

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

Task 8.1: National report from the pilot tests of
Case application 2, Residential building envelope improvement;
Case application 4, Residential condensing boilers in space heating

Performed under

The French White Certificates Scheme

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The Project in brief

The objective of this project is to assist the European Commission in developing harmonised evaluation methods. It aims to design methods to evaluate the measures implemented to achieve the 9% energy savings target set out in the EU Directive (2006/32/EC) (ESD) on energy end-use efficiency and energy services. The assistance by the project and its partners is delivered through practical advice, technical support and results. It includes the development of concrete methods for the evaluation of single programmes, services and measures (mostly bottom-up), as well as schemes for monitoring the overall impact of all measures implemented in a Member State (combination of bottom-up and top-down).

Consortium

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Task 8.1: National report from the pilot tests performed on French White Certificates and residential space heating

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1 Executive summary

► The Work Package 8 in the EMEEES project

The first phase of the EMEEES project has developed two evaluation methodologies (bottom-up and top-down), applied to 20 bottom-up and 14 top-down case applications. The second phase was then a feedback loop to disseminate and confront these outcomes to real and concrete situations:

- on the one hand, debates with key stakeholders (e.g., ministries, national agencies, national experts) on the main methodologies' principles illustrated through a few case applications in national EMEEES workshops (Work Package 9);
- on the other hand, pilot tests where EMEEES methods were applied to concrete cases (i.e. already existing facilitating measures) (Work Package 8).

EMEEES WP8's pilot tests therefore aim at both providing a hands-on feedback on the EMEEES methods and disseminating EMEEES outcomes towards national practitioners.

► Introducing this pilot test

Why a French case study? And how was the corresponding partnership built?

Three French partners were involved in the EMEEES project, which offered a unique opportunity to work on a case study having in the team the two main stakeholders involved in the evaluated measure (the French agency ADEME and the main French energy supplier EDF) together with an outsider and independent look from a research institute (ARMINES), which in addition took part in the definition of the EMEEES bottom-up methodology.

Why the French White Certificates (FWC) Scheme?

→ It is one of the main measures of the French NEEAP.

→ It includes a new monitoring & evaluation system, with both general principles and many concrete case applications (as in the EMEEES project), providing interesting material to compare with the EMEEES outcomes.

→ Feedback from several presentations made at the European level proved that the European Commission and many Member-States (especially new Member-States) were very interested in this system.

Why focusing on space heating in the residential sector?

→ It is the priority target FWC scheme: sector with high consumption, and high energy savings potential but very scattered (millions of households).

→ This objective is confirmed in practice: efficient boilers (condensing and low temperature boilers, both for individual and collective housing) and insulation actions (roof and windows) represent respectively 40% and 13% of the savings credited in the FWC scheme for the period July 2006-December 2008. Together they cover more than half of these credited savings.

► Pilot tests' objectives

The main objectives of the pilot tests performed were:

- to test two bottom-up EMEEES case applications (building envelope improvements and condensing boilers), according to data available from the FWC scheme ;
- to confront the FWC evaluation system to the EMEEES methodology, both:
 - o on a general level: is the FWC scheme compatible with ESD requirements?
 - o through concrete cases (insulation and boilers): are both (FWC and EMEEES) calculations consistent? do the evaluated results differ when applying distinct levels of evaluation efforts (according to the three levels proposed in EMEEES)?
- to compare bottom-up and top-down evaluation approaches on a specific segment (energy savings from space heating in the residential sector) (this latter objective was finally not possible to cover).

These objectives aim at providing a concrete feedback to the EMEEES team and to French stakeholders interested in the reporting of FWC results for ESD purpose.

► Report contents

After a short introduction of the case study (chapter 2), chapter 3 describes the facilitating measures considered in this pilot test: mainly the FWC scheme, and more briefly the other measures which may overlap with it.

Chapter 4 is the core part of this report, including the global comparison between FWC and EMEEES methodologies (section 4.3), and the analysis of the potential contributions of the FWC scheme to the ESD implementation, in terms of results and evaluation system (sections 4.7 and 4.8). Then chapters 5 and 6 detail the concrete cases, respectively of insulation actions and condensing boilers.

► General conclusions

(summary of chapter 7, which gives more details about these conclusions)

The case study emphasised key messages related to the compliance of the FWC scheme with the EMEEES methodology:

- The global bottom-up methodology of 4 steps and 3 levels developed in EMEEES fits with the methodology for FWC calculation methods.
- Going more into details about the bottom-up cases, the specific methods (e.g., for insulation actions) may differ between EMEEES and FWC: this suggests the necessity to keep flexibility for each Member State in order to use the methods best adapted to its context (e.g. data availability), provided that the global methodology remains harmonised at the EU level.
- Energy savings amounts largely depend on parameters describing the 'before' situation (baseline). The adopted values must be explicitly sourced. In particular, the assumptions used should be transparent.

- FWC calculation methods, which are mainly based on ex-ante deemed estimates, constitute an interesting compromise between accuracy and limited transaction costs. The FWC monitoring system appears to be efficient for data collection, provided a relevant selection of data to be registered for each action is performed (in order to limit transaction costs)

About the free-rider/multiplier effect's issue, the FWC scheme has to be considered as a market transformation instrument: first feedback tends to prove that, from a qualitative point of view, the resulting multiplier effects more than compensate the possible free rider effects. For example, the FWC scheme strongly helps to structure the insulation market and to increase the professional awareness on best practices for energy efficiency actions. This is difficult to translate into calculated savings, but should be taken into account in the NEEAP evaluation by the Commission.

About the comparison between bottom-up and top-down approaches, only qualitative conclusions could have been drawn (e.g., differences in the data used). To make a quantitative comparison of both results, it would have been required that the bottom-up evaluations cover all the facilitating measures (or at least all the main ones) targeting the end-use (sub-)sector monitored by the top-down indicators. For this case study, details about the main¹ measure for residential heating (Tax Credits) were not available. This will be a priority issue for the preparation of the 2nd French NEEAP. Due to time and resource constraints, it was therefore decided to focus on the bottom-up part.

► Specific conclusions (cases of insulation actions and condensing boilers)

Case of insulation actions

It was not possible to apply directly the EMEEES method in this case, due to differences between the data expected for the EMEEES method and the data available for this test. Nevertheless, the EMEEES method was analysed from the point of view of an application for a specific case (French context), to see what can be used and what can not.

The first conclusion is that Member States can take advantage of the EMEEES method to better use their own existing evaluation methods: describing them in a harmonised way, detecting what complementary studies would be useful to improve results reliability, justifying differences compared to the EMEEES evaluation approach.

The comparisons between the tested calculation scenarios (according to the three levels proposed by EMEEES) emphasise the importance of the choice of the sample. If the buildings stock in the sample is similar to the whole national buildings stock, there is no major deviation between the different levels of evaluation efforts. This means that it seems relevant to assume that for a sufficiently high number of actions, level 2 (national) and level 3 (participant-specific) results are not significantly different. Then a level 2 evaluation could be reliable enough. A monitoring or survey of the refurbishment market (see Appendix II about the OPEN observatory) should provide complementary analysis.

¹ In terms of energy savings' volume.

Comparing the savings estimated from the FWC and EPC² methods, both calculation approaches appear to be similar, at least using the same main parameters. However, significant differences are observed in the calculated energy savings, mainly due to differences in the values used for the initial thermal transmission. This highlights how important the baseline choice is. Indeed, deviations observed in the FWC vs. EPC comparison (mainly due to distinct baseline values) are much (until ten times) higher than the ones between the calculation scenarios (due to distinct levels of desegregation, i.e. level 2 vs. level 3 values).

Finally, it seems necessary to perform ex-post studies (on relevant samples) to verify actual energy savings (e.g. based on energy bills or measurements), and thus check whether calculated FWC values can be reliably trusted.

Case of condensing boilers

The first conclusion from this case is that there is a very significant gap between level 1 (European default values) and level 2 (national average) results. This highlights that either the proposed level 1 default values may be too conservative, or the FWC values overestimate the savings (for condensing boilers), especially due to the low boiler efficiency used in the FWC baseline. It is possible at a national level to use a particular baseline to encourage a given action. But for the ESD reporting, this should be justified, for harmonisation purpose.

The second conclusion is that the calculated savings are higher, when more participants' data are used (i.e. level 3 savings > level 2 savings). For a small sample (154 boilers analysed here), the possible variations due to the different parameters taken into account do not compensate statistically (contrary to the previous case of insulation actions). In these conditions (small sample, targeting specific situations), a level 3 evaluation (i.e. registering more participants' data) appear to be worthwhile.

However, as for the case of insulation actions, it should be noticed that the main differences observed in the comparisons are related to the values used for the baseline situation (here for boiler efficiencies). These have a much higher impact on the energy savings' results than the differences between level 2 and level 3 calculations.

² Energy Performance Certificates (see EPBD).

2 Introduction

2.1 List of EMEEES case applications tested

	EMEEES case applications tested (bottom-up)	Sector
1	Case application 2 Building envelope improvement	Residential
2	Case application 4 Condensing Boilers	Residential

2.2 General approach and objectives

2.2.1 The Work Package 8 in the EMEEES project

The first phase of the EMEEES project has developed two evaluation methodologies (bottom-up and top-down), applied to 20 bottom-up and 14 top-down case applications. The second phase was then a feedback loop to disseminate and confront these outcomes to real and concrete situations:

- on the one hand, debates with key stakeholders (e.g., ministries, national agencies, national experts) on the main methodologies' principles illustrated through a few case applications in national EMEEES workshops (Work Package 9) ;
- on the other hand, pilot tests where EMEEES methods were applied to concrete cases (i.e. already existing facilitating measures) (Work Package 8).

EMEEES WP8's pilot tests therefore aim at both providing a hands-on feedback on the EMEEES methods and disseminating EMEEES outcomes towards national practitioners.

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Three French partners were involved in the EMEEES project which offered a unique opportunity to work on a case study having in the team the two main stakeholders involved in the evaluated measure (the French agency ADEME and the main French energy supplier EDF) together with an outsider and independent look from a research institute (ARMINES), which in addition took part in the definition of the EMEEES bottom-up methodology.

Why the French White Certificates (FWC) Scheme?

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- It includes a new monitoring & evaluation system, with both general principles and many concrete case applications (as in the EMEEES project), providing interesting materials to compare with the EMEEES outcomes.
- Feedback from several presentations made at the European level proved that the European Commission and many Member States (especially new Member States) were

very interested in this system.

Why focusing on heating in the residential sector?

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→ This objective is confirmed in practice: efficient boilers (condensing and low temperature boilers, both for individual and collective housing) and insulation actions (roof and windows) represent respectively 40% and 13% of the savings credited in the FWC scheme for the period July 2006-December 2008. Together they cover more than half of these credited savings.

2.2.3 Pilot test's objectives

The main objectives of this case study were:

- to test two bottom-up EMEEES case applications (building envelope improvements and condensing boilers), according to data available from the FWC scheme ;
- to confront the FWC evaluation system to the EMEEES methodology, both:
 - o on a general level: is the FWC scheme compatible with ESD requirements?
 - o through concrete cases (insulation and boilers): are both (FWC and EMEEES) calculations consistent? do the evaluated results differ when applying distinct level of evaluation efforts (according to the three levels proposed in EMEEES)?
- to compare bottom-up and top-down evaluation approaches on a specific segment (energy savings from heating in the residential sector) (this latter objective was finally not possible to cover).

These objectives aim at providing a concrete feedback to the EMEEES team and to French stakeholders interested in the reporting of FWC results for ESD purpose.

For the concrete cases, calculations were applied to a sample of implemented actions provided by EDF.

2.2.4 Report contents

After a short introduction of the case study (chapter 2), chapter 3 describes the facilitating measures considered in this pilot test: mainly the FWC scheme, and more briefly the other measures which may overlap with it.

Chapter 4 is the core part of this report, including the global comparison between FWC and EMEEES methodologies (section 4.3), and the analysis of the potential contributions of the FWC scheme to the ESD implementation, in terms of results and evaluation system (sections 4.7 and 4.8). Then chapters 5 and 6 detail the concrete cases, respectively of insulation actions and condensing boilers.

3 Description of the EEI facilitating measure considered for the pilot test

The bottom-up part of the pilot test focuses on the French White Certificates (FWC) scheme. However, the FWC scheme cannot be evaluated without considering the other facilitating measures targeting the same end-use actions (especially when dealing with double counting and multiplier effects). This would also be necessary to enable a comparison between a Bottom-Up and a Top-Down evaluation of the savings for heating in the residential sector. However, such a quantitative comparison between BU and TD results has not been possible to achieve within this test, due to time constraints and data availability.

Initially, the general approach planned for the bottom-up part of this pilot test was to use the actions implemented within the FWC scheme (which are registered, i.e. for which level 2 or 3 data are available) as a sample for the evaluation of all the actions resulting from the whole package described in this chapter. But at the end, it was not possible within this pilot test to access the minimum data necessary (i.e. the number of implemented actions) to evaluate other measures than the FWC scheme (especially Tax Credits). Moreover, considering that all the actions on heating for existing residential buildings was necessary in order to compare bottom-up and top-down results, this comparison was finally not possible.

This chapter first introduces the FWC scheme, and then lists the other facilitating measures which may have interactions with it (for the considered end-use actions).

3.1 The French White Certificates Scheme

Title of the EEI measure	
White Certificates Scheme	
<i>In addition to this synthetic description, a detailed analysis of the White Certificates Scheme is presented below this table.</i>	
Category	
EEI mechanisms: Public service energy saving obligation for energy suppliers (this is a new market instrument, regulated by the Ministry in charge of energy).	
Regional application	
This is a national measure, effective on the whole country.	
Sector(s) addressed	
This is a cross-sectoral measure (residential, tertiary, industry and transport), but actually focused on the residential and tertiary sectors.	

Target group	
For residential and tertiary sectors, the mechanism targets in priority existing buildings.	
End-use EEI action targeted And effectiveness	
<p>The public authority imposes for a period of 3 years an energy savings obligation on the energy suppliers (electricity, gas, fuel for buildings). Each supplier has to meet a target of energy savings and will pay a penalty if it fails. The first period began in July 2006 and will end in June 2009.</p> <p>To respect this obligation, suppliers have to carry out programmes to encourage the implementation of energy saving actions at final customers' sites. A list of 139 eligible actions has been set with professionals: for each action, an amount of ex-ante unitary energy savings has been determined, based on few parameters (type of dwelling, climatic zone, surface ...). A public authority certifies these programmes and assigns certificates.</p> <p>Suppliers are allowed to fulfil their obligation by buying certificates from other actors involved. Indeed, public bodies and companies are eligible actors and can implement programs and obtain certificates too. Exchanges of white certificates are tracked on the national register.</p> <p>The "kWh cumac" is the accounting unit of the scheme: the energy savings are calculated in final energy, they are cumulated over the lifetime of each action and discounted with a rate of 4%. For the first period, the global obligation equals to 54 TWh cumac, shared between 2 500 suppliers. The penalty has been fixed at 2 c€ / kWh cumac.</p> <p>The following table details the different categories of eligible standardised actions in the scheme. This mainly concerns buildings.</p>	

Table 1. Number of standardised actions³ per category (in the FWC scheme).

Categories of standardised actions	Number of distinct standardised actions
Residential Building	58
Envelope	7
Thermal systems	43
Appliances	7
Services	1
Tertiary Buildings	80
Envelope	14
Thermal systems	47
Appliances	18
Services	1
Grids ⁴	8
Industry	19
Transport	5
TOTAL	170

<p>Actions considered for the tests :</p> <ul style="list-style-type: none"> - Building envelope improvement (chapter 5) - Condensing boilers (chapter 6) <p>Link with other EEI measures: the FWC scheme is compatible with a VAT reduction and the a Tax Credit mechanism in place for most of the end-use actions considered in this pilot test.</p>	
If available:	
expected annual energy savings in 2016 and 2010	
<p>For its first period (2006-2009), the FWC scheme had a target of 54 TWh cumac. This unit (kWh cumac) means that energy savings are cumulated and discounted (at a 4% rate) over the action lifetime (see also section 4.3.2). Moreover, special coefficients are also sometimes applied to take account of specific situations (e.g., initial market share, actions in the overseas) (see section 4.3.2). Consequently, to assess the contribution of the FWC scheme to the ESD target (expressed in annual kWh saved in 2016 or 2010), it is first necessary to convert the kWh cumac in annual kWh by using a deemed average action lifetime (see section 4.3.3.5).</p> <p>The corresponding result may be deduced from the actions registered and credited in the FWC scheme by the end of 2008, as data required for this translation process are at least partially publicly available. Based on this, an average ratio can be calculated between FWC and ESD savings for a sample representing more than 70% of the savings (see Table 8 in</p>	

³ As of end of 2008.

⁴ District Heating & Cooling, and Public Lighting.

<p>section 4.7.1). This ratio is around 10. So a rough estimate of the contribution of the FWC scheme to the ESD target for France would then be around 5,4 TWh saved in 2016. This figure and the limits of this kind of assessment are further discussed in section 4.7.</p>	
Status of implementation and exact timeframe	
<p>The Scheme began in July 2006 for a first period of 3 years. A second period is now under negotiations: this should extend from July 2009 to December 2012. A third period might be implemented after 2012.</p> <p>The FWC scheme will still be effective in 2010, and probably in 2016 too. The global FWC scheme's impact in 2016 (in terms of annual energy savings) will depend on the lifetime of the actions that actors will implement (as mentioned above), and on the targets defined for the next periods of the scheme.</p>	

As the FWC scheme is the facilitating measure this test focuses on, more details about it are presented in Appendix III. In addition, details about its evaluation system are provided in section 4.3.2. The general comparison with the EMEES methodology is then introduced in section 4.3. The current progress of the FWC scheme is presented in section 4.7.1. An analysis of the contribution of the FWC scheme to the ESD implementation is finally proposed in sections 4.7 and 4.8.

3.2 Other relevant facilitating measures for this pilot test

This section describes the following facilitating measures which may overlap with the FWC scheme:

- Value – Added Tax (VAT) Reduction on dwellings renovation works ;
- Tax Credit for energy-efficient equipment and renewable energies.

These measures are included in the French NEEAP (see chapters 9 and 10 of the French NEEAP). Some other measures complete the tools set for the residential sector, but will not be specially considered in this study:

- Energy Performance Assessments (or EPC, Energy Performance Certificates) of new and existing buildings (see chapter 8 of the NEEAP): an energy performance assessment has to be provided when a building or a part of a building is purchased or leased, in application of the Energy Performance of Buildings Directive (EPBD). This measure will not be taken into account: it's a too recent measure, effective from November 2006 for purchases and July 2007 for leases, and doesn't directly interfere with the FWC scheme. Indeed, actions considered in a FWC program are not necessarily concerned by a purchase or a lease operation. However, in the future, if energy savings are to be attributed to French EPC, then it should be checked whether there is an overlap with the FWC scheme ;
- New building code for existing buildings (see chapter 8 of the NEEAP): this new regulation applies in case of renovation works and has been in force since November

2007 (elemental (or “components”, see EPBD) approach) and April 2008 (general performance or “system” approach). However, FWC are only delivered for energy savings due to energy performance strictly beyond this new regulation. That’s why equipment and works considered in the FWC actions studied here can not be linked to the implementation of this regulation. However, in the future, there could be a multiplier effect between the FWC scheme and this building code (see section 5.3.4) ;

- The sustainable development account (see chapter 10 of the NEEAP): in 2007, the French Government changed the former “Codévi” (account for industrial development) to extend it to encourage energy savings (and renewable energies) actions in housings. This account provides funding for soft loans proposed to private individuals, co-owners or professionals who engage energy savings works (these works have to be eligible to the tax credit). However, information available do not allow establishing whether FWC actions also benefited from soft loans.

At the end of this section, a graph represents the implementation chronology of the considered facilitating measures.

Title of the EEI measure	
Value Added Tax (VAT) Reduction on dwellings renovation works	
Category	
Financial Instruments: Tax rebates and other taxes reducing energy end-use consumption. (this is a fiscal measure, to globally encourage building refurbishment, transformation and maintenance works).	
Regional application	
The VAT Reduction is a national measure, effective on the whole country.	
Sector(s) addressed	
This measure concerns the residential sector only.	
Target group	
This fiscal reduction targets principal households’ dwellings. The building must have been delivered for more than 2 years.	
End-use EEI action targeted and effectiveness	
The Value Added Tax equals 5,5% (instead of 19,6%) for supplying and installation of systems (heating , lighting, air – conditioning ...), and for works on the envelope. The VAT reduction equals a 12% subsidy on equipment and works costs. This reduction applies to any renovation work (no energy efficiency criteria is required).	
Actions considered for the test :	
- Building Envelope Improvements (part 5)	

<ul style="list-style-type: none"> - (Other) Heating Systems Improvements (part 6) - Condensing Boilers (part 7) <p>Link with other measures: some equipment or materials are eligible to the tax credit and to the White Certificates Schemes.</p>	
If available: expected annual energy savings in 2016 and 2010	
--	
Status of implementation and exact timeframe	
This measure had been decided in 1999 and is valid until the end of 2010. It should be effective until 2016.	

Title of the EEI measure	
Tax credit for energy efficiency equipments and renewable energies	
Category	
Financial Instruments: Tax rebates and other taxes reducing energy end-use consumption (this is a fiscal measure to encourage the development of energy efficient equipment, renewable systems markets and insulation works)	
Regional application	
The Tax Credit is a national measure, effective in the whole country.	
Sector(s) addressed	
This measure concerns the residential sector only.	
Target group	
This measure targets principal households' dwellings. The building must have been delivered for more than 2 years. Higher credit rates are also used to promote some actions in old (built before 1977) dwellings.	
End-use EEI action targeted and effectiveness	
The following table details the different type of equipment or material eligible, the minimum performance requirements and the credit rate (from 15 to 50%).	

Table 2. End-use actions and eligibility criteria for Tax Credits in France.

Equipment or material		Requirements	Rate
Condensation boiler	Individual or collective boiler	Defined in the European Directive 92/42/CE	25% or 40% (*)
Low temperature boiler	Individual or collective boiler		15%
Insulation	Walls and roof	$R > 2,8 ; 3 \text{ or } 5 \text{ m}^2\text{K} / \text{W}$ (floor and walls, flat roof, attics)	25% or 40% (*)
	Windows	$U_w < 1,4 \text{ to } 2 \text{ W/m}^2\text{K}$	
	Shutter	$R > 0,2 \text{ m}^2\text{K/W}$	
	Lagging	$R > 1 \text{ m}^2\text{K/W}$	
Regulation and programming equipments			25% or 40% (*)
Individual solar water heating		Certified Solarkeymark or CSTBat	50%
Wood stoves, inserts, wood boilers		Efficiency > 70% CO emissions < 0,6 %	50%
Heat Pumps	Geothermal and aérothermal equipments	COP > 3,3 (Coefficient of Performance)	50%

(*): 40% if the dwelling was built before 1977 and the works are achieved during the 2 years following the acquisition.

The credit concerns equipment expenses only and doesn't apply to labour costs.

During the whole period 2005 – 2009, the credit can not exceed for a given household a certain amount: 8 000 euros for a single and 16 000 euros for a couple, increased by 400, 500 or 600 euros by dependent person or child.

Actions considered for the tests:

- Building envelope improvement (part 5)
- Heating Systems Improvement (part 6)
- Condensing boilers (part 7)

Link with other EEI measures: the VAT reduction applies for all of these actions, which are

also eligible to the White Certificates Scheme.	
If available: expected annual energy savings in 2016 and 2010	
--	
Status of implementation and exact timeframe	
<p>The actual tax credit rules have been established for a 5 years period, from 2005 to the end of 2009. This measure should be extended beyond 2010, but with different rules (list of eligible actions, performance requirements, rates).</p> <p>Tax credit is an “early measure”, that has been existing from 1990:</p> <ul style="list-style-type: none"> - From 1990 to 1999: the tax credit applied to dwellings in general (acquisition, health adaptations ...) but didn't specifically target the renovation works or efficient equipments. This was more precisely a tax reduction between 15 and 25% that concerned the taxpayers only, and not a tax credit. - From 1999 to 2005: the tax reduction became a tax credit of 15%, that beneficiates to every household, paying or not tax. Maintenance of walls, heat system installations or replacements are eligible, like systems using renewable energy (heat solar production, wood stove, etc.) from 2001. 	

The tax credit has met a progressive success from 2005 and more and more households take advantage of this measure to engage renovation works. Table 3 below details the amounts of tax credits granted per year since 2005, according to the MINEFI, the ministry in charge of taxes.

Table 3. Amounts of tax credits granted per year

2005	400 M€
2006	950 M€
2007 (est.)	1 700 M€
2008 (est.)	2 500 M€

Source : Ministère du Budget, des Comptes Publics et de la Fonction Publique / Direction Générale des Finances Publiques / Direction de la Législation Fiscale

The breakdown by operation or equipment is not systematically available. Table 4 below presents the details available for the year 2006.

Table 4. Distribution of tax credits according to action types (in 2006).

Insulation of roofs and walls	0.3%
Windows replacement	55.4%
Low Temperature Boilers	11.6%
Condensation Boilers	4.3%
Renewable equipments	29.1%

Source : Direction Générale du Trésor et de la Politique Economique

This distribution is only based on financial data (i.e. tax credits' volumes). The quantities of corresponding technical actions are not known (e.g., number of boilers and windows).

The following graph represents the implementation chronology of the 3 facilitating measures described.

Main events happened in:

- 1999: tax reduction becomes a tax credit, the VAT reduction is adopted and ADEME engage large programs to promote renewable energy;
- 2005: the tax credit is reinforced and better targeted (by requiring specific energy performance levels);
- 2006: the white certificate scheme is launched in July for a first period of 3 years.

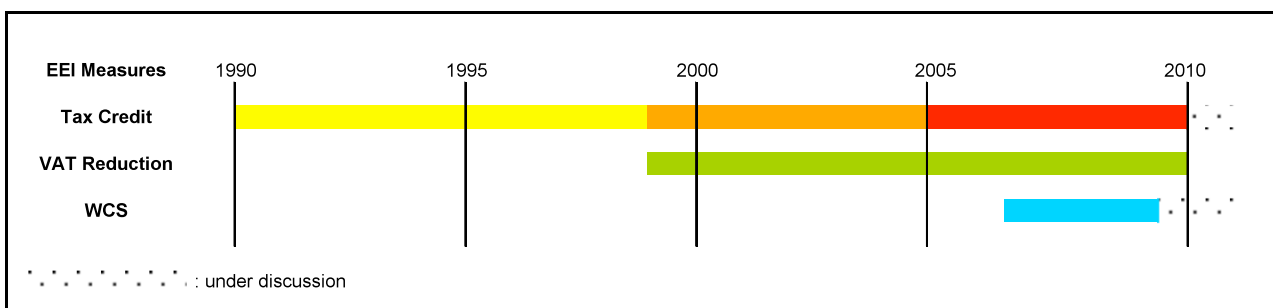


Figure 1. Chronology of the facilitating measures considered in this pilot test.

All these measures should be effective in 2010, but some strong evolutions are expected (for tax credit and white certificates). Moreover, the more recent measures (EPC, soft loans, building code for existing buildings) are expected to have an increasing effect on end-use actions, especially on renovation works and heating systems' replacements.

3.3 Sample used for the pilot test

The pilot test studies database, a FWC file which was deposited by EDF to the DRIRE and accounts for a total amount of 1.16 TWh cumac resulting from more than 20 energy efficiency actions:

- Around 344.000 m² of insulated area.
- Around 8.400 space heating systems.

This sample of FWC represents around 3.22% of the 25 TWh cumac of FWC already achieved at the end of year 2008. The sample only contains end-use actions implemented in the residential sector, as is the case for 88.1% of the FWC actions implemented so far at the national level (Ministry of Ecology, 2009). The data collection process is described in Annex IV.

4 Test of French White Certificates vs. EMEEEES: global analysis and conclusions

This chapter introduces the general description of the pilot test (for its bottom-up part), and then presents analysis and conclusions from the global comparison between the French White Certificates and the EMEEEES bottom-up methodologies.

In addition, chapters 5 and 6 detail the concrete test of two particular case applications, respectively for building envelope improvements and for condensing boilers (as this pilot test focuses on end-use actions related to space heating).

4.1 General description of the pilot test (bottom-up part)

4.1.1 Which are the main aspects considered for the test and how have these aspects been tested and verified?

The main aspects considered for this test are the following (for the bottom-up part):

- qualitative comparisons between the evaluation method proposed by EMEEEES, and the FWC (using the EMEEEES frame of the 4-steps calculation process and the 3-levels approach);
- quantitative assessment of the energy savings resulting from an EDF sample of French White Certificates actions, using different calculation scenarios in order to analyse the possible influences of evaluation choices (baseline, level of evaluation efforts);
- qualitative and quantitative assessment of the contribution of the FWC scheme for the ESD implementation;
- qualitative evaluation of the market transformation (or multiplier) effects of the considered facilitating measures (for actions related to heating consumption in existing residential buildings).

4.1.2 Which end-use (EEI) actions and (EEI) facilitating measures have been considered (in the BU part of the test)?

The test mainly focuses on the FWC scheme. Other measures (mainly VAT reduction and Tax Credits) are also considered when dealing with double counting and multiplier effects, as these measures may overlap with the FWC scheme. These measures are described in chapter 3.

In parallel, the scope of the test is limited to energy use related to space heating in residential buildings. The end-use actions studied are related to building envelope improvements (see chapter 5) and condensing boilers (see chapter 6).

4.1.3 In which year such actions are supposed to be or have been implemented?

The chronology of the facilitating measures is presented in Figure 1, at the end of section 3.2.

4.1.4 Which stakeholders have you involved in the pilot test (e.g. facilitating measure evaluators, government representatives, energy companies, etc.)?

The stakeholders directly involved in the pilot test are:

- ADEME, the French public agency for energy efficiency and environment;
- EDF, one of the main European energy suppliers;
- ARMINES, a research centre with experts in bottom-up evaluations.

All were also partners of the EMEEES project.

Other organisations may have been involved in the production or collection of data used for this test (e.g. CEREN, ATEE). However, they were not directly involved in the test, as the team already had access to these data or reports before the test.

Finally, a workshop should be held with the government representatives and other relevant stakeholders for exchanges and for this study to be an input for the next French NEEAPs. But due to very busy agendas, this workshop had to be postponed, and could not be held before this report was finalised.

4.1.5 Have energy savings achieved through these actions already been estimated by other existing evaluation methods?

Today, ODYSSEE's works are the only evaluation approach developed to quantify energy savings in the residential field (Top – Down method).

Actually, some studies have been done or are being developed to measure the global energy efficiency activity: data on the energy efficient equipment's market shares and households' energy efficiency demand have been collected to this aim and surveys to characterize the residential buildings' performance have been realised. However, these works don't concern the establishment of integrated energy savings methods.

On the bottom-up side, occasional studies or measurement campaigns looked at specific issues (e.g., boilers, insulation actions) but do not provide representative results (statistically significant). The main bottom-up evaluation system is now the White Certificates Scheme.

4.2 Main data sources used for the pilot test

4.2.1 Available data for the test

This section describes the data sources common for all BU methods tested here.

Different data sources are available to evaluate the French energy efficiency market, especially for renovation works:

- Energy Management – 2006 assessment [French title: *Maîtrise de l'énergie – bilan 2006*], TNS-Sofres under the aegis of ADEME [1]
- Permanent monitoring of housing energy efficiency enhancement [French title: *Observatoire permanent de l'amélioration énergétique du logement – OPEN*], BIIS under the aegis of ADEME [2] (see also Appendix II)
- Monitoring of the building stock and energy consumption [French title: *Suivi du parc et des consommations*], Economic research and study centre on energy - CEREN [3]
- Monitoring of new residential buildings [French title: *Observatoire des logements neufs*], BATIM [4]
- Household survey – 2006 assessment [French title: *Enquête Logement – 2006*], INSEE [5]
- Household survey – 2001 assessment [French title: *Enquête Logement – 2001*], INSEE [6]
- Flow of space heating systems in old dwelling – in 2006 – sample group of installation engineers [French title: *Flux de chauffages centraux en habitat ancien en 2006 – Panel installateurs*], Economic research and study centre on energy - CEREN [7].

Table 5. General data sources used for the pilot test (bottom-up part).

Subject	Data	Unit	Source	Data availability
About energy consumption				
Heating consumption	energy consumption (broken down by building age and energy carrier)	kWh/hh.y	[3]	private
About Condensing boilers				
Type of boiler replaced	Condensing, low temperature, standard	Units/y	[7]	private
Age of the boiler replaced	broken down by fuel and by age (10, 15, 20, >20)	Units/y	[7]	private
Type of boiler replaced	Condensing, low temperature, standard	Units/y	[2]	public
About renovation works				
Roof insulation	insulation during roof retrofitting	Units/y	[2]	public
Wall and floor insulation	Number of faces insulated	Units/y	[2]	public
Insulation of building envelope	Number of dwellings retrofitted by type of wall insulated (roof, floor,	Units/y	[1]	public

	vertical wall) and type of insulation (outside or inside insulation)			
glazed/window insulation (in the buildings refurbishment market)	Thermal performance (U_w) of double glazed installed	W/m ² .K	[2]	public
Windows retrofitting	Number of households	Units/y	[1]	public
<u>About facilitating measures</u>				
Facilitating measures dedicated to refurbishment	Nature of incentives (VAT reductions, tax credit, public subsidies...) used	%	[1]	public

Data used in the FWC methods (mainly level 2 data)

ATEE and ADEME made the calculation rules for the FWC standardised actions with very explicit (even if not always sourced) computations. Dwellings' energy consumptions are thus differentiated according to the following characteristics:

- dwelling type (house or apartment) ;
- dwelling vintage (built before or after 1975, date of the entry into force of the first French building code);
- fuel type for space heating (electricity or fossil fuels);
- dwelling size (defined by the number of rooms);
- climatic zone (H1, H2, H3) related to the dwelling location.

All these characteristics are registered for each FWC action (providing thus level 3 data). However the resulting data are not publicly available. For this test, we have access to these details for the studied EDF sample, through privacy statements.

CEREN provides to its members (namely EDF and ADEME) valuable results from field surveys on energy consumption. Some of these statistics were used in this pilot test, especially because they were the basis of the FWC calculations. CEREN data are indeed the sources for the average values used to define the energy consumption for each configuration described above. These values are detailed in section 6.4.2.1.

"*Enquete logement*" (i.e. dwellings survey), managed by the national statistics institute (INSEE), is a piece of data in which surveyed people describe their dwellings, some refurbishment actions and their energy bills.

The French administration (DGEC) publishes periodically a synthesis from the national FWC registry that enables to display some national statistics. However the level of details available can only be used for level 2 calculations (none of the level 3 data registered are published, only the volume of actions (in kWh cumac) per action type for the 10 major actions (in terms of % of credited certificates).

4.3 Global comparison of French White Certificates and EMEEES methodologies

4.3.1 Key elements of the EMEEES Bottom-Up methodologies

The EMEEES Bottom-Up methodology is detailed in (Broc et al., 2007). The key elements and the methods developed are summarised in (Vreuls et al., 2008). To make this report self-understandable, it is necessary to remind here three of these key elements:

- the definition of three levels of evaluation efforts;
- the breakdown of the calculation process into four steps;
- the definition of three main reference situations (or baseline types).

Before describing these elements, it is also useful to specify some of the terms used in the EMEEES project.

4.3.1.1 EMEEES terminology

Within the EMEEES project, an analytical clarification of the subject of monitoring and evaluation was introduced, since the term 'energy efficiency improvement measure' used in the ESD was considered too vague. It was concluded that the subject of monitoring and evaluation can be either, or a combination, of:

- an energy efficiency improvement facilitating measure (**facilitating measure**),
- an end-use energy efficiency improvement action (**end-use action**).

A **facilitating measure** is an action by an actor that is not the final consumer him-/herself, which supports the final consumer in implementing the end-use action, or implements it for the final consumer. Examples are energy efficiency programmes, energy services or mechanisms.

An **end-use action** is a technical, organisational or behavioural action taken at an end-user's site (or building, equipment, etc.) that improves the energy efficiency of that end-user's facilities or equipment, and thereby saves energy. It can be a result of a facilitating measure.

4.3.1.2 Three levels of evaluation efforts

Three main cases may occur when a country wants to evaluate the energy savings related to a given energy efficiency measure (in the ESD context):

1. the country has only a few data about this measure (e.g. number of participants) and needs other data sources to complete the evaluation: for that case, the proposal is to provide countries with European default values as far as this is possible (= level 1 evaluation) ;
2. the country can evaluate energy savings by using mainly data available at national level (e.g. national statistics or surveys): for that case, the proposal is to provide MS with general guidelines (for ensuring harmonisation at the EU level) (= level 2 evaluation) ;

3. the MS can evaluate the energy savings by using mainly data specific to the evaluated measure (e.g. registry of participants' data): for that case, the proposal is to provide MS with detailed guidelines (for ensuring harmonisation at the EU level) (= level 3 evaluation).

The basic idea behind these three levels is that the more evaluation efforts a MS makes, the more reliable should be the results, and so the more recognised the results should be by the Commission. This approach is using conservative default values at level 1 to induce a progressive improvement of the values used by the MS, rewarding their evaluation efforts. MS shall comply with minimum requirements on the one hand, and are free (and encouraged) to go beyond these requirements on the other hand, according to their own evaluation practice and objectives.

Features of the proposed three levels are summarised in below.

Table 6. Three levels of evaluation efforts.

	Data scale	Main data sources	Data processing and documenting
Level 1	European default values	existing/available European regulation, studies and statistics	reliability coefficient according to the level of reliability of the default value
Level 2	National representative values	up-to-date national statistics, surveys, samples, registries	requirements = minimum set of information and justifications to be reported
Level 3	Programme- or Participant-specific values	specific monitoring systems, registries, surveys, measurements	requirements to report on the specific data and justifications in detail (standard report at least available)

4.3.1.3 Four-steps calculation process

The second main principle of the EMEES methodology is to break down the whole calculation process, in order to deal with the different issues raised one after the other, making the calculation work easier to prepare and more transparent when reporting.

Step 1 → Unitary gross annual energy savings means annual energy savings resulting from a unitary end-use (EEI) action. The **unit of an end-use action** may be:

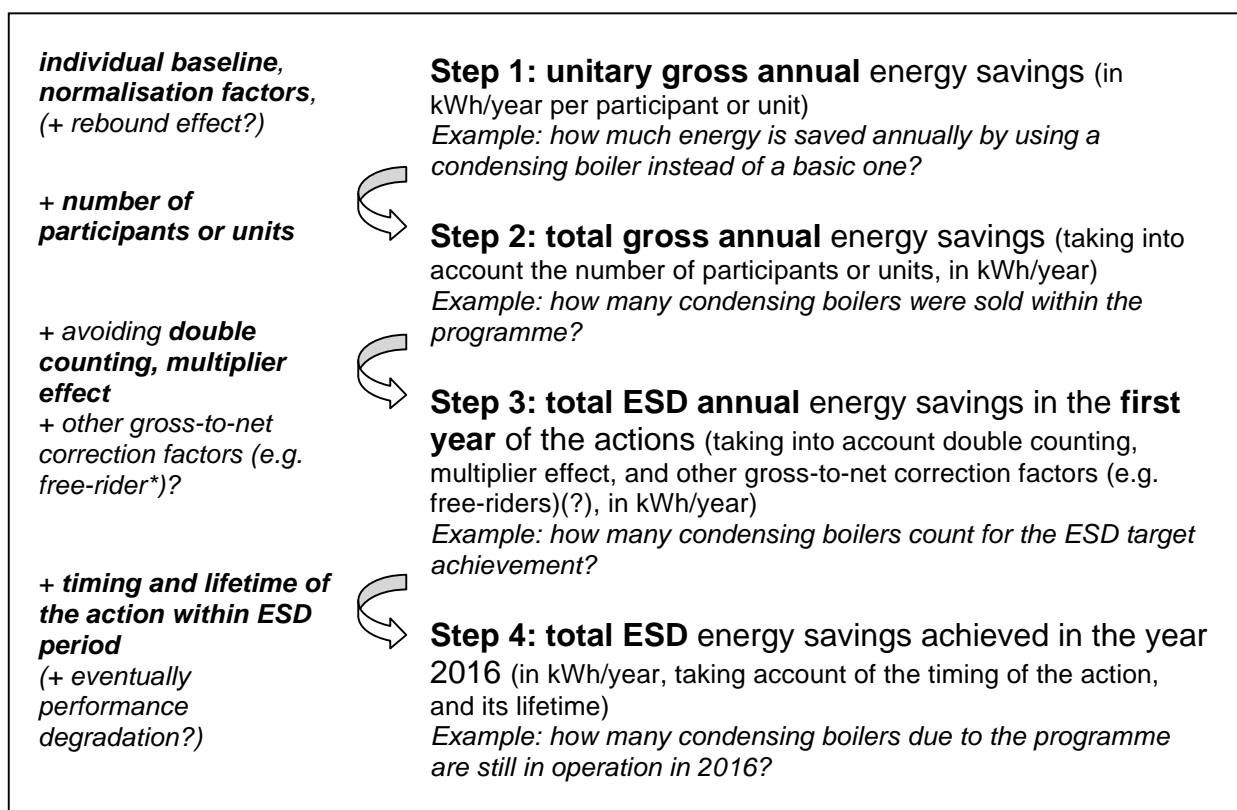
- either a unit of energy-efficient **equipment** (e.g., a compact fluorescent lamp or an appliance) ;
- or a **participant's** premises (dwelling, building, company; e.g. a single family home being insulated or a company benefiting from an energy audit programme).

Step 2 → Total gross annual energy savings refer to the amount of energy saved as observed/perceived by all the participants/final users taking advantage of the evaluated measures. Assessing total gross energy savings means using an **accounting method**, i.e. how the actions/participants are registered/accounted for (e.g. national registries for energy savings certificates or for energy audit participants).

Step 3 → Total ESD annual energy savings refer to the amount of energy saved as surveyed by the European Commission (i.e. from the point of view of ESD implementation), which means taking account of gross-to-net correction factors. These include factors correcting for **double-counting** and **multiplier effects**, explicitly mentioned in the ESD Annex IV, in any case. In addition, **free-rider effects** may need to be taken into account to the extent feasible when accounting for “additional” savings (for the difference between “all” and “additional” savings, see next section about baselines).

Step 4 → checking whether the evaluated energy savings are still effective in the target year (2016), using **lifetime** values and eventually persistence/retention studies.

The proposed four-steps process is described in Figure 2 below.



(*): the free-rider effect will only be relevant, if the aim of the evaluation is to calculate energy savings additional to those that energy consumers, investors, or other market actor would have achieved by themselves anyway. This effect is not mentioned in the ESD.

Figure 2. Four-steps calculation process.

4.3.1.4 Baseline definition

“All” or “additional” savings

It is not explicit in the ESD, whether energy savings counting for the 9% target correspond to gross (or “all”) savings or to net (or “additional”) savings. As mentioned in the previous section, gross savings are the amount of saved energy as perceived by the end-users whereas net savings are these taken into account from a public authority or society

standpoint. In concrete terms, this means that for gross savings, all actions saving final energy can be accounted for (regardless why they were implemented). While for net savings, only additional actions are accounted (i.e. only those which would not have happened without the evaluated measure).

If the objective is to evaluate “**all**” energy savings, the guiding question will be:
What would have happened if all equipment had stayed at the same energy efficiency level as before? (“before-after” situation)

In this case, there are two options for the situation before the implementation of the end-use action:

- A. There is a real situation ‘before’, and this can be taken and the energy use can be measured or estimated; e.g. for the renovation of a building;
- B. There is no situation before, so one has to create a reference situation (e.g., for a new building).

If the objective is to evaluate “**additional**” energy savings as an impact of (combinations of) facilitating measures, the guiding question will be:

What would have happened in the absence of the facilitating measure that is to be evaluated? (“with and without” situation)

In this case, one always has to create a reference situation.

Three main cases

Considering the possible options to define baselines for “all” and “additional” savings, these can be summarised by three main cases.

Case 1: Replacement of existing equipment; baseline=base point / reference point

Case 1 is when an equipment (e.g. appliances, lighting) is replaced by a more energy-efficient one. The “all savings” baseline is therefore the energy consumption of the replaced equipment (when known, i.e. for level 3 evaluations) or the average consumption of the equipments’ stock (for level 1 or 2 evaluations). To account for additional savings, the assumption is that the equipment would have been replaced anyway (normal turnover). The proposed baseline is then the energy consumption of the equipment which would have been bought without the measure, assumed to be the average of the “inefficient” market for this equipment⁵.

Case 2: Energy efficiency retrofit (add-on energy efficiency investment or management without replacement of existing equipment or building)

In this case, for the lifetime of the retrofit actions, energy is saved compared to the consumption of the equipment **before** the end-use actions. This is valid in both cases (**all** and **additional** energy savings). An example is the refurbishment of the outer wall of a building, or the installation of a variable speed drive on an existing electric motor.

⁵ The “inefficient” market is here the market less the efficient models promoted by the facilitating measure. Consequently, the share of these efficient models, which would have been bought anyway, among the participants or buyers affected by the measure, represents the free-rider effect.

Case 3: The new building or appliance

In this case, no real “before” situation exists. So a reference situation has to be selected among several options. As this case does not correspond to the cases treated in this pilot test, these options are not detailed here (see Vreuls et al., 2008 for more details).

The baseline options for the two cases addressed in this test are summarised below.

Table 7. Baseline options for the cases treated in the pilot test.

Case	Baseline for “all” savings	Baseline for “additional” savings
1: replacement of existing equipment	Before action situation (= stock average for level 1 or 2)	Without measure situation (= inefficient market average for level 1 or 2)
2: energy efficiency retrofit	Before action situation (= stock average for level 1 or 2; individual before situation for level 3)	

For this pilot test, case 1 will apply for the condensing boilers (see chapter 6), and case 2 for the insulation actions (see chapter 5).

4.3.2 Evaluation system of the FWC scheme

4.3.2.1 Two main types of FWC actions

As mentioned in section 3.1, the FWC scheme makes the distinction between two types of actions: standardised actions, and non-standardised (or specific) actions. Standardised actions are accounted by standardised methods (i.e. always the same energy savings ratios for a given action type), whereas specific actions are evaluated case by case.

In order to minimise the registering costs, the FWC scheme encourages actors to target standardised actions. Indeed, standardised actions represented 98.88% of the certificates delivered as end of year 2008 (Ministry of Ecology, 2009). This pilot test only deals with standardised actions. So the details specific to the evaluation of non-standardised actions are not presented here.

4.3.2.2 Baseline and additionality

When defining the baseline for the standardised actions, a distinction is made between the end-use actions related to the building envelope or to heating systems on the one hand, and the other end-use actions on the other hand.

For end-use actions related to buildings, the baseline is the average energy consumption per dwelling in the building stock, according to a given dwelling typology.

For the other end-use actions, there are two options:

- either the baseline is the average unitary energy consumption representative of the equipments' market (based on equipments' sales (e.g. case of refrigerators));
- or the baseline is the average unitary consumption representative of the replaced equipments' stock, to which is applied a correction factor to take account of the initial market share of the new efficient equipments (e.g. case of the CFL, where the baseline is the energy consumption of incandescent light bulbs, to which is applied a factor taking account the share of CFL already replacing another CFL).

Moreover, other conditions are required so that the end-use actions can be eligible to FWC, in order to ensure the additionality and the quality of the FWC actions:

- certificates are delivered for actions beyond the regulations in force (i.e. no savings are credited when only the minimum energy performance level required by law is achieved);
- non-obliged actors can not receive certificates for actions corresponding to their usual business activities;
- quality requirements (existing national or international standards, installation by professionals, etc.).

4.3.2.3 Calculation principles

The FWC calculations use a mix of national average values (i.e. level 2 values) and participants' data (i.e. level 3 values). National values come from national statistics, past experiences or experts' views. Whereas participants' data are data provided in the FWC files deposited to the DRIRE.

In order to minimise registration costs, the number of data registered for each participant is limited, and these data correspond to data easy to collect (e.g. postcode to know the location, and then the climate zone).

Consequently, the calculations are mainly based on average values, taking account of differentiation criteria (i.e. using typologies) according to the participants' data registered. Consequently, it is assumed that the number of actions implemented will be large enough and randomly distributed among the possible configurations, so that eventual deviations from the average values used will compensate. Likewise, this means that the average values used in FWC calculations are not relevant to evaluate a particular action.

Standardised energy savings ratios (in kWh saved per action) are then defined. Distinct ratios can be used for a given action type, according to the possible differentiation criteria.

Moreover special coefficients may be applied for strategic reasons:

- bonus (x2) for actions implemented in the overseas (DOM): the aim is to induce actions in these territories as costs of electricity production are higher there;
- malus (x0.5) for "not BAT (Best Available Technique)" actions: for some equipments, several levels of energy performance may be available on the market → two performance thresholds are then defined in the FWC forms, as represented in the below, and the eligible but "not BAT" actions are only credited of 50% of their calculated savings in the FWC scheme, in order to induce "BAT" actions.

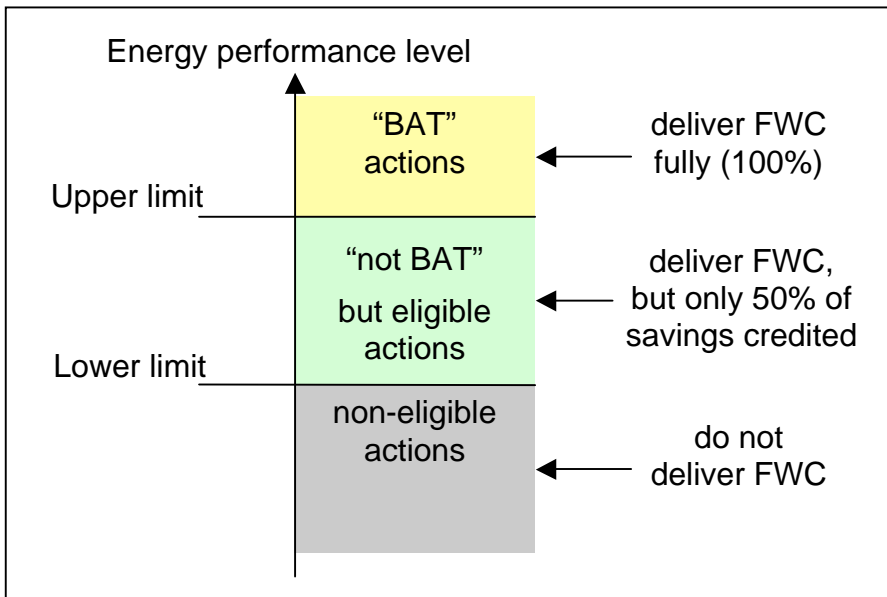


Figure 3. Energy performance thresholds in the FWC scheme.

Finally the calculation principles can be summarised as presented in Figure 4 below.

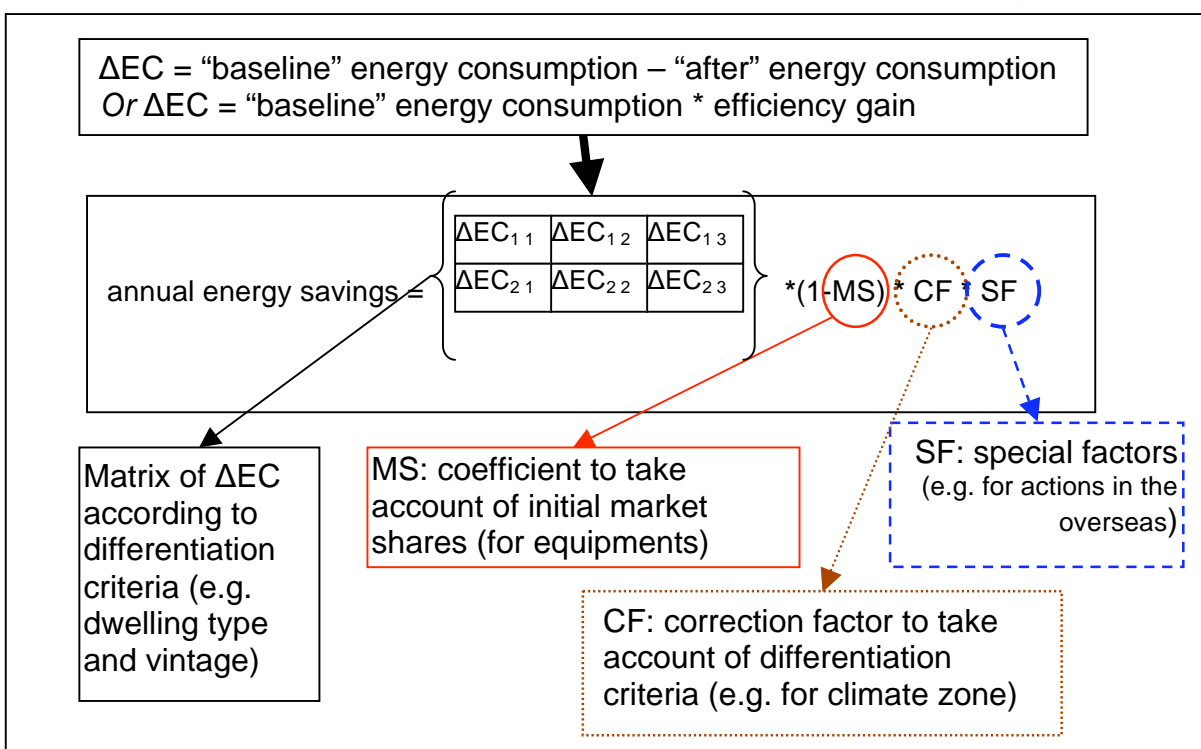


Figure 4. General calculation formula used in the FWC scheme (for annual energy savings).

4.3.2.4 Definition of calculation forms

In practice, standardised actions are defined in standardised forms, hereafter named FWC

forms. These forms exist in two versions:

- a complete version where calculations are detailed, named FWC calculation forms, which is not public (only actors involved in their definitions have access to it);
- a summarised version where only the information required to constitute a FWC file are presented, and this version (named FWC summary form) is public by law.

As mentioned in section 3.1, the definition of these forms is co-managed by ATEE and ADEME, and then validated by the central administration (DGEC). Before submitting a form to DGEC for validation, ATEE and ADEME must first agree on the form contents. In case of disagreement, DGEC has the final decision. As ATEE represents the interests of private actors (energy suppliers, building sector, etc.) and ADEME represents the interests of the public policies for energy efficiency, the compromise between both is assumed to ensure that the values used in the forms are realistic.

Finally, as current regulations and market shares are taken into account when considering the baseline and the eligibility conditions, the FWC forms may have to be updated periodically.

4.3.2.5 Accounting unit for FWC energy savings

The FWC energy savings deal with final energy saved and are expressed in kWh cumac, meaning cumulated and discounted (in French, **cumulés actualisés**). This value of energy savings corresponds to the standardised annual energy savings (in kWh/year, see Figure 4 above) summed over the action lifetime and discounted at a 4% rate.

Equation 1. Formula for FWC energy savings (in kWh cumac).

$\text{FWC energy savings} = \text{annual energy savings} * \left[1 + \frac{1}{a} * \left(1 - \frac{1}{(1+a)^{n-1}} \right) \right]$			
<table style="width: 100%; border: none;"> <tr> <td style="width: 33%; text-align: center;">(kWh cumac)</td> <td style="width: 33%; text-align: center;">(kWh/year)</td> <td style="width: 33%; text-align: center;">(discounted action lifetime)</td> </tr> </table>	(kWh cumac)	(kWh/year)	(discounted action lifetime)
(kWh cumac)	(kWh/year)	(discounted action lifetime)	

Where: a=discount rate (4%) ; n=action lifetime.

Energy savings are cumulated over the action lifetime to encourage actions with longer lifetime (especially for buildings).

Energy savings are discounted over the action lifetime, because the resulting certificates are economic goods, and they are delivered once (when the action is implemented) whereas the corresponding energy savings are achieved over the action lifetime.

4.3.3 Are both approaches compatible / consistent?

4.3.3.1 Common elements

The FWC evaluation system uses a bottom-up approach. So the two first calculation steps are equivalent for both FWC and EMEEES methods:

- 1) defining unitary savings at the level of the end-use action ;
- 2) adding the number of implemented actions to obtain the total gross savings.

Consequently, the FWC system includes the two main components required by the

EMEEES methodology:

- calculation methods, which are the FWC calculation forms ;
- an accounting method, which is the FWC registry.

4.3.3.2 Baselines and “all” vs. “additional” savings

The main difference between FWC and EMEEES methodology relies in the principles used to define baselines.

EMEEES (see section 4.3.1.4) makes a clear distinction between “all” and “additional” savings, and then proposes options to evaluate both, according to three main situations (replacement, retrofit, new).

Whereas the FWC approach is to ensure that the actions (but not necessarily the savings) are additional, by defining eligibility conditions. Then when calculating the energy savings, the FWC methods distinguish two main cases:

- 1) actions related to building envelope⁶ and heating systems → baseline = stock average;
- 2) remaining actions (mainly appliances) → baseline = market average (but not always).

At first sight, it could then be assumed that for case 1, FWC savings are equivalent to EMEEES “all” savings, and that for case 2, FWC savings are like EMEEES “additional” savings. But in practice, the devil is often in the details and the FWC baselines would need to be checked carefully.

In order to prepare the reporting for ESD purpose, there would be two possible options:

- 1) adopting new (and clearer) rules for defining baselines, taking account as far as possible of what is required by the ESD (this could be done when updating the system while preparing a new round of the scheme) ;
- 2) keeping the same rules, but making them more transparent and ensuring all calculation forms comply with them (but this should be discussed with the Commission to be sure they will accept this).

4.3.3.3 Specific correction factors

The FWC methods do not address explicitly the possible correction factors mentioned in the EMEEES methodology (rebound effect, technical interactions, free-rider and multiplier effects, double counting). However, according to the FWC action type, some of these factors may be partially included in the average values used in the FWC calculations. E.g., the coefficient to take into account the initial market share can be interpreted as a proxy for the free-rider effect.

Moreover, except for double counting and multiplier effect, the other effects are not explicitly required for ESD reporting in the Directive.

⁶ For the building envelope the stock average is based on the most inefficient buildings (no or poorly insulated).

In order to improve the compliance of the FWC system with the ESD requirements, there will be two issues to address:

- making as evident as possible the assumptions used related to correction factors (e.g., what is and what is not taken into account, and why);
- monitoring at a general level the risks of double counting and multiplier effects (see respectively sections 4.5 and 4.6 for more details).

4.3.3.4 Different accounting units

With the definition of baselines, the other main difference between the FWC and EMEES methodologies lies in the accounting unit: lifetime-cumulated and discounted savings for the FWC scheme (kWh cumac), annual savings in 2016 (or 2010) for the ESD (kWh saved in 2016).

Consequently, a process is required to translate FWC into ESD savings. But this remains straightforward as general translation rules can be defined (see section below).

4.3.3.5 General process to translate FWC into ESD savings

The objective is to multiply by a coefficient (C_{ij}) – which is to be defined – the annual volume (Q_{ij}) of saved TWh cumac, resulting from actions of a given type (i) and implemented in a given year (j). This would give the value of TWh saved in 2016 for the action type (i) and the year (j), or globally for the whole FWC scheme by summing up on action types and implementation years.

We define C_{ij} as the ratio between the amount of the ESD savings generated by a given standardised operation (in kWh saved in 2016) and the FWC savings per operation for the attribution of certificates (in kWh cumac):

Equation 2. General formula for translating FWC into ESD savings.

$$\text{kWh ESD} = \text{kWh cumac} \times C_{ij}$$

C_{ij} is not always the direct image of the annualising and de-discounting of FWC savings.

Equation 3. Formula for the C_{ij} coefficient.

$$C_{ij} = \frac{1}{\text{discounting coefficient}_i} \times \text{coef 2016}_{ij} (\times \text{coef special}_i)$$

The main term is indeed the discounting coefficient (or discounted action lifetime, see Equation 1). This coefficient depends on the action lifetime, and therefore on the action type (i).

“coef2016_{ij}” is a dummy variable (0 or 1) according to the implementation year (j) and lifetime (related to the action type (i)) of the action (checking whether it will be still effective).

Finally, there is an additional coefficient “coef special_i” (see also section 4.3.2.3) to compensate the impact of some political decisions (inducing actors to target certain action types or locations, or taking account of additionality):

- 0.5 for actions implemented in the overseas (DOM): these actions are given a bonus

(x2) in the FWC scheme, so the corresponding coefficient is the inverse (0.5) ;

- 2 for "not BAT (Best Available Technique)" actions: for some equipment types, several levels of energy performance may be available on the market → two performance thresholds are then defined in the FWC forms (see Figure 3), and the eligible but "not BAT" actions are only credited of 50% of their calculated savings in the FWC scheme, in order to induce "BAT" actions (the special coefficient is then the inverse (2));
- for most of the equipment types which are not related to the building envelope nor heating systems, the initial market shares of the FWC-eligible categories of equipments are taken into account in the calculation of the credited FWC:

Equation 4. Taking account of initial market shares in the FWC scheme.

credited CEE = calculated savings × (1 - initial market share)

and therefore special coefficient = $\frac{1}{(1 - \text{initial market share})}$

The special coefficient is especially useful so that FWC savings are translated into "all" energy savings (according to EMEEES definition, see section 4.3.1.4).

4.3.4 Testing different scenario calculations

The EMEEES methodology suggests qualifying the evaluation efforts through a three levels frame (see Table 6). As the FWC methods use a mix of national average values (e.g., average heating consumption by dwelling type) and participants' data (e.g., details on dwelling type), these methods correspond to a mix of level 2 and level 3 data.

This pilot test offers the opportunity to compare scenarios using the different possible level of evaluation efforts as defined in EMEEES:

- level 1 scenarios will use as much as possible European default values (when included in the tested EMEEES methods);
- level 2 scenarios will be based on national average values provided by the FWC calculation forms or other available national statistics;
- level 3 scenarios will use as much as available participants' data (using the EDF sample, see section 3.3).

Level 1 and level 2 scenarios implicitly assume that the evaluated actions have been implemented according to a distribution representative of the building stock (i.e. each dwelling has the same chance to have benefited from a FWC action). In particular, using a level 2 scenario for ESD reporting would mean assuming that for a large enough number of actions, the possible deviations between the FWC group of dwellings⁷ and the whole building stock compensate (for the distribution according to the dwelling type for example).

At the opposite, level 3 scenarios take account of the evaluated sample's specificities (e.g., if there are more houses than apartments).

Finally, the aim of comparing these scenarios is to observe on a concrete case (the EDF

⁷ FWC group of dwellings means here the group of dwellings where FWC actions were implemented.

sample) whether using different calculation scenarios will induce different results, and especially if higher evaluation efforts lead to higher results.

4.3.5 What should be checked in the FWC calculations?

As a conclusion for this part on comparing FWC and EMEES methodologies, the following points can be highlighted:

- both methodologies are compatible, provided the assumptions made are transparent and the values used are sourced;
- these conditions should be met, if the rich documentation of the FWC calculation forms is maintained and updated taking into account the ESD requirements;
- considering this documentation, the main assumptions to explain are those used for defining the baseline;
- a national accounting system (for energy savings) may differ from the ESD requirements (e.g., due to specific policy targets), while reporting these savings to the Commission can be done according to ESD rules by using a general process to translate national savings into ESD savings, provided this process is defined beforehand and the details required to apply it are registered and made available;
- these conditions should be met for the FWC scheme, as long as the following details are kept registered for each FWC action: action type (according to the FWC typology), implementation (or registration) year;
- when updating the FWC registration system, the possible consequences of changing the action details registered in the FWC database (and therefore used as level 3 data in the savings calculations) should be carefully studied in terms of savings results: reducing the number of registered details will decrease transaction costs, but may also lower the quality/reliability of savings results (and possibly give lower results) → the selection of the details to be registered should then be done looking for the best compromise between limiting transaction costs and keeping reliable results.

4.4 General conclusions on early actions and additionality issues

4.4.1 About early actions

The lifetimes for the considered end-use actions (insulation actions and condensing boilers) are long enough (respectively at least 25 and 16 years) so that all “early energy savings” will be still effective in 2010 and 2016. Indeed, the FWC actions were implemented from July 2006. Moreover, as 2006 is close to 2008, there is no necessity to use different baselines for “early” and “new” actions.

This could be different if actions resulting from VAT reductions and Tax Credits were to be reported to the ESD, as the measures started earlier. Moreover, it is not explicit in the French NEEAP whether France will report early savings.

4.4.2 About additionality

As explained in the section 4.3.2.2, the FWC scheme includes additionality requirements. However this additionality first relates to the conditions for actions to be eligible to the FWC scheme, and not necessarily to the savings calculations.

This means that an action may be additional (according to FWC criteria), while its credited savings will correspond to “all” savings (according to EMEES definitions, see section 4.3.1.4). In concrete terms, this action may comply with FWC eligibility conditions (and then be assumed to be additional to business-as-usual activities) while its savings will be calculated using a baseline corresponding to “all” savings calculations.

This is a key difference between EMEES and FWC methodology:

- in the EMEES methodology, additionality is looked at when defining the baseline;
- in the FWC scheme, additionality is an eligibility criterion, but then may or may not be taken into account in the savings calculation.

Consequently, FWC savings may correspond to “all” or “additional” savings according to the action type. But it is easy to proceed FWC data so that the savings reported for the ESD all correspond to “all” savings (see translation process described in section 4.3.3.5). At the contrary, it would require more efforts to assess “additional” savings from FWC savings, as not all FWC calculation forms include the information needed.

4.5 General conclusions on Double Counting issues

There are **several risks of double counting**:

- between distinct facilitating measures considered in this test (see chapter 4): this may be addressed by evaluating the whole package of measures as the ESD does not require to evaluate the measures separately⁸ ;
- between measures evaluated in this test and other national measures which may have an impact on the end-use actions considered in this test: this may be addressed by checking how the measures are presented in the French NEEAP and by defining “rules of priority” ;
- between measures evaluated in this test and regional or local measures: this may be also addressed by checking the NEEAP and “rules of priority”.

In this pilot test, it was not possible to evaluate quantitatively the risk of double counting between the main facilitating measures considered (FWC scheme and Tax Credits), as no details about Tax Credits’ results were available.

MINEFI (French ministry for taxes) should have statistics on tax exemptions, but these are not publicly available so far. Moreover, it is not sure that it would be technically possible to disaggregate these statistics into results per action type, especially to obtain the number of subsidised actions per action type (e.g. number of condensing boilers). It was not possible

⁸ However, from a more qualitative point of view, it is interesting to assess what are the respective effects of each measure to better understand their effectiveness and their possible synergy.

to know what details are actually recorded.

Consequently, the possible interactions between facilitating measures are not known yet and this also true for other measures than the tax credits (e.g. Energy Performance Certificates).

With regard to the overlap between tax credits and the FWC scheme, it should be noticed that the FWC scheme do not capture all the market so far, while tax credits are claimed by most of the purchasers of eligible energy efficiency actions (condensing boilers, insulation, etc.). Therefore, as default assumption, it is reasonable to think that the actions which delivered FWC also benefited from tax credits, but not necessarily the opposite.

During the observed period (2006-2008), both instruments (FWC and tax credits) reinforced each other, so it would be difficult to separate clearly their respective energy savings contribution.

Thus, to avoid double counting, a simple option would be that the results reported for the ESD be the number of energy efficiency actions whose purchasers benefited from tax credits (data not public presently). However, there is no registry linked to tax credits providing data specific to participants. The FWC results could then be used as a sample for which level 2 and level 3 data are available, then providing an average ratio for unitary savings being a mix of level 2 and level 3 data. This ratio could then be applied on the number of actions assessed for the tax credits to evaluate the total energy savings for these actions in France. But this requires that the number of Tax Credits' actions per action can be assessed.

Assuming that FWC actions form a representative sample seems realistic, as it would be a sufficiently large sample (e.g., probably more than 50.000 units for condensing boilers).

Moreover, the tax credits will be updated in 2009, so it should be checked what energy efficiency actions will still be eligible for this new round of tax credits. If some action types were excluded from the tax credits scheme, the number of these actions registered in the FWC scheme would become the most significant figure (provided these actions will still be eligible to FWC).

From the analysis of the FWC scheme, an interesting conclusion about double counting is that it could be avoided by applying distinct eligibility criteria. For example, actions are eligible to FWC only if their performance level is above the one required by current regulation. Therefore this restricts overlapping risks between the FWC scheme and current building codes. This way, it is easier to calculate the singular contribution of each instrument.

4.6 General conclusions on Multiplier Effects

ADEME has created in 2007 an observatory of energy efficiency improvements in order to monitor the effectiveness of the different facilitating measures applied in the residential sector (see Appendix II).

Beyond the FWC scheme and the energy savings it represents, some other qualitative benefits for the energy efficiency market development can be observed (multiplier effects):

- Actors concerned by the FWC - energy suppliers, retailers, manufacturers, installers and consultants - are involved in the process of scheme selection. Indeed, the public authorities asked ATEE, a federation which represents these actors, to propose

“standardised actions” with “deemed savings” (see also sections 3.1 and 4.3.2). ATEE has also been consulted by the Government about the definition of rules and decrees from the outset of the process. This induced the development of a platform of companies interested in energy efficiency, a negotiation partner on energy efficiency policies for the government that didn’t exist before.

- Some energy suppliers have developed services to respect their obligation by promoting energy savings actions: advices, energy assessments, financial services, etc. Energy suppliers had to create partnerships with retailers or manufacturers and to develop building firms’ (in particular SMEs) networks, that specially help to structure the refurbishment market. An important training programme has been set up to increase professionals’ awareness about energy savings works’ best practises: about 10 000 workers have already taken part into this programme, out of an objective of 50 000 persons.
- Eligible bodies’ experiences show that the standardized actions catalogue is used as a BREF (Best References): some contracting owners decide now to follow the FWC performance specifications in their calls for tenders for renovation works, and some public authorities use this catalogue to define requirements for their local energy efficiency programmes. Standardized actions help the communication and the diffusion of best practises for corresponding equipments or actions.

4.7 Contribution of the French White Certificates scheme to the ESD target for France

4.7.1 Current results

Progress of the FWC Scheme by the end of 2008

From January 2008, the DGEC (General Directorate for Energy and Climate, previously DGEMP, General Directorate for Energy and Raw Materials) issues each two months a publication on the progress of the FWC scheme, including some indicators about the amount of registered certificates⁹. The information below is based on the last publication (January 2009) presenting achieved results by the end of 2008 (Ministry of Ecology, 2009).

617 sets of certificates have been delivered to 147 actors reaching the total volume of 36 TWh cumac (i.e. around 66% of the total target of 54 TWh cumac for the period 2006-2009).

This total amount is made of two parts: 35.6 TWh cumac resulting from standardised actions, and (only) 403 GWh cumac achieved by specific actions. This clearly comes from the fact that standardised actions are encouraged (e.g. the certification process is much easier and faster for standardised actions than for specific ones).

The distribution (in %) of the achieved savings (in kWh cumac) per sector is presented below, showing the large predominance (88%) of the residential sector, which is indeed one of the priority target of the FWC scheme (e.g., most of the first standardised action types were defined for this sector).

⁹ <http://www.industrie.gouv.fr/energie> and then section « Les certificats d'économies d'énergie ».

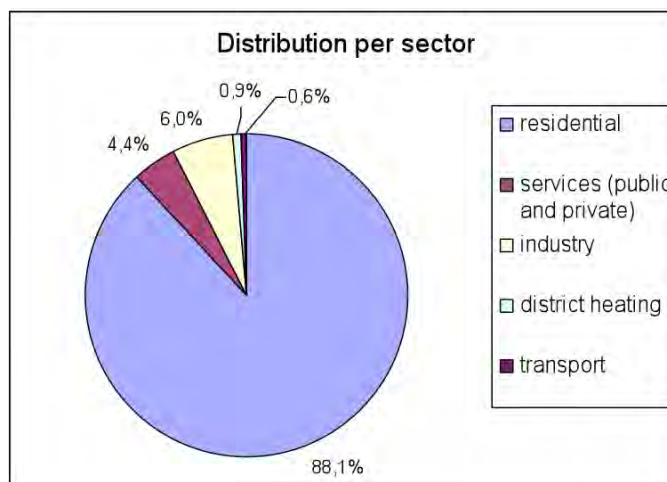


Figure 5. Distribution of FWC savings per sector (for 2006-2008).

The FWC newsletter also gives the top-ten FWC actions, i.e. the 10 action types which represent the highest share of credited savings. As the FWC newsletter is published every two months, it is possible to disaggregate the FWC results per year and per action type, which is the necessary condition to translate FWC savings into ESD savings (see section 4.3.3.5).

Table 8. Top-ten FWC actions (for 2006-2008).

Top-ten actions	(% kWh cumac)	GWh cumac	C_{ij}^{10}	GWh ESD (2016)
individual condensing boilers	14,6%	5256	0,082	434
individual low temperature boilers	11,1%	3996	0,165	660
collective condensing boilers	10,4%	3744	0,068	257
air/air heat pumps	9,3%	3348	0,086	291
roof insulation	6,8%	2448	0,051	126
windows insulation	6,4%	2304	0,051	119
collective low temperature boilers	4,0%	1440	0,137	197
VSD for electric motors	3,6%	1296	0,122	158
air/water heat pumps	3,5%	1260	0,082	105
solar water heater (overseas)	3,5%	1260	0,051	65
TOTAL (for the top-ten actions)	73,2%	26352		2539

As mentioned in the introduction, efficient boilers (condensing and low temperature boilers, both for individual and collective housing) and insulation actions (roof and windows) represent respectively 40% and 13% of the savings credited in the FWC scheme for the period July 2006-December 2008. Together they cover more than half of these credited savings.

This can be explained by the following reasons:

- these actions are the priority targets for the FWC scheme, and they probably represent the most cost-effective actions for the obliged actors ;
- these actions also benefit from Tax Credits, which make them more attractive (both for obliged actors (or professionals) which can use a “free” incentive, and for final

¹⁰ coefficient to translate FWC savings into ESD savings (see section 4.3.3.5)

customers).

It is likely that in the next period of the FWC scheme (2009-2012), rules could be added to avoid this kind of overlap between FWC and Tax Credits.

4.7.2 Limits of a direct transposition from FWC savings to ESD savings

Some limits have been encountered when translating FWC savings into ESD savings:

- as mentioned in section 4.3.3.5, the translation process can be applied only if the necessary details are available (distribution of the savings per action type, and implementation year): so far these details are publicly available only for the top-ten FWC actions (but this represents more than 70% of the FWC savings) but exist in the national register (EMMY database);
- when applying the translation coefficient C_{ij} , this coefficient is assumed to ensure that all calculated ESD savings are then homogeneous and corresponding to “all” savings (as defined in EMEEES, see section 4.3.1.4) → however, the baseline values still need to be checked (e.g. looking at their sources);
- if the proposed translation process makes possible to assess “all” savings, it would not be possible to assess “additional” savings so directly → a global survey and monitoring of the FWC scheme could be an option (see the ADEME initiative based on the OPEN observatory presented in Appendix II).

4.8 Is a White Certificates scheme an efficient Monitoring & Evaluation system?

4.8.1 Evaluation of costs related to method application

The issues considered in this section are what evaluation costs have to be considered and how they can be assessed.

Two types of costs have to be considered:

- Direct costs linked to the FWC scheme, including:
 - costs of getting the certificates registered:
 - fees to submit files to the official FWC registry (fixed by law; the registry is managed by a subcontractor of the public regulator);
 - internal costs for the obliged (or other eligible) actors to prepare the files before submissions (data gathering, quality control...);
 - costs for the public regulator¹¹ to check the files submitted by the obliged (or other eligible) actors, and to monitor the whole scheme→

¹¹ Mainly DRIRE Ile de France for checking the files, and DGEC for monitoring the whole scheme.

the FWC administration can be assessed to represent about 12 equivalent full-time employees (10 for ministry (DGEC) and local representatives (DRIRE), 2 for ADEME);

- costs of developing the accounting system:
 - ATEE working groups and ADEME experts, who define the standardised actions and the FWC calculation forms.
- Indirect cost including:
 - actual costs of already available level 2 data (mainly for recurring studies (e.g., CEREN, ADEME), see also section 4.2.1).

Today, there has been no official costs' assessment about the FWC yet, but some public data may be published at the end of the first period (end of 2009).

Looking at the calculation forms, two types of costs related to their development can typically be distinguished: "hard costs" (surveys, campaigns, studies) and "soft costs" (work specially dedicated to develop the FWC calculation forms):

- For the first ones, we can observe that few additional studies have been implemented in order to set up a specific standardised action. In fact, actors use data available before FWC scheme implementation. Indeed, available data on an equipment or an action (e.g., market, energy savings campaign, potential) is a key issue to decide if it's worth to attempt standardising this action (i.e. defining its calculation form). Therefore so far, the direct "hard costs" are probably low, but part of the initial costs of these reference data should be taken into account as indirect costs.
- The "soft costs" might represent the essential development costs for the first period (2006-2009) of the FWC scheme. It is quite difficult to exactly quantify the effort of each actor involved in the process (because of wide spread costs), but we can give the following first assessments:
 - ATEE, which is specifically in charge of defining standardised actions and calculation forms, bears a global effort through the participation of its members. The "Club C2E" (ATEE sub-group dedicated to the FWC issues) counts 250 members, 100 of which can be considered as active participants (energy suppliers, consultants, professional organisations (e.g., representing building trade), manufacturers and retailers). Six working groups met 6 to 12 times a year on different topics: building, transport, industry, public bodies, and services. This represents 3000 to 6000 hours of experts meetings a year to exchange and develop standardised actions. This work is managed by a general delegate and 2 full time ATEE employees dedicated to monitor the working groups and to animate the "Club C2E" (e.g. organising dissemination activities, trainings);
 - The working time necessary to develop a new FWC calculation form can be assessed between 20 and 50 hours on average (170 calculation forms were validated so far).

Concerning the indirect costs for recurrent studies (used as sources either for defining

standardised actions, or for monitoring energy efficiency markets), even if the total costs should not be attributed only to the FWC scheme, the following figures could be considered:

- CEREN studies “Monitoring of the building stock and energy consumption”, on which reference energy consumptions for the FWC is based, is a large sample group of more than 1000 dwellings with a global cost of around 400 k€ per annum.
- ADEME studies (SOFRES surveys, OPEN observatory) : around 400 k€ per annum to analyse the demand side and to follow the renovation market figures.

4.8.2 Advantages and drawbacks of such a Monitoring & Evaluation system

- FWC calculation forms, which are mainly based on ex-ante deemed estimates, constitute an **interesting compromise between accuracy and limited transaction costs**.
- The process to define FWC calculation forms was also an opportunity for stakeholders to exchange their experiences about evaluating energy savings. The related activities (ATEE working groups, training sessions, etc.) have **significantly increased the awareness of a very large share of stakeholders about evaluation issues** (e.g., baseline, additionality).
- It was also a good occasion to **review the available data and sources** related to energy savings calculations.
- The official publication of list of standardised actions gives **more visibility and credibility** to the corresponding end-use actions.
- This is also a way to disseminate **quality criteria** for end-use actions, ensuring these actions will be implemented with a high quality level.
- Even if the FWC scheme does not capture the whole energy efficiency markets (see for example the case of boilers, section 6.4.2.3), it gathers **useful details on significant samples** which may be used as input data for the evaluation of other facilitating measures (e.g. Tax Credits).
- The application of these FWC methods for delivering white certificates at a large scale requires **operating a well adapted information system** that contains only the strictly necessary data for each action, in order to keep the system easy to handle, and to limit the transaction costs.
- As detailed in the previous section, setting up such a M&E system requires a lot of effort (but which is very valuable over time). The size of the effort can differ very much from one case to the other, according to the available data and experience before setting up the scheme. The approach used to define the standardised actions should be adapted to the national context (for example, the approach used for the Italian scheme was quite different). Therefore it would be very interesting to compare the

approaches used in the different similar existing systems (UK, France, Italy, New South Wales (Australia), etc.). So far, studies on this topic (e.g., Capozza et al., 2006, Vine and Hamrin, 2008) mainly focused on the accounting system, i.e. how the actions were registered and credited but not on how the rules to do so were defined.

4.9 Target group perspective

As explained in the introduction, three partners were involved in this pilot test:

- ADEME, the French public agency for energy efficiency and environment;
- EDF, the main French energy supplier;
- ARMINES, an independent public research institute.

ADEME and EDF can be considered as representative of the stakeholders involved in the definition of the FWC calculation forms. Moreover, EDF represents more than half of the FWC obligations.

Moreover, all three partners (ADEME, EDF and ARMINES) were also EMEEES partners, meaning they had a good knowledge of the EMEEES outputs before this pilot test, and they also took part in the peer review process of the EMEEES methods.

Consequently they can provide a detailed feedback on the methods. However, this feedback comes from EMEEES insiders, and therefore does not give an account of a new eye or perspective on EMEEES outputs. That's why the focus of this pilot test was more on comparing FWC and EMEEES methods, than on how stakeholders perceive the EMEEES methods.

To complement this view, it was planned to organise a workshop with ministry representatives (concerned by reporting FWC savings for ESD purpose) and stakeholders involved in the monitoring of the FWC scheme. But due to agenda and time constraints, this workshop could not be held before finalising this report.

5 BU Method 1 Building envelope improvement (residential buildings)

5.1 Testing activity description

5.1.1 Which end-use (EEI) actions and (EEI) facilitating measures have been considered to test the method?

The main **facilitating measure** considered here is the French White Certificates (FWC) scheme.

Other **facilitating measures** are considered as they may have strong interactions with the FWC scheme:

- VAT (Value Added Tax) Reduction on dwellings' renovation works;
- Tax Credit for energy efficient equipments and renewable energies.

These measures are described in Chapter 4 above (included their timing). They are taken into account when dealing with double counting issue (see section 4.5).

The **end-use actions** considered here are those promoted by the above measures¹² and targeting the building envelope improvement (in the residential sector):

- roof and attic insulation;
- flat roof insulation;
- wall insulation;
- floor insulation;
- glazed/window insulation.

5.1.2 Summary of the testing activities presented in this chapter.

The general approach of the Bottom-Up part of this pilot test is presented in section 4.1.1.

The main objectives specific to the case of insulation actions can be summarised as follows:

- comparing the EMEEES and FWC methods (mainly the formula and data used for the energy savings calculation) by using the EMEEES framework (4 steps + 3 levels);
- using scenarios (as described in sections 4.3.4 and 5.4) to compare the results obtained according to the level of data used as inputs (i.e. national values (level 2) or participants-specific data (level 3) ; European default values (level 1) are not available for insulation actions);
- comparing the results based on the one hand on the FWC method and on the other hand, on the Energy Performance Certificates method.

¹² All these end-use actions are eligible for all the facilitating measures mentioned above. Additional eligibility criteria apply, such as minimum energy performance requirements.

Main conclusions about the case of insulation actions are then summarised in section 5.4.2.4.

5.2 Data sources specific to building envelope improvements

Market data (renovation market)

ADEME has monitored households' expenses for energy efficiency for many years through periodic survey done by SOFRES. This monitoring was recently improved and completed by the creation of an observatory (named OPEN) focused on the renovation market.

Data specific to implemented actions (mainly level 3 data)

For this pilot test, EDF provided an access to a sample of FWC actions deposited to the DRIRE (see section 3.3), which enables to calculate different scenarios (level 2 and level 3) for this sample. The participants' data registered are: dwelling type (houses or apartments), dwelling size (through the number of rooms), building vintage (before or after 1975), climate zone and fuel type for space heating (electricity or fossil fuel). In practice, only the data related to climate zones and fuel types are used in the FWC calculations for insulation actions.

5.3 Test of methodology application step by step

For more details about the EMEEES method for insulation actions see (Amman et al. 2008).

5.3.1 Baseline issues

As mentioned in section 4.3.1.4, insulation actions correspond to case 2 (retrofit actions), when defining baselines according to the EMEEES methodology.

This means that for this case, the baseline will be:

- either the energy consumption of the dwelling where the end-use action is implemented, when such participants' data are available (i.e. for level 3 evaluations) ;
- or the average energy consumption per dwelling in the building stock (if possible according to a dwelling typology), when only national or European data are available (i.e. for level 1 or 2 evaluations).

Moreover in this case, the baseline is the same for both, "all" and "additional" savings.

5.3.2 Step 1: Unitary gross annual energy savings

Level 1 (European default value)

In the EMEEES method for building envelope improvements, **level 1 is considered not possible**, so no level 1 default values (for unitary savings) can be used for this test. Consequently, the comparison between EMEEES and FWC values for unitary savings can only be qualitative (differences between the approaches, not between the values).

However, the EMEEES method provides a level 1 default value for the **rebound effect** (20%).

Level 2 (national average)

The proposed formula for **level 2** is:

Equation 5. Step 1 formula for insulation actions (EMEEES method)

$$UFES_{i,m,j,t} = UFED_{baseline,i,m,j,t} - UFED_{action,i,m,j,t} \quad (\text{option 1})$$

$$UFES_{i,m,j,t} = \left(\frac{SHD_{baseline,i,m,j,t}}{\eta_{baseline}} - \frac{SHD_{action,i,m,j,t}}{\eta_{action}} \right) \cdot (1 - RE) \quad (\text{option 2})$$

Where:

UFES = Unitary Final Energy Savings [kWh/m²/a]

UFED = Unitary Final Energy Demand [kWh/m²/a]

SHD = Specific Heating Demand [kWh/m²/a]

RE = rebound effect ratio (0 ≤ RE ≤ 1)

η = energy efficiency of the heating system (seasonal)¹³ (see also Adnot et al., 2008)

i = building age class (construction period)

j = description of the energy efficiency measure/action

m = building type

t = time (year)

With the available data for this test, it would be possible to define national average UFED

¹³ Here, η is not the efficiency of the boiler or the heating system as a technical unit. It is the relation of heat demand to final energy demand for heating and, thus, the characteristics of the whole building have to be considered. The final energy demand (FED) also includes losses by the heating and the distribution system, expressed by efficiency parameters (details in EMEEES case application 4, improvement of the heating system/condensing boiler).

per building age class and per building type for the building stock ($=UFED_{baseline,i,m,j,t}$)¹⁴ (see Table 9 below). So the first option of Equation 5 would be preferred (the second option is more appropriate for level 3 but could also be evaluated at level 2, if SHD and η data are available for the most important building types).

*Level 2 data from the calculation sheet of the FWC standardised actions*¹⁵

Efficiency of the heating systems:

- Direct electric heating efficiency: 95% (average for the building stock);
- Fuel boiler efficiency: 60% (average for the building stock).

Table 9. Space heating consumption broken down by building type, age and fuel¹⁶.

(in kWh/year)	Individual dwelling		collective dwelling	
heating fuel	fossil	electricity	fossil	electricity
<1975	22932	14568	10847	4894
>1975	20698	12162	9247	3472

Source: (CEREN, 2004)

However, it would not be possible to define such values for existing buildings **after** a refurbishment ($=UFED_{action,i,m,j,t}$), unless by modelling building types and action types for the whole stock. So Equation 5 **can not be used for this test**.

In the EMEES method, another option is proposed: “For some classes of similar buildings (e.g., single family houses) with standardised end-use actions taken on them, it may be possible to estimate **deemed energy savings** in kWh/m²/a.” In the EMEES method, this option is presented for the level 3 of step 2. This may be a confusion, as deemed savings are more to be used for unitary savings (so step 1) and for levels 1 and 2.

And as the end-use actions considered for this test are precisely **standardised actions**, this option can be applied here. Nevertheless, the EMEES method does not provide more details about the application of this option. So the presentation of the test of this level 2 option will be made in the section 5.4 describing the FWC method.

¹⁴ This is also used for the top-down approach.

¹⁵ Energy saving certificate, calculation sheet, *insulation of walls*, BR93, rev. 7, December 2005.

¹⁶ Energy saving certificate, calculation sheet, *water/water heat pump*, BR112, Rev. 89, august 2006.

Level 3 (participant-specific value)

The **proposed formula for level 3** is the same as for level 2 (see Equation 5), except that instead of considering average values per building age class and building type, the values considered are these specific to the participant.

The EMEEES method proposes to use the Energy Performance Certificates (EPC) for buildings (as defined in the EPBD) as data sources for the energy demand before and after the refurbishment. But **in France, EPC are not required in case of refurbishment** (nor for the facilitating measures mentioned here), but only when a dwelling is built, for rent or for sale. And it can be assumed that a significant share of the refurbishments is implemented in existing dwellings owned by their occupants, i.e. where no EPC is required. In addition, EPC requirements entered into force in France progressively in 2006 and 2007, so EPC could not be used anyway for “early actions”. Moreover, French EPC data are not centralised as recommended in the EMEEES method¹⁷.

Finally, the data available for this test do not enable to evaluate the unitary savings at a “full” level 3. They can be evaluated by a **mix of level 2** (national statistics) **and level 3** (participant-specific) data. This corresponds to the “**deemed savings**” option proposed in the EMEEES method. Its application is detailed in the section 5.6 about the FWC method.

Conclusions about step 1

In the equation of the EMEEES method, it first seems clear that FED (Final Energy Demand) corresponds to the energy consumed for heating (i.e. the energy metered and billed), and that SHD (Specific Heat Demand) corresponds to the energy needed for keeping a given inner temperature (i.e. taking account of the building characteristics but not of the heating system and distribution).

But then, it is not clear whether the unitary savings should be calculated by using FED data or SHD data. Moreover, in case EPC are not available, it is not clear what data should be used.

That’s why, due to differences between the data expected for the EMEEES method and the data available for this test, **it is not possible to apply directly the EMEEES method** for evaluating the unitary energy savings. However, it is possible to compare the FWC method used for this test with the EMEEES method (see section 5.5).

5.3.3 Step 2: Total gross annual energy savings

First, the accounting of the number of units has to be **level 3 for a bottom-up method**. The proposed level 2 (stock modelling) is more a top-down than a bottom-up approach. So here we will only consider the level 3 options.

¹⁷ See also the DATAMINE project: <http://www.meteo.noa.gr/datamine/>.

The EMEEES method requires **specifying the unit used**, which may be a m², a dwellings or an action. In case the unit used is the m², then a clear definition of the type of area considered (e.g. net, gross, etc.) is required.

There are various definitions of dwelling area (expressed in m²). In France, two types of area are generally used:

- net floor area (in French: *surface habitable, Sh*): defined by the building and dwelling code, article R. 111-2 (French title: *Code de la construction et de l'habitation*) as the total floor area deducted from the surface taken up by the walls, partitions, stairs and well, ventilation shaft, doorway or windows. Surfaces of attic, cellar, basement, shed, garage, terrace, balcony, veranda, outbuilding and part of the dwelling with a roof height under 1,8 meter.
- net gross floor area or inner surface (or net outside gross area) (in French: *Surface hors-œuvre nette (SHON)*): defined by the town planning code, article R. 112-2, as the total floor area of each level deducted from the basement, attic, garage... and area used for wall insulation.

The most used area data is the net floor area that is well known by the inhabitants of the dwelling. It will be noticed that the French building code (RT2005) referred to the net gross floor area which is larger than the net floor area.

However, the unit used to account for the insulation actions in the FWC scheme is not the net floor area of the insulated dwellings, but the m² of installed insulation materials.

As mentioned for step 1, the proposed option of the EMEEES method to collect the EPC before and after refurbishments is not possible for this test.

In the FWC scheme, some data (depending of the type of standardised actions) are registered for each participant, including for actions related to heating systems and building envelope:

1. General:
 - a. age of the building (after or before 1975) ;
 - b. climate zone (H1, H2, H3) ;
 - c. type of dwelling (individual housing or flat) ;
 - d. heating space energy carrier (electricity or fossil fuel) ;
2. quantization:
 - a. area (m²) of insulating material or solar collector
 - b. floor space heated (or number of rooms) for heating space systems
3. efficiency:

- a. for boilers (low temperature, condensing) or heat pump (COP)
- b. for thermal insulation (added thermal resistance expressed in $m^2.W/K$)

5.3.4 Step 3: Total ESD energy savings

Double counting

Double counting issues linked with the FWC scheme are dealt with in the section 4.5. There are no additional elements which would be specific to the case of insulation actions.

Technical interactions

The EMEEES method considers four possible cases of technical interactions. This test deals with the fourth case (i.e. “single technical actions”, corresponding to the “components” approach of the EPBD). For that case, the EMEEES method assumed that “*the impacts of the changes to the building envelope on the efficiency of the heating system can be neglected*”. So **the technical interactions may be neglected for this test.**

Multiplier effect

Possible multiplier effects of the FWC scheme are dealt with in the section 4.6. So far, there is no available quantitative data which could be used for this test. So it could only be addressed by a qualitative approach. However, the monitoring and studies planned within the OPEN frame (see Appendix II) should provide data for evaluating possible multiplier effects.

The EMEEES method highlights the link between multiplier effects and requirements of national building codes for existing buildings. In France, the code for existing buildings only applies since November 2007. So it is too early for getting a feedback on possible interactions between the FWC scheme and the new building code. The only effect which can be observed yet is not a multiplier effect, but an update of the FWC forms due to the new regulations. Indeed, due to the entry into force of the building code, there was an update of the requirements on energy efficiency levels for eligibility of insulation actions to FWC. Indeed, one of the FWC principle is that actions are eligible to FWC only if they are more efficient than the levels required by the current regulations. So when a building code is created or updated, the FWC forms (see section 4.3.2) are to be updated consequently.

According to the EMEEES method, what should be looked at in the future is whether the FWC scheme supports a market transformation (i.e. multiplier effects on the refurbishment market), so that the code for existing buildings can be more easily strengthened.

Free-rider effect

The EMEEES method proposes a level 1 default value of 20% for the free-rider effect related to building envelope improvements, based on existing literature. But the method's authors also highlighted that values for free-rider ratios may vary a lot from one situation to another (according to the context, the type of facilitating measure, etc.). So they recommend to perform an ex-post study for programmes providing a significant contribution to the national ESD targets (e.g., more than 40 GWh saved/year).

So far, there is no specific data on possible free-rider effects for the facilitating measures considered in this test. However SOFRES (a survey company) performed regularly for ADEME surveys on household expenses for energy efficiency. In these studies, a distinction is made between refurbishment works realised directly by the dwellings' occupants and those realised by professionals. This could be used to assess a certain form of free-rider effect (especially looking at trends over the past years).

More recently, ADEME set a new observatory (OPEN) to monitor the French refurbishment market (see Appendix II for more details). This could provide useful data for assessing free-rider effects.

Finally, for the FWC scheme, possible free-rider effects are assumed to be limited due to the eligibility conditions (see sections 4.4.2 and 5.4).

5.3.5 Step 4: total ESD energy savings for 2010 and 2016

For the action lifetime, the EMEEES method refers to the values proposed by the CEN Workshop Agreement 15693 (CEN, 2007), i.e. level 1 savings lifetime of 25 years for building envelope improvements, except for windows (24 years).

Even if the values used in the FWC method are slightly different (see section 5.4), **the savings lifetimes are long enough** for all "new" actions (i.e. from 2008) and "early" actions (from 1995) to be effective in 2010 and 2016. So **step 4 is straightforward for this test**.

The EMEEES method mentioned the issue of possible deterioration over time (e.g. due to moisture). But no data were available to provide quantitative indications about this effect. This is also the case for this test, so this issue can not be addressed here.

However, more generally, ex-post studies to verify actual energy savings (compared to estimated energy savings) would be very valuable, both for improving values of deemed savings and for improving the actions' effectiveness (e.g. by detecting key implementation points to avoid nonconforming work).

5.3.6 Conclusions about the test of the EMEEES method

As detailed in the above step-by-step description, it was not possible to apply directly the

EMEEES method for this test, due to differences between the data expected for the EMEEES method and the data available for this test. Nevertheless, the EMEEES method was analysed from the point of view of an application for a specific situation (French context), to see what can be used and what can not.

The main conclusion is that data availability can not be foreseen for all Member States. The data available (routinely registered statistics, regular surveys, specific studies, etc.) may vary a lot from one country to the other, especially because data needed for energy savings calculations are at a more detailed level than the data standardised for Eurostat.

Consequently, the calculation formula proposed in the EMEEES methods may not always fit to the data available in a given country. However, European Directives (such as EPBD, ESD or EcoDesign Directive) should encourage an harmonisation in the data and calculation methodologies.

Moreover, the EMEEES methods constitute a useful basis for:

- detecting what data is missing, or what studies would be required or interesting to perform (in case no evaluation method was applied so far in the country) ;
- or reviewing the existing national evaluation methods to check compatibility with ESD requirements.

This feedback is completed in sections 5.5 and 5.6, especially by the conclusions from the comparison between the EMEEES and FWC methods described in section 5.4.

5.4 Method comparison and interactions with already existing evaluation methods

This section is an important piece of the pilot test, comparing the method used for the test (based on the FWC methods) with the EMEEES approach to check compatibility.

The FWC method is described following the EMEEES 4-steps calculation process, indicating for each step what level (of the EMEEES 3-levels approach) is used/possible (section 5.4.1). When possible, a comparison is made between results for the different levels to highlight to what extent increasing the evaluation level will enable to report more accurate (and higher) results (section 5.4.2).

5.4.1 Method comparison

This section describes the FWC method according to EMEEES 4 steps, highlighting differences with the EMEEES method presented in section 5.3.

5.4.1.1 Step 1: Unitary gross annual energy savings

For the FWC scheme, the unitary savings (in kWh/m² of insulated surface¹⁸) are calculated

¹⁸ The reference unit for the ESC calculation is not the m² of heated area, but the m² of installed insulation material.

as presented in Equation 6. below¹⁹.

Equation 6. Step 1 formula for insulation actions (FWC method).

$$unitary_saving = \left(\frac{1}{\frac{1}{U_{init}} + R} - U_{init} \right) * HDD * CZ * h * I * \frac{1}{\eta}$$

With :

R: the additional thermal resistance (in m².K/W) A minimal performance of R in m²/K/W is necessary to obtain white certificates (see Table 10 in section 5.4).

U_{init}: the thermal transmission of the initial surface (in W/m².K), as defined in the FWC form (see Table 10 in section 5.4).

HDD: Heating Degree Days (2450 K) corresponding to a normalised heating period

CZ: correction factor related to the climate zone of the dwelling

h : number of hours in a day (24 h)

I: intermittency coefficient (0.5)

η: average efficiency of the stock of heating systems (0.95 for the direct electric heating, 0.6 for fossil fuel boilers).

Both formulas (FWC and EMEEES) are based on the heating demand, even if they use distinct parameters to express it: thermal transmission combined with the heating degree days and the climate zone for the FWC, and directly the specific heat demand according to a given dwelling typology (e.g. building ages, classes, etc.) for EMEEES. Both methods used thus consistent physics considerations. Both models also use the same definition for the reference situation or baseline, i.e. the level of heating demand before implementing the insulation actions. But a difference remains when dealing with the rebound effect : it is neglected in the FWC model, whereas the EMEEES method proposes a default value of 20% (based on existing literature).

Besides, for the unitary savings result, the EMEEES method considered that it was not possible to define European default values (for level 1 evaluation). So the savings should be evaluated at least at level 2, i.e. based on national statistics or other national reference values. For the level 3 (participant-specific values) the EMEEES method proposes to use EPC as data sources for the energy demand before and after refurbishment.

Finally, the method used for FWC corresponds to an EMEEES level 2 evaluation, as the FWC baseline is based on average national values for the French building stock.

The FWC approach for insulation is a component approach (as defined in the EPBD), different from the system approach recommended by the EMEEES method (see also next section 5.4.1.2). Therefore, in the FWC scheme, different “component” actions are distinguished:

¹⁹ Energy saving certificate, calculation sheet, *insulation of walls*, BR93, rev. 7, December 2005.

1. wall insulation,
2. roof insulation,
3. window insulation (double glazed),
4. floor insulation.

Moreover, the resulting unitary savings are differentiated by:

1. climate zone (called: H1, H2, H3²⁰) depending on the location of the dwelling (postcode registered for each participant),
2. energy carrier for space heating (electricity or fossil) related to the average efficiency of the stock of heating systems (respectively 0.95 and 0.6).

Initially, another distinction was made according to the performance level of the insulating material (i.e. its thermal resistance). Two levels were considered (best and medium), defined by thermal resistance thresholds specific to each component (wall, roof, window, floor). When attributing the FWC, a special coefficient was then applied according to the performance category to induce “best performance” actions:

- 100% for “best performance” actions (i.e. the FWC credited for these actions equal to 100% of the calculated savings) ;
- 50% for “medium performance” actions (i.e. the FWC credited for these actions equal to 50% of the calculated savings).

This “performance” distinction is no longer used in the FWC scheme since end of year 2007, as the “medium performance” actions are not eligible anymore (due to the entry into force of the building code for existing buildings²¹). In fact, only the “best performance” actions are still eligible (i.e. above a specific threshold of thermal resistance) and will be studied here, as the actions from the EDF sample all belong to the “best performance” category.

Table 10 below presents the minimum performance level now required for insulation actions in the FWC scheme (after the updates taking account of the code for existing buildings).

²⁰ The H1 zone is corresponding to the main part of the country and is the coldest, H3 is the most temperate, H2 is the intermediate zone.

²¹ This is a general rule of the FWC scheme: an action can be eligible only if its energy performance level is above the one required in the regulations. So when a new regulation comes into force (here the code for existing buildings), the list of eligible actions has to be updated consequently.

Table 10. Thermal transmission (U, in W/m².K) or thermal resistance (R, in m².K/W) values used in the FWC calculations.

Action type	Baseline values (average "before" situation)	Minimum performance level required for the FWC scheme
wall insulation	U = 3,3 W/m ² .K	R ≥ 2,4 m ² .K/W
roof insulation	U = 2 W/m ² .K	R ≥ 5 m ² .K/W
window insulation (double glazing)	U = 4,5 W/m ² .K	U ≤ 2 W/m ² .K
floor insulation	U = 4 W/m ² .K	R ≥ 2,4 m ² .K/W

Source: FWC forms (updated versions, end of 2007) (DGEC, 2009)

5.4.1.2 Step 2: Total gross annual energy savings

The main difference of calculation models relies then on the two distinct approaches in the analysis of the insulation actions: in the EMEES method, the dwelling is considered as a whole (i.e. system approach), whereas the FWC scheme deals with dwelling components (e.g. roof, windows, etc.). This difference is due to the data registered to account for the actions: bills of insulation works for FWC vs. EPC for EMEES. This means also two different units of action: m² of installed insulating material for FWC vs. m² of heated surface (or net floor area) for EMEES. Finally, even if the EMEES method recommends using a system rather than a component approach, this latter option is also presented as possible in the ESD context. Therefore, although they are different, FWC and EMEES methods are compatible for ESD reporting.

Compared to the list of data usually registered for each FWC action (see section 5.3.3), in the case of insulation actions, the corresponding data are required:

- amount of installed insulating material (expressed in m²) ;
- fuel type (for the heating system) (i.e. electric or fossil-fuel heating) ;
- climate zone (called: H1, H2, H3²²) depending on the location of the dwelling (postcode registered for each participant).

The FWC includes therefore these level 3 values together with national average (i.e. level 2) values for the other parameters.

It should be noticed that the floor area of the dwelling is not required to calculate the FWC savings.

The information about the age of the building (i.e. built before any building code [i.e. <1975] or after the first building code [i.e. >1975]) and the dwelling type (individual or collective housing) are gathered in the FWC data processing system but are not used for

²² The H1 zone is corresponding to the main part of the country and is the coldest, H3 is the most temperate, H2 is the intermediate zone.

the energy savings calculation (for the case of insulation actions).

5.4.1.3 Step 3: Total ESD energy savings

Double counting and multiplier effects are not addressed explicitly in the FWC calculations. However, they could be taken into account by exploiting existing monitoring and performing specific studies, as explained in sections 4.5, 4.6 and 5.3.4.

Free-rider effects are not included in FWC calculations for insulation actions, which means that the FWC savings correspond to the category “all energy savings”, as defined in the EMEEES methodology (see section 4.3.1).

The choice of the “stock” baseline was probably due to two main reasons:

- a technical (“objective”) one: refurbishment rate was quite low until recently (at least for refurbishments aiming at improving building energy efficiency);
- a political (“subjective”) one: space heating is a major energy end-use in the French energy balance and renewal rate for buildings is very low, so existing buildings are a priority target for improving energy efficiency and corresponding actions should be encouraged.

The first reason justifies the assumption of a low free-rider effect. Moreover, the observatory OPEN (see Appendix II) now monitors the quality and energy efficiency level of the refurbishment works. This should provide additional data to check this assumption.

The second reason means implicitly that, even if there are some free-riders, encouraging such actions is worth as it is a major energy stake. In addition, the FWC scheme includes eligibility conditions which are assumed to ensure a high quality and energy efficiency level for the credited actions. This reinforces the position to neglect the free-rider effect in the French context. However, it should be discussed with the Commission if this position is in line with the ESD, or if FWC savings should be corrected for ESD reporting.

5.4.1.4 Step 4: total ESD energy savings for 2010 and 2016

The assessed lifetime of the insulation actions in the FWC scheme is 35 years, which is longer than the value proposed by the CEN Workshop Agreement (25 years).

Whatever the value used (35 or 25 years), the FWC actions were implemented from July 2006, which means that they all can be assumed to be still effective in 2010 and 2016.

For the conversion of FWC savings into ESD savings, an action lifetime of 35 years corresponds to a discounting coefficient of 19.411 (see section 4.3.2).

5.4.2 Calculation scenarios

5.4.2.1 Definition of the scenarios

As mentioned in section 5.3, the EMEEES method for insulation actions does not provide level 1 default values. Therefore, it is only possible to compare calculation scenarios using

level 2 and/or level 3 values.

As mentioned in section 5.4.1.2, for insulation actions, level 3 values are available for the following parameters used in the calculation:

- m² of installed insulating material ;
- fuel type (for the heating system) (i.e. electric or fossil-fuel heating) ;
- climate zone (H1, H2, H3).

When calculating energy savings, m² of insulation material are always to be defined at level 3, as it represents the number of actions. But fuel type and climate zone can be defined by either level 2 (national distribution) or level 3 (participants' data) values. Consequently, for the pilot test, we calculated the energy savings according to three levels of desegregation from the detailed to simple one:

1. full²³ desegregation (i.e. fuel type and climate zone are recorded for each participant): the savings are estimated as a function of fuel type (electricity, fossil) and the climate zone (H1,H2,H3), which means 6 possible distinct configurations ; this would correspond to the level 3 result.
2. medium desegregation (i.e. climate zone is recorded for each participant ; whereas fuel type distribution is based on a weighted average of the stock): the savings are estimated regardless of the fuel type for space heating (dealt with by a weighted average), but taking account of the climate zone, which means 6 possible distinct configurations.
3. no desegregation (i.e. climate zone and fuel type distributions are based on a weighted average of the stock): the savings are estimated using a weighted average based on the distribution of the building stock according to the fuel types and the climate zones, which means that only a "national representative" configuration is considered ; this would correspond to the level 2 result.

In the medium desegregation approach we consider that the most accessible information is the climate zone (only related to the postcode) which is written on the invoice.

The calculation scenarios used are summarised in Table 11 below.

Table 11. Calculation scenarios for insulation actions.

Level of desegregation	Data for climate zone	Data for fuel type
Full (level 3)	Participants' data Possible values: H1; H2; H3	Participants' data Possible values: electric ; fossil fuel
Medium	Participants' data Possible values: H1; H2; H3	Weighted average, based on the distribution of the national building stock

²³ According to the data available. This scenario uses as much level 3 data as possible. But it is still a mix of level 2 and level 3 data, as level 3 data are not available for all parameters.

No desegregation (level 2)	Weighted average, based on the distribution of the national building stock
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5.4.2.2 Values used for the weighting factors (level 2 distribution)

Source for the distribution of the building stock: 2004 national statistics from INSEE. (INSEE, 2009)

Distribution of the building stock according to fuel type (for space heating):

- Fossil fuel space heating: 15.386 millions of dwellings (i.e. 66%).
- electricity space heating: 7.765 millions of dwellings (i.e. 33%).

Table 12. Distribution of the building stock according to the climate zones.

Climate zone	H1	H2	H3
Correction factor (CZ) ²⁴	1.1	0.9	0.6
Share of the building stock	59%	30%	11%

5.4.2.3 Results

The results from the calculation scenarios (see in Table 11) are presented hereafter.

Table 13 and Table 14 show the results for step 1 (unitary savings) according to the different components (roof, window, wall, floor). For all action types, the unit of action is the m² of installed insulating material.

Table 15, Table 16 and Figure 6 show the results for step 2 per action type, respectively the amount of actions (for Table 15) and the total gross savings in GWh/year (for Table 16 and Figure 6). The amount of actions is expressed in m² of installed insulating material. No indication of the number of dwellings is available as well as of the area treated by dwelling.

²⁴ Source: FWC calculation forms.

Table 13. Unitary savings for roof insulation and window insulation (step 1 results for the EDF sample).

Action type	Roof insulation ($R \geq 5 \text{ m}^2 \cdot \text{K/W}$)				Window insulation ($U_w \leq 2 \text{ W/m}^2 \cdot \text{K}$)			
Full desegregation (level 3)	Fuel type for space heating				Fuel type for space heating			
	electricity		fossil fuel		electricity		fossil fuel	
Climate zone	kWhcumac/m ² .y	kWh/m².y	kWhcumac/m ² .y	kWh/m².y	kWhcumac/m ² .y	kWh/m².y	kWhcumac/m ² .y	kWh/m².y
H1	1200	61.82	1900	97.88	1700	87.6	2700	139.1
H2	980	50.48	1600	82.43	1400	72.1	2200	113.3
H3	660	34	1000	51.52	900	46.4	1500	77.3
Medium desegregation	No fuel type (weighted average from above values)				No fuel type (weighted average from above values)			
Climate zone	kWhcumac/m ² .y		kWh/m².y		kWhcumac/m ² .y		kWh/m².y	
H1	1665		85.78		2365		121.8	
H2	1392		71.71		1932		99.5	
H3	886		45.64		1299		66.9	
No desegregation (level 2)	No fuel type and no zoning (weighted average from above values)				No fuel type and no zoning (weighted average from above values)			
No climate zone	1497		77.15		2117		109.1	

Table 14. Unitary savings for wall insulation and floor insulation (step 1 results for the EDF sample).

Action type	Wall insulation ($R \geq 2.4 \text{ m}^2 \cdot \text{K/W}$)				Floor insulation ($R \geq 2.4 \text{ m}^2 \cdot \text{K/W}$)			
Full desegregation (level 3)	Fuel type for space heating				Fuel type for space heating			
	electricity		fossil fuel		electricity		fossil fuel	
Climate zone	kWhcumac/m ² .y	kWh/m².y	kWhcumac/m ² .y	kWh/m².y	kWhcumac/m ² .y	kWh/m².y	kWhcumac/m ² .y	kWh/m².y
H1	1900	97.9	3100	159.7	2400	123.6	3800	195.8
H2	1600	82.4	2500	128.8	2000	103.0	3100	159.7
H3	1100	56.7	1700	87.6	1300	67.0	2100	108.2
Medium desegregation	No fuel type (weighted average from above values)				No fuel type (weighted average from above values)			
Climate zone	kWhcumac/m ² .y		kWh/m².y		kWhcumac/m ² .y		kWh/m².y	
H1	2698		140.0		3330		171.6	
H2	2198		113.2		2731		140.7	
H3	1499		77.2		1832		94.4	
No desegregation (level 2)	No fuel type and no zoning (weighted average from above values)				No fuel type and no zoning (weighted average from above values)			
No climate zone	2416		124.6		2986		153.8	

Table 15. Amount of actions (in m² of installed insulating material) per action type in the studied EDF sample.

Action type	Insulated roof surface (m ²)				Insulated window surface (m ²)				Insulated wall surface (m ²)				Insulated floor surface (m ²)			
Climate zone	Fuel type for space heating				Fuel type for space heating				Fuel type for space heating				Fuel type for space heating			
	electricity		fossil fuel		electricity		fossil fuel		electricity		fossil fuel		electricity		fossil fuel	
H1	11 517	10%	21 506	19%	12 135	12%	38 438	38%	1 068	13%	1 902	23%	620	23%	768	28%
H2	32 879	30%	38 716	35%	13 294	13%	26 899	27%	2 164	27%	2 863	35%	311	11%	981	36%
H3	4 356	4%	2 186	2%	5 137	5%	4 342	4%	49	1%	78	1%	72	3%	0	0%
Total	111 160				100 245				8 124				2 752			

Table 16. Total gross annual savings (in GWh/year) per action type (step 2 results for the EDF sample).

Scenarios ↓	Action → type	Roof insulation (total savings in GWh/year)	Window insulation (total savings in GWh/year)	Wall insulation (total savings in GWh/year)	Floor insulation (total savings in GWh/year)
Full desegregation (level 3)		7.93	10.99	0.96	0.42
Medium desegregation		8.27	10.79	0.99	0.43
No desegregation (level 2)		8.58	10.93	1.01	0.42
Maximum deviation between scenarios		8%	2%	5%	2%

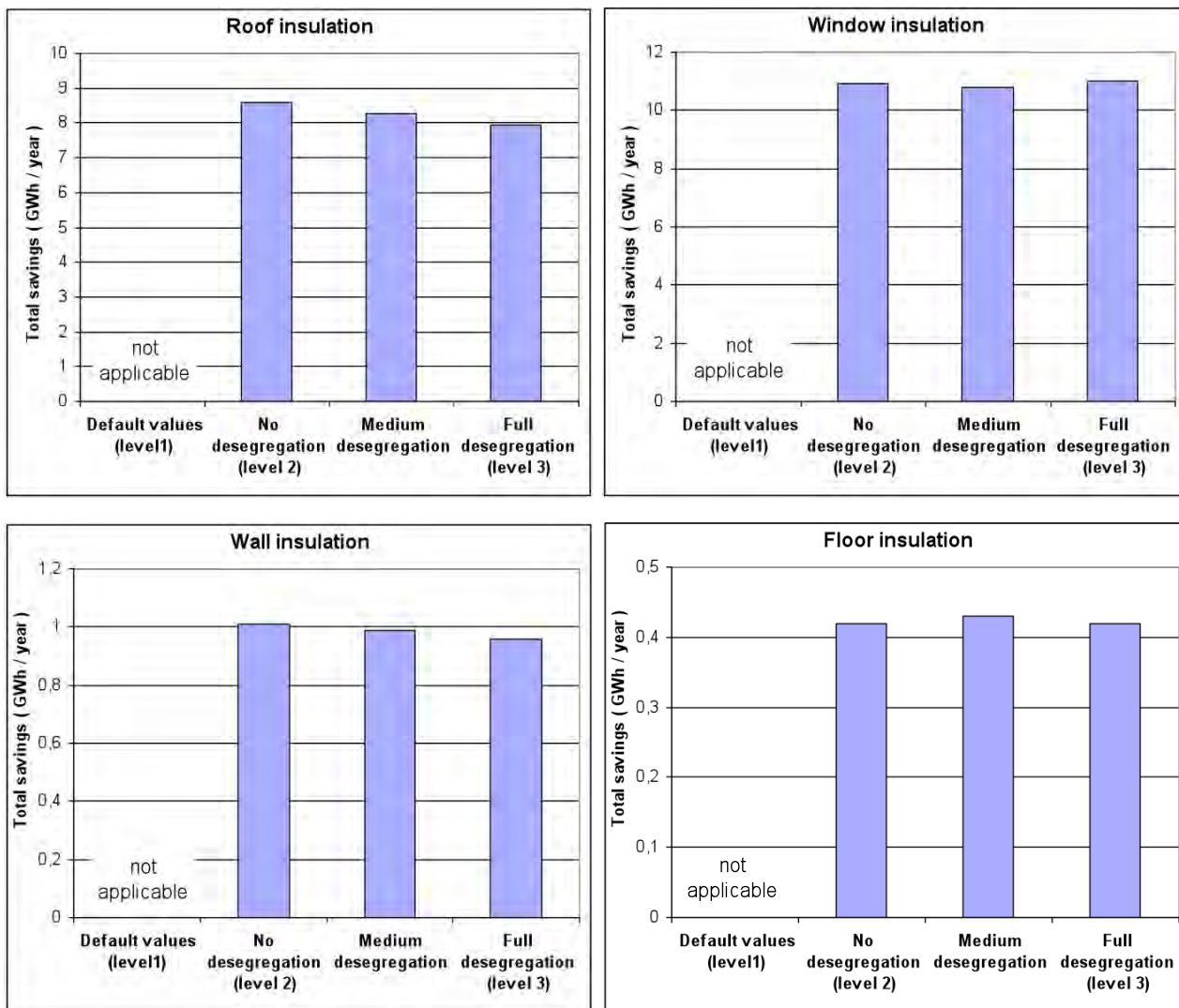


Figure 6. Total gross annual savings (in GWh/year) per action type.

5.4.2.4 Conclusions

The first observation is that the differences between calculation scenarios remain low (the biggest deviation is of 8% for roof insulation).

One possible explanation for these low deviations between scenarios could be that the distribution of dwellings according to the two tested variables (climate zone and fuel type) would be similar in the building stock (used to define the level 2 values) and in the EDF sample (used to define the level 3 values). Table 17 below shows that this conclusion is consistent for the distribution according to fuel type, but not for the one according to the climate zone.

Table 17. Distribution of the building stock and the EDF sample according to the climate zone and the fuel type.

Distribution according to climate zone			Distribution according to fuel type (for space heating)		
Climate zone	Building stock	EDF sample	Fuel type	Building stock	EDF sample
H1	59%	40%	Fossil	66%	62%
H2	30%	53%	Electricity	33%	38%
H3	11%	7%			

(Figures from Table 17 should be used with caution. The distribution of the building stock is based on the number of dwellings, whereas the one of the EDF sample is based on m² of installed insulation material, which is not necessarily representative of the corresponding number of dwellings.)

Analysing the impact of the differences in the distributions can be done by calculating for each distribution the equivalent weighted value²⁵.

Table 18. Comparison of equivalent weighted values between building stock and EDF sample.

	Building stock	EDF sample
Correction factor for climate zone	0.99	0.96
Boiler efficiency	0.71	0.73

Table 18 proves that despite the differences in the distributions between building stock and EDF sample, the corresponding equivalent values for both groups are similar.

The second observation is that, for the cases of roof and wall insulation, the more desegregated the calculation, the lower the results. But it should be reminded that these deviations are less than 8%. Moreover, for the cases of window and floor insulation, the deviations between scenarios are even lower (around 2%), and so the corresponding results can be assumed to be the same, whatever the level of desegregation.

At last, for the case of the insulation actions of the studied EDF sample, the conclusion is that level 2 and level 3 results can be assumed to be similar. This would mean that, for ESD reporting purpose, it would not be necessary to register climate zone and fuel type for each participant. However, such a conclusion needs to be confirmed by an analysis of the whole sample of insulation actions registered during the 1st period of the FWC scheme.

²⁵ i.e. the value which would be used in Equation 2 for CZ, correction factor for climate zones, and for η , boiler efficiency, for a calculation based on an “average dwelling” representative of the whole sample.

More generally, this case supports the assumption that when the number of evaluated actions is high enough, level 2 and level 3 results may not be significantly different (i.e. assuming that, for a large enough sample, the possible deviations compensate).

Moreover the choice of the variables tested in the scenarios (climate zone and fuel type) was forced by the data availability (i.e. what data are registered for each FWC action). It should be checked whether other variables or values have a significant influence on the energy savings' results (e.g. actual boiler efficiency, actual initial value of thermal transmission, actual heat demand). The best way would be to verify the actual energy savings on a sample.

5.4.3 EPC vs. FWC estimation

5.4.3.1 Reference situation

The test with the EPC is performed with a one-level individual house built before 1975 (with no insulation) with an area of 100 m² in the climate zone H1. The space heating system is an old fossil boiler (efficiency = 0.6). The conventional consumption²⁶ of fossil fuel for space heating is 61.92 MWh/y. It has to be noticed that the energy consumption is overestimated²⁷ but as we deal with a before/after methodology for the calculation of the energy savings, the absolute value may not be so important.

Hereafter, a comparison is made between calculations based on FWC and EPC²⁶ methods for the four action types analysed in this case study (roof insulation, window insulation, wall insulation, floor insulation).

5.4.3.2 Roof insulation

After insulation of the roof (area of 100 m²) with a thermal resistance of R=5 m².K/W, the conventional consumption became 50.2 MWh/y. The specific savings are 117 kWh/m².y (m² meaning here m² of installed insulating materials).

These savings have to be compared to the FWC savings (97.88 kWh/m².y) which are similar²⁸ to the EPC estimation. This result is not surprising as the equation and value of the two methodologies are equal:

- U roof =2 W/m².K, added insulation: R=5 m².K/W in the EPC.
- U roof =2 W/m².K, added insulation: R=5 m².K/W in the FWC.

However, a difference in the order of 20% remains and, without any further explanation, this has to be attributed to the difference in the calculation methodologies. For the other cases presented below (windows, walls and floor insulation), differences also arose but

²⁶ Calculation made with DPEWIN software from Perrenoud (publisher of thermal calculation software).

²⁷ For comparison, CEREN data (based on energy bills) assess the final heating consumption for a dwelling with the same configuration (house of 100 m², before 1975, H1 zone) at around 25 MWh/year. Deviations between both estimations (based on metered data and based on calculations) mainly result from the way behaviours and previous refurbishment are taken into account in the calculations. But it has to be noticed that the FWC calculations for insulation actions are not based on metered consumption, but on calculated consumption (see Equation 6) with a formula similar to the one used for the EPC calculations.

²⁸ For such calculations, a 20% difference can be assumed to be reasonable.

there were explained by the differences in the U values used for the reference situation.

5.4.3.3 Windows insulation

The same assumptions and building type described above are used for the assessment of the energy savings according to the EPC methodology. In this case, we kept in mind that the house is equipped with simple glazed windows and the conventional consumption is 61.92 MWh/y.

With the old windows changed by low emitting double glazed (10 m² treated) with a thermal transmittance of $U_w=2 \text{ W/m}^2\cdot\text{K}$, the conventional consumption became 60.59 MWh/y. The specific savings are 133 kWh/m².y (m² meaning here m² of installed double glazed window).

These specific savings have to be compared to the FWC savings (139 kWh/m².y). This very low difference (less than 5%) is not surprising as the values used in the two methodologies are similar:

- $U_w=4.2 \text{ W/m}^2\cdot\text{K}$, new window: $U_w=2 \text{ W/m}^2\cdot\text{K}$ in the EPC,
- $U_w=4.5 \text{ W/m}^2\cdot\text{K}$, new window: $U_w=2 \text{ W/m}^2\cdot\text{K}$ in the FWC.

5.4.3.4 Wall insulation

The same assumptions and building type used previously are used for the assessment of the energy savings. As presented before, the conventional consumption for space heating is 61.92 MWh/y.

With an internal insulation of the walls (91 m² treated), the conventional consumption became 52.426 MWh/y. The specific savings are 104 kWh/m².y (m² meaning here m² of insulated walls).

These specific savings have to be compared to the FWC savings (160 kWh/m².y). This difference (35%) is not surprising as the values used by the two methodologies vary in the same range:

- $U_{\text{wall}}=2.0 \text{ W/m}^2\cdot\text{K}$, added insulation: $R=2.5 \text{ m}^2\cdot\text{K/W}$ in the EPC,
- $U_{\text{wall}}=3.3 \text{ W/m}^2\cdot\text{K}$, added insulation: $R=2.5 \text{ m}^2\cdot\text{K/W}$ in the FWC.

In that case, using the EPC as proposed in the EMEES method could lead to smaller energy savings than with the deemed estimates used for the FWC, as the assessed reference (baseline) values for the key thermal parameter (U_{wall}) are different, meaning the “before” situation is not the same in both cases.

5.4.3.5 Floor insulation

The same assumptions and building type as described above are used for the assessment of the energy savings with a specific low floor with a $U_{\text{floor}}=2 \text{ W/m}^2\cdot\text{K}$. Then the conventional consumption for space heating is 61.92 MWh/y.

With an insulation of the floor (100 m² treated), the conventional consumption became 51.84 MWh/y. The specific savings are 100 kWh/m².y (m² meaning here m² of insulated

floor).

These specific savings have to be compared to the FWC savings (195.76 KWh/m².y). This difference (around 50%) is not surprising as the values used by the two methodologies vary in the same range:

- $U_{\text{floor}}=2.0 \text{ W/m}^2\cdot\text{K}$, added insulation: $R=2.4 \text{ m}^2\cdot\text{K/W}$ in the EPC,
- $U_{\text{floor}}=4.0 \text{ W/m}^2\cdot\text{K}$, added insulation: $R=2.4 \text{ m}^2\cdot\text{K/W}$ in the FWC.

As for the floor insulation, using the EPC as proposed in the EMEEES method could lead to smaller energy savings than with the deemed estimates used for the FWC, as the assessed reference (baseline) values for the key thermal parameter (U_{floor}) are different, meaning the “before” situation is not the same in both cases.

5.4.3.6 Conclusions

The first observation is that most of the differences between EPC and FWC results are explained by differences in the definition of the reference situation (or baseline), here mainly expressed by the thermal transmission value.

Consequently, both calculation approaches (EPC and FWC) appear to be similar, at least using the same main parameters. And the observed differences in the results highlight how important the baseline choice is. Again, a complementary analysis would be to compare such calculated energy consumption values with verified values (from energy bills or measurements).

Moreover, the differences for the case of roof insulation remain unexplained.

5.4.4 Conclusions on the comparisons

As detailed in the section 5.3, it was not possible to apply directly the EMEEES method for this test, due to differences between the data expected for the EMEEES method and the data available for this test. Nevertheless, the EMEEES method was analysed from the point of view of an application for a specific case (French context), to see what can be used and what can not. To complete the methodological analysis of section 5.3, the existing FWC method was described in section 5.4, following the EMEEES approach (4-steps calculation process and 3-levels approach).

The first conclusion is that Member-States can take advantage of the EMEEES method to better use their own existing evaluation methods: describing them in a harmonised way, detecting what complementary studies would be useful to improve results reliability, justifying differences from other common evaluation approaches.

The comparisons between the tested calculation scenarios (section 5.4.2) emphasise the importance of the choice of the sample. If the buildings stock in the sample is similar to the whole national buildings stock, there is no major deviation between the various levels of assessment. In the tested cases, even if the sample was probably significantly different

from the typology of the building stock (see Table 17), the deviations in the results remain below 10%. This means that it seems relevant to assume that for a sufficiently high number of actions, level 2 (national) and level 3 (participant-specific) results are not significantly different. Then a level 2 evaluation could be reliable enough.

However, a monitoring or survey of the refurbishment market, like done through the OPEN observatory (see Appendix II), is necessary to assess the most accurate estimated energy savings without major deviations compared to verified energy savings, if an intermediate level of desegregation (i.e. mainly level 2 evaluations) is used for the energy savings assessment. Moreover, the choice of parameters to be evaluated at level 3 (i.e. based on data registered for each participant) should be justified.

Comparing the savings estimated from the FWC and EPC methods (section 5.4.3), both calculation approaches appear to be similar, at least using the same main parameters. However, significant differences are observed in the calculated energy savings, mainly due to differences in the values used for the initial thermal transmission. In fact, EPC results are lower than FWC ones. This highlights how important the baseline choice is. Indeed, deviations observed in the FWC vs. EPC comparison (mainly due to distinct baseline values) are much (until ten times) higher than the ones between the calculation scenarios (due to distinct levels of desegregation, i.e. level 2 vs. level 3 values).

Finally, both comparisons stress two main conclusions:

- to ensure results' reliability, the values used in the calculations need to be sourced and justified, especially the ones used for the baseline as their choice leads to the main differences in results from distinct methods (e.g. baseline values in the French EPC method are not sourced) ;
- it seems necessary to perform ex-post studies (on relevant samples) to verify actual energy savings (e.g. from energy bills or measurements), and thus check whether calculated values can be trusted.

5.5 Final conclusions specific to the case of insulation actions

The proposed EMEEES method for improvement of building envelope in residential buildings (Amman, 2008) presents transparent assumptions and hypothesis and is well documented.

Considering the usability of the method, the application to the French pilot test revealed some limitations.

The EMEEES method dedicated to insulating action is not directly applicable to the FWC case as the data sources for the levels 2b or 3 do not exist in France (e.g., no EPC database). Moreover, in the French policy, a large amount of refurbished dwelling is not covered by the EPC mechanism.

For the EMEEES level 2, the proposed calculation method is also not directly applicable to

our case study. However, the method is useful but with different data sources than proposed. The general framework of the EMEEES methodology was nevertheless used for the evaluation of the pilot test.

In this EMEEES method, no default value is proposed, so no assessment of accuracy or uncertainty of EMEEES values has been done.

The FWC evaluation costs have been looked at, but an accurate assessment of these costs is difficult as the method used relies on pre-existing studies (whose costs are not dedicated to the FWC) or as data on some costs are unavailable (transaction cost). However, the results show that the differences between well disaggregated calculations (level 3) and aggregated ones (level 2) for the assessment of the savings are likely to be small justifying the option to use a reduced quantity of data, and therefore cutting down the global costs.

The proposed method covers all the possible actions in the field of building insulation and remains sufficiently global to include all technologies and solutions available on the market.

5.6 Needs and potentials for improvement of the method tested

The EMEEES method for insulation actions included two main options (system or components approach, as defined in the EPBD). This makes easier the comparison with a national method. However, the components approach is not as detailed as the system one (which is based on EPC). This could be completed by a reference to the FWC method, which appears to be a good method based on the components approach.

It would also be interesting to have some assessments of the evaluation costs for the system approach (based on EPC) in order to compare both approaches (system and components).

Finally, in order to avoid any confusion, a clear distinction should be made between energy demand (based on calculations / simulations) and energy consumption (based on metered data, possibly completed by statistical analyses).

6 BU Method 7 Condensing Boilers

6.1 Testing activity description

6.1.1 Which end-use (EEI) actions and (EEI) facilitating measures have been considered to test the method?

The main **facilitating measure** considered here is the French White Certificates (FWC) scheme. Other facilitating measures are considered as they may have strong interactions with the FWC scheme:

- VAT (Value Added Tax) Reduction on dwellings' renovation works;
- Tax Credit for energy efficient equipments and renewable energies.

These measures are described in Chapter 4 above (included their timing). They are taken into account when dealing with double counting issue (see section 4.5).

The **end-use action** considered in this chapter is the replacement of an "old" natural gas (or fuel oil) boiler by a condensing boiler, as defined in Boiler Efficiency Directive 92/42/EC.

6.1.2 Summary of the testing activities presented in this chapter.

The general approach of the Bottom-Up part of this pilot test is presented in section 4.1.1.

The main objectives specific to the case of condensing boiler installations can be summarised as followed:

- comparing the EMEEES and FWC methods (mainly the formula and data used for the energy savings calculation) using the EMEEES framework (4 steps + 3 levels);
- using scenarios (as described in sections 4.3.4 and 6.4) to compare the results obtained according to the level of data used as inputs (i.e. European default values (level 1), national values (level 2) or participants-specific data (level 3)).

When dealing with the calculation scenarios, it is obvious that European default values appear to be very conservative, which prevents from using a level 1 evaluation. Conversely, it could be debated whether level 2 data are sufficient or level 3 will bring valuable additional information.

Main conclusions about the case of condensing boilers are then summarised in section 6.5.

6.2 Data sources specific to condensing boilers

Market data (condensing boilers sales)

GFCC²⁹ data are a reconstruction of the total sales of condensing boilers in France by a very representative manufacturers association. A comparison with supporting mechanisms data could show a multiplier effect.

Table 19. Sales of condensing boilers in France (1997-2007).

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
“Wall” condensing boilers (in units)	1 043	1 212	1 524	2 114	4 512	7 261	14 354	21 771	46 084	77 827	85 451
“Floor” condensing boilers (in units)					671	950	1 376	9 875	28 589	41522	54 861
TOTAL condensing boilers sold	1 043	1 212	1 524	2 114	5 183	8 211	15 730	31 646	74 673	119349	140312

Source: GFCC data.

Data specific to implemented actions (mainly level 3 data)

For this pilot test, EDF provided an access to a sample of FWC actions deposited to the DRIRE (see section 3.3), which enables to calculate different scenarios (level 1, level 2, level 3) for this sample. The participants’ data registered are: dwelling type (houses or apartments), dwelling size (through the number of rooms), building vintage (before or after 1975), climatic zone.

6.3 Test of methodology application step by step

More details about the EMEES method for condensing boilers can be found in (Adnot et al. 2008). For more details about boilers in general (European market, etc.), see also the corresponding preparatory study for the Eco-Design Directive (Kemna et al. 2007).

6.3.1 Baseline issues

As mentioned in section 4.3.1.4, condensing boilers correspond to case 1 (replacement of existing equipment), when defining baselines according to the EMEES methodology.

This means that for this case, the baselines will be different when evaluating “all” or “additional” savings.

For evaluating “all” savings, the baseline will be:

²⁹ GFCC: French professional organisation of central heating systems manufacturers (in French, *Groupement des Fabricants de matériels de Chauffage Central*)

- either the energy consumption of the replaced boiler, when such participants' data are available (i.e. for level 3 evaluations) ;
- or the average energy consumption of the boilers' stock, when only national or European data are available (i.e. for level 1 or 2 evaluations).

For evaluating “additional” savings, the baseline will be the average energy consumption of the boilers’ “inefficient” market, whatever the evaluation level. This applies in the usual case of a normal (or planned) replacement (e.g. because the replaced boiler was at its end of life). In case of an anticipated replacement (i.e. induced by the facilitating measure), the baseline for “additional” savings would be the same as for “all” savings. But then, it should be proven that the facilitating measure encouraged anticipated replacements.

6.3.2 Step 1: unitary savings

The EMEEES formula for unitary savings is based on energy needs (calculated from the building characteristics), and the unit of action is a m² being heated by a water loop and a boiler. A detailed modelling of ΔE, the unitary savings, has been made and simple default values have been proposed.

Equation 7. Step 1 formula for condensing boilers (EMEEES method).

$$\Delta E = \text{unitary gross annual energy savings}$$

$$= \left(\frac{1}{\text{efficiency of replaced plant}} - \frac{1}{\text{efficiency of efficient plant}} \right) \times E$$

With:

- E (kWh/m²): the heating need (European default value (based on the EcoBoiler study =86 kWh/m², to be corrected for HDD or replaced by national (or participants-specific) values) ;
- plant efficiency = boiler efficiency * emitter efficiency * efficiency of distribution network* controller efficiency.

The EMEEES method also proposes default values for each component of the heating system, according to the different situation (stock, “non efficient” market, “efficient” market) (based on Net Calorific Value):

Table 20. Level 1 default values for condensing boilers, from drat EMEEES case application.

Efficiencies	“Non efficient” stock values	“Non efficient” market values	“Efficient” values (condensing boilers, radiant panels, etc.)
Boiler	82%	89%	94%
Emitter	92.5%	92.5%	97%
Distribution	93%	93%	97%

Controller	84.8%	84.8%	96.7%
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Source: (Adnot et al. 2008)

Net Calorific Value (NCV) is recommended by the ESD but Gross Calorific Value (including latent heat of water vapour) is often used by practitioners; in case for some reason, national values based on GCV are used, about 11% should be included in the following formula: $efficiency_{GCV} = efficiency_{NCV} / 1,11$ to obtain the national value based on NCV; note also that there are at least two types of natural gas in Europe, one with High calorific value (called gas H) and one with Low calorific value (called gas L).

Based on existing literature, the EMEEES method suggests to neglect the possible direct rebound effects (e.g., participants who would increase the dwelling's inner temperature, instead of reducing their energy bills). As no specific data is available about this for France, this would be neglected too.

As the EMEEES method provides default values for all required parameters, it is possible to apply a level 1 evaluation to this pilot test. So it will be one of the tested scenarios in section 6.4.3.

When applying the EMEEES method at level 2, most of the data would be missing:

- the FWC method (see section 6.4.2.1) is not based on heating need (i.e. calculated value) but on energy consumption (i.e. metered value), so the available data are on final energy consumption, whereas data on primary energy demand are expected for the EMEEES method ; however these required data could be deduced either from the ones on final consumption or from the data used for the EPC method (see section 5.4.3);
- for the plant efficiency, data are available only for boiler efficiencies.

Consequently, it is not feasible to apply fully the EMEEES method at level 2. However, the FWC method corresponds to another option of level 2 method for condensing boilers. So there will be a level 2 scenario (see section 6.4.3).

These observations apply even more when considering applying the EMEEES method at level 3. None of the required data would be available. However, in the FWC scheme, some data are registered for each participant, providing thus level 3 values. These values are available for the tested EDF sample, and therefore a level 3 scenario was defined (see section 6.4.3).

In conclusion on step 1, the EMEEES method provides default values which enable to calculate a level 1 result in any case. Then for level 2 and level 3, the data expected for applying the EMEEES method may not be available. However, if other national or participants' data are available, other options may be used (as analysed in section 6.4).

6.3.3 Step 2: total gross annual energy savings

The formula proposed in the EMEEES method for TGES (Total Gross Annual Energy Savings) is:

Equation 8. Step 2 formula for condensing boilers (EMEEES method).

$$TGES = \sum_i (\Delta E_i \times \text{surface } A_i \text{ (m}^2))$$

As mentioned in the previous section, the unit used in the EMEEES method is a m² being heated. Therefore the unitary savings are expressed in kWh/m²/year, and the number of actions is to be accounted in m².

The FWC scheme counts the number of installed boilers. But the dwelling size is registered for each participant in terms of number of rooms. The matching between number of rooms and the net floor area (in m²) was then standardised (see Table 25 in section 6.4.2.2).

Finally, for step 2, the approach proposed in the EMEEES method could be applied.

6.3.4 Step 3: total ESD savings

The formula proposed in the EMEEES method for Total ESD Annual Energy Savings is:

Equation 9. Step 3 formula for condensing boilers (EMEEES method).

$$\begin{aligned} &\text{Total ESD Annual Energy Savings} \\ &= TGES * (1-\text{double counting coefficient}) * (1-\text{free-rider fraction} + \text{multiplier effect}) \end{aligned}$$

Double counting

When dealing with “condensing boilers” actions, it is necessary to consider the presence other facilitating measures applying for these actions (see section 4.5 and chapter 4), and especially the tax credits. It should thus be avoided to count the same energy savings twice. The current number of condensing boilers registered in the FWC scheme is rather small compared to the number of total sales for France. So the risk that the double counting of installed condensing boilers may seriously alter the total amount of the energy savings claimed under the French NEEAP is limited. However, FWC results are expected to grow very significantly, and the double counting issue may become important (see section 4.5 for more details, as the proposed solutions are similar for both, insulation actions and condensing boilers).

Free-riders

The problem is to evaluate the percentage or the number of final customers who would have made the same choice (i.e. here buying a condensing boiler) without the presence of a facilitating measure.

Implementing the ESD, there are two scenarios:

- either the Committee of the Directive decides that the free-rider effect is not to be taken into account for the ESD, and thus this is not an issue anymore for the ESD reporting ;
- or the Committee decides the opposite, and thus it would be necessary either to consider the default value suggested by the PoliMi (Pindar et al., 2008) (20% of the purchasers "free-riders" for boilers with condensation, which seems a high value from a

French perspective) or to make a specific study to provide a specific value.

An option could be to use the data provided by the manufacturers' association (Uniclima and GFCC) to perform a trend analysis.

Multiplier Effect

It would be necessary to lead investigations or market research (ex-post evaluations) at the national level to evaluate it. This could be made by using the sales data available, and by interviewing market actors (for more details, see section 4.6).

6.3.5 Step 4: total ESD energy savings for 2010 and 2016

For the action lifetime, the EMEEES method refers to the values proposed by the CEN Workshop Agreement 15693 (CEN, 2007), i.e. level 1 savings lifetime of 17 years.

For ESD purpose, the reported energy savings should be still effective in 2016. Assuming a lifetime value of 17 years (or 16 years as defined in the FWC scheme) for "condensing boilers" actions, all actions implemented from 2000 could count, if early energy savings are allowed.

However, there may be problems with some components of the boilers having a shorter lifetime. But no specific study on this is available so far.

6.4 Method comparison and interactions with already existing evaluation methods

The objective of this part is to compare the FWC and EMEEES methods (mainly the calculation formula and data used), using the EMEEES framework (4 steps, 3 levels).

6.4.1 Scope issues

6.4.1.1 Boilers' type

A first difference should be noticed in the scope of both methods (FWC and EMEEES), when dealing with natural gas boilers:

- in the FWC scheme, the eligible boilers are the so-called "low temperature" (LT) and "condensing" (CD) boilers ;
- whereas in the EMEEES method, only the "condensing" boilers are considered (the underlying assumption is that LT boilers already correspond to the market standard, meaning installing a LT boiler is a "normal" (and not "additional") actions, which would happen even without any facilitating measure).

This is an important issue, because in the sample of actions provided by EDF, the number of LT boilers is much higher than the CD boilers (2700 LT vs. 150 CD). Indeed, the additional costs of a LT boiler compare to a "standard" (or market average) boiler are much smaller than the ones of a CD boiler compared to the same "standard" boiler. Likewise, the energy efficiency improvement between the "standard" boiler and the LT

one is also moderate. To take account of this (and above all to encourage actors to target CD boilers more than LT boilers), a coefficient of 50% is applied to the assessed savings when crediting certificates for LT boilers (i.e., the credited unitary savings are 50% lower than their assessed value).

The list of actions eligible to the FWC scheme is periodically updated. It is likely that LT boilers become non-eligible to FWC in a near future, to take account of the progressive market transformation. However, so far these boilers were eligible, and the performance criteria applied in the EMEEES method are not applied in the ESD implementation. Energy savings from LT boilers could probably be reported in the NEEAP to the European Commission.

Finally, in this test, we only deal with the condensing boilers, as the EMEEES method is restricted to this type of boiler. But the test would be the same for LT boilers (as the corresponding FWC methods and data available are similar).

Moreover, the FWC methods cover both, individual and collective boilers, whereas the EMEEES method only considers the individual boilers. Consequently, only the individual boilers from the EDF sample were studied here.

6.4.1.2 Boilers' use

A second difference in the methods' scope lies in the energy use covered. The EMEEES method only considers consumption related to space heating, when two options are included in the FWC method: boilers for space heating only, and boilers for space and water heating.

As one of the objectives of this part is to compare EMEEES and FWC values, we calculated the energy savings related to space heating only. All the individual condensing boilers were included in the calculations (i.e. boilers for space heating only and boilers for space and water heating), but for both, only their energy consumption related to space heating were taken into account (the FWC method separates the consumption related to water heating from these related to space heating, which enables to do so).

6.4.2 Method comparison

6.4.2.1 Step 1: unitary savings

The EMEEES formula for unitary savings is based on energy needs (calculated from the building characteristics), whereas the FWC formula is based on final energy consumption (defined from national statistics on energy bills).

For the EMEEES method on residential heating, **the unit is a square meter** being heated by a water loop and a boiler. A detailed modelling of ΔE , the unitary savings, has been made and simple default values have been proposed.

$\Delta E = \text{unitary gross annual energy savings} = (1/\text{efficiency of replaced boiler} - 1/\text{efficiency of condensing boiler}) * E$

with E, the heating need (European default value = 86 kWh/m², to be corrected for HDD or replaced by national (or participants-specific) values)

In the FWC method, **the action unit is a dwelling** (but the areas are known through a detailed survey by category, see Table 25). A slightly different formula from EMEEES formula has been used to develop the national level 2 estimate of energy savings in kWh(NCV)/year:

Equation 10. Step 1 formula for condensing boilers (EMEEES method).

$$\Delta E_{i,j,k,l,m} = \text{standard energy consumption (Zi; Aj; Tk; Sl; Um)} * \Delta \text{efficiency gain (\%)}$$

Where standard energy consumption = the average consumption of the dwelling category, depending on several parameters:

- Zi, climatic zone (H1, H2 or H3);
- Aj, dwelling vintage (before/after 1975);
- Tk, dwelling type (house or apartment);
- Sl, dwelling size (through the number of rooms);
- Um, boiler use (space heating and water heating).

The main difference with the EMEEES method is that the EMEEES formula is based on energy needs (in primary energy, calculated from the building characteristics), whereas the FWC formula is based on final energy consumption (defined from national statistics on energy bills). Consequently, there is also a difference in the way the boiler efficiency is introduced in the formula (directly in the EMEEES method, and through the efficiency gain in the FWC method). In physics terms, the efficiency gain used in the FWC method is related to the boiler efficiency as follows:

Equation 11. Relation between efficiency gain and boiler efficiency (in the FWC method).

$$\Delta \text{efficiency gain (\%)} = 1 - \frac{\text{efficiency of the replaced boiler}}{\text{efficiency of the condensing boiler}}$$

Moreover, in the FWC method, only the boiler efficiency is considered, and not the emitter and other efficiencies as proposed in the EMEEES method.

The parameters differentiating the energy consumption values are registered for each participant. Most of the corresponding values of average energy consumption per category are based on CEREN data (defined from a recent national survey).

Table 21. Average energy consumption according to dwelling type and vintage, and boiler use.

Space heating (in kWh/year)				Water heating (in kWh/year)			
Houses		Apartments		Houses		Apartments	
(H) Before 1975	(H) After 1975	(A) Before 1975	(A) After 1975	(H) Before 1975	(H) After 1975	(A) Before 1975	(A) After 1975
22932	20698	10847	9247	4800	4800	3687	3687

Source: CEREN data

Table 22. Correction factors for dwelling size.

Number of rooms	1	2	3	4	5	6 et +
Apartments	0,3	0,7	1	1,4	1,7	2,2
Houses	0,2	0,4	0,7	0,9	1,1	1,4

Source: INSEE data (2002)

Table 23. Correction factors for climatic zone.

H1 zone	H2 zone	H3 zone
1,1	0,9	0,6

(this last correction is only applied to space heating data, not to water heating data)

Finally, the average efficiency gain is of 40%, based on a rather old survey of the stock, including both, natural gas and fuel oil boilers. The assumed efficiency values can be compared to the default values proposed by EMEEES:

Table 24. Boiler efficiency values used in the EMEEES and FWC methods

	Average efficiency (NCV) for the boilers' stock	Average efficiency (NCV) for the condensing boilers
EMEEES default values (level 1)	89%	94%
FWC values (level 2)	60%	100%

The FWC value used for the average efficiency for the boilers' stock implies the assumption that the condensing boilers will replace the oldest boilers. To be confirmed (so that this level 2 value can be considered as reliable), this assumption should be supported by a national investigation aiming to evaluate the "before" and "after" situation (in terms of boiler efficiency). This debate on the baseline used is highlighted in the "EMEEES vs. FWC" paragraph hereafter.

In case a "market" baseline should be used, the efficiency gain between the market average and the condensing boilers would be of approximately 15% for France according to experts' words.

For collective boilers, the computation is the same with a longer lifetime for the boilers. In concrete terms, this makes no difference for the savings in 2016.

Two questions are still open:

- are the CEREN survey values NCV or GCV?
- what can justify that the measure is really focused on replacing the oldest and less efficient boilers of the stock (assumption leading to the 40% gain)?

EMEEES vs. FWC: reference (or baseline) issues

As explained in section 6.3.1, the definition of the reference (or baseline) in the EMEEES method refers to the following assumption:

- either the action is an anticipated replacement, consequently the baseline for both “additional” and “all” savings should be the stock average ;
- or the action is a planned replacement, and therefore the baseline for “all” savings should be the stock average, but for “additional” savings the baseline should be the “inefficient market” average.

The energy savings assessed by the FWC method correspond thus to the category “all” savings, as the baseline is based on the stock average. To evaluate “additional” savings, it should either be justified that FWC actions are anticipated replacement (which seems unlikely), or to use another baseline based on the “inefficient market” average.

Moreover, the 40% used for the efficiency gain in the FWC method induces another assumption which is that the installed boilers replaced very old and inefficient boilers, which may not always be the case.

At the national level, there may be a reason which explains an energy gain equal to 40 %, like a political choice of certain savings opportunities. Indeed, the “condensing boilers” action is the most frequent one in the FWC actions registered so far (representing around 17% of the FWC credited as of the 1st November 2008). But if this value can not be justified, a different efficiency value will have to be used when reporting energy savings for ESD purpose (according to the EMEEES principles).

An option could be to make a survey on a sample of FWC participants to check, first what was the boiler replaced, and second whether it was a normal replacement (e.g. due to old boiler “death”) or an anticipated one.

6.4.2.2 Step 2: total gross annual energy savings

As mentioned above, the action unit for FWC is a condensing boiler, whereas for EMEEES it is a m² of heated surface (net floor area). This difference between the EMEEES and the FWC method is related to the type of data registered (m² for EMEEES, boilers’ bills and other participants’ data for FWC). A specific FWC calculation form provides the relations between both (m² and number of rooms). Indeed, this FWC form was published by ADEME and ATEE, as feedback from practitioners proved that depending on the situation, the net floor area can be more easily known than the number of rooms.

The FWC table (see Table 25 below) divides the apartments and the houses into a number of classes with rooms from “1” to “6 and more”, each one being related to a range of net floor area inside which take place the majority of residences. Correction factors are then deduced, also taking account of the dwelling type. This factor is then applied to the FWC value for average energy consumption, when crediting FWC.

Table 25. Relations between number of rooms and net floor areas.

Number of rooms	Net floor area (range)	Net floor area (average)	Correction factors	
			Houses	Apartments
1	< 35 m ²	29.08	0.2	0.3
2	35-60 m ²	48.41	0.4	0.7
3	60-80 m ²	70.17	0.7	1
4	80-100 m ²	89.57	0.8	1.4
5	100-130 m ²	108.41	1.1	1.7
6+	> 130 m ²	146.10	1.4	2.2

Source: FWC form (based on Enquête Logements, INSEE [2001])

Each individual replacement is registered and checked by local administration (DRIRE). When summarising the data used in the FWC method, and confronting this to the 3-levels approach of EMEEEES, the following distinction can be made:

Table 26. Distinction between level 2 and level 3 data in the FWC method for condensing boilers.

Level 2 data (based on national statistics)	Level 3 data (registered for each participant)
Average energy consumption by dwelling type and vintage, and boiler use	Dwelling type (house or apartment), vintage (before/after 1975) and boiler use (space heating/water heating)
Correction factors for dwelling size	Number of rooms
Correction factors for climatic conditions	Climatic zone (H1, H2, H3)
Average efficiency gains for “condensing” and “low temperature” boilers	Boiler type (“condensing” / “low temperature”)

Finally, energy savings are summed for the credited actions taking account of the characteristics registered for each participant (level 3 data). The FWC formula for TGES is therefore:

Equation 12. Step 2 formula for condensing boilers (FWC method).

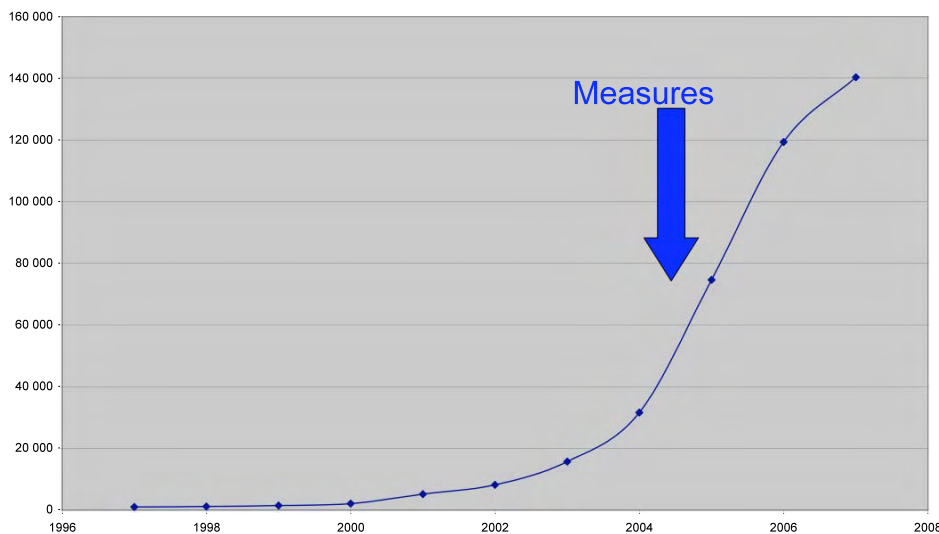
$$TGES = \sum_{i,j,k,l,m} (\Delta E_{i,j,k,l,m} \times \text{number of boilers in dwellings}_{i,j,k,l,m})$$

Where i,j,k,l,m stands for the following characteristics: climatic zone (Z_i), dwelling vintage (A_j), dwelling type (T_k), dwelling size (S_l) and boiler use (U_m).

6.4.2.3 Step 3: total ESD savings

The factors included in the EMEEES formula (see Equation 9) are not directly taken into account in the FWC scheme for the actions related to building envelope and heating systems (and so for condensing boilers). These factors are discussed in section 6.3.4 above from a methodological point of view.

Looking at the general trend of the “condensing boilers” market in France, the impact of national measures (altogether, i.e., Tax Credits, reduced VAT, FWC, etc.) on condensing boilers sales appears to be very high, as represented in Figure 7 below.



Source: GFCC data (see also Table 19)

Figure 7. Sales of condensing boilers in France (1997-2007)

However, the FWC scheme registers (or “captures”) only part of these sales: if we admit 7MWh saved per individual boiler (a reasonable average ratio³⁰), this gives an estimate of 29.000 condensing boilers before 31 dec 2007 and 33000 for 2008, significantly smaller than the number of sales reported by the manufacturers (i.e. GFCC data). This would indicate a potential multiplier effect as high as 4. Nevertheless, the curve of Figure 7 also shows that the take off started before the FWC scheme (i.e. around 2005, whereas the FWC scheme started in July 2006). This argues in favour of looking at the whole package of measures (FWC scheme, tax credits, etc.) when evaluating the multiplier effect. In that case, the take off of the sales seems to be (at least partially) due to the Tax Credits, as these were reinforced in 2005. But this should be checked more in details (e.g., by using data such as these provided in Table 3 and Table 4).

³⁰ Using the values defined in the FWC calculation form (see Tables 21 to 23), the national (level 2) average unitary savings (for space heating only) is around 7,5 MWh using a distribution of actions similar to the one of the whole building stock (“weighted” average) or around 6,5 MWh using an equal distribution according to the different possibilities distinguished in the FWC calculation form (“non weighted” average) (see section 6.4.3 about calculation scenarios for more details). 7 MWh/boiler is thus a realistic but conservative value. In reality it should be also taken account of the share of boilers used for both, space and water heating. But this is unknown. So the average savings per boiler would be higher and then the number of boilers covered by the FWC scheme would be even smaller.

6.4.2.4 Step 4: total ESD energy savings for 2010 and 2016

The value for action lifetime (for “condensing boilers”) used in the FWC calculation form is 16 years (one year less than the EMEES default value). As the FWC scheme started in 2006, and more generally as the results from the French measures for condensing boilers became really strong after 2004, all reported savings should count for the ESD if France decides to report those early actions.

6.4.3 Calculation scenarios

This section presents a comparison of results calculated for the same sample of actions (provided by EDF) according to the different evaluation levels defined in the EMEES methodology.

Based on the available data, different scenarios were used to highlight to what extent increasing the evaluation level enables to report more accurate (and higher) results:

- scenario [level 1 “stock”]: calculations using the default level 1 values proposed by the EMEES method (mainly based on the EcoBoiler study) for the energy consumption and the efficiency gain ; the only level 3 (i.e. specific to the EDF sample) data used is the number of implemented actions ; for the efficiency gain, the baseline is the average efficiency from the boilers’ stock ;
- scenario [level 1 “market”]: same as scenario [level 1 “stock”], except that for the efficiency gain, the baseline is the average efficiency from the boilers’ “inefficient” market ;
- scenario [level 2 “rough”]: calculations using level 2 (i.e. national) values for the energy consumption and the efficiency gain ; the only level 3 (i.e. specific to the EDF sample) data used is the number of implemented actions ; the energy consumption value is the direct arithmetic average of the different possible values presented in Table 21 (section 6.4.2.1), this is equivalent to the rough assumption that the implemented actions would be equally distributed according to the different possible characteristics (dwelling type, vintage, size, climatic zone and boiler use) ;
- scenario [level 2 “improved”]: same as scenario [level 2 “rough”] except that the energy consumption value is a weighted average of the different values presented in Table 21 (section 6.4.2.1), this is equivalent to a more realistic assumption that the implemented actions would be equally distributed among the existing building stock, taking as reference the building stock’s distribution according to the different characteristics (dwelling type, vintage, size, climatic zone and boiler use). The same distribution for these characteristics in the building stock and in the EDF sample is assumed ;
- scenario level 3: calculations using as far as possible level 3 data (i.e. specific to the EDF sample), meaning using all the data registered for each participant in the FWC scheme (number of actions, dwelling type, vintage, size, climatic zone and boiler use) combined with the corresponding level 2 (national) data (see section 6.4.2.1: energy consumption according to dwelling type, vintage and boiler use; correction factors for

dwelling size and climatic zone).

As mentioned in section 6.4.2.1, the FWC method only enables to estimate “all” savings. So the scenarios for level 1 “stock”, level 2 and level 3 correspond to “all” savings whereas the scenario for level 1 “market” corresponds to “additional” savings.

The description of the different scenarios is summarised in Table 27 below.

Table 27. Calculations scenarios for the “condensing boilers” actions.

Scenarios	Energy consumption	Efficiency gain
Level 1 “stock” (EMEEES based on EcoBoiler)	<i>EcoBoiler for France</i> 10.253 kWh/year/dwelling	12,8% (reference = stock average)
Level 1 “market” (EMEEES based on EcoBoiler)		5,3% (reference = “inefficient” market average)
Level 2 “rough” (national statistics on heating)	<i>“non-weighted” average</i> 15.931 kWh/year/dwelling	40% (reference = French stock average, including old natural gas and fuel oil boilers)
Level 2 “improved” (+ national statistics on building stock)	<i>“weighted” average</i> 18.837 kWh/year/dwelling	
Level 3 (based on participants data as far as possible)	<i>participants average</i> 24.310 kWh/year/dwelling	(level 2 value: 40%) (level 3 value: unknown)

The EDF sample contains 154 condensing boilers. Part of these boilers is used for space heating only, whereas the rest is used for both, space and water heating. As explained in section 6.4.1.2, this test only deals with energy consumption related to space heating (excluding the energy savings related to water heating).

Figure 8 below (next page) presents the average unitary savings for each scenario for this sample.

The first conclusion from these results is that there is a very significant gap between both level 1 (“market” and “stock”) and other results (levels 2 and 3). This highlights that either the level 1 default values proposed in the EMEEES method may be too conservative, or the national values used for the FWC scheme probably overestimate the savings (for the case of condensing boilers), especially due to the very low boiler efficiency used for the baseline. It is possible at a national level to use a particular baseline to encourage a given action. But for the ESD reporting, this should be corrected, or at least justified, for harmonisation purpose.

The second conclusion is that the calculated savings are higher, when more participants’ data are used (i.e. level 3 savings > level 2 savings). For such a small sample (154 boilers analysed here), the possible variations due to the different parameters taken into account

do not compensate statistically (contrary to the previous case of insulation actions). Indeed compared to the distribution of the building stock, the EDF sample includes more configurations corresponding to higher unitary savings (e.g. more old houses, or more dwellings located in H1, the coldest climate zone) (see Table 28 hereafter). In these conditions (small sample, targeting specific situations), a level 3 evaluation (i.e. registering more participants' data) appears to be worthwhile.

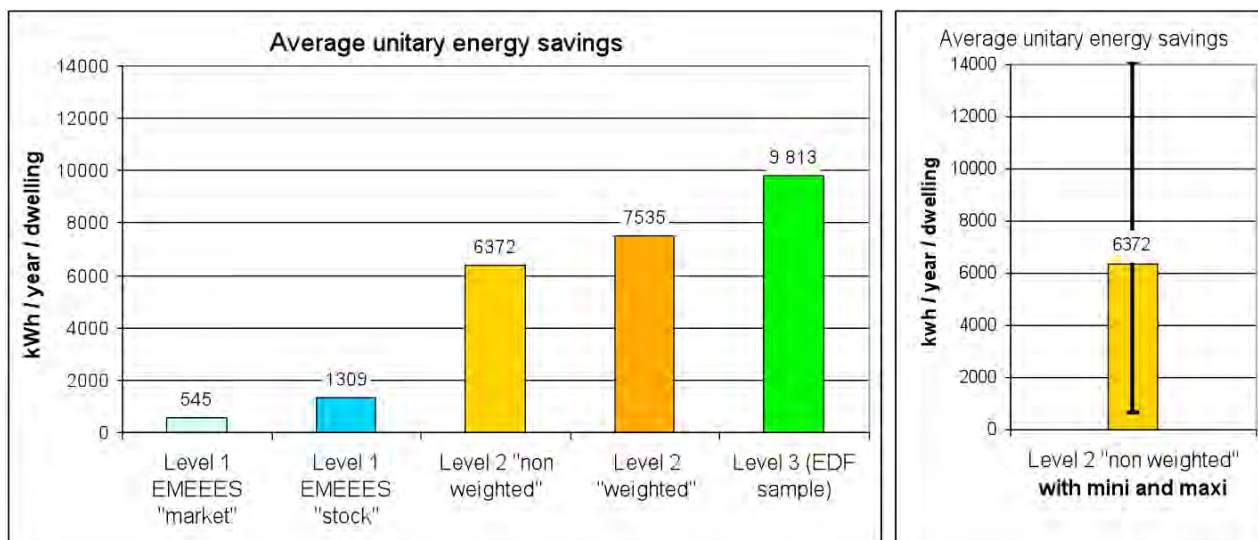


Figure 8. Average unitary energy savings for each scenario (for “condensing boilers” actions) ³¹.

Table 28. Comparison between distributions of the building stock and the EDF sample (for condensing boilers).

Distribution according to dwelling type and vintage					Distribution according to climate zone		
Dwelling type	Houses		Apartments		Climate zone	Building stock	EDF sample
	Before 1975	After 1975	Before 1975	After 1975			
Building stock	49,4%	25,0%	16,9%	8,6%	H1	59%	82%
EDF sample	64,9%	33,1%	1,3%	0,6%	H2	30%	14%
					H3	11%	5%

However, as for the case of insulation actions, it should be noticed that the main differences observed in the comparisons are related to the values used for the baseline situation (here between the level 1 and the other scenarios). These have a much higher impact on the energy savings' results than the differences between level 2 and level 3 calculations.

³¹ The minimum and maximum values calculated for the figure on the right are based on the possible level 2 values (see Tables 21 to 23), taking the “worst” (i.e., a small recent collective dwelling in the South of France) and the “best” (i.e. a big old individual house in the North of France), possible combinations.

6.5 Conclusions specific to the case of condensing boilers

The first conclusion from this case is that there is a very significant gap between level 1 (European default values) and level 2 (national average) results. This highlights that either the proposed level 1 default values may be too conservative, or the FWC values overestimate the savings (for condensing boilers), especially due to the low boiler efficiency used in the FWC baseline. It is possible at a national level to use a particular baseline to encourage a given action. But for the ESD reporting, this should be justified, for harmonisation purpose.

The second conclusion is that the calculated savings are higher, when more participants' data are used (i.e. level 3 savings > level 2 savings). For such a small sample (154 boilers analysed here), the possible variations due to the different parameters taken into account do not compensate statistically (contrary to the previous case of insulation actions). In these conditions (small sample, targeting specific situations), a level 3 evaluation (i.e. registering more participants' data) appears to be worthwhile.

However, as for the case of insulation actions, it should be noticed that the main differences observed in the comparisons are related to the values used for the baseline situation (here for boiler efficiencies and, to a smaller extent, the average heat demand or consumption). These have a much higher impact on the energy savings' results than the differences between level 2 and level 3 calculations.

6.6 Needs and potentials for improvement of the method tested

As direct feedback on the EMEES method, some complements or extensions could be proposed: integration of water heating, application for other boiler types (e.g., low temperature boilers).

About the level 1 default values, it would be interesting to check whether other sources would confirm that the proposed default values are too conservative, especially for boilers' efficiencies (default values for energy consumption seem to be adapted).

7 General conclusions

► General conclusions

The case studies emphasised key messages related to the compliance of the FWC scheme with the EMEEES methodology:

- The global bottom-up methodology of 4 steps and 3 levels developed in EMEEES fits with the methodology for FWC calculation methods: FWC calculation methods correspond to a mix of level 2 and level 3 sets of data. The energy savings unit used in both frames (FWC and ESD) are different, but, from this point of view, FWC savings can be simply translated into ESD savings, by applying the reverse way the discounted lifetime used in FWC calculations.
- Therefore both methodologies are compatible, provided the assumptions made are transparent and the values used are sourced: these conditions should be met, if the rich documentation of the FWC calculation forms is maintained and updated taking into account the ESD requirements. Considering this documentation, the main assumptions to explain are those used for defining the baseline (see also next comment).
- Energy savings amounts largely depend on parameters describing the before situation (baseline): thermal insulation before the refurbishment, energy performance of the former boiler, etc.. The adopted values must be as far as possible clearly sourced through studies, surveys or campaigns. In order to prepare the reporting for ESD purpose, there would be two possible options (for explaining baselines):
 1. adopting new (and clearer) rules for defining baselines, taking account as far as possible of what is required by the ESD (this could be done when updating the system while preparing a new round of the scheme) ;
 2. keeping the same rules, but making them more transparent and ensuring all calculation forms comply with them (but this should be discussed with the Commission to be sure they will accept this).
- Related to the baseline issue, the way “additionality” is considered in both (FWC and EMEEES) methodologies differs: in the EMEEES methodology, additionality is looked at when defining the baseline, whereas in the FWC scheme, additionality is an eligibility criteria, but then may or may not be taken into account in the savings calculation. The alternative approach used in the FWC scheme could be an input to the debates within the Energy Demand Management Committee, by proposing a compromise between accounting for “all” savings while also looking at the additional effect of the evaluated facilitating measures.
- Going more into details about the bottom-up cases (main part of this pilot test), the methods on each energy end-use efficiency improvement may differ between EMEEES

and FWC: this suggests the necessity to keep flexibility for each Member State in order to use the methods best adapted to the considered context (e.g., due to data availability, experience), provided that the global methodology remains harmonised at the EU level.

- Indeed, this case study proved that a national accounting system (for energy savings) may differ from the ESD requirements (e.g., due to specific policy targets), while reporting these savings to the Commission can be done according to ESD rules by using a general process to translate national savings into ESD savings, provided this process is defined beforehand and the details required to apply it are registered and made available. These conditions should be met for the FWC scheme, as long as the following details are kept registered for each FWC action: action type (according to the FWC typology), implementation (or registration) year.
- Correction factors are difficult to quantify in most of end-uses, because it requires heavy statistic studies on the different factors to be considered, different for each end-use: they might be estimated at an aggregated level, stressing uncertainties associated to this quantification.
- Double counting between distinct facilitating measures can be significant. This goes in favour of a possible global approach: methods could, not only focus on a given measure, but be used to analyse a package of measures too, when these measures have the same target and complete each other (e.g., in France, Tax Credits, FWC and EPC for the residential sector).
- FWC calculation methods, which are mainly based on ex-ante deemed estimates, constitute an interesting compromise between accuracy and limited transaction costs.
- The application of these FWC methods for delivering white certificates at a large scale requires operating a well adapted information system that contains only the strictly necessary data for each action, in order to keep the system easy to handle, and to limit the transaction costs. When updating the FWC registration system, the possible consequences of changing the action details registered in the FWC database (and therefore used as level 3 data in the savings calculations) should be carefully studied in terms of savings results: reducing the number of registered details will decrease transaction costs, but may also lower the quality/reliability of savings results (and possibly give lower results) → the selection of the details to be registered should then be done looking for the best compromise between limiting transaction costs and keeping reliable results.
- The FWC scheme has to be considered as a market transformation instrument: the multiplier effects associated to this instrument more than compensate the possible free rider effects that may be observed and not accounted. Indeed, some qualitative multiplier effects can not be measured but have to be observed as benefits. For example, the FWC scheme strongly helps to structure the insulation market and to increase the professional awareness on best practices for energy efficiency actions.

This is difficult to translate into calculated savings, but should be taken into account in the NEEAP evaluation by the Commission.

► About the bottom-up/top-down comparison

Due to time and resource constraints, it was not possible to develop the part on the top-down approach as planned initially.

The data required to cover all the main facilitating measures targeting residential space heating with the bottom-up approach were not all available (especially the details about the actions implemented within the Tax Credits scheme). And it was not the aim of this pilot test to collect new data (indeed it would have required significantly larger resources).

In that condition, it would have no sense to compare partial bottom-up results with total top-down results. Consequently it was not a priority anymore to develop a full top-down application for this pilot test. And as more resources than planned were necessary to complete the bottom-up part, the choice was made to focus on the bottom-up part where, as presented in this conclusive chapter, interesting results and analyses were achieved.

However, the comparison between bottom-up and top-down approaches remains an interesting topic, which would require to be addressed in a specific study for a case where data would be available for both sides. Such a study would be very valuable for the preparations of the next NEEAP (2011 and 2014).

► Specific conclusions (cases of insulation actions and condensing boilers)

Case of insulation actions

It was not possible to apply directly the EMEEES method in this case, due to differences between the data expected for the EMEEES method and the data available for this test. Nevertheless, the EMEEES method was analysed from the point of view of an application for a specific case (French context), to see what can be used and what can not.

The first conclusion is that Member-States can take advantage of the EMEEES method to better use their own existing evaluation methods: describing them in a harmonised way, detecting what complementary studies would be useful to improve results reliability, justifying differences from other common evaluation approaches.

The comparisons between the tested calculation scenarios (according to the three levels proposed by EMEEES) emphasise the importance of the choice of the sample. If the buildings stock in the sample is similar to the whole national buildings stock, there is no major deviation between the different levels of evaluation efforts. This means that it seems relevant to assume that for a sufficiently high number of actions, level 2 (national) and level 3 (participant-specific) results are not significantly different. Then a level 2 evaluation could be reliable enough. A monitoring or survey of the refurbishment market (see Appendix II about the OPEN observatory) should provide complementary analysis.

Comparing the savings estimated from the FWC and EPC³² methods, both calculation approaches appear to be similar, at least using the same main parameters. However, significant differences are observed in the calculated energy savings, mainly due to differences in the values used for the initial thermal transmission. This highlights how important the baseline choice is. Indeed, deviations observed in the FWC vs. EPC comparison (mainly due to distinct baseline values) are much (up to ten times) higher than the ones between the calculation scenarios (due to distinct levels of desegregation, i.e. level 2 vs. level 3 values).

Finally, it seems necessary to perform ex-post studies (on relevant samples) to verify actual energy savings (e.g. based on energy bills or measurements), and thus check whether calculated values can be reliably trusted.

As direct feedback on the EMEEES method, the main approach (“system” approach, mainly based on EPC, Energy Performance Certificates) of Bottom-up case application n°1 (building envelope improvement) could not be totally implemented (it would likely be the case for most of the Member States). In this pilot test, some data were not available: energy demand after refurbishment (Level 2 / Step 1) and EPC before and after the actions (Level 3). Another approach (“components” approach, based on deemed savings per action type) is also considered in the EMEEES method, which makes it more flexible. However this alternative option is not detailed. Therefore, methods like the FWC one could be good examples to complete guidelines on this option.

Case of condensing boilers

The first conclusion from this case is that there is a very significant gap between level 1 (European default values) and level 2 (national average) results. This highlights that either the proposed level 1 default values may be too conservative, or the FWC values overestimate the savings (for condensing boilers), especially due to the low boiler efficiency used in the FWC baseline. It is possible at a national level to use a particular baseline to encourage a given action. But for the ESD reporting, this should be justified, for harmonisation purpose.

The second conclusion is that the calculated savings are higher, when more participants’ data are used (i.e. level 3 savings > level 2 savings). For such a small sample (154 boilers analysed here), the possible variations due to the different parameters taken into account do not compensate statistically (contrary to the previous case of insulation actions). In these conditions (small sample, targeting specific situations), a level 3 evaluation (i.e. registering more participants’ data) appears to be worthwhile.

However, as for the case of insulation actions, it should be noticed that the main differences observed in the comparisons are related to the values used for the baseline situation (here for boiler efficiencies). These have a much higher impact on the energy savings’ results than the differences between level 2 and level 3 calculations.

As direct feedback on the EMEEES method, some complements or extensions could be proposed: integration of water heating, application for other boiler types (e.g., low temperature boilers).

³² Energy Performance Certificates (see EPBD)

References

► References on the European context

EPBD (2002), European Parliament and council, Directive 2002/91/EC on the energy performance of buildings of 16 December 2002.

ESD (2006), European Parliament and council, Directive 2006/32/EC on energy end-use efficiency and energy services of 5 April 2006.

European Committee for Standardization (2007), Saving lifetimes of Energy Efficiency Improvement Measures in bottom-up calculations, (CEN WS 27) Final CWA draft, 25p.

Kemna, R., van Elburg, M., Li, W., van Holsteijn, R. (2007) Task 2 Report: Market Analysis, Preparatory Study on Eco-design of Boilers, VHK, September 2007, 78p. (www.ecoboiler.org)

► FWC calculation forms used for this test

ATEE (2006), Technical Association on Energy and Environment, Energy saving certificate, calculation sheet, individual condensing boilers, BR85, rev. 9, January 2006

ATEE (2006), Technical Association on Energy and Environment, Energy saving certificate, calculation sheet, insulation of roof or virgin loft, BR80, rev. 9, January 2006

ATEE (2006), Technical Association on Energy and Environment, Energy saving certificate, calculation sheet, fitting of windows or French windows, BR81, rev. 8, January 2006

ATEE (2005), Technical Association on Energy and Environment, Energy saving certificate, calculation sheet, insulation of walls, BR93, rev. 7, December 2005

ATEE (2005), Technical Association on Energy and Environment, Energy saving certificate, calculation sheet, insulation of floor, BR94, rev. 7, November 2005

► References for national values or statistics

BATIM (yearly publication), Monitoring of new residential buildings [French title: *Observatoire des logements neufs*]

BIIS and CAH (2008), Monitoring of housing energy efficiency improvements [French title: *Observatoire permanent de l'amélioration énergétique du logement (OPEN) – Note de synthèse*], BIIS (Business Information Intelligence Services) and CAH (Club d'Amélioration de l'Habitat) under the aegis of ADEME (see also Appendix II)

CEREN (yearly publication), Monitoring of the building stock and energy consumption [French title: *Suivi du parc et des consommations*], CEREN (Economic research and study centre on energy)

CEREN (2006) Flows of space heating system in old dwelling – in 2006 – sample group of installation engineers [French title: *Flux de chauffages centraux en habitat ancien en 2006 – Panel installateurs*], CEREN (Economic research and study centre on energy)

INSEE, <http://www.insee.fr>

INSEE (2006), Households survey – 2006 assessment [French title: *Enquête Logement – 2006*]

INSEE (2001), Households survey – 2001 assessment [French title: *Enquête Logement – 2001*]

ODYSSEE database on energy efficiency data & indicators (march 2009)
<http://services.enerdata.eu>

SOFRES (2006), Energy Management – 2006 assessment [French title: *Maîtrise de l'énergie – bilan 2006*], TNS-Sofres under the aegis of ADEME

► References on White Certificates scheme

ATEE (2009) French White Certificate Club [*Le Club C2E - Certificats d'économies d'énergie*] <http://www.clubc2e.org/>

ATEE Club C2E (2006), Overview of the French White certificate scheme [*Présentation du dispositif des certificats d'économies*]

http://www.mines-energie.org/Conferences/PR_061218_Guyonnet.pdf

Bertoldi, P., Rezessy, S. (2007), Assessment of White Certificate Schemes and their Energy Savings Evaluation Methods, Proceedings of the 2007 International Energy Program Evaluation Conference, Reliable Program Results? You Betcha! pp.342-353, 13-16 August 2007, Chicago, IL.

Capozza, A., Devine, M., Enge, A.K., Grattieri, W., Monjon, S., Mundaca, L., Neij, L., Oikonomou, V. and Tarbé, M., 2006. *Market mechanisms for white certificates trading - Task XIV Final report*. Prepared for the International Energy Agency (IEA-DSM). IEA: Paris, June 2006.

DGEC (2009) http://www.industrie.gouv.fr/energy/develop/econo/1e_eco/

French Authorities (2008) Note from The French Authorities, Subject: Energy efficiency action plan for France, 27 February 2008, 37p

Ministry of Ecology (2009), Ministry of Ecology, Energy, Sustainable Development, and Town and country Planning, Energy savings certificate information letter, January 2009, 2p.

Ministry of Economics (2006), Ministry of Economic, Finances and Industry, Decree of 19/06/2006 defining standardized energy savings actions, NOR INDI0607665A

Vine, E. and Hamrin, J., 2008. Energy savings certificates: A market-based tool for reducing greenhouse gas emissions. *Energy Policy*, **36**(1), pp. 467-476.

► Other references from the EMEEES project (<http://www.evaluate-energy-savings.eu/>)

Adnot, J., Bory, D., Bourges, B., Broc, J.-S. (2008), Method 7: Residential condensing boilers for space heating, report for the task 4.2 of the EMEEES project, September 2008, 24p.

Amman, C., Geissler, S., Barreto, L. (2008), Method 2: improvement of the building envelope of residential buildings, report for the task 4.2 of the EMEEES project, revised draft, September 2008, 58p.

Broc, J.-S., Thomas, S., Adnot, J., Bourges, B., Vreuls, H. (2007), The developing process for harmonised bottom-up methods, report D4 of the EMEEES project, Revised version of 20 April 2007, 119p.

Pindar, A., Labanca, N., Palma, D. (2008), Method 10: Non residential space heating improvement in case of heating distribution by a water loop, report for the task 4.2 of the EMEEES project, September 2008, 66p.

Vreuls, H., Thomas, S., Broc, J.-S. (2008), General bottom-up data collection, monitoring, and calculation methods, Deliverable 6 of the EMEEES project, 30 September 2008, 55p.

Glossary

ADEME: The French public agency for energy efficiency and environment (*Agence de l'Environnement et de la Maîtrise de l'Energie*)

ARMINES: contract research association of French engineering school (mainly the Group of *Ecoles des Mines*)

BU: Bottom-Up

CEN: European Committee for Standardisation (*Comité Européen de Normalisation*)

CEREN: French economic research and study centre on energy

ATEE: Energy environment technical association [Association Technique Energie Environnement]

CD: condensing boiler

CFL: Compact Fluorescent Lamp

CODEVI: French savings capital for industrial development

COP: coefficient of performance

Cumac: lifetime cumulated and discounted

CWA: CEN Workshop Agreement

ESCo: Energy Service Company

DGEC: General Directorate for Energy and climate (previously DGEMP)

DGEMP: General Directorate for Energy and Raw Materials (now DGEC)

DHW: Domestic Hot Water

DRIRE: Regional Directorate for the Industry, Research and Environment (regional representations of the Ministry of Industry)

EDF: Electricité de France (main French electricity supplier)

EE : energy efficiency

EEl: Energy efficiency improvement

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

EPBD: Energy Performance of Buildings Directive (Directive 2002/91/EC (EPBD, 2003) on energy efficiency of buildings)

EPC: Energy Performance Certificate

ESC: Energy Saving Certificates

ESD: Energy Service Directive (Directive 2006/32/EC on energy end-use efficiency and energy services)

ETS: Emissions Trading Scheme

FED: Final Energy Demand

FWC: French White Certificates, also called Energy Savings Certificates³³ (or *Certificats d'Economie d'Energie* in French)

GCV: Gross Calorific Value

GFCC: French professional organisation of central heating systems manufacturers (in French, *Groupement des Fabricants de matériels de Chauffage Central*)

HDD: heating degree days

INSEE: National Statistics and Economic Studies Institute

LT: low temperature boiler

MINEFI: French ministry of economy, industry and employment

NCV : Net Calorific Value

NEEAP: National Energy Efficiency Action Plan

PoliMi: Politecnico di Milano

R: thermal resistance ($m^2.K/W$)

SHD: Specific Heat Demand

SWH: Solar Water Heater

TD:Top-down

UNICLIMA: syndicate of ventilation, heat and thermodynamic equipments companies

U: thermal transmittance ($W/m^2.K$)

VAT: value added tax

WC: White Certificates (for a standard definition, see ESD art.3(s))

WP : work package

³³ We use the term « White Certificates » in this report, as it is the term used in the ESD (cf. ESD art.3(s)).

Appendix I: List of persons involved in the pilot tests

Partners directly involved in the EMEEES project:

- ADEME: Luc Bodineau, Hervé Lefebvre, Didier Bosseboeuf, Robert Angioletti ;
- EDF R&D: Dominique Osso, Paul Baudry ;
- ARMINES: Jérôme Adnot, Jean-Sébastien Broc, Stefano Grassi, Bernard Bourges.

Appendix II: presentation of OPEN

OPEN is a national observation instrument dedicated to the existing housings' energy efficiency improvements. OPEN means "Observatoire Permanent de l'amélioration ENergétique du logement".

Actors

This instrument is managed and financed by ADEME, who selected two operators: "Club de l'Habitat" and the consultant "BIIS". "Club de l'Habitat" is an association gathering thirty private and public members working for the housing's renovation (building federation, manufacturers, retailers, etc.). For fifteen years, it has been producing studies, surveys and analyses in order to improve the knowledge and the understanding of the renovation market. BIIS is a consultant operating in the field of works and services for buildings.

Objectives

OPEN has been set to follow the general activity around housings' energy efficiency improvements. More precisely, three kinds of results are expected:

- Indicators on the market evolution: total turnovers, buildings' surfaces concerned, quantity of equipments, price indicators...
- Indicators on the efficiency's diffusion : equipments sales description according to efficiency levels, efficiency and decision factors...
- Prospective analyses: costs evolution, expected market for efficient equipments and measures.

Methodology

The methodology is based on both demand side analysis and observation of market offers:

- a general survey on 32 000 housings is used to determine a specific panel of 2 500 housings which have engaged works to reduce their energy consumption. The analyse of this panel give information about prices, reasons that led people to choose the type of works, the efficiency level, etc.
- 5 000 building installation companies are contacted and 1 000 industrials (manufacturers) are surveyed to characterise the offers market and understand the equipments and renovation works flows.

Perimeter

Renovation works for energy efficiency improvement are classified in different categories : heating (boilers, heat pumps, solar water heaters, wood stoves ...), openings (windows and doors), inside works (floors, roofs, ceilings, terraces) and roofing. Collected data concern individual housings only (collective housings non concerned).

First results

OPEN has been set in 2007, first surveys achieved at the end of 2007. First results were published in July 2008 (market data for the year 2006).

Appendix III: the French White Certificates Scheme

The context and objectives of the FWC scheme

The French White Certificates (FWC) scheme has been introduced in July 2006. The French government aims with this instrument at increasing the energy efficiency activities in order to contribute to the priority objectives of the national energy policy: national energy independence, security of energy supply, competitiveness of energy tariffs, and preservation of the environment. The overall French policy objective is a reduction of 2%/year of French final energy intensity by 2015 and of 2.5%/year by 2030 (compared to the 2005 situation). In order to contribute to this global objective, a target of 54 TWh cumac³⁴ has been established for the first three-years period of the FWC scheme (2006-2009). Based on the assumptions presented above, this target should correspond to around 4 TWh saved. Compared to the global national consumption (around 1870 TWh/year), this would mean a relative result of 0.2% saved/year.

The obligations

As mentioned above, to reach the FWC target, obligations are set on energy suppliers delivering electricity, gas, domestic fuel (not for transport³⁵), cooling and heating. The obliged actors then received targets in proportion to their market shares (sales) in the residential and tertiary sectors. Annual adjustments are made to take into account variations in the market (changes in the market shares, new entrants, etc.). The obligations must be fulfilled over the whole 3 years period (2006-2009), i.e., at the end of this period, each obliged actor should provide to the administration an amount of certificates corresponding to their obligations.

These certificates are delivered to any organisation (i.e. not only the obliged actors) who prove the implementation of end-use actions (by submitting FWC files to the administration), under certain eligibility conditions. Consequently, the obliged actors can obtain these certificates, either by submitting their own FWC files, or by buying certificates to other actors.

Energy savings certification and eligibility conditions

Tradable White Certificates are issued by regional representations of the Ministry of Industry (DRIRE, Regional Directorate of the Industry, Research and Environment). The DRIRE controls that the end-use actions were properly implemented by checking the files submitted by the company or public body which demands the certificates ownership. The applicant has to provide a description of the actions, to prove that it had an active role in the process of their implementation, and to hold invoices and technical documents concerning each individual action. These are the main elements composing the

³⁴ The “kWh cumac” is the accounting unit of the FWC. Energy savings are calculated in final energy, and cumulated over the lifetime of each action with a discount rate of 4%, to take account that the certificates are delivered once for the total lifetime of the actions (i.e. it is an economic discounting, not linked with the eventual technical deterioration of the action over time).

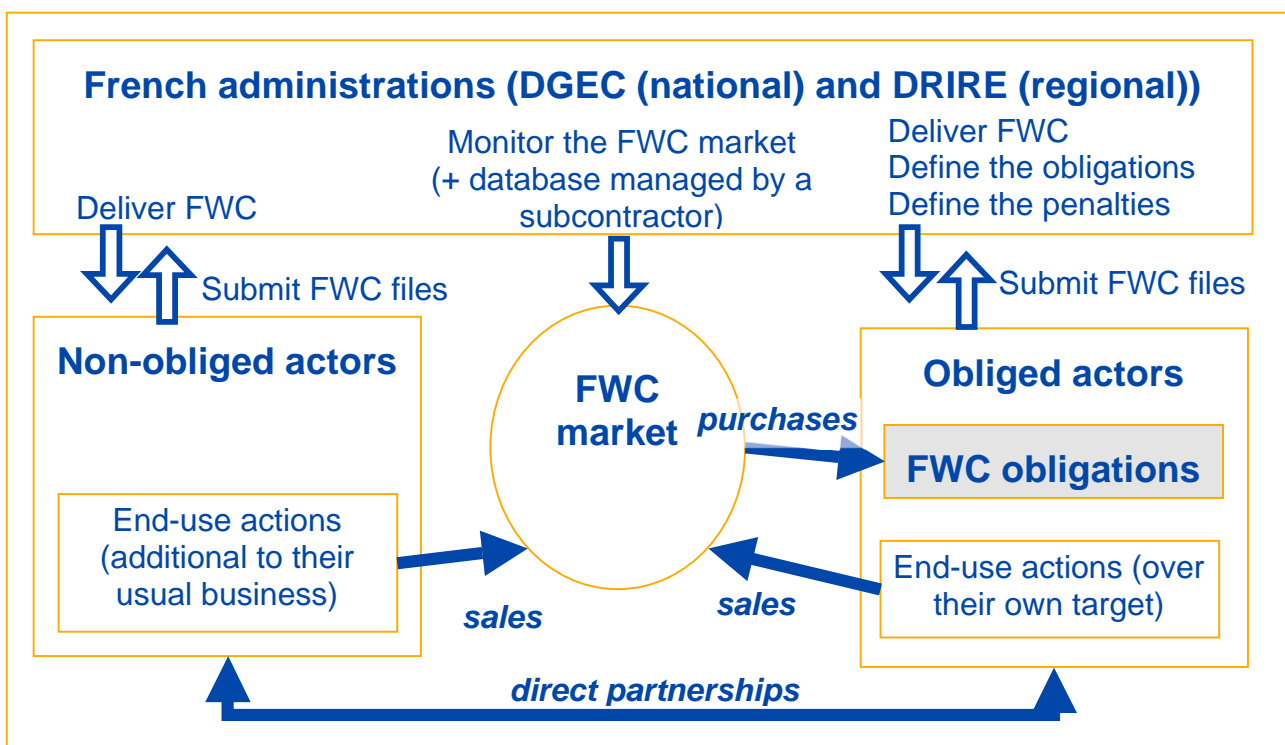
³⁵ Suppliers of fuel for transport may be included in the obliged actors in the next period of the scheme.

administrative demand for FWC³⁶.

Any economic actor can implement (or facilitate the implementation of) end-use actions delivering energy savings and gets certificates for it. A condition was set to avoid that too many files are submitted: the actions reported have to be grouped so that the corresponding file reach at least an amount of 1 GWh cumac, defined as a minimum threshold for file submission.

End-use actions are eligible for all energy carriers (including fuel) and all sectors (including transports), except for actions implemented in the installations covered by the Emissions Trading Scheme (ETS) which are excluded of the FWC scheme. Substitutions of fossil fuels with renewable energy sources for heating in buildings are also eligible (but substitutions of fossil fuels with other fossil fuels are not).

For non-obliged actors, actions must be additional relatively to their usual activity: e.g. a supermarket can not get certificates for its CFL sales; at the opposite, a local authority may get certificates for a CFL promotion campaign; actions by non-obliged actors on their own buildings/process are also eligible.



Source: figure adapted and translated from [ATEE club C2E, 2006]

Figure 9. How the FWC scheme works.

The categories and definition of the eligible end-use actions

The reported actions are accounted for, according to two main categories: standardised actions, and non-standardised (or specific) actions.

Standardised actions are encouraged as their certification process is easier and faster. For specific actions, more evidences are required, and the files are examined by ADEME

³⁶ Other administrative documents are required when an organisation submits a FWC file for the first time, in order to open its own account in the FWC registry. But these are not related with the implemented end-use actions.

experts for technical evaluation (in addition to the DRIRE for the administrative part).

ADEME and ATEE³⁷ are in charge of setting methodologies for energy savings calculation and of the definition of standardised actions. Once they are defined, the standardised actions are proposed to the DGEC (General Directorate for Energy and Climate)³⁸ for official validation and publication.

So far, 170 standardised actions were validated. They cover all sectors (residential, tertiary, industry and transport) and many end-use actions (improved insulation, efficient boilers, temperature control systems, etc) (see Table 1).

The market of white certificates

Presently no real trade has been realised. We can observe in October 2008 on the registry website (www.emmy.fr) that roughly 0.45 TWh cumac has been exchanged, which represents only 2% of the whole attributed FWC. The average price (which is a public information) is around 0.33 c€/kWh cumac (for comparison, the penalty in case an obliged actor does not reach its target is of 2 c€/kWh cumac). Note that the registry records FWC exchanged between actors on this registry, but doesn't take into account direct bilateral exchanges operated outside the registry. These direct partnerships most probably cover a much higher FWC volume.

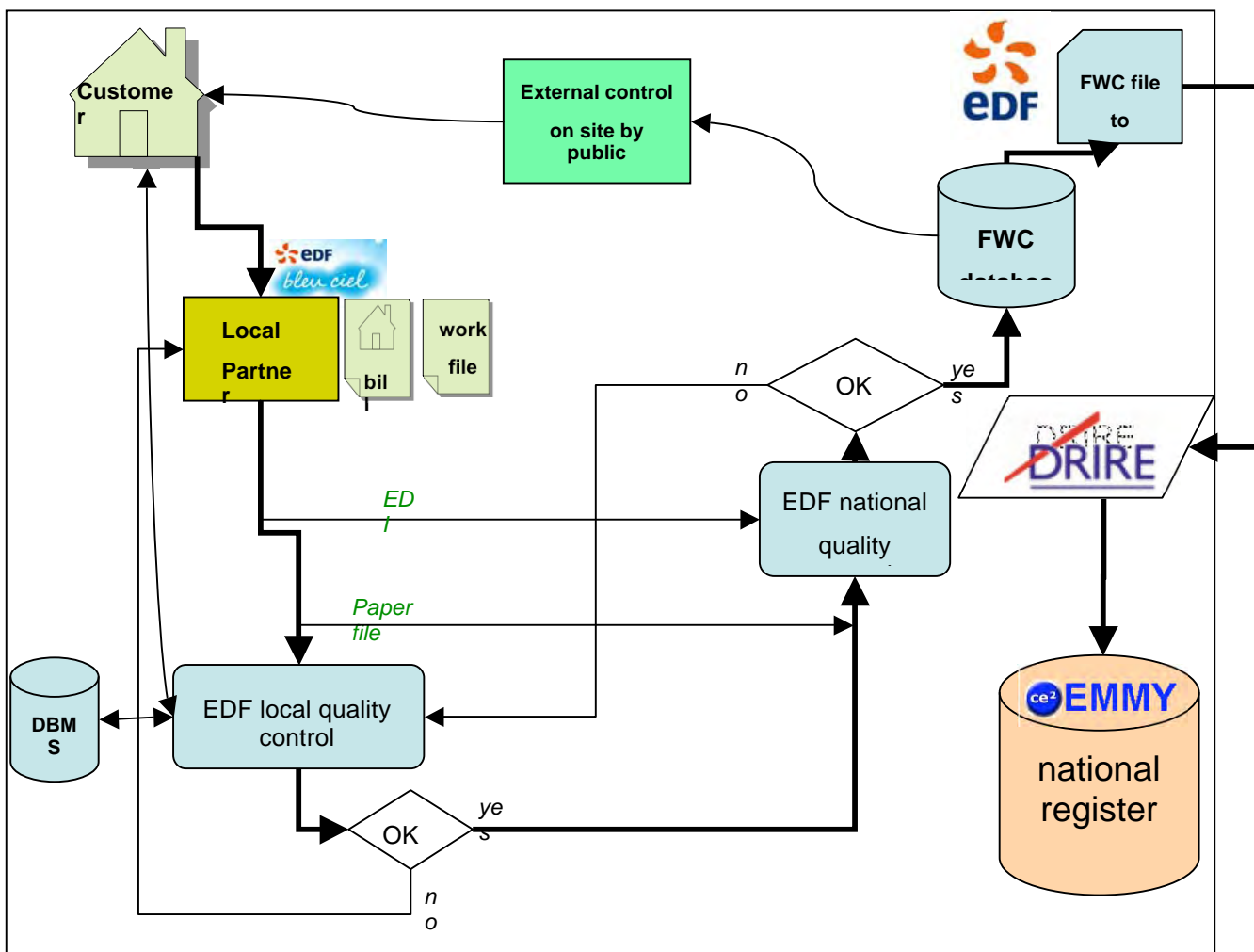
³⁷ Association Technique Energie Environnement, professional association whose members represent most of the energy suppliers, French ESCos and other stakeholders concerned by energy efficiency activities (e.g. building sector associations, appliances manufacturers, etc.)

³⁸ Department of the French Ministry in charge of Energy

Appendix IV: data collection process for a FWC file

The network for gathering the data documenting the energy savings, from the final customer to the DRIRE, is presented below. To sum up the route of a FWC from the final customer to the administration, we could break down the process in three stages:

- 1: Customer and installation contractor. At this stage, the end-use actions are done by local partners of the energy supplier and the refurbishment paid by the customer. The local partners send to the utility the data concerning the implemented actions (e.g., bills, actions and dwellings' characteristics).
- 2: Energy supplier. The energy supplier gathers, checks the eligibility for the FWC scheme and controls the quality of the data at regional and national levels.
- 3: Civil services. They issue the Certificates.



DBMS: database management system; DRIRE: Regional Directorate for the Industry, Research and Environment; EDI: electronic data interchange.

Figure 10. Schematic view of the EDF internal organisation for data gathering for the deposit of FWC files.

For the residential sector, the data processing circuit is the following³⁹ :

- Once energy savings actions have been carried out in customers' homes, partners fill in a data sheet (including data such as name, address, type and efficiency of equipment installed...)
- EDF technical experts check data, which are then registered.
- Files for white certificates request are prepared by addition of individual operations and controlled. Operations that don't comply with the requirements are eliminated and sent back for improvement of data quality.
- The program file is sent to the public authority for certification.
- Quality controls are also carried out at customer homes by a certified organisation.

³⁹ Louis-Jacques Urvoas, Dominique Glachant, Luc Lorge, Paul Baudry, The action of EDF in end-use energy efficiency, ECEEE 2007, 365-368

