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Dominique Osso, Marie-Hélène Laurent, Stanislas Nösperger

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Evolutions of the French EEO scheme through the ages according to emblematic measures: a testimony from within of a continuous work in progress

Dominique Osso
EDF Lab Les Renardières
Department of Technology & Research in Energy Efficiency
Avenue des Renardières
77250 Moret Loing et Orvanne
France
dominique.osso@edf.fr

Stanislas Nösperger
EDF Lab Les Renardières
Department of Technology & Research in Energy Efficiency
Avenue des Renardières
77250 Moret Loing et Orvanne
France

Marie-Hélène Laurent
EDF Lab Les Renardières
Department of Technology & Research in Energy Efficiency
Avenue des Renardières
77250 Moret Loing et Orvanne
France

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Abstract

The energy-saving obligation scheme in France launched in 2006 was revised each three-year period. The majority of EEOs issued are based on standardised action valued according to deemed energy savings. These revisions have made it possible to correct errors, to value new actions and to update eligible actions according to changes in the context and regulations. After more than 10 years of operation, and a potential extension of the scheme beyond 2020, it is interesting to look at the lessons of the past. For this purpose, we look at the evolution of the system through the prism of iconic actions. The assessment of a renovation action in the EEO scheme consists of 2 parts: the technical part helps to calculate energy savings (calculation sheet), the second deals with the verification of the eligibility of the works (certificate on honour). Both have evolved over time. The estimation of energy savings have evolved for technical reasons: reduction of the heating-degree-day, decrease of the space heating reference consumption and modifications of other coefficients. If these modifications were made for objective reasons, others have been made to explicit unexplained values. In addition, the EED directive has helped to modify energy saving to value only marginal savings (i.e. beyond the performance of Ecodesign). Recently, the problem of fraud has led to the simplification of modulating energy savings due to the impossibility of verifying certain criteria while adding constraints on the execution of work (proof, on site-visit).

Effectiveness of these changes should be studied to ensure this scheme still fosters energy retrofit of the building stock. This study could help to make a relevant trade-off between process simplification and the valuation of accurate energy savings. In summary, the EEO scheme will always be a work in progress and the preparation of the next period will not escape it but lessons from the past should enlight future developments.

Introduction

The French energy efficiency obligation (CEE – “*Certificat d’Economie d’Energie*”) scheme was introduced since June 2006 thanks to the 2005 POPE Law (JORF 2005). The French EEO scheme is now used as a response to Article 7 of the EED¹ Directive. In its notification to the Commission, France indicated that the 1.5 % annual savings will be achieved through the CEE (DGEC 2018). Such EEO schemes are currently used in Europe (15 EEOs scheme identified) (Fawcett et al. 2018) as well as around the globe (Rosenow et al. 2018).

Based on a three-year timeframe, the CEE scheme has seen its level of obligation revised upwards each period and nowadays the scheme is in the middle of its 4th period (2018–2020). The latest revision of the EED for the period from 2020 to 2030 (OJEU 2018), encourages us to look with interest at such a key scheme.

From a theoretical economic viewpoint an EEO scheme may seem simple in as much as it relies on a combination of a tax on energy suppliers and a financial incentive for energy efficiency actors (Bye & Bruvoll 2008). In such a scheme, the most profit-

1. Directive 2012/27/EU on energy efficiency.

able actions are supposed to be carried out as a priority (market approach). However, a large-scale implementation represents an important task. It is recognized that the performance of an EEO scheme depends on the features of the scheme and the context (Eyre et al. 2009, Mundaca and Neij 2009). Such features include notably technical and regulatory aspects, scope of involved stakeholders, verification process, and market rationalisation, and should be embedded in an evaluation study beyond the volume and price of energy savings.

While the general description of the French scheme has been provided in several papers (Bertoldi et al. 2010, ENSPOL 2015, Giraudet et al. 2012, Baudry & Osso 2011, Bodineau and Bodiguel 2009, Lees 2014), few publications have provided a detailed description of the CEE procedures, which for outsiders may seem nebulous or complex (UFC-Que Choisir 2018). However, additional papers dealing with the CEE scheme rely more on evaluating the scheme or comparing it to another energy efficiency policies (Giraudet and Quirion 2008, Giraudet and Finon 2015, Gazeau et al. 2014, Rohde et al. 2015, Duval and Charru 2018, Rosenow and Bayer 2017).

The objective of this paper is therefore to describe, with a historical perspective, the functioning of the CEE scheme exemplified by iconic eligible measures (e.g. roof insulation, efficient boiler) in the residential sector which remains today the sector where the most energy efficiency actions have been carried out to date. The most important results for residential buildings in the 3rd period (2015–2017) are the installation of 160,000 efficient boilers, 10,000 wood stoves and 370,000 isolated dwellings (Premartin 2017).

If history perspective of former European EEO schemes in another countries were existing (UK: Rosenow 2012, Italy: Di Santo et al. 2018) few papers deal with the history of the CEE scheme.

The document is organized as follows: paragraph 1 will provide an overview of the CEE scheme, paragraph 2 will detail what constitutes an EEO file nowadays, and paragraph 3 will present historical developments since the beginning of the scheme.

Overview of the French EEO scheme

The CEE scheme sees the intervention of four types of economic actors:

1. The obligated parties are the energy retailers/suppliers² (electricity, gas, LPG, heat and cooling, heating oil and motor fuels) that bear the national obligation and are supposed to actively promote energy efficiency among energy consumers.
2. The delegates³ are companies which take over the obligation of an obligated party. Each delegate with a CEE obligation is in turn considered as an obligated party. The entrance fee on the CEE market for a delegate is low because it only requires obtaining the delegation of an obligated party (Tracfin 2016).

3. The eligible parties which have the possibility to registered CEE are public authorities, social housing organizations and the National Housing Agency (ANAH).
4. Trading companies are legal entity that only buy and sell CEEs on the market like another commodities.

We must notice that since the year 2016, a CEE obligation dedicated to “low-income households”⁴ was added to the historical obligation (namely “standard CEE”) (Figure 1).

The most frequently carried out CEE actions are covered by standardised operations on the basis of fact sheet (see section below for details). These fact sheets, drawn up by working groups of the Technical Energy Environment Association⁵ in consultation with all the professionals in the sectors concerned and in conjunction with ADEME⁶, are published by decree in the Official Journal after validation by the Ministry⁷ and an opinion from the CSE⁸ (MTES 2016). The fact sheet defines the requirements for issuing CEEs and the amounts of energy savings, expressed in cumulative⁹ and discounted kWh (namely kWhc).

Two other marginal ways to produce CEEs exist: specific measures and programmes¹⁰. The specific measures concern non-reproducible energy efficiency actions based on metering before/after situation and most particularly in the industrial sector (ADEME 2018). Since the second period of the scheme, the direct financial contribution to information, training and innovation programmes has enabled CEEs to be issued¹¹ (MTES 2019).

At the end of each obligation period the cumulative volume of CEEs issued since the beginning of the scheme have exceeded the obligation itself (Table 1, Figure 1), however it is mainly due to the stock from the previous periods and not due to the volume delivered strictly during the period. The evolution of the CEE public price (Figure 2) gives an idea of the development of the CEE market (the volume traded for the same price level has increased over time). Since the middle of 2016 the price of CEE increased as the volume decreased. However, recently the price and volume have been increasing together, reflecting the beginning of tension on the market.

We must notice that in 2018 (Pownext 2018), the volume of certificates issued by the PNCEE is approximately the same regardless of the nature of the CEEs even if the “low-income” obligation represents only 25 % of the total obligation. Moreover,

2. The national obligation is allocated in proportion to energy sales (75 % by value and 25 % by volume) mainly to housing and to tertiary sectors (end users not covered by the EU Emissions Trading Scheme).

3. A little less than 100 delegates in the 3rd period were registered and only 24 at the beginning of the 4th period (November 2018).

4. Households with an income below two different thresholds (“low-income” and “very low-income” in term of income). The amount of CEE for the very low-income households are doubled.

5. Association Technique Energie Environnement (<http://atee.fr/>).

6. ADEME (Environment and Energy Management Agency) is a public establishment (<http://www.ademe.fr/>).

7. DGEC (Directorate-General for Energy and Climate) is a French central administration department (<https://www.ecologique-solidaire.gouv.fr/direction-generale-energie-et-du-climat-dgcec>).

8. The CSE (Higher Energy Council) is a French national body created by the Ministry of Energy. It shall be consulted on any State regulatory act relating to the energy policy.

9. Cumulated over lifetime with a discount rate of 4 % applied to annual energy savings.

10. Specific measures represent only 6 % and programs 4 % of the CEEs delivered in the 3rd period (Briand and Dozieres 2017).

11. A subset of a maximum of 40 TWhc (approximately EUR200 million) is dedicated to the 2018–2020 call for programs (MTES 2018). The programs support structuring actions that contribute to energy savings without it being possible to quantify them directly. CEEs delivered are based on contributions to the program, through a rate defined by decree (Pausader 2017).

Table 1. CEE national obligation and delivering.

| period | years | Obligation (TWhc) | | EEOs delivered (TWhc) | | Cumulative deviation from obligation (TWhc) | |
|-----------------|-----------|-------------------|------------|-----------------------|------------|---|------------|
| | | standard | Low-income | standard | Low-income | standard | Low-income |
| 1 st | 2006–2009 | 54.0 | none | 65.2 | – | +11.2 | – |
| Intermediate | 2010 | – | none | 99.1 | – | +110.3 | – |
| 2 nd | 2011–2013 | 345.0 | none | 297.8 | – | +63.1 | – |
| Extension | 2014 | 120.0 | none | 172.0 | – | +113.1 | – |
| 3 rd | 2015–2017 | 700.0 | 150.0 | 646.0 | 174 | +59.1 | +24.0 |
| 4 th | 2018–2020 | 1,200.0 | 400.0 | ongoing | | – | – |

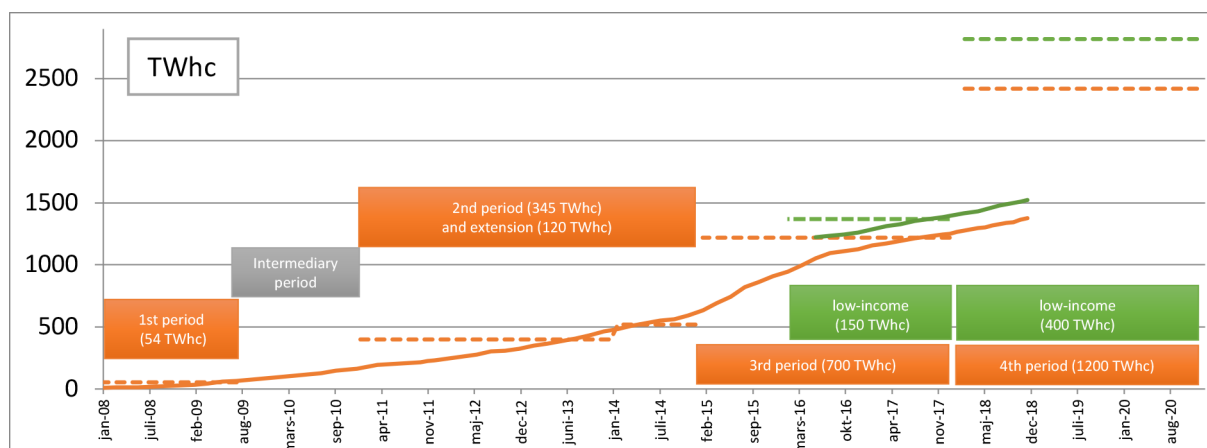


Figure 1. CEEs delivered and obligation levels (source: national register EMMY) (Powernext 2018). Dotted lines represent the obligation level. Color code – orange: standard CEE, green: low-income CEE.

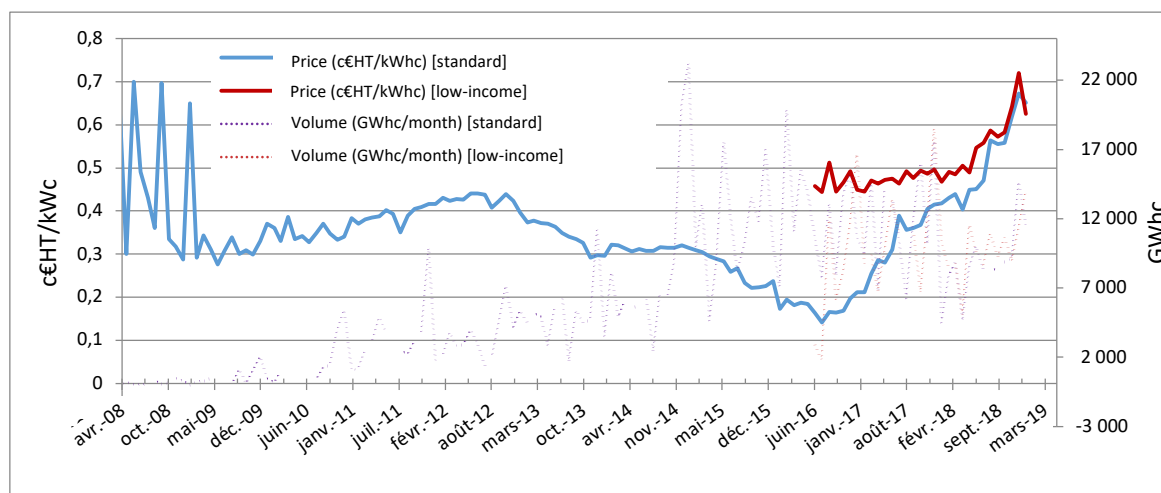


Figure 2. CEE public price (a blend of spot and forward prices in c€/kWhc) and volume exchanged monthly (GWhc/month) (source: CEE national register EMMY) (Powernext 2018).

the average weighted prices of standard and low-income CEEs are in 2018 about the same for an equivalent number of transactions (respectively 5.20 Euro/MWhc vs. 5.58 Euro/MWhc).

What's constitute an EEO file nowadays

The reporting of an energy efficiency action in the CEE scheme consists of 2 main parts: the technical part helps to calculate deemed energy savings (based on spreadsheet), the second

deals with the verification of the eligibility of the measure (declaration on honour). CEE fact sheets¹² are publicly available and could be found on the METS website¹³ and also in the form of an 800 pages book published by ATEE (ATEE 2018).

12. It must be noticed that the detailed calculation sheets with the whole hypothesis (inc. reference situation) are not publicly available.

13. <http://www.ecologique-solidaire.gouv.fr/operations-standardisees-deconomies-denergie>

Each CEE fact sheet consists of a description of the standardised operation itself, defining the energy saving requirements and energy savings amount (CEE calculation), and the declaration on honour specifying the composition of an application for energy saving certificates and the documents to be filed by applicants. The declaration on honour is specific to each CEE action and includes the criteria of the implemented measure to which the beneficiary and the professional undertake (MTES 2019).

From the obligated perspective, a CEE file concerning actions targeting households is composed of 4 or 5 different documents to be sent to the PNCEE (CEE National Centre), body in charge of CEE validation:

1. A commitment letter to inform the customer that the retrofit action is eligible for CEE and that, as such, he will receive a reward. It allows to meet the new regulations related to the 4th period of the CEEs, which require more visibility for the customer. By signing the commitment letter, the installer or the craftsman undertakes to pay a financial incentive to the client (e.g. a discount on the invoice).
2. A quotation materializing the energy savings operation and the agreement of the customer to carry out the retrofit. It also allows to justify the “Active and Encouraging Role (called AER¹⁴)” and incentive of the obligated party.
3. The invoice certifying that the retrofit work has been carried out. It also makes it possible to inform on the equipment used as well as its energy performance. The amount of the bonus paid by the obligated must be clearly indicated in it.
4. The certificate on the honour gathering on the same document information necessary for the control of the eligibility of the EEO operation and data required to calculate the amount of CEE certificate.
5. The tax notice in case of “low-income” CEE as a proof of income level.

CALCULATION SHEET

The spreadsheet specifies the application sector (e.g. existing building), the conditions of issue (e.g. efficiency, power or thermal resistance ...) and the means of evidence (e.g. applying standard to measure efficiency) and lists the documents to be provided. The calculation of energy savings (expressed in kWhc) are detailed in the CEE spreadsheet (see sections below for detail in some example).

DECLARATION ON HONOUR

The objective of the declaration on honour is to gather on a single document the information necessary for checking the eligibility of the operation and the data necessary for calculating the CEE. The declaration on honour, filled by the installer, includes different documents to make it possible to justify compliance:

- The methods of proof.
- The dates of commitment and date of completion concerning the CEE measure implemented.

- A model framework adapted to each CEE factsheet for the description of the operation and included in the certificate on honour signed by the beneficiary and the professional.

In view of the regulatory nature of standardised energy saving transaction forms, it appeared necessary for the public bodies to adopt common rules for their creation and revision and to harmonise their content, in order to ensure that they were well understood by the stakeholders and that they were legally sound (MTES 2019).

Historical modification

Since 2006, the CEE scheme have evolved over time and the scheme has gain importance: the number of obligated parties increased (inclusion of the fuel car wholesalers in 2011) as well as the level of energy savings obligation (from 54 TWhc to 1,600 TWhc per 3 year period) which reflects a significantly increasing level of constraint.

In parallel and continuously the scheme has been modified. The estimation of energy savings (*ex-ante* deemed savings) have evolved for technical reasons: reduction of the heating-degree-day (resulting from already observable climate change), decrease of the space heating reference consumption and modifications of other coefficients. If these modifications were made for objective reasons, others have been done to explicit unexplained values and to increase accuracy. In addition, the EED directive has helped to modify energy saving to value only additional savings (i.e. beyond the performance of Ecodesign¹⁵) increasing also the constraint. Recently, the problem of fraud has led to the simplification of modulating energy savings due to the impossibility of verifying certain criteria while adding constraints on the execution of retrofit (proof, on site-visit). All these past events show the very difficult balance between precision and simplicity and this is detailed in the following sections.

A very large revision process was initiated at the end of 2014, which is only 5 years after the beginning of the scheme to prepare the 3rd period ensuring consistency with European rules, harmonization of procedures, standardisation of documents, simplified CEE requests with post-control and reinforcement of possible sanctions (Briand and Dozieres 2017). But due to time constraint, the revision of all the CEE fact sheets was finally completed during the third period on the basis of the following principles that are still applicable (MTES 2019):

- Compliance with the EED: taking into account technological and market developments to update the conditions for issuing and calculating CEE energy savings (kWhc). The CEE sheets thus take the regulations Ecodesign in order to deliver only energy savings beyond market standards (instead of taking as reference the energy performance of already installed components and systems in the existing building stock);
- Harmonisation of criteria with other public schemes, in particular the tax credit (especially concerning the minimum efficiency for action not covered by Ecodesign – see below for energy saving calculation);

14. In French: RAI, « rôle actif et incitatif ».

15. Directive 2009/125/EC on the Ecodesign of energy-related products.

- Harmonisation of the CEE fact sheets documents to reduce the administrative burden on the actors and the PNCEE and to provide better information to the beneficiaries and professionals about the scheme.

As part of the preparation for the fourth period, and in accordance with the guidelines resulting from the stakeholder's consultation following the previous consultation another round of revision started. The revision of the standard operating sheets initially focused on the most frequently used sheets in order to (MTES 2019):

- Update the market references and consumption¹⁶ reference data used in the CEE spreadsheet allocating energy savings certificate.
- Take into account upcoming regulatory changes, in particular those related to the application of Ecodesign regulations for products or the thermal regulation (JORF 2017) on existing buildings;
- Adapt the conditions for issuing certain forms in order to take into account the feedback from the third period of the scheme;

CALCULATION MODIFICATION

The CEE savings calculation is generally based on a blend of participant data (*ex-post*) and on average national data (*ex-ante*) using engineering calculation. The calculation framework for annual energy savings used in the CEE scheme was already presented in (Broc et al. 2010). We will take as example two iconic CEE measures: the roof insulation (CEE fact sheet¹⁷ BAR-EN-101) and the energy efficient boiler (CEE fact sheet¹⁸ BAR-TH-106) to present the calculation methodology.

Attic insulation measure (CEE reference: BAR-EN-101)

The calculation of energy savings (ES_{cee} in kWhc) concerning roof insulation are based on a simple engineering equation (ATEE 2018):

$$ES_{cee} = \frac{\left[\left(\frac{1}{\left(\frac{1}{U_{init}} + R_{add} \right)} \right) - U_{init} \right] * HDD * 24 * I}{\eta} * DF^{4\%} * Zone * S \quad (1)$$

with:

HDD : Heating Degree Days

η : efficiency of space heating system

R_{add} : thermal resistance added [(m².K)/W]

U_{init} : existing thermal transmittance [W/(m².K)]

I : intermittence coefficient and free contribution

$DF^{4\%}$: discounting factor

S : surface area insulated (m²)

$Zone$: thermal zone factor (H1/H2/H3)

16. Energy consumption and HDD data were provided by CEREN (Centre for Economic Studies and Research on Energy) which is a producer of detailed statistical data on energy demand (<https://www.ceren.fr>).

17. Rank#1, representing 10.3 % of the standard CEEs and 31.8 % of the low-income CEEs implemented since 2015 (MTES 2018).

18. Rank#4, representing 5.4 % of the standard CEEs; rank#9 and 2.7 % of the low-income CEEs implemented since 2015 (MTES 2018).

The reference situation (expressed by the $U_{init} = 2 \text{ W}/(\text{m}^2.\text{K})$) is considered as an average of two initial situations: no roof insulation and old and low roof insulation in order to simplify the process and since it will be difficult to verify the initial state after the fact regardless of the initial state.

If the equation 1 remained unaltered since the beginning, some of the values of the terms evolve over time. So, in 2006, the HDD value was 2,450 K and was lowered to 2,250 K during the 2014 CEE spreadsheet revision to take into account the global warming. Today, the HDD reference is 1,900 K (ADEME 2018). Thus, in 10 years, HDDs have fallen by more than 20 %, reducing the energy savings recovered by the same amount.

The intermittence coefficient (I), to into account the energy management and the inertia of the building, was initially set by public bodies at 0.5 without any precise calculation or reference to a particular source. In the 2014 CEE revision, in order to trace and justify all calculations the value has been increased to a sound value of 0.7 on the basis of the 1988 thermal regulation (JORF 2012). This, at the opposite of the previous modification, increased the energy savings by around 20 %.

As far as the life span is concerned, it was initially set at 35 years according to an expert opinion in 2006. The need to justify this value during the revision of the 3rd period, has led to a compromise between stakeholders based on different sources of information that gave between 25 and 50 years of lifetime. In the absence of available validated data, a 30-year value was chosen (i.e. $DF^{4\%} = 17.984$).

Finally, the minimum thermal resistance to obtain CEEs has increased in order to be in line with the tax credit scheme ($R > 7 \text{ (m}^2.\text{K)/W}$ for lost attic) by avoiding two different minimum efficiency levels for policies aimed at the same measure. It must be noticed that this minimum value is higher than the minimum value requested by the thermal regulation of existing buildings ($R > 4.8 \text{ (m}^2.\text{K)/W}$) (JORF 2017).

Recently and for reasons of difficulty in controlling the differentiation between heating modes (i.e. electric vs. fossil fuels) a weighted average value between the values has been chosen leading to a simplistic calculation (Table 2) without taking into consideration any difference of efficiency of space heating appliances. In conclusion, if the initial calculation is based on a detailed method, the final estimate of energy savings appears very simplified.

High efficiency boiler (CEE reference: BAR-TH-106)

Concerning the high efficiency boiler, the calculations of energy savings (ES_{cee}) are made by considering the overall difference of efficiencies of the Minimum Energy Performance Standard (MEPS) boiler and the efficient one multiplied by the value of the reference consumption and modulated by some corrective factors (ATEE 2018):

$$ES_{cee} = \frac{\left(\frac{1}{EE_{init}} - \frac{1}{87.5 * ETAS} \right)}{\left(\frac{1}{68.9} \right)} * C_{ref}^{MFH/SFH} * DF^{4\%} * zone * af \quad (2)$$

Table 2. Amount of CEE certificate for roof insulation (BAR-EN-101) in the current CEE factsheet (ATEE 2018).

| CEE amount (kWhc/m ²) according to thermal zone | | | x | Surface area insulated (m ²) |
|---|---------|---------|---|--|
| Zone H1 | Zone H2 | Zone H3 | | S |
| 1,700 | 1,400 | 900 | | |

Table 3. Amount of CEE for high efficiency boiler (BAR-TH-106) in the current CEE factsheet (ATEE 2018).

| CEE amount (kWhc) according to thermal zone | | x | SFH | | MFH | |
|---|--------|---|-----|------------------------------|---|--------|
| | | | af | S (m ²) | CEE amount (kWhc) according to thermal zone | |
| H1 | 46,900 | | 0.5 | S < 70 m ² | H1 | 24,800 |
| | | | 0.7 | 70 ≤ S < 90 m ² | | |
| H2 | 39,600 | | 1.0 | 90 ≤ S < 110 m ² | H2 | 21,200 |
| | | | 1.1 | 110 ≤ S < 130 m ² | | |
| H3 | 28,500 | | 1.6 | 130 m ² < S | H3 | 15,800 |

SFH: single family housing, MFH: multi-family housing, af: area factor, H1/H2/H3: thermal zone.

with:

EE_{init} : initial efficiency of the existing space heating system (i.e. 68.9 %) taking into account distribution, emission regulation and generation (MEPS ecodesign 86.0 % for generation)

ETAS: the seasonal efficiency (generation only) of a high energy performance boiler complying with the requirement imposed by the eco-design directive (average value: 96.8 %)

Zone: thermal zone factor (H1/H2/H3)

$DF^{4\%}$: discounting factor

af: area factor

$C_{ref}^{MFH/SFH}$: National reference consumption (kWh/y) [MFH: multi-family housing, SFH: single family housing]

Equation 2 leads to an assessment of a little less than 20 % of energy savings between before and after situation compared to the initial 2006 value of 40 % (see below).

Initially in 2006, the spread sheet was more complex because it included also a surface parameter for the MFH and a modulating parameter according to the end-use of the boiler: single or double service heating (inc. DHW).

The most important modification of the factsheet is the justification of the energy savings (ES_{eco}) that was initially evaluated according to expert judgment on the basis of 40 % gain compared to average existing boiler stock performance without significant justification. In 2010, a review of the most commonly used CEEs measures was carried out for publication in the 6th decree. The purpose of these revisions was to simplify and harmonise of the portfolio of existing factsheets. In this context, and in order to take into account the improvement in the energy performance of the boiler stock since the initial calculation made in 2006, the DGEC decided on an overall reduction in the amount of certificates for condensing boilers (a 12.5 % reduction in kWhc) (ATEE-ADEME 2010). Finally, in the 2014 revision the calculation was deeply revised to comply with EED¹⁹ requirements in annex V. This last point will

not be detailed further as it was previously presented in (Osso et al. 2015) and led to Equation 2 used today. Nevertheless the choice of the reference situation (i.e. minimum Ecodesign performance) gave rise to important discussions between stakeholders. Initially during the 2014 revision, the Ecodesign MEPS was chosen at 75 %²⁰ but following a complaint from the CLER²¹, the reference value was raised to 86 %, following an injunction from the European Commission to the DGEC (Enerpresse 2016).

Impacts on the EEO potential

It could be relevant to synthesise to what extent all these changes have impacted the overall CEE potential (at least of the potential building stock) over the time. For each measure we can consider the minimal energy performance of a measure to get CEE, which has obviously evolved over time in accordance with state-of-the art technologies and practices. In as much as there are numerous eligible actions, we focus on the two previously presented measures and taking into account all the modifications, and for a same dwelling²², the annual energy savings were:

- in 2006: 12,708 kWh/y for a condensing boiler and 98 kWh/(m².y) for roof insulation;
- in 2010: 10,893 kWh/y for a condensing boiler and 98 kWh/(m².y) for roof insulation;
- in 2015: 6,634 kWh/y for a condensing boiler and 128 kWh/(m².y) for roof insulation;
- in 2018: 4,078 kWh/y for a condensing boiler and 95 kWh/(m².y) for roof insulation.

20. 75 % is the minimum seasonal space heating energy efficiency concerning type B1 boiler (Ecodesign directive).

21. CLER (network for the energy transition) is a French association for the protection of environment (<http://cler.org>) complaining about a factsheet too favourable to fuel boilers.

22. A SFH of 110 m² in the north of France (climate zone H1) using gas for space heating.

19. "Only savings that go beyond the minimum requirements originating from EU legislation can count. For products the requirements established by implementing measures under the Ecodesign Directive ..." (European Commission 2013).

- in 2019: 8,623 kWh/y for a condensing boiler and 100 kWh/(m².y) for roof insulation thanks to a specific program²³ integrating a bonus for the years 2019–2020 (JORF 2019).

The last values can be compared with the values resulting from the 2006 calculation which shows us that the energy savings valued in CEE have evolved in different ways depending on the action and not always in the same direction. These developments, resulting from several different changes in the reference values, are difficult to follow from the outside and, above all, do not favour a stable energy efficiency market.

EVOLUTION OF THE DECLARATION ON HONOUR

The evolution of the declaration on honour of the CEE scheme is directly linked with the difficult issue of verification and fraud. Originally the CEE sheet only included the spreadsheet part (ATEE 2010), the recovery of evidence was left to the discretion of obligated parties. After the 2014 revision and in order to harmonisation, each CEE spreadsheet was accompanied by a form defining the content of the certificate on honour. In addition, each spreadsheet contains details of the methods of proof²⁴, supporting documents to be provided. As part of the implementation of the 4th period, new rules have been put in place to improve the transparency and readability of the scheme on the one hand and to strengthen control on the other. In particular, they aim to strengthen the requirements relating to companies that are delegated by a contractor to carry out CEE actions (Sénat 2017).

These developments have highlighted the “active and encouraging role” (AER) of the obligated parties towards consumers, which is becoming one of the cornerstones of the CEE scheme. This AER is at the core of the scheme in order to ensure that the obligated parties are at the origin of the triggering of actions by the consumer. The role of the obligated parties must therefore be taken into account before the decision is taken by the beneficiaries in order to avoid a windfall effect. Historically this effect was supposed to be avoided by a high level of obligation (Bodineau and Bodiguel 2009). For the 4th period, a 2017 decree establishes the list of elements of an CEE file, those to be archived by the obligated parties and that the nature of the AER be specified, which may take the form of a bonus, a purchase order, a subsidised loan, a personalized audit or advice, a gift, product or service (ATEE 2018).

Concerning the anteriority of the AER, it is required that the obligated parties’ commitment to the beneficiary be reliably time-stamped²⁵.

Example of the attic insulation measure (BAR-EN-101)

According to the spreadsheet the proof of the completion (i.e. the invoice) of the CEE operation shall include the following information:

- The brand and reference as well as the thickness and area of the insulation installed;

- The thermal resistance of the insulation installed evaluated, depending on the nature of the insulation, according to one of the mentioned standards.

Simultaneously, the declaration on honour shall contains:

- The date of commitment (e.g. date of acceptance of the quotation) and the date of proof of completion of the operation (e.g. date of invoice and its reference);
- Characteristics of the insulation installed: insulation area installed and thermal resistance;
- In lack of information concerning brand and reference on the invoice the declaration on honour shall be filled with these.
- The existence of subcontracting.

With regard to the declaration of the address for this attic insulation measure, elements were recently added following the request of the PNCEE in order to strengthen controls due to significant fraud on this action:

- Date of the preliminary on-site visit of the building where the retrofit will took place and the address;
- The cadastral reference²⁶ in lack of a complete address (i.e. street name and street number) in some locality.

We must notice that a certain redundancy exists between each file.

THE EMERGENCE OF MISUSE PRACTICES WITHIN THE EEO SCHEME

Unfortunately, with the increasing obligation of the CEE scheme, fraud problems²⁷ have appeared (Lebelle and Pelloli 2017, Gauchard 2016, Sénat 2017, Tracfin 2016) leading to the first public cancellation²⁸ of CEEs. Two types of fraudsters have been identified by the public authorities. On the one hand, the craftsman who “backdates or exaggerates the retrofit he has done, or even issues false invoices”. On the other hand, the structured network of companies set up for the sole purpose of illegally obtaining CEEs. Such fraud would have been facilitated by the appearance of insulation offers for lost attic at a price of 1 Euro in the context of the low-income obligation, the up-front cost being borne by the amount of incentive (Lacas 2017).

Conclusion and policy implications

This historical review of the French EEOs allowed us to show that the scheme has continually changed to adapt to the context both in terms of procedures and calculation methods. Moreover, the motivations for the evolution of the energy savings were based on technical reasons (e.g. to improve calculation)

23. Program called “helping hand” (in French “*coup de pouce*”).

24. As example concerning attic insulation, the thermal resistance is evaluated according to NF EN 12664, NF EN 12667 or NF standard EN 12939 for non-reflective insulation.

25. As defined by the decree n°2011-434 of the 20th april 2011.

26. To fill-in the cadastral reference, the craftsman must go to a website (cadastre.gouv.fr or geoportail.fr) and search for the plot with the address or the geolocation of the building.

27. According to (Tracfin 2016) the CEE scheme “is similar to a mechanism by which the major French energy suppliers are called upon to finance criminal networks transnational”.

28. To our knowledge since 2017: 19 decrees cancelling CEEs: 681 GWhc concerning standard CEE and 159 GWhc low-income CEE. Before end of 2017, CEE cancellation weren’t unveiled. The total amount of fraud is not of public knowledge but the fraud must involve several tens of millions of euros (Tracfin 2018, Tracfin 2016).

and other reasons (e.g. to avoid abuse). In summary, an EEO scheme will always be an ongoing work in progress and a time consuming one. But what history tells us beyond simply commenting on a complex and unstable system?

First of all, we have made out that the CEE scheme is complex, presents difficulties in running and requires significant resources to operate and that the perfect scheme is a conundrum. Overall, the system has been constrained for the obligated parties but not only due to the increase in the obligation.

Secondly, we have learnt that the devil is in the details and that a poorly designed scheme or fact sheets are the door to upcoming problem. Different calculation methods between actions leading to better CEE reward for some than others may orient or distort the market (e.g. boiler vs. insulation, lack of differentiation of space heating energy). Generous CEE actions, in terms of the amount of incentive compared to the upfront cost²⁹, are usually widely exploited and can lead to perverse effects (leading the DGEC to delete them³⁰ as a consequence of their overexploitation).

A broad consensus among the stakeholders must be reached to avoid constantly modifying the EEO fact sheet. Such consensus is necessary to mitigate risk about subsequent complaint, particularly in the event of interpretation of legislative texts or a lack of reliable data. An unexpected revision is perceived by the stakeholders as a negative signal that distorts market confidence in the ability to support energy efficiency actions in a sustainable way.

Obviously over the long term, the sheets must be regularly reviewed to take into account changes in consumption or climate and regulatory changes (e.g. European directive, national regulation). Another reason to update the fact sheet is to avoid quality deviations (product & installation) and avoid misinterpretations in the use of eligible measure (Gendron 2017).

The question that arises then is the modality of fact sheet revisions over time: in a planned way (every x-years) or by each 3-years obligation period? The experience of revising all the fact sheets at the same time to prepare for the next period, which spilled over into almost the entire period, supports the first option. The scheme having become too large-scale and complex to be able to review everything at once.

A need for transparency is also important to help in understanding and acceptance of the scheme. For example, there should be a consensus on the definition of the amount of EEO obligation per period on the basis of various studies on accessible energy savings potential (ATEE 2016, Trauchessec 2016). Another example concerns the public price of the CEE published by the national register which was assessed as an inappropriate and an inaccurate price³¹ (Pownext 2016) and has recently evolved toward a short-term transaction (spot price) (Buffard 2017). Thus, since December 2018, the spot price

(8.45 Euro/MWhc) is also published for the first time and can be compared to the historical market price (6.72 Euro/MWhc) showing the effect of forward transactions (Pownext 2018).

Furthermore, to simplify understanding of the CEE scheme by customers and its large-scale deployment, it is necessary to ensure that it is consistent with other schemes (e.g. tax credit, reduced VAT, soft-loans) targeting the same measures.

Our results complement what other studies have presented (Berthou et al. 2017): simplification of procedures, stability of the scheme and long-term visibility, information and regular communication. Another recommendation of the authors concerns the creation of “adaptive” eligible actions, which is in line with our findings showing the need to adapt the fact sheets according to the context.

The issue of energy policy fraud seems to recur as a scheme put in place become more widespread³². This applies to all energy policies as soon as large sums of money are involved like ETS (Wikipedia 2018), electricity certificates (Euractiv 2016) as well as the Italian EEO scheme (Di Santo et al. 2018). Thus, a good balance must be found between control, modes of evidence and ease of EEO action. In this way, the calculation methodology is to be correlated with easy-to-check calculation data to prevent error or fraud while remaining as close as possible to the reality of real energy savings. It seems for some actions to square the circle as tighter regulation³³ pushes fraudsters to adapt (sub-contracting chains are the source of fraud risks) (Tracfin 2018).

Any acceptable improvement of the system in the future should be based on simplification, but the consequence is that in this case we move away from the reality when it comes to calculations. Sometimes it is necessary to use simplified calculation methods to facilitate the assessment of energy savings even if this is detrimental to accuracy. The question of available and accurate data to produce CEE spreadsheet is crucial. The need for statistical data on energy consumption but also on energy product markets (market survey, efficiency, prices) is important to properly calibrate the certificate amounts.

Maybe it's time to look back at the scheme before changing something again. Having both energy savings as close as possible to reality and a simple and robust system to facilitate decision-making may appear to be an unattainable goal. The question arises as to whether or not after more than 10 years of operation the CEE scheme is an efficient process (obviously the CEE scheme works but is it in an optimal way?).

Finally, it should not be forgotten that another aspect of the scheme that this paper does not address concerns the *ex-post* evaluation of the CEE scheme (e.g. energy savings and cost of energy saved). On another side, it could be relevant to investigate to what extent the practices, skills and competences of the involved players have evolved since the beginning of the CEE scheme. This analysis of players' work and activities could encompass the technical understanding of the calculation methods, the regulation understanding of the scheme, the change in technical skills to adapt them to the new scheme, the development (or not) of customer advice activities, the ability to

29. Depending on the investment cost and the CEE market price, the full cost of the eligible action can be covered by the CEE incentive. As reported by (Tracfin 2016) among the CEE eligible measures, some are more profitable than others. The most profitable operations are the subject of massive promotional campaigns by mailing or radio and television spots, from fraudulent companies.

30. For example, the hydro-efficient system (i.e. jet regulator on faucet – BAR-EQ-112) measure repealed in May 2016.

31. According to (Pownext 2016) the price published by the national register EMMY does not act as a market price index in a context of volatile prices. The historical CEE public price is a blend of forward price and spot price.

32. As a reminder, the amount to be financed by energy suppliers estimated at nearly €6 billion for the period 2018–2020.

33. As example, the status of delegate was renewed on June 2018 to strengthen regulatory requirements, including in terms of technical and financial capacity criteria (Tracfin 2018).

handle the administrative process... Investigated stakeholders could be obligated parties and eligible players, their partners in the building trades, bodies for process administration and verification and households. In such a way, it could be possible to confirm or not a real market change effect produced by such a scheme in all its dimension.

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