Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services

Bottom-up evaluation methods: the example of condensing boilers

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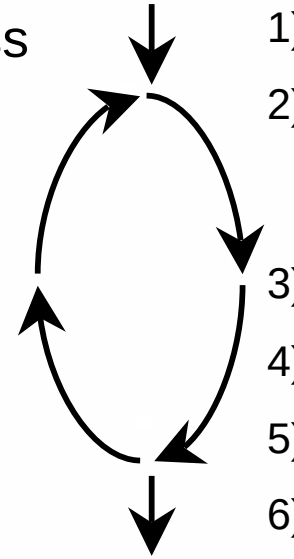
Plan of the presentation

- **Introduction**
- **Step 1: unitary gross annual energy savings (in kWh/year/participant or unit)**
- **Step 2: total gross annual energy savings (in kWh/year)**
- **Step 3: total ESD annual energy savings in the first year (in kWh/year)**
- **Step 4: total ESD annual energy savings achieved in 2016 (in kWh/year, in year 2016)**
- **Conclusion**

Introduction

- presentation of a concrete application of the methodology

→ advised process



1) preliminary work
2) possible options for formulas (calculation / accounting)
   a. assessment
   b. choice
3) data needs
4) data collection options
5) differences between MS
6) final decision on levels of evaluation efforts
7) summarising (key points of the evaluation methods)

→ state of progress: phases 1 + 2

Introduction

- **phase 1 - preliminary work → available material**:

• four case studies from the 1990's (France, UK, Germany, the Netherlands)

• current accounting in the obligation systems (EEC in UK, White Certificates in France and Italy) + *others ?*

• regulations and standards (Directive 92/42/EEC, Dutch and UK regulations) + *others ?*

• Ecoboiler (in the framework of the Ecodesign Directive) and IMPRO-Building studies

• other past SAVE projects and literature

➔ various sources: examples of evaluations, accounting methods, technical regulations

Step 1: unitary gross annual energy savings

→ contents of step 1

- Step 1.1: formula for unitary gross annual energy savings
- Step 1.2: “technical” baseline
- Step 1.3: normalisation factors
- Step 1.4: proposed three levels of efforts
- Step 1.5: conversion factors

Step 1: unitary gross annual energy savings

- **step 1.1: general formula**

• annual energy savings (kWh/year/unit)

= average annual heating consumption x efficiency gain

• average heating consumption (kWh/year/dwelling or m²)

= f (type of dwellings (age, size, etc.), climatic zones, boiler use)

→ based on statistics and/or engineering calculations

• efficiency gain (%)

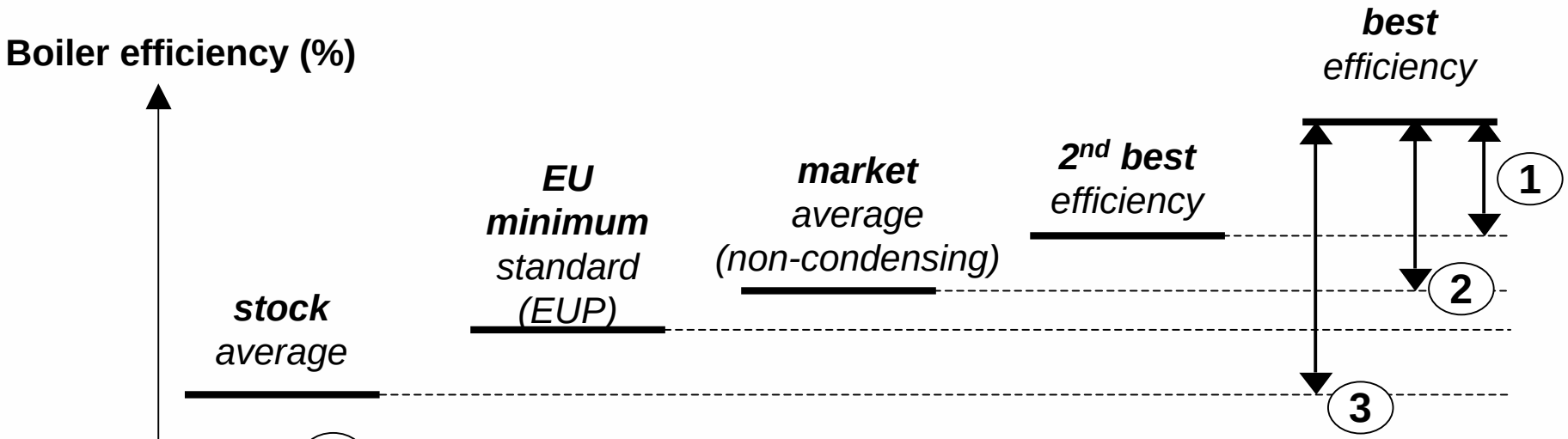
= η(condensing boiler) – η(standard boiler)

→ based on normalisation, field test and/or modelling

+ CAUTION: the efficiency may be expressed compared to the Gross Calorific Value or to the Net Calorific Value

Step 1: unitary gross annual energy savings

- **step 1.2: "technical" baseline: proposed principle for 3 levels**



1 **Level 1: default conservative** efficiency gain

2 **Level 2: MS-specific** efficiency gain

3 **Level 3** baseline in **special cases** (proven early replacements)

+ EU minimum standard = minimum efficiency for level 2 baseline?

+ default assumption: the replacement is "**fuel neutral**"

Step 1: unitary gross annual energy savings

- **step 1.3: normalisation factors**

• **size** of the dwelling: no change for a given dwelling, but taking account of the differences between dwellings

• **location** of the dwelling → Heating Degree Days

Level **1**	Large climatic zones defined at a **European scale**
Level **2**	Climatic zones defined at a **national scale**
Level **3**	Registering of the participants' location and use of **local HDD**

• **rebound effect**: to be investigated (using existing feedback)

→ the zones, data sources and way of addressing the rebound effect should be the same for all methods dealing with heating (+ sharing the work)

Step 1: unitary gross annual energy savings

- **step 1.4: proposed three levels of efforts**

Level **1**	- **average energy consumption**: **default conservative value** based on the available data among Member-States - **efficiency gain**: **default conservative value** → baseline = 2nd best efficiency of the market
Level **2**	- **average energy consumption**: average value taking into account **national statistics** about the building stock, return temperature of heating equipment and weather conditions - **efficiency gain**: average value based on sales data (**national market shares**)
Level **3**	- **average energy consumption**: average value taking into account **participants' data** (e.g. billing data, location, building characteristics) - **efficiency gain**: **participants' data** (boiler replaced + early replacement ?)

➔ the level 1 values and the level 2 and 3 requirements should be harmonised between the methods dealing with heating (+ sharing the work)

Step 1: unitary gross annual energy savings

- **step 1.5: conversion factors**

• level 1: ESD Annex II: 1 kg of Natural Gas → 13,10 kWh (NCV)

• level 2 value: based on national production and imports + for both: the calculation of the energy savings AND of the target

• level 3 value: no real meaning for natural gas

CAUTION1: it should be checked that the energy savings are expressed in **end-use (final) energy and <u>not</u> in primary energy** (e.g. in Italy)

CAUTION2: Savings should be corrected **from GCV to NCV** by dividing by 1.11 (taking away latent heat)

Step 2: total gross annual energy savings

- **step 2: summing up the number of actions**

• unit of action = the equipment (one condensing boiler)

total gross energy savings
*= average energy savings per boiler * number of boilers*

• data sources:

→either **monitoring** of the boilers installed (in the frame of the monitored EEI measure) or market **sales data** (but with a market analysis as justification)

→ no possible EU default or harmonised values, because the market situations are too different

Step 3: total ESD annual energy savings in the first year

→ **contents of step 3**

- step 3.1: formula for ESD savings
- step 3.2: double counting
- step 3.3: technical interactions
- step 3.4: multiplier energy savings
- step 3.5: free-rider effect

Step 3: total ESD annual energy savings in the first year

- **step 3.1: formula for ESD savings**

  total net energy savings

  = average energy savings per boiler

  * gross number of boilers

  * (1 - free-rider ratio (?)+ multiplier ratio)

  * double-counting factor

→ free-rider effect not explicitly mentioned in the ESD (still to be decided) + free-riders may be included in the “technical” baseline (depending on the type of EEI measure)

Step 3: total ESD annual energy savings in the first year

- **step 3.2: double counting**

Level **1**	reporting one single measure/programme related to condensing boilers
Level **2**	forming one consistent package of measures related to condensing boilers
Level **3**	sharing results according to priority rules

→ when several measures/programmes are related to condensing boilers, the level 2 option (package) should be encouraged

Step 3: total ESD annual energy savings in the first year

- **step 3.3: technical interactions**

→ possible interactions with measures improving the building performance: in that case, the efficiency gain should be applied to the improved heating consumption

→ difficulties: monitoring the cases where it occurs → is it worth? shouldn't global approach be favoured?

→ possible alternative: regularly updating the average heating consumption (using national trends)

Step 3: total ESD annual energy savings in the first year

- **step 3.4: multiplier energy savings**

→ studying multiplier effect = market transformation analysis

→ multiplier savings happened in the past (e.g. in the Netherlands)

→ requirements common as for market analysis + always level 3 (+ common for all methods related to the promotion of an efficient product)

→ what about the case where a real market transformation happened? How long should the multiplier savings be accounted for?

Step 3: total ESD annual energy savings in the first year

- **step 3.5: free-rider effect**

→ still to be discussed if it should be included

→ two main options:

  - option 1: assuming free-riders are included in the “technical” baseline
  - option 2: defining gross-to-net ratios

Step 4: total ESD annual energy savings achieved in 2016

- **step 4.1: saving lifetimes**

→ CWA value: 17 years

- **step 4.2: performance degradation**

→ to be investigated, but later
(when the evaluation system will be “mature”)

Conclusion

- a rich available material, but some need for updates
- outline of a method, to be completed by:
  - sources not included yet
  - exchanges with the Committee, Member-States and other EMEEES partners
- sharing the work for common tasks with other methods on heating (energy consumption data, climatic zones, requirements for market analysis)
- what will be our approach for consistency of conservative coefficients?
- next step: task 4.3 → defining level 1 values

Thank you for your attention.

Comments and questions are welcome !

Step 1: unitary gross annual energy savings

- **step 1.1: general formula**

• details about the average heating consumption (kWh/year/dwelling or m²)

→ usually data are available for the building stock: it should be taken account of the difference of efficiency between the “replaced” boiler and the “new standard” boiler

average annual heating consumption with standard "new" boilers =

$$\textit{average annual heating consumption with replaced boiler} * \frac{\eta_{\textit{"new" standard boiler}}(\%)}{\eta_{\textit{replaced boiler}}(\%)}$$

Step 1: unitary gross annual energy savings

- **step 1.2: "technical" baseline**

→ proposed three levels:

Level **1**	- default standard boiler: 2nd most efficient kind of boilers (**labelling**) or standard boiler based on **European statistics**? → default conservative average efficiency gain
Level **2**	- standard boiler based on the **national sales data** + average efficiency gain taking into account the **climatic conditions** of each MS
Level **3**	- "replaced" boiler based on **participants' data** (measure-specific) *"replaced" = what would have been installed without the promotion measure*

Step 2: total gross annual energy savings

- **step 2.2: five categories of buyers**

1. participants in the programme who made the purchase due to the programme (“decision changers”, the “good” participants contributing to energy savings);

2. participants in the programme who would have made the purchase in the absence of the programme, too (“free riders”);

3. non-participants of the programme who bought a condensing boiler due to spill-over effects of the programme (“free drivers”, who hence also contribute to measure-induced energy savings);

4. non-participants of the programme who would have made the purchase in the absence of the programme, too (“autonomous non-participant savers”);

5. non-participants of the programme who purchased a boiler but not a condensing boiler (“the indifferent”).

Step 2: total gross annual energy savings

- **step 2.2: five categories of buyers**

- gross result from number of subsidies = (1 *participants*) + (2 *free-riders*)

- gross result from sales data = (1) + (2) + (3 *free-drivers*) + (4 *non-participants*)

➔ **non-participant ratio** (sales data → gross result of the measure) =

$$\frac{gross\ result\ \ from\ number\ of\ \ subsidies}{gross\ result\ \ from\ sales\ data} \rightarrow \begin{cases} \dfrac{(1)+(2)}{(1)+(2)+(3)+(4)} \\ 1-\dfrac{(3)+(4)}{(1)+(2)+(3)+(4)} \end{cases}$$

Step 2: total gross annual energy savings

➔ **non-participant ratio** =

$$\frac{gross\ result\ \ from\ number\ of\ \ subsidies}{gross\ result\ \ from\ sales\ data} \dashrightarrow \frac{(1)+(2)}{(1)+(2)+(3)+(4)}$$

➔ **free-rider ratio** =

$$\frac{number\ of\ \ freeriders}{total\ number\ of\ \ participants} \dashrightarrow \frac{(2)}{(1)+(2)}$$

➔ **spill-over ratio** =

$$\frac{number\ of\ \ freedrivers}{total\ number\ of\ \ participants} \dashrightarrow \frac{(3)}{(1)+(2)}$$

Example of the French White Certificates (2)

- **energy consumption data** used for the French White Certificates

= f (age and type of the buildings ; boiler use)

Condition	Individual Home		Apartment	
	Space Heating	Water Heating	Space Heating	Water Heating
≤ 1975	22932 kWh/year	4800 kWh/year	10847 kWh/year	3687 kWh/year
> 1975	20698 kWh/ year	4800 kWh/year	9247 kWh/year	3687 kWh/year

- **normalisation factor for the size of the dwelling (C1)**

Section	Average room number	1 room	2 rooms	3 rooms	4 rooms	5 rooms	6 rooms
Apartment	2.9	0.3	0.7	1.0	1.4	1.7	2.2
House	4.5	0.2	0.4	0.7	0.9	1.1	1.4
Area (m²)		<35	35-60	60-80	80-100	100-130	>130

Example of the French White Certificates (2)

• **normalisation factor for the climatic conditions** (applied to space heating consumption only) (C2)

Zone	Climatic Coefficient
H1	1.1
H2	0.9
H3	0.6

• **average unitary annual energy savings** used for the White Certificates

Conditions	House		Apartment	
	Heating	Water Heating	Heating	Water Heating
≤ 1975	9173 kWh/year	1920 kWh/year	4339 kWh/year	1475 kWh/year
> 1975	8279 kWh/year	1920 kWh/year	3699 kWh/year	1475 kWh/year