EPATEE

Saving calculation methods and their application in the EPATEE Toolbox

Internal Note

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1 | Saving calculation methods and their application in the EPATEE Toolbox

1.1 Introduction

One of the objectives of the EPATEE project is to develop a Toolbox which can help users to find suitable methods for the evaluation of energy savings. The development builds on the Knowledge base that characterizes studies on evaluation of energy savings. One of the characteristics is the method applied to calculate energy savings. This note concerns a number of subjects and issues concerning the calculation methods. These are clarified in order to help compose the descriptions for the tools in the Toolbox.

Remark
This is an internal note which may not cover all possibilities as for the application of (combinations of) methods. When composing the description of the tools you can add your own views and use information contained in the case studies and other supporting documents of the EPATEE project.

1.2 Methods defined in the Knowledge Base and EPATEE case studies

A set of 10 methods to calculate energy savings (see table 1) has been defined in the Knowledge Base (KB) which contains a large number of evaluation studies. Each study encoded in the Knowledge Base is characterized by one applied savings calculation method, unless no method at all can be ascribed.

In the case studies composed as part of the EPATEE project reference is made to the defined KB methods. Sometimes the case studies elaborate on the methods.

However, further analysis reveals that also other methods can be needed to calculate the savings, in combination with the methods already defined in the KB. Moreover, such a combination of methods can be applied in practice for reasons of cost-effectiveness and/or reliability of results. The enlarged scope with regard to methods has to be taken into account when advising the users of the EPATEE Toolbox. Therefore, an analysis of extra methods and combinations of methods has been made in this report.

Table 1: Methods to calculate energy savings defined in the Knowledge Base

	Name	Description
1	Direct measurement	Measurement of unitary energy savings (unit usually participant)
2	Billing analysis	Unitary energy savings are established on the basis of billing analysis (unit usually participant)
3	Deemed savings	Estimate of unitary energy savings (unit usually equipment, sometimes participant if end-use action rather uniform)
4	Mixed deemed / ex-post	Mixed deemed and ex-post estimate (e.g. unitary energy savings based on equipment sales data, inspection of samples, monitoring of equipment purchased by participants)
5	Engineering estimate	Detailed engineering estimates (e.g. through calibrated simulation). More or less complex modelling of individual unit (an energy balance of an individual building) or individual company (unit is participant)
6	Stock modeling	Based on stock and market statistics, and surveys monitoring diffusion/uptake of energy-efficient solutions. This method will be a bottom-up method, if the surveys enable to identify end-use actions and policy measures. Otherwise, this will be a top-down method
7	Diffusion indicators	Share of specific equipment or practice in the market. Monitoring of these indicators will be a bottom-up method, if the change is due to policy measures. If this is not the case, and a regression analysis has to be performed to identify the energy savings due to EEI measures, this method will be a top-down method
8	Energy consumption indicators	Either unit energy consumption for whole sectors or sub-sectors (energy-intensity), or specific energy consumption indicators for equipment (unit consumption)
9	Econometric methods	Top-down modelling (e.g. econometric methods, simulation at aggregated level)
10	Other	Diverse methods (e.g. combinations of methods, guidelines or meta-evaluations that consider several types of methods)

1.3 Adaptation of the set of KB methods

In order to perform the analysis in the right way, the KB methods have been adapted as follows:

- For KB method 4 on mixed deemed/ex-post new information became available on how ex-ante and ex-post were combined in this method. Based on this information this method has not been dealt with in the analysis of complementary methods (section 5) and additional methods ex-post (section 6) but dealt with in section 7 on Combination of ex-ante and ex-post methods. It was agreed that method 4 will not be used as a category in the EPATEE toolbox.
- For KB-method 6 on stock modeling only the bottom-up approach will be taken into account
- For KB method 7 on diffusion indicators the part requiring regression analysis is ignored
- KB method 8 on energy consumption indicators has been split into energy-intensity at (sub)sector level (method 8a) and unit consumption at equipment level (method 8b)

respectively. Both concern total savings (not only the part due to policy) for a group of energy users, but the scope of unit consumption is smaller.

- KB method 9 on econometric methods is split into regression analysis (adapted method 9a) and price elasticity analysis (adapted method 9b). Regression analysis uses a formula where (the change in) a dependent variable (generally energy consumption) is assumed to be a function of a number of explaining variables (including savings), each multiplied times a factor. On basis of time-series for all variables, using the least square algorithm, the values of the factors are estimated, which can provide information on the relation between policy and savings. The elasticity method concerns the relative decrease in energy consumption due to a price increase, e.g. due to an energy tax. The savings due to a tax is calculated as price change times an elasticity value that is derived from literature (for short run as well as long run).
- KB method 10 is ignored in the analysis as it encompasses too many different methods. Insofar method 10 concerns a combination of already defined methods this will be dealt as a combination of the methods mentioned.

The resulting set of methods, used in the analysis, is shown in table 2 in the column “Method”.

1.4 Analysis of different combinations

The following combinations of methods have been analyzed:

- **Complementary**: extra methods, which in combination with already chosen method(s) enable to calculate total energy savings
- **Additional ex-post**: an additional method to be combined with the chosen method, in order to improve the ex-post calculation of savings
- **Ex-ante versus ex-post**: combinations of one method for ex-ante calculation of savings and another method for ex-post calculation, or the same method ex-ante and ex-post.

1.5 Complementary combinations (to assess total energy savings)

In table 2 the primary subject of each method is specified. For methods 1, 2, 3, 5 and 8b the focus is on unitary savings, i.e. the savings for one energy using system such as an appliance, a dwelling or a car, or a participant in a program on changing energy behavior. In order to calculate the total savings the unitary savings must be multiplied by the number of more efficient appliances, dwellings or cars or number of participants (the “number of actions”). Therefore another, complementary, method is needed to obtain the number of actions.

For the 30 selected PSMCs (tools) in the Toolbox it has been analyzed whether the applied method in the PSMC concerns a method on unitary savings, and which other method was applied to obtain the number of actions (see Annex I for the analysis of the 30 PSMCs). The different complementary methods are given in table 3.

Table 2: Methods to calculate energy savings and complementary methods needed

	Method	Primary subject of method	Subject to be covered as well	Complementary method* (see A/B/C/D in Table 3)
1	Measurement	Unitary savings	Number of actions	B, C or D
2	Billing analysis	Unitary savings	Number of actions	A, B, C or D
3	Deemed savings	Unitary savings	Number of actions	A, B, C or D
5	Engineering estimate	Unitary savings	Number of actions	A, B or C
6	Stock modeling	Number of actions	Unitary savings	Method 3 or 5
7	Diffusion indicator	Number of actions	Unitary savings	Methods 1,2,3,-5 or 8b
8a	Energy-intensity (sector)	Total savings	None	none
8b	Unit consumption	Unitary savings	Number of actions	A, C of D
9a	Regression analysis	Total savings	None	none
9b	Elasticity analysis	Total savings	None	none

* *In theory, almost all types of combinations are possible. We note here the ones that are the most frequently encountered in the literature and case studies.*

The complementary methods to obtain the number of actions can be grouped into four types, starting from the data source used to count or estimate the number of actions, as the topic of complementary method is firstly an issue of data collection (about the number of actions). The data sources are characterized as direct counting (A and B) or indirect counting (C and D). Then a distinction is made for the "maths" behind the determination of the number of actions, such as extrapolation in case of non-exhaustive data. In practice, the choice of the complementary method will be guided by data availability.

Table 3: Complementary methods on number of actions

	Data source	Direct/ indirect counting	Exhaustive/ extrapolation	Examples
A	Direct monitoring of the actions or participants	Direct counting	Exhaustive	Monitoring done of the licenses for new buildings (building codes), the subsidies approved (subsidy scheme), or the actions validated (EEO scheme)
B	Survey of participants	Direct counting	Extrapolation	Survey of a sample of participants to assess the number and types of actions implemented, extrapolated to the whole group of participants
C	Statistics	Indirect counting	Exhaustive	National statistics about the building stock
D	Sales or market data	Indirect counting	Exhaustive or extrapolation	Sales data about new appliances

Complementary methods can be related to one or more types of method or policy measure:

- for a policy measure of type Legislative/Normative (new dwellings according to an efficiency standards) counting the number of building licenses (method A) should preferably be applied. If this method of direct counting is not possible use can be made of statistics or sales data (indirect counting). Surveys can be applied for most policy measure types, but the extrapolation to all saving actions of participants creates more uncertainty for the saving results.
- for engineering estimates, with often non-uniform unitary savings (buildings for different purposes and of different scale; companies with different sizes, production processes, etc.) method A is preferred
- stock modeling (method 6) concerns changes, due to savings policy, in the stock of energy using systems, such as dwellings, appliances or cars. Every year, part of the old systems is replaced by a more efficient new one and these saving actions lead to increasing overall savings over time. The (yearly) number of saving actions is covered in stock modeling (see table 2) but the unitary savings to some extent as well. In most cases (see Knowledge Base) deemed savings (method 3) are used to calculate the unitary savings, but for dwellings engineering estimates can be used as well
- the primary focus of method 7 (diffusion indicator) is the number of actions. In order to calculate total savings there should be a complementary method to calculate the unitary savings. The analysis for the 30 PSMCs shows that it is possible to use the already existing methods 1, 2, 3, 5 or 8b as complementary methods to calculate the unitary savings (see Annex I)
- methods 8a, 9a and 9b provide total savings directly (as they use a top-down approach), and thus do not need a calculation of unitary savings or calculation of the number of actions. Therefore, no complementary methods are needed for these methods (see Annex I).

In practice other combinations are possible, mostly depending on data availability or feasibility of data collection. The EPATEE case studies also show that energy savings can be evaluated in successive steps, using different combinations of methods, as for example discussed in the next section below.

1.6 Additional methods ex-post (to verify or improve unitary savings results)

Sometimes an additional method can be applied on top of an already chosen method to improve the reliability of the evaluation results, e.g. billing analysis for a sample group of dwellings to check the deemed savings applied for the total stock of dwellings (see EPATEE case study “Better energy homes” for Ireland). The deemed savings method can indeed be less costly and easier to apply on all dwellings than billing analysis, the combination can also be more cost-effective. In practice, a frequent reason to choose deemed savings is also the time constraint for reporting. Methods based on measured (direct measurements) or metered (billing analysis) data need more time to provide results, as pointed in some case studies (see e.g., case on Warm Front). Whereas deemed savings or engineering calculations can be applied directly to data collected along the monitoring of the policy measure. Therefore, the need to report annually (or even more frequently) about energy savings often leads to choose to use deemed savings or engineering calculations (see section 1.4 of the task 3.2 report- Volume I Main findings).

An analysis of possible additional methods on top of chosen methods has been performed for part of the methods specified in table 2. This analysis in **Annex II** concerns the set of 30 PSMCs (combinations of a Policy measure, Sector and Method) in the EPATEE Toolbox.

The analysis is restricted to PSMCs where the focus of the chosen method is on calculating unitary savings. Therefore, no additional methods are searched for when the chosen method concerns total savings (methods 8a, 9a or 9b in table 2).

For method 6 (stock modeling) there are already various complementary methods to calculate the unitary savings, next to the calculation of number of actions through stock modeling. One key point for stock modelling, as for any modelling, is calibration. For method 7 (diffusion indicator) the focus of the chosen method is on number of actions and various complementary methods are available to calculate the unitary savings..

For each of the selected PSMCs in Annex II , pairs of the chosen method and one of the other additional methods have been analyzed. E.g. for PSMC-2, with deemed savings as the chosen method, measurement as additional method was analyzed in the case study 'Better energy homes for Ireland'.

in Annex II for most PSMCs at least one additional method is available but it concerns set (on unitary savings). Good examples are the chosen methods Billing analysis, Deemed savings and Engineering estimate, which can be combined with the additional method Measurement for a sample group. The chosen method Measurement can be combined with additional method Deemed savings (see Annex II).

1.7 Ex-ante versus ex-post methods (optimal match)

Ex-ante and ex-post evaluations

The focus of the EPATEE project is on ex-post evaluations of realized savings, i.e. evaluations done after the policy measure (or the energy saving actions) has been implemented. Evaluations can also be done ex-ante, i.e. before the start of the policy measure (or before the actions are implemented). Ex-ante evaluations are about expected energy savings.

The current NEEAPs (National Energy Efficiency Action Plans) that EU-countries had to submit to the European Commission in 2017 contain both realized savings (from ex-post evaluation) for past years as well as expected savings (from ex-ante evaluation) for years until 2020.

Methods for ex-ante and ex-post savings calculations
If an ex-ante evaluation has been executed the method used could be applied as well for the ex-post evaluation. This facilitates the comparison of expected and realized savings for a policy measure. In some cases it will be possible to re-use ex-ante data, e.g. the deemed savings values, for the ex-post evaluation (see also 'Deepening case study on Estimated versus Measured savings'). However, using another method for ex-post evaluation than for the ex-ante evaluation might be more optimal, e.g. provide more reliable saving figures.

When an ex-ante evaluation is available it is important to look at matching methods to be used in the ex-post evaluation. This has been done in **Annex III.**

The analysis provides a much broader picture of ex-ante/ex-post interaction than is the case in method 4 on "Mixed deemed/ex-post" in the Knowledge Base (see table 1). In method 4, the ex-post unitary

savings are calculated with a mix of ex-ante and ex-post data. Because of the broader focus of application taken here, method 4 has not been dealt with in the previous analysis.

Table 4 shows which of the methods to be chosen can be used for ex-ante and/or ex-post evaluations. It shows that all methods can be applied for ex-post evaluation but only four of these methods can generally be used for ex-ante evaluation, because:

- the methods measurement and billing analysis cannot be applied ex-ante because they need observed data (however it should be noted that deemed savings can make use of previous studies using measurements or billing analysis)
- for diffusion indicators, energy intensity and unit consumption an ex-ante evaluation based on scenario calculations is possible. For regression analysis it is in principle possible to calculate ex-ante savings with a regression model and expected values for all explaining variables. However, a question mark is inserted for ex-ante because detailed scenario calculations, including all saving actions and relevant drivers will generally not be available
- for the methods engineering estimate and stock modeling also some expected input values are needed in the ex-ante evaluation. However, these methods are comparable with the deemed savings approach which is applied both for ex-ante and ex-post.

Table 4: Methods applicable for ex-ante and/or ex-post evaluations

	Method	Ex-ante	Ex-post	Comments
1	Measurement	NO	OK	Ex-post: before/after, or participants/control group
2	Billing analysis	NO	OK	Ex-post: before/after, or participants/control group
3	Deemed savings	OK	OK	Ex-post value can be the same as ex-ante
5	Engineering estimate	OK	OK	Ex-ante: modeling of energy using system, ex-post validation (also new)
6	Stock modeling	OK	OK	Ex-ante scenario for stock development, ex-post observed stock
7	Diffusion indicator	?	OK	Ex-ante: extrapolation, Ex-post: observed data
8a	Energy-intensity (sector)	?	OK	Ex-ante: scenario, Ex-post: statistical data
8b	Unit consumption	?	OK	Ex-ante: expected, Ex-post: observed data
9a	Regression analysis	?	OK	Ex-ante: all expected explaining values, Ex-post: all observed explaining values
9b	Elasticity analysis	OK	OK	Ex-ante: scenario for prices, taxes, etc.

OK = applicable, NO = not applicable, ? = only applicable given future explorations

As discussed in section 6 about additional methods, methods can also be compared to assess the robustness of the results and improve the understanding of the different effects of actions or policy measures. Likewise, evaluations of energy savings can also be done on a more continuous way than

ex-ante assessment before the start of the policy measure and ex-post evaluation once it is ended. Therefore different methods can be used successively, particularly when new data become available.

A distinction can be made between two possible situations for ex-ante and ex-post combinations: one where they are the same and one in which they are different.

Same method ex-ante and ex-post
For the four cases for which the same method can be applied for ex-ante and ex-post, there are differences between the two. Ex-ante deemed savings (method 3) will be an estimate, while ex-post deemed savings can be checked with e.g. the measurement method (see section 6). This differs from the approach in KB-method 4 where unitary savings are the same but and the estimated number of actions (ex-ante) is replaced by the observed number (ex-post).

Engineering estimates (method 5) often use models of various energy using systems that can predict ex-ante savings due to saving actions; by calibrating the same model to actual data on energy consumption (validation), the model can provide more reliable ex-post savings.

For stock modeling (method 6) the deemed savings from the ex-ante evaluation can be used again in the ex-post evaluation, while the expected number of actions will be replaced by the observed number of actions (like in method 4).

The calculated ex-post savings using the Elasticity analysis (method 9b) are very dependent on the elasticity factors found in literature (see section 3). This holds also for ex-post savings, unless a (regression) analysis is performed to check the elasticity values for the ex-post case. Because of the amount of time and efforts needed, this exercise is generally not executed. The amount of calculated savings will of course be different when the actual tax is higher or lower than assumed in the ex-ante evaluation. But the reliability of ex-post savings will not be better than that of the ex-ante savings.

Different method ex-ante and ex-post
For practical reasons (see above) only the four ex-ante methods 'Deemed savings', 'Engineering estimate', 'Elasticity analysis' or 'Stock modelling' are taken into account. Only combinations of these four methods and ex-post methods (not the same as ex-ante method) have been analyzed in **Annex III**. These expert judgements show that the case 'Deemed savings' ex-ante & 'Measurement' ex-post provides a most relevant combination. With measurement at the right aggregation level, given the saving action with deemed savings, the ex-ante estimate deemed saving can be checked ex-post, and probably correction factors (e.g. rebound effect) can be calculated.

Other relevant combinations (see also the references of the Knowledge Base) are:

- Deemed savings ex-ante versus Engineering estimate ex-post (last one more reliable but also more costly to execute than deemed savings)
- Deemed savings ex-ante versus Unit-consumption ex-post (savings definitions should be comparable)
- Deemed savings ex-ante versus Billing analysis ex-post (provided that the deemed savings concern a major part of energy consumption, e.g. a dwelling retrofit with various actions)
- Engineering estimate ex-ante versus Measurement ex-post (measurement to be used to validate the engineering estimate, thus providing better estimates for next ex-ante evaluations)
- Engineering estimate ex-ante versus Billing analysis ex-post (the details on savings in the engineering estimate are lost in the aggregated billing analysis) -

- Engineering estimate ex-ante versus Unit consumption ex-post (the scope of the ex-ante engineering estimate should be comparable with that of the unit consumption)

It must be noted that in the EPATEE case studies other combinations are applied, but these may not concern ex-ante/ex-post combinations.

Annex I: Analysis of complementary methods for the set of 30 PSMCs

Each PSMC concerns a combination of a **P**olicy measure type, a **S**ector/application and a **M**ethod (see note on Definition, applicability analysis and selection of tools for the Toolbox). From all possible combinations the applicability as to calculation of energy savings has been analyzed. From these, a subset of 30 combinations has been selected as tools to be included in the EPATEE Toolbox.

For the following 30 tools an analysis has been performed of possible complementary methods and of how the calculation can be done with available data sources.

1. **LN - Buildings/residential – Measurement** (PDF 55): number of actions needed

Minimum efficiency standards for insulation in existing dwellings
Number of actions for incidental measurement ex-ante/ex-post: number of measured dwellings (before and after) with applied type of insulation (per dwelling type). Data from measurement program (to be scaled to total renovated dwellings).

Minimum efficiency standards for new dwellings
Number for incidental measurement, ex-post: number of measured new dwellings (per dwelling type). Data from measurement program (to be scaled to total new dwellings).

2. **LN - Buildings/residential – Deemed savings** (PDF 97): number of actions needed

Minimum efficiency standards for insulation in existing dwellings
Number of actions: number of dwellings with applied type of insulation (per dwelling type). Data from license administration or increase of insulation rate from a yearly survey in insulation measures.

Minimum efficiency standards for new dwellings
Number of actions: number of new buildings built in year for which standard is valid (per dwelling type). Data from license administration for new dwellings.

3. **LN - Buildings/non-residential – Engineering estimate**: number of actions needed

Minimum efficiency standards for renovated buildings
Number of actions: number of m^2 renovated according to the standard (per type of building). Data from the license administration or building surveys.

Minimum efficiency standards for new buildings
Number of actions: number of m^2 for new buildings built in year for which standard is valid (per building type). Data from license administration or building surveys.

4. **LN – HH/Other (appliances) – Deemed savings** (PDF 16/38): number of actions needed

Minimum efficiency standard for appliances
Number of actions: number of appliances sold (per type and size category) or increase in ownership rate. Data from (EU wide) sales database or from yearly surveys.

5. **LN - HH/Other (appliances) – Stock modeling**: unitary savings needed

Minimum efficiency standard for appliances

Unitary savings: average savings when replacing old appliance by more efficient appliances according the standard, specified per type of appliance and for different old classes (that define average savings). Data derived from methods on measured savings, deemed savings or engineering estimates.

6. **LI - Buildings/residential - Billing analysis** (PDF 38): number of actions needed

Efficiency labels for appliances

Number of actions: number of dwellings with specific label category . Data from database on assigned labels to dwellings.

7. **LI – HH/Other (appliances) - Measurement** (PDF 58): number of actions needed

Efficiency labels per type of appliance

Number of actions: number of measured replaced appliances (before) / new (after) with specific label category (per type and size category). Data from measurement program (to be scaled to total population).

8. **FT - Buildings/residential – Billing analysis** (PDF 20): number of actions needed

Subsidized insulation actions for existing dwellings

Number of actions: number of billed dwellings without subsidized insulation (before) and with the subsidized type of insulation (after), per dwelling type. Data from monitoring of the subsidy scheme.

Subsidized actions for new above standard dwellings

Number of actions: number of billed above standard dwellings built in year for which the standard is valid (per dwelling type). Data from monitoring of the subsidy scheme.

9. **GS (FT) - Buildings/residential – Deemed savings** (PDF 52/102/109): number of actions needed

Subsidized insulation actions for existing dwellings

Number of actions: number of dwellings with the subsidized type of insulation per dwelling type. Data from subsidy program.

Subsidized actions for new above standard dwellings

Number of actions: number of subsidized above standard dwellings built in year for which the standard is valid (per dwelling type). Data from subsidy program.

10. **GS - Buildings/residential - Stock modeling** (PDF 23): unitary savings needed

Subsidized insulation actions for existing dwellings

Unitary savings: average savings when applying subsidized insulation/boiler actions, for which categories have been defined in the stock model. See methods on measured savings, deemed savings or engineering estimates.

Subsidized actions for new above standard dwellings

Unitary savings: average savings compared to the new dwelling according to the standard, for which categories have been defined in the stock model. Data derived from methods on measured savings, deemed savings or engineering estimates.

11. **GS - Buildings/residential - Diffusion indicator** (PDF 22/136): unitary savings needed

Subsidized insulation actions for existing dwellings

Unitary savings: average savings when applying subsidized insulation/boiler actions, for which separate diffusion indicators have been defined. Data derived from methods on measured savings, deemed savings or engineering estimates.

Subsidized actions for new above standard dwellings

Unitary savings: average savings compared to a new dwelling according to the standard, for which diffusion indicator categories have been defined. Data from methods on measured savings, deemed savings or engineering estimates.

12. **GS – Buildings/non-residential – Energy indicator/subsector intensity** (PDF 53): No complementary method required as the method provides directly the savings

13. **GS – Services-ex-buildings (devices) – Deemed savings**: number of actions needed

Subsidized actions on more efficient devices

Number of actions: number of subsidized devices, with unitary savings compared to the replaced device (per type of device and other categories). Data from the subsidy program.

14. **GS (FT)- HH/Other (appliances) – Deemed savings** (PDF 38/175): number of actions needed

Subsidized more efficient appliances

Number of actions: number of subsidized appliances, with unitary savings compared to the replaced appliance (per type and size category. Data from the subsidy program.

15. **GS – Buildings/residential – Billing analysis** (PDF 116/135): number of actions needed

Subsidized insulation measures and boilers

Number of actions: number of dwellings with the subsidized type of insulation or more efficient boiler per dwelling type. Data from subsidy program.

16. **GS (VA) – Industry/specific – Engineering estimate** (PDF 118): number of actions needed

Subsidized energy efficiency actions for processes (as part of Voluntary Agreement)

Number of actions: subsidized measures, per type or for overall plan, for which savings have been estimated per action or plan, for individual companies. Data from the subsidy program and submitted savings plans.

17. **GS – Industry/general –Energy indicator/unit consumption**: number of actions needed

Subsidized more efficient energy using systems

Number of actions: number of subsidized devices, with unitary savings compared to the replaced device (per type of device and other categories). Data from the subsidy program.

18. **GS – Agriculture) – Energy indicator/subsector intensity** (PDF 40): No complementary method required as the method provides directly the savings.

19. **GS – Transport/freight – Engineering estimate**: number of actions needed

Subsidized energy efficiency actions on lorries and logistics

Number of actions: subsidized measures, per type or for overall plan, for which savings have been estimated per action or plan, for individual companies. Data from the subsidy program and submitted savings plans.

20. **FT – Transport/persons – Stock modeling** (PDF 147): unitary savings needed

More efficient new cars due to tax rebates

Unitary savings: average savings when providing rebates for types of new cars, for which categories have been defined in the stock model. Data on unitary savings from methods on measured savings, deemed savings or engineering estimates.

21. **FT (tax) – All sectors – Econometric/regression**: No complementary method required as the method provides directly the savings

22. **FT (tax) – All sectors – Econometric/elasticity** (PDF 68): No complementary method required as the method provides directly the savings

23. **IE – HH/Other (appliances) – Measurement** (PDF 108): number of actions needed

Information (excluding mandatory labels) on more efficient appliances

Number of actions: appliances chosen, per type for which unitary savings have been calculated (per type of appliance and size category). Data from surveys/interviews on the follow-up of IE activities.

24. **IE – Services-ex-buildings – Billing analysis** (PDF 25): number of actions needed

Information on saving actions for activities of SME (not buildings)

Number of actions: measures due to IE activities, per type for which unitary savings have been calculated. Data from surveys/interviews on the follow-up of IE activities (bill only used for unitary savings).

25. **IE (audit) – Industry/general – Econometric/regression** (PDF 132): No complementary required as the method provides directly the savings.

26. **IE – Transport/persons – Deemed savings** (PDF 111): number of actions needed

More efficient new cars due to information (excluding labels)

Number of actions: new cars where the choice was influenced by information, resulting in the calculated unitary savings per car (per category). Data from survey/interviews on the effect of IE activities.

27. **VA– Industry/general - Energy indicator/subsector intensity** (PDF 35): No complementary method required as the method provides directly the savings

28. **MB – Building/residential – Deemed savings** (PDF 70): number of actions needed

Insulation for existing dwellings under EEO scheme

Number of actions: dwellings with the stimulated type of insulation per dwelling type. Data from the mandatory EEO or WCS reporting.

29. **MB - Building/residential – Econometric/regression** (PDF 51): No complementary method required as the method provides directly the savings

30. **MB - Industry/general - Engineering estimate** (PDF 83): number of actions needed

Energy efficiency actions/plan as part of EEO or WCS system

Number of actions: implemented measures, per type or for overall plan, for which unitary savings have been estimated per action or plan, for individual companies. Data from the mandatory EEO or WCS reporting.

Annex II: Analysis of relevant additional methods ex-post for the set of 30 PSMCs

Each PSMC concerns a combination of a **P**olicy measure type, a **S**ector/application and a **M**ethod (see note on definition, applicability analysis and selection of tools for the Toolbox). For all possible combinations, the applicability of the different calculation options of energy savings have been analysed. From these, a subset of the 30 most relevant combinations have been selected as tools for the EPATEE Toolbox.

For the following 30 tools an analysis has been performed regarding additional methods, given the already chosen method. The additional methods only concern methods to calculate unitary savings (methods 1 - 5 and 8b) or total savings (methods 8a, 9 and sometimes 10). The additional method is rated as:

Relevant
Less relevant
Not relevant

Less relevant means that using the additional method usually offers limited benefits/more efforts or costs, or is not always applicable. However, it should be noted that the relevance of the combinations of methods strongly depends on the evaluation objectives, context, constraints, etc. So the analysis presented here should be read as suggestions, and not as prescriptive recommendations.

1. **LN - Buildings/residential – Measurement** (PDF 55)

Minimum efficiency standards for insulation in existing dwellings

For thermal insulation according to standards regularly measuring ex-ante/ex-post energy consumption to calculate the savings for each insulation action is too costly. The method is only applied incidentally to check the savings calculated with other less costly methods. Often, measuring is combined with deemed savings (per type of insulation measure) as the additional method. The same is true for billing analysis before/after insulation that can show changes in overall energy consumption, but must be combined with measurement to show which part of these changes is the results of insulation. For engineering estimates a combination with measurement is less useful as it is normally not applied to simple insulation measures (see new dwellings). The unit consumption method, in this case average gas consumption (for heating) per dwelling, will show much more effects than only the effect of standards for specific insulation measures. Therefore, it is not regarded as an additional method to be combined with measurement.

As to total savings calculated with the method energy-intensity (here energy consumption per dwelling or households) the same rating holds as for unit consumption. For total savings calculated with the method regression analysis measurement can possibly be used to specify unitary savings in the regression formula.

Minimum efficiency standards for new dwellings

Measurement can only be applied ex-post and thus cannot show savings figures to check the results of other, less costly, methods. It can show whether the standard has been met or not, but that is another subject than calculating the savings. However, for engineering estimates which concern both the situation without and with the (more stringent) standard measurement can help to check the

"with" case, i.e. fit simulated energy consumption to actual figures. A combination with other methods (billing analysis, deemed savings, unit consumption, energy intensity and regression) is not useful.

2. **LN - Buildings/residential – Deemed savings** (PDF 97)

Minimum efficiency standards for insulation in existing dwellings

For thermal insulation of renovated dwellings deemed savings per insulation type is an simple, but not so reliable, method to calculate savings due to standards, both ex-ante and ex-post. The measurement method is a suitable additional method to incidentally check the deemed savings. Billing analysis before/after insulation can show changes in overall energy consumption, but due to many other influencing factors, it is less suitable to check the deemed savings. Engineering estimates are seen as a better, bur more costly, estimate of the savings compared to deemed savings, but still have to be checked once and again. Due to the overlapping nature this additional method is less useful. The unit consumption method (in this case average gas consumption (for heating) per dwelling) will show much more effects than only the effect of standards for specific insulation measures. Therefore, it is not regarded as an additional method to be combined with deemed savings.

As for total savings methods the energy-intensity method is not regarded as an additional method due to it containing too much other effects than savings from insulation measures. The method regression analysis can possibly use deemed savings to specify unitary savings in the regression formula.

Minimum efficiency standards for new dwellings

Here no "before" situation exists which is needed for methods like measurement, billing and unit consumption to calculate the savings. The engineering estimate method can be applied on both the "without" as the "with" situation as for an efficiency standard for new dwellings, thus is a useful additional method to check the deemed savings. The scope of energy-intensity method does not fit with savings effects for new dwellings. The same holds for regression analysis using overall data for dwellings and households.

3. **LN - Buildings/non-residential – Engineering estimate**

Minimum efficiency standards for insulation in existing buildings

The engineering estimates method is very suitable for calculating the savings for a complex energy using system like a building, both ex-ante and ex-post. However, the estimates have to be checked regularly, for which the measurement method (ex-ante, but especially ex-post) is a very useful and cost-effective additional method. This is also possible with the billing analysis method, but less reliable due to many other influencing factors. Deemed savings as additional method is not useful due to its limited coverage of the complexity of calculating savings in buildings. This holds even more for unit consumption (energy use per m2 floor space) that has to cope with very different types of buildings.
As for the total savings methods the energy-intensity method is not applicable as it concerns energy consumption of whole (sub)sectors and all policy measures. Finally, the method regression analysis is generally not applied for savings in buildings.

Minimum efficiency standards for new buildings

The engineering method can be applied on both the "without" as the "with" situation as to an efficiency standard for new dwellings. Because no "before" situation exists methods like measurement, billing and unit consumption cannot be used as additional methods to calculate the savings. The deemed savings method cannot be applied as additional method as it cannot cover the complexities of savings in new buildings.

As for total savings methods the energy-intensity method is not applicable as additional method as it concerns energy consumption of whole (sub)sectors and all policy measures. The same holds for regression analysis that is generally not applied for buildings due to the many different situations.

4. **LN – HH/Other (appliances) – Deemed savings** (PDF 16/38)

Minimum efficiency standard per type of appliance

An average savings figure is the only way to calculate total savings because individually calculated figures for more efficient appliances are way too costly. The deemed savings methods concerns average savings but is not very reliable, and should be checked regularly with other methods such as the measurement method. Billing analysis before/after replacing appliances can show changes in overall electricity consumption, but due to many other influencing factors, it is not suitable to check the deemed savings of one appliance type. The engineering estimate method is not an obvious additional method as its ability to cope with complex systems is not needed for appliances. The unit consumption method applied yearly can show the average savings, but bot the part due to standards. As for total savings methods the scope of the energy-intensity method is way too aggregated to be useful for checking deemed savings. Regression analysis can use deemed savings as an input to calculate total savings, and in this sense acts as an additional method, but does not add to the results from the deemed savings method.

5. **LN - HH/Other (appliances) – Stock modeling**

Minimum efficiency standard for appliances

This tool concerns number of actions, not analysed for additional methods.

6. **LI – Buildings/residential – Billing analysis(PDF 38)**

Efficiency labels for existing dwellings

Signing a label to a dwelling that shows how energy efficient it is can stimulate saving actions in dwellings. Billing analysis before/after or with/without the label is a rather cheap way to calculate savings but it concerns overall fuel consumption (including fuel for hot water) and is influenced by other factors than the policy measure at hand. Therefore, the savings should be regularly checked by an additional method, such as measurement (focusing on the part of energy consumption that is influenced by the actions that define the label). Billing can also be combined with deemed savings (for the set of actions that define the label) as the additional method. For engineering estimates a combination with billing is less obvious as it is normally not applied to simple insulation measures. The unit consumption method, in this case average gas consumption per dwelling, is normally based on billing data, thus does not provide better data.

As for total savings methods the energy-intensity method for the sector households/dwellings does not provide useful information on savings due to labeling. The regression analysis method is generally not applied for this tool as it demands a large number of data, of which the label class is only one with a minor effect.

7. ***LI – HH/Other (appliances) - Measurement (PDF 58)***

Efficiency labels per type of appliance

Measuring ex-ante/ex-post to calculate the savings for each appliance sold (and the replaced appliance) is way too expensive. The method is only applied incidentally to check the savings calculated with other less costly methods, such as deemed savings that represents the additional method. Billing analysis can only show changes in overall electricity consumption, and not the effect of replacing appliances by a new one with a label. The same holds for the unit consumption method (average kWh/year per appliance) that provides yearly savings which are only partly due to labels. The engineering estimate method is not a n obvious additional method to measurement as its ability to cope with complex systems is not needed for appliances.

As for total savings methods the energy-intensity method (in this case concerning electricity consumption per household) will show much more saving effects than only the effect of labels per type

of appliance. Measurement is generally not combined with regression analysis that concerns data on electricity use and influencing factors at a higher aggregation level.

8. **FT - Buildings/residential – Billing analysis**

Subsidized insulation actions for existing dwellings

Billing analysis ex-ante/ex-post is a rather cheap way to calculate savings but it concerns overall energy (sometimes also motor fuel or electricity) consumption which is influenced by many other factors than the policy measure at hand. Therefore, the savings should be regularly checked by an additional method, such as measurement (including more energy efficient behavior on which information has been provided). Billing can be combined with deemed savings (per type of insulation measure) as the additional method. For engineering estimates a combination with billing is less obvious as it is normally not applied to simple insulation measures (see new dwellings). The unit consumption method, in this case average gas consumption (for heating) per dwelling, asks for another data source which billing analysis tries to avoid. Therefore, it is not regarded as an additional method.

As for total savings methods the energy-intensity method provides no other results than billing analysis. The regression analysis method is generally not applied for this tool.

9. **GS (FT) - Buildings/residential – Deemed savings** (PDF 52/102/109)

Subsidized insulation actions for existing dwellings

Deemed savings per insulation type are a simple, but not so reliable, method to calculate savings due to subsidized actions, both ex-ante and ex-post. The measurement method is a suitable additional method to incidentally check the deemed savings. Billing analysis before/after insulation can show changes in overall energy consumption, but due to many other influencing factors, it is less suitable to check the deemed savings. Engineering estimates are seen as a better, bur more costly, estimate of the savings compared to deemed savings, but still have to be checked once and again. Due to the overlapping nature this additional method is less useful. The unit consumption method (in this case average gas consumption for heating per dwelling) will show much more effects than only the effect of subsidized insulation actions and therefore not regarded as an additional method.

As for total savings methods the energy-intensity method is not regarded as an additional method due to it containing too much other effects than savings from insulation measures. The method regression analysis can possibly use deemed savings to specify unitary savings in the regression formula.

Subsidized actions for above standard new dwellings

Here no “before” situation exists which is needed for methods like measurement, billing and unit consumption to calculate the savings. The engineering estimate method can be applied for both the “without” as the “with” situation as for subsidized actions on new dwellings, thus is a useful additional method to check the deemed savings. The scope of energy-intensity method does not fit with savings effects for new dwellings. The same holds for regression analysis using overall data for dwellings and households.

10. **GS - Buildings/residential - Stock modeling** (PDF 23)

Tool does concern number of actions, not analysed for additional methods.

11. **GS - Buildings/residential - Diffusion indicator** (PDF 22/136)

Tool does concern number of actions, not analysed for additional methods.

12. **GS – Buildings/non-residential –Energy indicator/subsector intensity** (PDF 53)

Tool does not concern unitary savings, not analysed for additional methods.

13. **GS – Services-ex-buildings (devices) – Deemed savings**

Subsidized actions per type of device

An average savings figure is the only way to calculate total savings as individually calculated figures for each device are too costly. The deemed savings methods concerns average savings but is not very reliable, and should be checked regularly with other methods such as the measurement method. Billing analysis before/after replacing devices can show changes in overall energy consumption, but due to many other influencing factors, it is not suitable to check the deemed savings of one type of device. The engineering estimate method is not an obvious additional method as its ability to cope with complex systems is not needed for uniform devices. The unit consumption method applied yearly can show the average savings per device, but bot the part due to subsidies.

As for total savings methods the scope of the energy-intensity method is way too aggregated to be useful for checking deemed savings. Regression analysis can use deemed savings as an input to calculate total savings, and in this sense acts as an additional method, but does not add to the results from the deemed savings method.

14. **GS (FT)- HH/Other (appliances) – Deemed savings** (PDF 38/175)

Subsidized more efficient appliances

An average savings figure is the only way to calculate total savings as individually calculated figures for each appliance are too costly. The deemed savings methods concerns average savings but is not very reliable, and should be checked regularly with other methods such as the measurement method. Billing analysis before/after replacing appliances can show changes in overall energy consumption, but due to many other influencing factors, it is not suitable to check the deemed savings of one type of appliance. The engineering estimate method is not an obvious additional method as its ability to cope with complex systems is not needed for uniform appliances. The unit consumption method applied yearly can show the average savings per appliance, but bot the part due to subsidies.

As for total savings methods the scope of the energy-intensity method is way too aggregated to be useful for checking deemed savings. Regression analysis can use deemed savings as an input to calculate total savings, and in this sense acts as an additional method, but does not add to the results from the deemed savings method.

15. **GS – Buildings/residential – Billing analysis** (PDF 116/135)

Subsidized insulation measures and boilers

Billing analysis ex-ante/ex-post is a rather cheap way to calculate savings but it concerns overall energy (sometimes also motor fuel or electricity) consumption which is influenced by many other factors than the policy measure at hand. Therefore, the savings should be regularly checked by an additional method, such as measurement (including more energy efficient behavior on which information has been provided). Billing can be combined with deemed savings (per type of insulation measure) as the additional method. For engineering estimates a combination with billing is less obvious as it is normally not applied to simple insulation measures (see new dwellings). The unit consumption method, in this case average gas consumption (for heating) per dwelling, asks for another data source which billing analysis tries to avoid. Therefore, it is not regarded as an additional method.

As for total savings methods the energy-intensity method provides no other results than billing analysis. The regression analysis method is generally not applied for this tool.

16. **GS (VA) – Industry/specific – Engineering estimate** (PDF 118)

Subsidized energy efficiency actions for energy-intensive processes

The engineering estimates method is very suitable for calculating the savings for large non-uniform energy using systems, both ex-ante and ex-post. However, the estimates have to be checked regularly,

for which the measurement method (ex-ante, but especially ex-post) is a very useful and cost-effective additional method. This is also possible with the billing analysis method, but less reliable due to many other influencing factors. Deemed savings are not applied for the case at hand. The unit consumption method (energy use per unit of process-output) can show the yearly total savings as a maximum for the savings due to subsidized actions.

As for the total savings methods the energy-intensity method concerns energy consumption of whole (sub)sectors and all policy measures, thus does not provide effects for one company and subsidized actions. The method regression analysis is generally not applied for processes in industry.

17. **GS – Industry/general – Energy indicator/unit consumption** (PDF 56)

Subsidized more efficient energy using systems

The unit consumption method can calculate savings from energy using systems ranging from a device (electric motor) to a production unit (chemical reactor). However, the results incorporate other factors (e.g. utilization rate) and concern total savings and not the part due to policy. The measurement method is well suited to check the unit consumption results, but not the policy part. The same holds for the engineering estimate. Deemed savings can be used to check savings from more efficient devices. Billing analysis concerns overall consumption with not only energy consumption for unit consumption.

As for total savings methods the subsector intensity method is only useful when unit consumption covers almost all energy consumption. But then the extra information is limited. Regression analysis is not applicable to individual cases.

18. **GS – Agriculture) – Energy indicator/subsector intensity** (PDF 40)

Subsidized actions under a Voluntary Agreement scheme

The energy-intensity of VA-participants, based on physical production (specific energy consumption for various crops) is used to calculate (total) yearly savings. However, other factors (e.g. higher yields per m2 greenhouse) might be incorporated and it is not always clear which part of savings is due to subsidized actions and/or participating in the VA. Measurement for the most important actions can be used as a check on part of the reported total savings, but cannot show the policy related part. The billing analysis method is not a useful additional method as it uses the same overall energy consumption figures as the intensity method. Deemed savings per crop type can be used to check the reported savings, but not the policy related part. If unit consumption concerns a specific crop the same holds for this method. The engineering estimate method, meant for more complex energy using systems, is more costly and does not better results than previous methods.

As for total savings methods the regression analysis is the only one that could show the policy related part of the reported savings, but this method cannot be applied at individual company level.

19. **GS – Transport/freight – Engineering estimate**

Subsidized energy efficiency actions on lorries and logistics

The engineering estimates method is suitable for calculating the savings for various actions on vehicles and logistics, both ex-ante and ex-post. However, the estimates have to be checked regularly, for which the measurement method (ex-ante, but especially ex-post) is a very useful additional method. This is sometimes also possible with the billing analysis method, but less reliable due to many other influencing factors. Deemed savings can also be applied in simple cases (uniform vehicle actions) but overlaps with the engineering estimate. The unit consumption method (energy use per vehicle-km) can show the yearly total savings as a maximum for the savings due to subsidized actions.

As for the total savings methods the energy-intensity method concerns energy consumption of whole (sub)sectors and all policy measures, thus does not provide effects for one company and specific subsidized actions. The method regression analysis is generally not applied for freight transport.

20. **FT – Transport/persons – Stock modeling** (PDF 147)
Tool does concern number of actions, not analysed
for additional methods.

21. **FT (tax) – All sectors – Econometric/regression**.
Tool does concern total savings that cannot be specified, not analysed for additional methods

22. **FT (tax) – All sectors – Econometric/elasticity** (PDF 68)
Total savings due to (higher) energy taxes
The elasticity method can not only calculate the demand reduction (savings) of higher energy prices, but also the savings due to energy taxes. However, the results are very dependent on the elasticity values, for which literature shows a large margin. Moreover, the effects of other policy measures overlap with that of the tax. Additional methods can be applied to check the results of the elasticity method, but they have to cover all energy consumption that is targeted by the tax and have to address the overlap. The measurement method is too costly to check the numerous saving actions under a broad based energy tax. The same is true for engineering estimates. With billing analysis it is possible to check elasticity results per sector, but the overlap problem is not addressed. The deemed savings method is not applicable because the focus is uniform actions only. The same holds for unit consumption.

As for total savings the subsector intensity method can be used to check the elasticity results per (sub)sector, but comparison is difficult due to the different savings definitions (total savings versus policy savings). The method regression analysis can check the elasticity values used and, with other policy measures incorporated, the overlap with other policies. However, this asks for extensive data.

23. **IE – HH/Other (appliances) – Measurement** (PDF 108)
Information (excluding mandatory labels) on more efficient appliances
Measuring ex-ante/ex-post to calculate the savings for each appliance is way too expensive. The method is only applied incidentally to check the savings calculated with other less costly methods, such as deemed savings that represents the additional method. Billing analysis can only show changes in overall electricity consumption, and not the effect of replacing appliances by a new one due to information. The same holds for the unit consumption method (average kWh/year per appliance) that provides yearly savings which are only partly due to information. The engineering estimate method is not a n obvious additional method as its ability to cope with complex systems is not needed for appliances.

As for total savings methods the energy-intensity method (electricity consumption per household) will show much more than the saving effects of information for one appliance type. Measurement is generally not combined with regression analysis that concerns data on electricity use and influencing factors at a higher aggregation level.

24. **IE – Services-ex-buildings – Billing analysis** (PDF 25)
Information on saving actions for activities of SME (not buildings)
Billing analysis ex-ante/ex-post is a rather cheap way to calculate savings but it concerns overall energy (sometimes also motor fuel or electricity) consumption which is influenced by many other factors than the policy measure at hand. Therefore, the savings should be regularly checked by an additional method, such as measurement (including more energy efficient behavior on which information has

been provided). The deemed savings method is generally not applied due to the non-uniform actions and circumstances. The same holds for the engineering estimate method and the unit consumption method.

As for total savings methods the energy-intensity method provides too aggregated saving results for all policy measures to be useful. The regression analysis method is generally not applied for this tool.

25. **IE (audit) – Industry/general – Econometric/regression** (PDF 132 on voluntary audits)
Regression analysis can provide the part of changes in energy consumption that is due to actions as a result of policy, the net savings (in this case the savings effect of companies joining a voluntary audit scheme that provides information on saving options). However, the results depend on the completeness of the set of explaining variables and availability of reliable data for both participants and non-participants, which have to be checked with other methods. Billing analysis not applicable it applies the same data as regression analysis, but cannot separate savings from other effects. The measurement method can be applied at disaggregated level (all actions due to the audits) but that is too costly. With the deemed savings method the savings can be calculated, but these have to be specified for all actions due to the audits, while regression analysis only registers the participation. The same holds for Unit consumption and for engineering estimates, but that method is more costly.

As for total savings methods the (sub)sector intensity method concerns the same energy consumption data, while not providing the policy part of the savings.

26. **IE – Transport/persons – Deemed savings** (PDF 111)
More efficient new cars due to information (excluding labels)
A new car will save fuel compared to the old car, depending on the choice of buyers, which is influenced by information (excluding mandatory labels). The deemed savings method is a cost-effective way of calculating total savings but not very reliable as for the follow-up of information and the chosen new car versus the old car. The deemed savings can be checked with the additional method measurement that should focus on the various new versus old cases and related unitary savings (the follow-up is part of the calculation of number of actions). Billing analysis before/after replacing cars can show changes in overall fuel consumption for the surveyed group, but due to many other influencing factors, it is not suitable to check the deemed savings due to providing information. The engineering estimate method is not an obvious additional method rather simple car-for-car cases. The unit consumption method (average fuel use per car) cannot show the part of the savings due to information influencing choices for new cars.

As for total savings methods the scope of the energy-intensity method (fuel consumption for passenger transport) is way too aggregated to be useful for checking deemed savings. Regression analysis can use deemed savings as an input to calculate total savings, and in this sense acts as an additional method, but does not add to the results from the deemed savings method.

27. **VA– Industry/general - Energy indicator / subsector intensity** (PDF 35)
Methodology concerns total savings which are not specified, not analysed for additional methods.

28. **MB – Building/residential – Deemed savings** (PDF 70)
Actions on insulation types for existing dwellings under EEO scheme
Deemed savings per insulation type are a simple, but not so reliable, method to calculate the savings from an Energy Efficiency Obligation system. The measurement method is a suitable additional method to incidentally check the (gross) deemed savings through before/after measurement for a representative group. Billing analysis before/after insulation can show the changes in overall energy consumption, but due to other influencing factors and other actions, it is less suitable to check the

deemed savings due to the stimulated actions. Engineering estimates are seen as a better, but more costly, estimate of the savings compared to deemed savings, but still have to be checked once and again. Due to the overlapping nature this additional method is less useful. The unit consumption method (in this case average gas consumption for heating per dwelling) will show much more effects than only the effect of stimulated insulation actions and therefore not regarded as an additional method.

As for total savings methods the energy-intensity method is not regarded as an additional method due to it containing too much other effects than savings from insulation measures. The method regression analysis can possibly use deemed savings to specify unitary savings in the regression formula.

29. **MB - Building/residential – Econometric/regression** (PDF 51 cohort / logistic regression)
Regression analysis can attribute changes in energy consumption to all kind of explaining factors, in this case the uptake of different retrofit actions and their effects on gas consumption, dependent on a set of dwelling features, income and tenure. The results incorporate also the effects of higher energy prices and stimulating policies (including free riders and take-back, thus the net savings). But these effects have not been separated from total savings because they were not taken into account in the regression analysis. None of the additional methods can address these effects because there is not a control group with different prices and policy. As for total savings billing anblysis is not useful because it cannot attribute the savings to different retrofit actions or policy effects. The measurement method can be applied (on a subset of dwellings) at disaggregated level to check the savings per type of retrofit action, but cannot separate the policy effect. The same is true for engineering estimates, but this method is more costly. Deemed savings that have been checked with other methods can be used as a check on savings per retrofit action. But the unit consumption method is only useful for equipment and not for insulation measures.

As for total savings methods the (sub)sector intensity method provides neither the savings per retrofit action, nor the policy effects.

30. **MB - Industry/general - Engineering estimate** (PDF 83)
Energy efficiency actions/plan as part of EEO or WCS system
The engineering estimates method is suitable for calculating the savings of non-uniform actions, or savings from a set of actions (energy plan), and cost-effective due to the scale of energy use. However, the estimates have to be checked regularly, for which the measurement method (ex-ante, but especially ex-post) is a very useful and cost-effective additional method. Checking is also possible with the billing analysis method, but less reliable due to the larger scope and other influencing factors. The deemed savings method is not suited for non-uniform actions and thus not an additional method here. The unit consumption method cannot be applied because it concerns energy use for one equipment type.

As for the total savings methods the energy-intensity method concerns energy consumption of whole (sub)sectors and all policy measures, thus does not provide effects for one company and actions due to an EEO or WCS scheme. The method regression analysis is generally not applied for processes in industry.

Annex III: Analysis of relevant combinations of ex-post methods and ex-ante methods

For the following combinations the feasibility of the combination has been analysed and rated relevant, less relevant (not always, not optimal) and not relevant (due to methodological problems, far better alternatives or too costly).

Deemed savings

Measurement ex-post & Deemed savings ex-ante
The combination of deemed savings (ex-ante) and measurement before/after (ex-post) is quite relevant, provided that the measurement covers the energy consumption for the uniform saving action, for which deemed savings have been defined.

Billing analysis ex-post & Deemed savings ex-ante
The scope as to energy consumption of billing analysis (e.g. total gas consumption for space heating) is generally (much) larger than that of the saving action for which deemed savings (gas savings of wall insulation) have been defined. However, retrofitting with a combination of actions with deemed savings can be combined with billing analysis, thus sometime relevant

Engineering estimate ex-post & Deemed savings ex-ante
The combination of deemed savings (ex-ante) and engineering estimate before/after (ex-post) is relevant, but not logical. If an engineering estimate is possible ex-ante, applying the same method for both ex-ante and ex-post provides better saving results.

Unit consumption ex-post & Deemed savings ex-ante
The savings derived from the trend for Unit consumption (ex-post) can be compared with the deemed savings (ex-ante) if it covers the yearly efficiency improvement for the equipment at stake. But the combination is less useful because unit consumption represents total savings while deemed saving often represent net savings.

Subsector intensity ex-post & Deemed savings ex-ante
The scope of subsector intensity method is generally (much) larger than energy consumption of the saving action for which deemed savings have been defined. The combination is not relevant.

Regression analysis ex-post & Deemed savings ex-ante
The scope of regression analysis and deemed savings differ too much to have a useful combination. Also because of different definitions of savings the combination is rated as not relevant.

Elasticity analysis ex-post & Deemed savings ex-ante
The scope of elasticity analysis and deemed savings differ too much to have a useful combination. Also because of different definitions of savings the combination is rated as not relevant.

Engineering estimate

Measurement ex-post & Engineering estimate ex-ante
The combination is less relevant. An engineering estimate for both ex-ante and ex-post provides comparable results as for savings definition.

Billing analysis ex-post & Engineering estimate ex-ante
The scope for energy consumption of billing analysis (ex-post) can be the same as that for an engineering estimate (ex-ante), e.g. space heating in a dwelling or an industrial process. But the engineering approach is more detailed on savings than the billing approach, thus reasonably relevant.

Deemed savings ex-post & Engineering estimate ex-ante
The combination of deemed savings (ex-post) and engineering estimate with/without (ex-ante) is less relevant. Applying the engineering estimate method for both ex-ante and ex-post provides better saving results.

Unit consumption ex-post & Engineering estimate ex-ante
The savings derived from the trend for unit consumption (ex-post) can only be compared with the engineering estimate with/without (ex-ante) if the estimate covers the yearly efficiency improvement for the equipment at stake. But the combination is not logical because unit consumption concerns a simple calculation case (kWh of device per year) while the engineering estimate method is meant for complex calculations (e.g. buildings). The combination is rated as less relevant.

Subsector intensity ex-post & Engineering estimate ex-ante
The scope as for energy consumption of the subsector intensity method is generally (much) larger than that of the saving action for which engineering estimates have been calculated. Moreover, the savings definitions will generally differ. The combination is not relevant.

Regression analysis ex-post & Engineering estimate ex-ante
The scope of regression analysis and engineering estimates differ too much to have a useful combination. Also because of different definitions of savings the combination is rated as not relevant.

Elasticity analysis ex-post & Engineering estimate ex-ante
The scope of elasticity analysis and engineering estimates differ too much to have a useful combination. Also because of different definitions of savings the combination is rated as not relevant.

Stock modeling

All ex-post methods & Stock modeling ex-ante
Ex-ante stock modeling generally uses deemed savings for the unitary savings. Therefore, the same results are found as for combinations of ex-post methods and deemed savings ex-ante.

Elasticity analysis

All ex-post methods & Elasticity analysis ex-ante
Elasticity analysis is a top-down approach that provides savings at a high aggregation level, e.g. sector or total end-use. Moreover, this method is only capable to calculate the effect of one policy measure type, namely energy taxes. Most other methods use a bottom-up approach at a low aggregation level and calculate effects of various policy measure types. Due to difference in scope and savings definition the combinations are rated as not relevant.