). In case these future changes are already made official, this can be done by proposing different baselines depending on the year of implementation of an action. Additionally, if the market average approach is used, it is useful to update the data used for the definition of the baseline. For example, the baseline could be affected by new appliances entering the market, or maybe the formerly considered efficient option has now become the most commonly used technology, in which case the additionality criterion is no longer valid.

As the correct definition of the baseline has been indicated as a concern by the Member States in the survey carried out in October–November 2020, streamSAVE has prepared baselines and provided indicative values where available. In defining the baselines for the different PAs, the future changes in the regulatory framework published by August 2021 have been taken into account. Therefore, most baselines are defined using the legal requirements approach, where either Ecodesign or broader EU legislation have been the guiding principles.

Illustration Ecodesign: road lighting

The 'simplified' methodology for Road Lighting uses indicative calculation values for Energy Savings (ES_j) per light point according to the old/inefficient technology type and lamp power, and an equivalent LED lamp power (Table 3). The power conversion factor between technologies was obtained by considering the indicative rated lamp efficacy of the old/inefficient technology, based on the Commission Regulation (EC) No 245/2009 (European Commission, 2009), and the threshold efficacy for LED light sources based on the new requirements of the Commission Regulation (EC) No 2019/2020 (European Commission, 2019a).

Illustration Union emission performance standards: Electric Vehicles

For Electric Vehicles (EVs) streamSAVE developed indicative values for the specific final energy consumption of the reference vehicle, per fuel type. This was calculated based on the CO_2 emission performance standards for cars and vans (EC, 2021). In the 2020–2030 timeframe, the values are updated every 5 years. Alternatively, the values can be updated every year using the average carbon dioxide emissions from new cars (EEA, 2021a) and vans (EEA, 2021b), considering the most re-

Table 3. Indicative calculation values for road lighting.

Old/inefficient light point		New/efficient light point		Energy savings in lighting system 'j' (ESj) [kWh/a]	Value for the ratio Lighting Control in lighting system 'j' (LCj) [1]	
Technology	Lamp power (W)	Technology	Light point power (W)		Dimming to 50% for 7 h/day	Dimming to 50% for 5 h/day
High-Pressure Sodium (HPS)	400	Light Emitting Diode (LED) with at least 120lm/W	250	777.76	1.41	1.29
	250		160	471.12	1.43	1.31
	200		125	388.88	1.41	1.29
	150		95	286.68	1.42	1.30
	100		60	219.76	1.35	1.25
	70		40	169.40	1.3	1.22
	50		30	115.28	1.33	1.24
Metal-Halide (MH)	400	Light Emitting Diode (LED) with at least 120lm/W	300	577.76	1.66	1.47
	250		180	391.12	1.59	1.42
	175		125	277.76	1.57	1.41
	150		110	226.68	1.62	1.44
	70		50	129.40	1.49	1.35

1) The values for the Lighting Control ratio (LCj) are based on calculations using the savings achieved by installing lighting control technologies on the new/efficient lighting systems, matching the referred control strategy (i.e. dimming percentage and hours per day), according to each proposed technology retrofit.

cent data. The EU average values for each year were assessed considering the percentage of vehicles in use per fuel type, presented in (ACEA, 2021), which allows the evaluation of savings without detailed knowledge of the vehicles replaced.

BEHAVIOURAL EFFECTS

Energy efficiency measures can lead to desired or undesired changes in the behaviour of final energy consumers, which can, in turn, lead to increased but also decreased total savings. It is difficult to evaluate the effects of these behavioural changes, which should therefore be based on empirical data, such as surveys and studies that show how behaviour has been affected. Nevertheless, various behavioural effects can be discerned: rebound effects (direct and indirect), sufficiency effects and spillover effects. Although not explicitly mentioned in the EED, rebound effects should be estimated and taken into account by the Member States within their savings methodologies in order to produce more accurate estimates of the generated energy savings (Labanca & Bertoldi, 2016).

Direct rebound effects (or take-back effect) occur where increased efficiency of a product or service lowers the cost of consumption and, as a result, more consumption of this product or service occurs (Maxwell et al., 2011). These consumptions imply that the savings action's actual impact could be smaller than theoretically estimated. In addition to direct rebound effects, indirect rebound effects and macro-economic rebound effects occur. As these types of behavioural effects play at the system or economy level, and as the project focuses on the level of the action, only direct rebound effects have been considered. Still, these can be further differentiated into (Fish & Grießhammer, 2013):

- Income effects: when money is saved through efficiency measures, these savings can lead to increased use of the more efficient goods (direct rebound) or of other goods (indirect rebound);
- Substitution effect: the price of the resource is lower due to the efficiency measure, which leads to the resource being used more intensively and effectively substituting other resources;
- Psychological effects: the efficiency measures produce a "green conscience" and in turn, the same or other goods are used more;
- Technological rebound: the price reduction of a resource allows new technologies that require this resource to emerge which were previously not economically viable;
- Consumer accumulation: new, more efficient technologies are used additionally instead of replacing less efficient technologies.

Rebound effects are not always easy to quantify as they are rather context-dependent, meaning the sector, the instrument type and even national circumstances have an influence. The residential heating and transport sectors are the most common examples. However, studies show, that rebound effects can be quite significant and thereby reduce the total impact of measures set out to generate energy savings. This also means that if such behavioural effects are not considered, the calculated energy savings and related greenhouse gas emissions are overestimated. It is therefore important to take these into account for the relevant PAs.

As mentioned above, there are also other types of behavioural effects, namely sufficiency and spill-over effects. These can be described as the opposite of direct and indirect rebound effects, as they have a positive, strengthened influence on energy savings. Sufficiency effects occur when the purchase of a product leads to increased awareness of the energy-efficient use of that product (so within the same area); spill-over effects occur when the purchase of a product leads to the purchase of other, related products that also save energy (so in other areas). As was the case for the rebound effects, where only direct rebound effects were observed due to the focus on effects directly relatable to the level of the Priority Actions, the project will only regard the sufficiency effect, when available or applicable, following the same reasoning.

Illustration: rebound effects in residential heating (BACS)

BACS or Building Automation and Control Systems comprise all products, software and engineering services for automatic controls (including interlocks), monitoring, optimization for operation, human intervention and management to achieve energy-efficient, economical and safe operation of building services. The use of the word 'control' does not imply that the system/device is restricted to control functions. Processing of data and information is possible (CEN, 2017). BACS covers a wide range of product types, streamSAVE focuses on energy savings in five end-use types, namely heating, cooling, domestic hot water, ventilation and lighting, and this across residential and non-residential sectors. The rebound effects in residential heating have been described in various studies (Sorrell et al., 2009; Maxwell et al., 2011; Buchanan et al., 2014) and could lead to lessened overall savings. The research on rebound effects for heating and cooling in the residential sector has suggested a value between 10 and 30 %. Hence, the indicative value recommended by the streamSAVE project amounts to 80 %, reflecting a rebound effect or decreased impact on energy savings of 20 %.

Illustration: rebound effects in transport: Electric Vehicles

Another example of the rebound effect can be found in the transport sector. When a more fuel-efficient vehicle makes travelling cheaper, consumers may use the vehicle more often and/or drive it further, which will offset part of the energy savings achieved by the increased efficiency of the vehicle (Sorrel, 2007). A rebound effect can also occur when a vehicle becomes more economical, when the engines become more powerful, or when the vehicle is driven at a higher speed (Ricardo Energy & Environment, 2020). For instance, the speed and acceleration in EVs can lead to a change in driver behaviour with a potential speed rebound of 20 % (Galvin, 2016). However, as the precise factors depend on the specific technology, users, prices, etc. the streamSAVE formula foresees the use of a behavioural factor, but did not suggest an indicative calculation value for it given the broad range of values found and the lack of empirical data available.

ESTIMATION OF GREENHOUSE GAS SAVINGS

Although the focus of streamSAVE is on energy savings in the frame of the Energy Efficiency Directive (EED), it is evident that energy savings work hand in hand with emission savings and that the EED is meant to contribute to the achievement of the EU climate targets as put forward by the "Delivering on the EU Green Deal" package. That is why a similar methodology has been developed to assess the greenhouse gas (GHG) emission reduction potential of the energy savings actions implemented under the EED.

The formula is as simple as the difference between the GHG emissions in the baseline situation and the GHG emissions after the action has been implemented. To determine the greenhouse gas emissions before and after implementation of an action, the energy consumption must be multiplied by the emission factor of the respective energy carrier. Usually, one specific energy carrier is replaced in a single energy saving action. However, there are also energy saving actions in which several energy carriers are replaced at the same time. As soon as several energy carriers are involved, a weighted emission factor should be applied. Such a weighted emission factor can also be used when creating standardized values or when evaluating several energy saving actions at the same time. streamSAVE provides a set of emission factors for different energy carriers based on EU data. However, these values should be adapted to national circumstances for more accurate results.

Equation 3:

$$\boldsymbol{GHG_{Baseline/Action} = FEC_{Baseline/Action} \cdot \sum_{ec} (share_{ec} \cdot f_{GHG,ec})}$$

Lessons learned from Member States' EED practices

Next to the Guidance, streamSAVE provides in the Capacity Support Facility (CSF) tailored support to the partner Member States to tackle the challenges they are facing to enable them to use the previously untapped potential of energy savings. In the CSF the above described methodologies and related indicative values are tested and validated by country policy and technology experts, when translating the streamSAVE guidance into Member States' EED practices. For this paper, two cases have been selected to illustrate lessons learned: the implementation of the BACS methodology in Austria and the implementation of the methodology for EVs in Belgium.

BACS IN AUSTRIA

The Building Automation & Control Systems methodology prepared by streamSAVE was adapted in order to be integrated in the Austrian catalogue on standardized bottom-up calculation methodologies.

For residential buildings, the catalogue offers standardized calculation data of reference buildings based on statistical data of the residential building stock in Austria. Therefore, all building related parameters used in the methodology (floor area, final energy consumption of the relevant application) were adapted according to national data. For the identification of the BACS factors before and after implementation of the action, data provided by the streamSAVE project was used. Since the reference buildings in the Austrian catalogue include neither cooling nor ventilation systems and no data is available on the energy consumption for lighting, the standardized calculation methodology only includes the installation of BACS systems for heating in residential buildings.

For non-residential buildings, no data on standardized reference buildings is available. Therefore, stakeholders opting to use the methodology have to provide data on the building parameters based on actual data from implemented projects.

The methodology offers standardized values for BACS-factors before and after implementation and takes into account the additionality criterion for the obligatory implementation of BACS systems in specific non-residential buildings as stipulated in the Energy Performance of Buildings Directive (EPBD) Articles 14 & 15.

The adapted methodology additionally includes suggestions on data needed for the verification of implemented actions, such as evidence of the installation of BACS (for example via invoices or certificate of installation) as well as evidence on the technical building parameters (for example via energy certificate).

ELECTRIC VEHICLES IN BELGIUM

The Belgian federal public service was drafting new requirements for the newly bought cars in their own fleet and was interested to have a first estimate of the potential energy savings that the switch to EV could yield. The data for calculating the baseline and the savings had already been gathered, such as fuel-type, year of purchase, and distance travelled. Hence, detailed data were already available. The main request from the federal public service concerned the correct definition of the baseline and the additionality principle, especially referring to the Clean Vehicle Directive (2019/1161). More specifically, vehicles purchased by the federal public services must comply with the requirements of the Clean Vehicle Directive; this means there are national targets for procuring clean vehicles in addition to a changing definition of what exactly is a 'clean vehicle'. Therefore, it was unclear how the additionality criterion applied to this specific measure. The CSF developed an exemplary calculation, extending the calculation tools that exist via the Training Module, to incorporate the requirements of the Clean Vehicle Directive into the baseline. For the years prior to 2021, when the national target of 38.5 % clean vehicles in the newly purchased vehicles via public procurement was not yet in place, a division was made per fuel-type. The average shares of vehicles per fuel type were calculated, considering three years to account for fluctuations in purchase. From 2021 onwards, the share of clean vehicles coincides with the 38.5 % target, while the shares of the other fuel types were redistributed over the total amount of vehicles purchased. In this way, the obligatory share of 38.5 % clean vehicles (either full electric of plug-in hybrid vehicles according to the definition in effect) is incorporated into the baseline of the federal car fleet. By providing this field to fill out the number of clean vehicles purchased for each year from 2021 to 2030, the tool can then calculate the savings from those electric and/or hybrid vehicles that are purchased in addition to this obligatory share. Thereby, ensuring that the energy savings emanating from the federal public service's purchasing policy are eligible for Article 7 EED.

The provision of the easy-to-use templates made it possible to estimate savings for past and future years, allowing them to monitor savings in a qualitative and efficient way. Concerning the indicative values, EU-wide values were applied, next to translating some of these to country specific estimates based on the national data available. An example in this regard would be the value for distance travelled: as the federal public service disposed of the distance travelled by each car in their fleet, a very specific value could be used instead of a European or even Belgian average. The more specified excel template, adapted to Belgian situation, also defines the clear scope of the data that should be collected by the policy officers in the upcoming years to allow for proper monitoring of savings when the measure will be further implemented and strengthened.

Conclusion

The streamSAVE project aims to streamline energy savings calculations and to provide support to Member States to increase their chances of successfully and consistently meeting their energy efficiency targets, so they are well equipped in frame of the 'fit for 55'-package. Therefore, streamSAVE focuses on bottom-up calculation methodologies of standardized technical actions. In a first round, streamSAVE considered five measures with high energy savings potential, referred to as Priority Actions. These comprised Heat Recovery, BACS, Commercial and Industrial Refrigeration, Electric Vehicles and Road Lighting. For each of these Priority Actions, a standardized, bottom-up calculation methodology was developed. These methodologies comprise a formula to estimate energy savings, indicative calculation values, indicative values for the baseline situation and values for considering behavioural effects. A part on estimating greenhouse gas savings is included as well. In addition, these methodologies have been made available to stakeholders in the forms of an online tool and downloadable excel sheets to make estimations offline. Furthermore, the methodologies developed have been validated through the Capacity Support Facility, where streamSAVE offered concrete, tailored support to the Member States. Two cases have been described here, illustrating their application for policies in two countries. In addition to the lessons learned through those cases, they demonstrate the validation of the methodologies and the value of the support to the Member States.

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