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Lot 22

Domestic and commercial ovens (electric, gas, microwave), including when incorporated in cookers

Task 8: Scenario, Policy, Impact and Sensitivity Analysis

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In association with

ERA TECHNOLOGY

Bio Intelligence Service - Scaling sustainable development
Industrial Ecology - Nutritional Health

Bio Intelligence Service S.A.S - bio@biois.com
20-22 Villa Deshayes - 75014 Paris - France
Tél. +33 (0)1 53 90 11 80 - Fax. +33 (0)1 56 53 99 90

Contact BIO Intelligence Service
Shailendra Mudgal – Benoît Tinetti
☏ + 33 (0) 1 53 90 11 80
shailendra.mudgal@biois.com
benoit.tinetti@biois.com

Project Team

BIO Intelligence Service

Mr. Shailendra Mudgal

Mr. Benoît Tinetti

Mr. Eric Hoa

Mr. Guillaume Audard

ERA Technology

Dr. Chris Robertson

Dr. Paul Goodman

Dr. Stephen Pitman

Contents

8. TASK 8 – SCENARIO, POLICY, IMPACT AND SENSITIVITY ANALYSIS

8.1. INTRODUCTION

This task summarises and totals the outcomes of all previous tasks. It looks at suitable policy means to achieve the potential e.g. implementing Least Life Cycle Cost (LLCC) as a minimum and Best Available Technology (BAT) as a promotional target, using legislative or voluntary agreements, labelling and promotion. It draws up scenarios for the period 2010–2025 quantifying the improvements that can be achieved with respect to a Business-as-Usual (BAU) scenario, compares the outcomes with EU environmental targets, and estimates the societal costs if the environmental impact reduction would have to be achieved in another way, etc.

It makes an estimate of the impact on consumers (purchasing power, societal costs) and industry (employment, profitability, competitiveness, investment level, etc.) as described in Annex 2 of the Directive. Finally, in a sensitivity analysis of the main parameters it studies the robustness of the outcome.

8.2. POLICY ANALYSIS

In this section on policy analysis, policy options are identified considering the outcomes of all previous tasks. They are based on the exact definition of the product, according to Task 1 and modified/ confirmed by the other tasks. Specific recommendations to the three sectors covered by the Lot 22 studies are detailed in the following sub-sections.

8.2.1. CAVEAT

In this section 8.2, some of the options considered require the conversion of electricity into primary energy. For that purpose, the factor used is the one mentioned in Annex II of the Energy Service Directive, reflecting the estimated 40 % average EU generation efficiency (2.5), which is also used in the current version of the working documents concerning DG ENER Lot 1 on boilers. However, the use of this factor remains a sensitive issue as it could be wrongly perceived as a locked value given the precedence with Lot 1, although it should be reassessed when renewable shares within the electricity generation vary. Finally, it is not part of the Ecodesign preparatory study to revise this conversion factor.

Please note that all other primary energy consumption presented in this study were calculated using the EcoReport tool, required by the European Commission to undertake the cost and environmental impact analysis in Ecodesign preparatory studies. Consequently, for primary energy consumptions presented in Task 5, Task 7 and in the other sections of Task 8, 1 kWh of electricity was converted into 10.5 MJ of primary energy (conversion factor: 2.917).

8.2.2. DOMESTIC OVENS

8.2.2.1. SUMMARY OF CONSIDERED SPECIFIC ECODESIGN REQUIREMENTS

In order to ease reading this report, the main recommendations are summarised here. Please refer to the corresponding sub-section to get detailed information.

- **ENERGY LABELLING**

A revision of the existing energy label for domestic electric ovens is needed. Moreover, implementing an energy label for domestic gas ovens would enable users to buy more energy efficient appliances.

The energy efficiency of an oven should be evaluated using an Energy Efficiency Index (EEI), depending on the cavity volume, which would remove the inconsistencies due to several size categories.

The question of common or separate energy classes for electric and gas ovens is discussed. A database provided by CECED, detailing the energy consumption of electric and gas ovens available on the market in 2009 is analysed. For that purpose, two approaches are exposed in details. These approaches are only suggestions, and are not representative of the final decision which will be taken by the European Commission.

Both approaches are based on an EEI depending on the cavity volume. Only the energy consumption per cycle is taken into consideration, as the database did not include standby power which would allow calculating the annual energy consumption. However, using the annual energy consumption would also be valid, but would require additional data which is not currently available.

In Approach 1, separate energy classes for electric and gas ovens are recommended. Energy classes are defined in order to encourage manufacturers to improve their electric and gas appliances, while keeping consistency with the existing energy classes for electric ovens. However, it would not allow consumers to compare appliances using different energy sources, although this choice may not always be relevant at the purchaser level (e.g. considering a pre-existing installation in a building).

Common energy classes are investigated with Approach 2. The energy consumption in primary energy is used for the calculation of the EEI. Electricity is converted into primary energy using a conversion factor of 2.5 (or an updated value that may be defined by the EC in the future). Gas ovens, which are normally more primary energy efficient, will be better rated than electric ovens. Compared to the current label for domestic electric ovens, a new scale would have to be introduced, which can be confusing from a consumer's perspective, as some domestic electric ovens may be downgraded although their efficiencies did not change. Besides, a harmonised test standard is needed for a fair comparison of the appliances or at least very similar test protocols for gas and electric ovens for which equivalence is well-accepted.The effectiveness of this approach could potentially contribute to reverse the current trend towards more electric appliances.

The relevancy of an energy label for domestic microwave ovens is unclear. Several types of appliances have a microwave heating function. Specialised appliances, offering only microwave heating, are the most efficient. Combination microwave ovens, allowing cooking with different modes, are less efficient for microwave heating, but also include other cooking mode which are energy efficient. An energy labelling for all microwave ovens would result in a distribution per type. Inside each category, the disparity in energy efficiency is too small to define enough energy classes. The benefits of an energy label for microwave ovens are unclear.

MINIMUM ENERGY PERFORMANCE STANDARDS (MEPS)

MEPS are proposed in section 8.2.2.5 for electric and gas ovens, as well as for microwave ovens. They are suggested in the form of two "Tiers"; a first one in 2014, the second one in 2018.

For electric and gas ovens, limits are defined to be coherent with the proposed energy classes. Concerning microwave ovens, MEPS are differentiated depending on the category of microwave oven, in order to take into account their specificities.

8.2.2.2. PROPOSED EXACT PRODUCT DEFINITIONS AND SCOPE FOR POLICY MEASURES

"Best" definitions proposed in existing standards or used in some voluntary or mandatory programmes will be included for all product categories within the scope of ENER Lot 22. These definitions should be based on the ones available in the relevant test standards for measuring the energy consumption.

A. Domestic electric oven

The scope for domestic electric ovens should be based on the current Electric Oven Energy Label Directive (2002/40/EC) with the modification to include traditional ovens with integrated microwave function. It then covers household electric ovens, whose primary cooking function is thermal heating and includes ovens being part of larger appliances.

Excluded are:

- Ovens whose primary cooking function is microwave heating (they are covered by the "domestic microwave oven" definition)
- Portable ovens, being appliances other than fixed appliances, having a mass of less than 18kg or a volume capacity < 12L, provided that they are not designed for built-in installations.

B. Domestic gas oven

Domestic gas ovens that should be covered by regulation should be compatible with EN 15181:2009, which applies to:

> *Gas-fired domestic ovens which are capable of utilising gases of group H or group E, possibly after conversion according to manufacturer's instructions. It applies to these gas-fired domestic ovens, whether they are separate appliances or component parts of domestic cooking appliances. It also applies to domestic appliances that can utilise gas and/or electrical energy to provide heat for cooking when the ovens are utilising gas energy to provide heat for cooking, but not when electric energy is used to provide any or all of the heat for cooking in the oven*

The term "Domestic gas oven" will cover these appliances.

C. Domestic microwave oven

The category "Domestic microwave oven" refers to microwave ovens and combination microwave ovens for household use, whose primary function is microwave heating.

A combination microwave oven is a system providing not only the primary microwave oven function but also other cooking functions, such as forced-air function, grill function, steam cooking function or conventional heating function as alternative cooking functions.

8.2.2.3. Generic ecodesign requirements

Most domestic ovens are sold with instruction booklets, containing the information on how to use them properly. This mainly consists of instruction regarding food quality and recommended settings for different meals. These booklets are also a means to influence user behaviour, which was shown to have a major influence on the annual energy consumption of ovens. Consequently, the following information could be provided:

- For multifunction ovens, the energy consumption per cycle using each mode should be explicitly provided. While ensuring a satisfying quality of the meal, users should be encouraged to use the most energy efficient mode, which should be clearly identifiable on the appliance. Likewise, it should be mentioned that microwave cooking offers energy efficient alternatives to reheating / cooking in the oven or on the hob.
- Best practices regarding preheating: while preheating is necessary for some meals, there are some cases where it could be avoided to save energy. For instance, no preheating is needed for reheating a meal already cooked. Moreover, forced-air convection ovens needs less time to produce a uniform temperature inside the cavity. This information should be mentioned in booklets.

- For ovens which offer a cleaning function, the booklet should provide information on the number and/or frequency of cleaning cycles needed (e.g. once every 20 uses, etc). Such indications would only be a guide, not compulsory, but could discourage unnecessarily frequent cleaning.

In addition to these requirements, consumers could be informed on the following points through a general awareness campaign on how to cook in an energy efficient manner:

- Users should be encouraged to use the right appliance for the right purpose. For example, users should be informed that reheating a meal with a microwave oven consumes less energy than with a convection oven, even if the taste is not always equal.
- Users could be encouraged to optimise the filling of the oven, by for instance cooking more than one course at a time.
- Users could be encouraged to better use the afterheat, as it is possible to save energy by turning off the oven about 15 minutes before the food is finished for certain types of meal.
- Along with recommended settings for cooking different meals, manufacturers could be encouraged to include the amount of energy needed to cook some standard amounts of various food items. This would help users adopt a low energy demanding diet, by helping them choosing their meals. Obviously, this would need the development of "standard" recipes to be comparable between models.

Additional information on the performance of the oven in terms of heat distribution and evenness of heating could also be provided. Introducing a performance criterion could prevent possible appliance development that results in an energy efficient oven to the detriment of heating and cooking performance.

8.2.2.4. Specific ecodesign requirements: policy recommendations for labelling

This section will consider how energy labelling can be established with the aim of reducing the overall energy consumption due to domestic ovens at EU level.

A. Existing energy label for domestic electric ovens

Directive 2002/40/EC imposes an energy label for household electric ovens. An example of such label is provided in Figure 8-1.

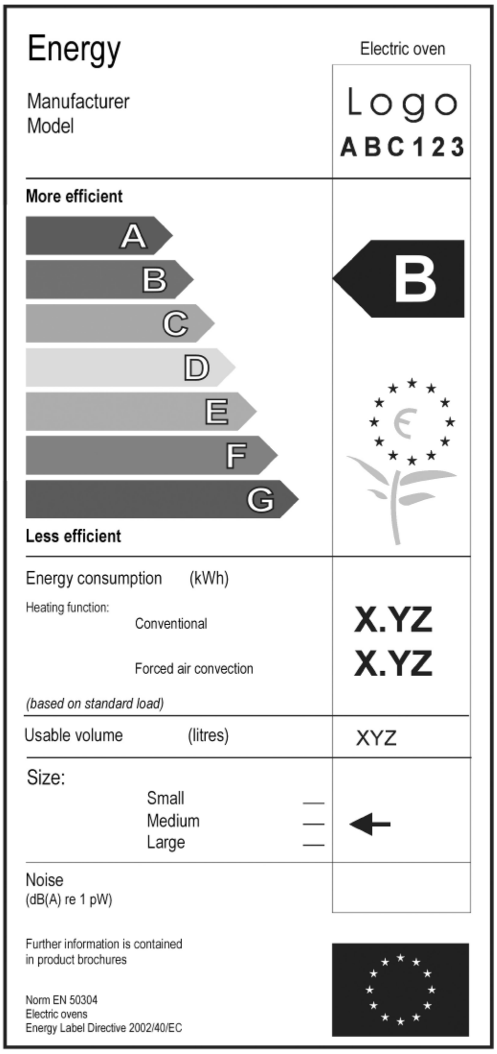


Figure 8-1: Current European label for domestic electric ovens

The energy class is defined according to the energy consumption per cycle, as defined in the standard EN 50304/60350:2009. When there are several heating functions, the higher energy consumption is used. The energy thresholds for classes depend on the usable volume, as presented in Table 8-1.

Table 8-1: Thresholds for energy classes for the current European domestic electric ovens label

Class	Small cavity (< 35 L)	Medium cavity (35 – 65 L)	Large cavity (≥ 65L)
A	E < 0.6	E < 0.8	E < 1.0
B	0.6 ≤ E < 0.8	0.8 ≤ E < 1.0	1.0 ≤ E < 1.2
C	0.8 ≤ E < 1.0	1.0 ≤ E < 1.2	1.2 ≤ E < 1.4
D	1.0 ≤ E < 1.2	1.2 ≤ E < 1.4	1.4 ≤ E < 1.6
E	1.2 ≤ E < 1.4	1.4 ≤ E < 1.6	1.6 ≤ E < 1.8
F	1.4 ≤ E < 1.6	1.6 ≤ E < 1.8	1.8 ≤ E < 2.0
G	1.6 ≤ E	1.8 ≤ E	2.0 ≤ E

E: Energy consumption (kWh) for the heating function(s) (conventional and/or the forced air convection) (of appliances) based on standard load determined in accordance with the test procedure of harmonised standards.

Energy labelling for domestic electric ovens was proven to be very effective in driving the market towards more efficient appliances. As shown in Task 2, most electric ovens sold today are Class A or Class B. Task 6 and 7 showed that it was technically possible to achieve efficiencies that are more efficient than class A.

B. Discussion on energy labelling for domestic ovens

A revision of the energy classes for electric ovens is needed to ensure that more energy-efficient appliances are purchased and to allow a relevant differentiation between models available on the market. Moreover, there is a significant improvement potential for domestic gas ovens, but due to the absence of an energy label, manufacturers were more focussing on electric ovens. Implementing an energy label for gas ovens would encourage consumers to buy more efficient gas ovens and also manufacturers to produce more efficient models.

The main characteristics of an energy label for domestic ovens are discussed below, taking into account the experience acquired with the current energy label for domestic electric ovens.

Appliances with multiple cavities

For appliances with multiple cavities, a label should be provided for each cavity, which is already the case for the current energy label.

Energy consumption considerations for defining energy classes

The energy class is the main information on an energy label. For the current label for electric ovens, the energy class is attributed according to the energy consumption measured by the test standard EN 50304/60350:2009, and only consumption for a typical cooking cycle is displayed. For many new energy labels, the annual energy consumption is used, taking into account not only the energy consumption in active mode, but also for the other modes, such as standby or left-on modes.

For an oven, most of the energy is consumed during the cooking cycles. As assessed in the consumer behaviour analysis in Task 3, domestic ovens are used for 110 cycles a year on average. However, this use frequency varies significantly across Member States, from 23 times a year in Italy to 185 times a year in Finland[1].

A significant amount of energy is also consumed in standby/off-mode for most ovens. Standby power with display is limited to 2W since January 2010 and will be limited to 1W from January 2013 onwards. For an oven consuming 0.84 kWh with 2W standby power, energy consumption in standby represents 16% of the annual energy consumption (assuming 110 cycles per year). With 1W standby power and the same assumptions, it is reduced to 9%. However, significant reduction beyond 1W is unlikely, and therefore, the energy consumption in standby should be similar for all domestic ovens.

Most fan-forced convection ovens have a cooling down phase, during which fans are left on, typically for 30 minutes. During this phase, an oven needs 15W, which represent 0.0075 kWh of electricity after each cycle. The average electric oven sold in 2007 consumes 0.84 kWh per cycle; the energy consumed in cooling down mode is therefore less than 1% of the consumption per cycle. Moreover, this consumption is likely to be very similar across different ovens. Therefore, it can be excluded from the calculation of annual energy consumption.

Finally, the cleaning features of ovens also consume some energy, however no information is available to characterise an average European value. It is strongly dependent on user behaviour and most ovens sold in the EU do not include the cleaning feature.

In conclusion, it is likely that the same ranking would be obtained by considering the annual energy consumption or the energy consumption per cycle. From a consumer point of view, the annual energy consumption is interesting information to have, as it can be used to calculate the annual running costs. This would help him estimating whether buying a more expensive oven will become profitable.

VOLUME DEPENDENCY

With the current energy label for domestic electric ovens, thresholds between energy classes are constant and different for small, medium, and large ovens. As a result, an electric oven with an energy consumption of 0.79 kWh per cycle can be class A or class B depending on whether its cavity size is higher or lower than 35 litres. As a result, many ovens are just above the limit in order to get a better energy class.

[1] Kasanen, P. (2000) “Save II Project - Final Report on Efficient Domestic Ovens”.

Removing these volume categories and introducing an energy efficiency index, depending on the cavity volume, would be more adapted. This new Energy Efficiency Index (EEI) would be calculated by the function:

$$EEI = \frac{EC}{SEC} \times 100 \qquad\qquad SEC = c_1 \times V + c_2$$

With:

- EC: Energy consumption (in kWh), either annual or per cycle
- SEC: Standard energy consumption (in kWh), consistent with EC.
- V: Oven cavity volume (in litre)
- c_1, c_2: constants determining the relationship between volume and standard energy consumption

However, there is a risk that this new methodology could lead to an increased availability of larger appliances, as it has been seen for other domestic appliances such as washing machines, although it is unlikely that consumers increase the amount of food put in an oven because they would have purchased a larger oven.

MULTIFUNCTION OVENS

Currently, the Directive 2002/40/EC is ambiguous regarding ovens having more than one heating function: it does not clearly mention which heating function the energy class refers to. According to the MTP Briefing Note on energy label for domestic ovens[2], the European Commission confirmed that the energy consumption for each heating function should be provided in kWh/cycle. The energy class is attributed according to one of the heating function, selected by the manufacturer. Consumers are however informed of the energy consumption per cycle for both conventional heating and forced-air convection heating.

➢ Attribution of the energy class

If a new label is set up, legislation should clearly explain how to attribute the energy class for multifunction ovens. Several options are possible:

- Manufacturers could finally define the primary heating function of their oven, which would be the one used to define the energy class. This is equivalent to the current situation with energy label for domestic electric ovens. In that case, the label should mention which heating function is the primary one.
- The energy consumption could be measured for each heating function, and the energy class could depend on the worst performing one. This solution has the advantage to ensure manufacturers will not concentrate on the efficiency of the primary heating function, without trying to improve the efficiency of the

[2] *BNCK02: Energy label for domestic ovens*, Market Transformation Programme, 2006. Retrieved Mars 2011 from: http://efficient-products.defra.gov.uk/spm/download/document/id/558

other ones. However, on domestic electric and gas ovens, the efficiencies of natural and forced-air convection are linked.

- The energy class could also depend on the average of the energy consumptions in different heating functions. There are no statistics about the use of ovens with multiple heating functions, so assuming they are all used equally would allow taking into account the efficiency of all heating functions.

➢ Information on cooking functions

On the current energy label for domestic electric ovens, the energy consumption per cycle is given for both natural and forced-air convection. New energy labels under the Directive 2010/30/EU are encouraged to be multilingual, the use of text is therefore not recommended. On the new label, several approaches could be considered:

- Displaying the energy consumption per cycle for each cooking function: This is currently the case on the label for domestic electric ovens. However, this value is directly used to attribute the energy class, and this is the only information about energy consumption.
- Displaying A-G classes for each cooking function: secondary labels are used for the new labels for washing machines and dishwashers. However, they are used to inform about the performance of the appliance in terms of process (e.g. efficiency of spinning). The meaning of these sub-classes would not be consistent between all the energy labels.
- Only information about the availability of other cooking functions: Loss of information compared to the existing label for domestic electric ovens. Manufacturers would have no more interest in having an efficient secondary heating function. For convectional ovens, the energy efficiencies in conventional heating and in forced air convection are linked, but the energy consumption for secondary heating functions is a criterion of comparison between two models. Moreover, removing this information might lead to a less efficient secondary heating function. As there is no information available about user habits regarding the use of secondary heating function for domestic ovens, the consequences on the EU energy consumption is unpredictable.

COMPARISON OF APPLIANCES USING DIFFERENT ENERGY SOURCES

Allowing consumers to compare appliances using different energy sources is possible through different solutions. The first one would be a common labelling based on primary energy efficiency. As well, energy classes could be attributed according to criteria specific to each type of oven, and comparison could be made possible by including additional information.

➢ Common energy classes

A common label would promote those appliances which are the most "primary energy efficient", which currently are in most cases gas ovens. This would require the conversion of electricity into primary energy, using a conversion factor. This solution will be further investigated later in this section, based on energy consumption data provided by CECED. It is likely that the effectiveness of this common labelling could potentially contribute to reverse the current trend towards more and more electric ovens. That may not be in perfect line with the EU Roadmap[3] for moving to a competitive low carbon economy, which forecasts a more carbon-neutral renewable electricity. Separate energy classes would then be more adapted to improve each type of oven independently. This current market trend can certainly be explained in part because of the current energy label for electric ovens, making them look more efficient than gas ovens in the mind of consumers. However, this trend is also observed in the commercial sector, where there is no energy labelling scheme for electric and gas ovens. Therefore, thought being accentuated by the label, it can be explained by other reasons. According to the Market Transformation Program, on its own, energy labelling is unlikely to change consumers' basic cooking preference[4]. Moreover, as shown in Table 2-50 in Task 2[5], for domestic oven, the first criteria for consumers is the fuel used. Energy performance - to a larger extent than energy efficiency - is considered as being of "high importance", but at the same level than functionalities, size and design. Therefore, it is difficult to predict if common energy classes would bring about more primary energy and GHG emissions savings at EU level than separate ones.

➢ Separate energy classes with information allowing comparison on the label

Defining common energy classes is not the only solution to enable consumers to compare appliances using different energy sources. Energy classes can be attributed separately for each type of oven, but some additional information can be displayed to allow comparison of different ovens:

- Annual energy consumption could be provided with a unit similar to the one used on energy bills (kWh for electricity and MJ for gas), in order to enable consumers to calculate the annual running costs. Converting energy consumption into costs is a way to compare, although not optimal. As shown in Tasks 5 and 7, gas ovens are less expensive to run than electric ovens. However, this information does not enable a direct comparison as it is likely that an average consumer is not aware of the price per unit (e.g. kWh) of gas and electricity.
- Informing the consumer about primary energy consumption in MJ, addition to the annual final energy consumption in kWh is a possible solution for electric appliances. However, the distinction between primary and final energy is a concept with which the general public is unfamiliar.

[3] published 8.3.2011 : http://ec.europa.eu/clima/documentation/roadmap/docs/com_2011_112_en.pdf
[4] *BNCK02: Energy label for domestic ovens*, Market Transformation Programme, 2006. Retrieved Mars 2011 from: http://efficient-products.defra.gov.uk/spm/download/document/id/558
[5] Table 2-50 presents CECED's view of consumer preferences in domestic oven choice. A survey among a representative number of European consumers would bring a more global picture.

- People are more and more informed about climate change and greenhouse gases (GHG) emissions. Reducing GHG emissions is one of the objectives of the 20/20/20 targets for 2020 defined by the European Union[6]. Informing the consumer about GHG emissions is a viable solution, although this information is not present on any existing European energy label. Such a value would be expressed in CO_2 equivalent as it is a well known unit already used for the GHG emissions for cars, and would only consider the use phase. Further, the EU energy mix would be used as an average to convert the energy consumption into GHG emissions, even if it would under or overestimate the GHG emissions depending on the Member State and their national energy mix.
- Finally, a more flexible solution would be to add an additional voluntary label, containing a barcode, which can link to a website when taking a picture of it with a smartphone. On this website, custom information could be presented according to the Member State. However, it is difficult to predict if this feature will actually be used by the purchaser and how the additional information will effectively impact its choice.

OTHER INFORMATION TO BE DISPLAYED ON THE ENERGY LABEL

The cavity volume is important information, which should be available on the energy label. The cavity volume is currently measured with the measurement method described in EN 50304:2001. However, this method is currently being updated by the IEC.

Furthermore, noise should be measured following the standards EN 60704-2-10 (noise measurement) and EN 60704-3 (verification) and displayed on the label. In the case of multifunction ovens, for consistency, the noise would be measured for the function determining the energy class.

SPECIFIC CASE OF DOMESTIC MICROWAVE OVENS

The potential introduction of an energy label for microwave ovens is discussed in this section.

The Base-case was defined to cover microwave solo and microwave with grills, which represent the biggest share of the market (see Task 2). According to Task 7, the Base-case is already the product with the least life cycle cost (considering a reduction in standby power consumption following the Standby Regulation). Microwave ovens which allow cooking with either natural convection or forced air convection heating ("combination microwave ovens") and ovens that have a secondary microwave function were not considered within the Base-case but may bring labelling issues as they consume more energy than an average microwave solo, based on stakeholders' feedback. Different labelling options are here presented.

[6] 20 20 by 2020 - Europe's climate change opportunity, COM(2008) 30 final

➢ Option 1: Label covering all type of microwave ovens

A common labelling scheme for all types of microwave ovens would encourage consumers to buy microwave ovens which are more efficient considering only the microwave heating function. It would also enable users to compare the efficiency of all microwave ovens. However, the other types of microwave ovens have other heating functions, and which could not be covered by the label. Especially, combination microwave ovens can be used in combined mode, which is one of the most efficient cooking methods for some meals. A common label is likely to result in a distribution of appliances according to their type.

➢ Option 2: Separate labelling for microwave solo/grill and combination microwave ovens

Combination microwave ovens consume more energy than the other types of ovens for microwave heating, but they have additional functions. Therefore, a separate label taking into account this specificity could be considered.

However, considering only microwave solo and microwave ovens with grills, the standard deviation only represents 5% of the average consumption, based on stakeholders' feedbacks. The most efficient model would consume around 25% less energy per cycle than the least efficient one, with respect to the new draft standard currently developed by CENELEC. Defining 7 energy classes on this small interval would be very difficult. Most ovens would be in the same classes and this would provide little additional value to the consumer.

➢ Option 3: No energy labelling for microwave ovens

Considering the conclusions of Task 7 and the data provided by CECED, it seems that an energy labelling scheme would not necessarily be an adapted policy tool for the microwave ovens market. Other measures, such as the definition of minimum energy performance standard, could be more adapted to reduce the EU energy consumption due to microwave ovens.

C. Possible energy labels for domestic electric and gas ovens

Following the discussion conducted in the previous paragraphs, two approaches are investigated in detail in order to provide quantitative information to the European Commission. **Please note that these approaches are only suggestions**. Decision regarding an energy labelling for domestic electric and gas ovens will be taken by the European Commission.

No data is available concerning the energy consumption in standby mode. Therefore, only an approach based on the energy consumption per cycle can be investigated. If using annual energy consumption is preferred, making again the calculations using a database with information on standby mode will be needed to define correct thresholds in the Regulation. It is however likely that the conclusions will be the same.

PRESENTATION OF THE APPROACHES

The main characteristics of the two approaches are presented in Table 8-2. Approach 1 aims at promoting the energy efficiency of appliances independently, while Approach 2 promote the primary energy efficiency of the appliance, through common energy classes (in line with previously proposed labelling measures by the European Commission).

Table 8-2: Presentation of the two approaches

Approach 1: Separate energy classes	Approach 2: Common energy classes
General description	
✓ Energy label specific for each type of appliance: electric oven, gas oven ✓ For multifunction ovens, consumers are informed about the efficiency of all heating functions, and the energy class is defined according to an EEI depending on the energy consumption for all heating functions and on the cavity volume.	✓ Manufacturers define a primary and secondary function (for multifunction ovens) for their appliance. ✓ Same EEI for electric and gas ovens, depending on cavity volume and on the energy consumption for the primary heating function, in primary energy. Electricity converted using a 2.5 conversion factor. ✓ No energy consumption displayed for secondary functions, only the availability is indicated.
Electric oven	
✓ Energy consumption per cycle is measured using EN 50304/60350:2009 for both conventional heating and forced-air convection (if available). Both energy consumptions per cycle are displayed on the label. ✓ Energy class is attributed according to an EEI calculated from the cavity volume and the average of the energy consumptions by heating function. ✓ Introduction of classes A+ to A+++ for electric heating modes.	✓ Manufacturers define a primary and secondary function for their appliance, among conventional heating and forced-air convection. ✓ Energy consumption per cycle is measured for all heating functions using a new harmonised test standard or an approved test protocol which is similar to the gas one. ✓ Energy class is attributed according to an EEI calculated from the cavity volume and the primary energy consumption of the primary heating function. Energy classes are common to electric and gas ovens.
Gas ovens	
✓ Energy consumption per cycle is measured using EN 15181:2009 for both conventional heating and forced-air convection (if available). Both energy consumptions per cycle are displayed on the label. ✓ For models using both gas and electricity, only the gas consumption is displayed. ✓ Energy class (A+ to G) attributed according an EEI calculated from the cavity volume and the average of gas consumptions per cycle. ✓ Introduction of classes A++ to A+++ once the market shifted towards more efficient appliances (which is the current situation for domestic electric ovens).	✓ Manufacturers define a primary and secondary function for their appliance, among conventional heating and forced-air convection. ✓ Energy consumption per cycle is measured for all heating functions using a new harmonised test standard or an approved test protocol which is similar to the electric one. ✓ Energy class is attributed according to an EEI calculated from the cavity volume and the primary energy consumption of the primary heating function. Energy classes are common to electric and gas ovens.

For both approaches, the use of an Energy Efficiency Index (EEI) depending on the cavity volume was chosen, as it appears to remove some drawbacks of the current system for domestic electric ovens.

The two approaches are also different regarding multifunction ovens. In Approach 1, the EEI is calculated from the average of the energy consumptions by heating function. For Approach 2, manufacturers are allowed to choose the primary heating function of the appliance.

Concerning energy classes, in Approach 1, energy classes above A are introduced for electric ovens only. For gas oven, these classes would be introduced later. In Approach 2, the common energy classes would range from A+++ to G.

These two approaches are further detailed in the following sub-sections.

APPROACH 1: SEPARATE ENERGY CLASSES: ELECTRIC OVENS

For approach 1, the energy class is attributed according to an Energy Efficiency Index (EEI) calculated from the average of the energy consumptions per cycle of all heating functions. Using an average energy consumption would increase the costs for market surveillance (tests) because it would be necessary to carry out measurements for each heating function in order to estimate the average value. This is proposed in order to provide more transparency on the energy consumption of the appliance. The fact that manufacturers could choose the most efficient heating mode in the current label could be considered as a loophole.

Figure 8-2 presents the distribution of electric ovens according to their cavity volume and their energy consumption. The thresholds of the current label are displayed. For multifunction ovens, the current label allows manufacturers to choose the heating function that should be used to attribute the energy class. Therefore, the lowest consumption was used (manufacturers are likely to choose the most efficient heating function as the primary one).

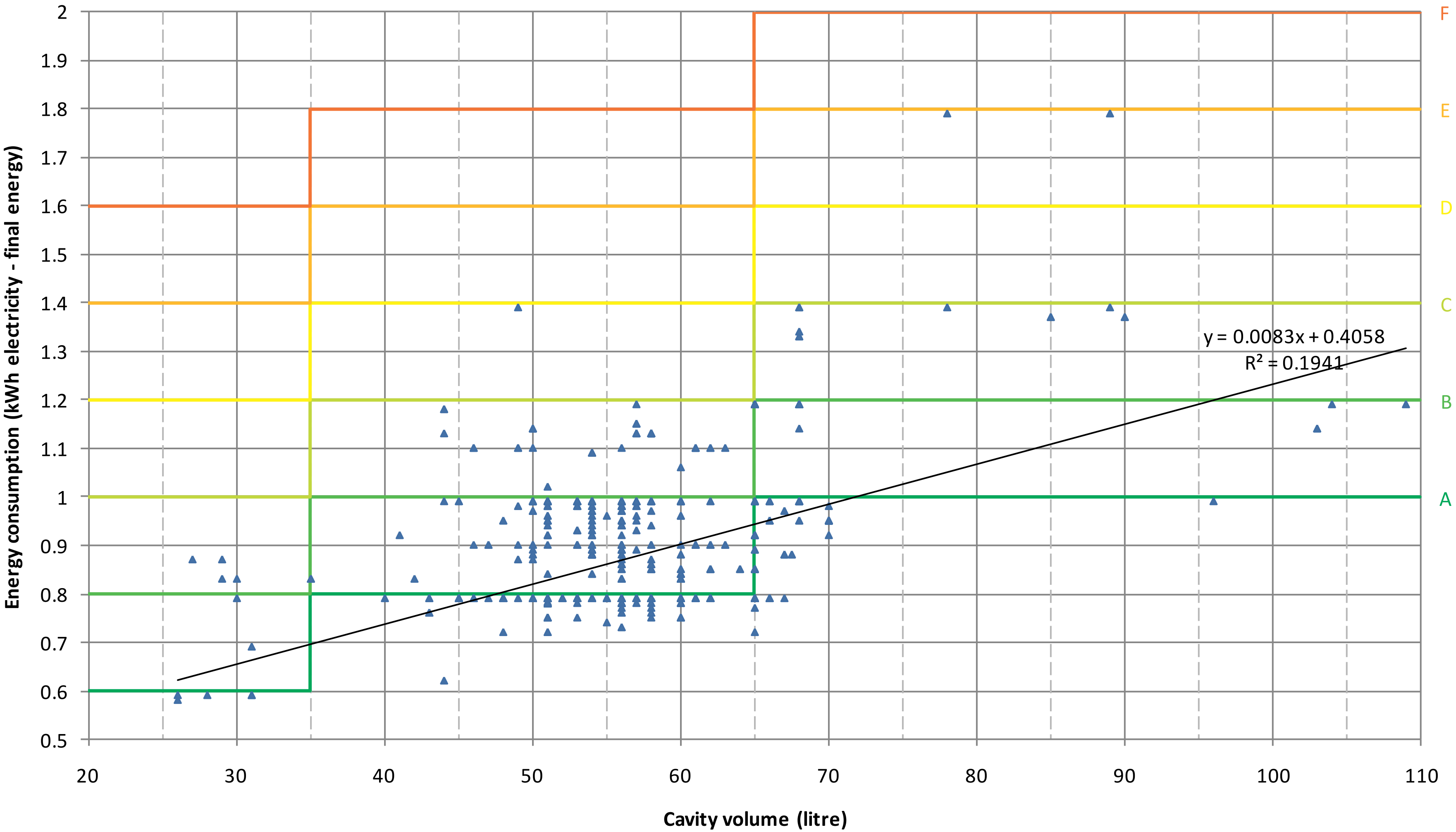


Figure 8-2: Electric ovens from CECED database (2009) – Most efficient heating function

Electric ovens were ranked according to their Energy Efficiency Index (EEI), calculated using the following formula:

$$EEI = \frac{EC}{SEC} \times 100 \qquad SEC = c_1 \times V + c_2$$

Constants c_1 and c_2 were calculated so that the current best performing ovens would be labelled A+. The energy consumption per cycle of the most efficient ovens is indeed much lower than the limit for class A. Table 8-3 presents the thresholds for the new energy classes for domestic electric ovens. The limit between class D and class E was defined as EEI = 100. Interval between two classes was kept constant in proportions. In order to take into consideration the error margin of the test standard for measuring the energy consumption, the interval was set at 12.5%. The thresholds were rounded to the closest integer to ease the determination of energy class.

Table 8-3: Suggested energy efficiency thresholds for approach 1

Energy Efficiency Class	Energy Efficiency Index	Delta
A+++	EEI < 45	
A++	45 ≤ EEI < 51	11.8%
A+	51 ≤ EEI < 59	13.6%
A	59 ≤ EEI < 67	11.9%
B	67 ≤ EEI < 77	13.0%
C	77 ≤ EEI < 88	12.5%
D	88 ≤ EEI < 100	12.0%
E	100 ≤ EEI < 114	12.3%
F	114 ≤ EEI < 131	13.0%
G	EEI ≥ 131	

The current best performing ovens should be rated A+, and should therefore have an energy factor of below 59. This is an arbitrary choice. The lower will be this parameter, the more ambitious will be the label.

With c_1 = 0.0102 kWh/l and c_2 = 0.7119 kWh

The distribution of models according to their EEI and energy class is presented in Figure 8-3 and Figure 8-4. 2.1% of the models in the database would be A+.

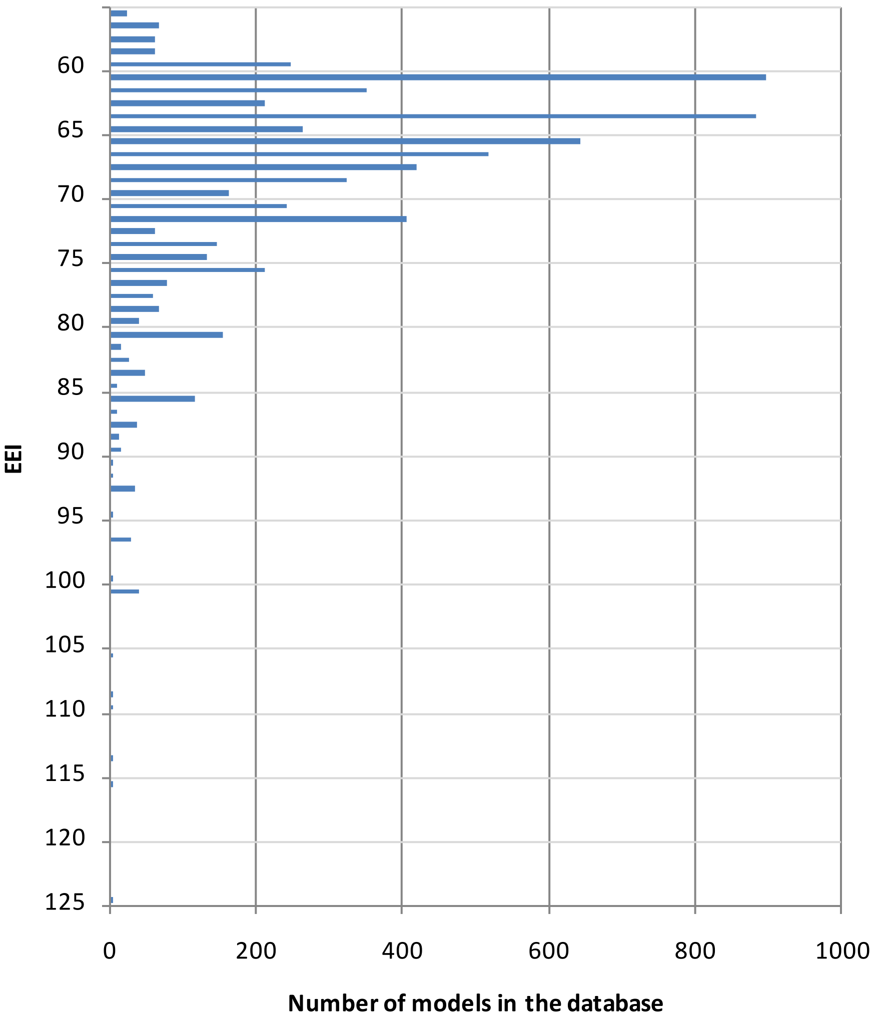


Figure 8-3: Electric ovens: Number of models per EEI

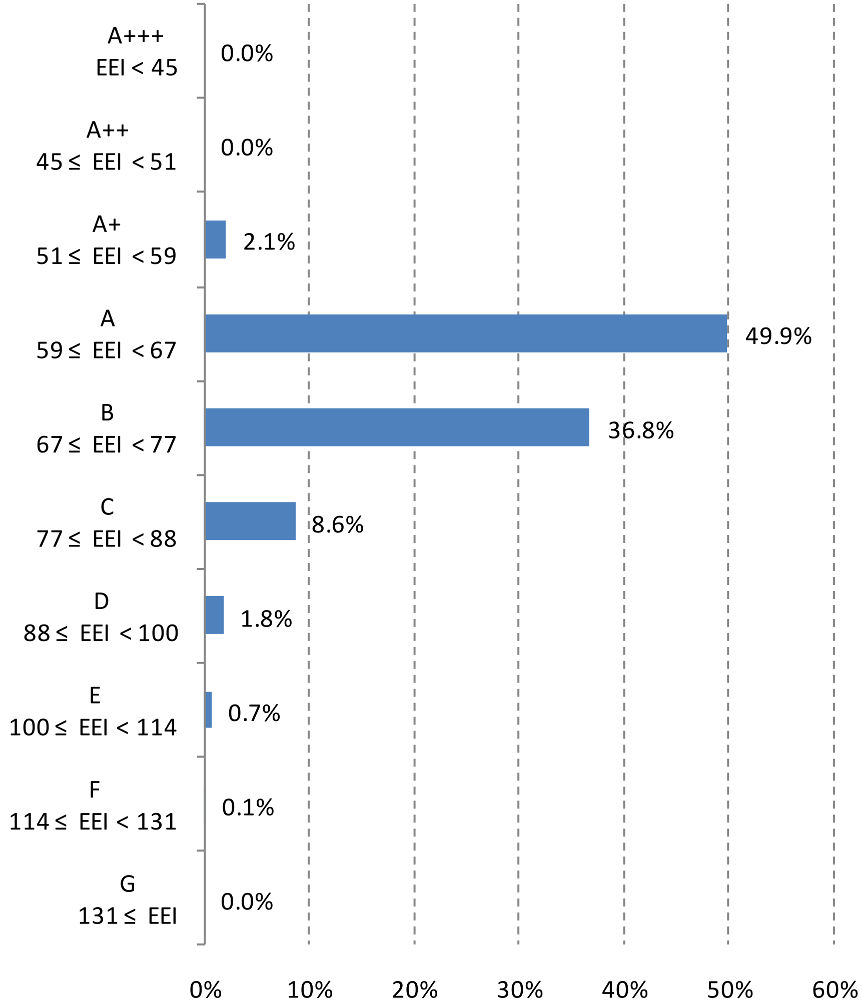


Figure 8-4: Electric ovens: Percentage of models per energy class

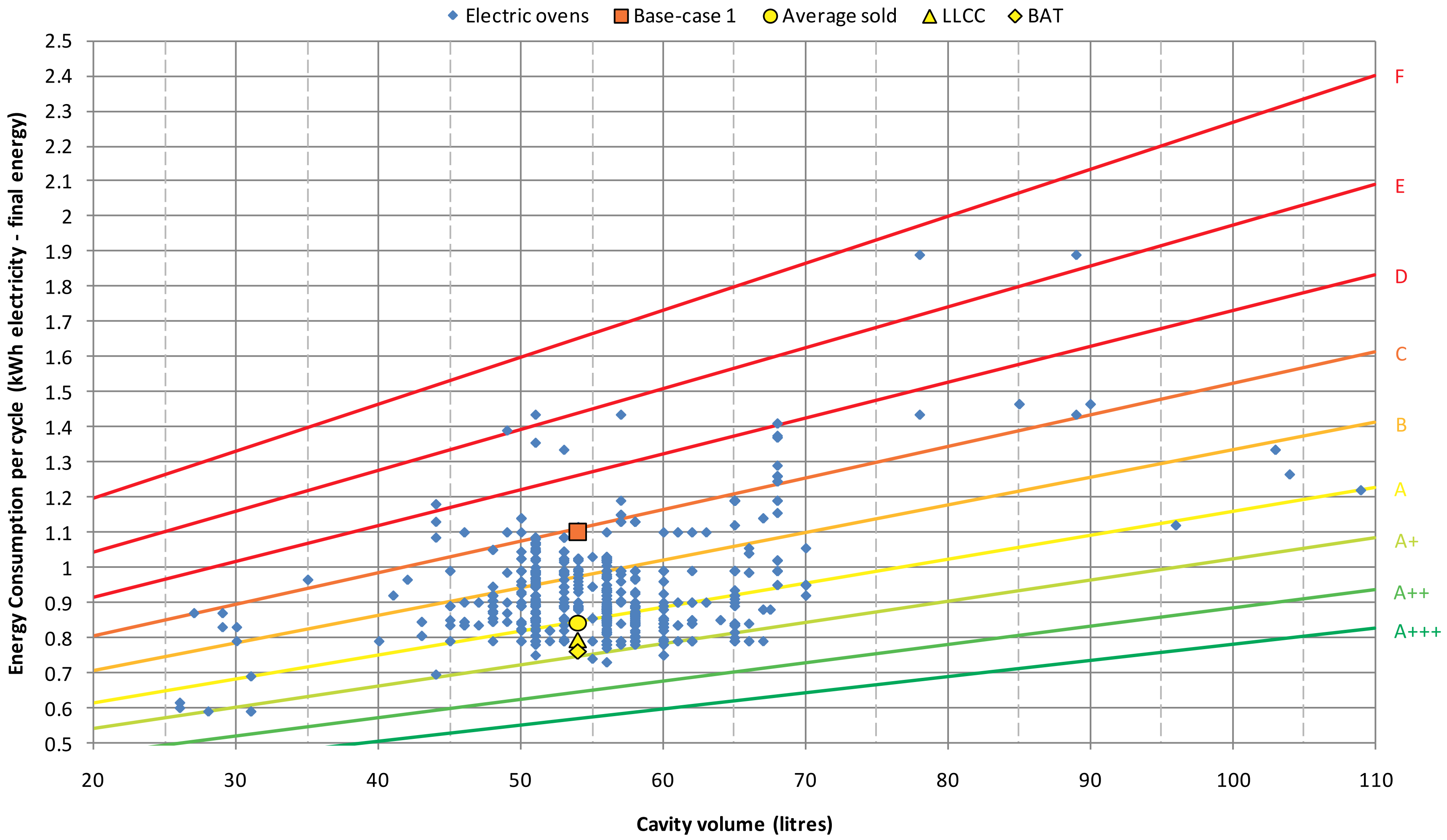


Figure 8-5: Proposed energy classes for electric ovens

Figure 8-5 presents the limits for energy classes in terms of annual energy consumption. Base-case 1 would be class C, which is its current energy class. The LLCC product described in Task 7 is class A while the BAT product is very close to class A+. No ovens reach class A++. Setting such high limits will leave room for further improvement.

With this new energy classes, 54% of the models in the database keep the same energy class (see Figure 8-6). 3% get a higher class while 43% get a lower class. The balanced distribution of models according to their energy class is presented in Figure 8-6. This class switch is mainly due to the fact that for multifunction ovens, the EEI is calculated using the average of the energy consumptions for all heating functions, while previously only the energy consumption of the most efficient heating function was used. Compared to the current label for domestic electric ovens, some adjustments would have to be introduced, which can be confusing from a consumer's perspective, as some domestic appliances may be downgraded although their efficiencies did not change. Nevertheless, it is not obvious that this would have a significant impact on consumers' purchase decision as they do not buy frequently an oven (lifetime of 19 years).

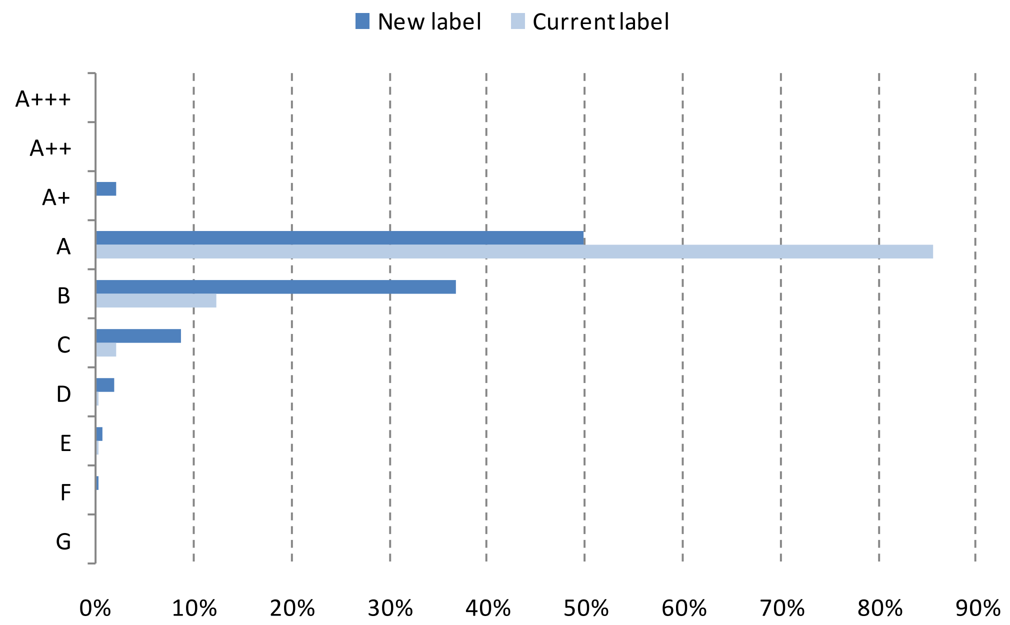


Figure 8-6: Distribution of models according to their current and new labels.

APPROACH 1: SEPARATE ENERGY CLASSES: GAS OVEN

For gas ovens, the same methodology was applied as for domestic electric ovens. However, some gas ovens use electricity as well as gas, to power fans, light and electronic components.

For gas ovens, only the gas consumption was taken into account. In CECED database, for ovens needing both gas and electricity, the average share of electricity consumption in the overall primary energy consumption on a cycle is 3% (by converting electricity to primary energy using a conversion factor of 2.5). This is lower than the tolerance of the test standard, and therefore was neglected.

Gas ovens were ranked according to their Energy Efficiency Index (EEI), calculated with the following formula:

$$EEI = \frac{EC}{SEC} \times 100 \qquad SEC = c_1 \times V + c_2$$

With c_1 = 0.0208 kWh/l and c_2 = 0.7738 kWh

The EEI calculations could also be expressed in MJ as the share of electricity consumption was neglected. This alternative does not impact on the final EEI values and determination of the energy class thresholds and can avoid confusion amongst purchasers who normally link kWh with electric energy consumption.

Constants c_1 and c_2 were calculated so that the current best performing ovens would be labelled A++ (lower limit) and the base-case would be labelled B, in order to have a distribution to the one for the electric ovens labelling scheme. Table 8-4 presents the thresholds for the new energy classes for domestic gas ovens. Interval between two classes was kept constant in proportions. In order to take into consideration the error margin of the test standard for measuring the energy consumption, the interval was set at 12.5%. The thresholds were rounded to the closest integer to ease the determination of energy class.

Table 8-4: Suggested energy efficiency thresholds for approach 1

Energy Efficiency Class	Energy Efficiency Index	Delta
A+++	EEI < 52	
A++	52 ≤ EEI < 60	13.3%
A+	60 ≤ EEI < 68	11.8%
A	68 ≤ EEI < 78	12.8%
B	78 ≤ EEI < 89	12.4%
C	89 ≤ EEI < 102	12.7%
D	102 ≤ EEI < 116	12.1%

Energy Efficiency Class	Energy Efficiency Index	Delta
E	116 ≤ EEI < 133	12.8%
F	133 ≤ EEI < 152	12.5%
G	EEI ≥ 152	

Figure 8-10 presents the limits for energy classes in terms of annual energy consumption. Base-case 2 would be class B, the LLCC product would be class A, while the BAT product would be class A++ (lower limit).

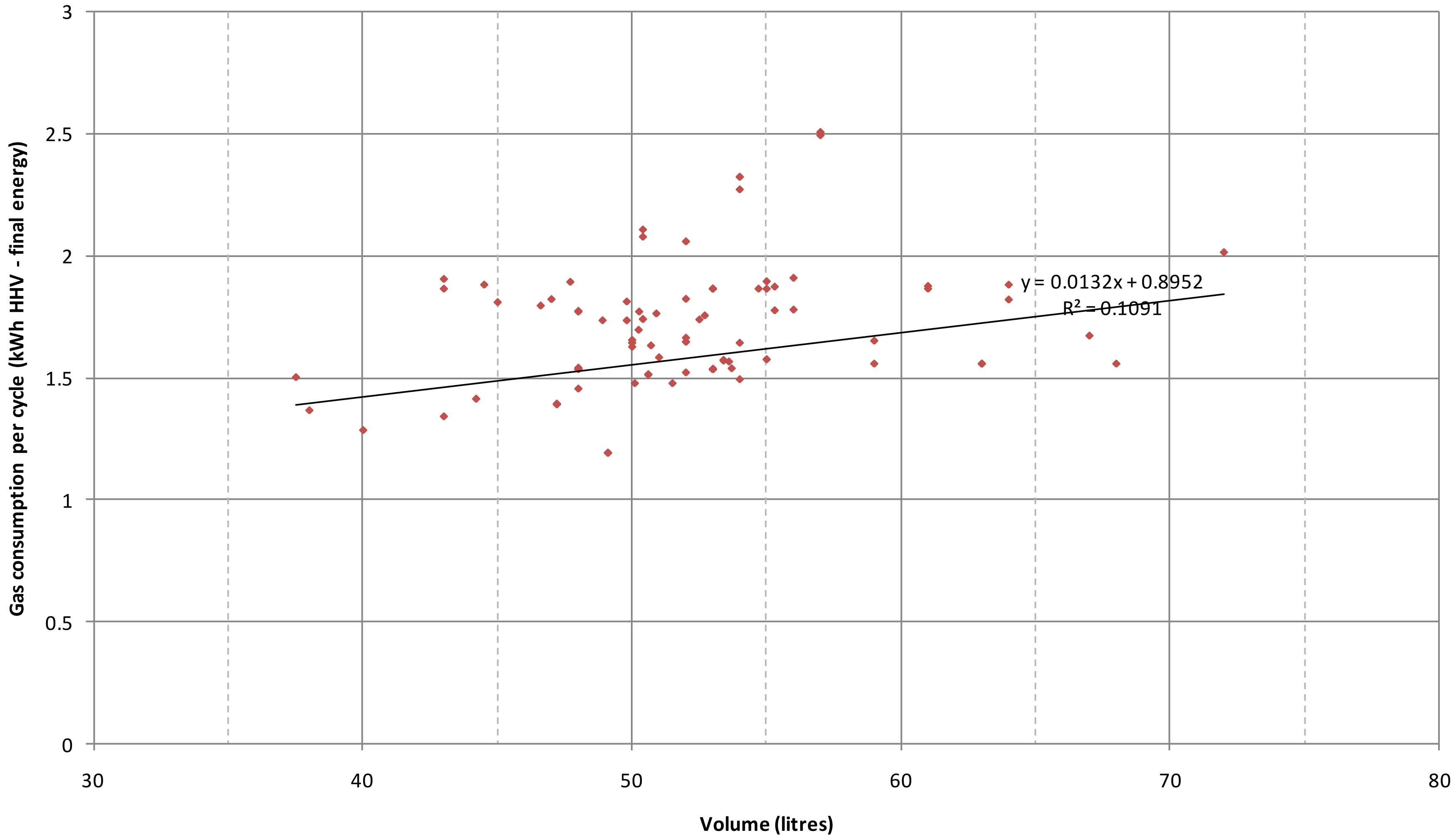


Figure 8-7: Gas ovens from CECED database (2009)

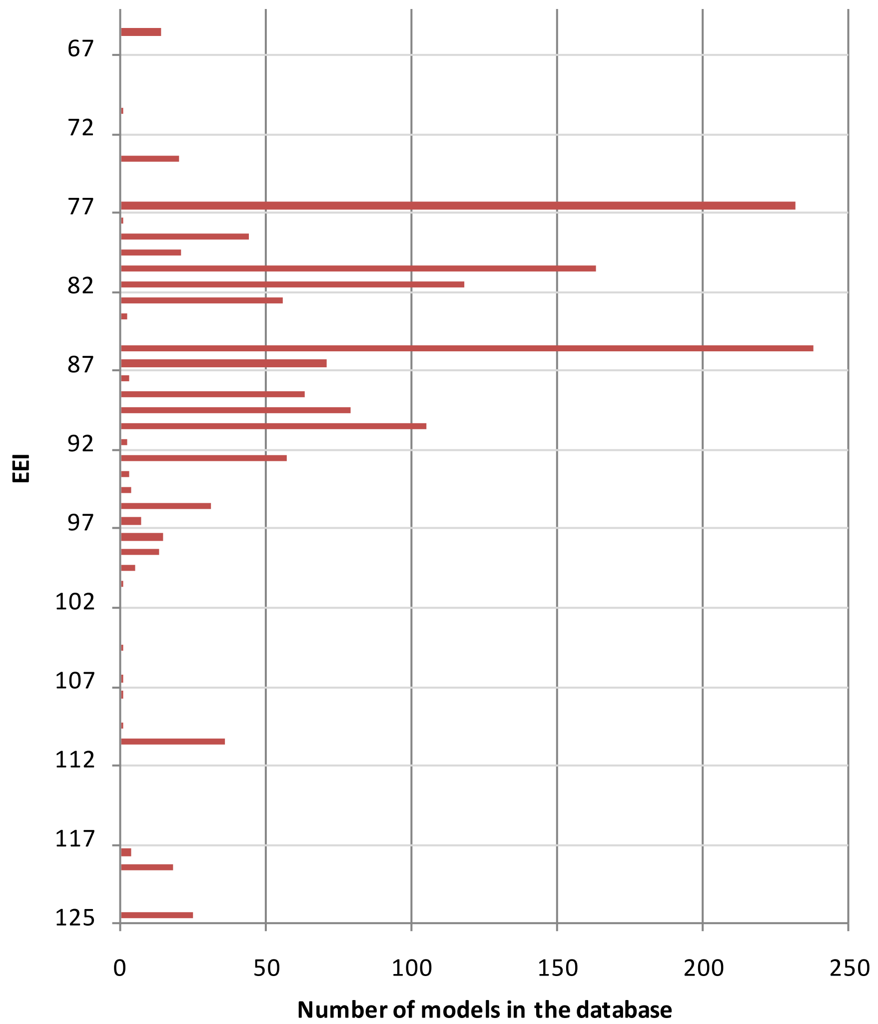


Figure 8-8: Gas ovens: Number of models per EEI

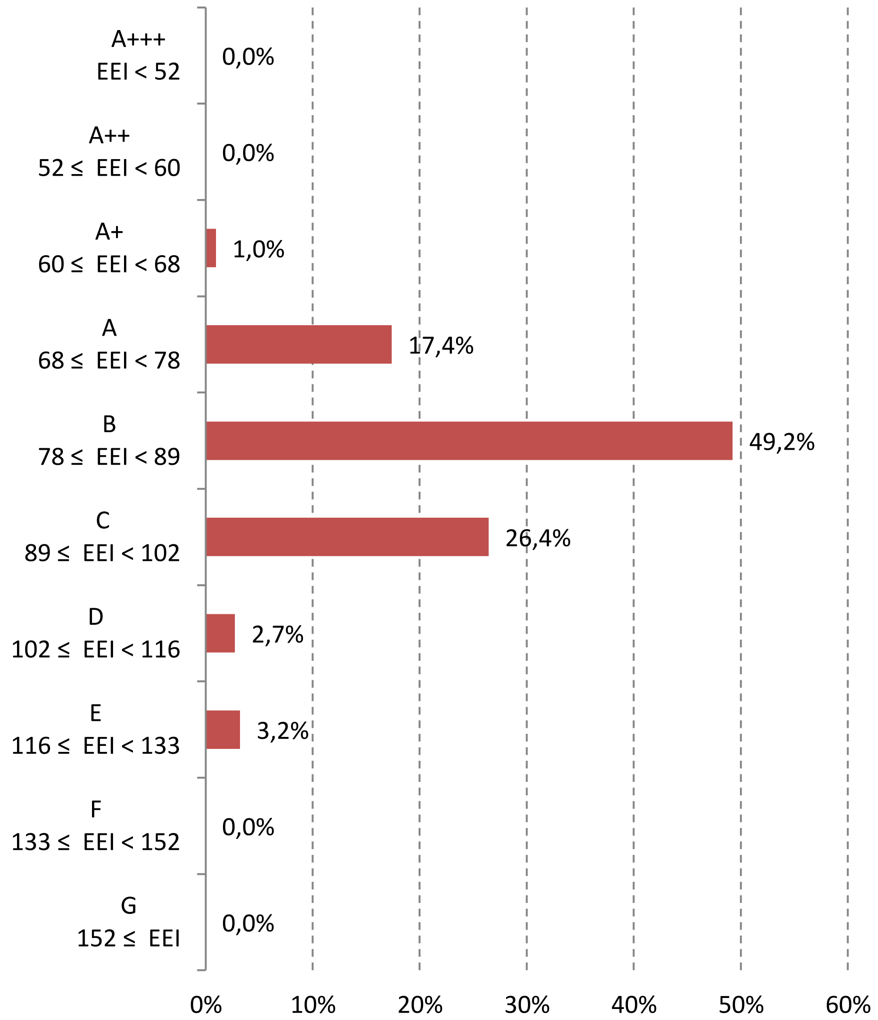


Figure 8-9: Gas ovens: Percentage of models per energy class

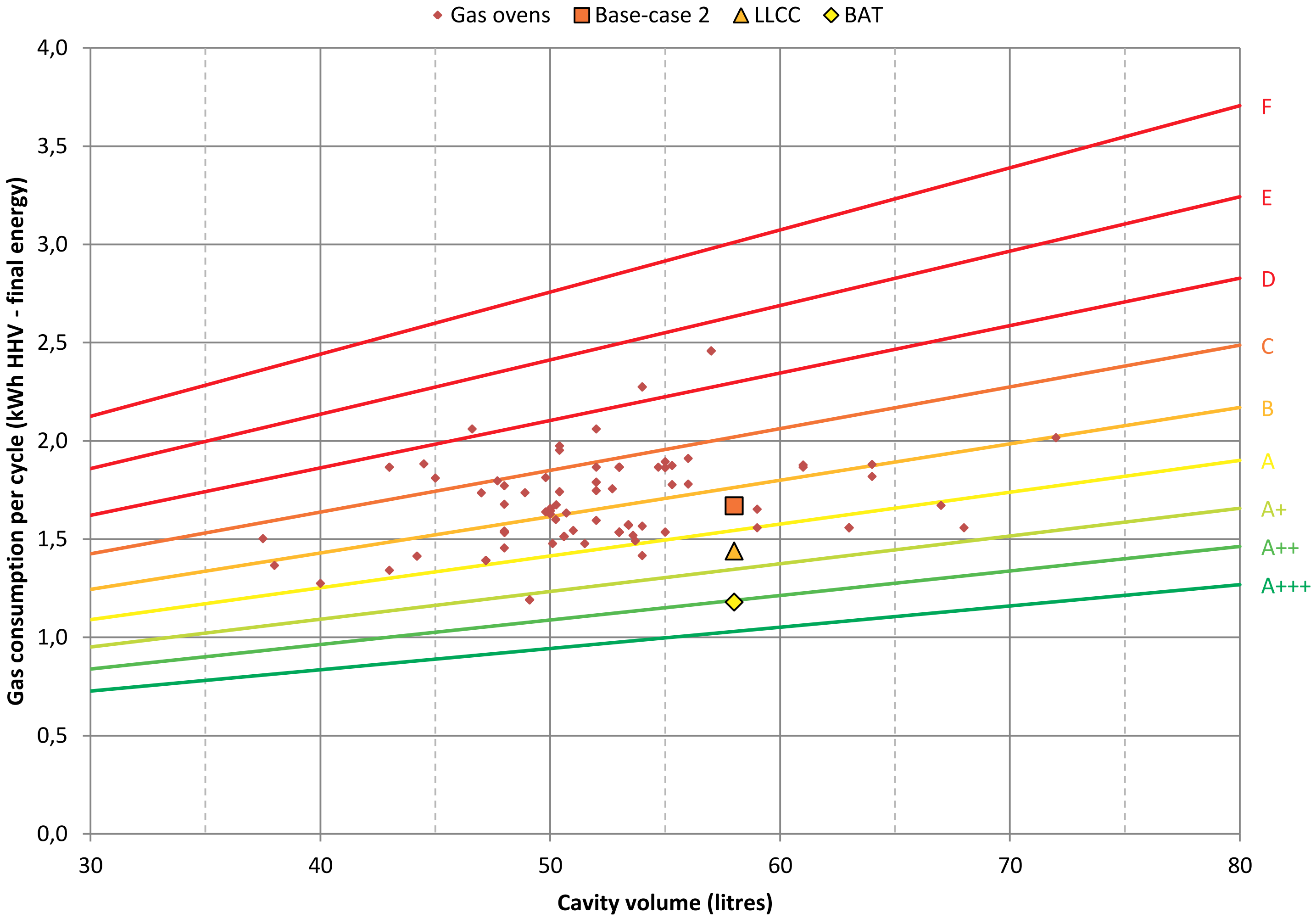


Figure 8-10: Proposed energy classes for gas ovens

Approach 2: Common energy classes

Approach 2 is in line with previously proposed EC labelling measures for appliances working with electricity or gas and offers a common labelling scheme where electricity consumptions are converted into primary energy using a conversion factor of 2.5. Energy consumption of electric and gas ovens are currently measured using different test standards, and while there are some similarities in the protocols, they are not identical. Therefore, if common energy classes are chosen, a harmonized test standard would be needed. However, in order to have an idea of the distribution of the ovens if common energy classes were used, energy consumptions in CECED database were converted into primary energy.

For gas ovens using both gas and electricity, both energy consumptions were included. Only the energy consumption of the most efficient heating function was used to calculate the EEI for multifunction ovens. Figure 8-11 presents the primary energy consumption of electric and gas ovens on a same graph according to their volume.

Energy classes are defined according to an Energy Efficiency Index as calculated with the following formula:

$$EEI = \frac{EC}{SEC} \times 100 \qquad SAEC = c_1 \times V + c_2$$

With c_1 = 0.0207 kWh/l and c_2 = 1.156 kWh

The thresholds between energy classes are presented in Table 8-5. The gap between two classes was set at 13%, and thresholds were rounded to the closest integer to ease the determination of energy class.

Table 8-5: Suggested energy efficiency thresholds for approach 2

Energy Efficiency Class	Energy Efficiency Index	delta
A+++	EEI < 43	
A++	43 ≤ EEI < 50	14.0%
A+	50 ≤ EEI < 57	12.3%
A	57 ≤ EEI < 66	13.6%
B	66 ≤ EEI < 76	13.2%
C	76 ≤ EEI < 87	12.6%
D	87 ≤ EEI < 100	13.0%
E	100 ≤ EEI < 115	13.3%
F	115 ≤ EEI < 132	12.9%
G	EEI ≥ 132	

The thresholds have been defined so that the most efficient electric ovens are class B. Indeed, if consistency with the existing label was kept, there would not have been enough energy classes on top of A to allow a good differentiation of ovens.

As visible on Figure 8-14, the most efficient gas ovens are class A+, leaving room for improvement, as gas ovens have not been covered by a label until now. Base-case 1 (domestic electric oven), currently class C, would become class F. The average product sold presented in Task 7, currently class B, would be class D (see point BC1-AS). The LLCC products for domestic electric ovens would also be class D, and the BAT product would be class C. Base-case 2 (domestic gas oven) would be class B, while the LLCC product would be class A and the BAT product would be class A+. Figure 8-13 presents the percentage of models from CECED database in each class.

As only two electric ovens reach class B, it would be technically very difficult to achieve class A for the time being, especially at acceptable cost. Consequently, it is likely that manufacturers will not be encouraged to improve their electric ovens, at least not as much as in the case of a specific label for electric label, which would be defined in order to foster the energy efficiency of these ovens. A common labelling would also give wrong signals to the consumers as more improvement potential would seem possible with electric ovens than with gas ovens, although significant improvements have already been integrated within electric ovens, thanks to the existing energy label.

A solution to this issue could be to consider an extended product approach, taking into account the energy requirements to ensure proper ventilation that is necessary for gas ovens.

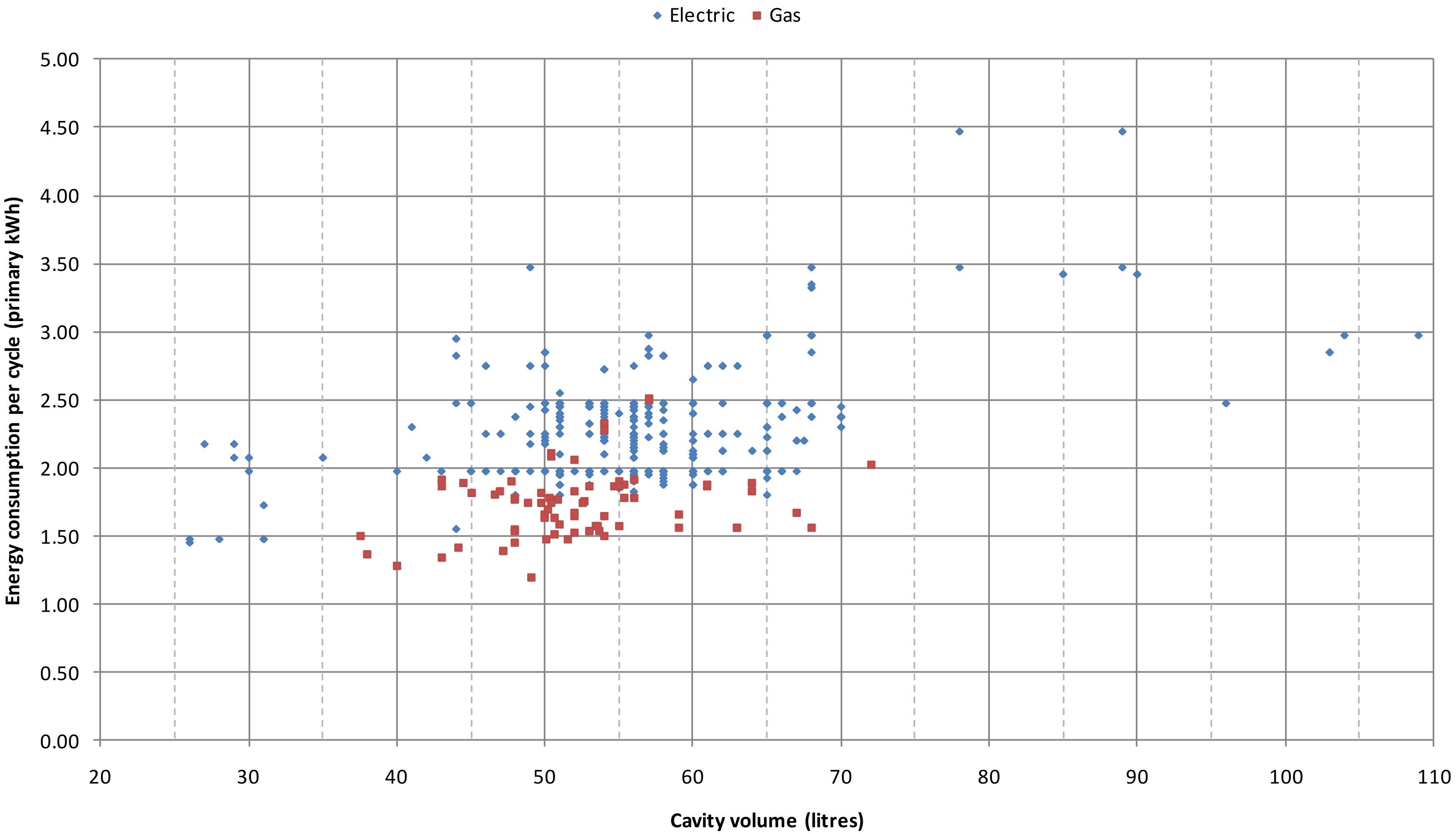


Figure 8-11: Annual energy consumption of electric and gas ovens (CECED, 2009) – red dots gas, blue dots electric

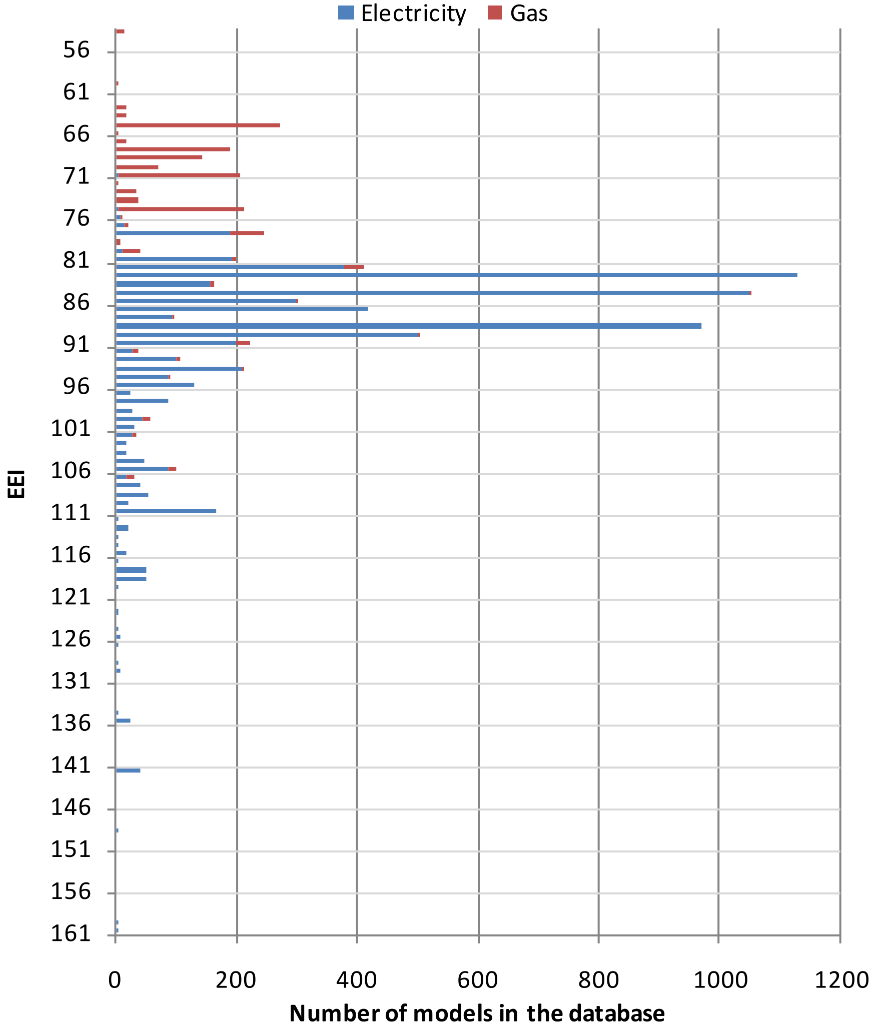


Figure 8-12: Common labelling: Number of models per EEI

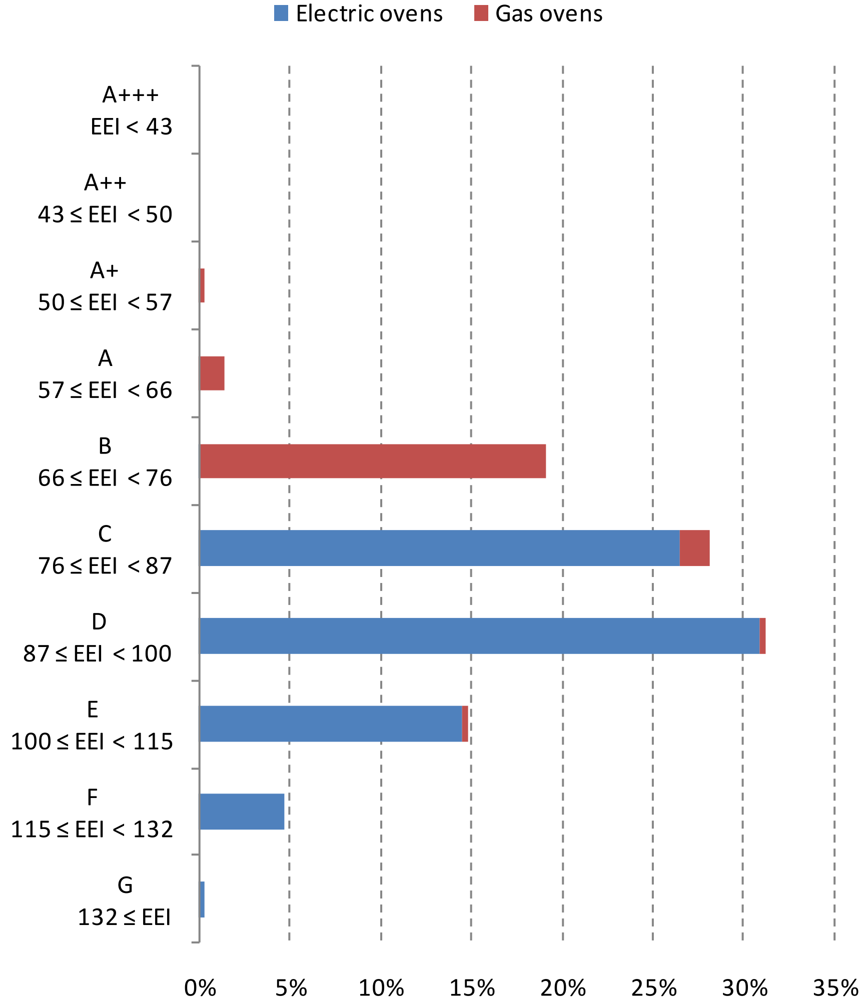


Figure 8-13: Common labelling: Percentage of models per energy class

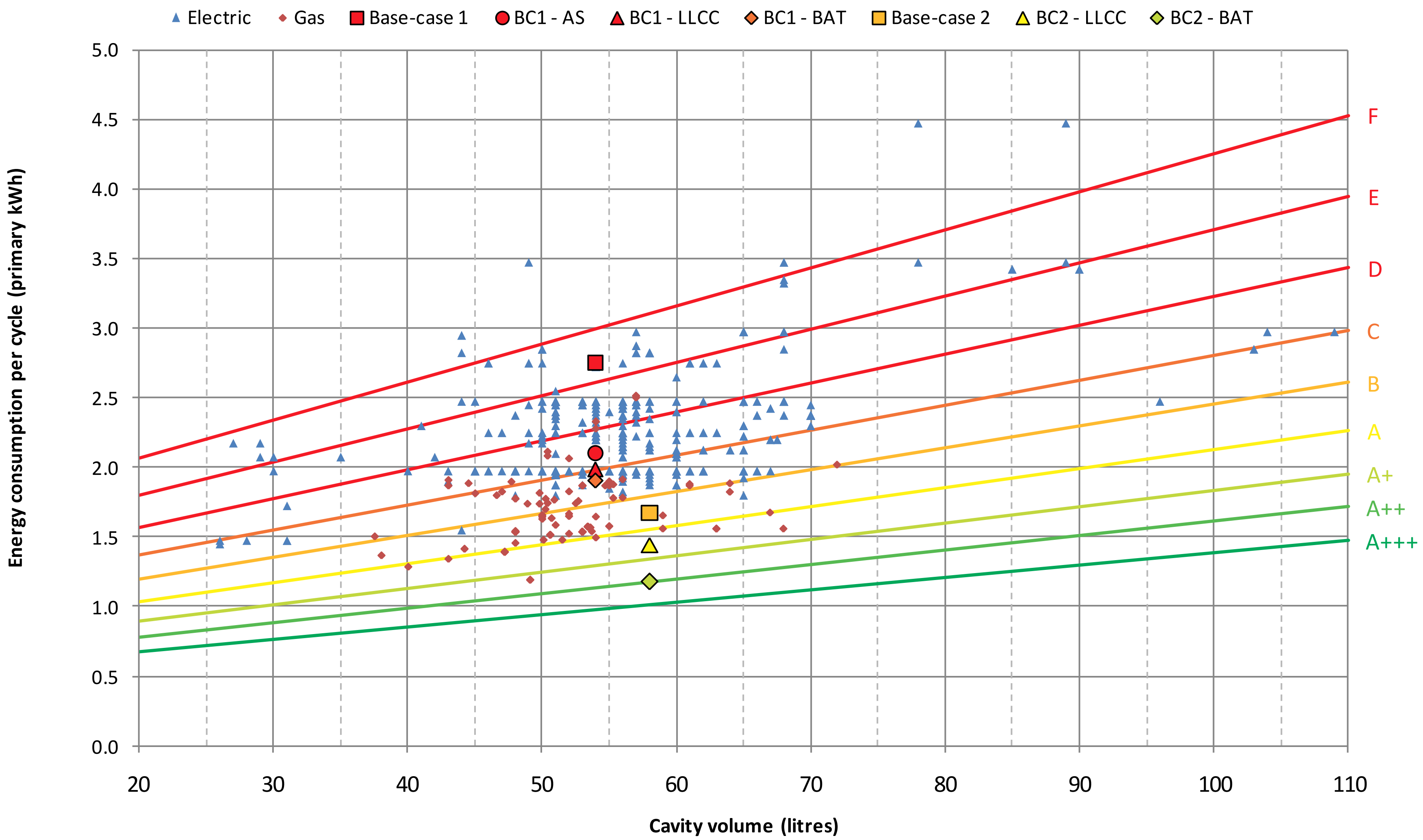


Figure 8-14: Common energy classes for electric and gas ovens

COMPARISON OF THE TWO APPROACHES

Approach 1: Separate energy classes	Approach 2: Common energy classes
Requirements	
	✓ For a fair comparison, harmonisation is required between EN 50304/60350:2009 (electric ovens) and EN 15181:2009 (gas ovens). ✓ Consistency with previous EC labelling work for other electricity/gas appliances.
Advantages	
✓ Consistency with the existing label for electric ovens. ✓ Improvement will be fostered in each domestic oven category.	✓ Possibility for consumers to compare different appliances using different energy sources. ✓ Only solution which allows covering appliances using both gas heating and electric resistances, which are out of the scope of the current standards.
Drawbacks	
✓ No possibility for consumers to compare products which use different energy sources but are used for the same purpose. ✓ During the first years, there will be some electric ovens rated A+, while gas ovens will be limited to A. Consumers could think incorrectly that an A+ electric oven uses less energy than an A gas oven.	✓ No consistency with the existing label for electric ovens. ✓ Energy consumption should be displayed in the same unit as on the energy bills, which is kWh both for electricity and gas. For consumers, there will be no obvious link between the energy class and the energy consumption figures displayed: e.g. consumers might be confused seeing a gas oven consuming 1.5 kWh of gas being better rated than an electric oven consuming 0.8 kWh of electricity. This could be avoided if the primary energy consumption was also displayed, but consumers are unfamiliar with this concept.
Challenges	
✓ How to promote the use of gas appliances, which are more primary energy efficient? ✓ In order to avoid irrelevant comparison between electric and gas ovens, additional information should be provided to consumer via manufacturers' website, booklets and retailers.	✓ A fair comparison can only be made if the test standards are compatible. It is still to be investigated whether the standards can be harmonized or not. ✓ Taking into account required external energy consumption for different energy sources (extended product approach). ✓ This common labelling will bring about more primary energy savings only if it results in a switch towards more gas ovens. Will a label promoting gas appliance be sufficient to invert the current tendency?

8.2.2.5. Specific ecodesign requirements: Minimum Energy Performance Standards (MEPS)

MEPS may be a relevant option to remove the least efficient appliances from the market. MEPS could be considered in the form of a "Tier 1" and "Tier 2" requirements. "Tier 1" could apply from 2014 onwards while "Tier 2" from 2018 onwards, and would enable to keep the most ambitious targets as a final goal. By that time, standards can be revised and new technologies may become available. The advantage of defining "Tier 2" now would give a clear signal regarding the direction in which the market should be heading.

The MEPS proposals have been made based on the analysis of the models in CECED's database conducted in section 8.2.2.3 and the EEI thresholds that were previously identified in Approach 1. The use of LLCC options as Tier requirements is usually relevant when determining MEPS, but it was not applied in these cases as the impacts on the current stock would strongly affect the manufacturers (76% and 98% of the current stock would be respectively removed for domestic electric and gas ovens). Table 8-6 describes the values of MEPS for "Tier 1" and "Tier 2".

Table 8-6: Proposals for MEPS by product categories

	Tier 1 (2014)	Tier 2 (2018)
Domestic electric ovens	EEI < 77 (Class B or higher)	EEI < 67 (Class A or higher)
Domestic gas ovens	EEI < 102 (Class C or higher)	EEI < 89 (Class B or higher)
Domestic microwave ovens – solo and with grill	EC ≤ 0.058 kWh	EC ≤ 0.056 kWh
Domestic microwave oven – combination ovens[7]	EC ≤ 0.060 kWh	EC ≤ 0.056 kWh

EEI: Energy Efficiency Index / EC: Energy Consumption per Cycle

Setting a minimal EEI of 77 for domestic electric ovens would remove from the market the 11% of the least efficient electric ovens, as visible on Figure 8-4. However, this database refers to 2009, and by 2014, it is likely that much fewer ovens will be lower than class A. The EEI for the LLCC product is 62.

Setting more ambitious MEPS would leave only very few energy classes. Manufacturers believe indeed that it will be technically very challenging for domestic electric ovens to

[7] Combination microwave ovens - whose primary heating function is microwave heating - are not covered by the Base-case for domestic microwave oven. Therefore, these MEPS proposals are only based on the data provided by CECED.

reach class A+++. Moreover, it could result in banning most low-end products (low price), which would not be beneficial for consumers.

For domestic gas ovens, excluding classes D, E, F and G would remove from the market 5.9% of the models in CECED database (2009). The Base-case is class B, with an EEI of 84. The LLCC product for domestic gas ovens is class A (EEI = 72). The BAT product is class A++, its EEI being just above 59. Excluding class C can be considered once the market switched towards more efficient appliances (Tier 2 requirement).

Furthermore, the relevance and feasibility for gas ovens which have standby mode and/or off-mode to not exceed the power consumption in these modes as specified in the Standby Regulation (1275/2008).

Regarding microwave ovens, a Tier 2 requirement of 0.056 kWh/cycle (corresponding to the LLCC of the base-case) is suggested. A Tier 1 requirement is also proposed as a mid-term target. That threshold could be different depending on the heating functions of the microwave oven. Therefore, a combination oven whose primary heating function is microwave heating has a Tier 1 requirement of 0.060 kWh/cycle. That primary cooking function is to be defined by the manufacturer.

8.2.2.6. BENCHMARKING

Benchmarks could also be considered, although the role of benchmarking under the Ecodesign Directive is less clear than the other measures described above. Benchmarks are non-binding for manufacturers but could also support product innovation and development prior to any other policy options. It would also allow the evaluation of the environmental performance achieved by a new product against the best-performing products available on the EU market at the time when the Regulation is published.

In particular, by the time that the present Ecodesign preparatory study was completed, new consumption data on domestic electric ovens was released (early 2012) and revealed energy consumptions lower than what was identified as BAT scenario in Task 7 (although data were only available for volumes of 65-74 L, compared to 52L of BC1).

Benchmarks could be specified by the European Commission in a Ecodesign Regulation based on the information provided in this study, more recent database and any harmonised standards that are developed. It might be possible to implement a well-chosen and widely disseminated set of benchmark products even more quickly than energy labels.

8.2.3. OVENS USED IN RESTAURANTS

Commercial combi-steamers (combination ovens) have been identified as the type of oven representing the highest share in sales of restaurant ovens. As a result, specific ecodesign requirements regarding ovens used in restaurants will be focused on these appliances. Generic recommendations can also apply to the other types of commercial ovens.

8.2.3.1. Proposed exact product definitions and scope for policy measures

In the EFCEM energy efficiency draft standard for commercial combination ovens, the following definition is given:

Commercial combination oven: Appliance in which the following methods of cooking and processing of food can be undertaken: baking, blanching, frying, steaming, broiling, conserving, soaking, reclaiming, toasting, au gratin, and cooking of cuisson sous vide. Following predefined operating modes can be distinguished during cooking or preparing:

- *Convection using hot air,*
- *Low-temperature steam (NT-steam) in moist, saturated air,*
- *Steam in a non-pressurized atmosphere.*
- *Combined cooking in a mixture of hot air and water steam*

The cooking and preparing process are running successively or alone as set in the program setting without interrupting the cooking process. The heating-up air or steam in the cooking chamber takes place through the contact with water coverage surfaces, like e.g. radiators. A turnover through fans takes place and a mixing with hot fumes is debarred.

This definition will be used in this section.

8.2.3.2. Generic ecodesign requirements

The energy consumption of restaurant ovens highly depends on the user behaviour. In the booklet supplied with the oven, most manufacturers include recommendations on settings for some typical meals (temperature, time, etc.). The aim of this information is to ensure that users will achieve the best food quality. In addition to this information, recommendations on energy efficiency should be provided:

- Users should be encouraged to use their oven at full-load.
- Moreover, users should be warned about the energy wasted to maintain temperature between two cooking cycles. As shown in the previous task, this represents a significant share of the annual energy consumption. The booklet should include information about the time needed for a typical heating-up phase.
- Maintenance has also an impact on energy efficiency. Recommendations regarding maintenance are usually related to safety. It could be complemented by information on the influence of maintenance on energy efficiency.

For ovens with electronic control, making mandatory an auto standby feature could be considered. An oven would be turned into the standby mode automatically after some time. As this feature can potentially hinder users, it could be configured in order to adapt to their needs, and eventually disabled. However, it would be activated by default, and estimated savings that can be achieved should be highlighted in the documentation supplied with the oven.

8.2.3.3. Specific ecodesign requirements: Minimum Energy Performance Standards (MEPS)

MEPS would remove from the market the appliances which are the less energy efficient. MEPS could be considered in the form of a "Tier 1" and "Tier 2" requirements. The duration between the two requirements must take into account the specificity of the commercial sector, which is very different from the domestic one. Manufacturers have usually a few series of appliances, which are renewed every 5 to 8 years depending on the manufacturer. Therefore, if targets are too close in time, manufacturers will have to comply with the most ambitious directly.

Prior to setting any MEPS, an EN standard for measuring the energy efficiency of commercial combination ovens must be available. A draft standard is currently being developed by EFCEM, but is not yet finalised. Therefore, the first requirement should not be set before 2014.

A specificity of this market is that Rational, which produces energy-efficient combi-steamers, represents more than 50% of the EU market. The Base-cases for combi-steamers were defined to be representative of their appliances, but there are other smaller manufacturers which could produce less efficient products. MEPS aim at removing from the market the least efficient appliances. it is possible that if MEPS are too ambitious initially, although they may remove only a small number of models from the market these could be made by a significant proportion of oven manufacturers which could cause competition issues. As we have no real oven consumption data, we do not know what will be the effect of MEPS. Consequently, the limit for "Tier 1" was set to a level of performance of around 3% less efficient than the Base-case.

"Tier 2" will be set as a minimal target to reach for the next redesign, and should therefore be much more ambitious. As "Tier 2" would be effective only in 2018, their level has been set levels close to the current LLCC identified in Task 7. For commercial electric combi-steamers, the LLCC product was also the BAT appliance. Moreover, combi-steamers are usually built on the same basis independently of their energy source. Therefore, modifications on a common component such as the door or the cavity insulation would be applied to all models.

MEPS can only be defined after the elaboration of a European standard for measuring the energy consumption of commercial combination ovens. The levels defined Table 8-7 are only indicative. Therefore, it should be considered with caution.

Table 8-7: Proposal of MEPS for 10 GN 1/1 commercial combination ovens (in on-mode)

Appliance	Unit	Base-case	Tier 1 (2014)	Tier 2 (2018)
Commercial electric combination oven	kWh electricity per cycle – final energy	4.20	4.33	4.00
	kWh electricity per year – final energy	9,266	9,510	9,016
Commercial gas combination oven	kWh natural gas (HHV) per cycle	5.40	5.56	5.10
	kWh natural gas (HHV) per year	11,887	12,187	11,590

Combi-steamers are available in different sizes. Most ovens sold are between 6 GN 1/1 and 20 GN 1/1. These MEPS should be modulated according to the appliance's capacity. Establishing a relationship between capacity and energy consumption is difficult. Once an EN standard for measuring energy consumption is available, a representative sample of ovens should be tested in order to determine a relationship between capacity and energy consumption.

Gas combination ovens are also consuming electricity, to power electronic components, lights, pumps and fans. MEPS proposed in Table 8-7 apply only to the gas consumption. They could also be defined to limit the primary energy consumption of the appliance, by converting electricity into primary energy, using a conversion factor.

Finally, setting minimum performance regarding the energy consumption in standby/off mode can be discussed, as commercial appliances are excluded from the scope of the "Standby" Regulation No 1275/2008. For commercial combi-steamers, energy consumption in standby/off mode is very low compared to energy consumed for heating the cavity (in the analysis carried out in this study, it was neglected). Moreover, the savings at EU level would be very low: if 3W were saved on every appliance in stock, it would result in 8.6 GWh of electricity, which is only 0.20% of the annual primary energy consumption of combi-steamers (see Table 8-8).

Table 8-8: Estimation of the maximum energy savings that could be achieved by reducing standby power of commercial combi-steamers

Parameter	Value	Unit
Stock of combi-steamers in the EU in 2007	480,000	Units
Standby power reduction	3	W
Time cooking per year	2808	hours
Time in standby per year	5952	hours
Annual electricity savings due to standby reduction	8.6	GWh/year
Annual primary energy savings due to standby reduction	90	TJ/year

Primary energy consumption of combi-steamers in the EU in 2007 (see section 5.4.2 in Task 5)	44,500	TJ / year
Share savings	0.20%	

More importantly, limiting the energy consumption in standby could affect the features linked to software control, which are one of the main improvement perspectives, resulting in an actual increase in the total energy consumption.

In conclusion, limiting standby power for commercial combi-steamers would result in very low energy savings, and could even be counterproductive.

8.2.3.4. Specific ecodesign requirements: Policy recommendations for labelling and incentives

A. Information to consumers

Similarly to domestic appliances, implementing an energy label for commercial ovens could be a solution to promote more energy efficient appliances. However, buying commercial equipment is different from buying a domestic oven in a shop. It is a more considered decision, where customers often make several estimates to choose the products which fit better their specific needs. Therefore, an energy label with energy classes and generic information is likely not to be the most relevant solution to improve the energy efficiency of commercial combination ovens.

Information about commercial ovens is usually provided by manufacturers through a technical sheet, describing different parameters such as capacity, power requirements or external dimensions. Once a European standard for measuring the energy efficiency of commercial appliances is available, it would be possible to make compulsory for manufacturers to inform users about how much energy their product is consuming according to this standard.

The following information should be provided on the technical sheet:

- Energy consumption according to the standard, for each cooking modes covered by the standard. For appliances using several energy source, energy consumption should be specified for each energy source.
- Water consumption for the cooking modes requiring it.
- Information on the representativeness of these consumptions: A study by CETIM showed that the wet brick test used in the current EFCEM draft standard under-estimates the actual energy consumption for cooking real food in steam modes. Moreover, as explained throughout this study, the energy used by an oven heavily depends on how it is used. Standards can only be representative of a typical use of an oven. However, users from the commercial sector may have an intense use of the oven in a mode that is not covered by the standard (e.g. smaller loads, shorter times, etc.). For these users, an oven with a lower performance in standard conditions could be more

efficient. Therefore, users should be informed on the representativeness of this energy consumption figure.

- Information on the availability of energy saving features, such as automatic standby feature.

B. Green Public Procurement (GPP)

Public procurement accounts for a large share of EU GDP and has a key role to play in market transformation by favouring products with the least environmental impact. Both environmental and cost criteria are important in any purchasing decision, and care must be taken that neither criterion is given undue weight. In the context of this study, an appropriate approach might be to consider putting in place more ambitious requirements for public procurement than the ones put in place for the rest of the market (see Table 8-9). Thus, all public buildings (e.g. hospitals, schools, etc.) could help drive the market towards more efficient appliances, as they represent a significant share of the markets concerned. These limits could be revised after some years.

Table 8-9: Minimum Energy Performance for public procurement

Appliance	Unit	Base-case	Minimum energy performance for public procurement (2014)
Commercial electric combination oven	kWh electricity per cycle – final energy	4.20	4.09
	kWh electricity per year – final energy	9,266	9,110
Commercial gas combination oven	kWh natural gas (HHV) per cycle	5.40	5.30
	kWh natural gas (HHV) per year	11,887	11,750

For electric combination oven, the level for GPP corresponds to the option Scenario A presented for Base-case 4 in Task 7, which has one of the lowest life-cycle costs. For gas combi-steamers, the level corresponds to Scenario A for Base-case 5, which is the LLCC product.

According to the statistics on restaurant industry presented in section 2.2.2.2 of Task 2, around 40% of the meals served in restaurants in EU are served in institutional restaurants. In public contracted catering, the equipment is usually owned by the institution, and only run by the contractor. As a raw estimate, the public sector could represent around 30% of the sales of commercial combination ovens.

According to calculations made using the Scenario tool presented in section 8.3. , this measure would save 800 TJ (primary energy), which represents 0.11% of the primary energy consumption due to combi-steamers in the EU. Moreover, the energy savings made would save 4.7 million Euros on the period 2014-2025 (0.02% of the expenditure on the same period).

C. Benchmarking

Benchmarks could also be considered, although the role of benchmarking under the Ecodesign Directive is less clear than the other measures described here. Benchmarks are non-binding for manufacturers but would allow the evaluation of the environmental performance achieved by a new product against the best-performing products available on the EU market at the time when the Regulation is published.

Benchmarks could be specified by the European Commission in an Ecodesign Regulation based on the information provided in this study and any harmonised standards that are developed. It might be possible to implement a well-chosen and widely disseminated set of benchmark products even more quickly than MEPS.

Another complementary option is to foster the use of fleet average, in order to encourage awareness raising and comparison between commercial appliances.

8.2.4. Ovens used in Bakeries

In this section, policy recommendations are made in regards to ovens used in bakeries, such as in-store convection ovens, deck ovens and rotary rack ovens. It was difficult to gather data representative of the EU market for this type of oven. First, there is no European association regrouping bakery oven manufacturers. Only a few bakery oven manufacturers were involved in this study and always specified that the information they provided was only relevant for their own market, and not necessarily for the EU. Moreover, the use of bakery ovens varies a lot across Member States, being heavily dependent on the traditions regarding bread and pastries. Consequently, conclusions regarding bakery ovens should be considered cautiously compared the ones on the other type of ovens.

8.2.4.1. Proposed exact product definitions and scope for policy measures

The definition of a bakery oven according EN 203-2-2 is the following:

> *Oven designed exclusively for the cooking of bread, cakes and pastries. It can receive the products to be cooked by an intermediate, fixed or rotating trolley in the cooking chamber, placed on sole plate or on grid shelf or on plates in the different cooking chambers of the oven (in case of sole plate oven).*

Definitions specific to each type of bakery ovens should be made before any regulation. More detailed definitions might be found in the following standards:

- EN 1673:2000+A1:2009: Food processing machinery - Rotary rack ovens - Safety and hygiene requirements

- DIN 18854-2003: Equipment for commercial kitchens – Multiple deck ovens – Requirements and testing
- DIN 18866: Equipment for commercial kitchens - Convection ovens and convection steamers - Requirements and testing

Deck ovens and rotary rack ovens are used both for Business-to-business and Business-to-consumer purposes. The scope of this study was limited to commercial ovens. An estimation of the stock of ovens used for commercial purpose was therefore carried out in Task 2 (see section 2.2.3.1). Conclusions regarding bakery ovens therefore concern only commercial ovens. However, in the case of rack ovens, the models used in factories are very similar. In the industry, a series of small rack ovens is usually preferred to bigger ovens, for flexibility. Moreover, some manufacturers claim that there is no clear difference between a rotary rack oven used for commercial purpose and for industrial purpose. Concerning deck ovens, there is more visible difference between the smaller ones used in commercial bakeries, and the bigger ones used in the industry. Finally, reusing heat outside of the baking process is worthwhile in the industry, while it is not always possible in commercial bakeries.

As a result, a regulation covering both commercial and industrial rotary rack ovens could be considered, while only deck ovens used for commercial purpose should be covered.

To determine if an oven is for commercial purpose or for industrial purpose, several options are possible:

- Intended use: Manufacturers could declare the intended use of the oven. It would be the simplest solution, but if regulation is covers only commercial ovens, manufacturers could avoid it by declaring that it is intended for industrial use.
- Limit on a technical parameter: A threshold on a parameter such as baking surface area, weight of dough that can be baked or power input could be used. Above a certain limit, ovens would be considered as industrial.

These points need to be further discussed with the relevant stakeholders and the European Commission, in order to find the best solution leading to a reduction of the environmental impacts of bakery ovens.

8.2.4.2. GENERIC ECODESIGN REQUIREMENTS

Generic ecodesign requirements for bakery ovens can be similar to the ones for restaurant ovens. Recommendations regarding energy efficiency should be included in the documentation provided with the ovens:

- Users should be encouraged to use their oven at full-load.

- Users should be warned about the energy consumed to maintain temperature between two baking cycles. As shown in the previous task, this represents a significant share of the annual energy consumption.
- Maintenance has also an impact on energy efficiency. Recommendations regarding maintenance are usually related to safety. It could be complemented by information on the influence of maintenance on energy efficiency.

For ovens with electronic control, making mandatory an auto standby feature could be considered. An oven would be turned into the standby mode automatically after some time. As this feature can potentially hinder users, it could be configured in order to adapt to their needs, and eventually disabled. However, it would be activated by default, and estimated savings that can be achieved should be highlighted in the documentation supplied with the oven.

8.2.4.3. Specific ecodesign requirements: Minimum Energy Performance Standards (MEPS)

MEPS would remove from the market the appliances which are the less energy efficient. MEPS could be considered in the form of a "Tier 1" and "Tier 2" requirements. As for restaurant ovens, manufacturers have usually a few series of appliances, which are renewed every 5 to 8 years depending on the manufacturer. Therefore, if targets are too close in time, manufacturers will have to comply with the most ambitious directly.

Prior to setting any MEPS, an EN standard for measuring the energy efficiency of commercial bakery ovens must be available. Currently, a DIN standard is being developed in Germany for multiple deck ovens, which could be submitted to EN standardisation committees. In France, a measurement protocol is also under preparation. For the other types of bakery ovens, no information about a standard is available, but all the manufacturers who contributed to this study are willing to develop a common standard in order to be able to compare their appliances.

MEPS can only be defined after the elaboration of a European standard for measuring the energy consumption of commercial combination ovens. The levels defined Table 8-7 are only indicative. "Tier 1" corresponds to the energy consumption of the LLCC product identified in Task 7, for the appliances where the base-case and the LLCC show a difference in energy consumptions which is below 5%, a percentage which is considered as reasonable to avoid asking too much efforts from manufacturers in short delay to make such improvement in their products. That is the case for the electric in-store convection oven and the rotary rack ovens (both electric and gas).No "Tier 2" is currently foreseen for such products, as any recommendations beyond the LLCC may economically challenge the consumers. For the deck ovens, "Tier 1" energy consumption corresponds to a 5% saving compared to the base-case, while "Tier 2" corresponds to the LLCC product. This preliminary approach should be considered with caution.

Table 8-10: Proposal of MEPS for bakery ovens (in on-mode), NA: not applicable

Appliance	Baking Surface Area	Unit	Base-case	Tier 1 (2014)	Tier 2 (2018)
Electric in-store convection oven	1.0 m²	kWh electricity per cycle – final energy	2.500	2.425	NA
		kWh electricity per year – final energy	12.500	12,125	NA
Electric deck oven	4.5 m²	kWh electricity per cycle – final energy	25.2	24.0	23.0
		kWh electricity per year – final energy	47,174	44,815	43,056
Gas deck oven	4.5 m²	kWh natural gas (HHV) per cycle	32.8	31.2	28.7
		kWh natural gas (HHV) per year	61,402	58,300	53,726
Electric rotary rack oven	7.5 m²	kWh electricity per cycle – final energy	25.5	25.2	NA
		kWh electricity per year – final energy	71,100	70,290	NA
Gas rotary rack oven	7.5 m²	kWh natural gas (HHV) per cycle	28.0	26.8	NA
		kWh natural gas (HHV) per year	78,345	75,105	NA

These MEPS should be modulated according to the appliance's capacity. Establishing a relationship between capacity and energy consumption is difficult. Once an EN standard for measuring energy consumption is available, a representative sample of ovens should be tested in order to determine a relationship between capacity and energy consumption.

Finally, setting minimum performance regarding the energy consumption in standby/off mode can be discussed, as commercial appliances are excluded from the scope of the "Standby" Regulation No 1275/2008. Most bakery ovens are used even more intensively than restaurant ovens. It is likely that the energy consumption in standby/off mode will also be negligible. Therefore, limiting standby power for bakery ovens would result in very low energy savings, and could even be counterproductive, as it could limit the features related to software control.

8.2.4.4. Specific ecodesign requirements: Policy recommendations for labelling

Similarly to restaurant ovens, an energy label with energy classes and generic information is likely not to be the most relevant solution to improve the energy efficiency of bakery ovens.

Information about commercial ovens is usually provided by manufacturers through a technical datasheet, describing different parameters such as capacity, power requirements or external dimensions. Once a European standard for measuring the energy efficiency of commercial appliances is available, it would be possible to make compulsory for manufacturers to inform users about how much energy their product is consuming according to this standard.

Moreover, as for restaurant ovens, benchmarks could also be specified by the European Commission in an Ecodesign Regulation based on the information provided in this study and any harmonised standards that are developed. They are non-binding for manufacturers but would allow the evaluation of the environmental performance achieved by a new product against the best-performing products available on the EU market at the time when the Regulation is published. Proposed policy actions related to Best Not Yet Available Technology (BNAT)

Information on BNATs was very difficult to obtain from manufacturers and there is a lack of independent research. However, it does not seem appropriate to recommend any specific policy support for R&D in this area as it would be difficult to show the additionality of such funding compared to what companies are already doing in these competitive markets.

8.3. SCENARIO ANALYSIS

An Excel tool was created to allow the impacts of different scenarios to be modelled (2010-2020 and 2010-2025). The tool was designed quite simply and relies on the following assumptions:

- The model is built on a discrete annual basis to match the available data.
- Sales and stock forecasts detailed in Task 2 were used as input.
- Primary energy consumption[8] was judged to be the most relevant and representative indicator to be modelled using the tool and also to allow comparing savings with other Ecodesign Lots. The tool calculates the expenditure in Euros and primary energy in GJ related to domestic ovens, under different policy scenarios. The primary energy results are not limited to the use phase, but take into account the energy required over the whole lifetime (including the

[8] Primary energy consumption was calculated using the EcoReport tool, assuming 1 kWh of electricity requires 10.5 MJ of primary energy (conversion factor: 2.917).

manufacturing, distribution and end-of-life phases). These primary energy consumptions are based on the result of the previous tasks. Therefore, 1 kWh of electricity is converted into 10.5 MJ of primary energy (conversion factor: 2.917).

- Energy consumption is allocated uniformly over the lifetime of the product although in theory this is only true for the use phase. Given the low shares of other life cycle phases in energy consumption (see Task 5), this assumption is considered reasonable in order to carry out the analysis; a more "realistic" modelling would not make a significant difference to the overall results.
- Expenditure measures the yearly value of the entire market. It consists of the money spent to buy the product (purchase price), taken into account at the time of purchase, and the operating costs (energy, water, maintenance and repair), which are spread over the lifetime of the machine.

In the following subsections, four scenarios are described: BAU, reflecting the natural evolution of the market if no new policy is adopted; Least Life-Cycle Cost (LLCC) scenario, which assumes that the LLCC options for all product categories are implemented from 2014; Best Available Technology (BAT) scenario, which assumes that the BAT options are implemented from 2018 (ideally, that would be the medium-term target). Additionally, the All-gas scenario assumes all domestic electric ovens are replaced by gas ovens starting in 2018. This last scenario is analysed with the only purpose of estimating the maximum primary energy savings that could be theoretically achieved. This does not mean that any recommendation on banning electric ovens is made to the European Commission, especially if a more-renewable-electricity EU scenario is to be envisaged with the benefit of decarbonising the whole European power production.

Scenarios are compared to the BAU scenario in order to estimate the overall potential of the improvement options. Most of the description in the sections below refers to 2025 for comparison.

8.3.1. Domestic ovens

Market data used for domestic ovens is presented in Table 8-11. "New" corresponds to the number of appliances sold to consumers who are not replacing an oven which reached its end-of-life. It corresponds to the stock increase.

Table 8-11: Market data of the scenario tool for domestic ovens

Year	Unit	BC1	BC2	BC3
2007	Stock	145,000,000	50,000,000	124,843,846
	Sales	8,991,084	2,183,426	13,871,538
	New	750,000	-250,000	1,498,126
	End-of-life	8,241,084	2,433,426	12,373,412
2008	Stock	145,750,000	49,750,000	126,341,972
	Sales	9,045,619	2,157,225	14,176,712
	New	764,500	-248,750	1,516,104
	End-of-life	8,281,119	2,405,975	12,660,609

Year	Unit	BC1	BC2	BC3
2009	Stock	146,514,500	49,501,250	127,858,076
	Sales	9,101,130	2,131,339	14,488,600
	New	779,075	-247,506	1,534,297
	End-of-life	8,322,055	2,378,845	12,954,303
2010	Stock	147,293,575	49,253,744	129,392,373
	Sales	9,157,622	2,105,762	14,807,349
	New	896,954	-246,269	646,962
	End-of-life	8,260,668	2,352,031	14,160,387
2011	Stock	148,190,529	49,007,475	130,039,335
	Sales	9,215,102	2,080,493	14,970,230
	New	922,167	-245,037	650,197
	End-of-life	8,292,935	2,325,531	14,320,033
2012	Stock	149,112,696	48,762,438	130,689,532
	Sales	9,273,576	2,055,527	15,134,903
	New	947,486	-243,812	653,448
	End-of-life	8,326,090	2,299,340	14,481,455
2013	Stock	150,060,182	48,518,625	131,342,979
	Sales	9,333,052	2,030,861	15,301,386
	New	972,917	-242,593	656,715
	End-of-life	8,360,135	2,273,454	14,644,672
2014	Stock	151,033,099	48,276,032	131,999,694
	Sales	9,393,536	2,006,491	15,469,702
	New	998,464	-241,380	659,998
	End-of-life	8,395,073	2,247,871	14,809,703
2015	Stock	152,031,563	48,034,652	132,659,693
	Sales	9,455,035	1,982,413	15,639,868
	New	1,024,130	-480,347	397,979
	End-of-life	8,430,905	2,462,759	15,241,889
2016	Stock	153,055,693	47,554,306	133,057,672
	Sales	9,519,681	1,958,624	15,764,987
	New	1,049,922	-475,543	399,173
	End-of-life	8,469,759	2,434,167	15,365,814
2017	Stock	154,105,615	47,078,763	133,456,845
	Sales	9,585,588	1,935,120	15,891,107
	New	1,075,843	-470,788	400,371
	End-of-life	8,509,745	2,405,908	15,490,737
2018	Stock	155,181,459	46,607,975	133,857,215
	Sales	9,652,767	1,911,899	16,018,236
	New	1,101,898	-466,080	401,572
	End-of-life	8,550,869	2,377,979	15,616,665
2019	Stock	156,283,357	46,141,895	134,258,787
	Sales	9,721,226	1,888,956	16,146,382
	New	1,128,092	-461,419	402,776
	End-of-life	8,593,134	2,350,375	15,743,606
2020	Stock	157,411,449	45,680,476	134,661,563
	Sales	9,790,976	1,866,289	16,275,553
	New	990,178	-456,805	269,323
	End-of-life	8,800,798	2,323,093	16,006,230
2021	Stock	158,401,627	45,223,672	134,930,886
	Sales	9,862,024	1,843,893	16,324,380
	New	1,005,919	-452,237	269,862
	End-of-life	8,856,106	2,296,130	16,054,518
2022	Stock	159,407,546	44,771,435	135,200,748
	Sales	9,934,383	1,821,767	16,373,353
	New	1,021,759	-447,714	270,401
	End-of-life	8,912,624	2,269,481	16,102,951
2023	Stock	160,429,305	44,323,720	135,471,150
	Sales	10,008,061	1,799,905	16,422,473
	New	1,037,700	-443,237	270,942
	End-of-life	8,970,361	2,243,143	16,151,531

Year	Unit	BC1	BC2	BC3
2024	Stock	161,467,004	43,880,483	135,742,092
	Sales	10,083,069	1,778,306	16,471,740
	New	1,053,743	-438,805	271,484
	End-of-life	9,029,326	2,217,111	16,200,256
2025	Stock	162,520,747	43,441,678	136,013,576
	Sales	10,159,417	1,756,967	16,521,156
	New	1,069,889	-434,417	272,027
	End-of-life	9,089,528	2,191,384	16,249,128

8.3.1.1. BAU Scenario

The BAU scenario is built on the following assumptions:

- The Standby Regulation is fully implemented from 2013. All electric and microwave ovens sold after 2013 have a 1W standby power.
- A natural improvement is assumed for electric ovens, consequent to the existing energy label. The average product in stock in 2007 consumes 1.1 kWh per cycle, while the average product sold consumes 0.84 kWh. No further improvement is assumed.
- The energy consumption per gas oven is assumed to stay constant until 2025.

Figure 8-15 and Figure 8-16 show the breakdown by Base-case of energy consumption and expenditure over the period 2010-2025. Base-case 1 has the highest share both in terms of energy consumption and expenditure.

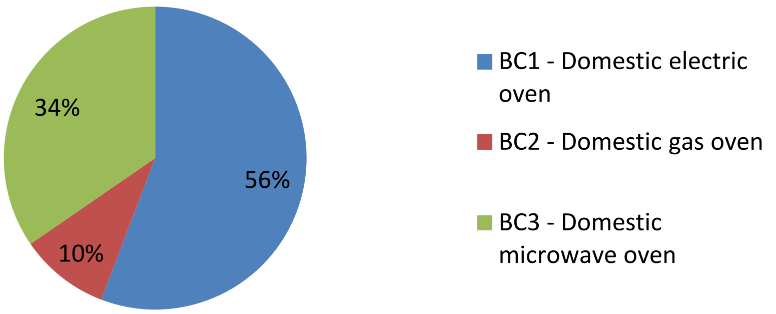


Figure 8-15: BAU Scenario: Total primary energy consumption by domestic Base-case over the period 2010-2025

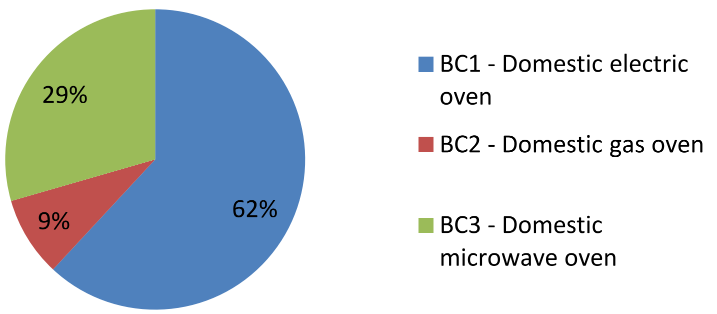


Figure 8-16: BAU Scenario: Total expenditure by domestic Base-case over the period 2010-2025

8.3.1.2. LLCC Scenario

In the LLCC scenario, all products sold after 2014 are the products with the least life-cycle cost, described in Table 8-12.

Table 8-12: Description of LLCC options for domestic Base-cases

Base-case	LLCC product	Description
BC1 – Domestic electric oven	Scenario A	Improved insulation and door glazing
BC2 – Domestic gas oven	Option 1	Improved insulation
BC3 – Domestic microwave oven	Option 0	Base-case with 1W standby power

Figure 8-17and Figure 8-18 presents primary energy consumption and expenditure by domestic Base-case over the period 2010-2025.

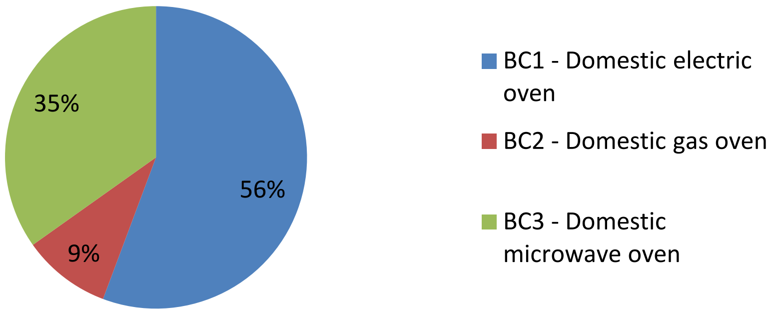


Figure 8-17: LLCC scenario: Total primary energy consumption by domestic Base-case over the period 2010-2025

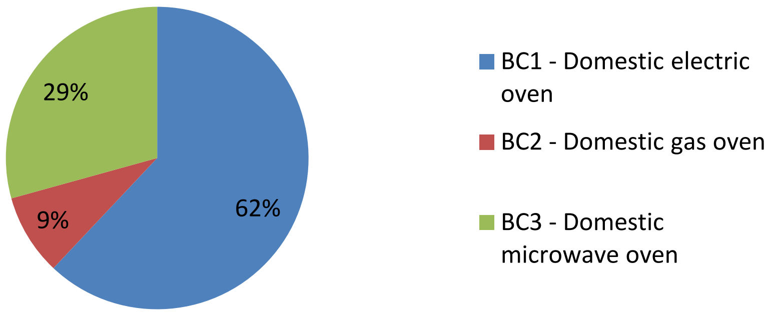


Figure 8-18: LLCC Scenario: Total expenditure by domestic Base-case over the period 2010-2025

8.3.1.3. BAT Scenario

The BAT scenario assumes that in addition to the LLCC scenario, all products sold after 2018 are BAT products, as presented in

Table 8-13: Description of BAT options for domestic Base-cases

Base-case	BAT product	Description
BC1 – Domestic electric oven	Scenario D*	Improved insulation and door glazing
BC2 – Domestic gas oven	Scenario C	Improved insulation
BC3 – Domestic microwave oven	Scenario C*	Base-case with 1W standby power

Figure 8-19 and Figure 8-20 presents primary energy consumption and expenditure by domestic Base-case over the period 2010-2025.

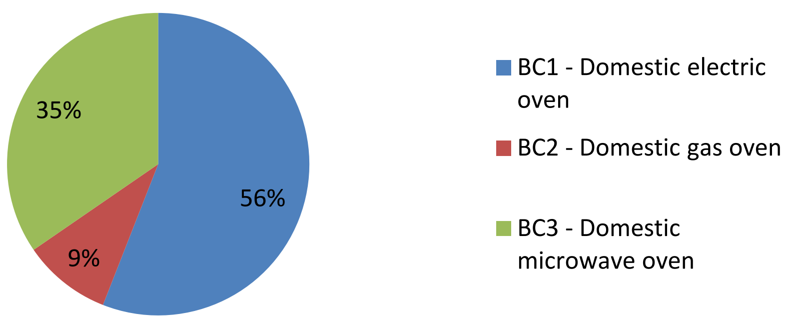


Figure 8-19: BAT scenario: Total primary energy consumption by domestic Base-case over the period 2010-2025

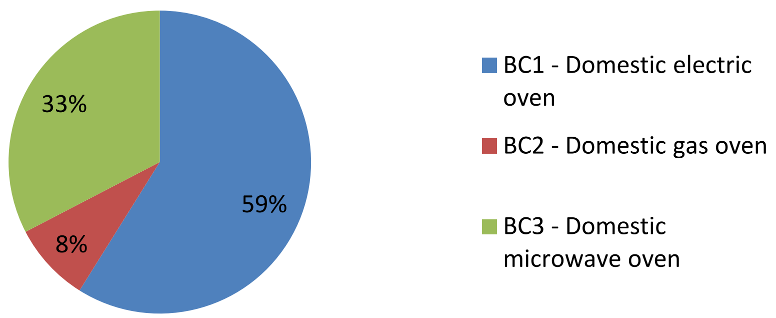


Figure 8-20: BAT scenario: Total primary energy consumption by domestic Base-case over the period 2010-2025

8.3.1.4. ALL-GAS SCENARIO

The All-gas scenario assumes that ovens sold after 2018 are gas ovens (except for microwave ovens). This is of course a hypothetical scenario, to estimate the maximum primary energy savings which could be achieved by replacing all electric ovens by gas ones. This does not mean that any recommendation on banning electric ovens is made to the European Commission, especially if a more-renewable-electricity EU scenario is to be envisaged with the benefit of decarbonising the whole European power production.

This scenario is similar to the LLCC scenario (LLCC products are sold starting in 2014). Moreover, starting in 2018, only gas ovens are sold. This is a very simplistic model, assuming that the switch is complete starting in January 2018.

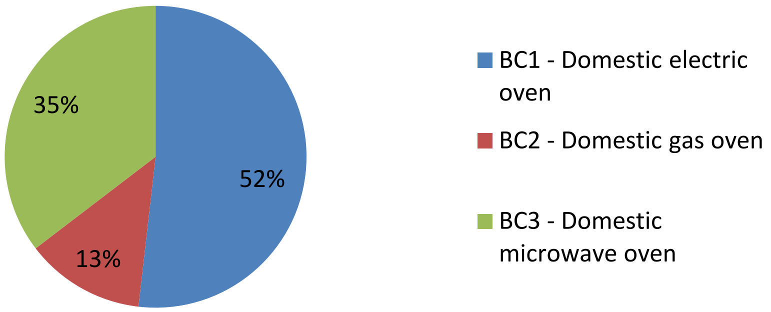


Figure 8-21: All-gas scenario: Total primary energy consumption by domestic Base-case over the period 2010-2025

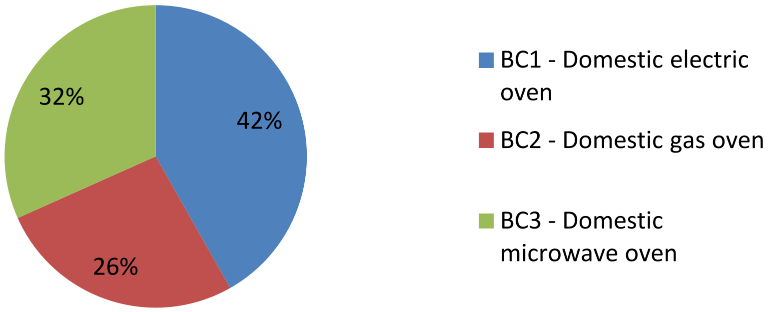


Figure 8-22: All-gas scenario: Total primary energy consumption by domestic Base-case over the period 2010-2025

8.3.1.5. Comparison of the scenarios

This comparison is made in terms of energy consumption and consumer expenditure. Figure 8-18 presents the savings of each scenario compared to the other.

Table 8-14: Primary energy savings by Scenario, cumulative over the period 2010-2025

Savings over the period 2010-2025 (TJ)	LLCC	BAT	All-gas
Compared to BAU	43,542	93,320	144,808
Compared to LLCC		49,779	101,266
Compared to BAT			51,487

Figure 8-23 to Figure 8-26 present the evolution of the primary energy consumption and expenditure by scenario, for each Base-case and aggregated. Figure 8-27 shows the primary energy consumed and the money spent for each Base-case over the period 2010-2025, according to the different scenarios.

In the LLCC scenario, 1.0% of energy is saved in the year 2020 compared to the BAU scenario. This increases to 2.0% for the year 2025, as more and more old appliances are replaced with more energy-efficient ones. Aggregated on the period 2010-2025, 0.7% less energy is consumed in the LLCC scenario than in the BAU scenario. On the 43,542 PJ (primary energy) saved over this period, 71% are saved on electric ovens, the rest comes from improvement on gas ovens. For microwave ovens, the Base-case is the product with the least life cycle cost, therefore no savings are obtained compared to the BAU.

In the BAT scenario, 1.9% of energy is saved in the year 2020 compared to the BAU scenario, and 5.4% for the year 2025. Over the period 2010-2025, 1.4% of energy is saved compared to the BAU scenario. Savings comes at 46% from electric ovens, 35% for microwave ovens and 20% from gas ovens.

Finally, the All-gas scenario would result in the highest primary energy savings. The energy consumption due to microwave oven remains the same as in BAU, as they cannot be replaced by gas appliances. The energy consumption due to gas ovens rockets starting in 2018, only this kind of appliances is sold. Similarly, the energy consumption due to electric ovens plummets, as they are not renewed anymore after 2018.

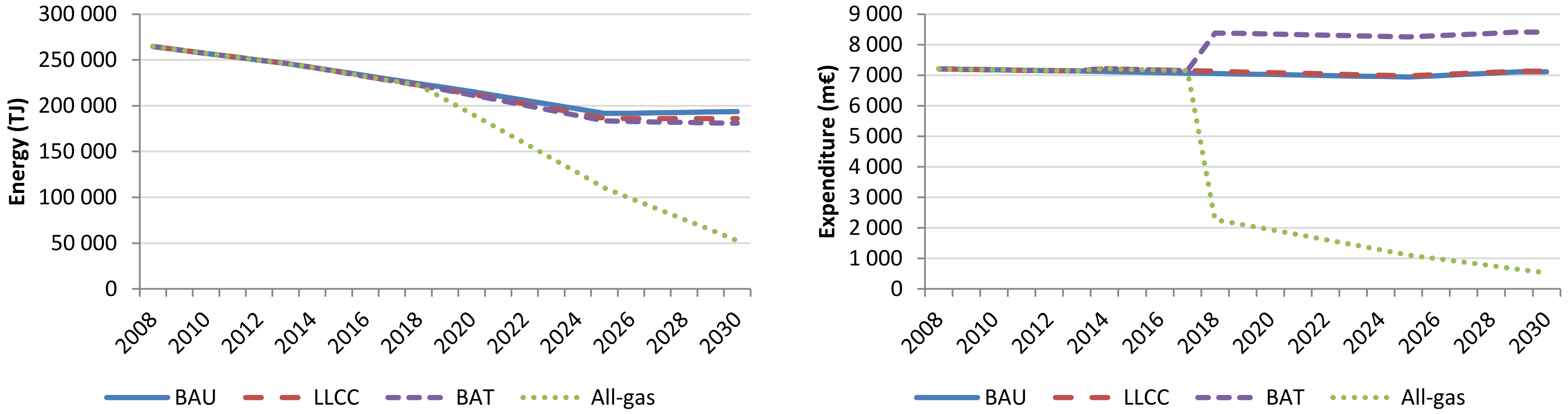


Figure 8-23: Base-case 1: Primary energy consumption and expenditure by scenario

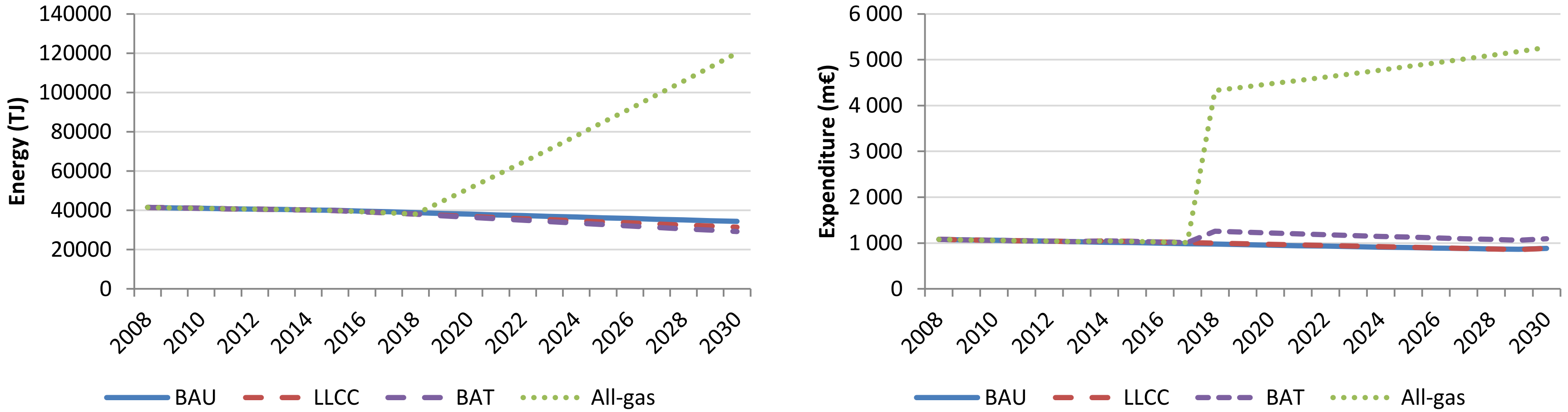


Figure 8-24: Base-case 2: Primary energy consumption and expenditure by scenario

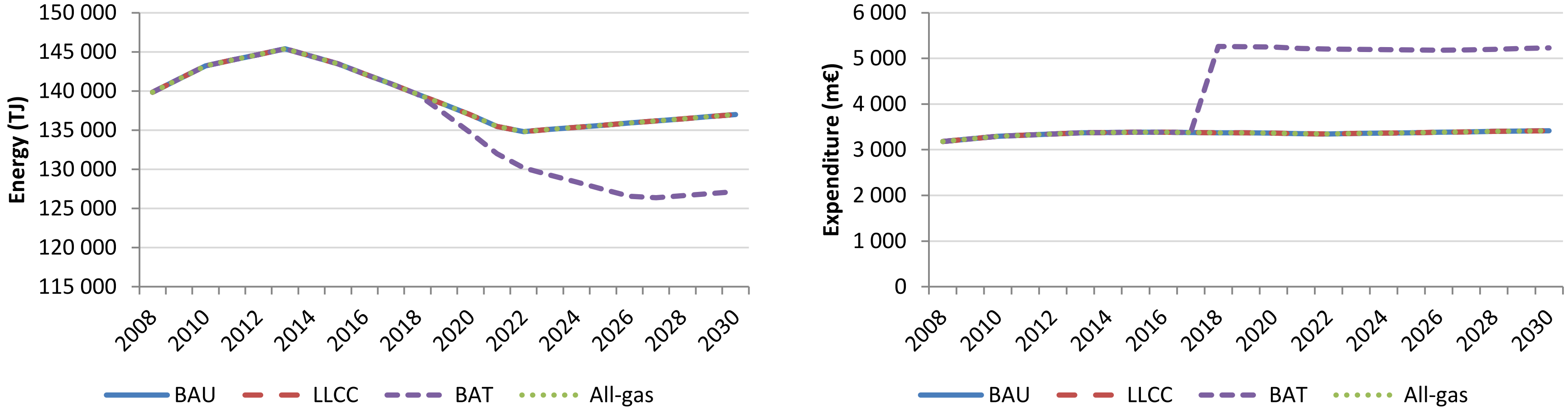


Figure 8-25: Base-case 3: Primary energy consumption and expenditure by scenario

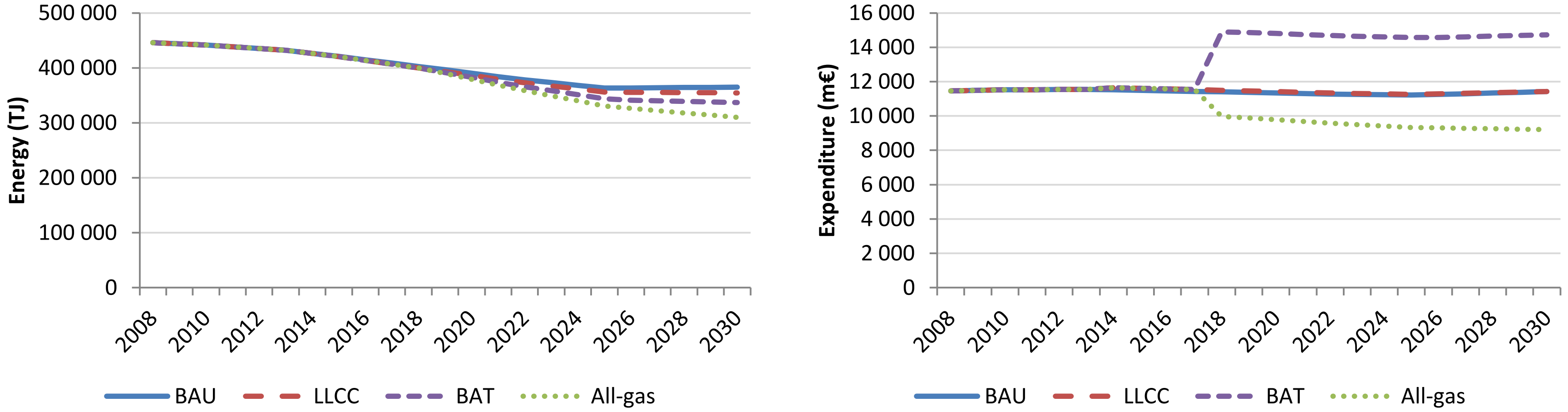
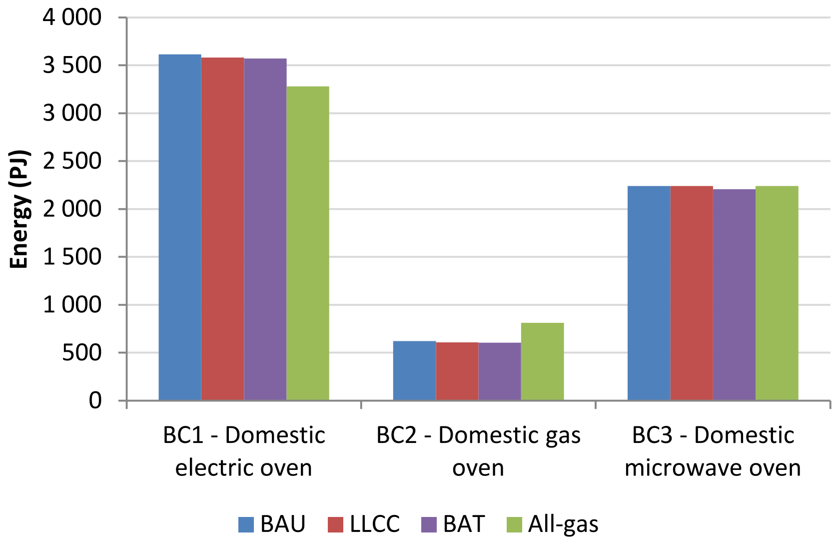


Figure 8-26: Domestic sector: Primary energy consumption and expenditure by scenario



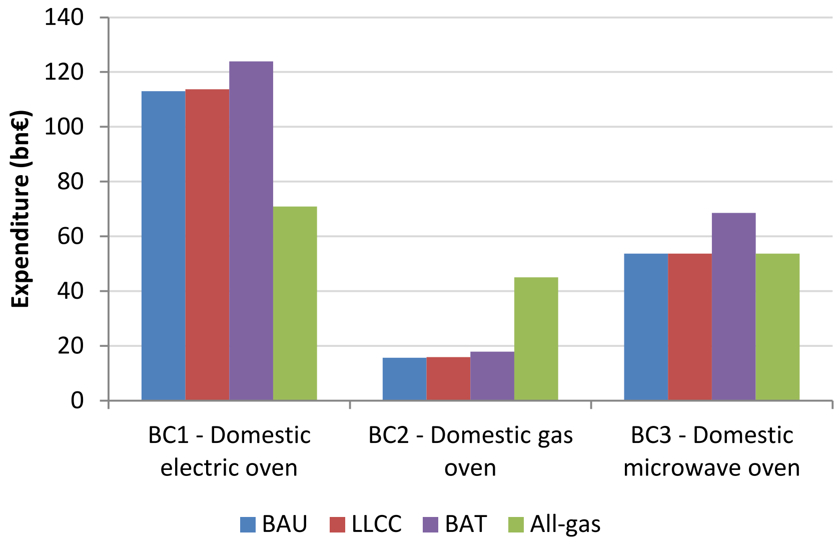


Figure 8-27: Primary energy consumption and consumer expenditure by domestic Base-Case over the period 2010-2025

8.3.2. OVENS USED IN RESTAURANTS

The market data used for the restaurant ovens are presented in Table 8-15.

Table 8-15: Market data of the scenario tool for restaurant ovens

Year	Unit	BC4	BC5
2007	Stock	400,000	80,000
	Sales	41,000	9,200
	New	2,000	-80
	End-of-life	39,000	9,280
2008	Stock	402,000	79,920
	Sales	41,410	9,200
	New	2,010	-80
	End-of-life	39,400	9,280
2009	Stock	404,010	79,840
	Sales	41,824	9,200
	New	2,020	-80
	End-of-life	39,804	9,280
2010	Stock	406,030	79,760
	Sales	42,242	9,200
	New	2,030	-399
	End-of-life	40,212	9,599
2011	Stock	408,060	79,361
	Sales	42,580	9,126
	New	2,040	-397
	End-of-life	40,540	9,523
2012	Stock	410,101	78,965
	Sales	42,921	9,053
	New	2,051	-395
	End-of-life	40,870	9,448
2013	Stock	412,151	78,570
	Sales	43,264	8,981
	New	2,061	-393
	End-of-life	41,204	9,374
2014	Stock	414,212	78,177
	Sales	43,610	8,909
	New	2,071	-391
	End-of-life	41,539	9,300
2015	Stock	416,283	77,786
	Sales	43,959	8,838
	New	1,665	-933
	End-of-life	42,294	9,771
2016	Stock	417,948	76,853
	Sales	44,311	8,741
	New	1,672	-922
	End-of-life	42,639	9,663
2017	Stock	419,620	75,930
	Sales	44,665	8,644
	New	1,678	-911
	End-of-life	42,987	9,556
2018	Stock	421,298	75,019
	Sales	45,023	8,549
	New	1,685	-900
	End-of-life	43,338	9,450
2019	Stock	422,983	74,119
	Sales	45,383	8,455
	New	1,692	-889
	End-of-life	43,691	9,345

Year	Unit	BC4	BC5
2020	Stock	424,675	73,230
	Sales	45,746	8,362
	New	1,274	-1,465
	End-of-life	44,472	9,827
2021	Stock	425,949	71,765
	Sales	45,975	8,237
	New	1,278	-1,435
	End-of-life	44,697	9,672
2022	Stock	427,227	70,330
	Sales	46,205	8,113
	New	1,282	-1,407
	End-of-life	44,923	9,520
2023	Stock	428,509	68,923
	Sales	46,436	7,992
	New	1,286	-1,378
	End-of-life	45,150	9,370
2024	Stock	429,794	67,545
	Sales	46,668	7,872
	New	1,289	-1,351
	End-of-life	45,378	9,223
2025	Stock	431,084	66,194
	Sales	46,901	7,754
	New	1,293	-1,324
	End-of-life	45,608	9,078

8.3.2.1. BAU SCENARIO

The BAU scenario assumes that there will be no natural improvement. The stock of appliances will grow according to the market figures presented in Table 8-15, but the energy consumption per appliance will remain the same.

Figure 8-28 and Figure 8-29 presents the primary energy consumption and the expenditure due to restaurant ovens over the period 2010-2025.

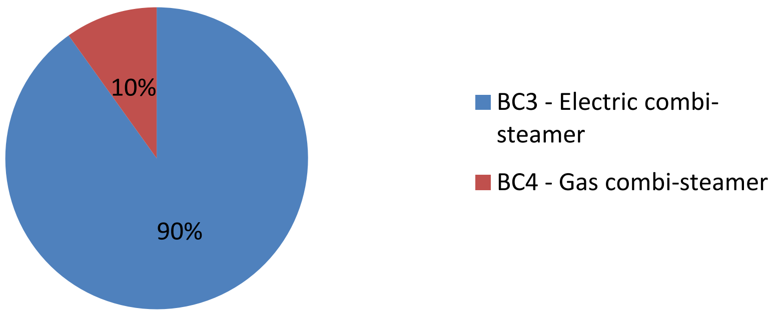


Figure 8-28: BAU scenario: Total primary energy consumption by restaurant Base-case over the period 2010-2025

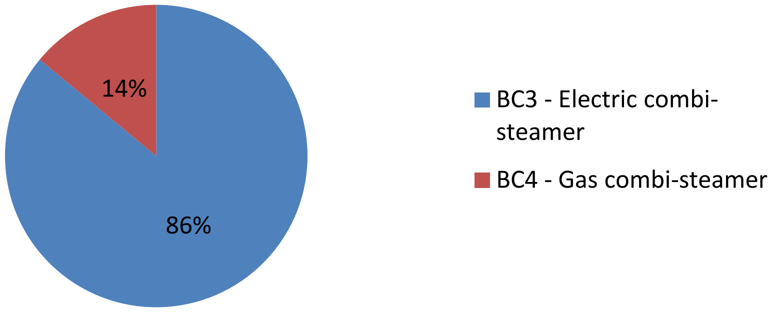


Figure 8-29: BAU Scenario: Total expenditure by restaurant Base-case over the period 2010-2025

8.3.2.2. LLCC Scenario

The LLCC scenario assumes that only LLCC products are sold after 2014.

Table 8-16: Description of LLCC options for restaurant Base-cases

Base-case	LLCC product	Description
BC4 – Commercial electric combi-steamer	Scenario B	Improved insulation and two additional glass sheets
BC5 – Commercial gas combi-steamer	Scenario A	Improved insulation and one additional glass sheet

Figure 8-30 and Figure 8-31 present the primary energy consumption and the expenditure over the period 2010-2025 for the LLCC scenario.

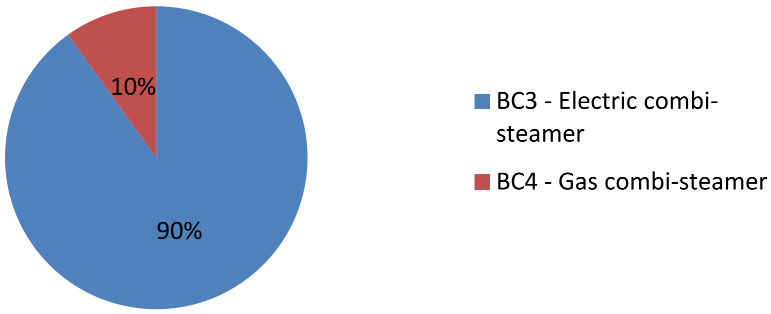


Figure 8-30: LLCC scenario: Total primary energy consumption by restaurant Base-case over the period 2010-2025

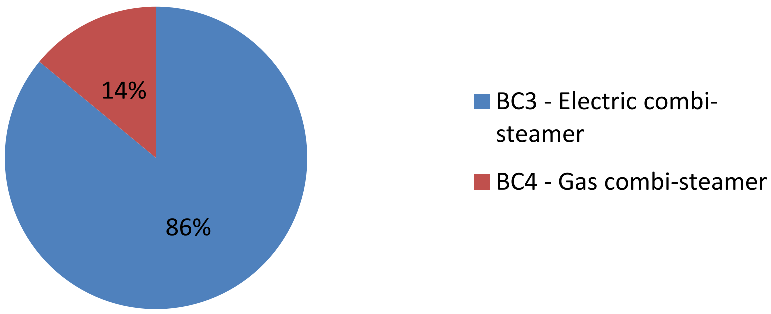


Figure 8-31: LLCC scenario: Total expenditure by restaurant Base-case over the period 2010-2025

8.3.2.3. BAT SCENARIO

The BAT scenario is based on the LLCC scenario. In addition, BAT products as described in ... are sold after 2018. In the case of the electric combi-steamer, as the LLCC product is also the BAT one, there is no change.

Figure 8-32 and Figure 8-33 present the outcomes of the BAT scenario analysis.

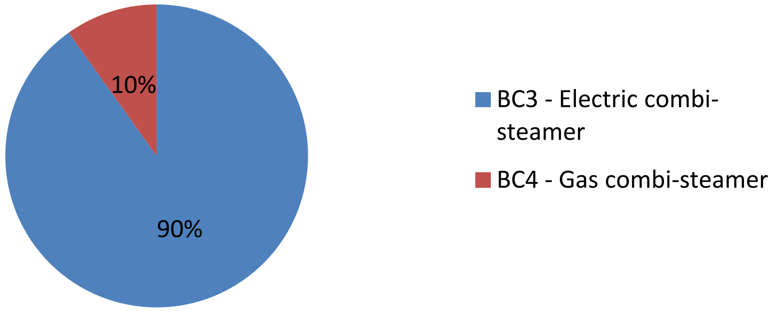


Figure 8-32: BAT scenario: Total primary energy consumption by restaurant Base-case over the period 2010-2025

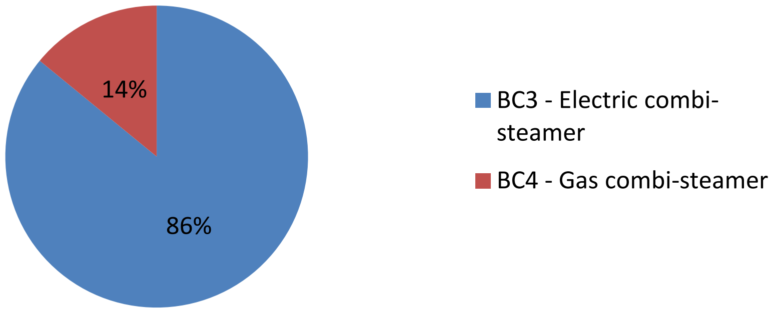


Figure 8-33: BAT scenario: Total expenditure by restaurant Base-case over the period 2010-2025

8.3.2.4. ALL-GAS SCENARIO

All-gas scenario is based on the LLCC scenario. However, starting in 2018, only gas combi-steamers are sold. This scenario is analysed only for estimating the maximum energy savings that could be achieved, and is not representative of any intention of banning electric ovens. This does not mean that any recommendation on banning electric ovens is made to the European Commission, especially if a more-renewable-electricity EU scenario is to be envisaged with the benefit of decarbonising the whole European power production.

Results can be seen on Figure 8-34 and Figure 8-35.

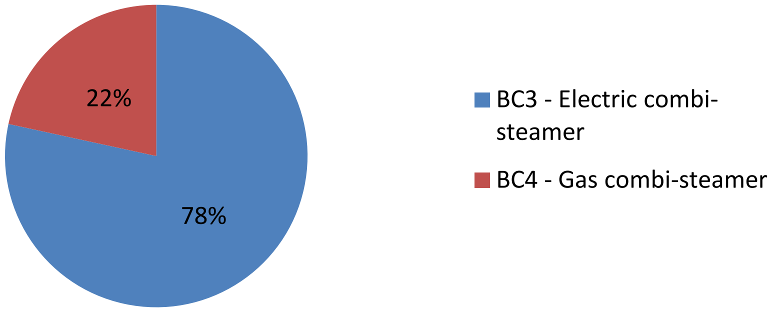


Figure 8-34: All-gas scenario: Total primary energy consumption by restaurant Base-case over the period 2010-2025

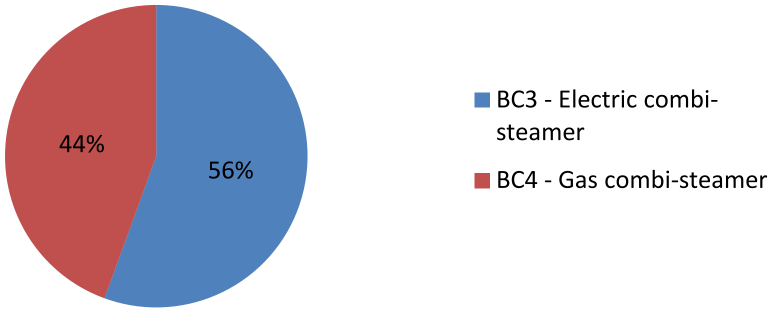


Figure 8-35: All-gas scenario: Total expenditure by restaurant Base-case over the period 2010-2025

8.3.2.5. Comparison of the scenarios

The comparison is made in terms of primary energy consumption and expenditure. Table 8-17 presents the primary energy savings in PJ of each scenario compared to the others.

Table 8-17: Primary energy savings by Scenario, cumulative over the period 2010-2025

Savings over the period 2010-2025 (PJ)	LLCC	BAT	All-gas
Compared to BAU	8,079	8,365	54,546
Compared to LLCC		286	46,466
Compared to BAT			46,180

Figure 8-36 to Figure 8-38 present the evolution of the primary energy consumption and expenditure due to restaurant Base-cases. Figure 8-39 presents the aggregated energy consumption per Base-case over the period 2010-2025, according to the different scenarios.

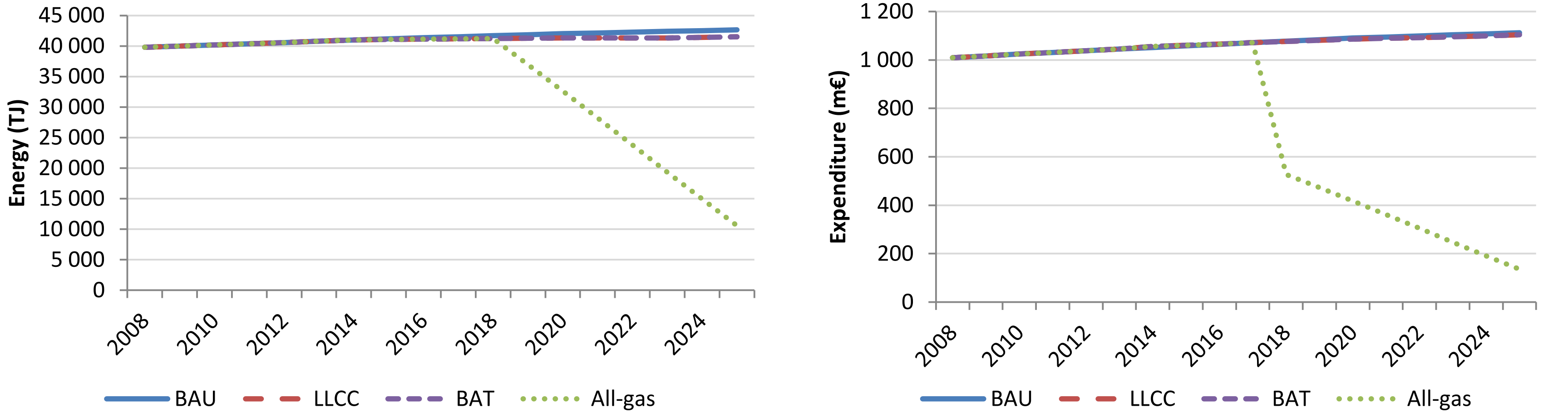


Figure 8-36: Base-case 4: Primary energy consumption and expenditure by scenario

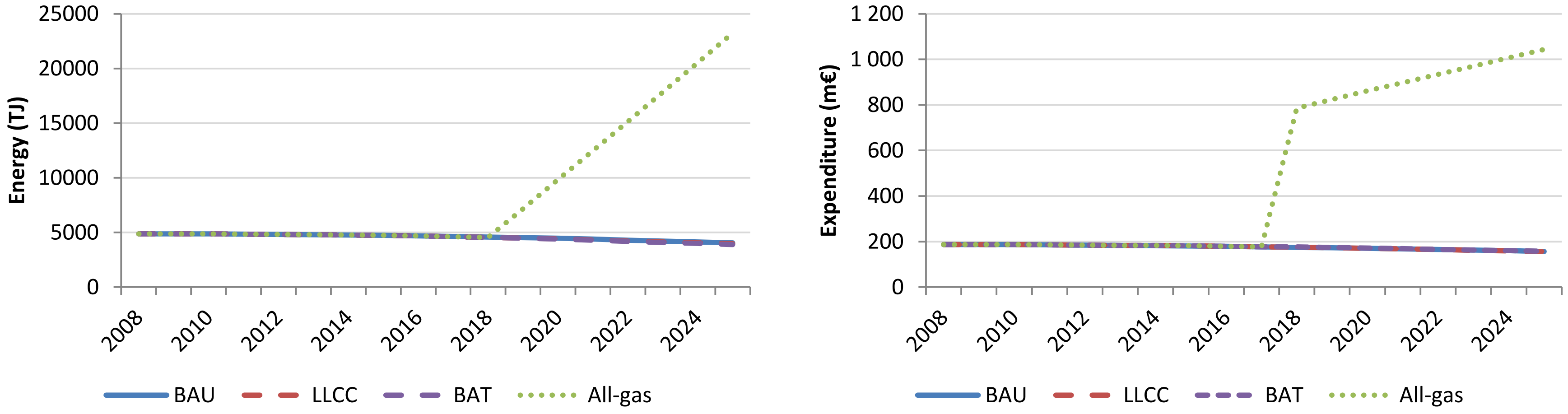


Figure 8-37: Base-case 5: Primary energy consumption and expenditure by scenario

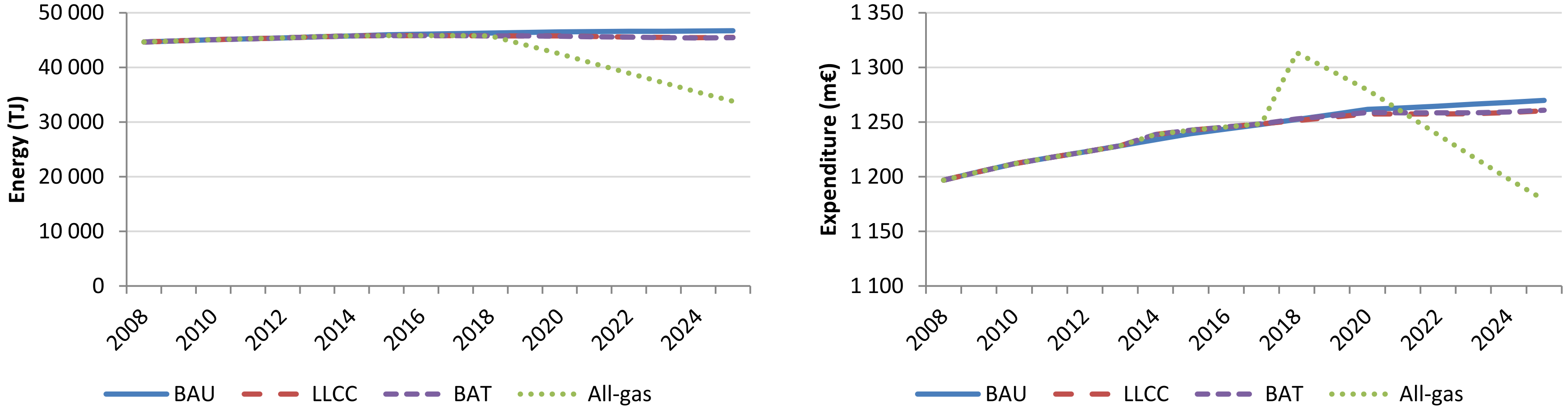


Figure 8-38: Restaurant ovens: Primary energy consumption and expenditure by scenario

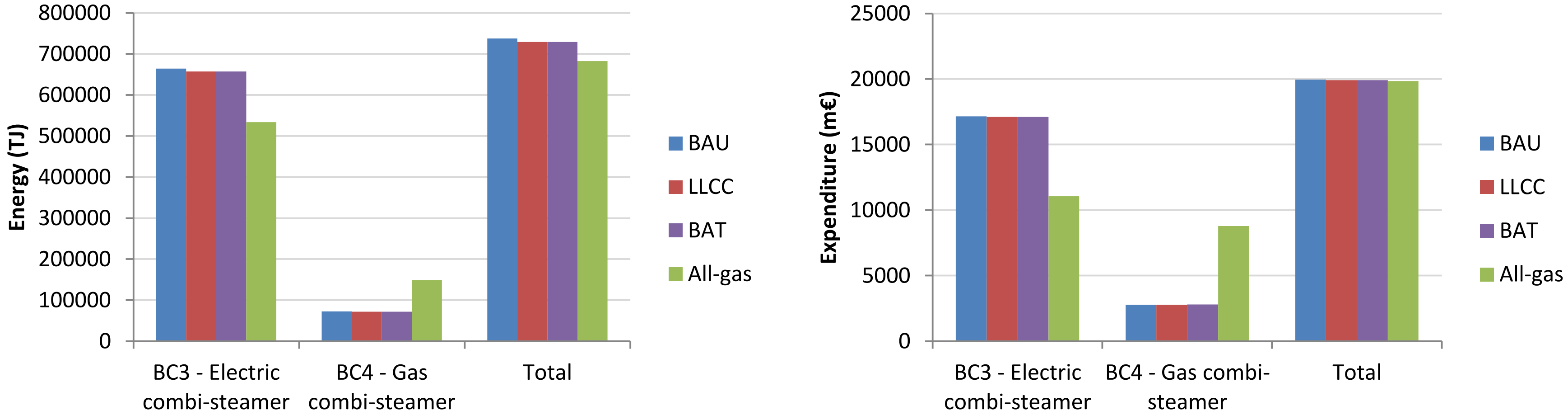


Figure 8-39: Primary energy consumption and consumer expenditure by restaurant Base-Case over the period 2010-2025

In the LLCC scenario, 1.6% energy is saved in the year 2020, and 2.6% in the year 2025. Over the period 2010-2025, the LLCC scenario leads to 1.1% of energy savings. More than 90% of the energy savings obtained on this period are due to improvement on electric combi-steamers (mainly because they represent the majority of the stock).

The additional energy savings that could be obtained with the BAT scenario are quite low, as the LLCC products are also as energy-efficient.

Finally, the all-gas scenario, which assumes that only gas ovens are sold after 2018, would lead to significant energy savings. The expenditure would be increased in the first years due to the higher cost of gas combi-steamers, but it would become profitable after 2021.

8.3.3. Ovens used in bakeries

Market data used for domestic ovens is presented in Table 8-18.

Table 8-18: Market data of the scenario tool for bakery ovens

Year	Unit	BC6	BC7	BC8	BC9	BC10
2006	Stock	85,000	53,000	43,000	30,000	45,000
	Sales	10,625	4,500	1,900	3,000	4,500
	New	2,550	1,325	-1,720	450	675
	End-of-life	8,075	3,175	3,620	2,550	3,825
2007	Stock	87,550	54,325	41,280	30,450	45,675
	Sales	10,944	4,568	1,824	3,045	4,568
	New	2,627	1,358	-1,651	457	685
	End-of-life	8,317	3,209	3,475	2,588	3,882
2008	Stock	90,177	55,683	39,629	30,907	46,360
	Sales	11,272	4,636	1,751	3,045	4,636
	New	2,705	1,392	-1,585	464	695
	End-of-life	8,567	3,244	3,336	2,581	3,941
2009	Stock	92,882	57,075	38,044	31,370	47,056
	Sales	11,610	4,706	1,681	3,137	4,706
	New	2,786	1,427	-1,522	471	706
	End-of-life	8,824	3,279	3,203	2,666	4,000
2010	Stock	95,668	58,502	36,522	31,841	47,761
	Sales	11,959	4,776	1,614	3,184	4,776
	New	2,105	2,048	-2,922	478	716
	End-of-life	9,854	2,729	4,536	2,706	4,060
2011	Stock	97,773	60,550	33,600	32,319	48,478
	Sales	12,222	4,872	1,485	3,232	4,848
	New	2,151	2,119	-2,688	485	727
	End-of-life	10,071	2,752	4,173	2,747	4,121
2012	Stock	99,924	62,669	30,912	32,803	49,205
	Sales	12,490	4,969	1,366	3,280	4,920
	New	2,198	2,193	-2,473	492	738
	End-of-life	10,292	2,776	3,839	2,788	4,182
2013	Stock	102,122	64,862	28,439	33,295	49,943
	Sales	12,765	5,068	1,257	3,330	4,994
	New	2,247	2,270	-2,275	499	749
	End-of-life	10,519	2,798	3,532	2,830	4,245
2014	Stock	104,369	67,132	26,164	33,795	50,692
	Sales	13,046	5,170	1,156	3,379	5,069
	New	2,296	2,350	-2,093	507	760
	End-of-life	10,750	2,820	3,249	2,873	4,309
2015	Stock	106,665	69,482	24,071	34,302	51,453
	Sales	13,333	5,273	1,064	3,430	5,145
	New	1,813	1,737	-2,407	515	772
	End-of-life	11,520	3,536	3,471	2,916	4,373

Year	Unit	BC6	BC7	BC8	BC9	BC10
2016	Stock	108,478	71,219	21,664	34,816	52,224
	Sales	13,560	5,352	957	3,482	5,222
	New	1,844	1,780	-2,166	522	783
	End-of-life	11,716	3,572	3,124	2,959	4,439
2017	Stock	110,323	73,000	19,497	35,338	53,008
	Sales	13,790	5,433	862	3,482	5,301
	New	1,875	1,825	-1,950	530	795
	End-of-life	11,915	3,608	2,811	2,952	4,506
2018	Stock	112,198	74,825	17,548	35,869	53,803
	Sales	14,025	5,514	775	3,482	5,380
	New	1,907	1,871	-1,755	538	807
	End-of-life	12,117	3,643	2,530	2,944	4,573
2019	Stock	114,105	76,695	15,793	36,407	54,610
	Sales	14,263	5,597	698	3,641	5,461
	New	1,940	1,917	-1,579	546	819
	End-of-life	12,323	3,679	2,277	3,095	4,642
2020	Stock	116,045	78,613	14,214	36,953	55,429
	Sales	14,506	5,681	628	3,695	5,543
	New	1,276	786	-1,706	554	831
	End-of-life	13,229	4,895	2,334	3,141	4,711
2021	Stock	117,322	79,399	12,508	37,507	56,260
	Sales	14,665	5,738	553	3,751	5,626
	New	1,291	794	-1,501	563	844
	End-of-life	13,375	4,944	2,054	3,188	4,782
2022	Stock	118,612	80,193	11,007	38,070	57,104
	Sales	14,827	5,795	486	3,807	5,710
	New	1,305	802	-1,321	571	857
	End-of-life	13,522	4,993	1,807	3,236	4,854
2023	Stock	119,917	80,995	9,686	38,641	57,961
	Sales	14,990	5,853	428	3,864	5,796
	New	1,319	810	-1,162	580	869
	End-of-life	13,671	5,043	1,590	3,284	4,927
2024	Stock	121,236	81,805	8,524	39,220	58,830
	Sales	15,155	5,911	377	3,922	5,883
	New	1,334	818	-1,023	588	882
	End-of-life	13,821	5,093	1,399	3,334	5,001
2025	Stock	122,570	82,623	7,501	39,809	59,713
	Sales	15,321	5,971	331	3,981	5,971
	New	1,348	826	-900	597	896
	End-of-life	13,973	5,144	1,232	3,384	5,076

The four scenarios for bakery ovens will be presented separately and then compared in terms of primary energy consumption and expenditure.

8.3.3.1. BAU SCENARIO

The BAU scenario assumes that there is no natural improvement in the average annual energy consumption of bakery ovens. Therefore, the EU energy consumption and expenditure varies according to market data variation.

Figure 8-40 and Figure 8-41 present the primary energy consumption and expenditure by bakery Base-case over the period 2010-2025.

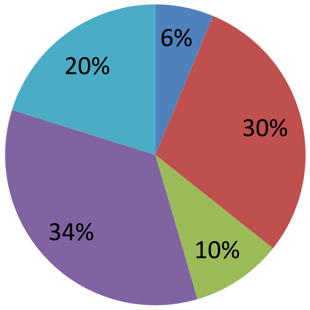


Figure 8-40: BAU scenario: Total primary energy consumption by bakery Base-case over the period 2010-2025

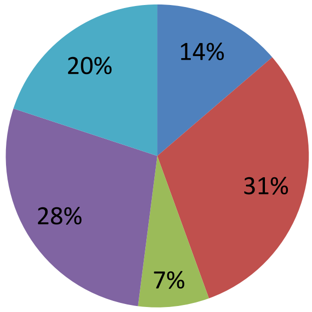


Figure 8-41: BAU scenario: Total expenditure by bakery Base-case over the period 2010-2025

8.3.3.2. LLCC Scenario

The LLCC scenario assumes that only LLCC products are sold after 2015.

Table 8-19: Description of LLCC options for bakery Base-cases

Base-case	LLCC product	Description
BC6 – Commercial in-store convection oven	Scenario C	Improved door design and improved software control
BC7 – Commercial electric deck oven	Scenario A	Improved insulation and door design
BC8 – Commercial gas deck oven	Scenario B	Improved insulation, improved door design, and improvement on the heat exchanges
BC9 – Commercial electric rotary rack oven	Option 1	Better insulation
BC10 – Commercial gas rotary rack oven	Option 1	Better insulation

In case of rotary rack ovens, Option 1 is not the LLCC option, but the “BA product” (best available product available on the market, described by manufacturers without providing details on how higher energy efficiency was achieved).

Figure 8-42 and Figure 8-43 present the primary energy consumption and the expenditure by bakery Base-case for the LLCC scenario.

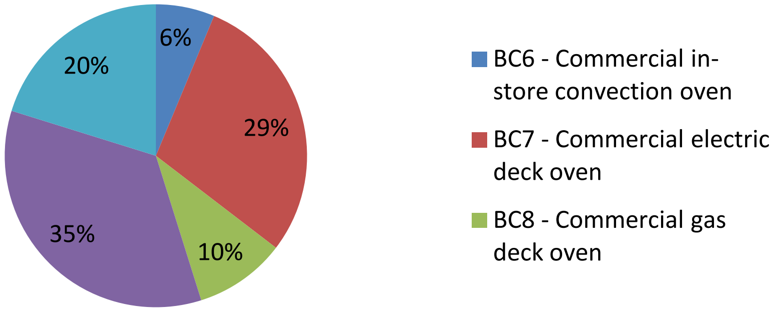


Figure 8-42: LLCC scenario: Total primary energy consumption by bakery Base-case over the period 2010-2025

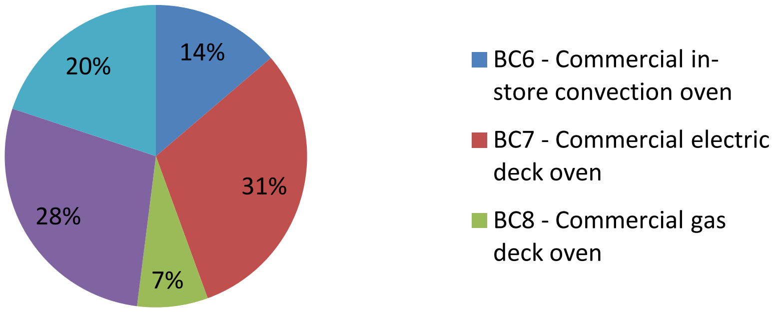


Figure 8-43: LLCC scenario: Total expenditure by bakery Base-case over the period 2010-2025

8.3.3.3. BAT SCENARIO

The BAT scenario is based on the LLCC scenario. In addition, starting in 2019, all products sold are BAT products, as described in Table 8-20.

Table 8-20: Description of BAT options for bakery Base-cases

Base-case	BAT product	Description
BC6 – Commercial in-store convection oven	Scenario E	Combination of all options
BC7 – Commercial electric deck oven	Scenario B*	Combination of all options
BC8 – Commercial gas deck oven	Scenario C*	Improved insulation, improved door design, and improvement on the heat exchanges
BC9 – Commercial electric rotary rack oven	BA product	Best available product on the market
BC10 – Commercial gas rotary rack oven	BA product	Best available product on the market

Results of the scenario analysis are presented in Figure 8-44 and Figure 8-45.

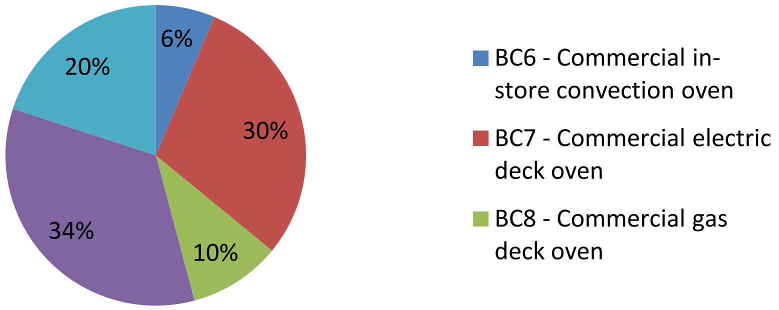


Figure 8-44: BAT scenario: Total primary energy consumption by bakery Base-case over the period 2010-2025

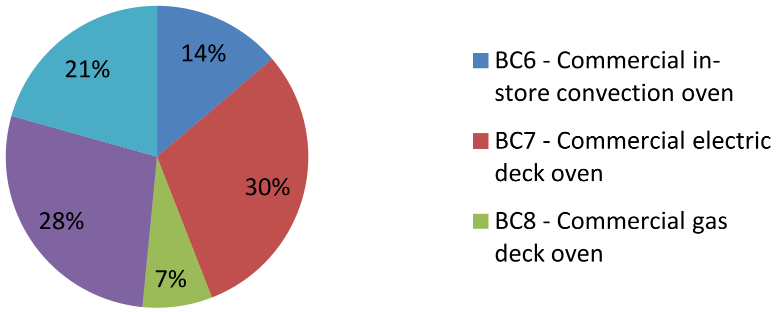


Figure 8-45: BAT scenario: Total expenditure by bakery Base-case over the period 2010-2025

8.3.3.4. ALL-GAS SCENARIO

In the all-gas scenario, electric deck ovens and rotary rack ovens are replaced by their gas version after 2019. As no gas version of in-store convection ovens was assessed in this study (their market share is negligible compared to the electric version, see Task 2), the sales of this type of bakery oven remain unchanged.

Figure 8-46 and Figure 8-47 present the results of the all-gas scenario analysis.

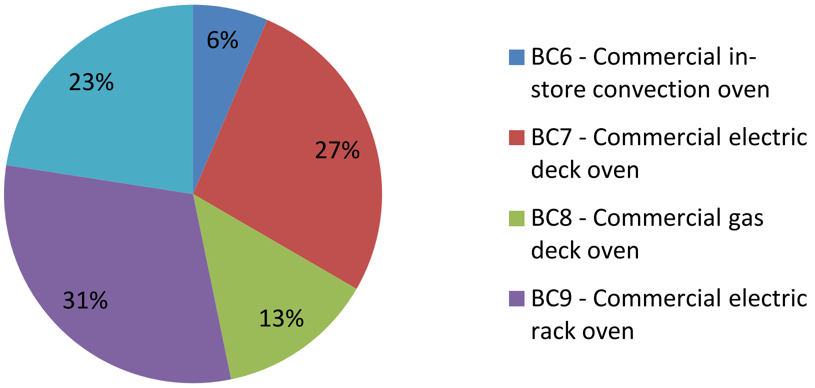


Figure 8-46: All-gas scenario: Total primary energy consumption by bakery Base-case over the period 2010-2025

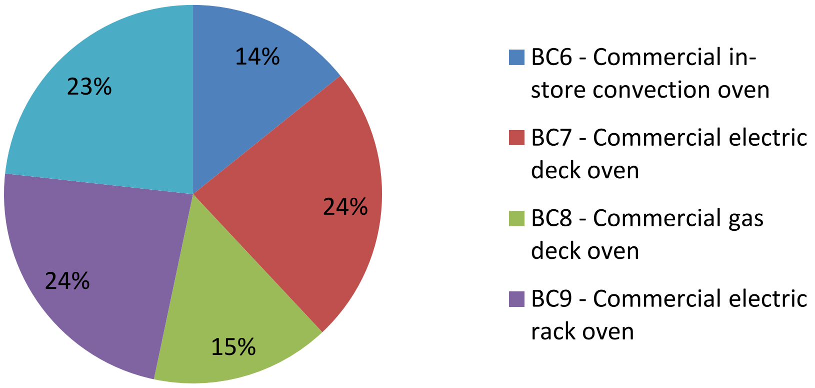


Figure 8-47: All-gas scenario: Total expenditure by bakery Base-case over the period 2010-2025

8.3.3.5. Comparison of the scenarios

The comparison is made in terms of primary energy consumption and expenditure. Table 8-21 presents the primary energy savings in PJ of each scenario compared to the others.

Table 8-21: Bakery ovens: Primary energy savings by Scenario, cumulative over the period 2010-2025

Savings over the period 2010-2025 (PJ)	LLCC	BAT	All-gas
Compared to BAU	19,065	44,946	56,706
Compared to LLCC		25,881	37,641
Compared to BAT			11,760

Figure 8-48 to Figure 8-53 present the evolution of the primary energy consumption and expenditure due to bakery Base-cases. Figure 8-54 presents the aggregated energy consumption per Base-case over the period 2010-2025, according to the different scenarios.

In the LLCC scenario, 1.7% energy is saved in the year 2020, and 3.4% in the year 2025. Over the period 2010-2025, the LLCC scenario leads to 1.2% of energy savings. More than 50% of the savings on this period are due to improvement in the energy-efficiency of electric deck ovens.

The BAT scenario would lead to 3.0% energy savings for the year 2020, and 10.7% in the year 2025. This represents 2.9% energy savings for the period 2010-2025. In the BAT scenario, most of the savings are due to rotary rack ovens (41% from the electric version, 27% from the gas version).

Finally, the all-gas scenario, which assumes that only gas ovens are sold after 2019, would lead to significant energy savings.

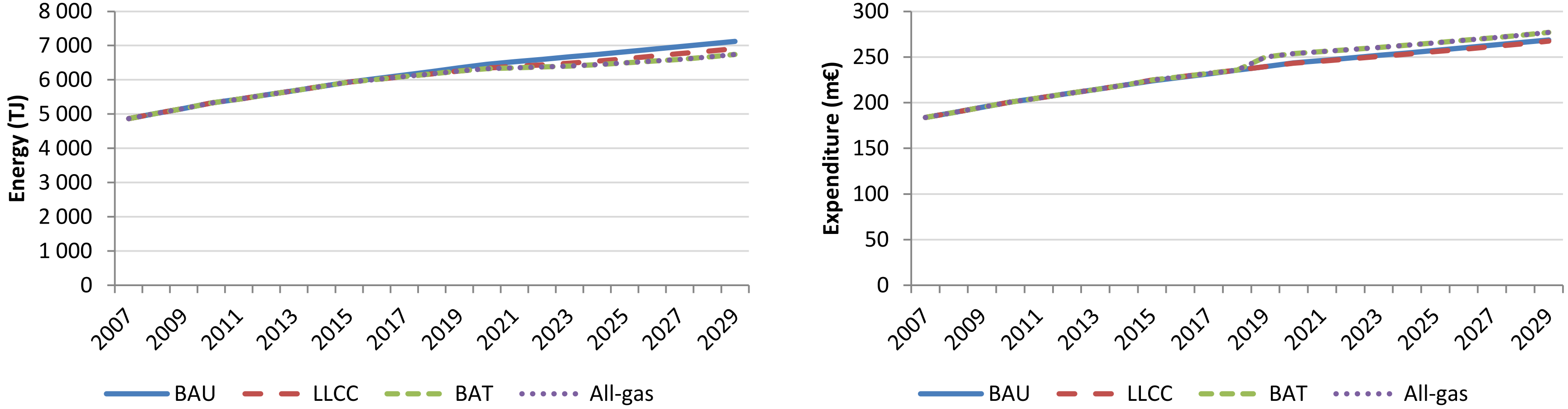


Figure 8-48: Base-case 6: Primary energy consumption and expenditure by scenario

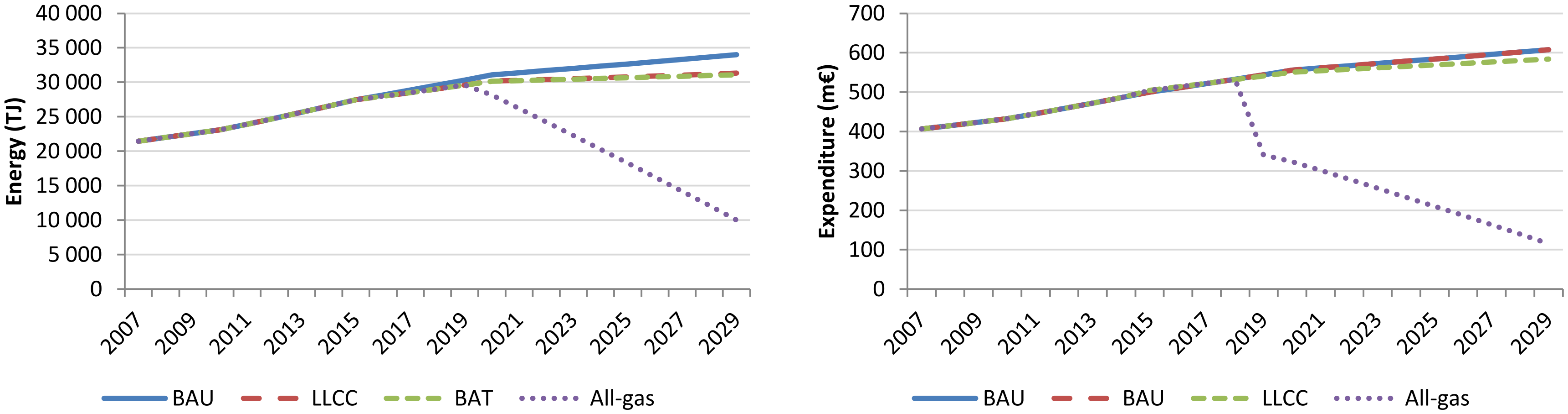
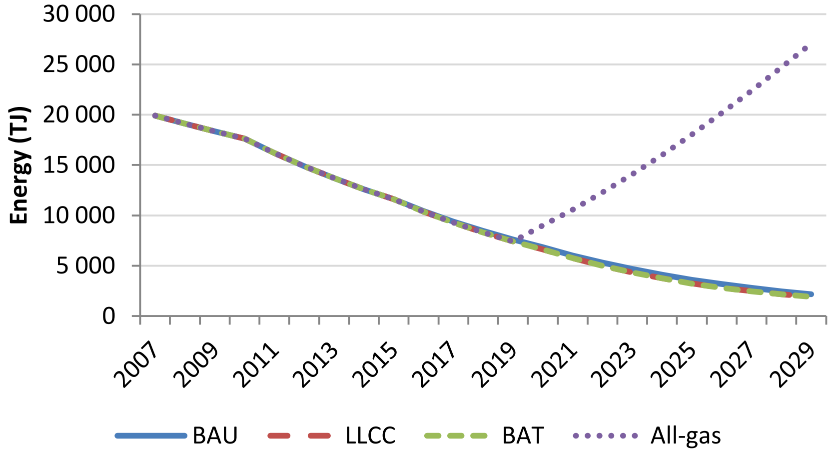


Figure 8-49: Base-case 7: Primary energy consumption and expenditure by scenario



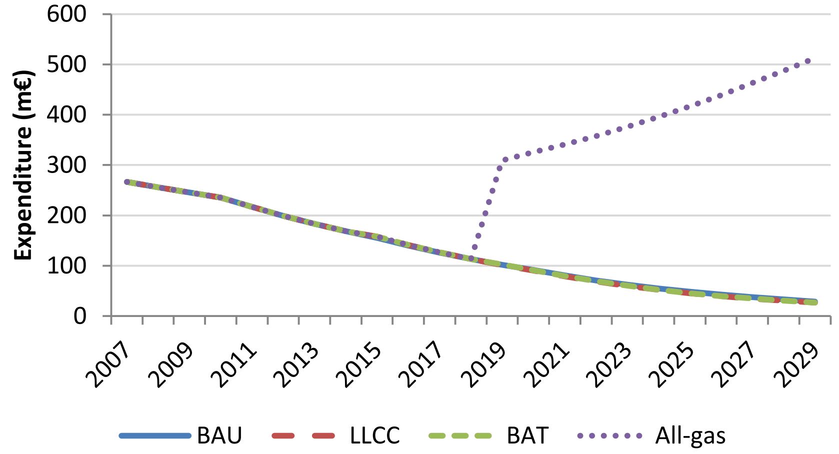
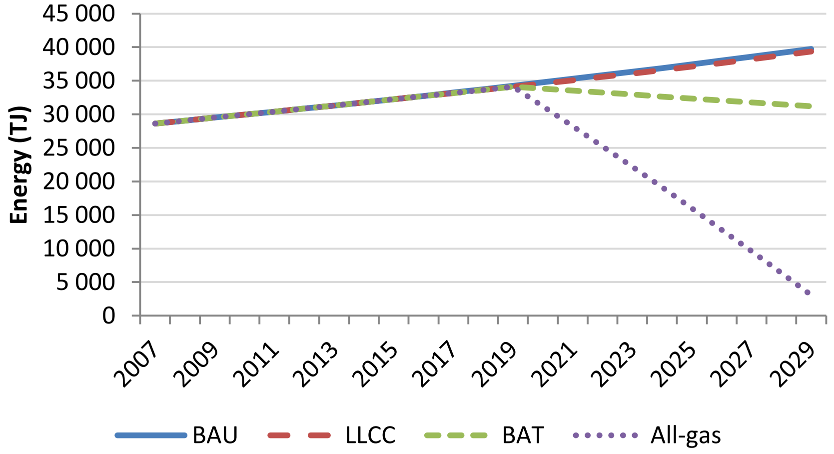


Figure 8-50: Base-case 8: Primary energy consumption and expenditure by scenario



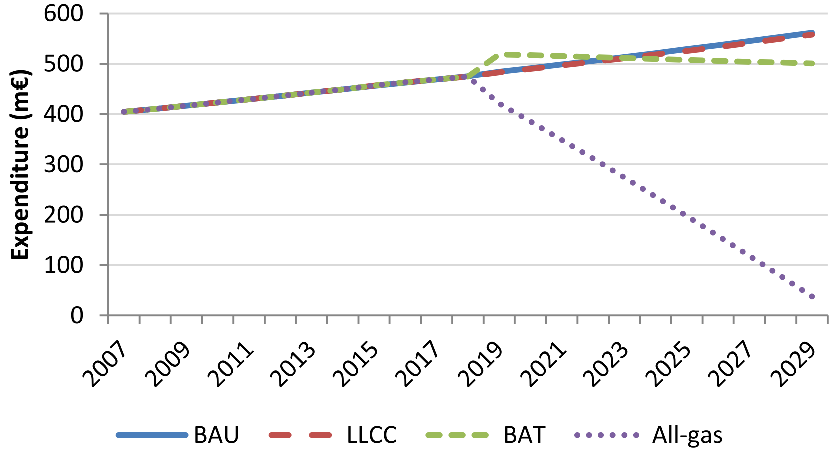


Figure 8-51: Base-case 9: Primary energy consumption and expenditure by scenario

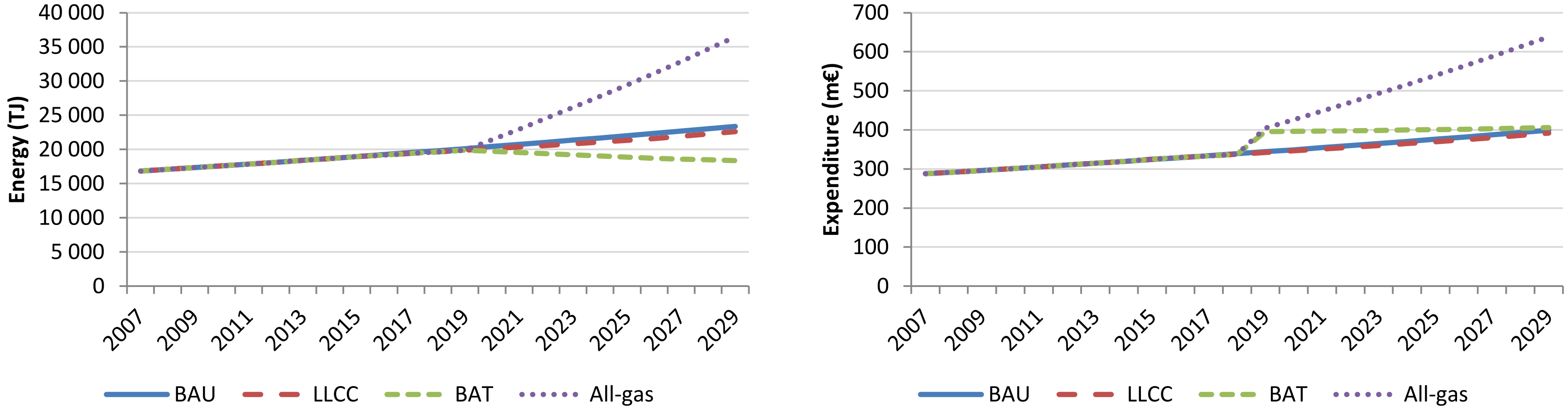


Figure 8-52: Base-case 10: Primary energy consumption and expenditure by scenario

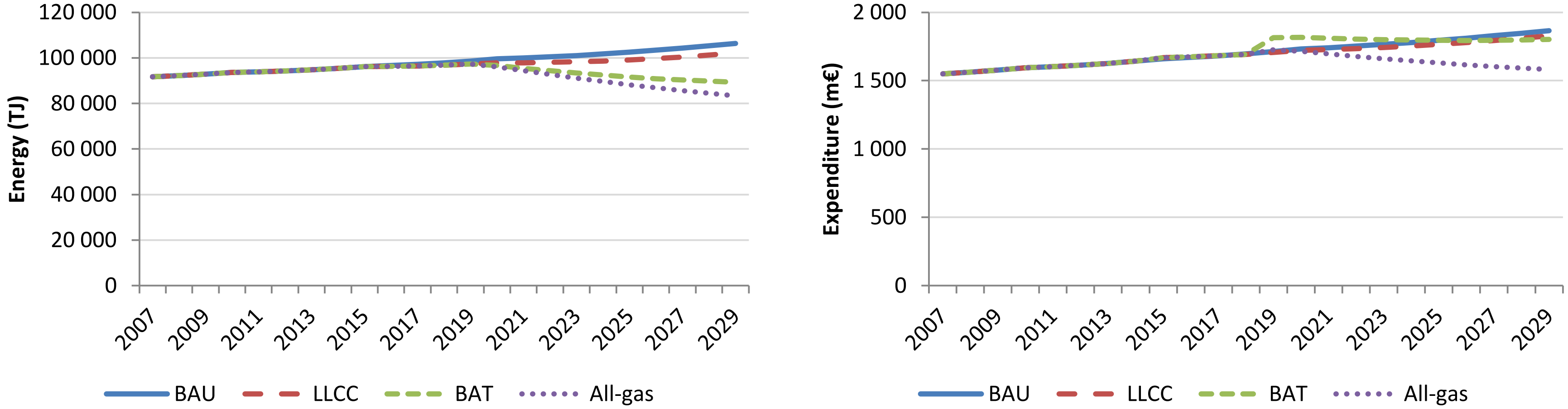


Figure 8-53: Bakery ovens: Primary energy consumption and expenditure by scenario

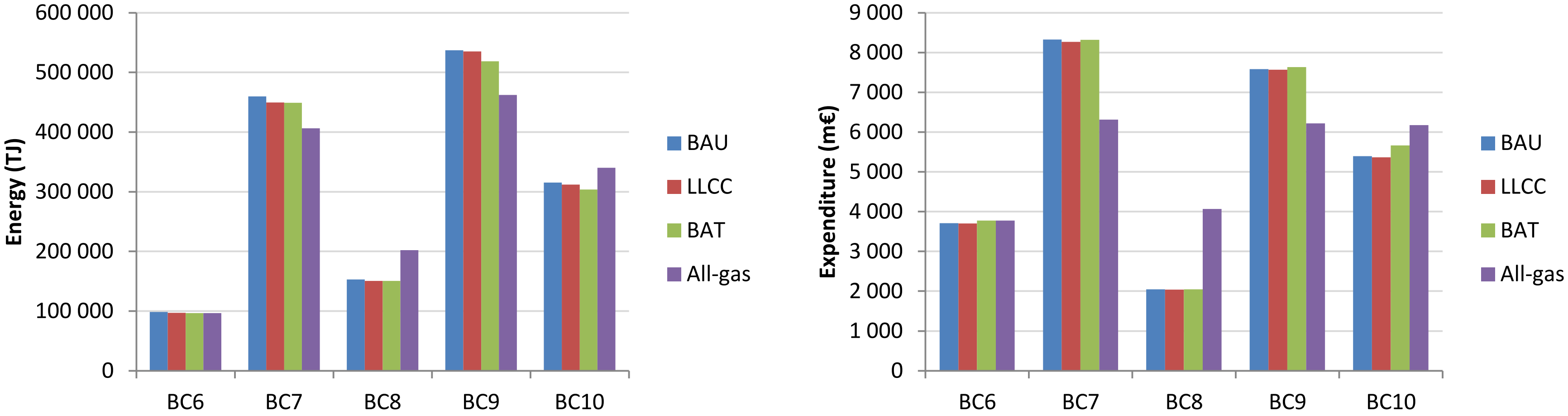


Figure 8-54: Primary energy consumption and consumer expenditure by restaurant Base-Case over the period 2010-2025

8.4. IMPACT ANALYSIS

The ecodesign requirements should not entail excessive costs nor undermine the competitiveness of European enterprises and should not have a significant negative impact on consumers or other users. In this section, the following impacts are assessed:

- Impacts on manufacturers and competition
- Monetary impacts
- Impacts on consumers
- Impacts on innovation and development
- Social impacts.

8.4.1. IMPACTS ON MANUFACTURERS AND COMPETITION

All the technologies described in this study and considered as improvement options in the scenarios are already available on the market. As a result, the implementation of MEPS dealing with saving targets is technically achievable although it would need an economical effort from the manufacturers.

Regarding the definition of a timeline to implement standards, it should take into account the time necessary to adapt production lines. This redesign time varies depending on the type of change to be achieved: it has been estimated that between 6 and 12 months are needed to replace a single part of the appliance, which is the case for every improvement option presented within the study. Therefore, Tier 1 has thus been set at 2014 for the MEPS and the scenario models.

Most manufacturers for the domestic sector - represented by CECED - seem to agree on the BAT products, with the implementation of the same improvement options, with a clear distinction for the sensors which have not been well-accepted by the customers when first introduced into the market. The European market mainly consists of large international companies. If minimum performance standards were set, it is believed that they should all be able to keep up with the market requirements, using common technology or their own technological developments.

Regarding the commercial sector, the manufacturers of ovens is more fragmented with less organised actions, especially at EU level. Therefore, the potential measures may be more difficult to be accepted and to implement than in the domestic sector. However, given the intensive use for commercial cooking purposes and the potential energy savings (in %), it is believed that they could all comply with the market requirements.

EU manufacturers claim to produce amongst the most efficient cooking appliances available worldwide. Therefore, the implementation of minimum performance standards is not expected to significantly hamper the economic development of large EU manufacturers to the benefit of extra-EU competitors.

8.4.2. Monetary impacts

The scenario analysis partly addresses monetary impacts. The possible implementation of MEPS requires additional capital investment from manufacturers to adapt manufacturing techniques to produce the more efficient products (e.g. changing production lines). In the domestic sector, these investments represent a significant concern for manufacturers in order to sustain the improved efficiency of their appliances. Investment costs can be partly offset by higher selling prices of more efficient machines but a good balance should be found in order to not strongly affect the purchaser. Besides, economies of scale may enable manufacturers to have a larger margin and/or drop prices when selling efficient appliances.

On the consumer side, purchasing a more efficient cooking appliance represents a larger initial investment but if performance requirements are set based on LCC calculations, the investment becomes beneficial in the long term. This might not be the case for the poorer consumers, for which purchase price is the priority, despite the possible savings. Some buyers could even be eager to buy more efficient products provided they are economic in the long run, and policy options could aim to encourage this long-term vision. Policy options could aim to encourage this long-term vision, which is beneficial both from the environmental and economic points of view.

8.4.3. Impacts on consumers

For the improvement options presented, the functional unit and the quality service given by the improved product remains the same as the Base-Case (this is a necessary condition to make a relevant comparative LCA).

There should be no trade-off in terms of heating function (e.g. reduced food nutritional quality or loss of taste features), as a result of the increased energy efficiency.

8.4.4. Impacts on innovation and development

BNATs and current research axes in the sector were not very thoroughly detailed in this study because of a lack of data. Such information is obviously very sensitive and manufacturers may not be willing to share. In addition, little or no independent research has been carried out. The possible implementation of MEPS can be seen as an opportunity for manufacturers to look for innovative and efficient technological solutions in order to decrease costs. Again, given the competitiveness of the sector, it seems that following the current trend regarding research and development is feasible for the manufacturers and should enable them to meet proposed requirements.

8.4.5. SOCIAL IMPACTS (EMPLOYMENT)

Most EU manufacturers have their production plants within the EU. Upgrading or changing production lines in the EU is often viewed as an opportunity to decide whether to relocate. If performance standards were set, they should not have a detrimental impact on the number of jobs or the well-being of the EU manufacturers' employees. In addition, the improvement options presented do not require any specific material that might be difficult to obtain within the EU so that the supply chain would not be unduly affected nor EU industries disadvantaged..

8.5. SENSITIVITY ANALYSIS

Scope: The sensitivity analysis checks the robustness of the overall outcomes. It should cover the main parameters as described in Annex II of the Ecodesign Directive (such as the price of energy, the cost of raw materials or production costs, discount rates, including, where appropriate, external environmental costs, such as avoided greenhouse gas emissions), to check if there are significant changes and if the overall conclusions are reliable and robust.

The parameters that would be considered the most relevant for this sensitivity analysis (because of their importance and/or uncertainty) in the case of professional dishwashers are listed below:

- Electricity consumption;
- Time in standby and off mode per day;
- Lifetime;
- Product price;
- Electricity, gas and water prices;
- Discount rate.

Parameters such as resource and consumables prices, product purchase prices and discount rate have a direct influence on the LCC calculations of the base-cases and their improvement options (but not on the environmental impacts of the products) while others (resource and consumables consumption, lifetime) will influence both the environmental impacts of the products and the LCC through operating costs.

Note that we use average EU prices for all calculations but there are significant differences between Member States. The BAT might be cost-effective in one Member State and not cost-effective in another.

8.5.1. Assumption related to the product lifetime

Variation on product lifetime is presented in Table 8-22.

Table 8-22: Variation of product lifetime for each Base-case

Base-case	Current value	Lower value	Upper value
Base-case 1	19	15	25
Base-case 2	19	15	25
Base-case 3	8	6	10
Base-case 4	10	8	12
Base-case 5	10	8	12
Base-case 6	8	6	10
Base-case 7	15	12	18
Base-case 8	15	12	18
Base-case 9	10	8	12
Base-case 10	10	8	12

Figure 8-55 to Figure 8-74 present the sensitivity to product lifetime.

A. Base-case 1: Domestic electric oven

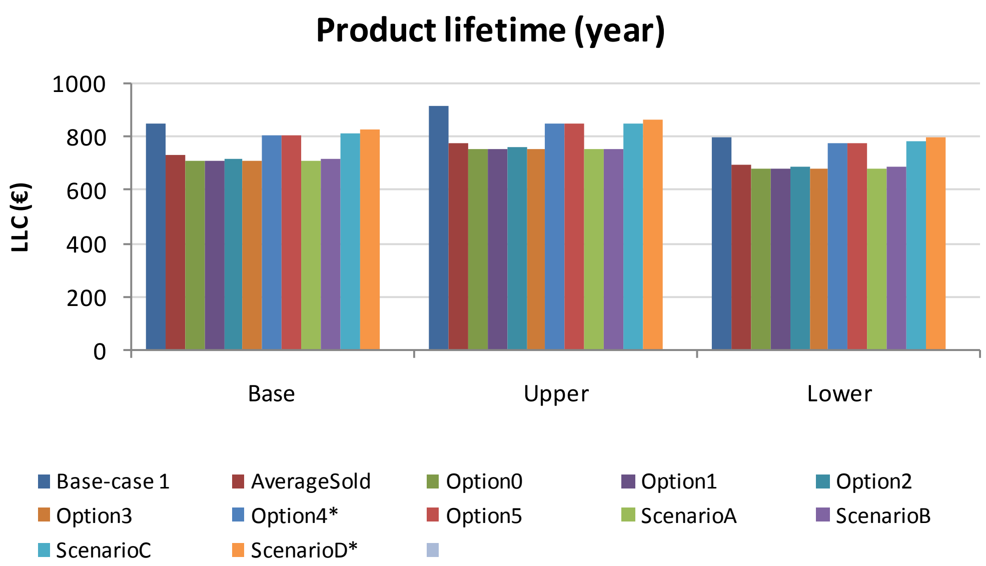


Figure 8-55: Sensitivity to product lifetime for Base-case 1's Life Cycle Cost

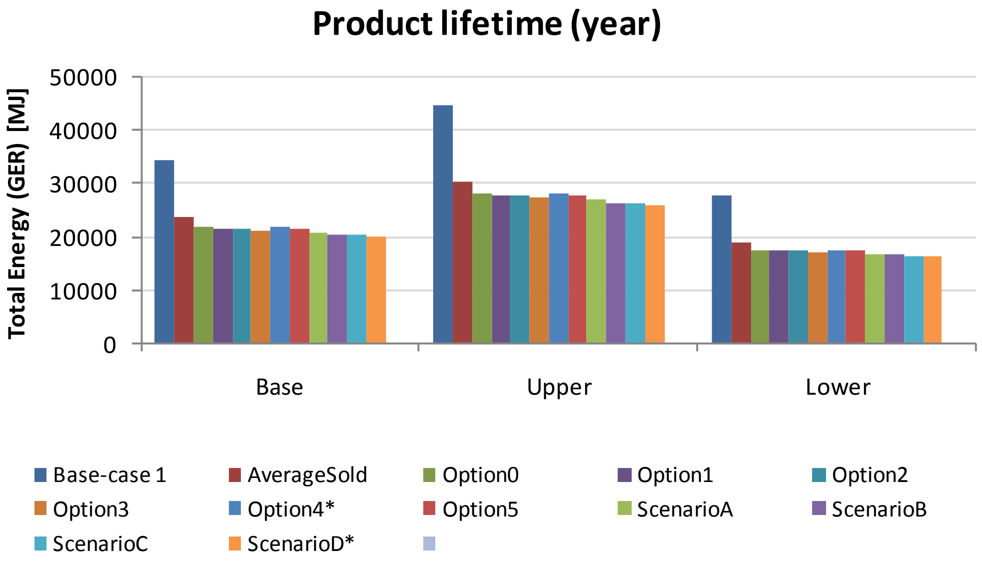


Figure 8-56: Sensitivity to product lifetime for Base-case 1's Total Energy

B. Base-case 2: Domestic gas oven

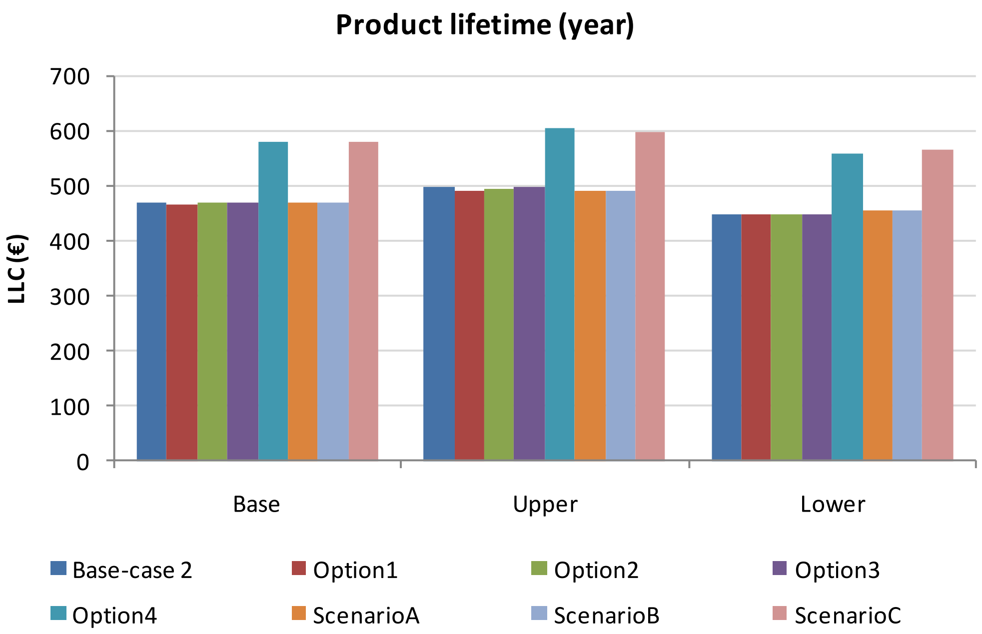


Figure 8-57: Sensitivity to product lifetime for Base-case 2's Life Cycle Cost

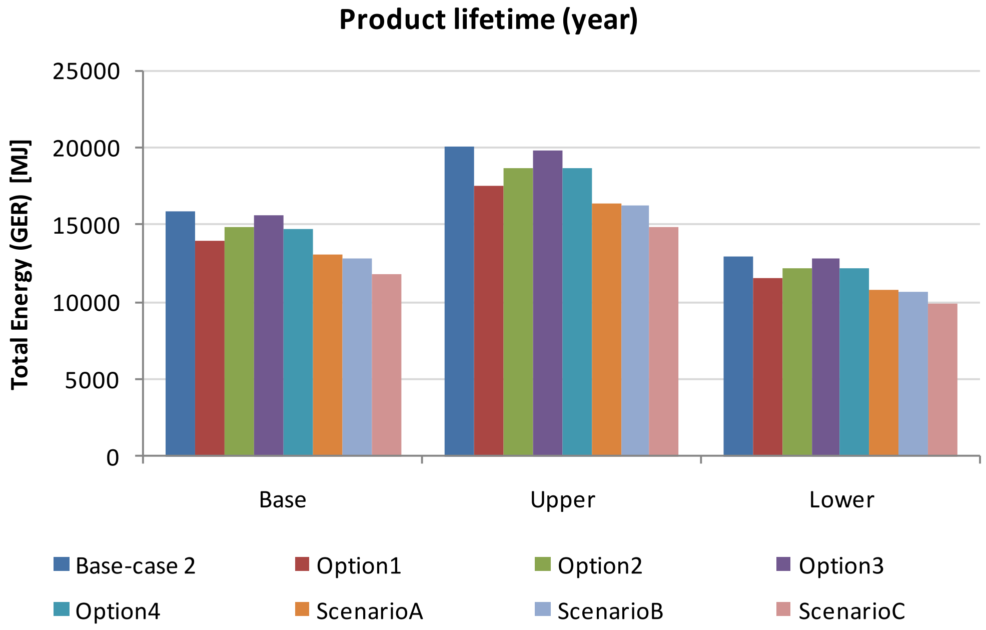


Figure 8-58: Sensitivity to product lifetime for Base-case 2's Total Energy Consumption

C. Base-case 3: Domestic microwave oven

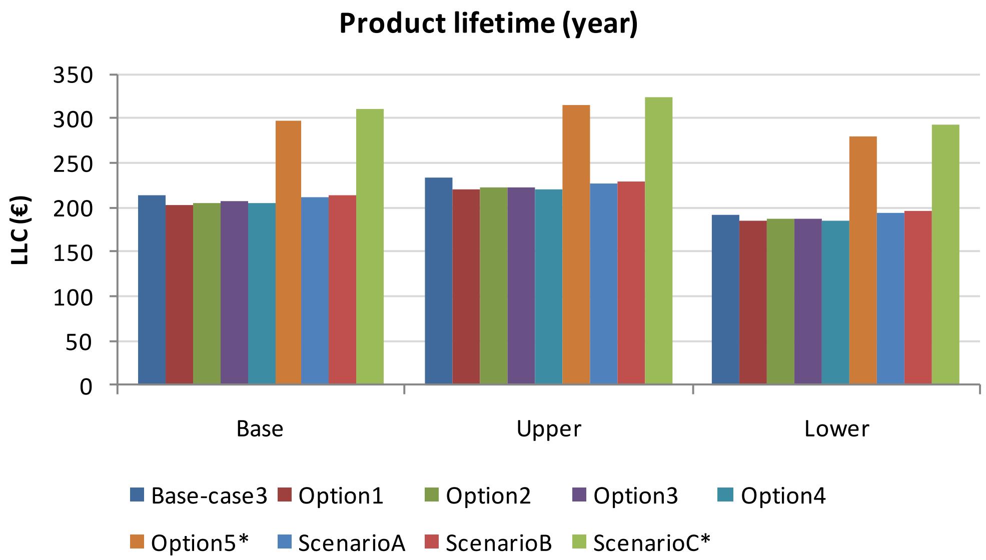


Figure 8-59: Sensitivity to product lifetime for Base-case 3's Life Cycle Cost

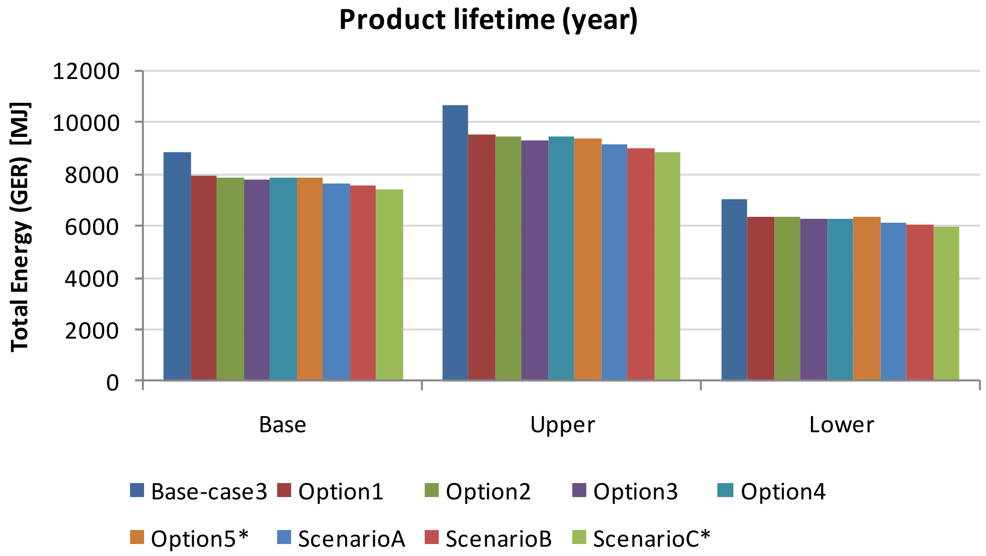


Figure 8-60: Sensitivity to product lifetime for Base-case 3's Total Energy Consumption

D. Base-case 4: Commercial electric combi-steamer

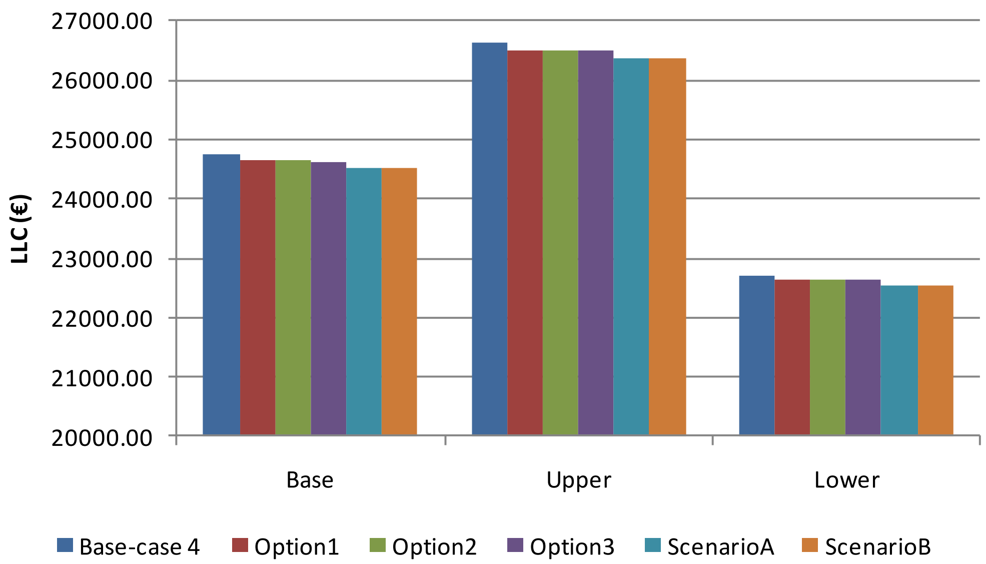


Figure 8-61: Sensitivity to product lifetime for Base-case 4's Life Cycle Cost

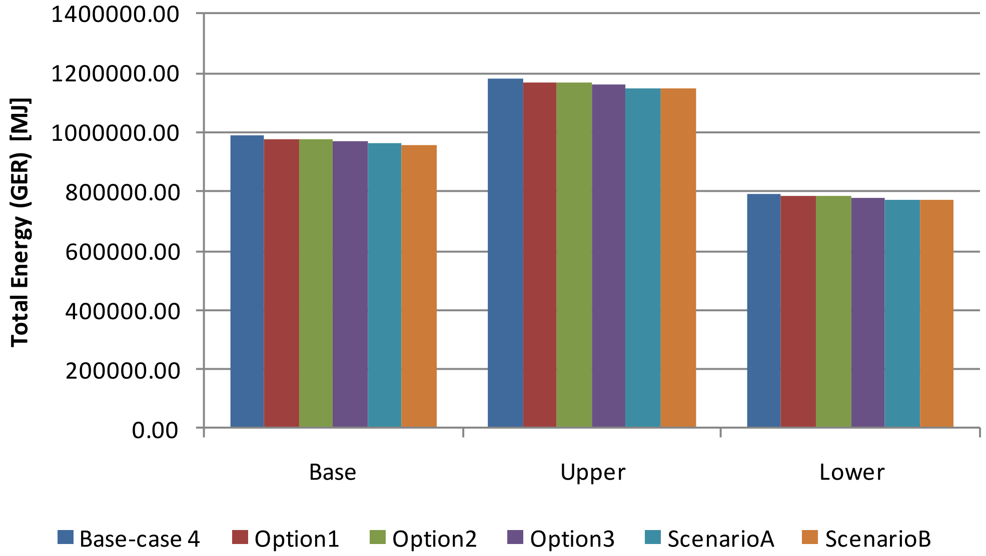


Figure 8-62: Sensitivity to product lifetime for Base-case 4's Total Energy Consumption

E. Base-case 5: Commercial gas combi-steamer

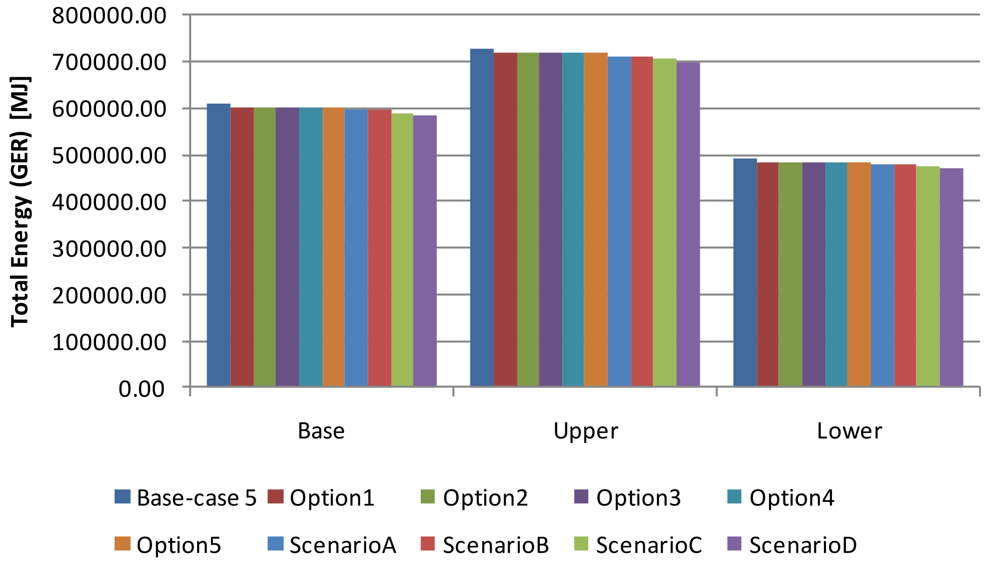


Figure 8-63: Sensitivity to product lifetime for Base-case 5's Total Energy Consumption

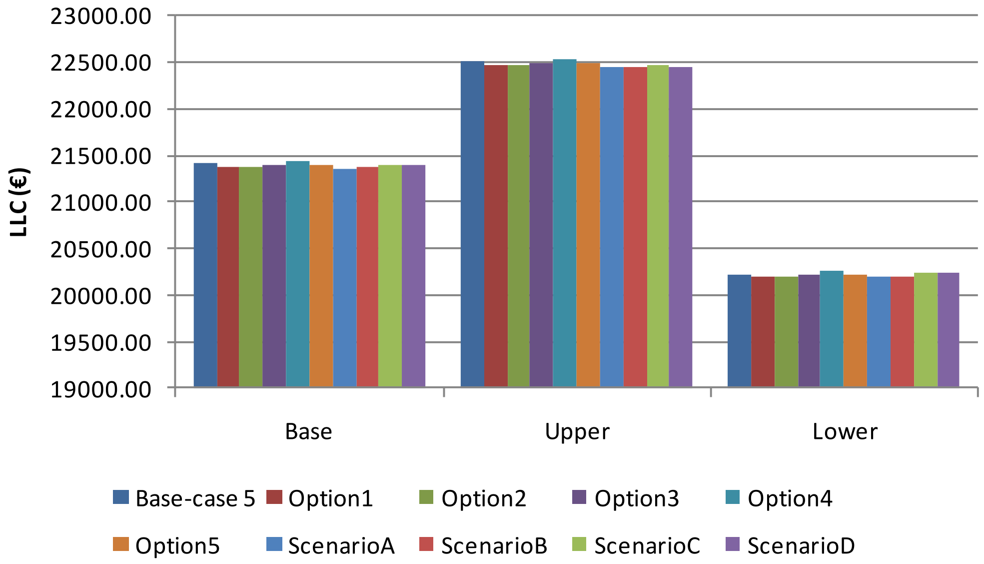


Figure 8-64: Sensitivity to product lifetime for Base-case 5's Life Cycle Cost

F. Base-case 6: Commercial in-store convection oven

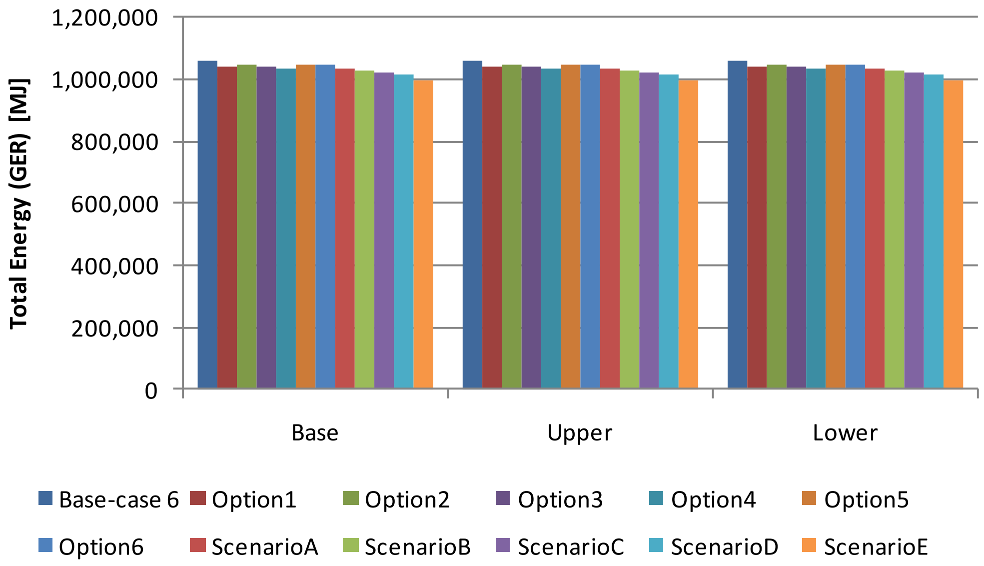


Figure 8-65: Sensitivity to product lifetime for Base-case 6's Total Energy Consumption

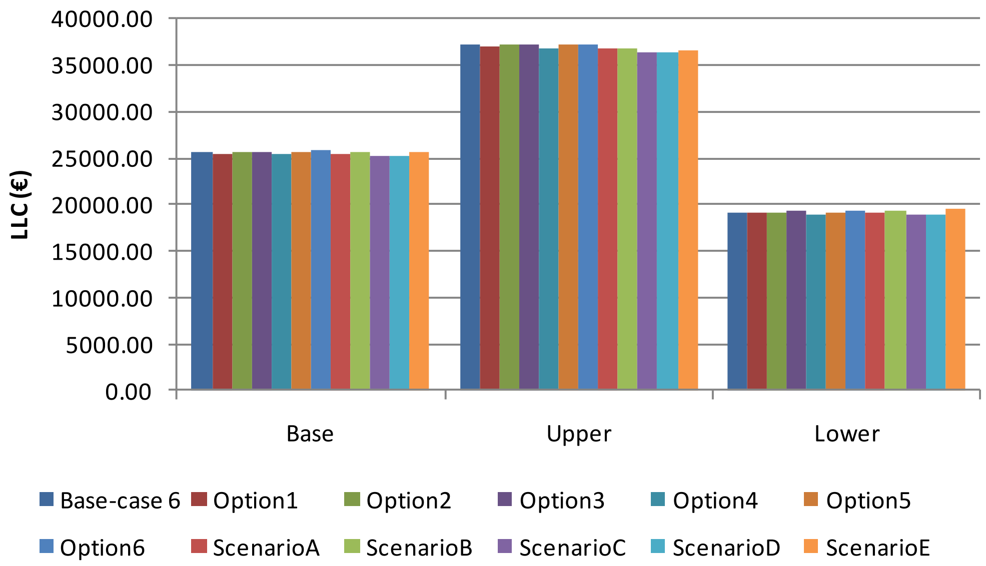


Figure 8-66: Sensitivity to product lifetime for Base-case 6's Total Energy Consumption

G. Base-case 7: Commercial electric deck oven

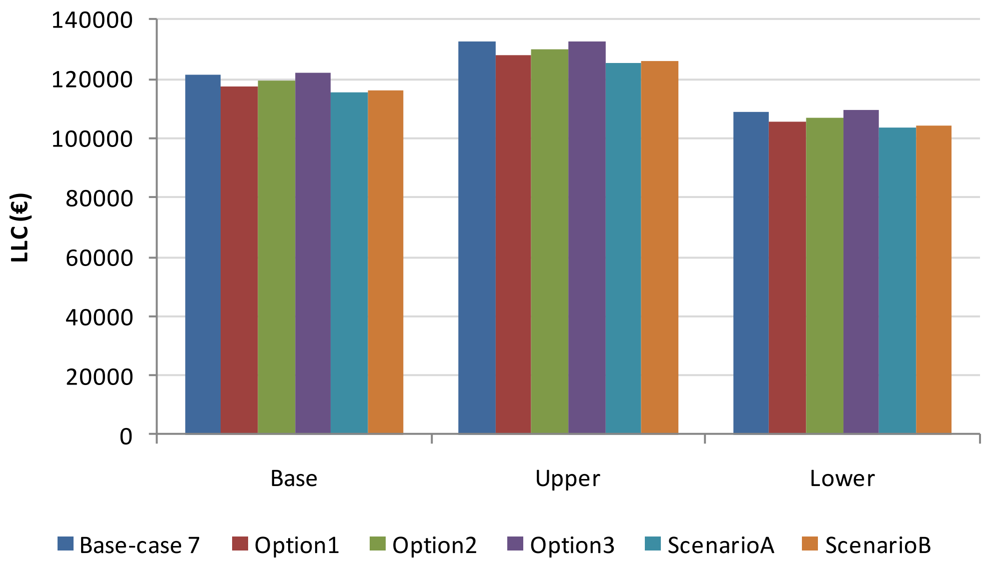


Figure 8-67: Sensitivity to product lifetime for Base-case 7's Life Cycle Cost

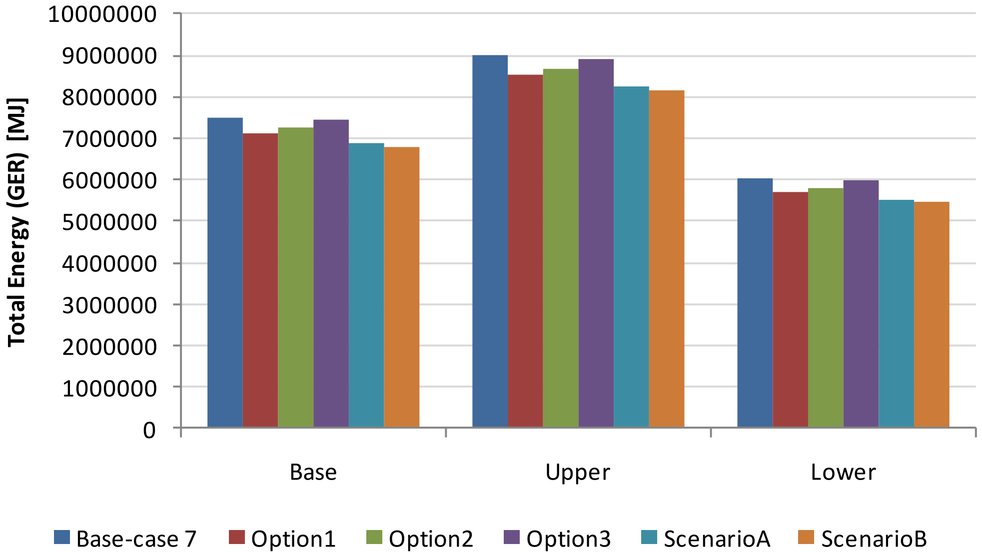


Figure 8-68: Sensitivity to product lifetime for Base-case 7's Total Energy Consumption

H. Base-case 8: Commercial gas deck oven

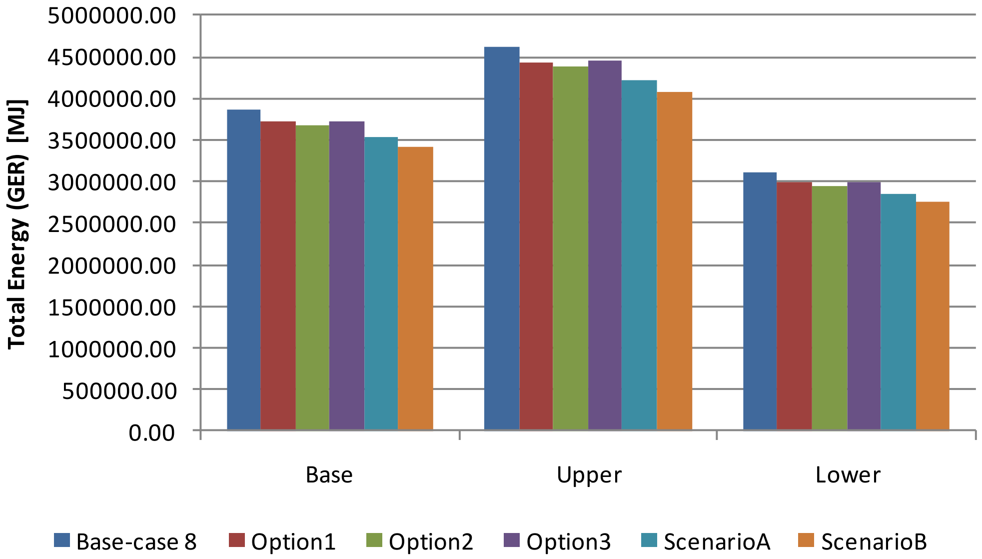


Figure 8-69: Sensitivity to product lifetime for Base-case 8's Total Energy Consumption

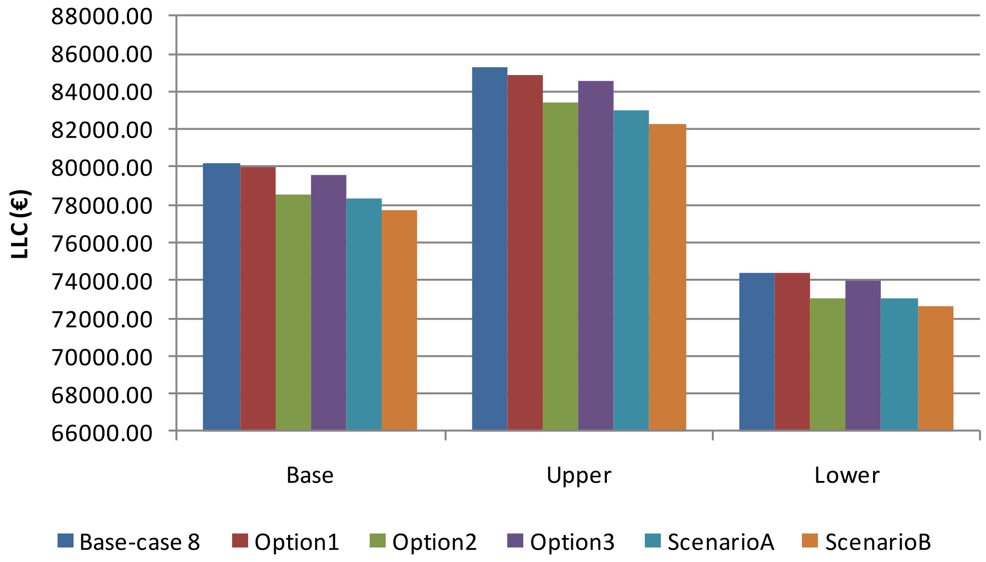


Figure 8-70: Sensitivity to product lifetime for Base-case 8's Life Cycle Cost

I. Base-case 9: Commercial electric rotary rack oven

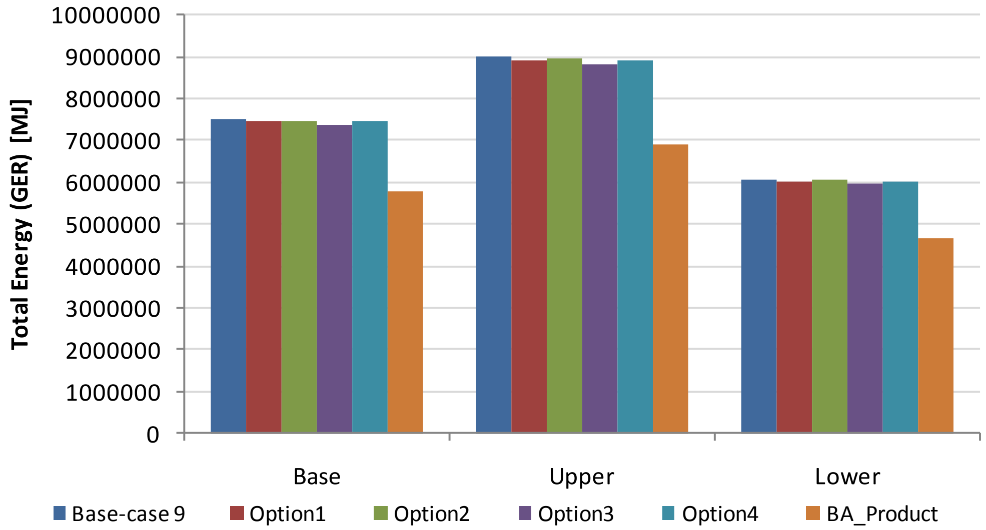


Figure 8-71: Sensitivity to product lifetime for Base-case 9's Total Energy Consumption

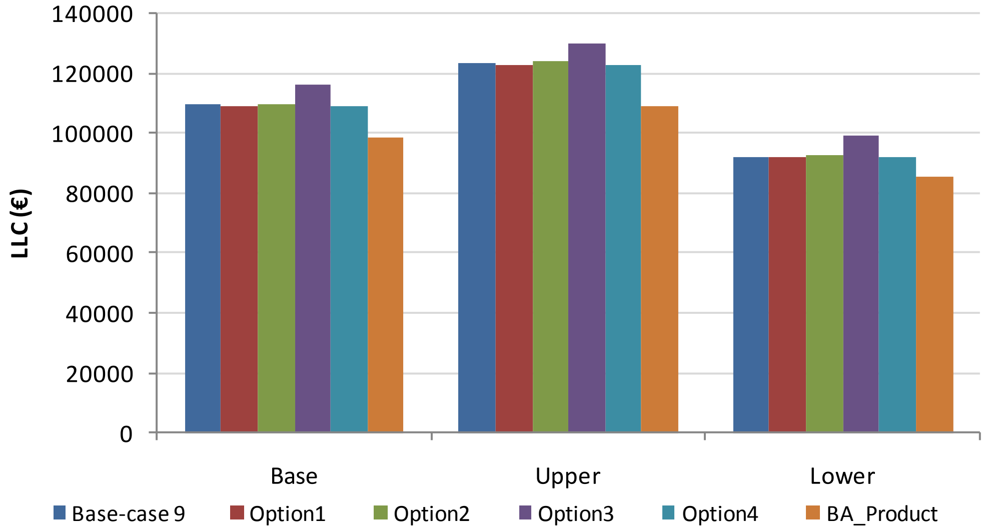


Figure 8-72: Sensitivity to product lifetime for Base-case 9's Life Cycle Cost

J. Base-case 10: Commercial gas rotary rack oven

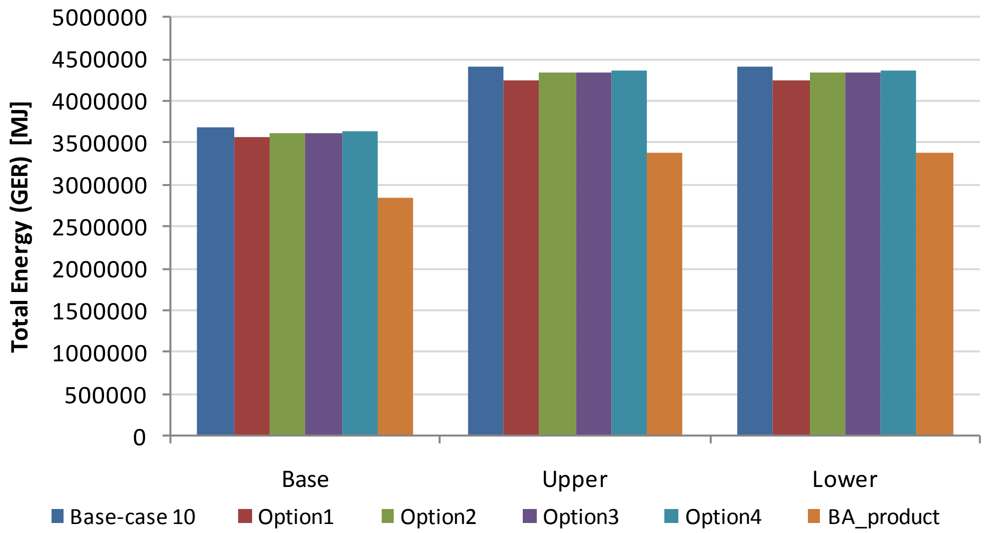


Figure 8-73: Sensitivity to product lifetime for Base-case 10's Total Energy Consumption

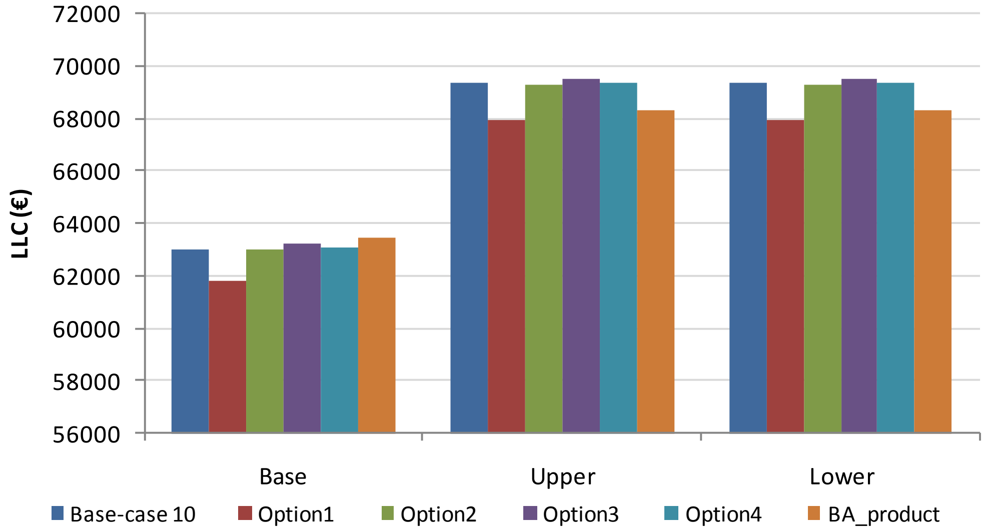


Figure 8-74: Sensitivity to product lifetime for Base-case 10's Life Cycle Cost

8.5.2. Assumption related to the product price

Product prices were increased and decreased by 10%. For options, this includes a variation of the price of the base-case and the additional price implied by the improvement.

Figure 8-75 to Figure 8-84 presents the sensitivity to product price.

A. Base-case 1: Domestic electric oven

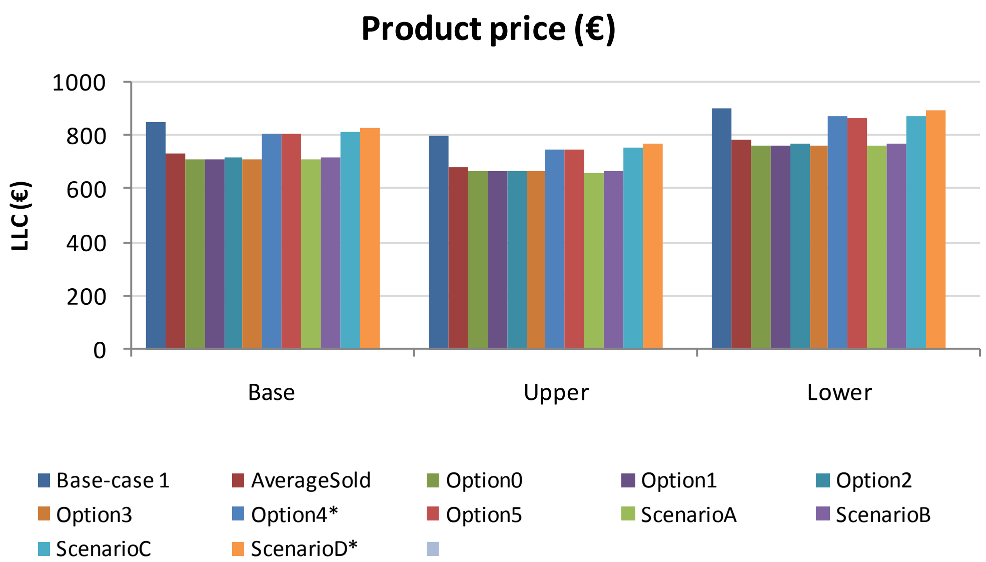


Figure 8-75: Sensitivity to product price for Base-case 1's Life Cycle Cost

B. **Base-case 2: Domestic gas oven**

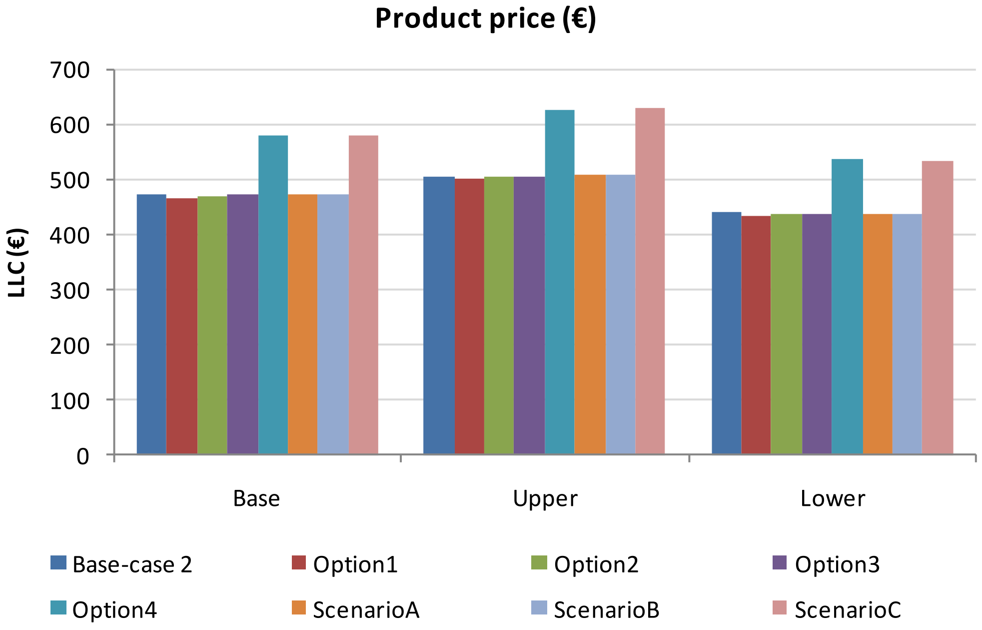


Figure 8-76: Sensitivity to product price for Base-case 2's Life Cycle Cost

C. **Base-case 3: Domestic microwave oven**

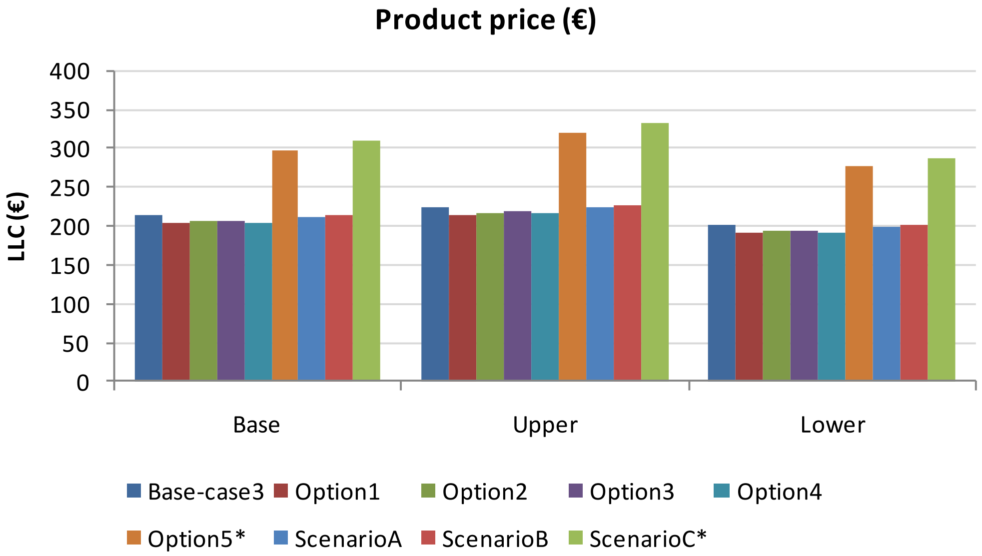


Figure 8-77: Sensitivity to product price for Base-case 3's Life Cycle Cost

D. Base-case 4: Commercial electric combi-steamer

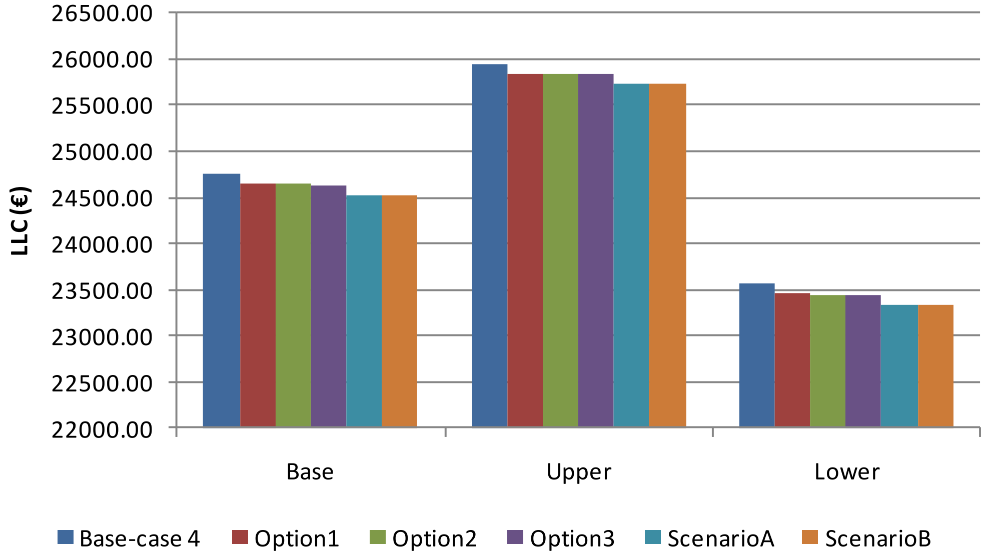


Figure 8-78: Sensitivity to product price for Base-case 4's Life Cycle Cost

E. Base-case 5: Commercial gas combi-steamer

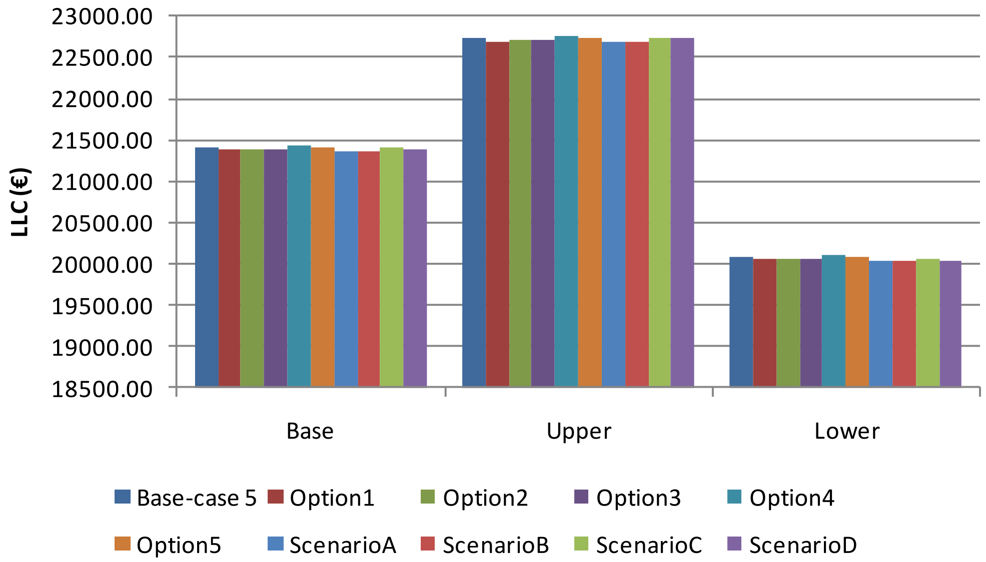


Figure 8-79: Sensitivity to product price for Base-case 5's Life Cycle Cost

F. **Base-case 6: Commercial in-store convection oven**

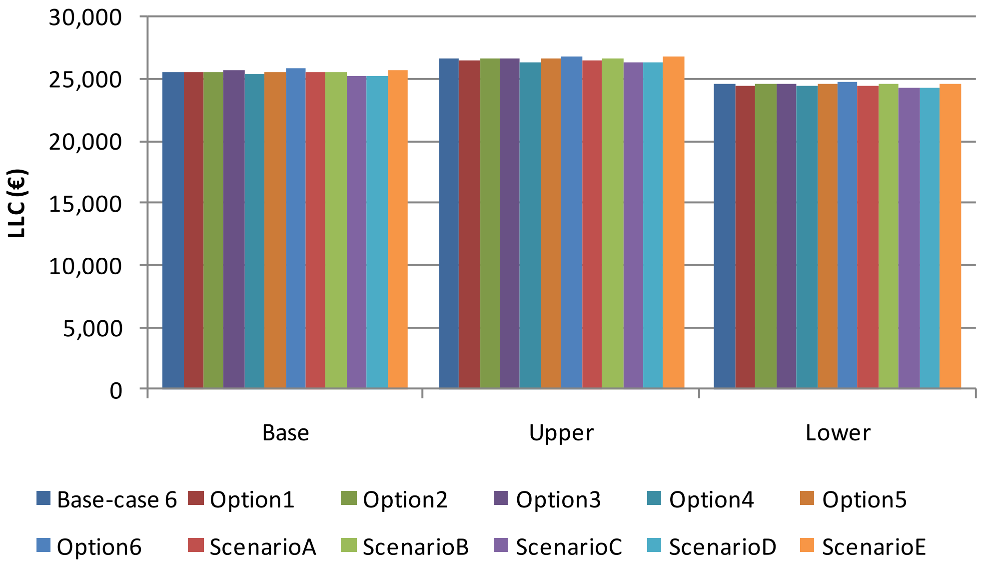


Figure 8-80: Sensitivity to product price for Base-case 6's Life Cycle Cost

G. **Base-case 7: Commercial electric deck oven**

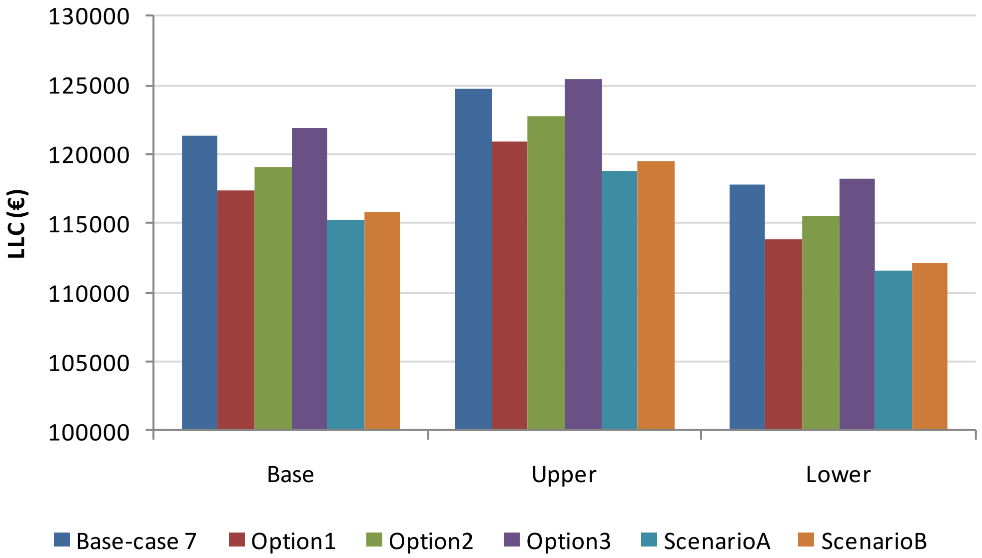


Figure 8-81: Sensitivity to product price for Base-case 7's Life Cycle Cost

H. Base-case 8: Commercial gas deck oven

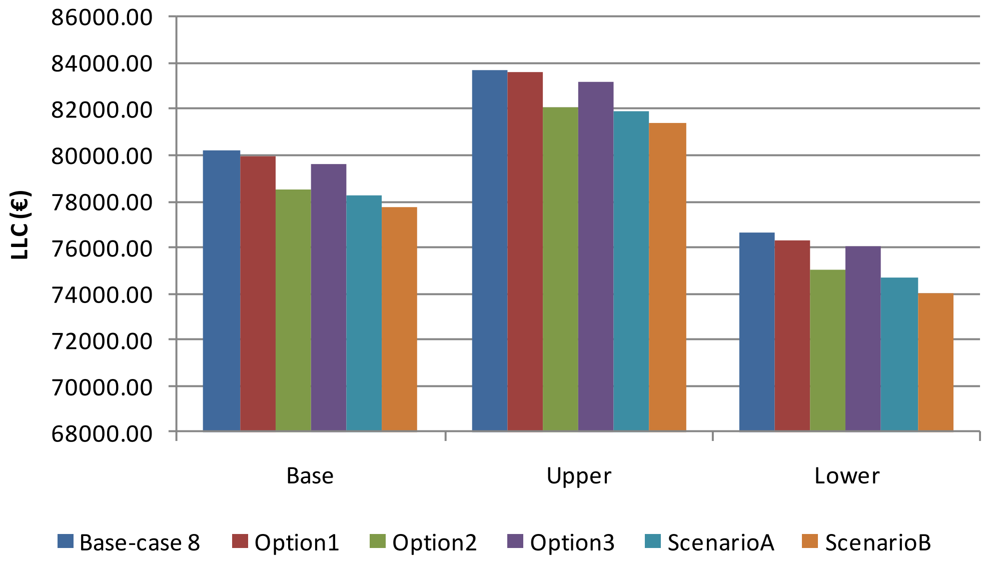


Figure 8-82: Sensitivity to product price for Base-case 8's Life Cycle Cost

I. Base-case 9: Commercial electric rotary rack oven

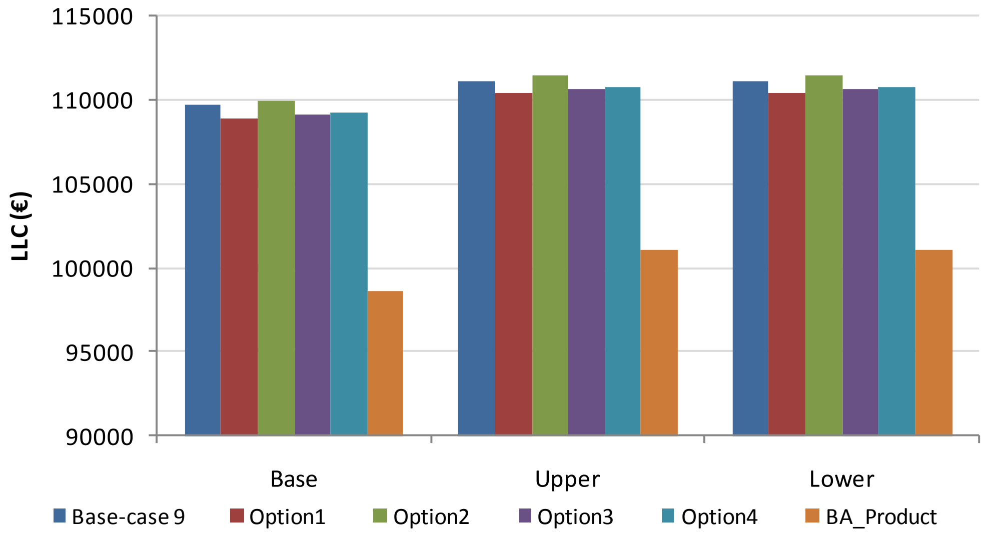


Figure 8-83: Sensitivity to product price for Base-case 9's Life Cycle Cost

J. Base-case 10: Commercial gas rotary rack oven

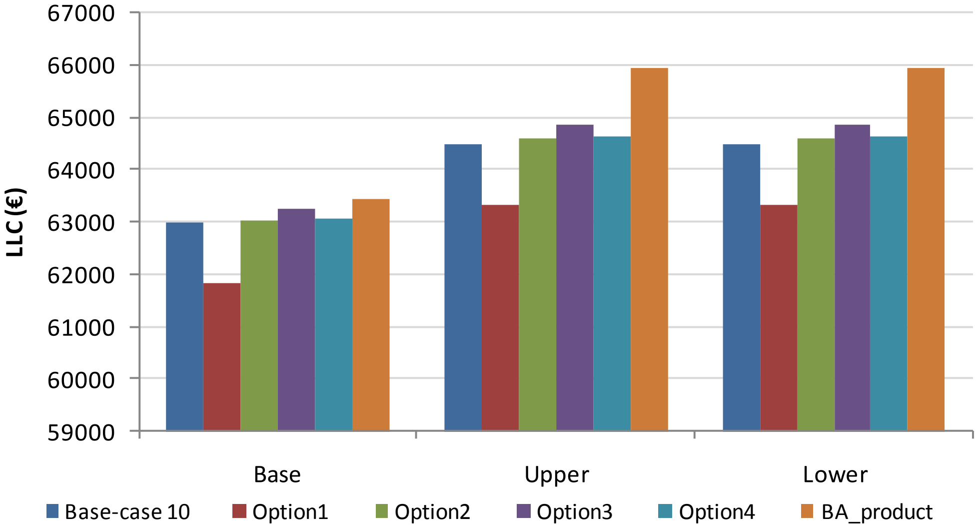


Figure 8-84: Sensitivity to product price for Base-case 10's Life Cycle Cost

8.5.3. Assumption related to the electricity rates

Price of electricity varies a lot across Member States. Electricity rate's variations are presented in Table 8-23. The sensitivity to electricity rate is analysed for all Base-cases except Base-case 2 for which there is no electricity consumption.

Table 8-23: Variation of electricity rate according to sector

Sector	Current value	Lower value	Upper value
Domestic	0.1658 €	0.0823 €	0.2698 €
Commercial	0.1554 €	0.0780 €	0.2928 €

Sensitivity to electricity rate is presented in Figure 8-85 to Figure 8-93.

A. Base-case 1: Domestic electric oven

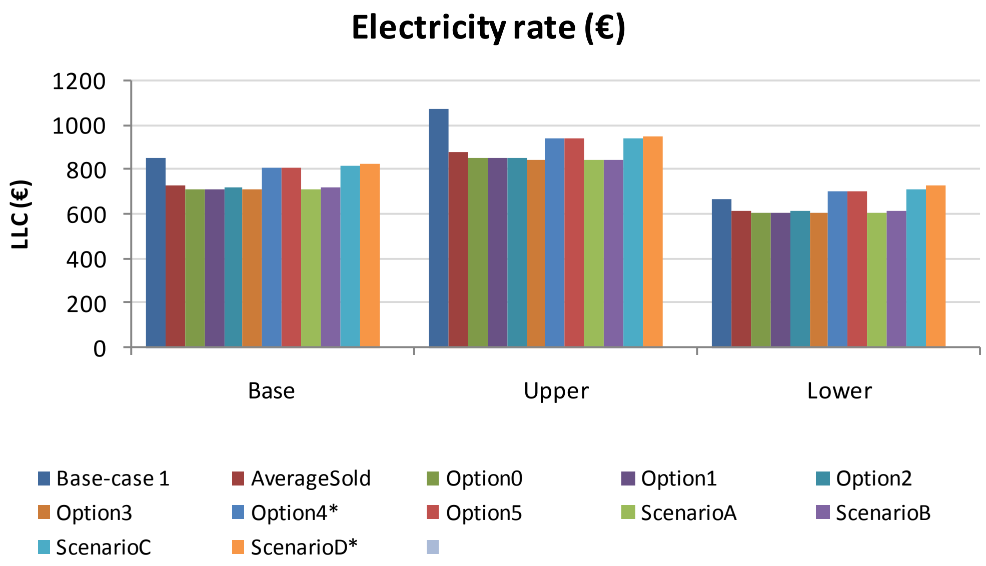


Figure 8-85: Sensitivity to electricity rate for Base-case 1's Life Cycle Cost

B. Base-case 3: Domestic microwave oven

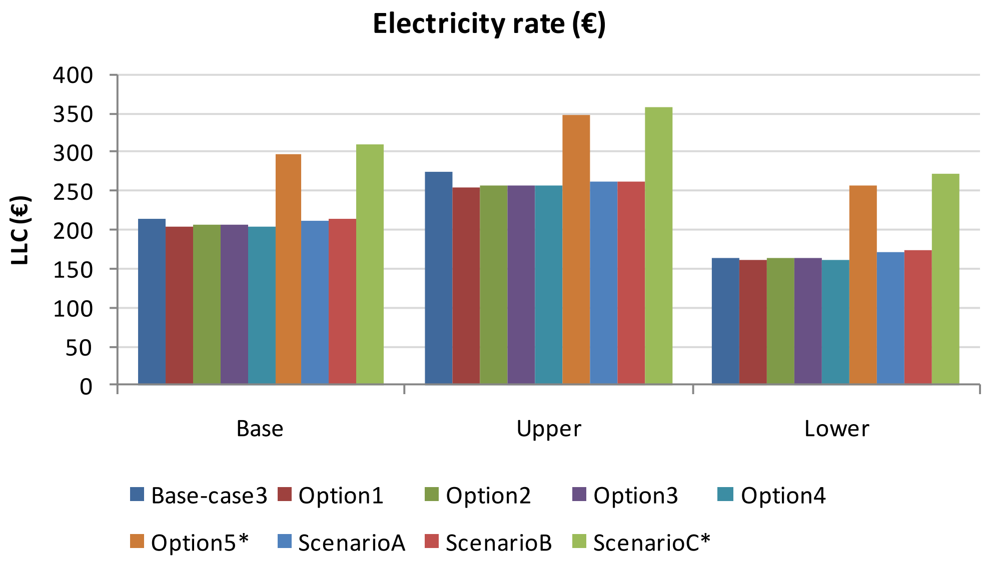


Figure 8-86: Sensitivity to electricity rate for Base-case 3's Life Cycle Cost

C. Base-case 4: Commercial electric combi-steamer

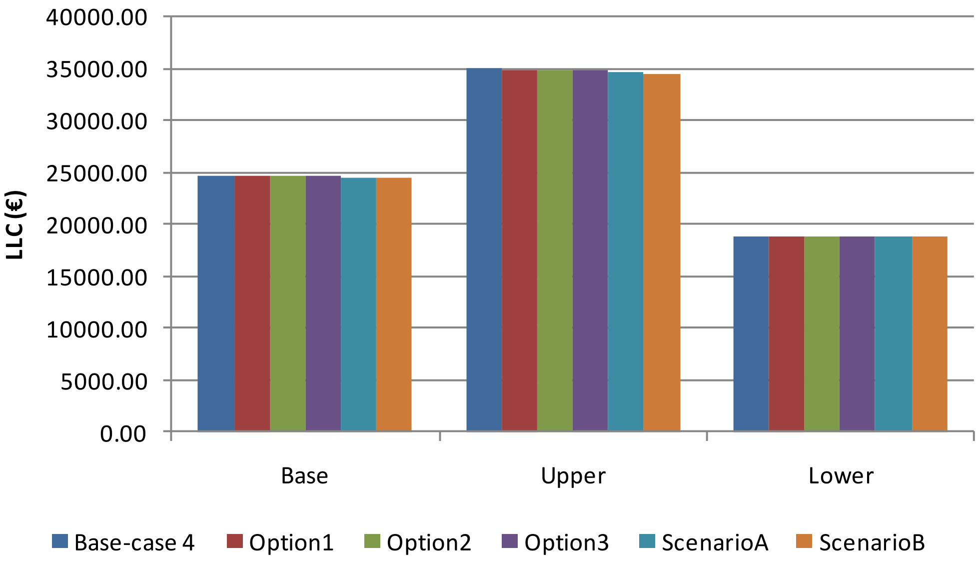


Figure 8-87: Sensitivity to electricity rate for Base-case 4's Life Cycle Cost

D. Base-case 5: Commercial gas combi-steamer

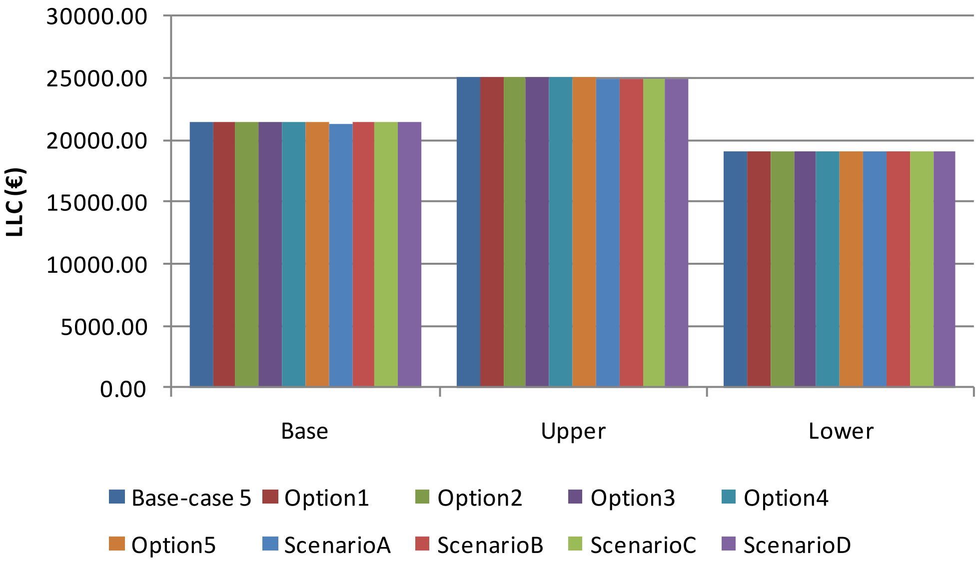


Figure 8-88: Sensitivity to electricity rate for Base-case 5's Life Cycle Cost

E. Base-case 6: Commercial in-store convection oven

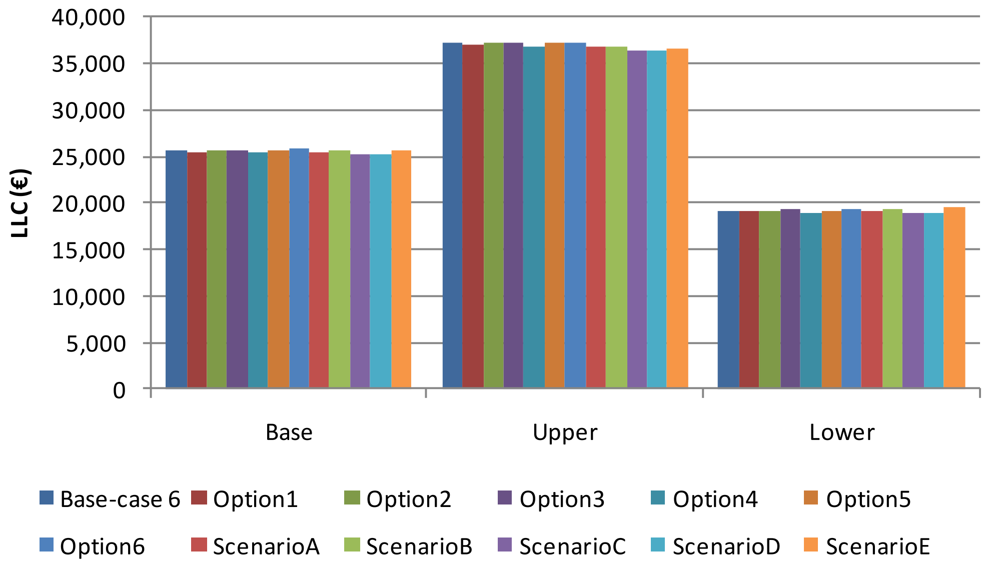


Figure 8-89: Sensitivity to electricity rate for Base-case 6's Life Cycle Cost

F. Base-case 7: Commercial electric deck oven

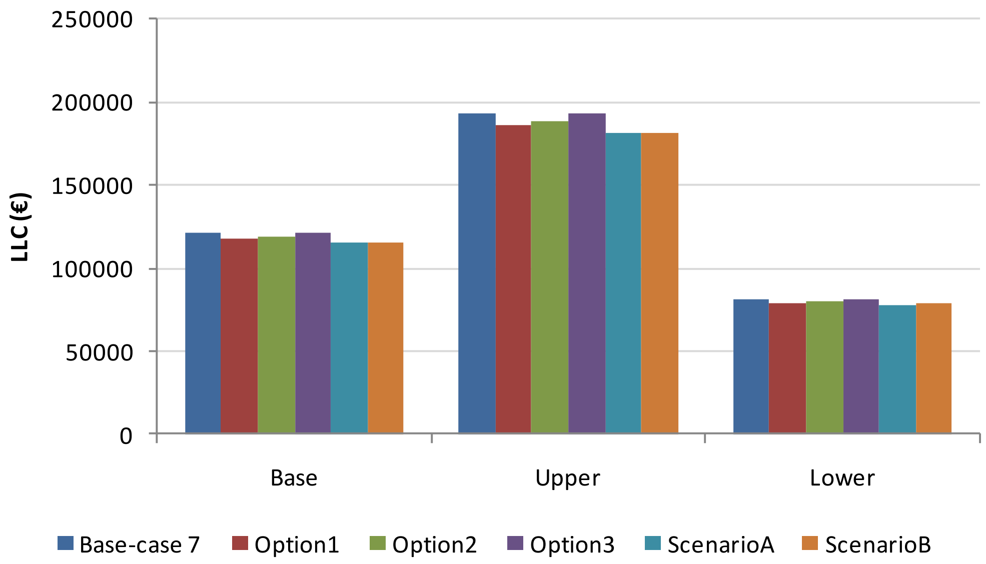


Figure 8-90: Sensitivity to electricity rate for Base-case 7's Life Cycle Cost

G. Base-case 8: Commercial gas deck oven

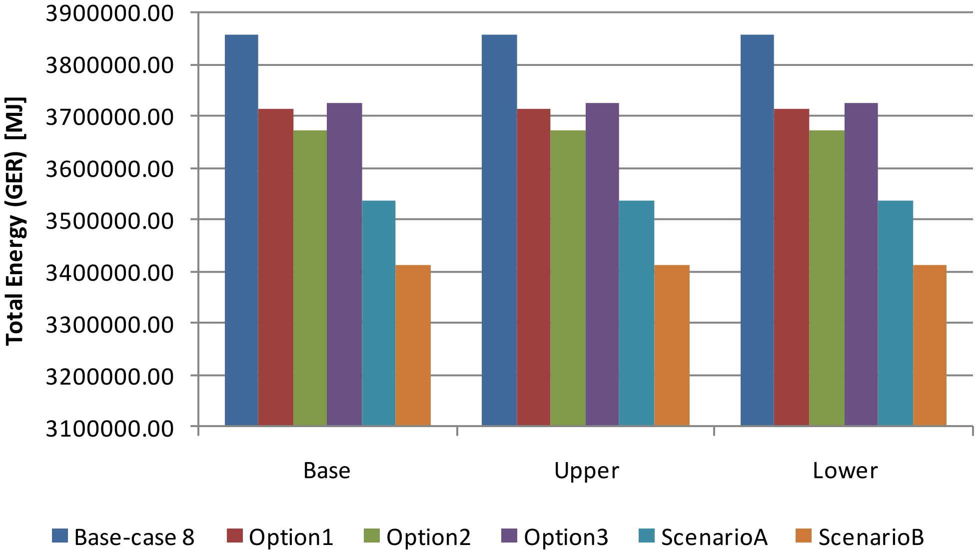


Figure 8-91: Sensitivity to electricity rate for Base-case 8's Life Cycle Cost

H. Base-case 9: Commercial electric rotary rack oven

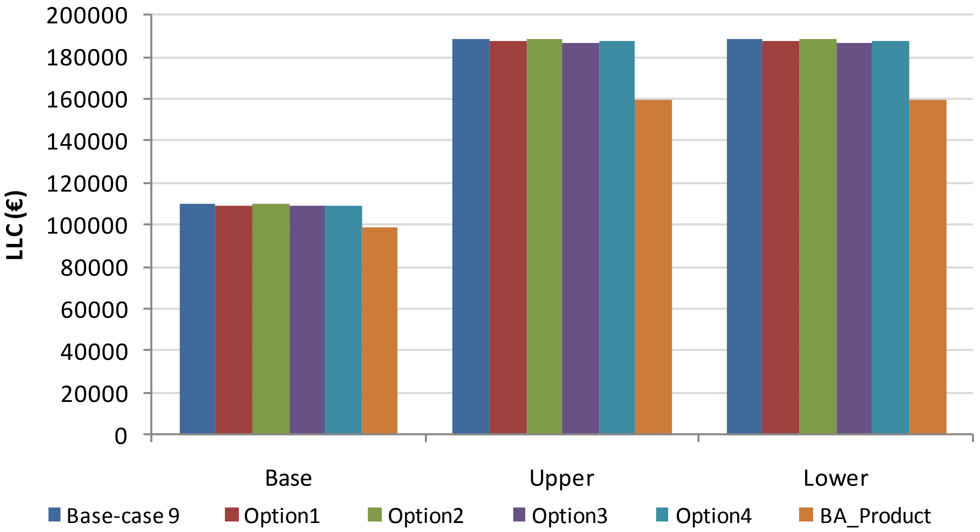


Figure 8-92: Sensitivity to electricity rate for Base-case 9's Life Cycle Cost

I. **Base-case 10: Commercial gas rotary rack oven**

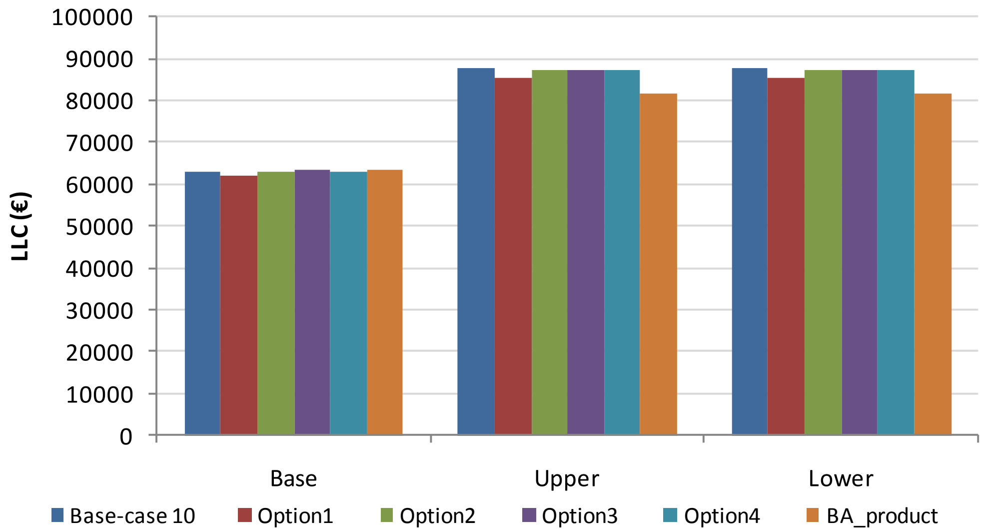


Figure 8-93: Sensitivity to electricity rate for Base-case 10's Life Cycle Cost

8.5.4. ASSUMPTION RELATED TO THE GAS RATES

Price of gas varies a lot across Member States. Gas rate's variations are presented in Table 8-24. The sensitivity to electricity rate is analysed for all Base-cases except Base-case 2 for which there is no electricity consumption.

Table 8-24: Variation of gas rate according to sector

Sector	Current value	Lower value	Upper value
Domestic	16.21 €	8.11 €	25.55 €
Commercial	14.81 €	7.94 €	25.55 €

Sensitivity to gas rate is presented in Figure 8-94 to Figure 8-97.

A. Base-case 2: Domestic gas oven

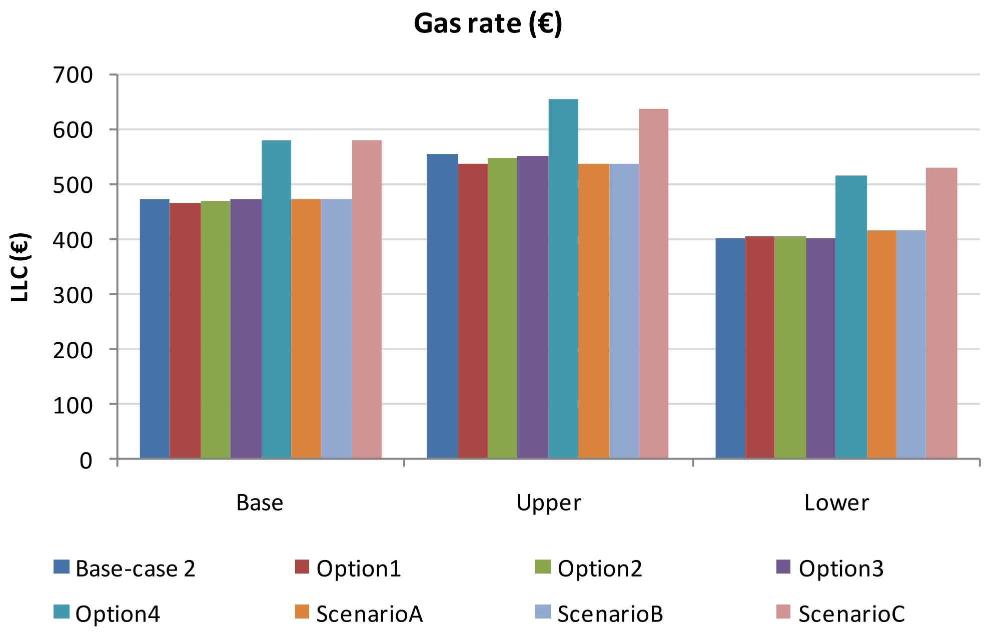


Figure 8-94: Sensitivity to gas rate for Base-case 2's Life Cycle Cost

B. Base-case 5: Commercial gas combi-steamer

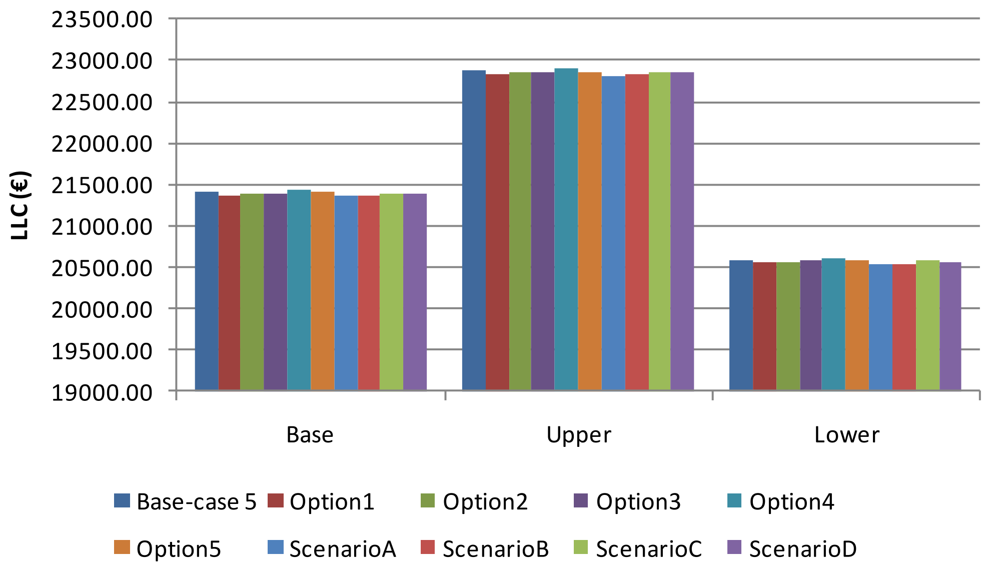


Figure 8-95: Sensitivity to gas rate for Base-case 5's Life Cycle Cost

C. Base-case 8: Commercial gas deck oven

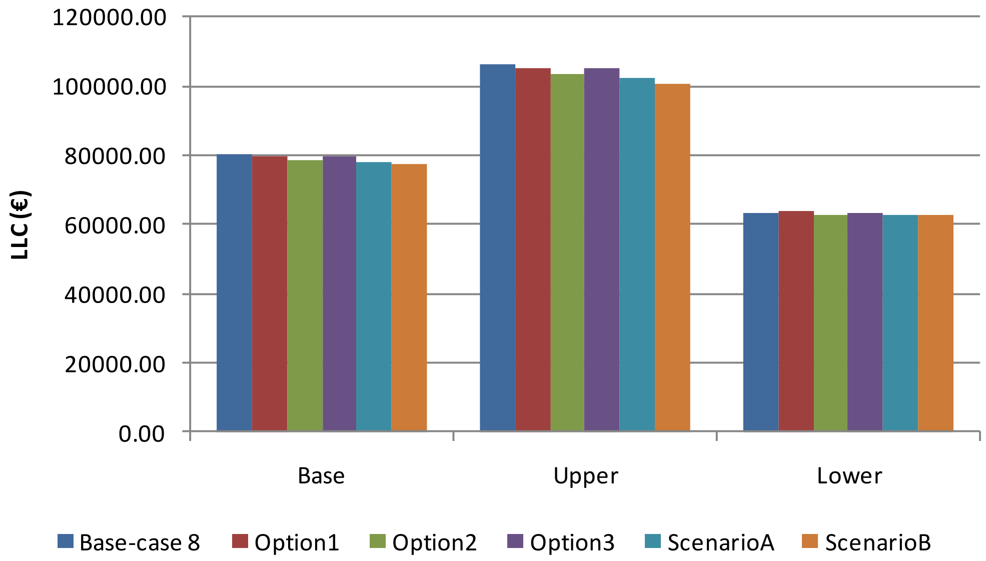


Figure 8-96: Sensitivity to gas rate for Base-case 8's Life Cycle Cost

D. Base-case 10: Commercial gas rotary rack oven

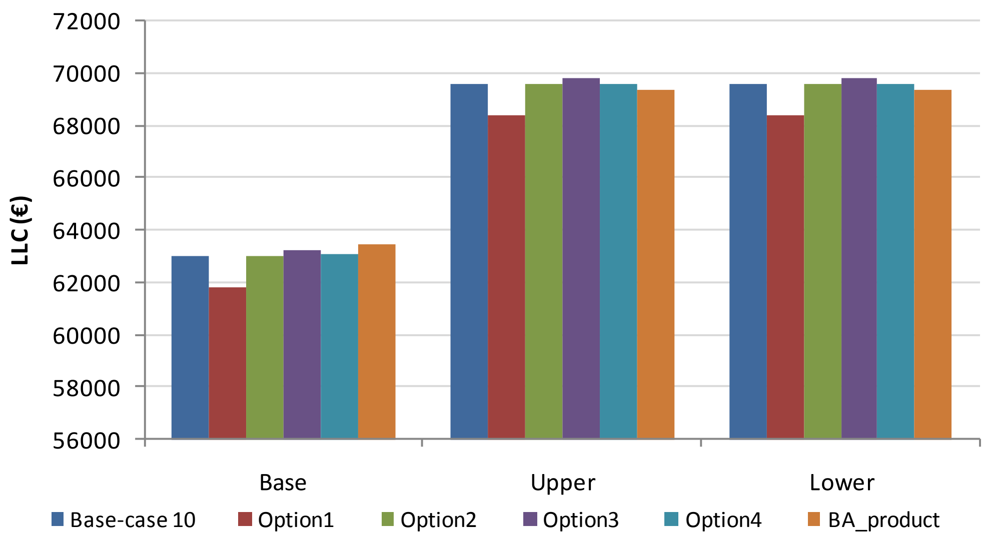


Figure 8-97: Sensitivity to gas rate for Base-case 10's Life Cycle Cost

8.5.5. Assumption related to the discount rate

The European Commission requires the use of 4% as discount rate. This parameter has a significant influence on the calculation of life cycle cost. It was varied between 2% and 6%. Results are presented in Figure 8-98 to Figure 8-107.

A. Base-case 1: Domestic electric oven

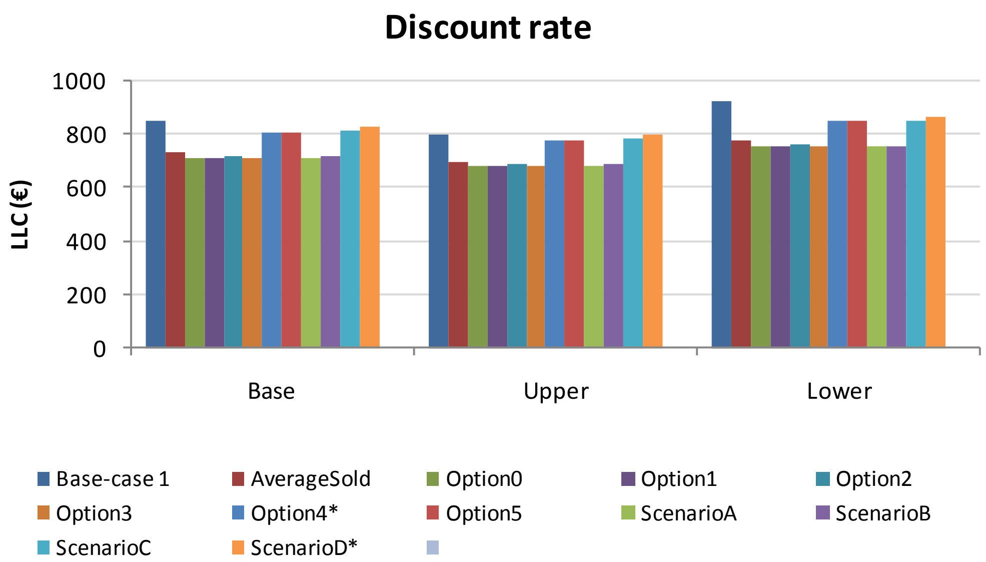


Figure 8-98: Sensitivity to discount rate for Base-case 1's Life Cycle Cost

B. Base-case 2: Domestic gas oven

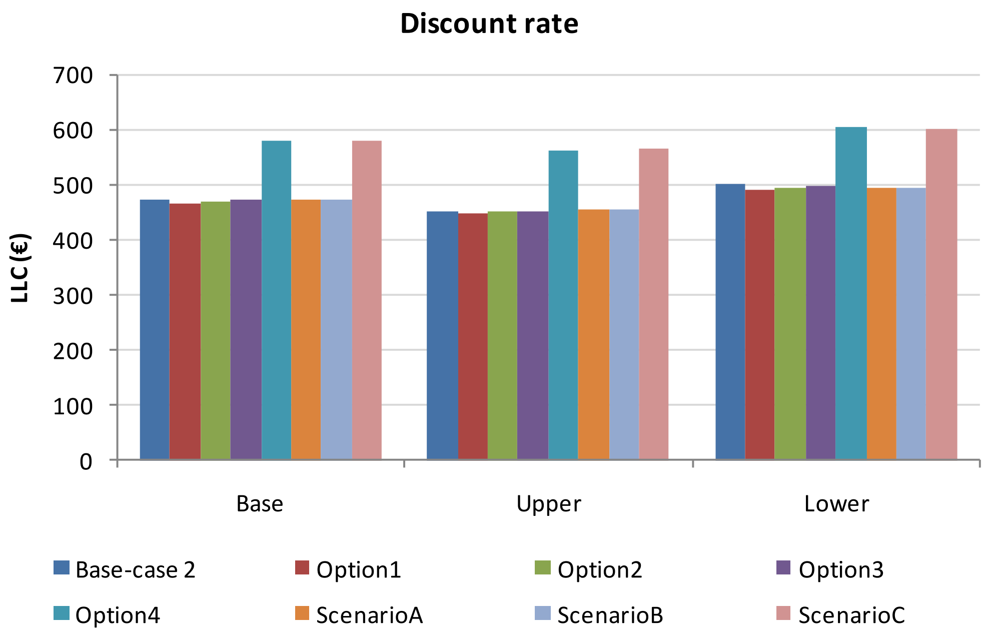


Figure 8-99: Sensitivity to discount rate for Base-case 2's Life Cycle Cost

C. Base-case 3: Domestic microwave oven

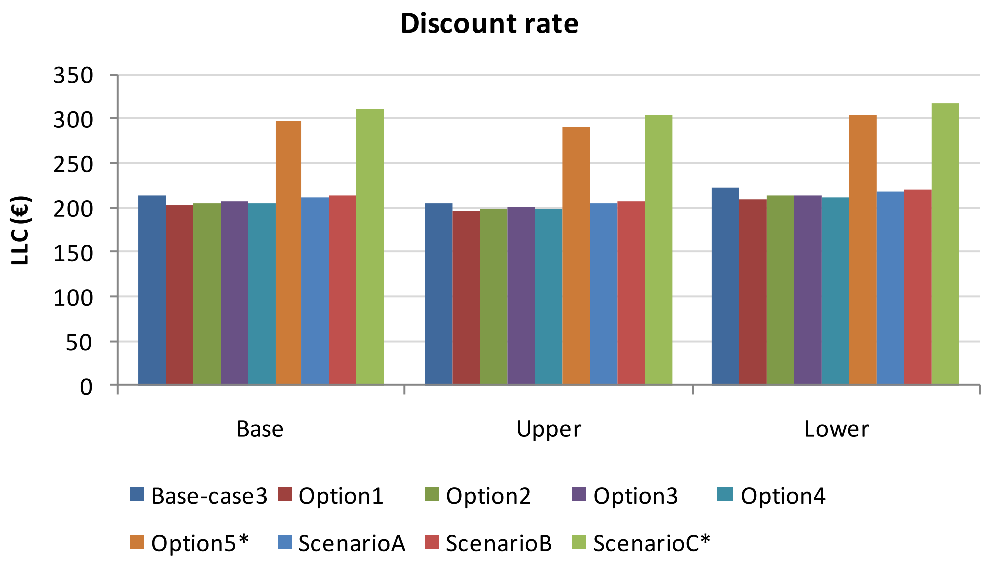


Figure 8-100: Sensitivity to discount rate for Base-case 3's Life Cycle Cost

D. Base-case 4: Commercial electric combi-steamer

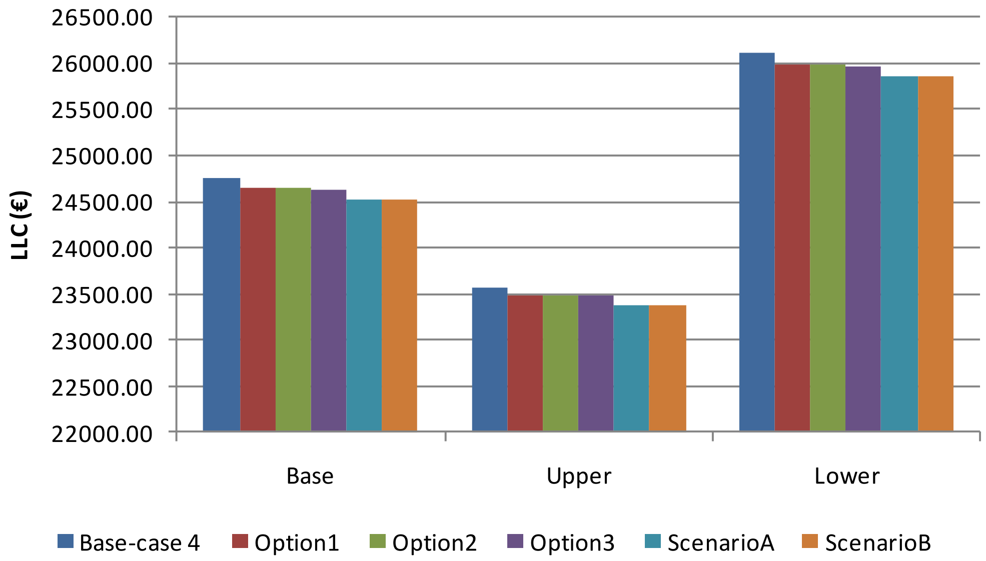


Figure 8-101: Sensitivity to discount rate for Base-case 4's Life Cycle Cost

E. Base-case 5: Commercial gas combi-steamer

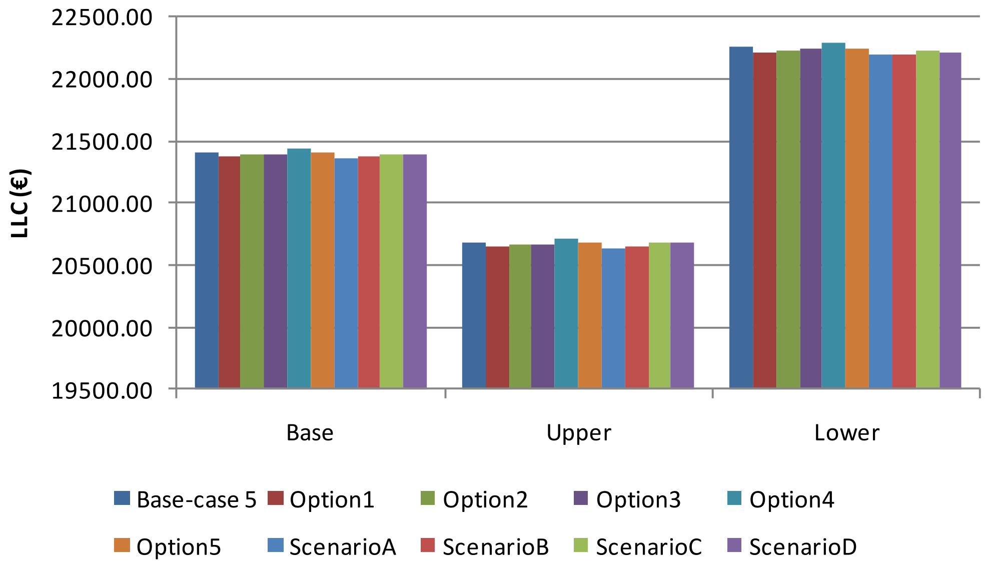


Figure 8-102: Sensitivity to discount rate for Base-case 5's Life Cycle Cost

F. Base-case 6: Commercial in-store convection oven

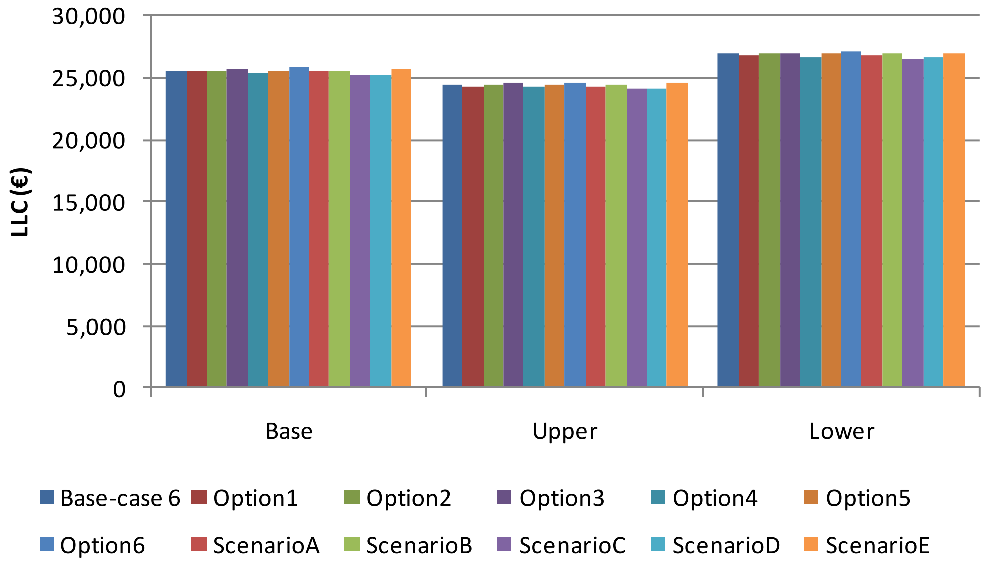


Figure 8-103: Sensitivity to discount rate for Base-case 6's Life Cycle Cost

G. Base-case 7: Commercial electric deck oven

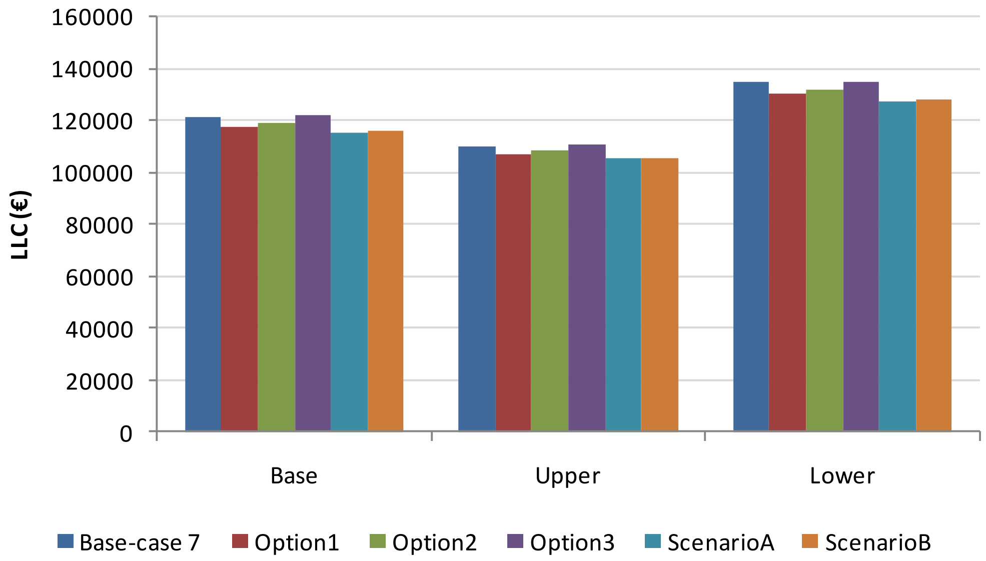


Figure 8-104: Sensitivity to discount rate for Base-case 7's Life Cycle Cost

H. Base-case 8: Commercial gas deck oven

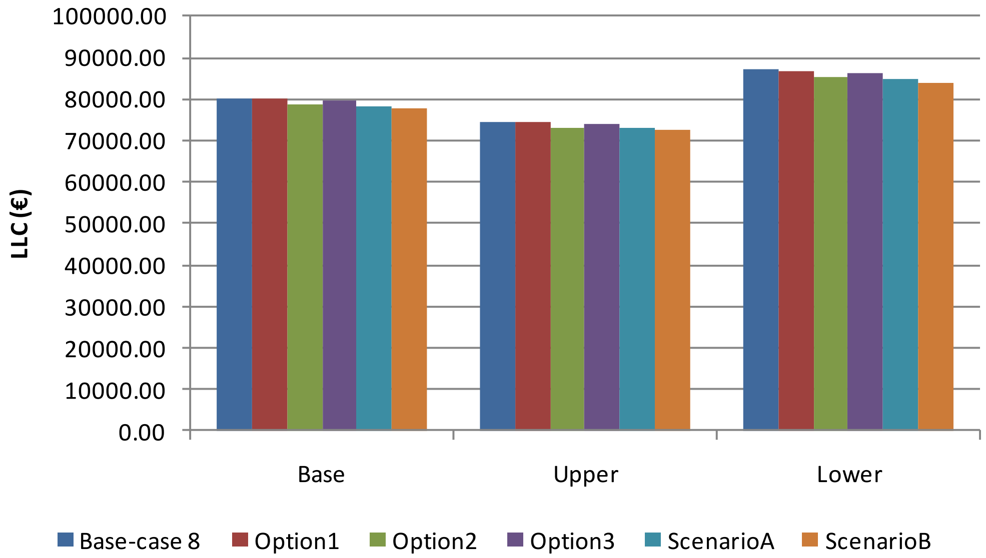
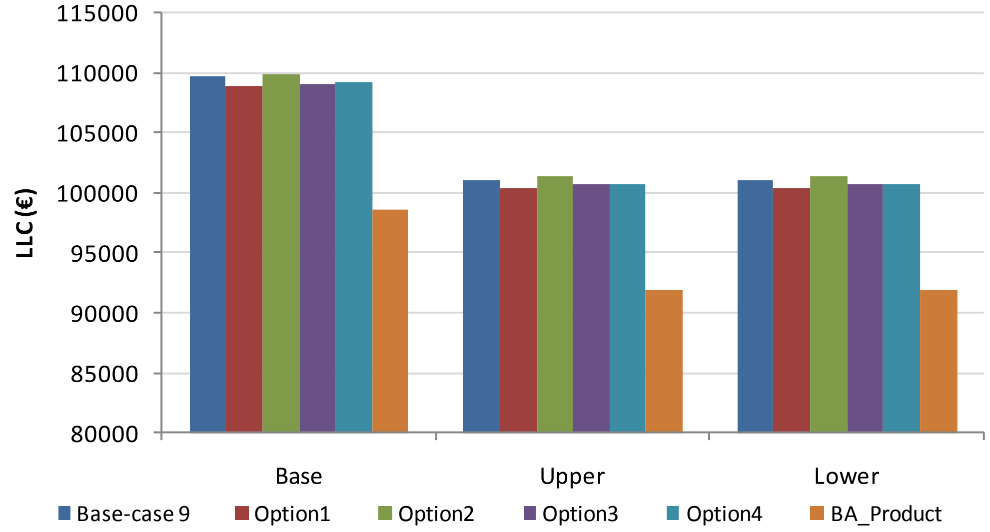


Figure 8-105: Sensitivity to discount rate for Base-case 8's Life Cycle Cost

I. Base-case 9: Commercial electric rotary rack oven



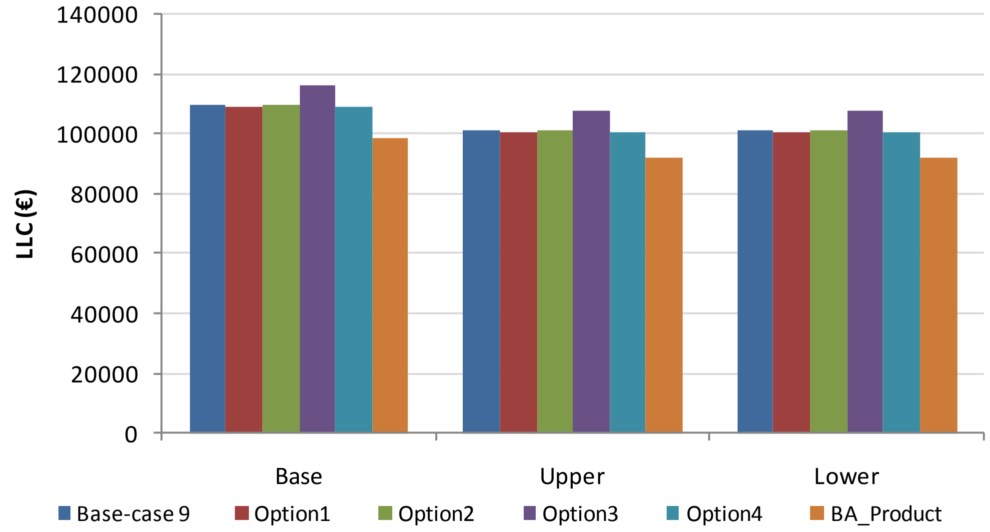


Figure 8-106: Sensitivity to discount rate for Base-case 9's Life Cycle Cost

J. Base-case 10: Commercial gas rotary rack oven

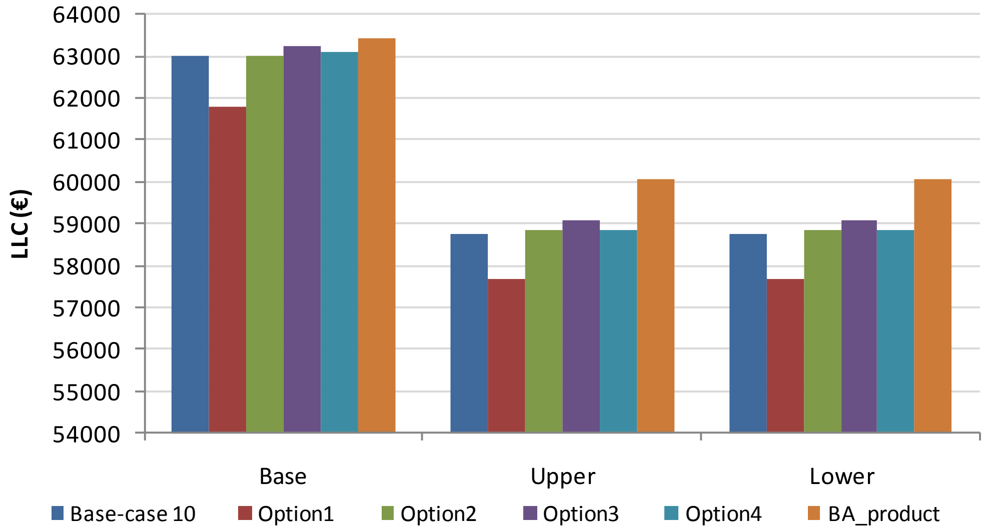


Figure 8-107: Sensitivity to discount rate for Base-case 10's Life Cycle Cost

8.6. CONCLUSIONS

This Task summarises the final outcomes of the ENER Lot 22 preparatory study. It looked at suitable policies and measures to achieve the environmental improvement potential, notably by the implementation an energy label for domestic ovens and by setting Minimum Energy Performance Standards (MEPS) adapted to each sector (domestic, restaurant, bakery). Such MEPS are dependent on the existence of harmonized standards. While harmonized test standards are available for domestic electric and gas ovens, there is no EN standard for measuring the energy consumption of commercial appliances. EFCEM is working on a draft standard concerning commercial combination ovens, which could lead to a possible EN standard in the coming years. The case of bakery ovens is more complex, as this industrial sector is less structured at the European level, and it is therefore likely that the development of an EN standard will take more time.

Concerning the domestic sector, a revision of the existing energy label for domestic electric ovens is worthwhile. Moreover, it is likely that implementing an energy label for domestic gas oven would reduce their average energy consumption. The question of common or separate energy classes for electric and gas ovens is discussed. Determining the approach which would lead to the largest energy savings is a delicate task, and would require further impact assessment. Additionally, the benefits of an energy label for microwave ovens are unclear, as all the solutions considered have significant drawbacks. MEPS were defined to be compatible with the suggestion energy label, and would result in banning the lower energy classes.

Policy recommendations concerning commercial combination ovens had to take into account the specificity of this market. Given its structure, too ambitious MEPS in the short term could harm European companies. Moreover, an energy label comparable to the domestic sector seems not to be adapted.

Recommendations regarding bakery ovens should be considered with caution. Indeed, these appliances were complex to assess as there are significant differences across the European Member States. Moreover, most manufacturers produce both commercial and industrial bakery ovens, and a differentiation between these two types is not always relevant, mainly in the case of rotary rack ovens. As only domestic and commercial appliances were in the scope of this study, the environmental and cost analysis was focused on commercial bakery ovens.

Finally, a sensitivity analysis was made with respect to the main assumptions used in the study. When varying the input data on 5 parameters: energy rate, discount rate, product purchase price, product lifetime and number of cycles/hours per year, the ranking of the Base-Case and the different improvement options / scenarios shows very limited variations for the 6 different Base-cases and tend to confirm the reliability of the outcomes.