Preparatory Studies for Eco-design Requirements of Energy-using Products

Lot 24: Professional Washing Machines, Dryers and Dishwashers

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Task 8: Scenario, Policy, Impact and Sensitivity Analysis

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For reasons of better readability, two Task 8 reports were prepared.

The report at hand covers ***professional dishwashers***.

The Task 8 report on *professional washing machines and dryers*
is published separately.

Part: Professional Dishwashers

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1 Introduction: Objective of Task 8

This task summarises the previous tasks and looks at suitable policy means to achieve the potential reduction in environmental impacts identified. Among the policy options to be considered are implementing Least Life Cycle Cost (LLCC) as a minimum and Best Available Technology (BAT) as a promotional target, using legislative or voluntary agreements, labelling public procurement, and other incentives.

The policy options considered and the conclusions are the opinions of the project team and do not represent the view of the European Commission. Unlike chapters 1-7, which will serve as the baseline data for future work (impact assessment, further discussions in the Consultation Forum, and possibly development of implementing measures) to be conducted by the European Commission, this chapter simply serves as a summary of policy implications as seen by the project team. Some parts of this chapter may be analysed in greater detail at the impact assessment stage.

The task draws up scenarios for the period 2010–2030 quantifying the improvements that can be achieved with respect to a Business-as-Usual (BAU) scenario, compares the outcomes with EU energy and environmental targets.

It makes an estimate of the impact on consumers and industry as described in Annex 2 of the Directive, explicitly describing and taking into account the typical design cycle (platform change) in a product sector as well as the cost of redesign necessary to apply the policy recommendations of Task 8. Finally, in a sensitivity analysis of the main parameters it studies the robustness of the outcomes.

In addition, an analysis of which significant impacts may have to be measured under possible implementing measures, and what measurement methods would need to be developed or adapted is provided.

2 Policy and scenario analysis

This section presents suggestions of policy options and a scenario analysis for the period 2010-2030. The scenarios quantify the improvements that can be achieved in comparison with a BAU (Business-As-Usual) scenario and compare the outcomes with EU environmental targets.

2.1 Scope

The policy analysis should identify policy option(s) considering the outcomes of all previous tasks. Notably the options should:

- Be based on the exact product definitions in Task 1 as modified/confirmed by the other tasks;
- Provide measurement requirements, including test standards and/or methods;
- Where appropriate, apply existing standards or propose needs/generic requirements for harmonised standards to be developed;
- Provide eco-design requirements, such as minimum (or maximum) requirements, considering the sensitivity analysis carried out in this Task;
- Be complemented, where appropriate, with (dynamic) labelling and benchmark categories linked to possible incentives relating to public procurement or direct and indirect fiscal instruments;
- Consider possible self-regulation, such as voluntary agreement or sectoral benchmark initiatives.

2.2 Generic eco-design requirements

Generic eco-design requirements aim at improving the environmental performance of products, focusing on significant environmental aspects thereof without setting limit values. According to Ecodesign Directive 2009/125/EC they method must be applied when it is not appropriate to set limit values for the product group under examination.

Generic eco-design requirements for professional dishwashers may enable the customer to know more about the products on the market, in order to allow easier comparison.

2.2.1 Need for the definition of a standard programme

Similarly to the recent Regulation for household dishwashers (N°1016/2010), also for professional dishwashers a ‘standard programme’ should be defined. Thus, for the calculation of the energy consumption and other parameters for professional dishwashers, a typical cycle which cleans typically soiled washware (hereafter standard cleaning cycle) shall be used within each dishwasher category. This cycle shall be clearly understandable by the user and as much as possible representative for the main customer segments for each dishwasher category. Further, it shall be clearly identifiable on the programme selection device of the professional dishwasher or the professional dishwasher display, if any, or both, and named ‘standard programme’ and shall be set as the default cycle for professional dishwashers equipped with automatic programme selection or any function for automatically selecting a cleaning programme or maintaining the selection of a programme.

2.2.2 Information requirements

Further, the **booklet of instructions** should provide information on:

- the standard cleaning cycle referred to as ‘standard programme’, which would be the most energy and water efficient programme for normally soiled washware.

- Power consumption of the operating modes, left-on or ready-to-use modes, off modes, etc.
- Indicative information on the main characteristics of the different programmes available (energy and water efficiency, temperature, time, etc.).

This information would not be sufficient to achieve large savings on its own. Taking into account the fact that dishwashers are frequently operated by untrained personnel, the development of **user guided programme menus** directly indicating the above information could further support changing the user behaviour. Making information about energy consumption available on the internet and in sales brochures would be another approach (e.g. basic information on resource efficient dishwashing processes). In parallel, harmonised information could be provided by the European Commission, such as:

a) Examples for best practice.

b) Overview on consumption values and benchmarks of appliances currently being on the market (based on a standardised measurement method).

c) Life cycle costs calculator which can be individually adapted according to the in-situ parameters.

However, precondition for implementing these generic eco-design requirements is a harmonised measurement standard which is currently not available. It would considerably help manufacturers in establishing the ecological profile of their products in a harmonised and understandable way (cf. Section 2.3.1).

2.2.3 Detergent consumption

As shown in Task 5, detergent consumption can have important environmental impacts, especially on eutrophication potential. In this study, detergents have been treated for the most part indirectly, since detergent consumption by dishwashers is closely linked to water consumption. Improvement options such as automatic detergent dispensing were not considered among the most relevant for professional machines. Besides, the washing process is a complex balance between the duration of the process, the strength of the detergent used, the quantity of water consumed and the temperature of the process. In the frame of the study, a typical temperature of process, a typical time and a typical detergent had been considered in order to study the machines from an energy and water performance perspective.

Nevertheless, different detergent types may have different levels of environmental impact. Some new detergents such as enzymatic detergents may allow a slightly lower washing temperature, and thus lower energy consumption, than regular detergents. Low-temperature detergents were analysed as an improvement option in the Lot 14 preparatory study on domestic dishwashers. If such detergents establish themselves in the market, they should be considered for promotional measures (e.g. **recommendations on European Ecolabel for detergents**).

In general, lower temperatures might imply larger doses or another composition of detergents in order to maintain the same wash performance. A new measurement standard and performance requirements should take these relationships into account.

It is commonly considered that misuse of detergent is more likely to involve over-dosage than under-dosage and would thus exacerbate negative environmental impacts. Optimum detergent dosage depends on a range of factors including detergent formulation, water hardness, temperature, as well as filling and soiling. Although consumer behaviour is partly beyond the scope of eco-design, **better information on optimum dosage** could be provided to users.

Finally, it should be noted that especially for large dishwashing appliances, the detergent service and supply (cleaners system) is provided by third party companies. Thus, **green procurement requirements for detergents** could also be included in the criteria to award the service contract to the best companies.

2.2.4 Water consumption

Results from previous tasks indicate that the consumption of external steps (manually pre-soaking and pre-cleaning of the dishes; manually cleaning of the dishwashing machines after the cycles) might be rather significant with regard to the overall consumption of the dish-washing process. For example, the water consumption in the external pre-cleaning phase for category 4 (utensil / pot dishwashers) is with around eight litres hot water per item 5 to 8 times higher compared to the water consumption within the machine (cf. Task 6).

Thus, in order to give incentive to reduce the overall water consumption of dishwashing, the inclusion of the whole process from dirty to clean (including the pre-soak and pre-cleaning phase) would be rather desirable for all dishwasher categories with special focus on utensil / pot dishwashers. However, the water consumption for those manual process steps is strongly dependent on the specific user behaviour and cannot be influenced by the technology of the dishwashing machine itself. Further, there is no standard measurement method and thus no reliable data to record the average consumption of those external processes. For those reasons, within Lot 24 we excluded the manually process steps outside the dishwashing machines from the scope of the study.

However, there might be prepared generic eco-design measures regarding the overall water consumption, e.g. a **linkage to the use of efficient pre-rinse valves.** For example, under the new products to be regulated under the Canadian Energy Efficiency Act[1] inter alia are

1 Source: http://oee.nrcan.gc.ca/regulations/home_page.cfm

pre-rinse spray valves.[2] Further, experiences and conclusions might also be drawn from a current EU pilot study on sanitary tapware (taps and showerheads)[3].

2.3 Specific eco-design requirements

Specific eco-design requirements aim at improving a selected environmental aspect of the product. According to Ecodesign Directive 2009/125/EC, they may take the form of requirements for reduced consumption of a given resource, such as a limit on the use of a resource in the various stages of an product's life cycle, as appropriate (such as a limit on water consumption in the use phase or on the quantities of a given material incorporated in the product or a requirement for minimum quantities of recycled material).

Generally, in the white goods sector energy (and water) efficiency has increased substantially in the past thirty years thanks to implementation of the most easy and straightforward technical solutions. The required effort and investment per unit of efficiency gained are now becoming larger and manufacturers may now tend to slow down their efforts in innovation and research because of this, especially in the household appliances sector. For professional appliances, the possible improvement potential seems to be more unclear as currently no standardised comparison between two different machines is possible in the EU[4] and short cycle times have been a dominating factor for product development so far. However, a common measurement standard is prerequisite for the implementation of efficiency requirements and labelling programmes, which would allow the end user to benefit from a relevant methodology providing him with reliable data and fair assessment of product performance. Therefore, the influence of the customers on the market development would be highly increased as their choices would be eased and justified by this initiative.

2.3.1 Need for the development of harmonised standards and definitions

Standard measurement methods are necessary to enable the setting of performance requirements. Today, there are no standards officially and widely used in the EU for the product categories in the scope of Lot 24, part professional dishwashers. This lack of standards is also a reason why consumption data was hard to obtain and remains uncertain

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2 These devices use a spray of water to remove food waste from dishes prior to cleaning in a commercial dishwasher. They are usually placed at the entrance to a commercial dishwasher or may also be located over a sink, in conjunction with a faucet fixture.

3 This study is being carried out by the Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) in cooperation with the AEA consultancy for the European Commission's DG Environment. The purpose of this pilot project is to develop a joint evidence base for the development of the three different policy instruments (Ecolabel, GPP and Ecodesign) in the area of water using products (taps and showerheads). http://susproc.jrc.ec.europa.eu/ecotapware/index.html

4 Exemption: In practice, for under-counter water change dishwashers (category 1), the EN 50242:2008-09 and EN 60436:2008-09 methods can currently be applied.

within this study. Discussions are currently ongoing at the EU level within the CENELEC Technical Committee TC 59X.

A harmonised testing methodology should take into account and define several parameters such as standard dishes in terms of size, soiling, heat capacity and dry-on time, rated cleaning capacity (maximum amount that can be cleaned in one cycle), definition of a test cycle (inter alia selection of programme), type (formulation) and dosage of detergent and rinse aid, the inclusion or not of the first filling, as well as several environmental parameters (ambient temperature and humidity, water temperature and hardness).

Relevant parameters to measure when establishing standards for professional dishwashers include:

- cleaning results and hygienic performance;
- drying performance;
- energy consumption/efficiency (in different operation modes);
- water consumption/efficiency;
- detergent/rinse aid consumption (defined quality);
- cycle time (more important for professional appliances than for household ones);
- noise level[5];
- testing under real-life use conditions (continuous vs. discontinuous cleaning process, partial load operation, use of other than standard programme).

The fact that multiple parameters have to be taken into account is crucial as some of them may conflict with each other. For instance, water efficiency could be improved by reducing the rinsing/drying performance, leading to non-satisfactory results of the washing process. Therefore, if levels of resources and consumables consumption are to be set, they should be associated with corresponding cleaning or drying performance levels.

In the commercial and industrial sectors, customers have different needs and the appliances are often customised to the demand of the customer. The goal of the standardisation process would ideally be to find one or several standard programme(s) that can be run on the machine to test it and measure its performance level, even if the washing programme wanted and used by the customer is different.

Along with the standards measurement methods, a tolerance level (taking into account the errors during the performance measurement) should be properly defined according to the product category specificities.

[5] Only in the case it is not yet covered under safety legislation.

2.3.2 Labelling requirements

Based on a harmonised standard measurement method, which would need to be developed first (see previous section), an energy labelling scheme could promote a voluntary shift in the market. Unlike performance requirements (which aim at removing the worst-performing products from the market), a label would help the costumers to pull the market towards the best-performing products via their purchase decisions. It should therefore be seen as a complementary tool to minimum requirements. To be fully effective, such a scheme should be mandatory so that all products on the market can be fairly compared.

It would be more appropriate for the smaller machines (categories 1 to 3) considered in this study because customers of larger industrial machines tend to be more sophisticated and are provided with a more detailed level of information at the time of purchase, while retailers have even more incentive to provide high efficiency machines than retailers of the smaller machines. This does not, however, mean that a labelling programme could not be implemented for heavy duty machines.

Energy consumption is intricately linked with water and detergent consumption and washing performance. Although energy consumption is the most appropriate basis for classification, any labelling scheme should take a holistic approach either by setting reference water and detergent consumption and reference washing performance associated with the energy consumption measured, or by providing clear and transparent information for all these other variables as is currently done for household dishwashers (the label indicates the energy and water consumption and the cleaning performance, see Figure 2-1). These issues have been discussed in detail earlier in the study.

The label itself could be similar in most respects to that used for household dishwashers:

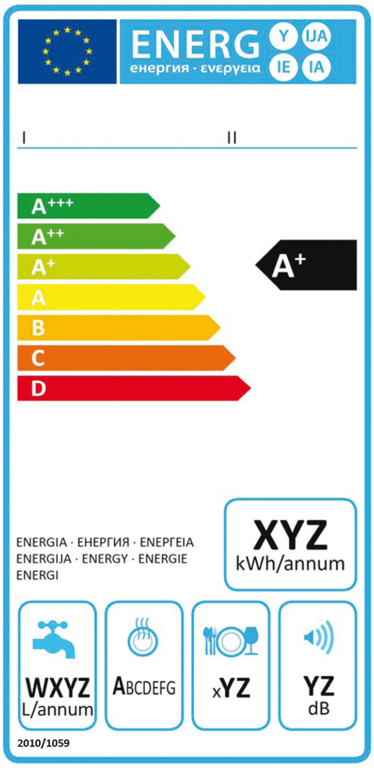

Figure 2-1 Domestic dishwashers label[6]

The following notes define the information to be included:

1. Supplier's name and name of model.
2. The energy efficiency class of the dishwasher, determined in accordance with future harmonised standards (cf. Section 2.3.1). The indicator letter should be placed at the same level as the relevant arrow. The classes would need to be revised every few years as machines become more efficient in order to maintain the incentive.
3. Specific energy consumption (kWh per cycle or 100 dishes).[7]
4. Specific water consumption (litres per cycle or 100 dishes).[7]
5. Drying efficiency.
6. Cleaning capacity (standard place settings) and cycle time, for the standard cleaning cycle.[8]
7. Airborne acoustical noise emissions expressed in dB(A) re 1 pW.
8. Option warm water supply available?

[6] EC 1059/2010 supplementing Directive 2010/30/EU with regard to energy labelling of household dishwashers.

[7] As professional dishwashing appliances are used very different according to the customer needs, data on annual consumption would not be very meaningful.

[8] Note: For efficiency calculations, real-life use should be taken into account (inter alia partial load).

The label for professional dishwashers in most respects could be similar to that one for household appliances. When drafting the labelling regulation for professional dishwashers it should be discussed whether a single labelling scheme could be applicable for all types of dishwashers (for instance undercounter dishwashers (water-change and one-tank), conveyor-type dishwashers) in order to allow comparison of products.

Along with the pictograms on the label more detailed information should be provided in the product fiche / technical information of the professional dishwasher and shall be included in the product brochure or other literature provided with the product (cf. also Section 2.2).

Specific case of warm water supply

Warm water input was analysed as a general improvement option throughout this study. However, it was not identified as the LLCC or BAT option when it should have because it is an option that considerably depends on the infrastructure available and may not be relevant for all situations. As a result, this technological choice cannot be imposed on a general basis but naturally the use of alternative energy sources should be considered by end users when relevant.

The Task 7 results clearly show that with the model used (a 90% efficiency gas boiler used to externally heat the water), the supply of warm water can be a beneficial option, both from the environmental and economic points of view, given the lower needs in primary energy (it is the virtual BAT and LLCC option for BC 1 to 4). It relies entirely on the fact that the water used in the washing process is heated outside the machines by a more efficient process than the electric resistance within the machine. It was assumed that this was available for no additional investment costs in comparison with the base case.

Thus it is important that the labelling scheme also enables the customer to choose between two products with a different heating system the one that will be the most economic for him.

2.3.3 Benchmarking

According to Ecodesign Directive 2009/125/EC, in addition to the legally binding requirements, indicative benchmarks for best available technologies should be identified to ensure the wide availability and easy accessibility of information on the lifecycle environmental performance of professional dishwashers.

The technical, environmental and economic analysis of preparatory study Lot 24 has already identified the best-performing products and technology available on the market (cf. Task 6). However, due to lack of standardised performance measurement data, this analysis should be renewed as soon as a harmonized test standard is applied. Thus, at the time of entry into force of a Regulation on professional dishwashers, data on best available technology on the market in terms of their energy efficiency, energy and water consumption, cleaning and drying efficiency and airborne acoustical noise emissions should be available and published in the Annexes of the Ecodesign Regulation.

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.

2.3.4 Minimum energy efficiency requirements

Minimum eco-design requirements on energy efficiency may be a relevant option to remove the least efficient appliances from the market and to push it towards more efficient appliances. Indicative levels are suggested in this section, based on the analysis made in previous tasks. However, because of the current lack of available and harmonised data on product performance, **these levels should be considered rather with caution and discussed again once harmonised tests, measurement methods and benchmarks have been defined, as suggested above.** For example, the cleaning performance was not assessed in the frame of the study but will be a key parameter to measure in a standardised process, in order to allow fair comparison of products. **Besides, as shown by the sensitivity analysis (see Section 4), the results are highly dependent on input parameters such as the electricity rate or the intensity of use.** As EU average parameters were estimated to carry out the environmental and economic analysis, the results may not be representative for all situations. **Finally, as an additional delay will be required before the finalisation of the standards, the market may continue to evolve and more ambitious targets could be set when the levels of eco-design requirements are decided.**

The current definition and quantification of the minimum performance levels may have to be completed or amended in accordance with the future harmonised standards. Indeed, the washing process is a complex balance between parameters that compete with each other (e.g. energy efficiency and cleaning performance). In the framework of this study, only basic quantification of the energy aspect has been possible, so the levels for eco-design requirements suggested will refer to these. In reality, more parameters will be needed (see Section 2.3.1 for more details).

Eco-design requirements could be considered in the form of “Tier 1” and “Tier 2” requirements. Tier 1 would apply from 2014 onwards, assuming a standard measurement method can be developed by the relevant organisation (CENELEC) by 2012. Tier 2 would apply from 2017 onwards, and would enable more ambitious targets to be kept as a long-term goal (e.g. heat pump efficiency levels for dryers). According to the Ecodesign Directive, minimum requirements should not exceed the LLCC level, to avoid creating difficulties for consumers. However, by 2017 new technologies will become available so that today’s BAT level will no longer be BAT in 2017. If they do not, then Tier 2 would not be implemented. The advantage of defining Tier 2 now would be that agents in the market today will have a clear signal of the direction the market is headed towards.

The proposals for eco-design requirements have been made based on the LLCC and BAT analysis in Task 7:

- For BC 1: the base case (BC) product is the LLCC. However, the improvement option M 4.2 'High efficient pumps and motors' reduces the primary energy by 3% for a small additional cost over the lifetime (1%, approximately 150 Euro). Thus it is proposed to adopt such a performance level for Tier 1.
- For BC 2: option M 4.2 'High efficient pumps and motors' was identified as the LLCC option and this energy performance level is proposed as a Tier 1 target.
- For BC 3 and 4: the base case product was identified as the LLCC option. However, similarly to BC 1, some options enable to lower the environmental impacts for reduced additional costs. Therefore, performance level of the option M 4.2 'High efficient pumps and motors' is also proposed as a Tier 1, and level of option M 3.1.1 'Waste water heat exchanger' is proposed for Tier 2.
- For BC 5: option M1.5 'Auxiliary rinsing' was identified as the LLCC and its level of performance is consequently suggested as a Tier 1 target.
- For BC 6: the BA product is the LLCC but might be too ambitious as a Tier 1 target. The performance level of the option M 4.2 'High efficient pumps and motors' is proposed for Tier 1 as it enables important energy savings for a reduced life cycle cost.

For some base cases, no Tier 2 is suggested as a further step in efficiency does not appear very cost effective (according to the outcomes of Task 7, which are based on average EU parameters).

Table 2-1 summarises the performance levels suggested as eco-design requirements for professional dishwashers.

Table 2-1 Proposals for eco-design requirements by product category[9]

Base case	Capacity	Tier 1 (2014)	Tier 2 (2017)
1. Undercounter water-change	200 dishes/hour	M 4.2 High efficient pumps and motors 4.17 kWh 76 litres	-
2. Undercounter one-tank	550 dishes/hour	M 4.2 High efficient pumps and motors 1.47 kWh 14.9 litres	-
3. Hood-type	860 dishes/hour	M 4.2 High efficient pumps and motors 1.56 kWh 14.9 litres	M 3.1.1 Waste water heat exchanger 1.44 kWh
4. Utensil/Pot	0.42 m^2 (rack area) 20 cycles per hour	M 4.2 High efficient pumps and motors 0.46 kWh 4.84 litres	M 3.1.1 Waste water heat exchanger 0.42 kWh
5. One-tank conveyor-type	1 750 dishes/hour	M 1.5 Auxiliary rinsing 1.76 kWh 11.44 litres	-
6. Multi-tank conveyor-type	3 600 dishes/hour	M 4.2 High efficient pumps and motors 1.76 kWh 10.2 litres	-

The performance levels indicated should be extrapolated for products with different capacities, according to rules that will need to be defined in the relevant standards.

The energy and water parameters in the table are quantified thanks to the parameters that were available within this study but in practice the harmonised standardisation process may result in other ways to measure product consumption and performance parameters.

The approach to checking compliance with the ecodesign requirements is based on self-declaration in the case of domestic dishwashing appliances. The information required should be measured according to harmonised standards. Once the harmonised standard has been defined, a detailed market review of the various product categories should be done to assess whether the proposed ecodesign requirements are still relevant or should be amended.

2.3.5 Verification procedure for market surveillance purposes

Member States shall apply a verification procedure when performing the market surveillance checks for compliance of products with the according requirements. In order to facilitate

[9] Energy and water consumption are given in operation mode for 100 dishes.

compliance checks, manufacturers should provide information in the technical documentation in so far as this information relates to the requirements laid down in the Regulation.

For comparison: for household dishwashers, the verification procedure for the purposes of checking conformity with the requirements, defines that authorities of the Member State shall test a single household dishwasher. If the measured parameters do not meet the values declared in the technical documentation file by the manufacturer within the range set out in the eco-design regulation, the measurements shall be carried out on three more household dishwashers. The arithmetic mean of the measured values of these three household dishwashers shall meet the requirements within the ranges defined in the regulation.

A similar approach is deemed relevant to the case of professional dishwashers: The usual procedure so far would be self-declaration with market surveillance. Framework Directive 2010/30/EG and the according implementation measures include that Member States shall test products and might require conformity in case of non-compliance; in case of recurrence the product might be taken off the market. However, practical experience e.g. from Germany[10] repeatedly shows that there are still great problems with the correct implementation of the energy labelling directive due to a lack of governmental controls and sanctions.

Based on this experience, suppliers of professional dishwashers could also be required to establish a more demanding approach. According to stakeholders' feedback, for domestic appliances a voluntary agreement (VA) enabling mutual testing between competitors is appropriate and works well; thus it could be adapted for professional appliances as well.

Basis would be sufficient technical documentation to assess the accuracy of the provided information (e.g. general description of the product, internal or independent tests reports). The information required should be measured according to harmonised standards. However, these standards are still under development at the time of the study at hand (see 2.3.1). Once the harmonised standard has been defined, a detailed market review of the various categories should be done to assess whether the minimum performance standards proposed are still relevant or should be amended.

2.3.6 Criteria for Green public procurement

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 propose more ambitious requirements for public procurement (oriented to the benchmarks, see 2.3.3) than the general eco-design requirements (see 2.3.4). Thus,

[10] According to tests of Deutsche Umwelthilfe, the provided tags and data tapes are often false or even not at all attached to the appliances. This concerns mainly air conditioning appliances being provided as special offer in the summer months in and built-in appliances (white goods) offered in kitchen studios and furniture stores (source: http://www.duh.de/energielabel.html).

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 (in Task 2, Section 3.3.2, it is estimated that hospitals and other institutions account for 23% of units sold, a large proportion of which is likely to be in the public sector). Proposed levels are indicated in Table 2-2, again assuming that the needed standards are adopted in 2012.

Table 2-2 Proposed GPP energy performance levels[11]

Base case	Capacity	Tier 1 (2014)
1. Undercounter water-change	200 dishes/hour	BA product 3.96 kWh 76 litres
2. Undercounter one-tank	550 dishes/hour	M 3.1.1 Waste water heat exchanger 1.44 kWh
3. Hood-type	860 dishes/hour	M 3.1.1 Waste water heat exchanger 1.44 kWh
4. Utensil/Pot	0.42 m^2 (rack area) 20 cycles per hour	M 3.1.1 Waste water heat exchanger 0.425 kWh
5. One-tank conveyor-type	1 750 dishes/hour	M 2.1.1 Exhaust air heat exchanger 1.6 kWh
6. Multi-tank conveyor-type	3 600 dishes/hour	M 2.1.2 Exhaust air heat pump 1.5 kWh

Note: The most efficient and economically attainable solution depends on the respective cleaning capacity; thus the above table is only exemplary. Public authorities should orient their procurement activities according to the least life cycle costs, however, including an additional charge for future cost developments (e.g. energy prices) and external costs.

2.4 Policy scenario analysis

An Excel tool allowing estimates of the impacts of different scenarios was created and used in order to build the scenarios analysis (2010-2020, 2010-2025 and 2010-2030) in this section. In that respect, the tool was designed quite simply and relies on the following assumptions:

- The stock and sales estimates were obtained with an assumed annual growth rate of 1% for base cases 1-4 and 2% for base cases 5-6. Initial stock (year 2009) are extracted from the market data presented in Task 2.

[11] Energy and water consumption are given in operation mode for 100 dishes.

- The tool displays the expenditure (in Euro) and the primary energy (in Joule) related to the consumption of professional dishwashers, following different policy options. The primary energy displayed is not limited to the use phase, but takes into account the energy required over the whole lifetime (including manufacturing, distribution and end-of-life phases). The model is kept simple because the global energy consumption is allocated uniformly over the lifetime of the product even if 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 acceptable to carry out this analysis as a more "realistic" modelling would make an insignificant difference to the overall results.
- Primary energy consumption was considered to be the most relevant and representative indicator to be modelled in the tool (see Task 7).
- Expenditure measures the yearly value of the entire market. It consists of the amount of money spent to buy the products (purchase price) which is taken into account entirely when the dishwasher is bought and of the operating costs (energy, water, detergent costs, maintenance and repair), which are split over the lifetime of the dishwasher.
- The model is built on a discrete basis (data given for each year).

In subsections, four scenarios are built: Business-as-Usual (BAU) scenario, which assumes that the products on the market do not include any improvement options in the future; Best Available Technology (BAT) scenario, which assumes that the BAT options are implemented in the near future for all product categories (ideally, that could be the target in the long term); Least Life Cycle Cost (LLCC) scenario, which assumes that the LLCC options are implemented in the near future: and Minimum Energy Performance Standard (MEPS) scenario, which will illustrate the influence of the proposals for eco-design requirements in Section 2.3.3. The BAT, LLCC and MEPS scenarios are also compared to the BAU scenario, in order to have an estimate of the improvement potential of the improvement options on a large scale. Most of the description in the sections below refers to 2025 for comparison.

The following inputs regarding the market data are used within the modelling tool:

Table 2-3 Market inputs of the policy analysis model

Category	Stock		Growth %/year	Lifetime (years)
	2009	2025		
BC1 Under-counter water change	207 223	242 985	1.0%	12
BC2 Under-counter one-tank	1 012 355	1 187 066	1.0%	8
BC3 Hood-type	482 728	566 037	1.0%	8
BC4 Utensil/Pot	19 309	22 641	1.0%	8
BC5 One-tank conveyor-type	68 425	93 933	2.0%	12
BC6 Multi-tank conveyor-type	18 015	24 731	2.0%	17

The replacement rate of products has been estimated to be inversely proportional to the dishwashers' lifetime. For example, 12.5% (1/8) of the stock of base cases 2, 3 or 4 is replaced each year. Table 2-4 presents the market data over time that result from the inputs.

Table 2-4 Market data of the policy analysis model

Year	Units	BC1	BC2	BC3	BC4	BC5	BC6
2009	Stock	207 223	1 012 355	482 728	19 309	68 425	18 015
	Sales	19 341	136 668	65 168	2 607	7 071	1 420
	Replaced	17 269	126 544	60 341	2 414	5 702	1 060
2010	Stock	209 295	1 022 479	487 555	19 502	69 794	18 375
	Sales	19 534	138 035	65 820	2 633	7 212	1 448
	Replaced	17 441	127 810	60 944	2 438	5 816	1 081
2011	Stock	211 388	1 032 703	492 431	19 697	71 189	18 743
	Sales	19 730	139 415	66 478	2 659	7 356	1 477
	Replaced	17 616	129 088	61 554	2 462	5 932	1 103
2012	Stock	213 502	1 043 030	497 355	19 894	72 613	19 118
	Sales	19 927	140 809	67 143	2 686	7 503	1 507
	Replaced	17 792	130 379	62 169	2 487	6 051	1 125
2013	Stock	215 637	1 053 461	502 329	20 093	74 065	19 500
	Sales	20 126	142 217	67 814	2 713	7 653	1 537
	Replaced	17 970	131 683	62 791	2 512	6 172	1 147
2014	Stock	217 793	1 063 995	507 352	20 294	75 547	19 890
	Sales	20 327	143 639	68 493	2 740	7 806	1 568
	Replaced	18 149	132 999	63 419	2 537	6 296	1 170
2015	Stock	219 971	1 074 635	512 425	20 497	77 058	20 288
	Sales	20 531	145 076	69 177	2 767	7 963	1 599
	Replaced	18 331	134 329	64 053	2 562	6 421	1 193
2016	Stock	222 171	1 085 382	517 550	20 702	78 599	20 694
	Sales	20 736	146 527	69 869	2 795	8 122	1 631
	Replaced	18 514	135 673	64 694	2 588	6 550	1 217
2017	Stock	224 393	1 096 235	522 725	20 909	80 171	21 107
	Sales	20 943	147 992	70 568	2 823	8 284	1 664
	Replaced	18 699	137 029	65 341	2 614	6 681	1 242
2018	Stock	226 637	1 107 198	527 953	21 118	81 774	21 530
	Sales	21 153	149 472	71 274	2 851	8 450	1 697
	Replaced	18 886	138 400	65 994	2 640	6 815	1 266
2019	Stock	228 903	1 118 270	533 232	21 329	83 410	21 960
	Sales	21 364	150 966	71 986	2 879	8 619	1 731
	Replaced	19 075	139 784	66 654	2 666	6 951	1 292
2020	Stock	231 192	1 129 452	538 564	21 542	85 078	22 399
	Sales	21 578	152 476	72 706	2 908	8 791	1 766
	Replaced	19 266	141 182	67 321	2 693	7 090	1 318
2021	Stock	233 504	1 140 747	543 950	21 758	86 779	22 847
	Sales	21 794	154 001	73 433	2 937	8 967	1 801
	Replaced	19 459	142 593	67 994	2 720	7 232	1 344
2022	Stock	235 839	1 152 154	549 389	21 975	88 515	23 304
	Sales	22 012	155 541	74 168	2 967	9 147	1 837
	Replaced	19 653	144 019	68 674	2 747	7 376	1 371

Year	Units	BC1	BC2	BC3	BC4	BC5	BC6
2023	Stock	238 197	1 163 676	554 883	22 195	90 285	23 770
	Sales	22 232	157 096	74 909	2 996	9 329	1 874
	Replaced	19 850	145 459	69 360	2 774	7 524	1 398
2024	Stock	240 579	1 175 313	560 432	22 417	92 091	24 246
	Sales	22 454	158 667	75 658	3 026	9 516	1 911
	Replaced	20 048	146 914	70 054	2 802	7 674	1 426
2025	Stock	242 985	1 187 066	566 037	22 641	93 933	24 731
	Sales	22 679	160 254	76 415	3 057	9 706	1 949
	Replaced	20 249	148 383	70 755	2 830	7 828	1 455
2026	Stock	245 415	1 198 937	571 697	22 868	95 812	25 225
	Sales	22 905	161 856	77 179	3 087	9 901	1 988
	Replaced	20 451	149 867	71 462	2 858	7 984	1 484
2027	Stock	247 869	1 210 926	577 414	23 096	97 728	25 730
	Sales	23 134	163 475	77 951	3 118	10 099	2 028
	Replaced	20 656	151 366	72 177	2 887	8 144	1 514
2028	Stock	250 348	1 223 035	583 188	23 327	99 682	26 244
	Sales	23 366	165 110	78 730	3 149	10 301	2 069
	Replaced	20 862	152 879	72 899	2 916	8 307	1 544
2029	Stock	252 851	1 235 265	589 020	23 561	101 676	26 769
	Sales	23 599	166 761	79 518	3 181	10 507	2 110
	Replaced	21 071	154 408	73 627	2 945	8 473	1 575
2030	Stock	255 380	1 247 618	594 910	23 796	103 709	27 305
	Sales	23 835	168 428	80 313	3 212	10 717	2 152
	Replaced	21 282	155 952	74 364	2 975	8 642	1 606

2.4.1 Business-as-Usual (BAU) scenario

The BAU scenario considers that the base case remains the only product sold on the market in the future: no improvement option or any other type of improvement are introduced on the market or purchased. In this model, it is consequently assumed that there is no phenomenon of continuous improvement of the products. This scenario is taken as a reference in order to compare the results with these of the BAT, LLCC and MEPS scenarios.

Figure 2-2 and Figure 2-3 show the breakdown by base case of energy consumption and expenditure over the period 2010-2025. BC 2 and BC 3 have the largest shares in energy consumption and expenditure but conveyor-types appliances (BC 5 and BC 6) also represent 32% of energy requirements and 21% of expenditure. Table 2-5 presents all the outcomes of the model.

In 2025, professional dishwashers would require 204.5 PJ of primary energy, and the total consumption over the period 2010-2025 represents 2 970 PJ. Professional dishwashers are expected to emit 132 600 ktCO_2 over the period 2010-2025. Regarding expenditure, 4 970 m€ are expected to be spent for professional dishwashers in 2025, and 72.8 b€[12] over the period 2010-2025.

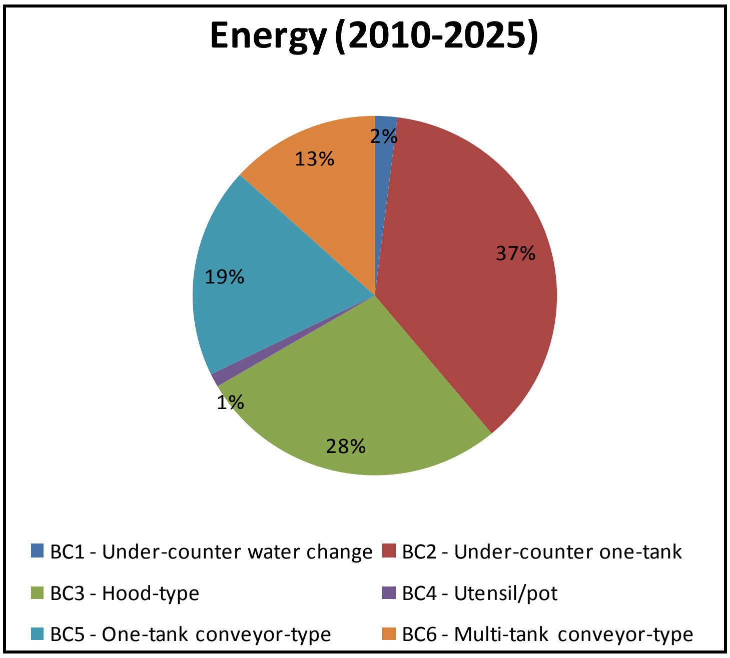

Figure 2-2 Breakdown of energy consumption of the six base cases over the period 2010-2025

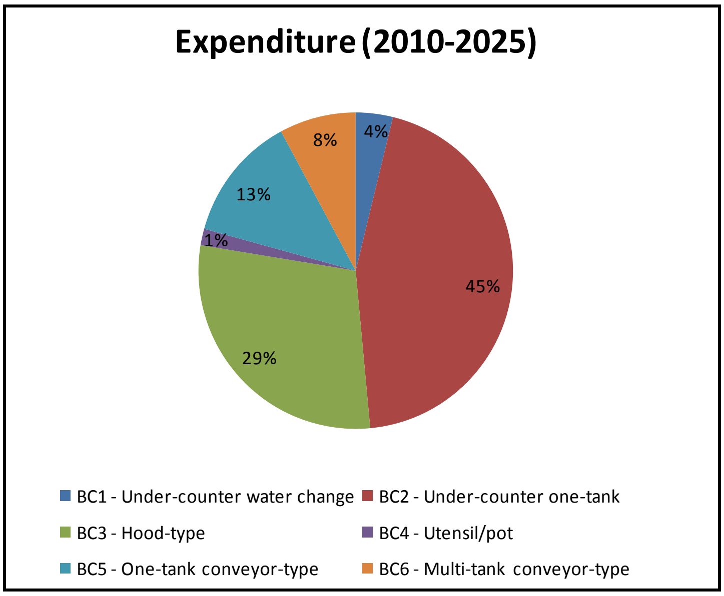

Figure 2-3 Breakdown of total expenditure of the six base cases over the period 2010-2025

[12] Billion Euros

Table 2-5 BAU scenario outcomes: market data, energy consumption and expenditure

Year	Units	BC1	BC2	BC3	BC4	BC5	BC6	Total
2009	**Stock (units)**	207 223	1 012 355	482 728	19 309	68 425	18 015	1 808 055
	Sales (units)	19 341	136 668	65 168	2 607	7 071	1 420	232 274
	Energy (TJ)	3 393.5	62 920.2	47 140.5	2 053.3	29 583.3	20 735.4	165 826.2
	Expenditure (m€)	159.5	1 866.0	1 212.4	70.1	492.1	302.4	4 102.6
2010	**Stock (units)**	209 295	1 022 479	487 555	19 502	69 794	18 375	1 827 000
	Sales (units)	19 534	138 035	65 820	2 633	7 212	1 448	234 682
	Energy (TJ)	3 427.4	63 549.4	47 611.9	2 073.9	30 175.0	21 150.1	167 987.6
	Expenditure (m€)	161.1	1 884.7	1 224.5	70.8	501.9	308.5	4 151.6
2011	**Stock (units)**	211 388	1 032 703	492 431	19 697	71 189	18 743	1 846 152
	Sales (units)	19 730	139 415	66 478	2 659	7 356	1 477	237 115
	Energy (TJ)	3 461.7	64 184.9	48 088.0	2 094.6	30 778.5	21 573.1	170 180.7
	Expenditure (m€)	162.7	1 903.6	1 236.8	71.5	512.0	314.7	4 201.2
2012	**Stock (units)**	213 502	1 043 030	497 355	19 894	72 613	19 118	1 865 512
	Sales (units)	19 927	140 809	67 143	2 686	7 503	1 507	239 575
	Energy (TJ)	3 496.3	64 826.7	48 568.9	2 115.5	31 394.1	22 004.6	172 406.1
	Expenditure (m€)	164.4	1 922.6	1 249.1	72.3	522.2	320.9	4 251.5
2013	**Stock (units)**	215 637	1 053 461	502 329	20 093	74 065	19 500	1 885 085
	Sales (units)	20 126	142 217	67 814	2 713	7 653	1 537	242 061
	Energy (TJ)	3 531.3	65 475.0	49 054.5	2 136.7	32 022.0	22 444.7	174 664.1
	Expenditure (m€)	166.0	1 941.8	1 261.6	73.0	532.6	327.4	4 302.4
2014	**Stock (units)**	217 793	1 063 995	507 352	20 294	75 547	19 890	1 904 871
	Sales (units)	20 327	143 639	68 493	2 740	7 806	1 568	244 573
	Energy (TJ)	3 566.6	66 129.7	49 545.1	2 158.1	32 662.4	22 893.6	176 955.4
	Expenditure (m€)	167.7	1 961.2	1 274.2	73.7	543.3	333.9	4 354.1
2015	**Stock (units)**	219 971	1 074 635	512 425	20 497	77 058	20 288	1 924 874
	Sales (units)	20 531	145 076	69 177	2 767	7 963	1 599	247 113
	Energy (TJ)	3 602.2	66 791.0	50 040.5	2 179.6	33 315.7	23 351.4	179 280.5
	Expenditure (m€)	169.3	1 980.8	1 287.0	74.5	554.2	340.6	4 406.4
2016	**Stock (units)**	222 171	1 085 382	517 550	20 702	78 599	20 694	1 945 097
	Sales (units)	20 736	146 527	69 869	2 795	8 122	1 631	249 679
	Energy (TJ)	3 638.3	67 458.9	50 540.9	2 201.4	33 982.0	23 818.5	181 640.0
	Expenditure (m€)	171.0	2 000.7	1 299.8	75.2	565.2	347.4	4 459.4

Year	Units	BC1	BC2	BC3	BC4	BC5	BC6	Total
2017	Stock (units)	224 393	1 096 235	522 725	20 909	80 171	21 107	1 965 541
	Sales (units)	20 943	147 992	70 568	2 823	8 284	1 664	252 274
	Energy (TJ)	3 674.6	68 133.5	51 046.4	2 223.5	34 661.6	24 294.8	184 034.4
	Expenditure (m€)	172.8	2 020.7	1 312.8	75.9	576.5	354.4	4 513.1
2018	Stock (units)	226 637	1 107 198	527 953	21 118	81 774	21 530	1 986 209
	Sales (units)	21 153	149 472	71 274	2 851	8 450	1 697	254 896
	Energy (TJ)	3 711.4	68 814.9	51 556.8	2 245.7	35 354.8	24 780.7	186 464.3
	Expenditure (m€)	174.5	2 040.9	1 326.0	76.7	588.1	361.4	4 567.5
2019	Stock (units)	228 903	1 118 270	533 232	21 329	83 410	21 960	2 007 104
	Sales (units)	21 364	150 966	71 986	2 879	8 619	1 731	257 546
	Energy (TJ)	3 748.5	69 503.0	52 072.4	2 268.1	36 061.9	25 276.4	188 930.3
	Expenditure (m€)	176.2	2 061.3	1 339.2	77.5	599.8	368.7	4 622.7
2020	Stock (units)	231 192	1 129 452	538 564	21 542	85 078	22 399	2 028 229
	Sales (units)	21 578	152 476	72 706	2 908	8 791	1 766	260 225
	Energy (TJ)	3 786.0	70 198.0	52 593.1	2 290.8	36 783.2	25 781.9	191 433.0
	Expenditure (m€)	178.0	2 081.9	1 352.6	78.2	611.8	376.0	4 678.6
2021	Stock (units)	233 504	1 140 747	543 950	21 758	86 779	22 847	2 049 586
	Sales (units)	21 794	154 001	73 433	2 937	8 967	1 801	262 933
	Energy (TJ)	3 823.8	70 900.0	53 119.0	2 313.7	37 518.8	26 297.5	193 973.0
	Expenditure (m€)	179.8	2 102.7	1 366.2	79.0	624.1	383.6	4 735.3
2022	Stock (units)	235 839	1 152 154	549 389	21 975	88 515	23 304	2 071 178
	Sales (units)	22 012	155 541	74 168	2 967	9 147	1 837	265 670
	Energy (TJ)	3 862.1	71 609.0	53 650.2	2 336.9	38 269.2	26 823.5	196 550.9
	Expenditure (m€)	181.6	2 123.7	1 379.8	79.8	636.5	391.2	4 792.7
2023	Stock (units)	238 197	1 163 676	554 883	22 195	90 285	23 770	2 093 008
	Sales (units)	22 232	157 096	74 909	2 996	9 329	1 874	268 437
	Energy (TJ)	3 900.7	72 325.1	54 186.7	2 360.2	39 034.6	27 359.9	199 167.3
	Expenditure (m€)	183.4	2 145.0	1 393.6	80.6	649.3	399.1	4 850.9
2024	Stock (units)	240 579	1 175 313	560 432	22 417	92 091	24 246	2 115 078
	Sales (units)	22 454	158 667	75 658	3 026	9 516	1 911	271 233
	Energy (TJ)	3 939.7	73 048.4	54 728.6	2 383.8	39 815.3	27 907.1	201 822.9
	Expenditure (m€)	185.2	2 166.4	1 407.6	81.4	662.3	407.0	4 909.9

Year	Units	BC1	BC2	BC3	BC4	BC5	BC6	Total
2025	**Stock (units)**	242 985	1 187 066	566 037	22 641	93 933	24 731	2 137 393
	Sales (units)	22 679	160 254	76 415	3 057	9 706	1 949	274 060
	Energy (TJ)	3 979.1	73 778.9	55 275.9	2 407.7	40 611.6	28 465.3	204 518.4
	Expenditure (m€)	187.1	2 188.1	1 421.6	82.2	675.5	415.2	4 969.7
2026	**Stock (units)**	245 415	1 198 937	571 697	22 868	95 812	25 225	2 159 953
	Sales (units)	22 905	161 856	77 179	3 087	9 901	1 988	276 917
	Energy (TJ)	4 018.9	74 516.6	55 828.6	2 431.8	41 423.8	29 034.6	207 254.3
	Expenditure (m€)	188.9	2 210.0	1 435.8	83.1	689.0	423.5	5 030.3
2027	**Stock (units)**	247 869	1 210 926	577 414	23 096	97 728	25 730	2 182 763
	Sales (units)	23 134	163 475	77 951	3 118	10 099	2 028	279 805
	Energy (TJ)	4 059.1	75 261.8	56 386.9	2 456.1	42 252.3	29 615.3	210 031.5
	Expenditure (m€)	190.8	2 232.1	1 450.2	83.9	702.8	432.0	5 091.7
2028	**Stock (units)**	250 348	1 223 035	583 188	23 327	99 682	26 244	2 205 825
	Sales (units)	23 366	165 110	78 730	3 149	10 301	2 069	282 724
	Energy (TJ)	4 099.7	76 014.4	56 950.8	2 480.6	43 097.3	30 207.6	212 850.5
	Expenditure (m€)	192.7	2 254.4	1 464.7	84.7	716.9	440.6	5 154.0
2029	**Stock (units)**	252 851	1 235 265	589 020	23 561	101 676	26 769	2 229 143
	Sales (units)	23 599	166 761	79 518	3 181	10 507	2 110	285 675
	Energy (TJ)	4 140.7	76 774.6	57 520.3	2 505.4	43 959.3	30 811.7	215 712.0
	Expenditure (m€)	194.7	2 276.9	1 479.3	85.6	731.2	449.4	5 217.1
2030	**Stock (units)**	255 380	1 247 618	594 910	23 796	103 709	27 305	2 252 719
	Sales (units)	23 835	168 428	80 313	3 212	10 717	2 152	288 658
	Energy (TJ)	4 182.1	77 542.3	58 095.5	2 530.5	44 838.5	31 428.0	218 616.9
	Expenditure (m€)	196.6	2 299.7	1 494.1	86.4	745.8	458.4	5 281.1
2010-2020	**Energy (TJ)**	**39 644**	**735 065**	**550 718**	**23 988**	**367 191**	**257 370**	**1 973 977**
	Expenditure (m€)	**1 864**	**21 800**	**14 164**	**819**	**6 108**	**3 754**	**48 509**
2010-2025	**Energy (TJ)**	**59 150**	**1 096 727**	**821 679**	**35 790**	**562 441**	**394 223**	**2 970 009**
	Expenditure (m€)	**2 781**	**32 526**	**21 133**	**1 223**	**9 355**	**5 750**	**72 767**
2010-2030	**Energy (TJ)**	**79 650**	**1 476 836**	**1 106 461**	**48 195**	**778 012**	**545 320**	**4 034 474**
	Expenditure (m€)	**3 744**	**43 799**	**28 457**	**1 646**	**12 941**	**7 954**	**98 541**

2.4.2 Least Life cycle Cost (LLCC) scenario

The LLCC scenario considers that all LLCC improvement options are implemented for each base case, as described in Task 7. The market modelling includes that from 2014, all products sold are equivalent to these LLCC options and no more base cases are sold (the market shift takes place in one single step). Table 2-6 reminds the LLCC options that were identified for each base case in Task 7. As a reminder, the warm water supply option was not eligible to be the LLCC option.

Table 2-6 LLCC improvement option for each base case

Base case	LLCC Improvement option
1. Undercounter water-change	Base case product
2. Undercounter one-tank	M 4.2 high efficient pumps and motors
3. Hood-type	Base case product
4. Utensil/Pot	Base case product
5. One-tank conveyor-type	M 1.5 Auxiliary rinsing
6. Multi-tank conveyor-type	BA product

Table 2-7 presents the outcomes of this scenario modelling. In 2025, the professional dishwashers market would require 187.4 PJ of primary energy (-8.4% compared to BAU), and would represent 4.93 b€ (-0.7% compared to BAU). Over the period 2010-2025, the total primary energy consumption would be 2 863 PJ (-3.6% compared to BAU), the total CO_2 emissions would account for 127 800 kt (-4 800 kt compared to BAU), and the total expenditure would be 73.2 b€ (+0.6% compared to BAU).

Table 2-7 LLCC scenario outcomes and comparison with BAU scenario: market data, energy consumption and expenditure

(1.5 = Auxiliary rinsing; 4.2 = High efficient pumps and motors)

Year	Indicator	BC1	BC2		BC3	BC4	BC5		BC6		Total	Difference with BAU	
		2010 BC	2010 BC	2014 4.2	2010 BC	2010 BC	2010 BC	2014 1.5	2010 BC	2014 BA product		Absolute	Relative
	Product price (€/unit)	**3 200**	**3 500**	**3 955**	**4 700**	**10 500**	**15 000**	**16 950**	**45 000**	**75 600**	-		
2009	**Stock (units)**	207 223	1 012 355	0	482 728	19 309	68 425	0	18 015	0	1 808 055	**0.0**	**0.0%**
	Sales (units)	19 341	136 668	0	65 168	2 607	7 071	0	1 420	0	232 274	**0.0**	**0.0%**
	Energy (TJ)	3 393.5	62 920.2	0.0	47 140.5	2 053.3	29 583.3	0.0	20 735.4	0.0	165 826.2	**0.0**	**0.0%**
	Expenditure (m€)	159.5	1 866.0	0.0	1 212.4	70.1	492.1	0.0	302.4	0.0	4 102.6	**0.0**	**0.0%**
2010	**Stock (units)**	209 295	1 022 479	0	487 555	19 502	69 794	0	18 375	0	1 827 000	**0.0**	**0.0%**
	Sales (units)	19 534	138 035	0	65 820	2 633	7 212	0	1 448	0	234 682	**0.0**	**0.0%**
	Energy (TJ)	3 427.4	63 549.4	0.0	47 611.9	2 073.9	30 175.0	0.0	21 150.1	0.0	167 987.6	**0.0**	**0.0%**
	Expenditure (m€)	161.1	1 884.7	0.0	1 224.5	70.8	501.9	0.0	308.5	0.0	4 151.6	**0.0**	**0.0%**
2011	**Stock (units)**	211 388	1 032 703	0	492 431	19 697	71 189	0	18 743	0	1 846 152	**0.0**	**0.0%**
	Sales (units)	19 730	139 415	0	66 478	2 659	7 356	0	1 477	0	237 115	**0.0**	**0.0%**
	Energy (TJ)	3 461.7	64 184.9	0.0	48 088.0	2 094.6	30 778.5	0.0	21 573.1	0.0	170 180.7	**0.0**	**0.0%**
	Expenditure (m€)	162.7	1 903.6	0.0	1 236.8	71.5	512.0	0.0	314.7	0.0	4 201.2	**0.0**	**0.0%**
2012	**Stock (units)**	213 502	1 043 030	0	497 355	19 894	72 613	0	19 118	0	1 865 512	**0.0**	**0.0%**
	Sales (units)	19 927	140 809	0	67 143	2 686	7 503	0	1 507	0	239 575	**0.0**	**0.0%**
	Energy (TJ)	3 496.3	64 826.7	0.0	48 568.9	2 115.5	31 394.1	0.0	22 004.6	0.0	172 406.1	**0.0**	**0.0%**
	Expenditure (m€)	164.4	1 922.6	0.0	1 249.1	72.3	522.2	0.0	320.9	0.0	4 251.5	**0.0**	**0.0%**
2013	**Stock (units)**	215 637	1 053 461	0	502 329	20 093	74 065	0	19 500	0	1 885 085	**0.0**	**0.0%**
	Sales (units)	20 126	142 217	0	67 814	2 713	7 653	0	1 537	0	242 061	**0.0**	**0.0%**
	Energy (TJ)	3 531.3	65 475.0	0.0	49 054.5	2 136.7	32 022.0	0.0	22 444.7	0.0	174 664.1	**0.0**	**0.0%**
	Expenditure (m€)	166.0	1 941.8	0.0	1 261.6	73.0	532.6	0.0	327.4	0.0	4 302.4	**0.0**	**0.0%**
2014	**Stock (units)**	217 793	1 063 995	0	507 352	20 294	75 547	0	19 890	0	1 904 871	**0.0**	**0.0%**
	Sales (units)	20 327	0	143 639	68 493	2 740	0	7 806	0	1 568	244 573	**0.0**	**0.0%**
	Energy (TJ)	3 566.6	66 129.7	0.0	49 545.1	2 158.1	32 662.4	0.0	22 893.6	0.0	176 955.4	**0.0**	**0.0%**
	Expenditure (m€)	167.7	1 458.5	568.1	1 274.2	73.7	426.2	132.3	263.4	118.5	4 482.6	**128.6**	**3.0%**
2015	**Stock (units)**	219 971	930 996	143 639	512 425	20 497	69 251	7 806	18 720	1 568	1 924 874	**0.0**	**0.0%**
	Sales (units)	20 531	0	145 076	69 177	2 767	0	7 963	0	1 599	247 113	**0.0**	**0.0%**
	Energy (TJ)	3 602.2	57 863.5	8 337.2	50 040.5	2 179.6	29 940.5	3 013.1	21 546.9	1 154.8	177 678.5	**-1 602.0**	**-0.9%**
	Expenditure (m€)	169.3	1 276.2	761.8	1 287.0	74.5	390.7	174.8	247.9	136.4	4 518.5	**112.2**	**2.5%**
2016	**Stock (units)**	222 171	796 666	288 715	517 550	20 702	62 830	15 769	17 527	3 167	1 945 097	**0.0**	**0.0%**
	Sales (units)	20 736	0	146 527	69 869	2 795	0	8 122	0	1 631	249 679	**0.0**	**0.0%**
	Energy (TJ)	3 638.3	49 514.6	16 757.8	50 540.9	2 201.4	27 164.2	6 086.5	20 173.3	2 332.8	178 409.8	**-3 230.2**	**-1.8%**
	Expenditure (m€)	171.0	1 092.0	957.5	1 299.8	75.2	354.4	218.1	232.1	154.7	4 554.9	**95.6**	**2.1%**

Year	Indicator	BC1	BC2		BC3	BC4	BC5		BC6		Total	Difference with BAU	
		2010 BC	2010 BC	2014 4.2	2010 BC	2010 BC	2010 BC	2014 1.5	2010 BC	2014 BA product		Absolute	Relative
2017	Stock (units)	224 393	660 994	435 242	522 725	20 909	56 280	23 891	16 309	4 798	1 965 541	**0.0**	**0.0%**
	Sales (units)	20 943	0	147 992	70 568	2 823	0	8 284	0	1 664	252 274	**0.0**	**0.0%**
	Energy (TJ)	3 674.6	41 082.3	25 262.6	51 046.4	2 223.5	24 332.4	9 221.3	18 772.2	3 534.3	179 149.5	**-4 884.9**	**-2.7%**
	Expenditure (m€)	172.8	906.1	1 155.1	1 312.8	75.9	317.5	262.3	216.0	173.3	4 591.8	**78.7**	**1.7%**
2018	Stock (units)	226 637	523 964	583 233	527 953	21 118	49 599	32 175	15 068	6 462	1 986 209	**0.0**	**0.0%**
	Sales (units)	21 153	0	149 472	71 274	2 851	0	8 450	0	1 697	254 896	**0.0**	**0.0%**
	Energy (TJ)	3 711.4	32 565.6	33 852.4	51 556.8	2 245.7	21 443.9	12 418.9	17 343.1	4 759.8	179 897.6	**-6 566.8**	**-3.5%**
	Expenditure (m€)	174.5	718.2	1 354.7	1 326.0	76.7	279.8	307.4	199.5	192.3	4 629.1	**61.6**	**1.3%**
2019	Stock (units)	228 903	385 565	732 705	533 232	21 329	42 784	40 625	13 801	8 159	2 007 104	**0.0**	**0.0%**
	Sales (units)	21 364	0	150 966	71 986	2 879	0	8 619	0	1 731	257 546	**0.0**	**0.0%**
	Energy (TJ)	3 748.5	23 963.7	42 528.2	52 072.4	2 268.1	18 497.7	15 680.4	15 885.4	6 009.8	180 654.2	**-8 276.1**	**-4.4%**
	Expenditure (m€)	176.2	528.5	1 556.3	1 339.2	77.5	241.4	353.3	182.7	211.7	4 666.9	**44.2**	**1.0%**
2020	Stock (units)	231 192	245 781	883 672	538 564	21 542	35 834	49 244	12 510	9 890	2 028 229	**0.0**	**0.0%**
	Sales (units)	21 578	0	152 476	72 706	2 908	0	8 791	0	1 766	260 225	**0.0**	**0.0%**
	Energy (TJ)	3 786.0	15 275.8	51 290.7	52 593.1	2 290.8	15 492.5	19 007.1	14 398.5	7 284.9	181 419.4	**-10 013.6**	**-5.2%**
	Expenditure (m€)	178.0	336.9	1 759.9	1 352.6	78.2	202.2	400.2	165.6	231.5	4 705.2	**26.5**	**0.6%**
2021	Stock (units)	233 504	104 599	1 036 148	543 950	21 758	28 744	58 036	11 192	11 655	2 049 586	**0.0**	**0.0%**
	Sales (units)	21 794	0	154 001	73 433	2 937	0	8 967	0	1 801	262 933	**0.0**	**0.0%**
	Energy (TJ)	3 823.8	6 501.1	60 140.8	53 119.0	2 313.7	12 427.3	22 400.3	12 882.0	8 585.4	182 193.4	**-11 779.6**	**-6.1%**
	Expenditure (m€)	179.8	143.4	1 965.5	1 366.2	79.0	162.2	448.0	148.2	251.7	4 743.9	**8.6**	**0.2%**
2022	Stock (units)	235 839	0	1 152 154	549 389	21 975	21 512	67 003	9 848	13 456	2 071 178	**0.0**	**0.0%**
	Sales (units)	22 012	0	155 541	74 168	2 967	0	9 147	0	1 837	265 670	**0.0**	**0.0%**
	Energy (TJ)	3 862.1	0.0	66 874.1	53 650.2	2 336.9	9 300.7	25 861.4	11 335.1	9 911.9	183 132.5	**-13 418.4**	**-6.8%**
	Expenditure (m€)	181.6	0.0	2 123.5	1 379.8	79.8	121.4	496.8	130.4	272.2	4 785.5	**-7.2**	**-0.2%**
2023	Stock (units)	238 197	0	1 163 676	554 883	22 195	14 136	76 149	8 477	15 293	2 093 008	**0.0**	**0.0%**
	Sales (units)	22 232	0	157 096	74 909	2 996	0	9 329	0	1 874	268 437	**0.0**	**0.0%**
	Energy (TJ)	3 900.7	0.0	67 542.9	54 186.7	2 360.2	6 111.6	29 391.8	9 757.2	11 265.0	184 516.1	**-14 651.2**	**-7.4%**
	Expenditure (m€)	183.4	0.0	2 144.7	1 393.6	80.6	79.7	546.6	112.2	293.2	4 834.1	**-16.8**	**-0.3%**
2024	Stock (units)	240 579	0	1 175 313	560 432	22 417	6 612	85 479	7 079	17 167	2 115 078	**0.0**	**0.0%**
	Sales (units)	22 454	0	158 667	75 658	3 026	0	9 516	0	1 911	271 233	**0.0**	**0.0%**
	Energy (TJ)	3 939.7	0.0	68 218.3	54 728.6	2 383.8	2 858.7	32 992.7	8 147.8	12 645.1	185 914.8	**-15 908.1**	**-7.9%**
	Expenditure (m€)	185.2	0.0	2 166.2	1 407.6	81.4	37.3	597.3	93.7	314.6	4 883.3	**-26.6**	**-0.5%**
2025	Stock (units)	242 985	0	1 187 066	566 037	22 641	0	93 933	5 653	19 078	2 137 393	**0.0**	**0.0%**
	Sales (units)	22 679	0	160 254	76 415	3 057	0	9 706	0	1 949	274 060	**0.0**	**0.0%**
	Energy (TJ)	3 979.1	0.0	68 900.5	55 275.9	2 407.7	0.0	36 255.7	6 506.2	14 052.9	187 378.0	**-17 140.4**	**-8.4%**
	Expenditure (m€)	187.1	0.0	2 187.8	1 421.6	82.2	0.0	643.7	74.8	336.5	4 933.7	**-36.0**	**-0.7%**

Year	Indicator	BC1	BC2		BC3	BC4	BC5		BC6		Total	Difference with BAU	
		2010 BC	2010 BC	2014 4.2	2010 BC	2010 BC	2010 BC	2014 1.5	2010 BC	2014 BA product		Absolute	Relative
2026	**Stock (units)**	245 415	0	1 198 937	571 697	22 868	0	95 812	4 198	21 027	2 159 953	**0.0**	**0.0%**
	Sales (units)	22 905	0	161 856	77 179	3 087	0	9 901	0	1 988	276 917	**0.0**	**0.0%**
	Energy (TJ)	4 018.9	0.0	69 589.5	55 828.6	2 431.8	0.0	36 980.8	4 831.8	15 488.8	189 170.2	**-18 084.2**	**-8.7%**
	Expenditure (m€)	188.9	0.0	2 209.7	1 435.8	83.1	0.0	656.6	55.6	358.7	4 988.4	**-41.9**	**-0.8%**
2027	**Stock (units)**	247 869	0	1 210 926	577 414	23 096	0	97 728	2 714	23 016	2 182 763	**0.0**	**0.0%**
	Sales (units)	23 134	0	163 475	77 951	3 118	0	10 099	0	2 028	279 805	**0.0**	**0.0%**
	Energy (TJ)	4 059.1	0.0	70 285.4	56 386.9	2 456.1	0.0	37 720.5	3 123.9	16 953.4	190 985.2	**-19 046.3**	**-9.1%**
	Expenditure (m€)	190.8	0.0	2 231.8	1 450.2	83.9	0.0	669.7	35.9	381.4	5 043.8	**-48.0**	**-0.9%**
2028	**Stock (units)**	250 348	0	1 223 035	583 188	23 327	0	99 682	1 200	25 044	2 205 825	**0.0**	**0.0%**
	Sales (units)	23 366	0	165 110	78 730	3 149	0	10 301	0	2 069	282 724	**0.0**	**0.0%**
	Energy (TJ)	4 099.7	0.0	70 988.3	56 950.8	2 480.6	0.0	38 474.9	1 381.8	18 447.3	192 823.3	**-20 027.2**	**-9.4%**
	Expenditure (m€)	192.7	0.0	2 254.1	1 464.7	84.7	0.0	683.1	15.9	404.6	5 099.9	**-54.1**	**-1.1%**
2029	**Stock (units)**	252 851	0	1 235 265	589 020	23 561	0	101 676	0	26 769	2 229 143	**0.0**	**0.0%**
	Sales (units)	23 599	0	166 761	79 518	3 181	0	10 507	0	2 110	285 675	**0.0**	**0.0%**
	Energy (TJ)	4 140.7	0.0	71 698.1	57 520.3	2 505.4	0.0	39 244.4	0.0	19 718.2	194 827.1	**-20 884.9**	**-9.7%**
	Expenditure (m€)	194.7	0.0	2 276.7	1 479.3	85.6	0.0	696.7	0.0	424.8	5 157.8	**-59.3**	**-1.1%**
2030	**Stock (units)**	255 380	0	1 247 618	594 910	23 796	0	103 709	0	27 305	2 252 719	**0.0**	**0.0%**
	Sales (units)	23 835	0	168 428	80 313	3 212	0	10 717	0	2 152	288 658	**0.0**	**0.0%**
	Energy (TJ)	4 182.1	0.0	72 415.1	58 095.5	2 530.5	0.0	40 029.3	0.0	20 112.6	197 365.0	**-21 251.8**	**-9.7%**
	Expenditure (m€)	196.6	0.0	2 299.4	1 494.1	86.4	0.0	710.7	0.0	433.3	5 220.6	**-60.5**	**-1.1%**
2010-2020	**Energy (TJ)**	**39 644.2**	**544 431.3**	**178 028.9**	**550 718.5**	**23 987.9**	**293 903.3**	**65 427.2**	**218 185.5**	**25 076.3**	**1 939 403.0**	-34 573.6	-1.8%
	Expenditure (m€)	**1 863.7**	**13 969.1**	**8 113.3**	**14 163.8**	**819.4**	**4 280.8**	**1 848.4**	**2 778.6**	**1 218.6**	**49 055.8**	547.2	1.1%
2010-2025	**Energy (TJ)**	**59 149.6**	**550 932.4**	**509 705.6**	**821 678.9**	**35 790.3**	**324 601.6**	**212 329.2**	**266 813.7**	**81 536.7**	**2 862 537.9**	-107 471.3	-3.6%
	Expenditure (m€)	**2 780.7**	**14 112.5**	**18 701.0**	**21 132.5**	**1 222.5**	**4 681.4**	**4 580.9**	**3 338.0**	**2 686.8**	**73 236.4**	469.3	0.6%
2010-2030	**Energy (TJ)**	**79 650.0**	**550 932.4**	**864 682.0**	**1 106 461.1**	**48 194.7**	**324 601.6**	**404 779.0**	**276 151.1**	**172 256.9**	**3 827 708.7**	-206 765.6	-5.1%
	Expenditure (m€)	**3 744.5**	**14 112.5**	**29 972.8**	**28 456.8**	**1 646.2**	**4 681.4**	**7 997.6**	**3 445.4**	**4 689.7**	**98 746.9**	205.5	0.2%

2.4.3 Best Available Technology (BAT) scenario

The BAT scenario considers that all BAT improvement options are implemented for each base case, as described in Task 7. The market modelling includes that from 2014, all products sold are equivalent to these BAT options and no more base cases are sold (the market shift takes place in one single step). Table 2-8 reminds the BAT options that were identified for each base case in Task 7. As a reminder, the warm water supply option was not eligible to be the BAT option.

Table 2-8 BAT improvement option for each base case

Base case	BAT Improvement option
1. Undercounter water-change	BA product
2. Undercounter one-tank	BA product
3. Hood-type	BA product
4. Utensil/Pot	BA product
5. One-tank conveyor-type	BA product
6. Multi-tank conveyor-type	BA product

Table 2-9 presents the outcomes of this scenario modelling. In 2025, the professional dishwashers market would require 168.4 PJ of primary energy (-17.7% compared to BAU), and would represent 5.65 b€ (+13.7% compared to BAU). Over the period 2010-2025, the total primary energy consumption would be 2 733 PJ (-8.0% compared to BAU) and the total expenditure 81.2 b€ (+11.6% compared to BAU). Also, 122 000 ktCO_2 would be emitted by professional dishwashers over the period 2010-2025.

Table 2-9 BAT scenario outcomes and comparison with BAU scenario: market data, energy consumption and expenditure

Year	Indicator	BC1		BC2		BC3		BC4		BC5		BC6		Total	Difference with BAU	
		2010 Base case	2014 BA product	2010 Base case	2014 BA product	2010 Base case	2014 BA product	2010 Base case	2014 BA product	2010 Base case	2014 BA product	2010 Base case	2014 BA product		Absolute	Relative
	Product price (€/unit)	**3 200**	**3 712**	**3 500**	**5 600**	**4 700**	**8 319**	**10 500**	**18 585**	**15 000**	**27 150**	**45 000**	**75 600**			
2009	**Stock (units)**	207 223	0	1 012 355	0	482 728	0	19 309	0	68 425	0	18 015	0	1 808 055	**0.0**	**0.0%**
	Sales (units)	19 341	0	136 668	0	65 168	0	2 607	0	7 071	0	1 420	0	232 274	**0.0**	**0.0%**
	Energy (TJ)	3 393.5	0.0	62 920.2	0.0	47 140.5	0.0	2 053.3	0.0	29 583.3	0.0	20 735.4	0.0	165 826.2	**0.0**	**0.0%**
	Expenditure (m€)	159.5	0.0	1 866.0	0.0	1 212.4	0.0	70.1	0.0	492.1	0.0	302.4	0.0	4 102.6	**0.0**	**0.0%**
2010	**Stock (units)**	209 295	0	1 022 479	0	487 555	0	19 502	0	69 794	0	18 375	0	1 827 000	**0.0**	**0.0%**
	Sales (units)	19 534	0	138 035	0	65 820	0	2 633	0	7 212	0	1 448	0	234 682	**0.0**	**0.0%**
	Energy (TJ)	3 427.4	0.0	63 549.4	0.0	47 611.9	0.0	2 073.9	0.0	30 175.0	0.0	21 150.1	0.0	167 987.6	**0.0**	**0.0%**
	Expenditure (m€)	161.1	0.0	1 884.7	0.0	1 224.5	0.0	70.8	0.0	501.9	0.0	308.5	0.0	4 151.6	**0.0**	**0.0%**
2011	**Stock (units)**	211 388	0	1 032 703	0	492 431	0	19 697	0	71 189	0	18 743	0	1 846 152	**0.0**	**0.0%**
	Sales (units)	19 730	0	139 415	0	66 478	0	2 659	0	7 356	0	1 477	0	237 115	**0.0**	**0.0%**
	Energy (TJ)	3 461.7	0.0	64 184.9	0.0	48 088.0	0.0	2 094.6	0.0	30 778.5	0.0	21 573.1	0.0	170 180.7	**0.0**	**0.0%**
	Expenditure (m€)	162.7	0.0	1 903.6	0.0	1 236.8	0.0	71.5	0.0	512.0	0.0	314.7	0.0	4 201.2	**0.0**	**0.0%**
2012	**Stock (units)**	213 502	0	1 043 030	0	497 355	0	19 894	0	72 613	0	19 118	0	1 865 512	**0.0**	**0.0%**
	Sales (units)	19 927	0	140 809	0	67 143	0	2 686	0	7 503	0	1 507	0	239 575	**0.0**	**0.0%**
	Energy (TJ)	3 496.3	0.0	64 826.7	0.0	48 568.9	0.0	2 115.5	0.0	31 394.1	0.0	22 004.6	0.0	172 406.1	**0.0**	**0.0%**
	Expenditure (m€)	164.4	0.0	1 922.6	0.0	1 249.1	0.0	72.3	0.0	522.2	0.0	320.9	0.0	4 251.5	**0.0**	**0.0%**
2013	**Stock (units)**	215 637	0	1 053 461	0	502 329	0	20 093	0	74 065	0	19 500	0	1 885 085	**0.0**	**0.0%**
	Sales (units)	20 126	0	142 217	0	67 814	0	2 713	0	7 653	0	1 537	0	242 061	**0.0**	**0.0%**
	Energy (TJ)	3 531.3	0.0	65 475.0	0.0	49 054.5	0.0	2 136.7	0.0	32 022.0	0.0	22 444.7	0.0	174 664.1	**0.0**	**0.0%**
	Expenditure (m€)	166.0	0.0	1 941.8	0.0	1 261.6	0.0	73.0	0.0	532.6	0.0	327.4	0.0	4 302.4	**0.0**	**0.0%**
2014	**Stock (units)**	217 793	0	1 063 995	0	507 352	0	20 294	0	75 547	0	19 890	0	1 904 871	**0.0**	**0.0%**
	Sales (units)	0	20 327	0	143 639	0	68 493	0	2 740	0	7 806	0	1 568	244 573	**0.0**	**0.0%**
	Energy (TJ)	3 566.6	0.0	66 129.7	0.0	49 545.1	0.0	2 158.1	0.0	32 662.4	0.0	22 893.6	0.0	176 955.4	**0.0**	**0.0%**
	Expenditure (m€)	102.6	75.5	1 458.5	804.4	952.3	569.8	44.9	50.9	426.2	211.9	263.4	118.5	5 079.0	**724.9**	**16.6%**
2015	**Stock (units)**	199 644	20 327	930 996	143 639	443 933	68 493	17 757	2 740	69 251	7 806	18 720	1 568	1 924 874	**0.0**	**0.0%**
	Sales (units)	0	20 531	0	145 076	0	69 177	0	2 767	0	7 963	0	1 599	247 113	**0.0**	**0.0%**
	Energy (TJ)	3 269.4	310.6	57 863.5	7 980.6	43 352.0	5 633.5	1 888.3	256.0	29 940.5	2 449.8	21 546.9	1 154.8	175 645.9	**-3 634.7**	**-2.0%**
	Expenditure (m€)	94.1	85.6	1 276.2	1 008.7	833.3	703.6	39.3	58.1	390.7	253.9	247.9	136.4	5 127.7	**721.3**	**16.4%**

Year	Indicator	BC1		BC2		BC3		BC4		BC5		BC6		Total	Difference with BAU	
		2010 Base case	2014 BA product	2010 Base case	2014 BA product	2010 Base case	2014 BA product	2010 Base case	2014 BA product	2010 Base case	2014 BA product	2010 Base case	2014 BA product		Absolute	Relative
2016	Stock (units)	181 313	40 858	796 666	288 715	379 880	137 670	15 195	5 507	62 830	15 769	17 527	3 167	1 945 097	**0.0**	**0.0%**
	Sales (units)	0	20 736	0	146 527	0	69 869	0	2 795	0	8 122	0	1 631	249 679	**0.0**	**0.0%**
	Energy (TJ)	2 969.2	624.2	49 514.6	16 041.0	37 096.9	11 323.3	1 615.8	514.5	27 164.2	4 948.7	20 173.3	2 332.8	174 318.6	**-7 321.4**	**-4.0%**
	Expenditure (m€)	85.4	95.8	1 092.0	1 215.0	713.1	838.8	33.7	65.4	354.4	296.7	232.1	154.7	5 177.0	**717.6**	**16.1%**
2017	Stock (units)	162 799	61 594	660 994	435 242	315 186	207 539	12 607	8 302	56 280	23 891	16 309	4 798	1 965 541	**0.0**	**0.0%**
	Sales (units)	0	20 943	0	147 992	0	70 568	0	2 823	0	8 284	0	1 664	252 274	**0.0**	**0.0%**
	Energy (TJ)	2 666.0	941.1	41 082.3	24 182.1	30 779.3	17 070.1	1 340.7	775.6	24 332.4	7 497.5	18 772.2	3 534.3	172 973.3	**-11 061.1**	**-6.0%**
	Expenditure (m€)	76.7	106.1	906.1	1 423.4	591.6	975.3	27.9	72.7	317.5	340.4	216.0	173.3	5 226.9	**713.8**	**15.8%**
2018	Stock (units)	144 099	82 537	523 964	583 233	249 845	278 107	9 994	11 124	49 599	32 175	15 068	6 462	1 986 209	**0.0**	**0.0%**
	Sales (units)	0	21 153	0	149 472	0	71 274	0	2 851	0	8 450	0	1 697	254 896	**0.0**	**0.0%**
	Energy (TJ)	2 359.8	1 261.0	32 565.6	32 404.5	24 398.5	22 874.3	1 062.7	1 039.4	21 443.9	10 097.2	17 343.1	4 759.8	171 609.8	**-14 854.6**	**-8.0%**
	Expenditure (m€)	67.9	116.5	718.2	1 633.8	469.0	1 113.1	22.1	80.1	279.8	384.9	199.5	192.3	5 277.3	**709.8**	**15.5%**
2019	Stock (units)	125 213	103 690	385 565	732 705	183 851	349 381	7 354	13 975	42 784	40 625	13 801	8 159	2 007 104	**0.0**	**0.0%**
	Sales (units)	0	21 364	0	150 966	0	71 986	0	2 879	0	8 619	0	1 731	257 546	**0.0**	**0.0%**
	Energy (TJ)	2 050.5	1 584.2	23 963.7	40 709.2	17 953.9	28 736.5	782.0	1 305.7	18 497.7	12 749.0	15 885.4	6 009.8	170 227.7	**-18 702.7**	**-9.9%**
	Expenditure (m€)	59.0	127.0	528.5	1 846.4	345.1	1 252.4	16.3	87.5	241.4	430.3	182.7	211.7	5 328.4	**705.7**	**15.3%**
2020	Stock (units)	106 138	125 054	245 781	883 672	117 197	421 367	4 688	16 855	35 834	49 244	12 510	9 890	2 028 229	**0.0**	**0.0%**
	Sales (units)	0	21 578	0	152 476	0	72 706	0	2 908	0	8 791	0	1 766	260 225	**0.0**	**0.0%**
	Energy (TJ)	1 738.1	1 910.6	15 275.8	49 096.9	11 444.8	34 657.4	498.5	1 574.8	15 492.5	15 453.8	14 398.5	7 284.9	168 826.7	**-22 606.3**	**-11.8%**
	Expenditure (m€)	50.0	137.6	336.9	2 061.1	220.0	1 393.0	10.4	95.1	202.2	476.7	165.6	231.5	5 380.1	**701.5**	**15.0%**
2021	Stock (units)	86 872	146 632	104 599	1 036 148	49 877	494 073	1 995	19 763	28 744	58 036	11 192	11 655	2 049 586	**0.0**	**0.0%**
	Sales (units)	0	21 794	0	154 001	0	73 433	0	2 937	0	8 967	0	1 801	262 933	**0.0**	**0.0%**
	Energy (TJ)	1 422.6	2 240.3	6 501.1	57 568.5	4 870.7	40 637.5	212.2	1 846.5	12 427.3	18 212.7	12 882.0	8 585.4	167 406.6	**-26 566.4**	**-13.7%**
	Expenditure (m€)	40.9	148.4	143.4	2 277.9	93.6	1 535.1	4.4	102.7	162.2	523.9	148.2	251.7	5 432.4	**697.1**	**14.7%**
2022	Stock (units)	67 413	168 426	0	1 152 154	0	549 389	0	21 975	21 512	67 003	9 848	13 456	2 071 178	**0.0**	**0.0%**
	Sales (units)	0	22 012	0	155 541	0	74 168	0	2 967	0	9 147	0	1 837	265 670	**0.0**	**0.0%**
	Energy (TJ)	1 103.9	2 573.3	0.0	64 013.8	0.0	45 187.2	0.0	2 053.2	9 300.7	21 026.8	11 335.1	9 911.9	166 506.0	**-30 044.9**	**-15.3%**
	Expenditure (m€)	31.8	159.2	0.0	2 445.0	0.0	1 644.7	0.0	108.7	121.4	572.2	130.4	272.2	5 485.5	**692.7**	**14.5%**
2023	Stock (units)	47 760	190 438	0	1 163 676	0	554 883	0	22 195	14 136	76 149	8 477	15 293	2 093 008	**0.0**	**0.0%**
	Sales (units)	0	22 232	0	157 096	0	74 909	0	2 996	0	9 329	0	1 874	268 437	**0.0**	**0.0%**
	Energy (TJ)	782.1	2 909.6	0.0	64 653.9	0.0	45 639.1	0.0	2 073.7	6 111.6	23 897.2	9 757.2	11 265.0	167 089.5	**-32 077.8**	**-16.1%**
	Expenditure (m€)	22.5	170.1	0.0	2 469.5	0.0	1 661.1	0.0	109.7	79.7	621.3	112.2	293.2	5 539.5	**688.6**	**14.2%**
2024	Stock (units)	27 910	212 669	0	1 175 313	0	560 432	0	22 417	6 612	85 479	7 079	17 167	2 115 078	**0.0**	**0.0%**
	Sales (units)	0	22 454	0	158 667	0	75 658	0	3 026	0	9 516	0	1 911	271 233	**0.0**	**0.0%**

Year	Indicator	BC1		BC2		BC3		BC4		BC5		BC6		Total	Difference with BAU	
		2010 Base case	2014 BA product	2010 Base case	2014 BA product	2010 Base case	2014 BA product	2010 Base case	2014 BA product	2010 Base case	2014 BA product	2010 Base case	2014 BA product		Absolute	Relative
	Energy (TJ)	457.1	3 249.2	0.0	65 300.5	0.0	46 095.5	0.0	2 094.5	2 858.7	26 825.0	8 147.8	12 645.1	167 673.4	**-34 149.6**	**-16.9%**
	Expenditure (m€)	13.2	181.2	0.0	2 494.2	0.0	1 677.7	0.0	110.8	37.3	671.5	93.7	314.6	5 594.2	**684.3**	**13.9%**
2025	Stock (units)	7 862	235 124	0	1 187 066	0	566 037	0	22 641	0	93 933	5 653	19 078	2 137 393	**0.0**	**0.0%**
	Sales (units)	0	22 679	0	160 254	0	76 415	0	3 057	0	9 706	0	1 949	274 060	**0.0**	**0.0%**
	Energy (TJ)	128.7	3 592.3	0.0	65 953.5	0.0	46 556.5	0.0	2 115.4	0.0	29 478.0	6 506.2	14 052.9	168 383.5	**-36 134.9**	**-17.7%**
	Expenditure (m€)	3.7	192.3	0.0	2 519.1	0.0	1 694.5	0.0	111.9	0.0	717.5	74.8	336.5	5 650.4	**680.7**	**13.7%**
2026	Stock (units)	0	245 415	0	1 198 937	0	571 697	0	22 868	0	95 812	4 198	21 027	2 159 953	**0.0**	**0.0%**
	Sales (units)	0	22 905	0	161 856	0	77 179	0	3 087	0	9 901	0	1 988	276 917	**0.0**	**0.0%**
	Energy (TJ)	0.0	3 749.5	0.0	66 613.0	0.0	47 022.0	0.0	2 136.6	0.0	30 067.5	4 831.8	15 488.8	169 909.2	**-37 345.1**	**-18.0%**
	Expenditure (m€)	0.0	197.9	0.0	2 544.3	0.0	1 711.4	0.0	113.1	0.0	731.9	55.6	358.7	5 712.9	**682.6**	**13.6%**
2027	Stock (units)	0	247 869	0	1 210 926	0	577 414	0	23 096	0	97 728	2 714	23 016	2 182 763	**0.0**	**0.0%**
	Sales (units)	0	23 134	0	163 475	0	77 951	0	3 118	0	10 099	0	2 028	279 805	**0.0**	**0.0%**
	Energy (TJ)	0.0	3 787.0	0.0	67 279.2	0.0	47 492.3	0.0	2 157.9	0.0	30 668.9	3 123.9	16 953.4	171 462.5	**-38 569.0**	**-18.4%**
	Expenditure (m€)	0.0	199.9	0.0	2 569.8	0.0	1 728.6	0.0	114.2	0.0	746.5	35.9	381.4	5 776.3	**684.5**	**13.4%**
2028	Stock (units)	0	250 348	0	1 223 035	0	583 188	0	23 327	0	99 682	1 200	25 044	2 205 825	**0.0**	**0.0%**
	Sales (units)	0	23 366	0	165 110	0	78 730	0	3 149	0	10 301	0	2 069	282 724	**0.0**	**0.0%**
	Energy (TJ)	0.0	3 824.9	0.0	67 951.9	0.0	47 967.2	0.0	2 179.5	0.0	31 282.3	1 381.8	18 447.3	173 034.9	**-39 815.6**	**-18.7%**
	Expenditure (m€)	0.0	201.9	0.0	2 595.4	0.0	1 745.8	0.0	115.3	0.0	761.4	15.9	404.6	5 840.5	**686.5**	**13.3%**
2029	Stock (units)	0	252 851	0	1 235 265	0	589 020	0	23 561	0	101 676	0	26 769	2 229 143	**0.0**	**0.0%**
	Sales (units)	0	23 599	0	166 761	0	79 518	0	3 181	0	10 507	0	2 110	285 675	**0.0**	**0.0%**
	Energy (TJ)	0.0	3 863.1	0.0	68 631.5	0.0	48 446.8	0.0	2 201.3	0.0	31 907.9	0.0	19 718.2	174 768.9	**-40 943.1**	**-19.0%**
	Expenditure (m€)	0.0	203.9	0.0	2 621.4	0.0	1 763.3	0.0	116.5	0.0	776.7	0.0	424.8	5 906.6	**689.5**	**13.2%**
2030	Stock (units)	0	255 380	0	1 247 618	0	594 910	0	23 796	0	103 709	0	27 305	2 252 719	**0.0**	**0.0%**
	Sales (units)	0	23 835	0	168 428	0	80 313	0	3 212	0	10 717	0	2 152	288 658	**0.0**	**0.0%**
	Energy (TJ)	0.0	3 901.8	0.0	69 317.8	0.0	48 931.3	0.0	2 223.3	0.0	32 546.1	0.0	20 112.6	177 032.8	**-41 584.0**	**-19.0%**
	Expenditure (m€)	0.0	206.0	0.0	2 647.6	0.0	1 780.9	0.0	117.7	0.0	792.2	0.0	433.3	5 977.7	**696.6**	**13.2%**
2010-2020	Energy (TJ)	**32 536.0**	**6 631.7**	**544 431.3**	**170 414.3**	**407 893.6**	**120 295.2**	**17 766.8**	**5 465.9**	**293 903.3**	**53 196.1**	**218 185.5**	**25 076.3**	**1 895 795.9**	-78 180.7	-4.0%
	Expenditure (m€)	**1 190.0**	**744.0**	**13 969.1**	**9 992.7**	**9 096.4**	**6 846.0**	**482.3**	**509.8**	**4 280.8**	**2 394.9**	**2 778.6**	**1 218.6**	**53 503.1**	4 994.6	10.3%
2010-2025	Energy (TJ)	**36 430.5**	**21 196.3**	**550 932.4**	**487 904.5**	**412 764.3**	**344 411.0**	**17 979.0**	**15 649.2**	**324 601.6**	**172 635.8**	**266 813.7**	**81 536.7**	**2 732 854.8**	-237 154.4	-8.0%
	Expenditure (m€)	**1 302.0**	**1 595.2**	**14 112.5**	**22 198.4**	**9 190.0**	**15 059.1**	**486.7**	**1 053.6**	**4 681.4**	**5 501.3**	**3 338.0**	**2 686.8**	**81 205.1**	8 438.0	11.6%
2010-2030	Energy (TJ)	**36 430.5**	**40 322.7**	**550 932.4**	**827 697.8**	**412 764.3**	**584 270.6**	**17 979.0**	**26 547.9**	**324 601.6**	**329 108.4**	**276 151.1**	**172 256.9**	**3 599 063.1**	-435 411.2	-10.8%
	Expenditure (m€)	**1 302.0**	**2 604.8**	**14 112.5**	**35 176.9**	**9 190.0**	**23 789.2**	**486.7**	**1 630.4**	**4 681.4**	**9 310.0**	**3 445.4**	**4 689.7**	**110 419.0**	11 877.7	12.1%

2.4.4 Eco-design requirements

The eco-design requirements consider that the suggested policy options presented in Section 2.3.3 are implemented for each base case. Depending on the Tier targets, the market modelling includes that from 2014 (Tier 1) and/or 2017 (Tier 2), all products sold are equivalent to options indicated in Table 2-10.

Table 2-10 BAT improvement option for each base case

Base case	Tier 1 (2014)	Tier 2 (2017)
1. Undercounter water-change	M 4.2 High efficient pumps and motors	-
2. Undercounter one-tank	M 4.2 High efficient pumps and motors	-
3. Hood-type	M 4.2 High efficient pumps and motors	M 3.1.1 Waste water heat exchanger
4. Utensil/Pot	M 4.2 High efficient pumps and motors	M 3.1.1 Waste water heat exchanger
5. One-tank conveyor-type	M 1.5 Auxiliary rinsing	-
6. Multi-tank conveyor-type	M 4.2 High efficient pumps and motors	-

Table 2-11 presents the outcomes of this scenario modelling (in the following referred to as "MEPS" – Minimum Energy Performance Standard – scenario). In 2025, the professional dishwashers market would require 186.5 PJ of primary energy (-8.8% compared to BAU), and would represent 4.96 b€ (-0.1% compared to BAU). Over the period 2010-2025, the total primary energy consumption would be 2 854 PJ (-3.9% compared to BAU) and the total expenditure 73.5 b€ (-1.0% compared to BAU). Also, 127 400 ktCO_2 would be emitted by professional dishwashers over the period 2010-2025.

Table 2-11 MEPS scenario outcomes and comparison with BAU scenario: market data, energy consumption and expenditure

(BC = Base case; 4.2 HEPM = High efficiency pumps and motors; 3.1.1 WWHE = Waste water heat exchanger; 1.5 AR = Auxiliary rinsing)

Year	Indicator	BC1		BC2		BC3			BC4			BC5		BC6		Total	Difference with BAU	
		2010 BC	2014 4.2	2010 BC	2014 4.2	2010 BC	2014 4.2	2017 3.1.1	2010 BC	2014 4.2	2017 3.1.1	2010 BC	2014 1.5	2010 BC	2014 4.2		Absolute	Relative
	Product price (€/unit)	**3200**	**3456**	**3500**	**3955**	**4700**	**5405**	**5546**	**10500**	**11550**	**11445**	**15000**	**16950**	**45000**	**51750**	-		
2009	**Stock (units)**	207223	0	1012355	0	482728	0	0	19309	0	0	68425	0	18015	0	1808055	**0.0**	**0.0%**
	Sales (units)	19341	0	136668	0	65168	0	0	2607	0	0	7071	0	1420	0	232274	**0.0**	**0.0%**
	Energy (TJ)	3393.5	0.0	62920.2	0.0	47140.5	0.0	0.0	2053.3	0.0	0.0	29583.3	0.0	20735.4	0.0	165826.2	**0.0**	**0.0%**
	Expenditure (m€)	159.5	0.0	1866.0	0.0	1212.4	0.0	0.0	70.1	0.0	0.0	492.1	0.0	302.4	0.0	4102.6	**0.0**	**0.0%**
2010	**Stock (units)**	209295	0	1022479	0	487555	0	0	19502	0	0	69794	0	18375	0	1827000	**0.0**	**0.0%**
	Sales (units)	19534	0	138035	0	65820	0	0	2633	0	0	7212	0	1448	0	234682	**0.0**	**0.0%**
	Energy (TJ)	3427.4	0.0	63549.4	0.0	47611.9	0.0	0.0	2073.9	0.0	0.0	30175.0	0.0	21150.1	0.0	167987.6	**0.0**	**0.0%**
	Expenditure (m€)	161.1	0.0	1884.7	0.0	1224.5	0.0	0.0	70.8	0.0	0.0	501.9	0.0	308.5	0.0	4151.6	**0.0**	**0.0%**
2011	**Stock (units)**	211388	0	1032703	0	492431	0	0	19697	0	0	71189	0	18743	0	1846152	**0.0**	**0.0%**
	Sales (units)	19730	0	139415	0	66478	0	0	2659	0	0	7356	0	1477	0	237115	**0.0**	**0.0%**
	Energy (TJ)	3461.7	0.0	64184.9	0.0	48088.0	0.0	0.0	2094.6	0.0	0.0	30778.5	0.0	21573.1	0.0	170180.7	**0.0**	**0.0%**
	Expenditure (m€)	162.7	0.0	1903.6	0.0	1236.8	0.0	0.0	71.5	0.0	0.0	512.0	0.0	314.7	0.0	4201.2	**0.0**	**0.0%**
2012	**Stock (units)**	213502	0	1043030	0	497355	0	0	19894	0	0	72613	0	19118	0	1865512	**0.0**	**0.0%**
	Sales (units)	19927	0	140809	0	67143	0	0	2686	0	0	7503	0	1507	0	239575	**0.0**	**0.0%**
	Energy (TJ)	3496.3	0.0	64826.7	0.0	48568.9	0.0	0.0	2115.5	0.0	0.0	31394.1	0.0	22004.6	0.0	172406.1	**0.0**	**0.0%**
	Expenditure (m€)	164.4	0.0	1922.6	0.0	1249.1	0.0	0.0	72.3	0.0	0.0	522.2	0.0	320.9	0.0	4251.5	**0.0**	**0.0%**
2013	**Stock (units)**	215637	0	1053461	0	502329	0	0	20093	0	0	74065	0	19500	0	1885085	**0.0**	**0.0%**
	Sales (units)	20126	0	142217	0	67814	0	0	2713	0	0	7653	0	1537	0	242061	**0.0**	**0.0%**
	Energy (TJ)	3531.3	0.0	65475.0	0.0	49054.5	0.0	0.0	2136.7	0.0	0.0	32022.0	0.0	22444.7	0.0	174664.1	**0.0**	**0.0%**
	Expenditure (m€)	166.0	0.0	1941.8	0.0	1261.6	0.0	0.0	73.0	0.0	0.0	532.6	0.0	327.4	0.0	4302.4	**0.0**	**0.0%**
2014	**Stock (units)**	217793	0	1063995	0	507352	0	0	20294	0	0	75547	0	19890	0	1904871	**0.0**	**0.0%**
	Sales (units)	0	20327	0	143639	0	68493	0	0	2740	0	0	7806	0	1568	244573	**0.0**	**0.0%**
	Energy (TJ)	3566.6	0.0	66129.7	0.0	49545.1	0.0	0.0	2158.1	0.0	0.0	32662.4	0.0	22893.6	0.0	176955.4	**0.0**	**0.0%**
	Expenditure (m€)	102.6	70.3	1458.5	568.1	952.3	370.2	0.0	44.9	31.6	0.0	426.2	132.3	263.4	81.1	4501.6	**147.5**	**3.4%**
2015	**Stock (units)**	199644	20327	930996	143639	443933	68493	0	17757	2740	0	69251	7806	18720	1568	1924874	**0.0**	**0.0%**
	Sales (units)	0	20531	0	145076	0	69177	0	0	2767	0	0	7963	0	1599	247113	**0.0**	**0.0%**
	Energy (TJ)	3269.4	322.1	57863.5	8337.2	43352.0	6250.0	0.0	1888.3	277.1	0.0	29940.5	3013.1	21546.9	1601.5	177661.4	**-1619.1**	**-0.9%**
	Expenditure (m€)	94.1	80.3	1276.2	761.8	833.3	496.9	0.0	39.3	37.9	0.0	390.7	174.8	247.9	101.2	4534.3	**128.0**	**2.9%**
2016	**Stock (units)**	181313	40858	796666	288715	379880	137670	0	15195	5507	0	62830	15769	17527	3167	1945097	**0.0**	**0.0%**
	Sales (units)	0	20736	0	146527	0	69869	0	0	2795	0	0	8122	0	1631	249679	**0.0**	**0.0%**
	Energy (TJ)	2969.2	647.3	49514.6	16757.8	37096.9	12562.4	0.0	1615.8	556.9	0.0	27164.2	6086.5	20173.3	3235.0	178380.0	**-3260.1**	**-1.8%**
	Expenditure (m€)	85.4	90.5	1092.0	957.5	713.1	624.9	0.0	33.7	44.2	0.0	354.4	218.1	232.1	121.7	4567.5	**108.1**	**2.4%**
2017	**Stock (units)**	162799	61594	660994	435242	315186	207539	0	12607	8302	0	56280	23891	16309	4798	1965541	**0.0**	**0.0%**
	Sales (units)	0	20943	0	147992	0	0	70568	0	0	2823	0	8284	0	1664	252274	**0.0**	**0.0%**
	Energy (TJ)	2666.0	975.9	41082.3	25262.6	30779.3	18938.0	0.0	1340.7	839.5	0.0	24332.4	9221.3	18772.2	4901.2	179111.2	**-4923.2**	**-2.7%**

Year	Indicator	BC1		BC2		BC3			BC4			BC5		BC6		Total	Difference with BAU	
		2010	2014	2010	2014	2010	2014	2017	2010	2014	2017	2010	2014	2010	2014		Absolute	Relative
		BC	4.2	BC	4.2	BC	4.2	3.1.1	BC	4.2	3.1.1	BC	1.5	BC	4.2			
	Expenditure (m€)	76.7	100.7	906.1	1155.1	591.6	372.8	391.4	27.9	17.9	32.3	317.5	262.3	216.0	142.5	4610.8	**97.7**	**2.2%**
2018	**Stock (units)**	144099	82537	523964	583233	249845	207539	70568	9994	8302	2823	49599	32175	15068	6462	1986209	**0.0**	**0.0%**
	Sales (units)	0	21153	0	149472	0	0	71274	0	0	2851	0	8450	0	1697	254896	**0.0**	**0.0%**
	Energy (TJ)	2359.8	1307.7	32565.6	33852.4	24398.5	18938.0	6138.2	1062.7	839.5	276.4	21443.9	12418.9	17343.1	6600.7	179545.3	**-6919.0**	**-3.7%**
	Expenditure (m€)	67.9	111.1	718.2	1354.7	469.0	372.8	524.1	22.1	17.9	38.8	279.8	307.4	199.5	163.8	4647.2	**79.6**	**1.7%**
2019	**Stock (units)**	125213	103690	385565	732705	183851	207539	141841	7354	8302	5674	42784	40625	13801	8159	2007104	**0.0**	**0.0%**
	Sales (units)	0	21364	0	150966	0	0	71986	0	0	2879	0	8619	0	1731	257546	**0.0**	**0.0%**
	Energy (TJ)	2050.5	1642.8	23963.7	42528.2	17953.9	18938.0	12337.8	782.0	839.5	555.6	18497.7	15680.4	15885.4	8334.2	179989.6	**-8940.8**	**-4.7%**
	Expenditure (m€)	59.0	121.6	528.5	1556.3	345.1	372.8	658.2	16.3	17.9	45.4	241.4	353.3	182.7	185.5	4684.0	**61.3**	**1.3%**
2020	**Stock (units)**	106138	125054	245781	883672	117197	207539	213828	4688	8302	8553	35834	49244	12510	9890	2028229	**0.0**	**0.0%**
	Sales (units)	0	21578	0	152476	0	0	72706	0	0	2908	0	8791	0	1766	260225	**0.0**	**0.0%**
	Energy (TJ)	1738.1	1981.3	15275.8	51290.7	11444.8	18938.0	18599.4	498.5	839.5	837.6	15492.5	19007.1	14398.5	10102.3	180444.2	**-10988.9**	**-5.7%**
	Expenditure (m€)	50.0	132.2	336.9	1759.9	220.0	372.8	793.6	10.4	17.9	52.0	202.2	400.2	165.6	207.7	4721.3	**42.7**	**0.9%**
2021	**Stock (units)**	86872	146632	104599	1036148	49877	207539	286534	1995	8302	11461	28744	58036	11192	11655	2049586	**0.0**	**0.0%**
	Sales (units)	0	21794	0	154001	0	0	73433	0	0	2937	0	8967	0	1801	262933	**0.0**	**0.0%**
	Energy (TJ)	1422.6	2323.1	6501.1	60140.8	4870.7	18938.0	24923.6	212.2	839.5	1122.4	12427.3	22400.3	12882.0	11905.8	180909.3	**-13063.7**	**-6.7%**
	Expenditure (m€)	40.9	142.8	143.4	1965.5	93.6	372.8	930.3	4.4	17.9	58.7	162.2	448.0	148.2	230.3	4759.1	**23.8**	**0.5%**
2022	**Stock (units)**	67413	168426	0	1152154	0	189422	359967	0	7577	14399	21512	67003	9848	13456	2071178	**0.0**	**0.0%**
	Sales (units)	0	22012	0	155541	0	0	74168	0	0	2967	0	9147	0	1837	265670	**0.0**	**0.0%**
	Energy (TJ)	1103.9	2668.4	0.0	66874.1	0.0	17284.8	31311.0	0.0	766.2	1410.0	9300.7	25861.4	11335.1	13745.4	181661.2	**-14889.7**	**-7.6%**
	Expenditure (m€)	31.8	153.6	0.0	2123.5	0.0	340.2	1068.4	0.0	16.4	65.4	121.4	496.8	130.4	253.3	4801.3	**8.5**	**0.2%**
2023	**Stock (units)**	47760	190438	0	1163676	0	120749	434135	0	4830	17365	14136	76149	8477	15293	2093008	**0.0**	**0.0%**
	Sales (units)	0	22232	0	157096	0	0	74909	0	0	2996	0	9329	0	1874	268437	**0.0**	**0.0%**
	Energy (TJ)	782.1	3017.2	0.0	67542.9	0.0	11018.3	37762.3	0.0	488.4	1700.6	6111.6	29391.8	9757.2	15621.8	183194.2	**-15973.1**	**-8.0%**
	Expenditure (m€)	22.5	164.5	0.0	2144.7	0.0	216.9	1207.9	0.0	10.4	72.3	79.7	546.6	112.2	276.8	4854.7	**3.8**	**0.1%**
2024	**Stock (units)**	27910	212669	0	1175313	0	51388	509044	0	2056	20362	6612	85479	7079	17167	2115078	**0.0**	**0.0%**
	Sales (units)	0	22454	0	158667	0	0	75658	0	0	3026	0	9516	0	1911	271233	**0.0**	**0.0%**
	Energy (TJ)	457.1	3369.4	0.0	68218.3	0.0	4689.2	44278.1	0.0	207.9	1994.0	2858.7	32992.7	8147.8	17535.7	184748.9	**-17074.1**	**-8.5%**
	Expenditure (m€)	13.2	175.5	0.0	2166.2	0.0	92.3	1348.8	0.0	4.4	79.2	37.3	597.3	93.7	300.8	4908.8	**-1.1**	**0.0%**
2025	**Stock (units)**	7862	235124	0	1187066	0	0	566037	0	0	22641	0	93933	5653	19078	2137393	**0.0**	**0.0%**
	Sales (units)	0	22679	0	160254	0	0	76415	0	0	3057	0	9706	0	1949	274060	**0.0**	**0.0%**
	Energy (TJ)	128.7	3725.1	0.0	68900.5	0.0	0.0	49235.5	0.0	0.0	2217.2	0.0	36255.7	6506.2	19487.9	186456.9	**-18061.5**	**-8.8%**
	Expenditure (m€)	3.7	186.7	0.0	2187.8	0.0	0.0	1457.1	0.0	0.0	84.5	0.0	643.7	74.8	325.3	4963.6	**-6.2**	**-0.1%**
2026	**Stock (units)**	0	245415	0	1198937	0	0	571697	0	0	22868	0	95812	4198	21027	2159953	**0.0**	**0.0%**
	Sales (units)	0	22905	0	161856	0	0	77179	0	0	3087	0	9901	0	1988	276917	**0.0**	**0.0%**
	Energy (TJ)	0.0	3888.2	0.0	69589.5	0.0	0.0	49727.9	0.0	0.0	2239.4	0.0	36980.8	4831.8	21479.2	188736.7	**-18517.6**	**-8.9%**
	Expenditure (m€)	0.0	192.2	0.0	2209.7	0.0	0.0	1471.7	0.0	0.0	85.3	0.0	656.6	55.6	350.2	5021.2	**-9.1**	**-0.2%**
2027	**Stock (units)**	0	247869	0	1210926	0	0	577414	0	0	23096	0	97728	2714	23016	2182763	**0.0**	**0.0%**
	Sales (units)	0	23134	0	163475	0	0	77951	0	0	3118	0	10099	0	2028	279805	**0.0**	**0.0%**
	Energy (TJ)	0.0	3927.1	0.0	70285.4	0.0	0.0	50225.1	0.0	0.0	2261.8	0.0	37720.5	3123.9	23510.2	191053.9	**-18977.6**	**-9.0%**
	Expenditure (m€)	0.0	194.1	0.0	2231.8	0.0	0.0	1486.4	0.0	0.0	86.2	0.0	669.7	35.9	375.6	5079.7	**-12.0**	**-0.2%**

Year	Indicator	BC1		BC2		BC3			BC4			BC5		BC6		Total	Difference with BAU	
		2010	2014	2010	2014	2010	2014	2017	2010	2014	2017	2010	2014	2010	2014		Absolute	Relative
		BC	4.2	BC	4.2	BC	4.2	3.1.1	BC	4.2	3.1.1	BC	1.5	BC	4.2			
2028	Stock (units)	0	250348	0	1223035	0	0	583188	0	0	23327	0	99682	1200	25044	2205825	0.0	0.0%
	Sales (units)	0	23366	0	165110	0	0	78730	0	0	3149	0	10301	0	2069	282724	0.0	0.0%
	Energy (TJ)	0.0	3966.3	0.0	70988.3	0.0	0.0	50727.4	0.0	0.0	2284.4	0.0	38474.9	1381.8	25581.9	193404.9	-19445.5	-9.1%
	Expenditure (m€)	0.0	196.0	0.0	2254.1	0.0	0.0	1501.2	0.0	0.0	87.1	0.0	683.1	15.9	401.6	5139.0	-15.0	-0.3%
2029	Stock (units)	0	252851	0	1235265	0	0	589020	0	0	23561	0	101676	0	26769	2229143	0.0	0.0%
	Sales (units)	0	23599	0	166761	0	0	79518	0	0	3181	0	10507	0	2110	285675	0.0	0.0%
	Energy (TJ)	0.0	4006.0	0.0	71698.1	0.0	0.0	51234.7	0.0	0.0	2307.3	0.0	39244.4	0.0	27344.4	195834.8	-19877.3	-9.2%
	Expenditure (m€)	0.0	198.0	0.0	2276.7	0.0	0.0	1516.2	0.0	0.0	87.9	0.0	696.7	0.0	424.0	5199.6	-17.5	-0.3%
2030	Stock (units)	0	255380	0	1247618	0	0	594910	0	0	23796	0	103709	0	27305	2252719	0.0	0.0%
	Sales (units)	0	23835	0	168428	0	0	80313	0	0	3212	0	10717	0	2152	288658	0.0	0.0%
	Energy (TJ)	0.0	4046.1	0.0	72415.1	0.0	0.0	51747.0	0.0	0.0	2330.3	0.0	40029.3	0.0	27891.2	198459.0	-20157.9	-9.2%
	Expenditure (m€)	0.0	200.0	0.0	2299.4	0.0	0.0	1531.4	0.0	0.0	88.8	0.0	710.7	0.0	432.5	5262.8	-18.3	-0.3%
2010-2020	Energy (TJ)	32536.0	6876.9	544431.3	178028.9	407893.6	94564.5	37075.3	17766.8	4191.9	1669.6	293903.3	65427.2	218185.5	34774.8	1937325.7	-36651.0	-1.9%
2010-2020	Expenditure (m€)	1190.0	706.7	13969.1	8113.3	9096.4	2983.2	2367.2	482.3	185.4	168.5	4280.8	1848.4	2778.6	1003.6	49173.4	664.9	1.4%
2010-2025	Energy (TJ)	36430.5	21980.2	550932.4	509705.6	412764.3	146494.9	224585.8	17979.0	6493.9	10113.8	324601.6	212329.2	266813.7	113071.6	2854296.2	-115712.9	-3.9%
2010-2025	Expenditure (m€)	1302.0	1529.9	14112.5	18701.0	9190.0	4005.4	8379.8	486.7	234.5	528.5	4681.4	4580.9	3338.0	2390.1	73460.8	693.7	1.0%
2010-2030	Energy (TJ)	36430.5	41813.8	550932.4	864682.0	412764.3	146494.9	478247.8	17979.0	6493.9	21536.9	324601.6	404779.0	276151.1	238878.5	3821785.5	-212688.8	-5.3%
2010-2030	Expenditure (m€)	1302.0	2510.2	14112.5	29972.8	9190.0	4005.4	15886.7	486.7	234.5	963.8	4681.4	7997.6	3445.4	4374.1	99163.2	621.8	0.6%

2.4.5 Comparison of BAT, LLCC and MEPS scenarios with BAU

Figure 2-4 to Figure 2-11 show the evolution of total primary energy consumption and expenditure in time (between 2010 and 2030) by base cases and according to the BAT, LLCC and MEPS scenarios previously described.

The figures show that the initial larger investment due to higher product prices can be counterbalanced by the lower operating costs: for example this is the case for base case 5 and base case 6 in the MEPS scenario. For base case 5, the MEPS and LLCC scenario annual expenditures become lower than the BAU annual expenditure in 2018. For base case 6, the MEPS scenario annual expenditure becomes lower than the BAU annual expenditure in 2019 while this is the case in 2024 for the LLCC scenario (which overlaps with BAT).

Looking at the overall results, the LLCC and the MEPS scenarios almost overlap, both in terms of energy consumption and expenditure. This is due to the fact that results of base cases with slightly more ambitious targets than the LLCC options (this is the case for base cases 1, 3, 4 as the LLCC was the base case product) counterbalance the effects of base case 6, for which the eco-design requirements (MEPS) are less ambitious than the LLCC option.

As planned, the BAT scenario is therefore the scenario that enables the largest primary energy savings (both annually and over the period 2010-2025) while the LLCC scenario results in the smallest annual expenditure. By extrapolating the trend of the cumulated expenditure from 2010, the LLCC scenario is expected to become economic from 2029 in comparison with the BAU scenario (see Figure 2-12) while this should happen in 2031 for the MEPS scenario (see Figure 2-13).

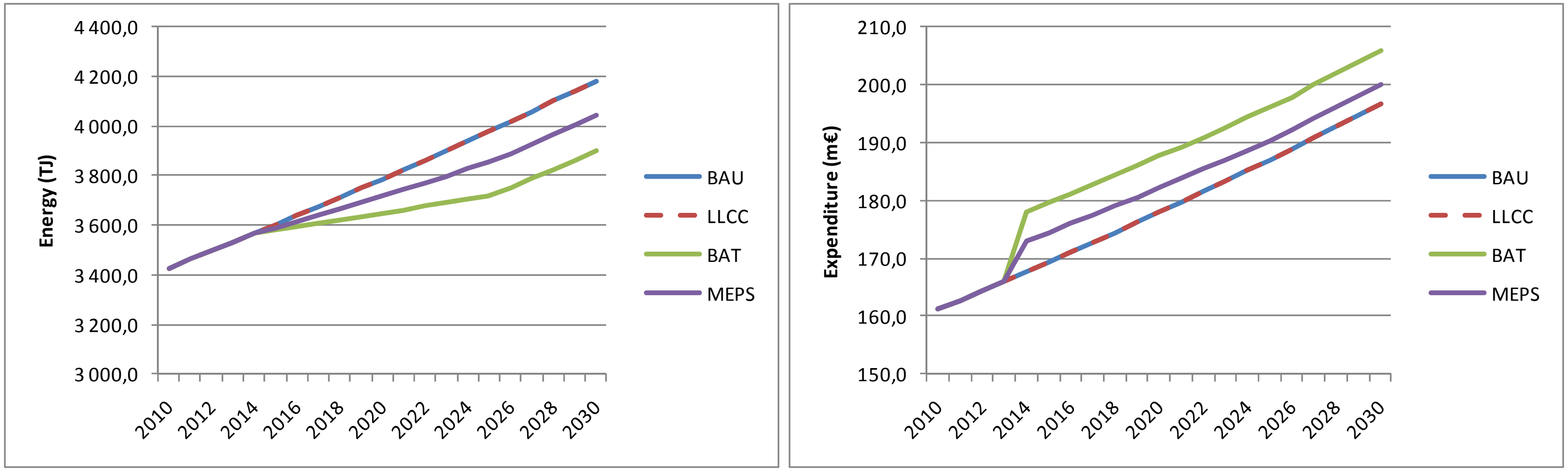

Figure 2-4 Primary energy consumption and expenditure by scenario, base case 1

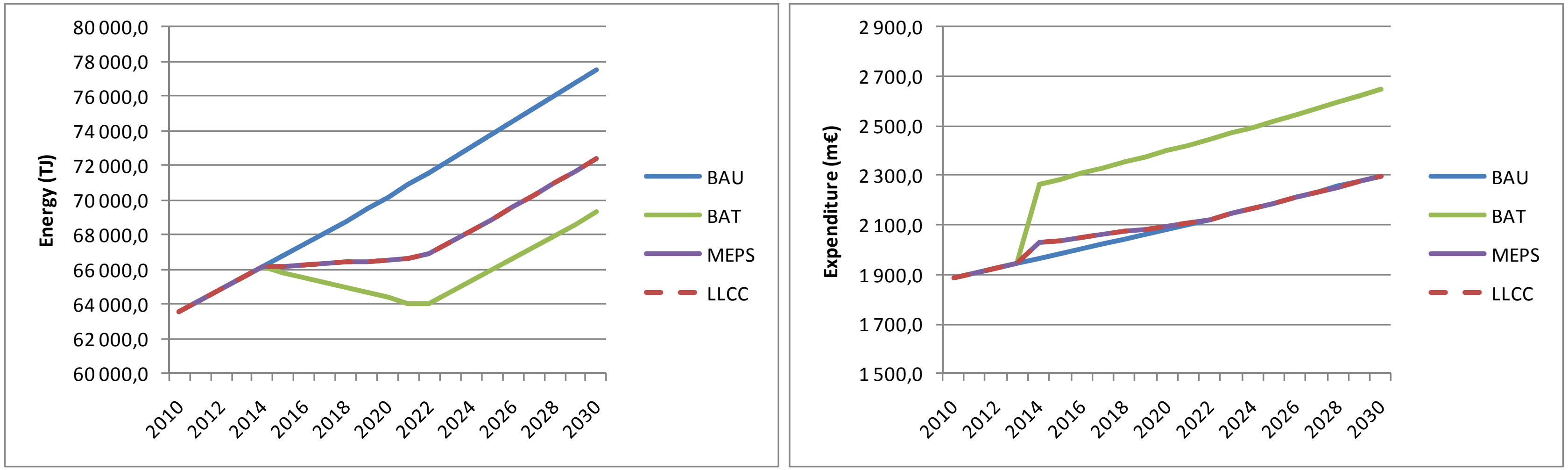

Figure 2-5 Primary energy consumption and expenditure by scenario, base case 2

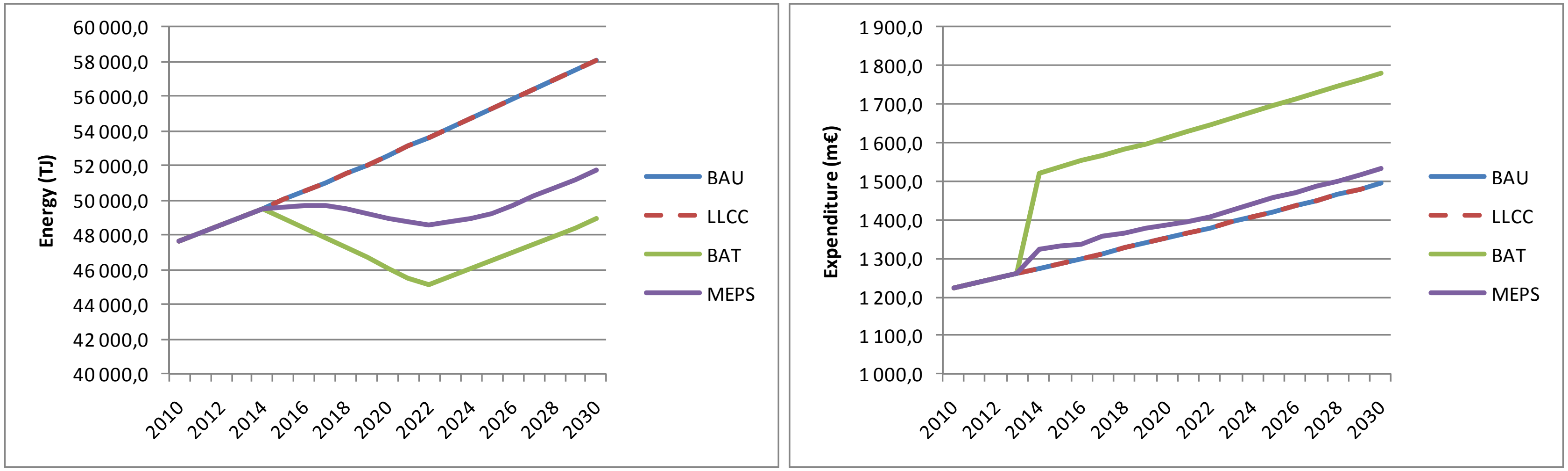

Figure 2-6 Primary energy consumption and expenditure by scenario, base case 3

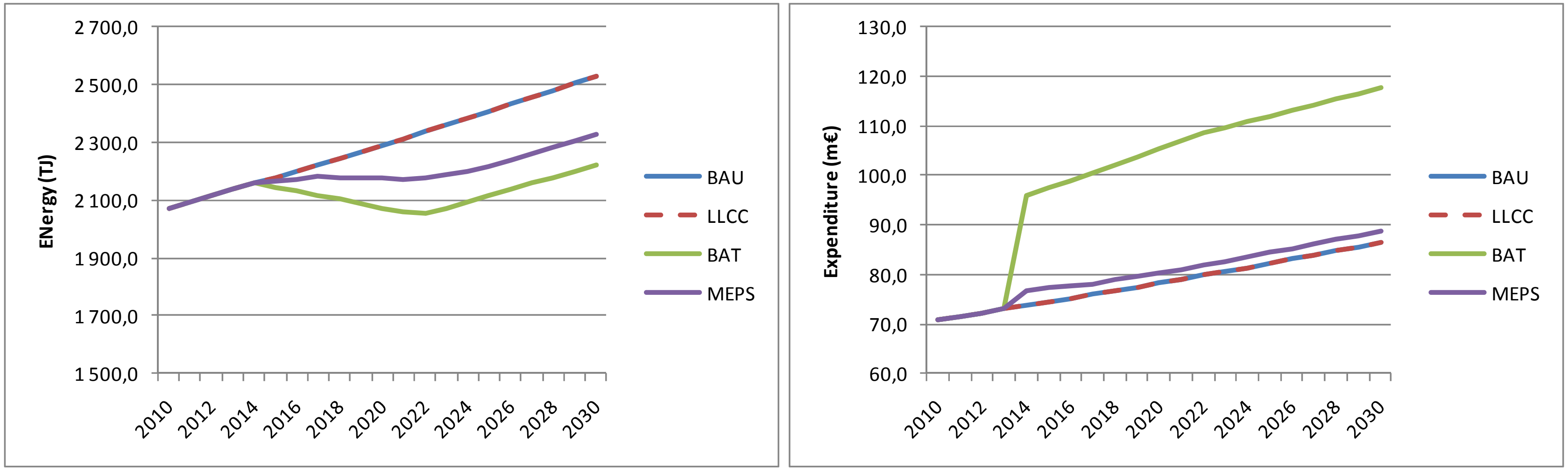

Figure 2-7 Primary energy consumption and expenditure by scenario, base case 4

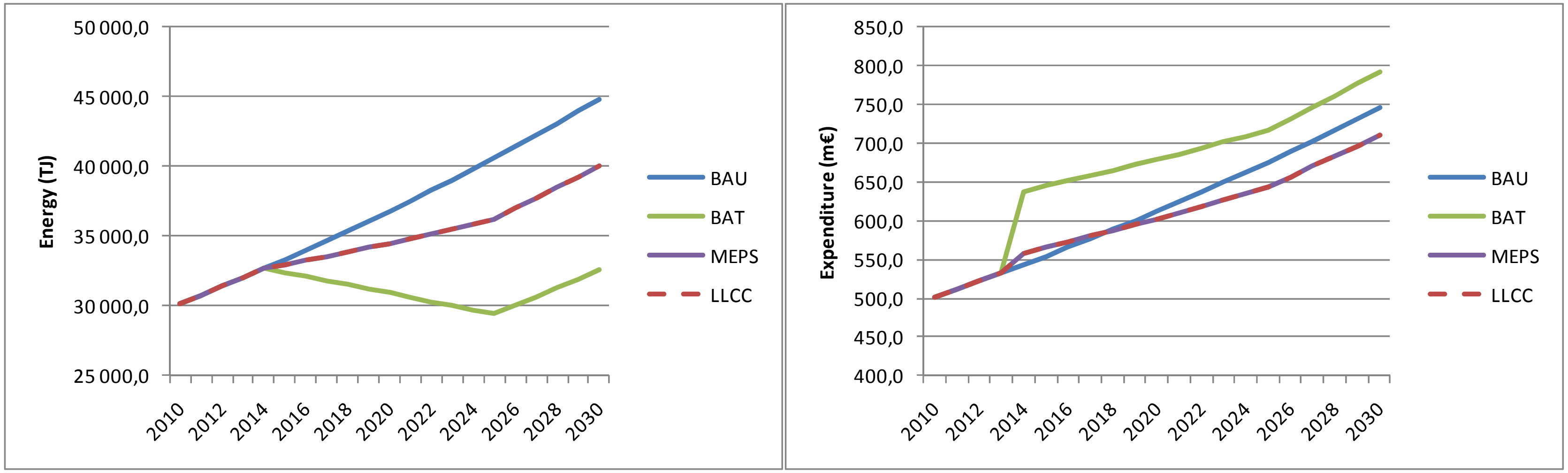

Figure 2-8 Primary energy consumption and expenditure by scenario, base case 5

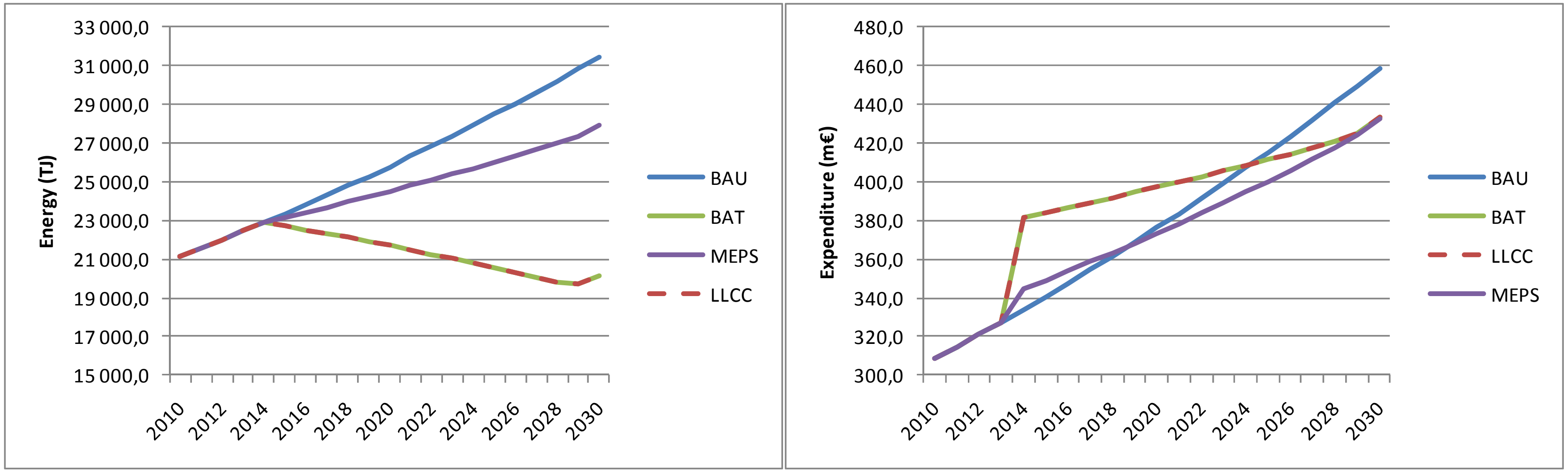

Figure 2-9 Primary energy consumption and expenditure by scenario, base case 6

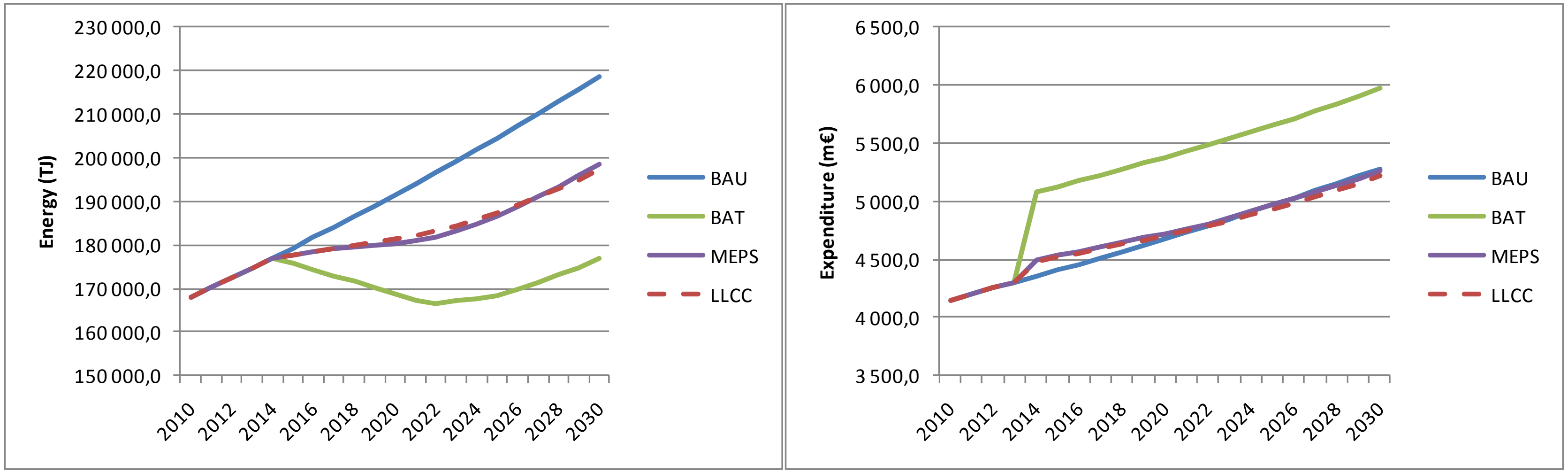

Figure 2-10 Primary energy consumption and expenditure by scenario, total for all base cases

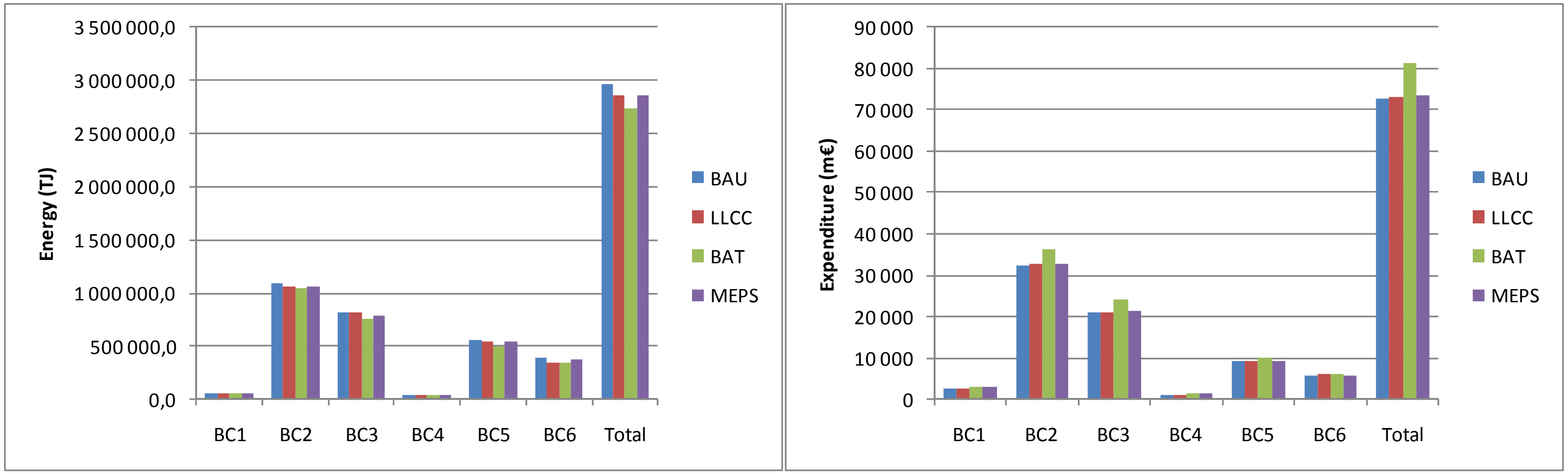

Figure 2-11 Primary energy consumption and expenditure by scenario, over the period 2010-2025

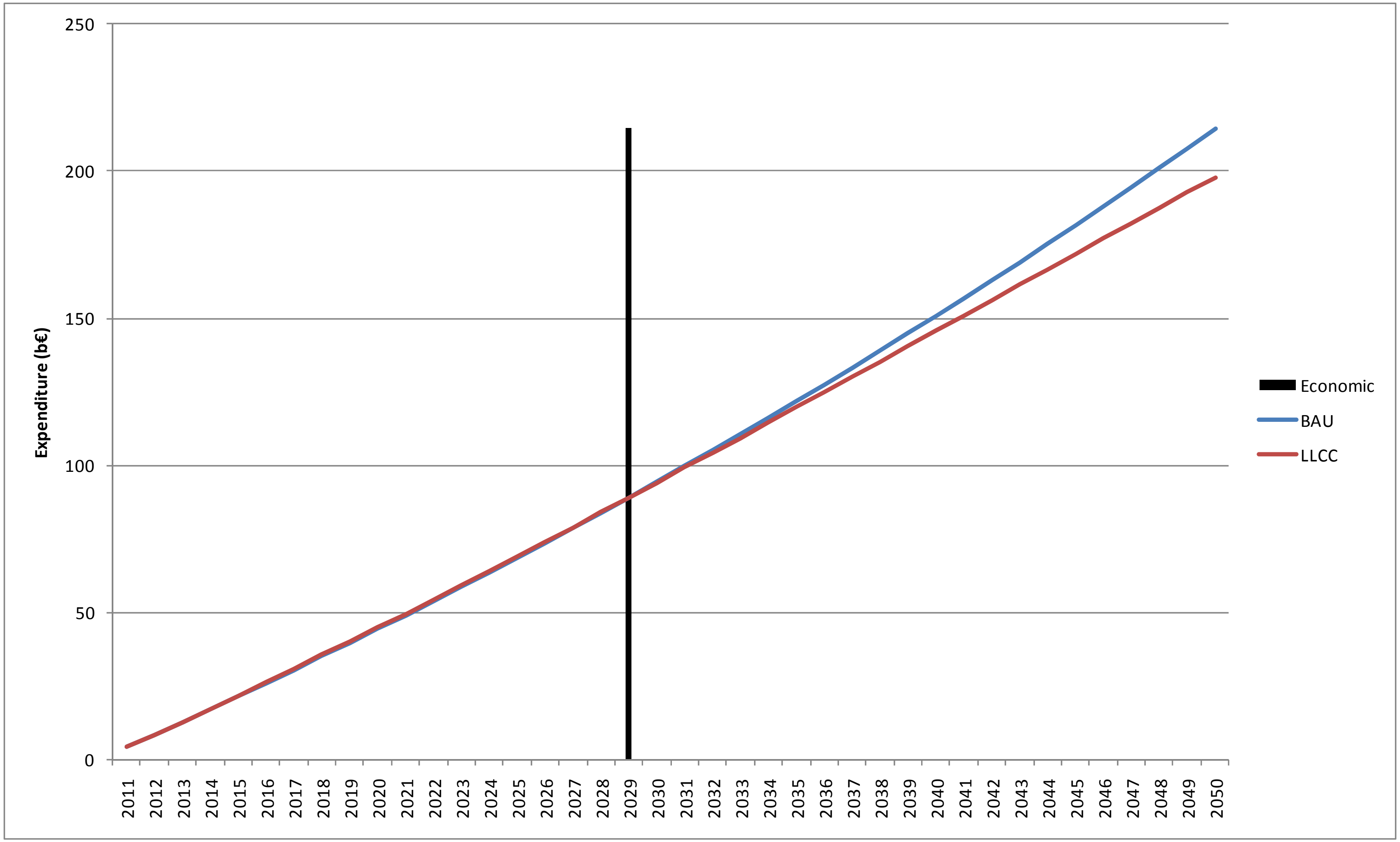

Figure 2-12 Extrapolation of cumulated expenditure of the BAU and LLCC scenarios, total for all base cases

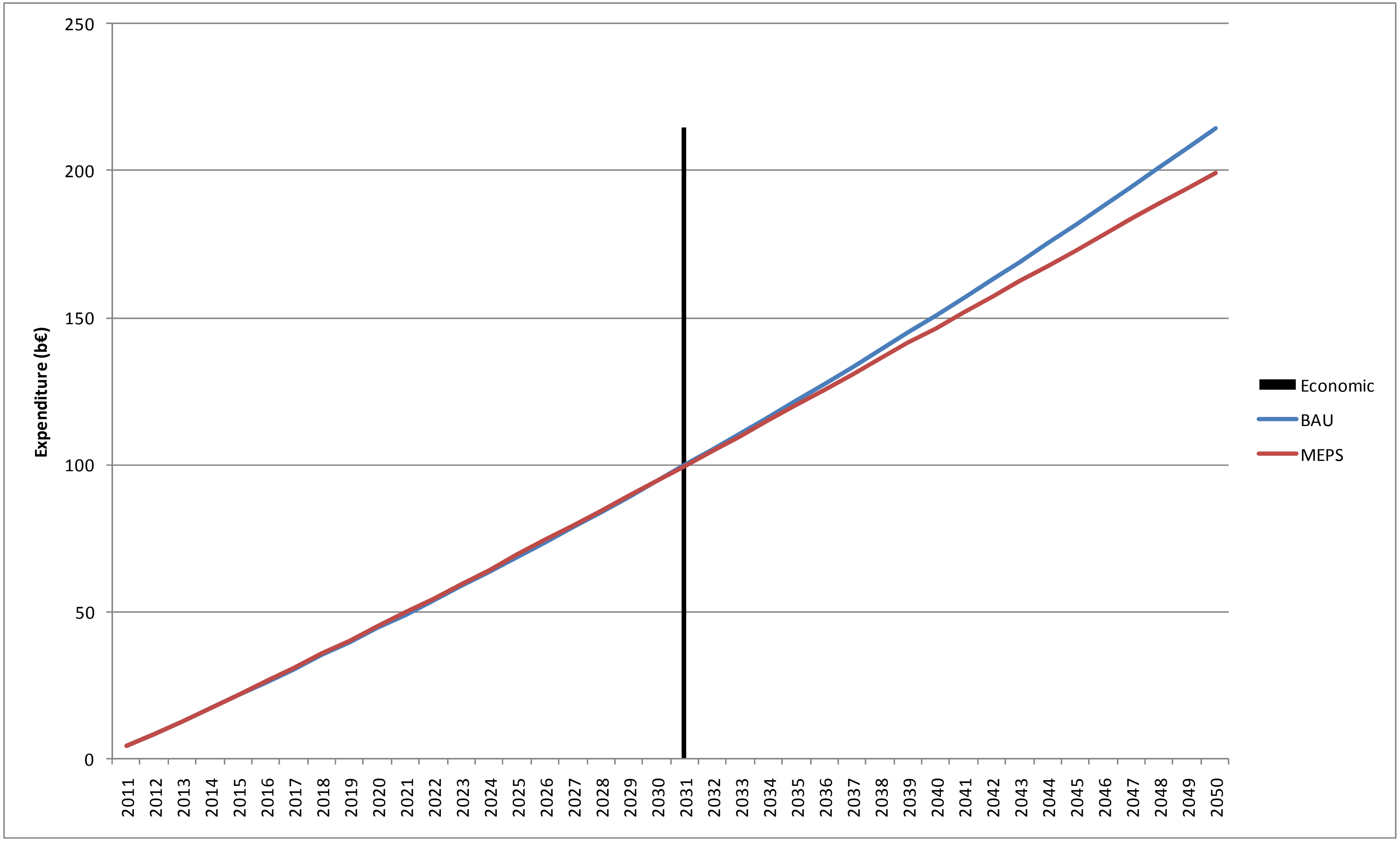

Figure 2-13 Extrapolation of cumulated expenditure of the BAU and MEPS scenarios, total for all base cases

3 Impact analysis

This section presents the impact analysis. It consists of an estimate of the impact on consumers (purchasing power, societal costs) and industry (employment, profitability, competitiveness, investment level, etc.), explicitly describing and taking into account the typical design cycle (platform change) in this product sector.

3.1 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 today. As a result, the possible implementation of minimum performance standards dealing with relevant targets should not have a major negative impact on manufacturers; especially because the professional dishwasher sector is very competitive and has been continuously improving product performance (see Task 2).

Regarding the definition of a timeline to implement standards, it should take into account the time necessary to adapt production lines. This redesign time is very variable depending on the type of change to be achieved: it has been estimated that between 6 and 36 months are needed for a change of a single part of the appliance (see Task 2), being the case for every improvement option as presented within the study. The full redesign cycle might take even longer. Assuming the development of the required standards (see Section 2.3.1) is finished by 2012, Tier 1 has thus been set at 2014 for the minimum eco-design requirements and the scenario model.

Most manufacturers seem to have similar BAT products, with the implementation of the same improvement options. Manufacturers of professional dishwashers are mostly large international companies, but smaller manufacturers are also present, especially in Spain and Italy. If minimum performance standards were set, all manufacturers should be able to keep up with the market requirements, using common technology or their own technological developments. However, smaller manufacturers might have some difficulty to react as quickly as the larger ones. Therefore, appropriate and progressive targets should be set, both in terms of performance and timeline.

EU manufacturers claim to produce amongst the most efficient professional dishwashers manufactured worldwide. Therefore, the implementation of minimum performance standards is not expected to hamper the economic development of large EU manufacturers to the benefit of extra-EU competitors. However, impacts on smaller manufacturers deserve further assessment.

3.2 Monetary impacts

The scenario analysis partly addresses monetary impacts. The MEPS scenario provides monetary benefits in 2018 for base case 5 and in 2019 for base case 6, and from 2031 in terms of cumulative expenditure.

The possible implementation of minimum performance standards may require additional capital investment from manufacturers to adapt manufacturing techniques to efficiently produce the more efficient products (e.g. changing production lines). It is however not estimated that these investments would represent a significant burden for manufacturers as they are used to continuously improving the efficiency of their appliances. Investment costs may also be partly counterbalanced by slightly higher selling prices of more efficient dishwashers. 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 professional dishwasher may represent a larger initial investment, but if performance requirements are set based on LCC calculations, the investment becomes beneficial in the long term. Buyers that use a Total Cost of Ownership (purchase price and running costs) approach could even be eager to buy more efficient products provided they are economic in the long run, and policy options could also aim to encourage this long-term vision, which is beneficial both from the environmental and economic points of view.

3.3 Impacts on consumer use

For the improvement options presented, the functional unit and the service given by the improved product remain the same as the base case (being a necessary condition to make a relevant comparative life cycle assessment): this is a paramount condition to assess their implementation in professional dishwashers. Thus, there should be no trade-off in terms of functionality (e.g. increase of noise, moisture in the room), for the increase of energy, water or detergent efficiency. In particular, the measurement of the cleaning and drying performance should appear in the standards to be developed (see 2.3.1).

For conveyor-type machines, reduction of life cycle costs via energy and water savings may form an important part of the marketing strategy as customers tend to be more aware of the long term operational costs of machines. Manufacturers try to sell more efficient (and expensive) appliances to the end user by reducing their operating costs.

3.4 Impacts on innovation and development

Best not yet Available Technologies (BNAT) and current axes of research in the sector were not very thoroughly described throughout this study because of a serious lack of available data. Such information is very sensitive and manufacturers were obviously not willing to share. In addition, little or no independent research has been carried out. The possible implementation of minimum performance standards 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.

3.5 Social impacts

Most EU manufacturers have their production plants within the EU. 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. Indeed, the professional dishwasher sector has been improving performance continuously over the last 30-40 years so that the companies have experience in carrying out continuous production transitions.

Regarding the security of supply, 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.

4 Sensitivity analysis of the main parameters

The sensitivity analysis checks the robustness of the overall outcomes. It should cover the main parameters as described in Annex II of the ErP 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.

As a reminder, the improvement options that were studied in detail in Task 7 are listed below:

- **M 1.5 Auxiliary rinsing:** for conveyor-type dishwashers, lower fresh-water consumption can be achieved thanks to a two- or three-step rinsing zone.
- **M 2.1.1 Exhaust air heat exchanger:** the heat from exhaust air can be used to preheat the incoming water of the machine through a counter-flow exchanger.

- **M 2.1.2 Exhaust air heat pump**: thanks to a heat pump, an electric device with cooling and heating capabilities, the energy contained in the exhaust air can be recovered more efficiently than with a heat exchanger.
- **M 3.1.1 Waste water heat exchanger**: the process is the same as for an exhaust air heat exchanger except that the heat is extracted from the waste water.
- **M 4.1 Insulation**, closed bottom: the wash tank and other parts of the dishwasher can be thermally insulated to reduce convection losses in the operating and ready-to-use modes.
- **M 4.2 High efficiency pumps and motors:** the efficiency of the whole hydraulic system (including pumps, motors and pipes) can be optimised, thus reducing energy losses.

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

- Electricity, water and detergent consumption;
- Intensity of use of the machines (number of cycles per year);
- Lifetime;
- Electricity, water and detergent prices;
- Product price;
- 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.

The influence of the single parameters on the results will be first studied separately and the analysis of combined changes in several parameters at the same time will be made in Section 4.7.

4.1 Resource and consumables consumption

4.1.1 Assumptions

In Task 4, average energy, water and detergent consumption data were determined for the base cases. Given the uncertainty that remains regarding the definition of "average market" products, the sensitivity analysis will consider an error margin of 20% on the given values, both for minimum and maximum values.[13] The tested values are therefore presented in

[13] This error margin was discussed and agreed during the final stakeholder meeting, 9 December 2010 in Paris.

Table 4-1, Table 4-2 and Table 4-3. This error margin is also used for the consumption values of improvement options as the consumption is calculated relatively (in %) with the base cases consumption.

Table 4-1 Electricity consumption range for the sensitivity analysis

Base case	Base total electricity consumption (kWh/year)	Min	Max
1. Undercounter water-change	1 254	1 003	1 505
2. Undercounter one-tank	5 253	4 202	6 304
3. Hood-type	8 258	6 606	9 910
4. Utensil/Pot	8 913	7 130	10 696
5. One-tank conveyor-type	37 703	30 162	45 244
6. Multi-tank conveyor-type	102 229	81 783	122 675

Table 4-2 Water consumption range for the sensitivity analysis

Base case	Base water consumption (m^3/year)	Min	Max
1. Undercounter water-change	25.92	21	31
2. Undercounter one-tank	55.82	45	67
3. Hood-type	86.65	69	104
4. Utensil/Pot	89.52	72	107
5. One-tank conveyor-type	255.686	205	307
6. Multi-tank conveyor-type	643.645	515	772

Table 4-3 Detergent consumption range for the sensitivity analysis

Base case	Base detergent consumption (in kg per year)	Min	Max
1. Undercounter water-change	87	70	104
2. Undercounter one-tank	188	150	226
3. Hood-type	292	234	350
4. Utensil/Pot	294	235	353
5. One-tank conveyor-type	865	692	1 038
6. Multi-tank conveyor-type	2 146	1 717	2 575

4.1.2 Results

4.1.2.1 Influence of the variation of the electricity consumption

Figure 4-1 to Figure 4-12 show the influence of the variation of the electricity consumption on the total energy consumption and the life cycle costs of the different base cases and associated improvement options. No relative change in the rankings of options happen concerning the primary energy consumption.

Regarding costs, for base cases 1, 4 and 6, despite the expected variations in absolute values, the ranking of the different improvement options remains the same whether the minimum or maximum parameter is used.

For base case 2, with the minimum value the option M 4.2 is no longer the LLCC option, as the base case product gets a lower LCC.

On the contrary, for base case 3, option M 4.2 becomes the LLCC when the maximum value is considered, at the expense of the base case product.

For base case 5, the BA product almost becomes economic in comparison with the base case product; in particular, it gets a lower LCC than option M 4.1. By extrapolation, it can be assumed that with even larger electricity consumption than the current maximum, the BA product would become economically beneficial. Using the minimum value, the option M 3.1.1 gets a higher LCC than the base case product.

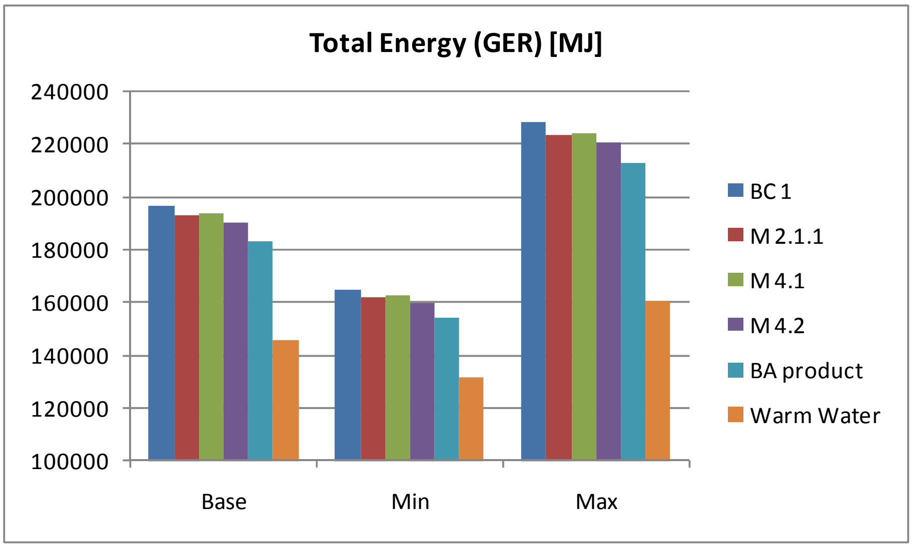

Figure 4-1 Base case 1 and improvement options – impact of electricity consumption on total energy over lifetime by product

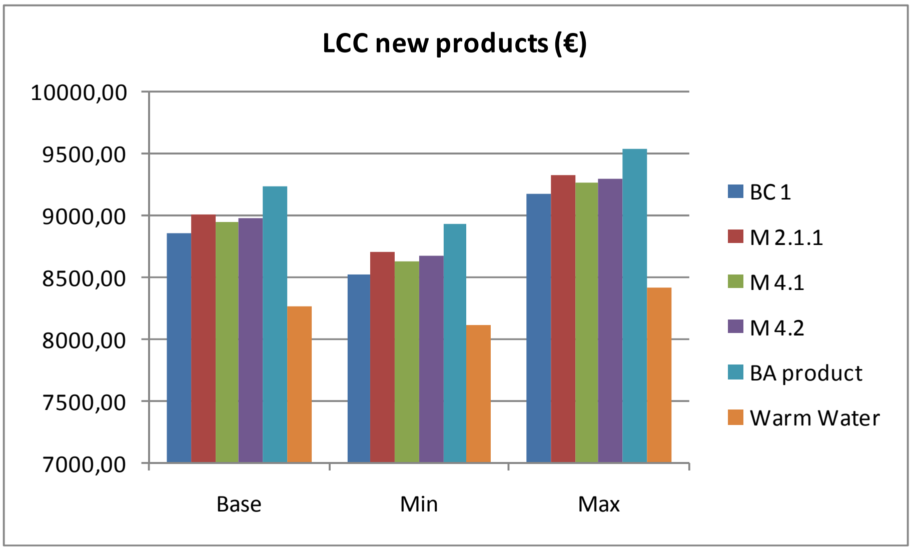

Figure 4-2 Base case 1 and improvement options – impact of electricity consumption on LCC by product

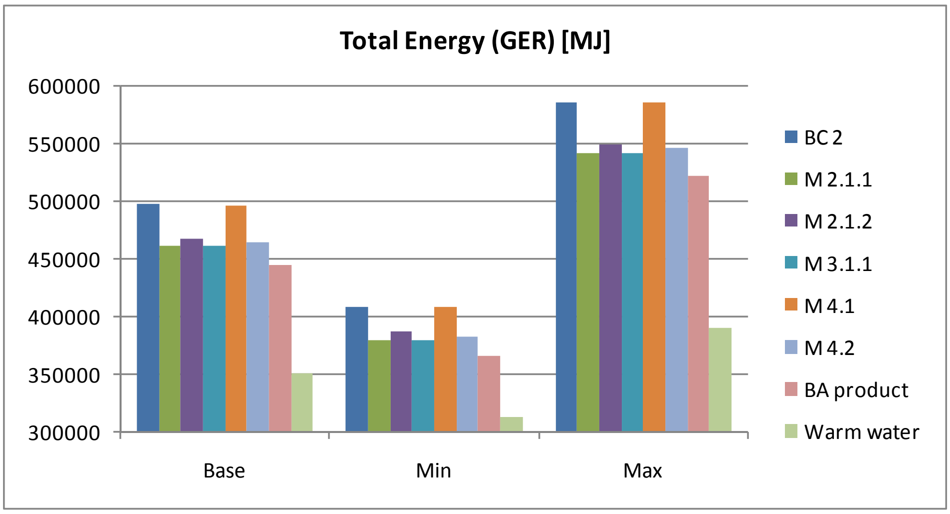

Figure 4-3 Base case 2 and improvement options – impact of electricity consumption on total energy over lifetime by product

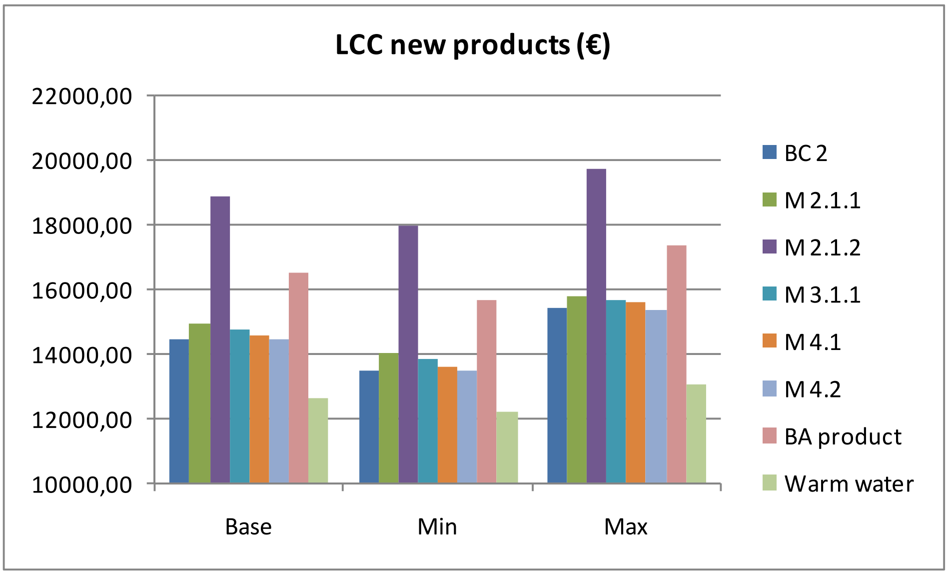

Figure 4-4 Base case 2 and improvement options – impact of electricity consumption on LCC by product

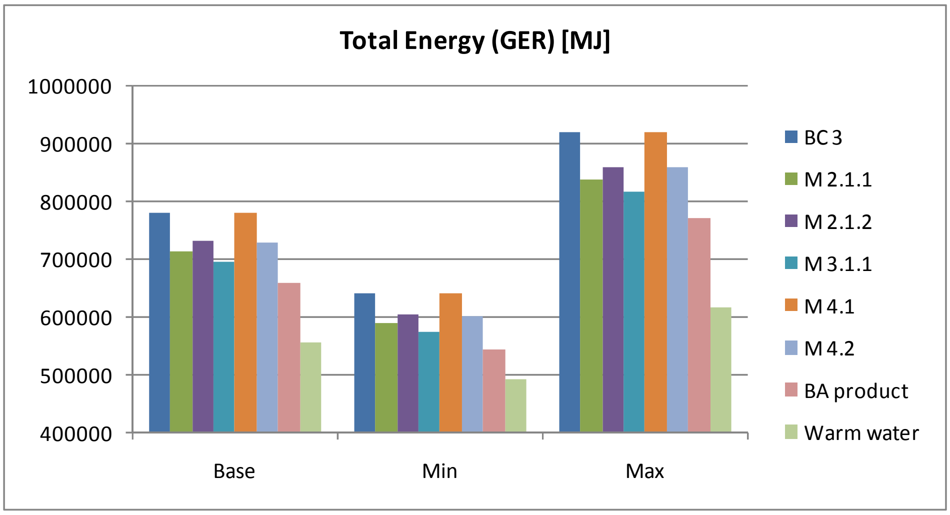

Figure 4-5 Base case 3 and improvement options – impact of electricity consumption on total energy over lifetime by product

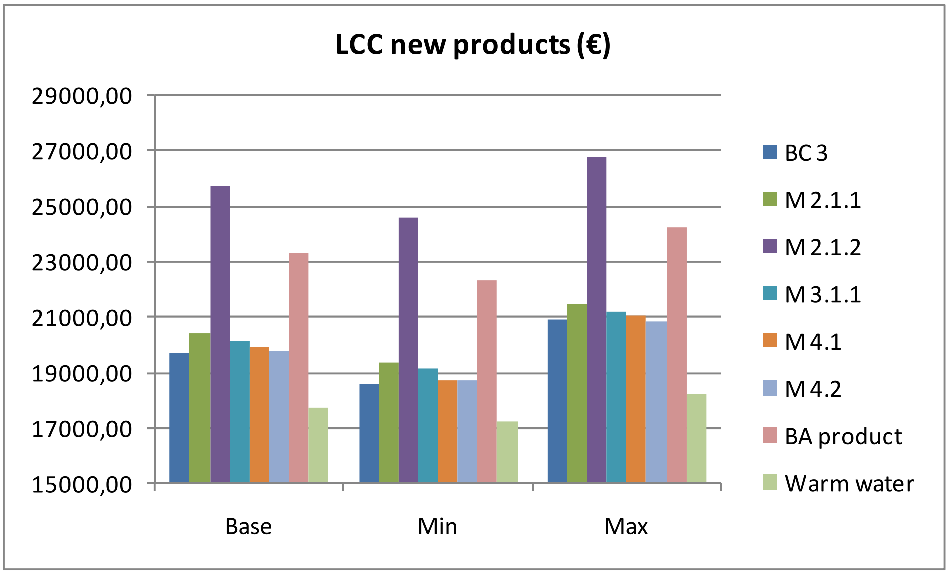

Figure 4-6 Base case 3 and improvement options – impact of electricity consumption on LCC by product

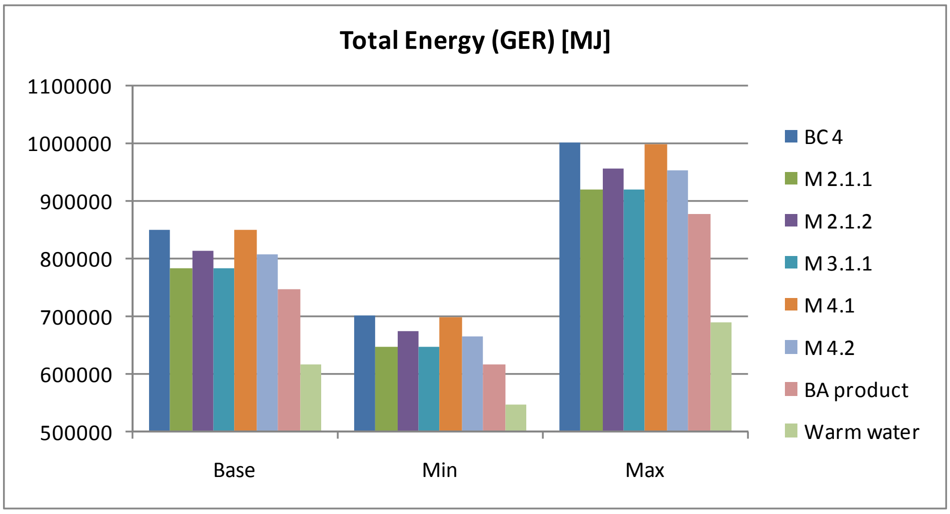

Figure 4-7 Base case 4 and improvement options – impact of electricity consumption on total energy over lifetime by product

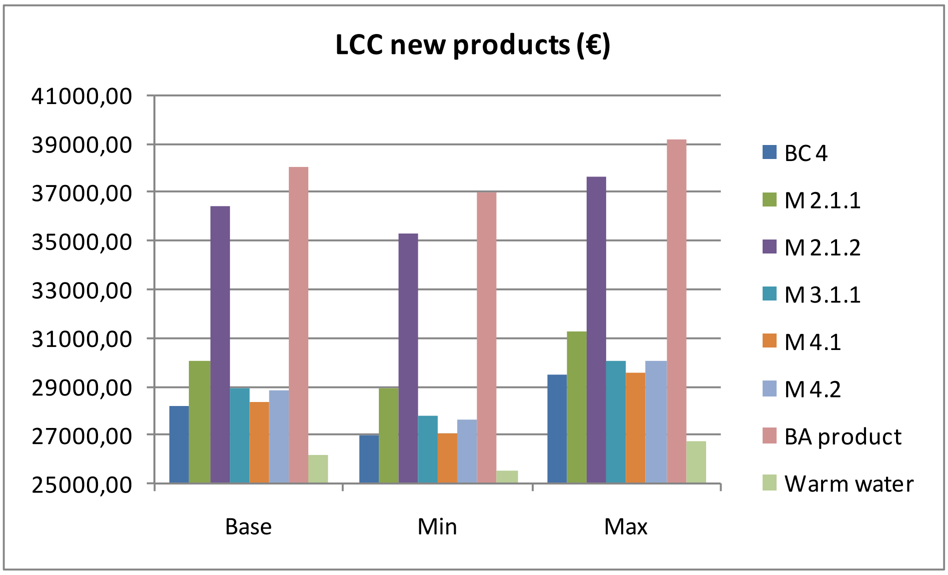

Figure 4-8 Base case 4 and improvement options – impact of electricity consumption on LCC by product

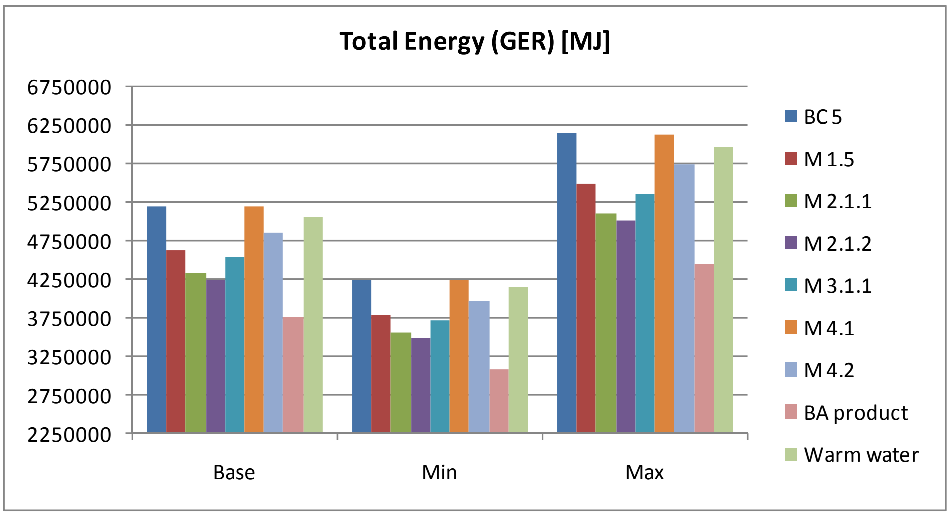

Figure 4-9 Base case 5 and improvement options – impact of electricity consumption on total energy over lifetime by product

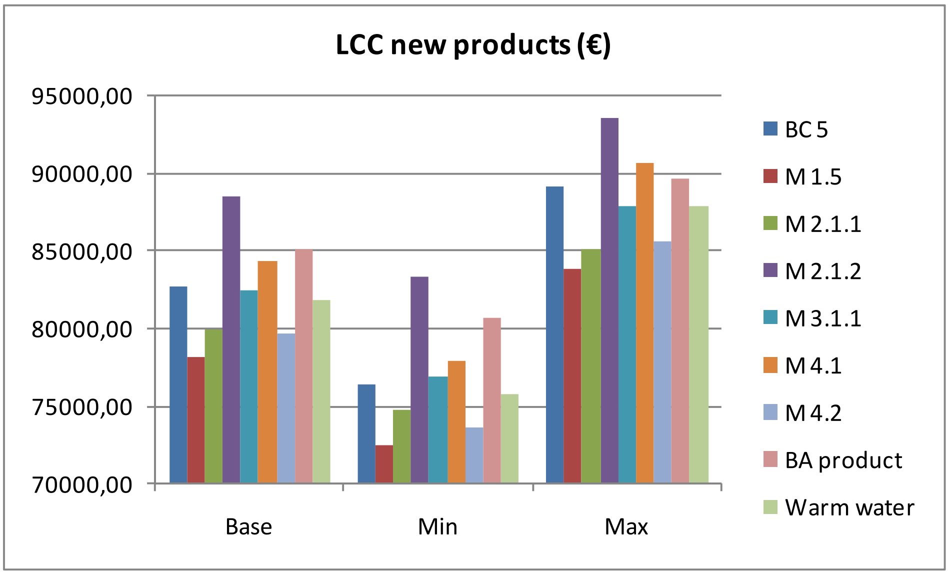

Figure 4-10 Base case 5 and improvement options – impact of electricity consumption on LCC by product

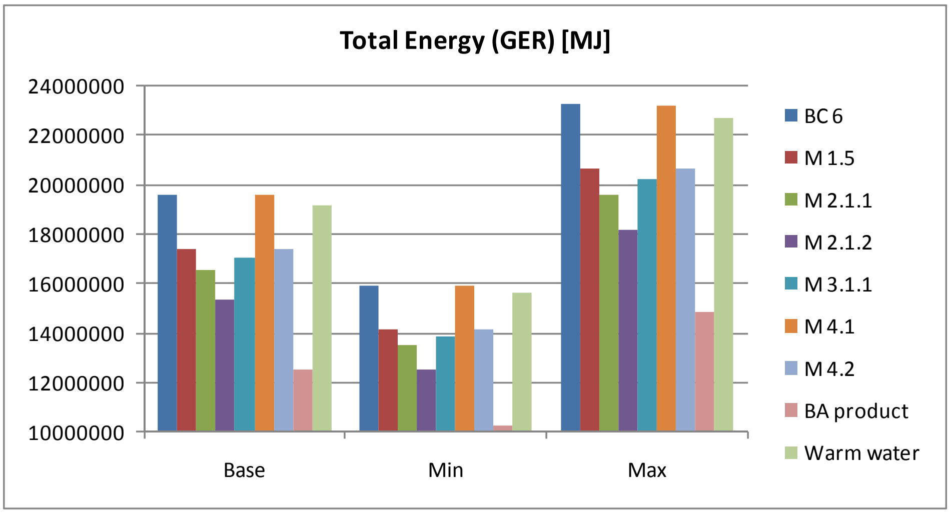

Figure 4-11 Base case 6 and improvement options – impact of electricity consumption on total energy over lifetime by product

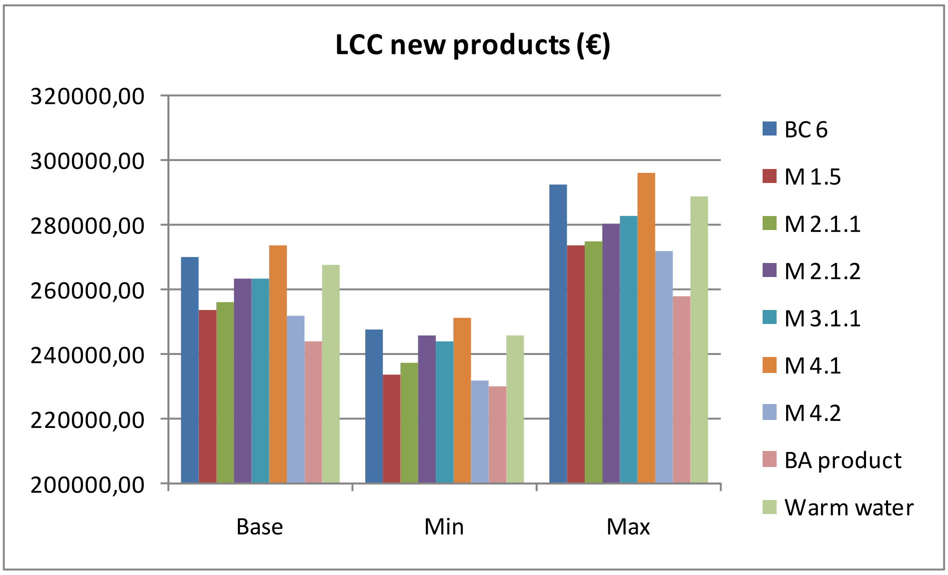

Figure 4-12 Base case 6 and improvement options – impact of electricity consumption on LCC by product

4.1.2.2 Influence of the variation of the water consumption

Figure 4-13 to Figure 4-24 show the influence of the variation of the water consumption on the total energy consumption and life cycle costs of the different base cases and associated improvement options. For all situations, despite the expected variations in absolute values, the ranking of the different improvement options remains the same whether the minimum or maximum parameter is used.

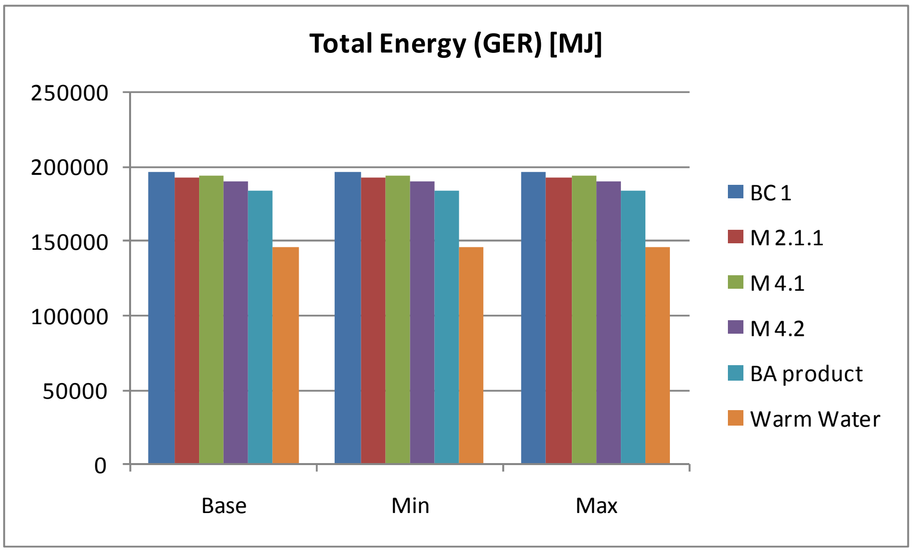

Figure 4-13 Base case 1 and improvement options – impact of water consumption on total energy over lifetime by product

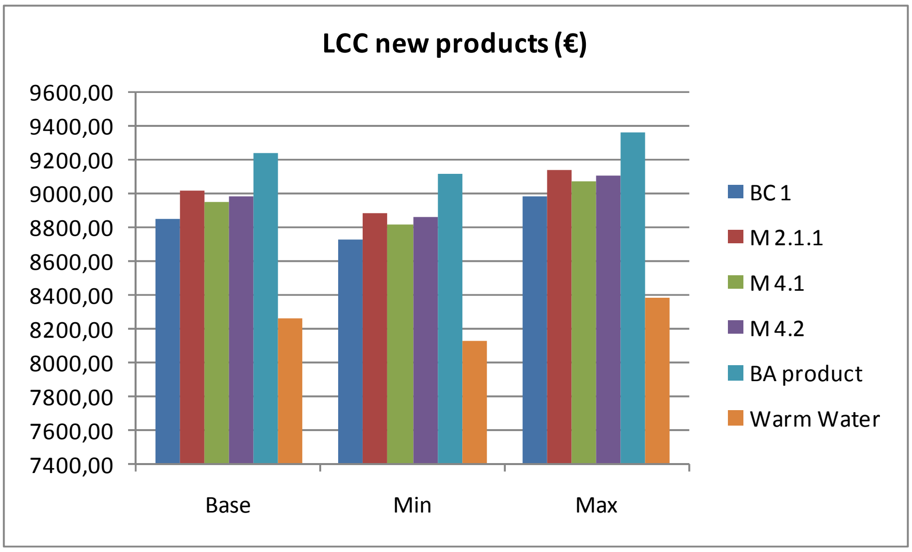

Figure 4-14 Base case 1 and improvement options – impact of water consumption on LCC by product

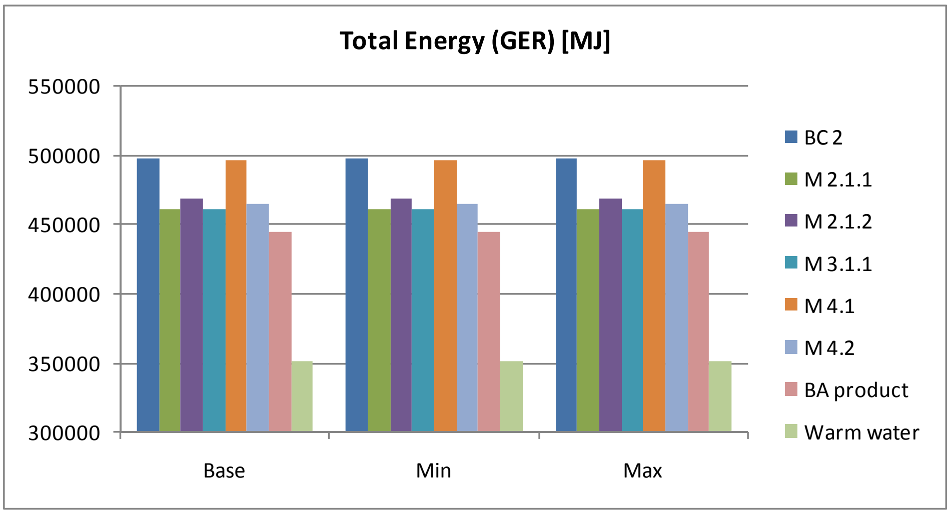

Figure 4-15 Base case 2 and improvement options – impact of water consumption on total energy over lifetime by product

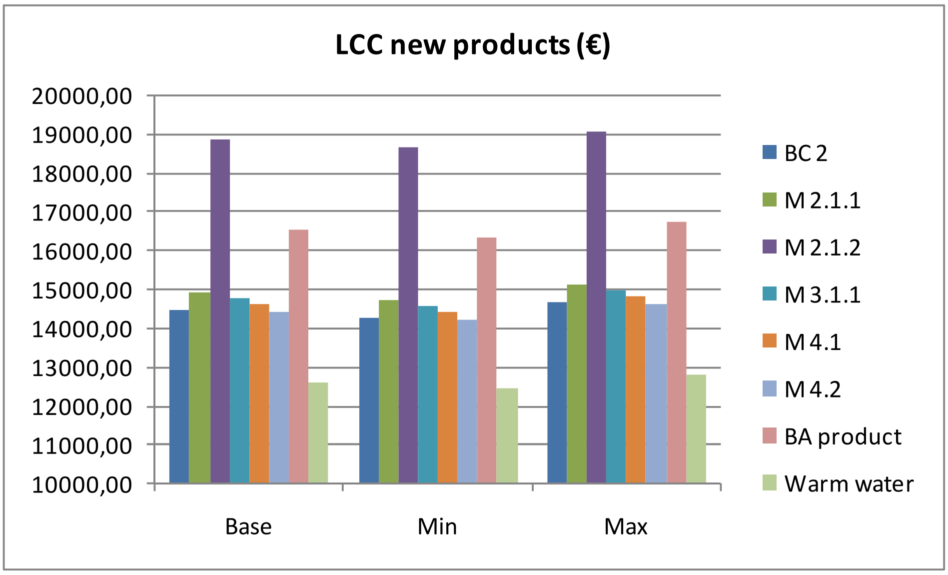

Figure 4-16 Base case 2 and improvement options – impact of water consumption on LCC by product

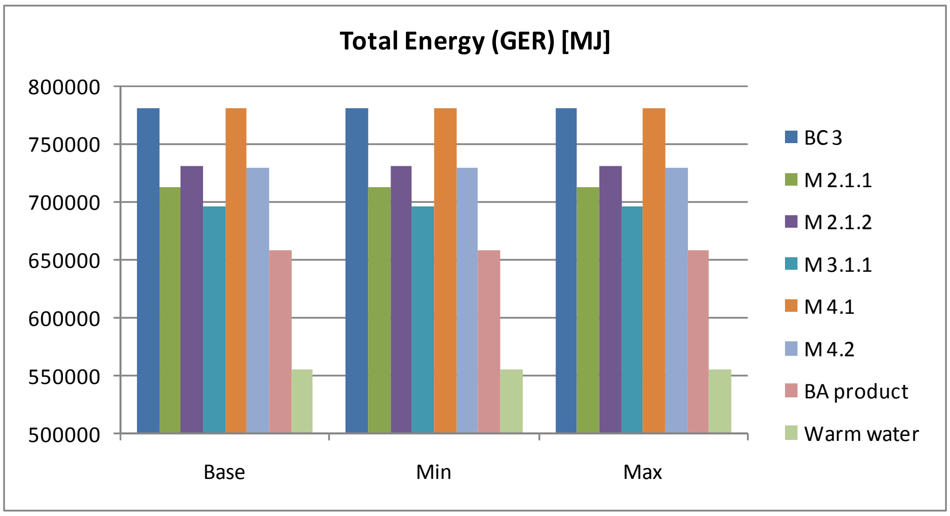

Figure 4-17 Base case 3 and improvement options – impact of water consumption on total energy over lifetime by product

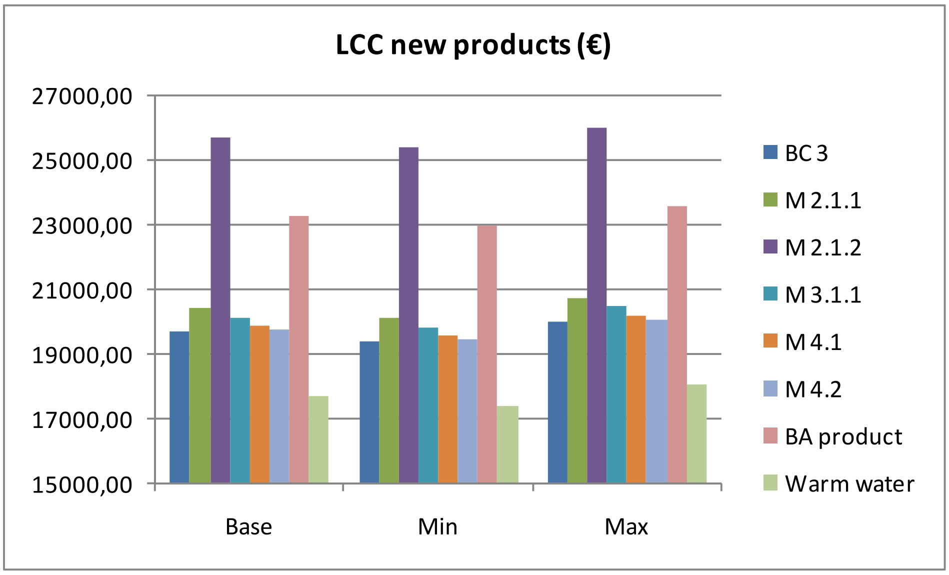

Figure 4-18 Base case 3 and improvement options – impact of water consumption on LCC by product

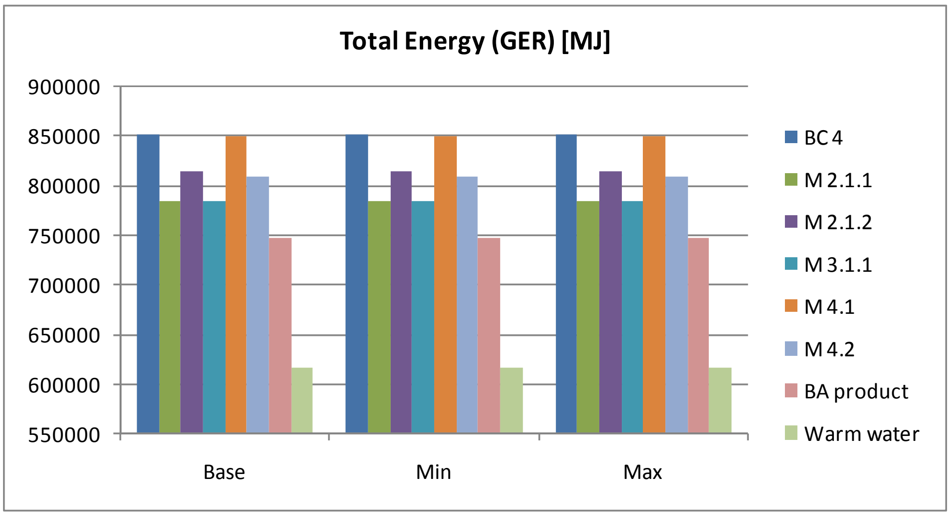

Figure 4-19 Base case 4 and improvement options – impact of water consumption on total energy over lifetime by product

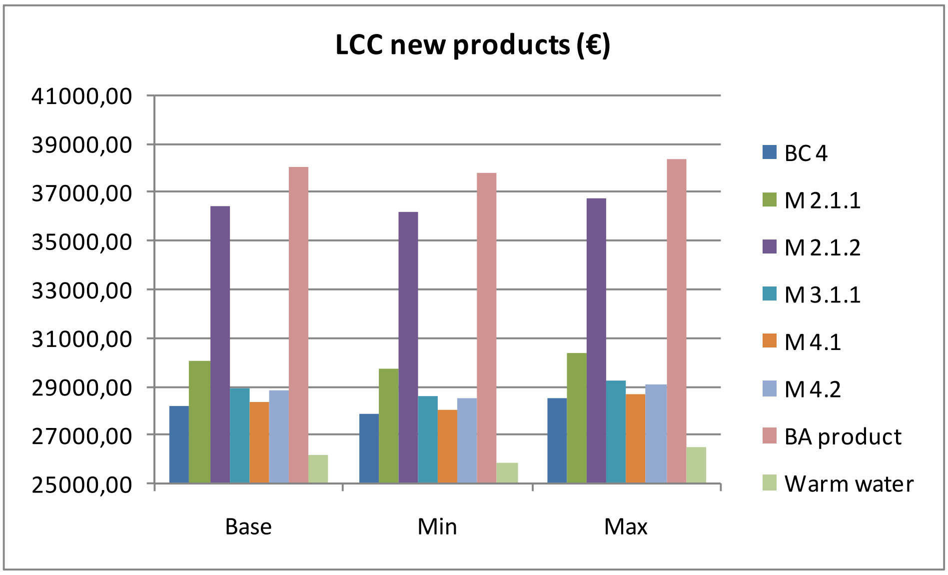

Figure 4-20 Base case 4 and improvement options – impact of water consumption on LCC by product

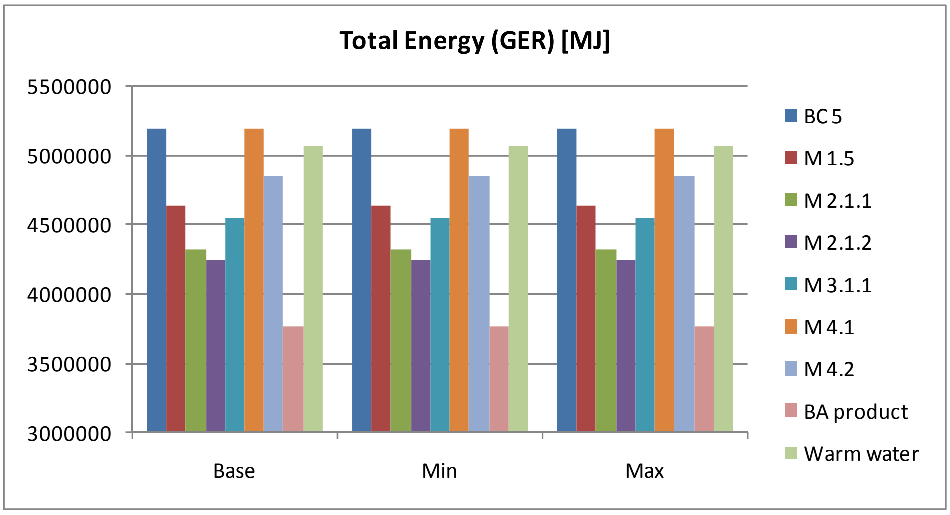

Figure 4-21 Base case 5 and improvement options – impact of water consumption on total energy over life-time by product

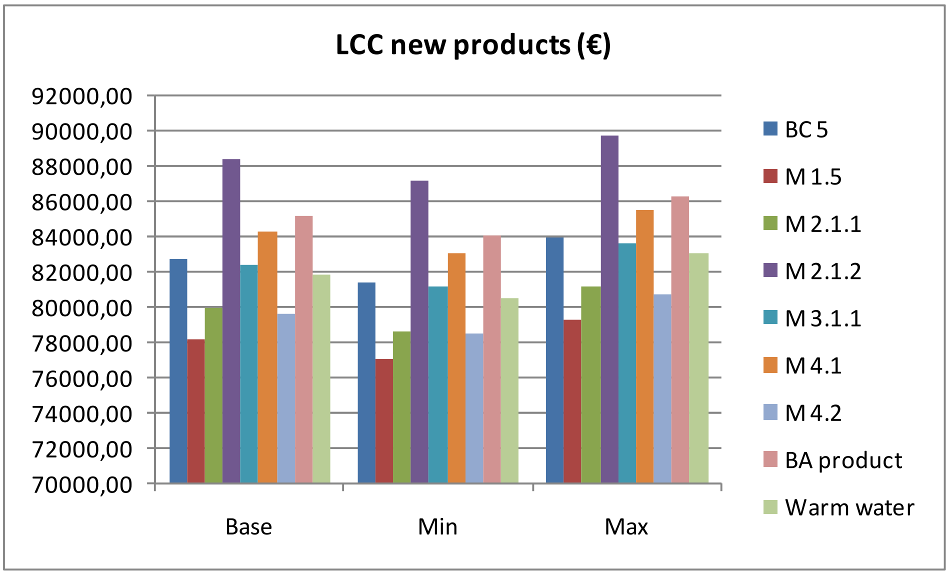

Figure 4-22 Base case 5 and improvement options – impact of water consumption on LCC by product

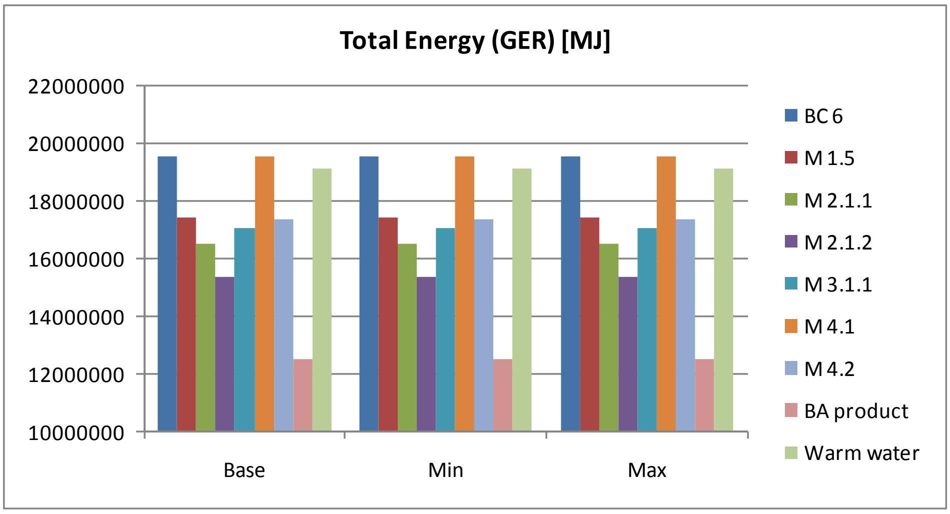

Figure 4-23 Base case 6 and improvement options – impact of water consumption on total energy over lifetime by product

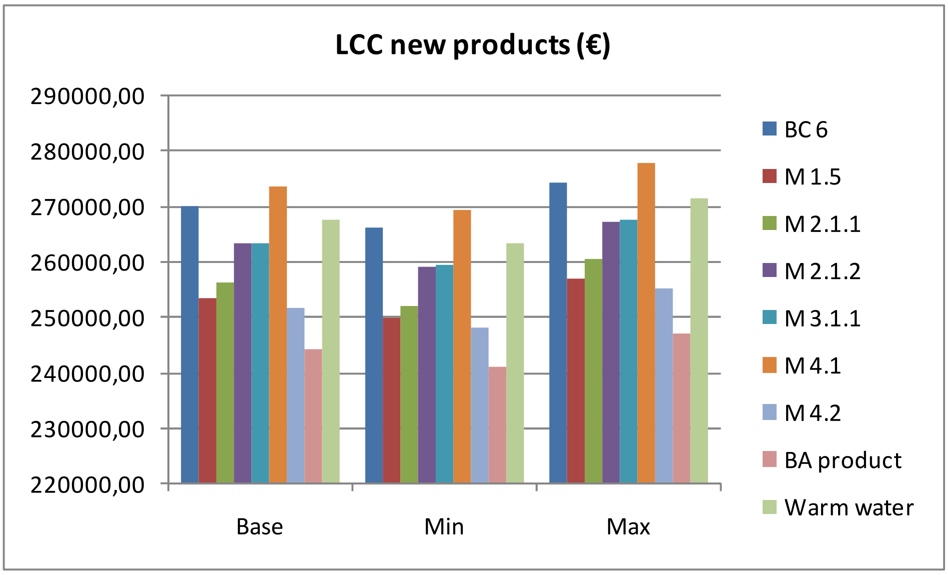

Figure 4-24 Base case 6 and improvement options – impact of water consumption on LCC by product

4.1.2.3 Influence of the variation of the detergent consumption

Figure 4-25 to Figure 4-36 show the influence of the variation of the detergent consumption on the eutrophication potential and the life cycle costs of the different base cases and associated improvement options.

For base cases 1, 4 and 6, despite the expected variations in absolute values, the ranking of the different improvement options remains the same whether the minimum of maximum parameter is used.

For base case 2, the option M 4.2 gets a higher LCC than the base case product when the minimum value is used: thus it is not the LLCC option anymore.

For base case 3, on the contrary, the option M 4.2 becomes the LLCC option when the maximum value is used, at the expense of the base case product.

Finally, for base case 5, no major change occurs. The option M 2.1.1 gets a lower LCC than option M 4.2 with the minimum parameter.

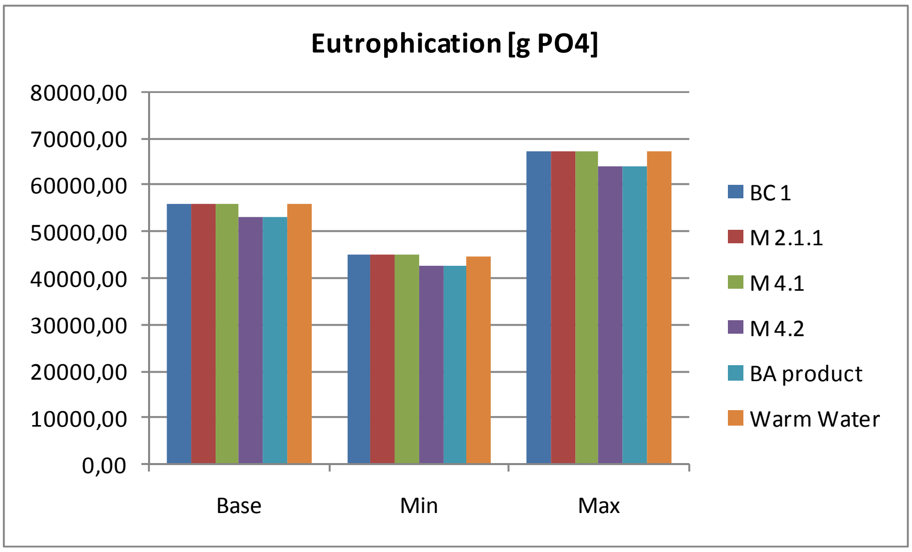

Figure 4-25 Base case 1 and improvement options – impact of detergent consumption on eutrophication over lifetime by product

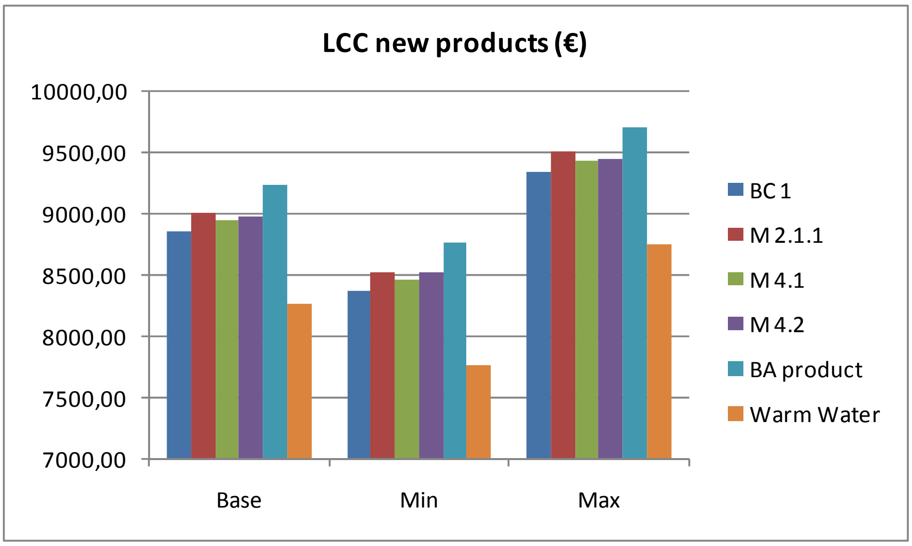

Figure 4-26 Base case 1 and improvement options – impact of detergent consumption on LCC by product

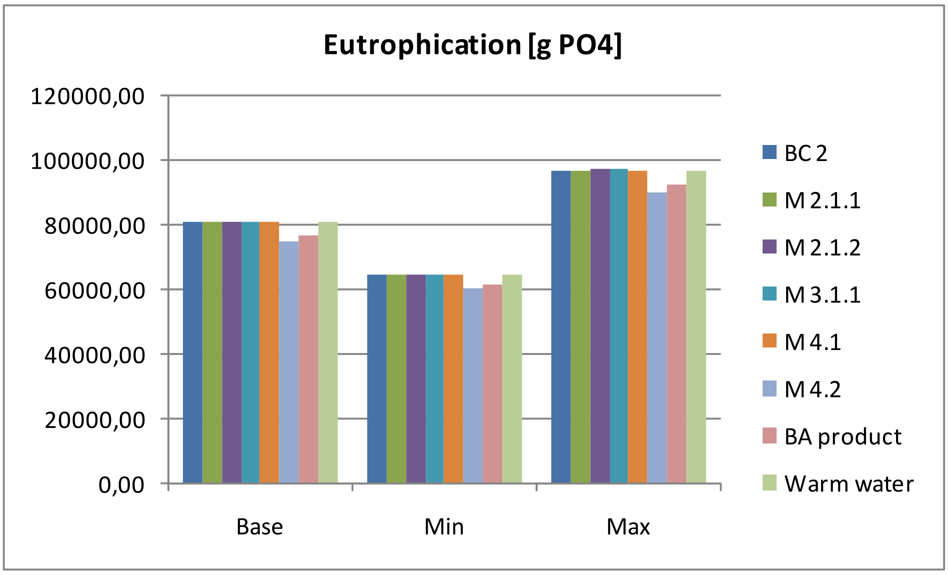

Figure 4-27 Base case 2 and improvement options – impact of detergent consumption on eutrophication over lifetime by product

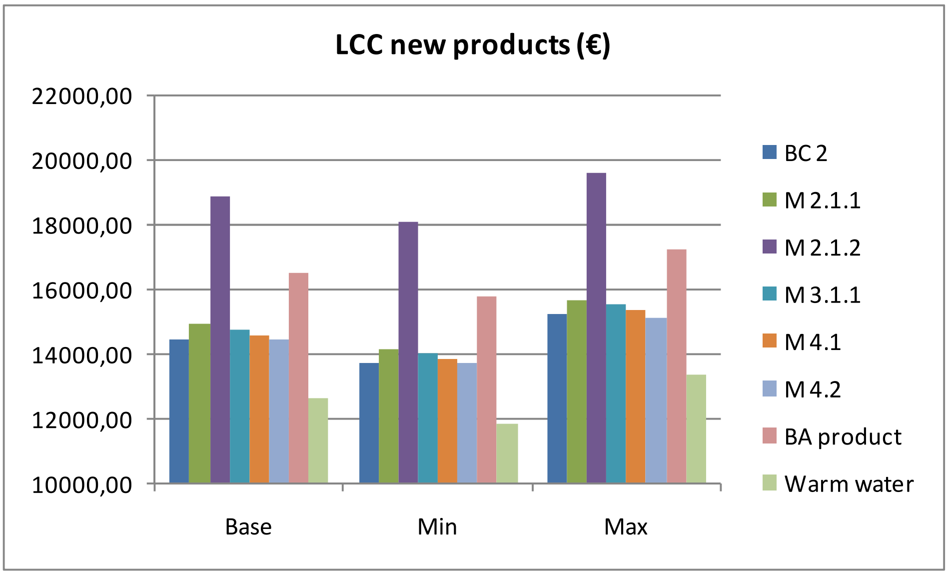

Figure 4-28 Base case 2 and improvement options – impact of detergent consumption on LCC by product

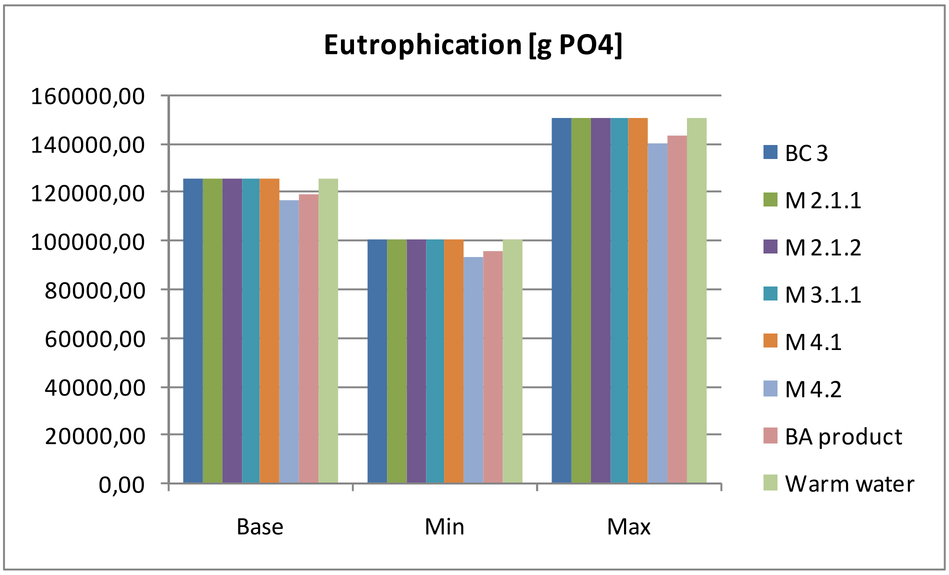

Figure 4-29 Base case 3 and improvement options – impact of detergent consumption on eutrophication over lifetime by product

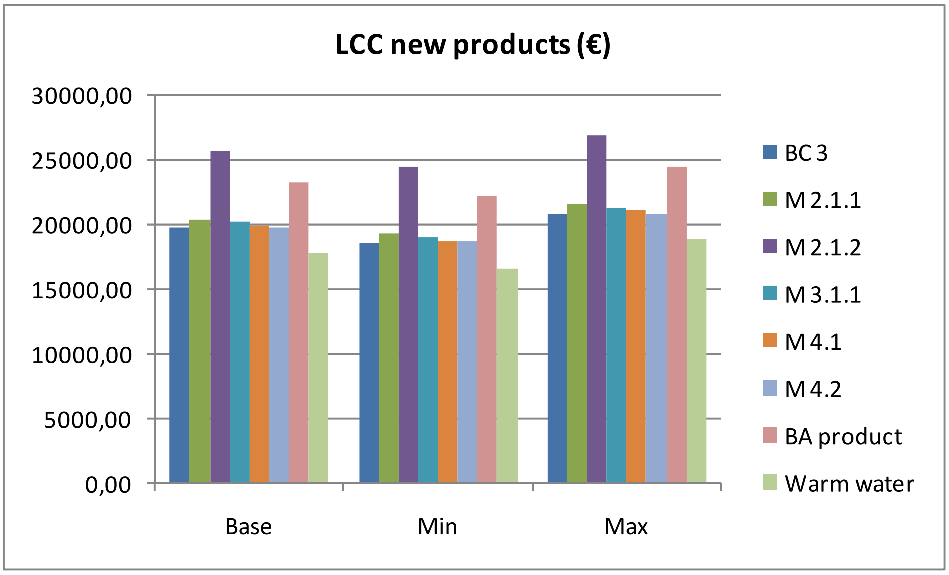

Figure 4-30 Base case 3 and improvement options – impact of detergent consumption on LCC by product

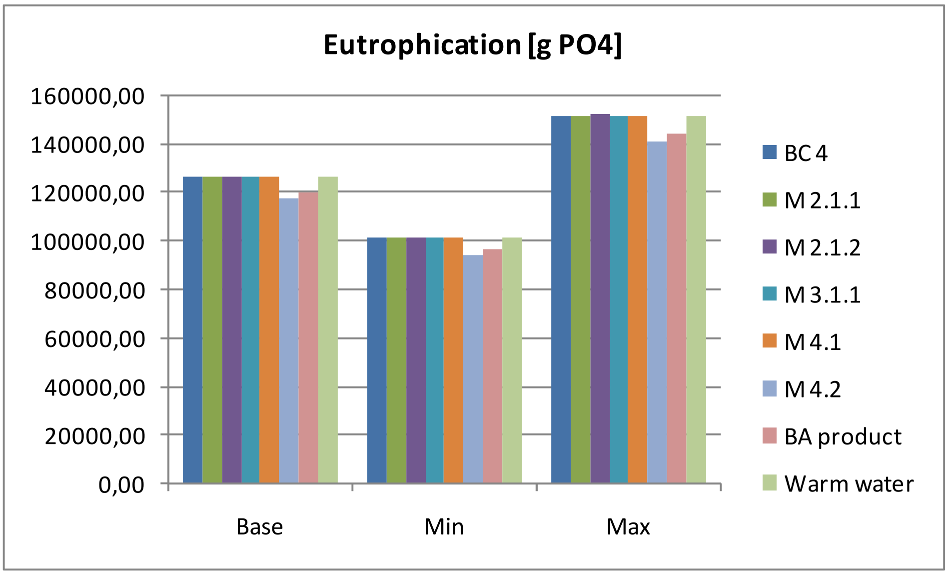

Figure 4-31 Base case 4 and improvement options – impact of detergent consumption on eutrophication over lifetime by product

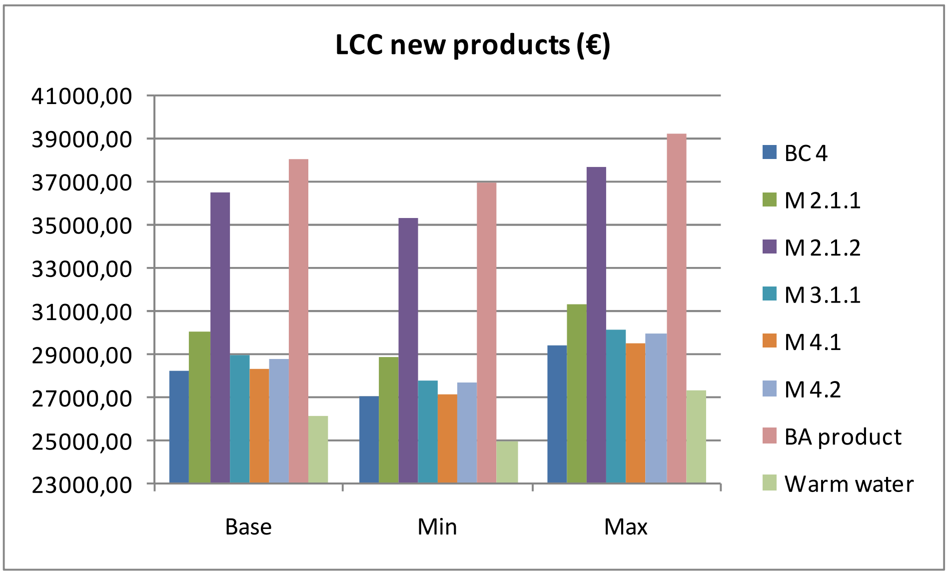

Figure 4-32 Base case 4 and improvement options – impact of detergent consumption on LCC by product

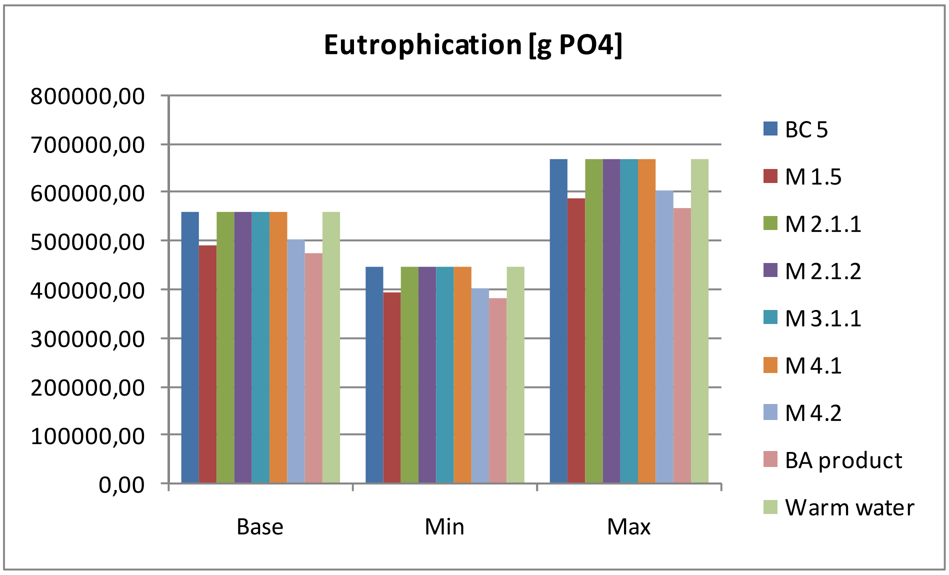

Figure 4-33 Base case 5 and improvement options – impact of detergent consumption on eutrophication over lifetime by product

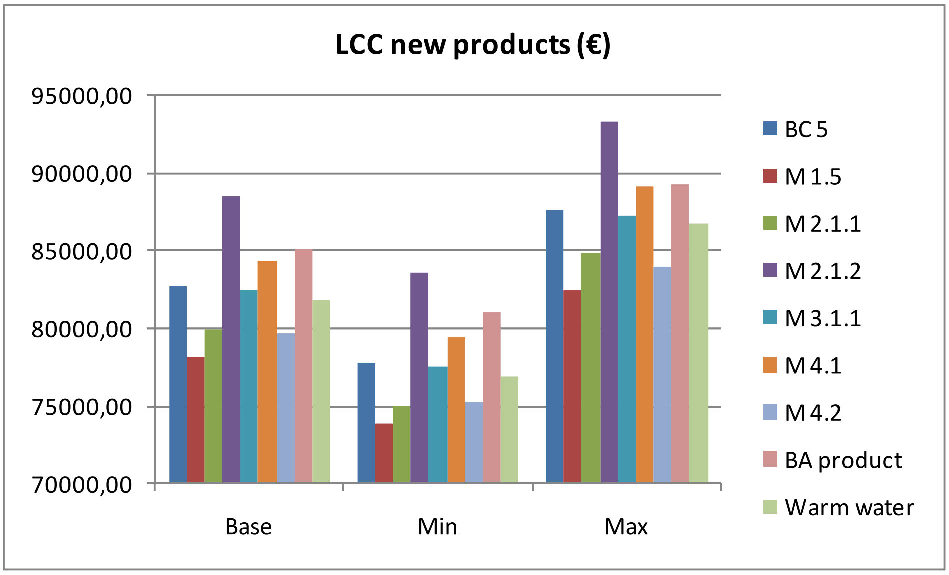

Figure 4-34 Base case 5 and improvement options – impact of detergent consumption on LCC by product

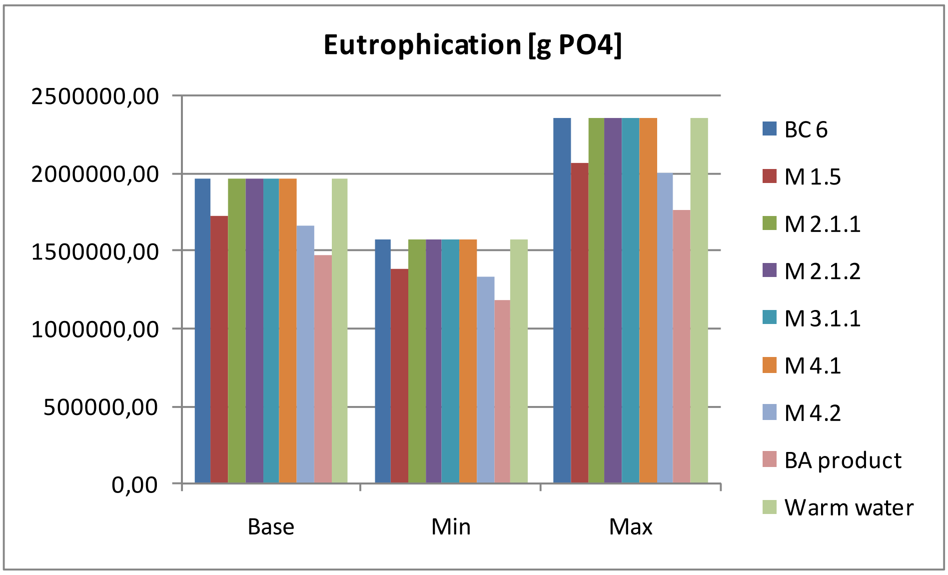

Figure 4-35 Base case 6 and improvement options – impact of detergent consumption on eutrophication over lifetime by product

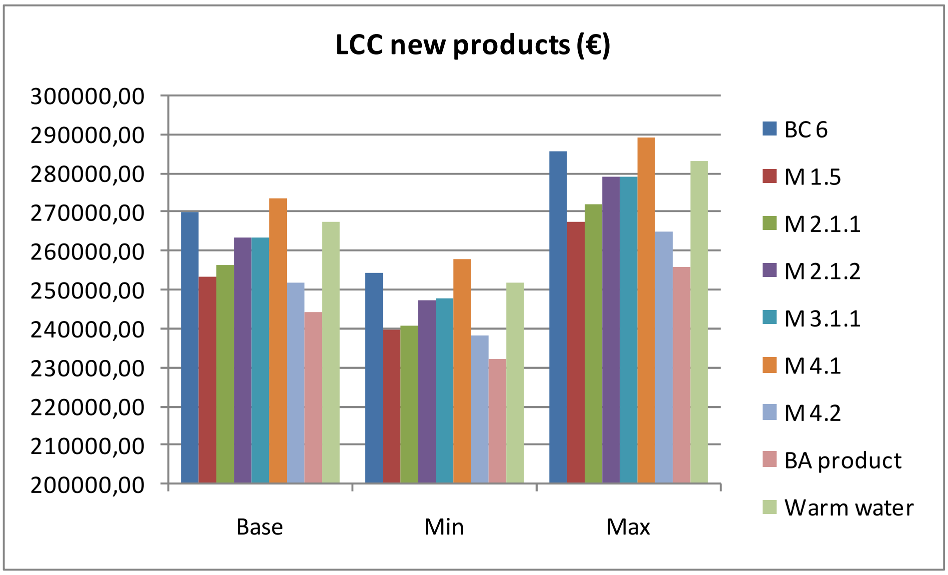

Figure 4-36 Base case 6 and improvement options – impact of detergent consumption on LCC by product

4.2 Intensity of use

4.2.1 Assumptions

In Task 4, average energy, water and detergent consumption data were determined for the base cases. These parameters are directly dependent on the intensity of use of the machines (i.e. the number of dishes washed per year). This intensity can be variable depending on the end user and the type of application and assumptions on this parameter have been made in Task 4.

The sensitivity analysis will consider an error margin of 20% on the given values, both for minimum and maximum values.[14] The tested values are therefore presented in Table 4-4. Table 4-5 to Table 4-7 present the calculated values of the electricity, water and detergent consumption corresponding to the minimum and maximum intensity of use: on the contrary to Section 4.1, these consumption values now vary simultaneously in the analysis.

Table 4-4 Use intensity range for the sensitivity analysis

Base case	Base typical use intensity (in number of dishes per year)	Min	Max
1. Undercounter water-change	24 000	19 200	28 800
2. Undercounter one-tank	237 600	190 080	285 120
3. Hood-type	345 600	276 480	414 720
4. Utensil/Pot	9 000	7 200	10 800
5. One-tank conveyor-type	1 515 900	1 212 720	1 819 080
6. Multi-tank conveyor-type	4 009 500	3 207 600	4 811 400

Table 4-5 Electricity consumption range corresponding to the use intensity range for the sensitivity analysis

Base case	Base total Electricity consumption (in kWh per year)	Min	Max
1. Undercounter water-change	1 254	1 004	1 503
2. Undercounter one-tank	5 253	4 375	6 131
3. Hood-type	8 258	6 889	9 627
4. Utensil/Pot	8 913	7 828	9 997
5. One-tank conveyor-type	37 703	30 851	44 555
6. Multi-tank conveyor-type	102 229	83 304	121 154

[14] This error margin was discussed and agreed during the final stakeholder meeting, 9 December 2010 in Paris.

Table 4-6 Water consumption range corresponding to the use intensity range for the sensitivity analysis

Base case	Base water consumption (in m^3 per year)	Min	Max
1. Undercounter water-change	25.92	20.736	31.104
2. Undercounter one-tank	55.82	45.557	66.086
3. Hood-type	86.65	71.720	101.580
4. Utensil/Pot	89.52	76.416	102.624
5. One-tank conveyor-type	255.686	211.149	300.223
6. Multi-tank conveyor-type	643.645	530.096	757.194

Table 4-7 Detergent consumption range corresponding to the use intensity range for the sensitivity analysis

Base case	Base detergent consumption (in kg per year)	Min	Max
1. Undercounter water-change	87	69	104
2. Undercounter one-tank	188	154	223
3. Hood-type	292	242	342
4. Utensil/Pot	294	251	337
5. One-tank conveyor-type	865	714	1 015
6. Multi-tank conveyor-type	2 146	1 768	2 525

4.2.2 Results

Figure 4-37 to Figure 4-48 show the influence of the variation of the intensity of use on the total energy consumption and the life cycle costs of the different base cases and associated improvement options.

For base case 1, only minor changes appear in the LCC results between the rankings of the options M 2.1.1, M 4.2 and M 4.1. With the minimum value, option M 4.2 gets a higher LCC than M 2.1.1 and for the maximum value, the M 4.1 LCC gets very close the M 4.2 LCC. However, no changes in the BAT and LLCC options occur.

For base case 2, nothing changes about the primary energy consumption. Regarding the LCC, the option M 4.2 which was identified as the LLCC remains the LLCC option when the maximum value of the intensity use is considered, but not with the minimum value: in this case, the BC 2 becomes the LLCC option.

For base case 3, the situation also remains the same for energy consumption but not for the economic analysis. With the default parameter, the base case was identified as the LLCC option (option M4.2 was second) while with the maximum value, option M 4.2 becomes the LLCC option. On the contrary, with the minimum value, this option only scores third, behind the base case, and option M 4.1.

For base case 4, no changes in the rankings of options occur, either the energy consumption or LCC: the base case remains the LLCC.

For base case 5, the LLCC option remains the same (option M 1.5). While option M 3.1.1 has a lower LCC than the base case with the default parameter, it is not the case anymore with the minimum value. On the contrary, the BA product was not an economical solution with the default parameter but its LCC becomes lower than the base case LCC when the maximum value is used.

Finally, for base case 6, The BA product remains the LLCC option for all values. However, with the minimum value, option M 4.2 has a very close LCC to the BA product one and it can be extrapolated that with even lower use intensity, this option would become the LLCC. The only other change is that option M 3.1.1 gets a smaller LCC than M 2.1.2 with the minimum value, which is not the case with the default value used.

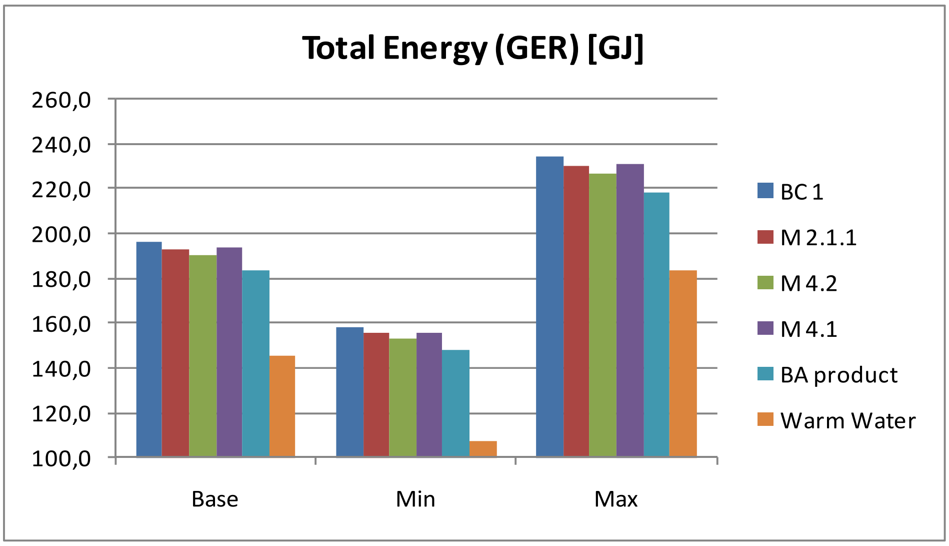

Figure 4-37 Base case 1 and improvement options – impact of use intensity on total energy over lifetime by product

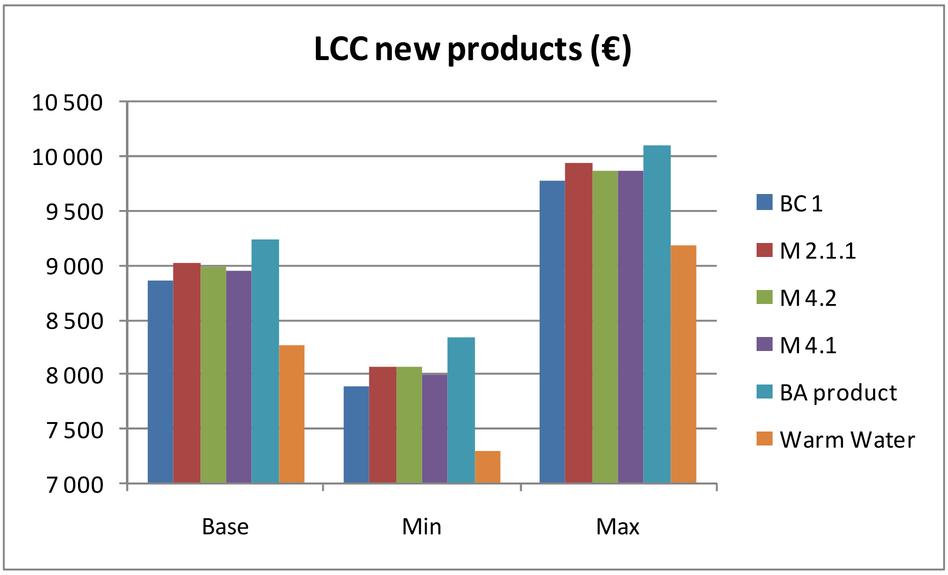

Figure 4-38 Base case 1 and improvement options – impact of use intensity on LCC by product

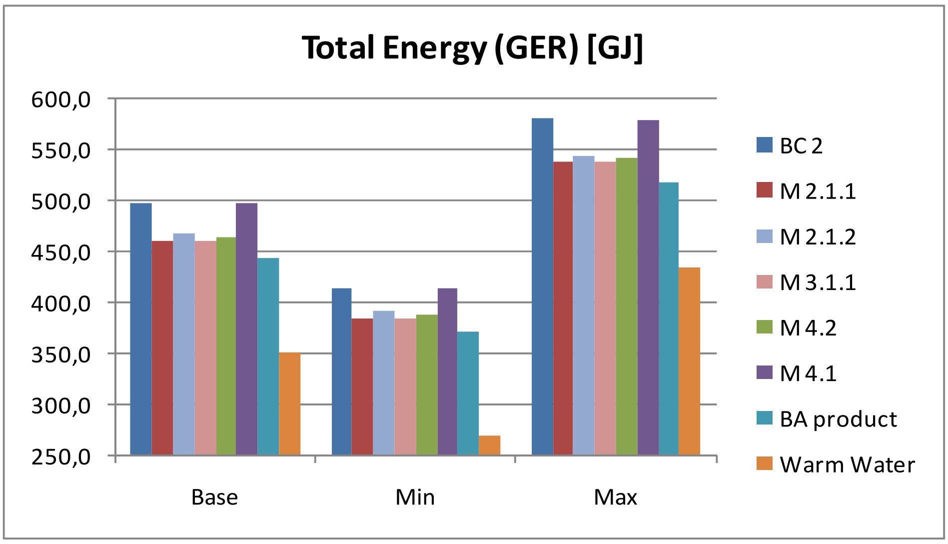

Figure 4-39 Base case 2 and improvement options – impact of use intensity on total energy over lifetime by product

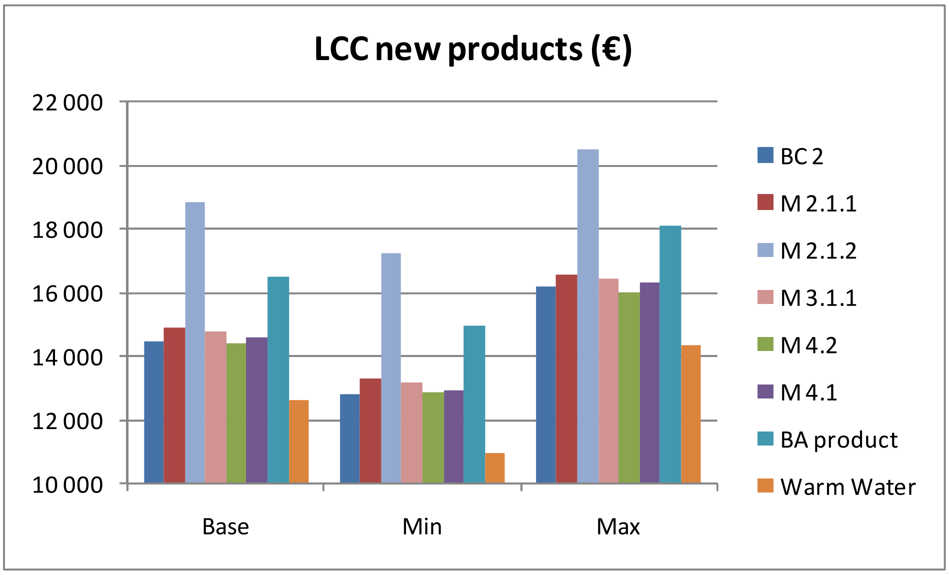

Figure 4-40 Base case 2 and improvement options – impact of use intensity on LCC by product

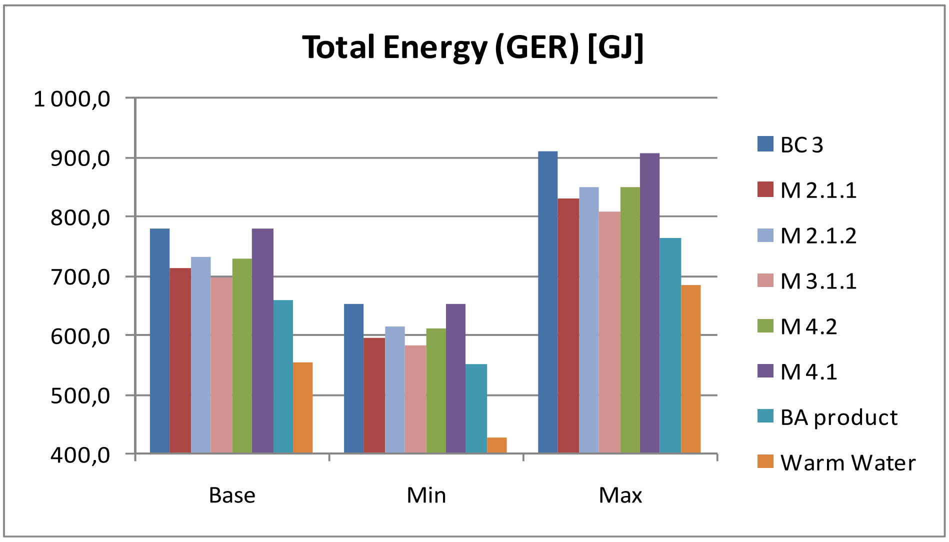

Figure 4-41 Base case 3 and improvement options – impact of use intensity on total energy over lifetime by product

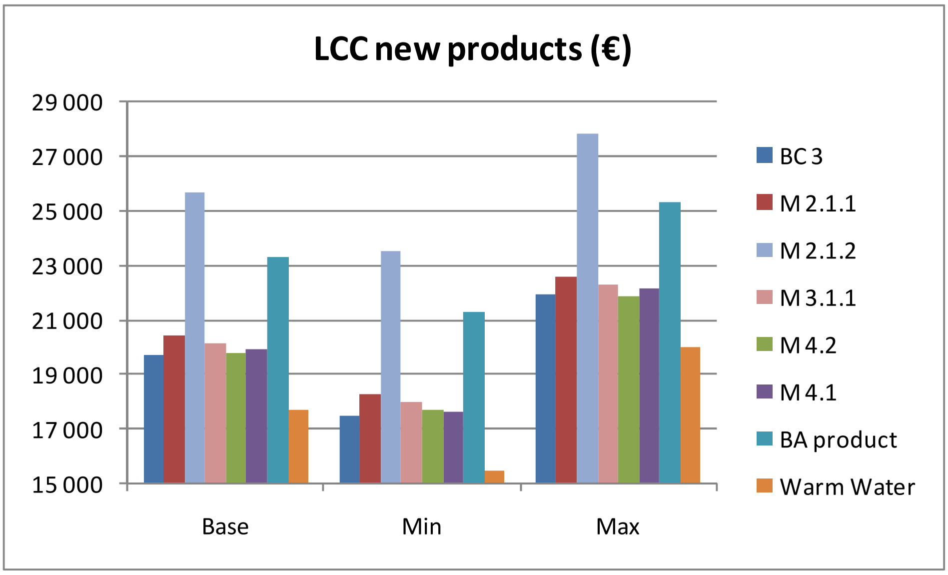

Figure 4-42 Base case 3 and improvement options – impact of use intensity on LCC by product

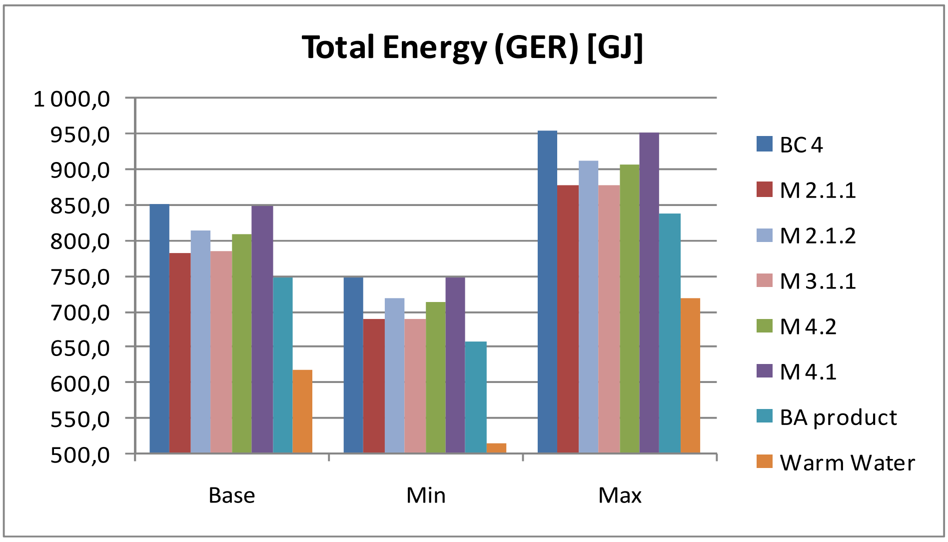

Figure 4-43 Base case 4 and improvement options – impact of use intensity on total energy over lifetime by product

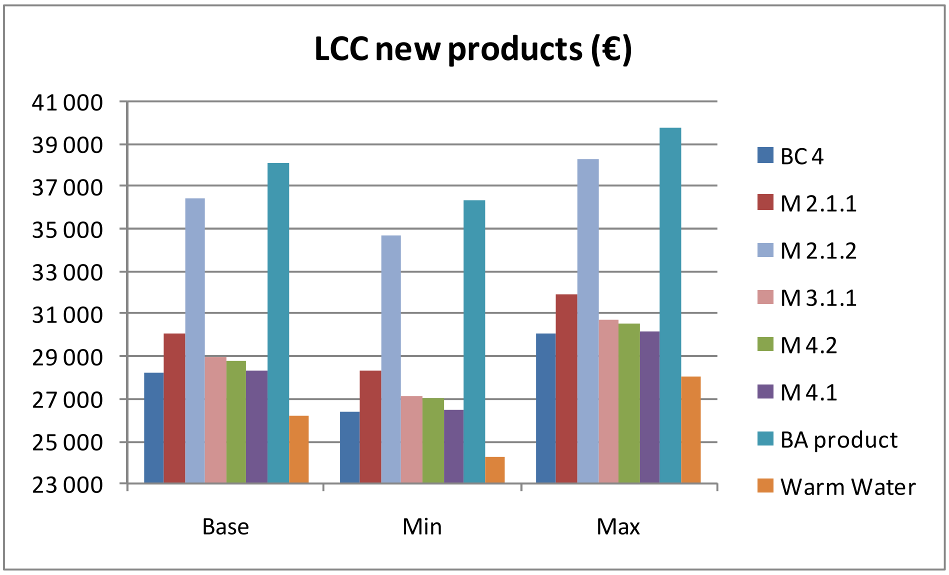

Figure 4-44 Base case 4 and improvement options – impact of use intensity on LCC by product

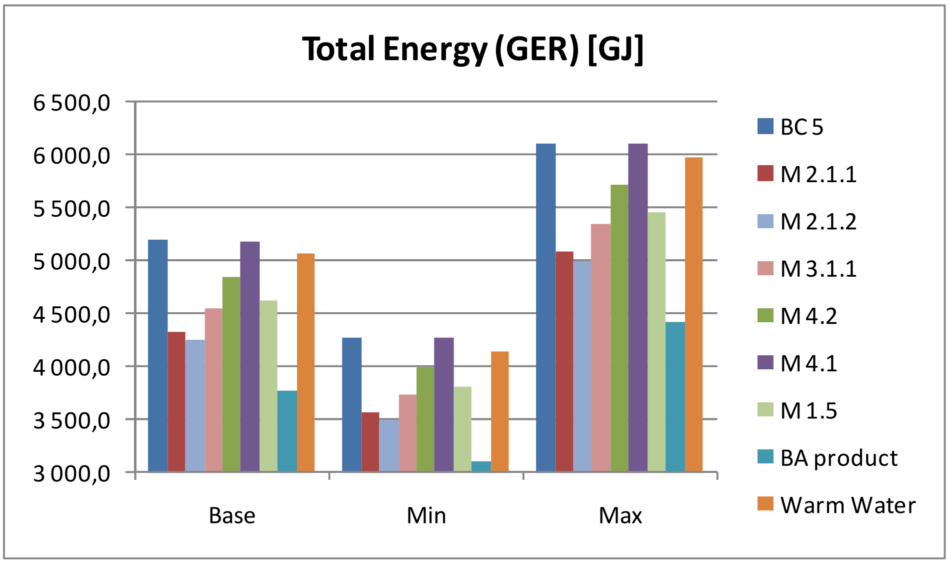

Figure 4-45 Base case 5 and improvement options – impact of use intensity on total energy over lifetime by product

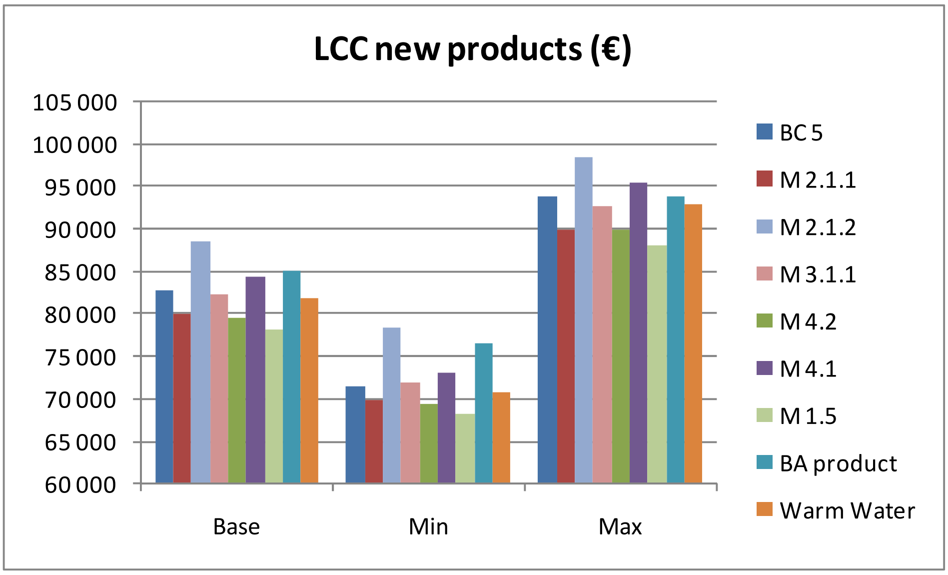

Figure 4-46 Base case 5 and improvement options – impact of use intensity on LCC by product

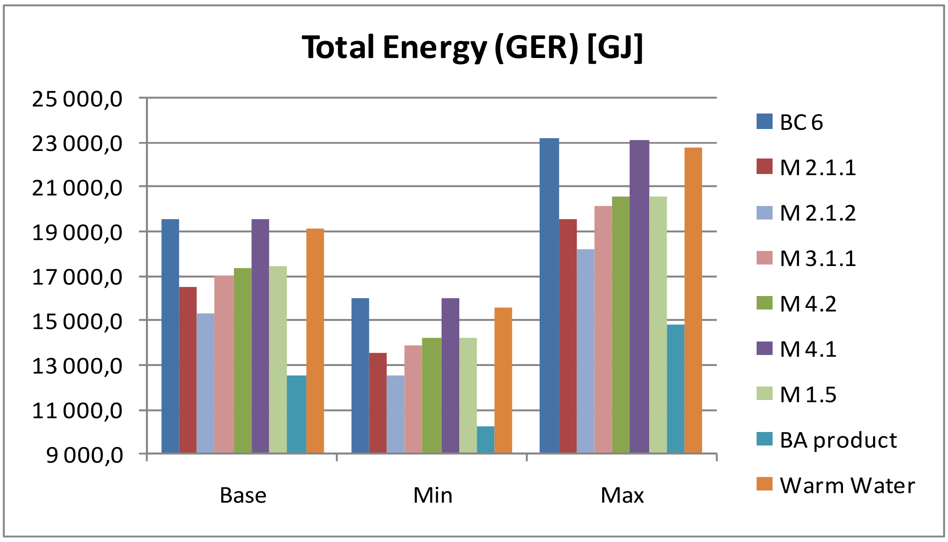

Figure 4-47 Base case 6 and improvement options – impact of use intensity on total energy over lifetime by product

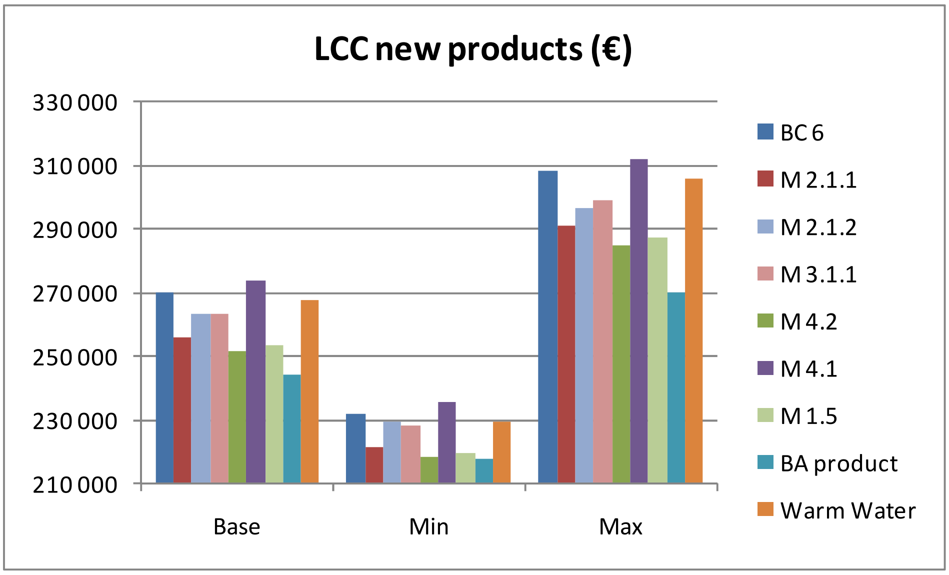

Figure 4-48 Base case 6 and improvement options – impact of use intensity on LCC by product

4.3 Product lifetime

4.3.1 Assumptions

The product lifetime is a major assumption as it has an influence on both the environmental impacts (by increasing the impacts of the use phase) and the life cycle costs (by increasing the operating costs during the use phase). Given the importance of the use phase as discussed in Task 5, it is paramount to take this parameter into account in the sensitivity analysis. Table 4-8 presents the minimum and maximum values that will be used for each base case: an error of 2 years is assumed between extreme values and the average lifetimes considered in the study.

Table 4-8 Product lifetime ranges for the sensitivity analysis

Base case	Base product lifetime (in years)	Min	Max
1. Undercounter water-change	12	10	14
2. Undercounter one-tank	8	6	10
3. Hood-type	8	6	10
4. Utensil/Pot	8	6	10
5. One-tank conveyor-type	12	10	14
6. Multi-tank conveyor-type	17	15	19

4.3.2 Results

Figure 4-49 to Figure 4-60 show the influence of the variation of the product lifetime on the total energy consumption and the life cycle costs of the different base cases and associated improvement options.

For base cases 1 and 4, despite the expected variations in absolute values, the ranking of the different improvement options remains the same whether the minimum of maximum parameter is used.

For base case 2, nothing changes about the primary energy consumption. Regarding the LCC, the option M 4.2 that was identified as the LLCC remains the LLCC option when the maximum value of the intensity use is considered (with a bigger gap to the base case LCC), but not with the minimum value: in this case, the BC 2 becomes the LLCC option.

For base case 3, the situation also remains the same for energy consumption but not for the economic analysis. With the default parameter, the base case was identified as the LLCC option (option M 4.2 was second) while with the maximum value, option M 4.2 becomes the LLCC option.

For base case 5, option M 3.1.1 is not economically beneficial compared to the base case product with the minimum value; the BA product almost becomes advantageous with the maximum lifetime.

For base case 6, no major changes occur: M 3.1.1 gets a smaller LLC than M 2.1.2 with the minimum lifetime.

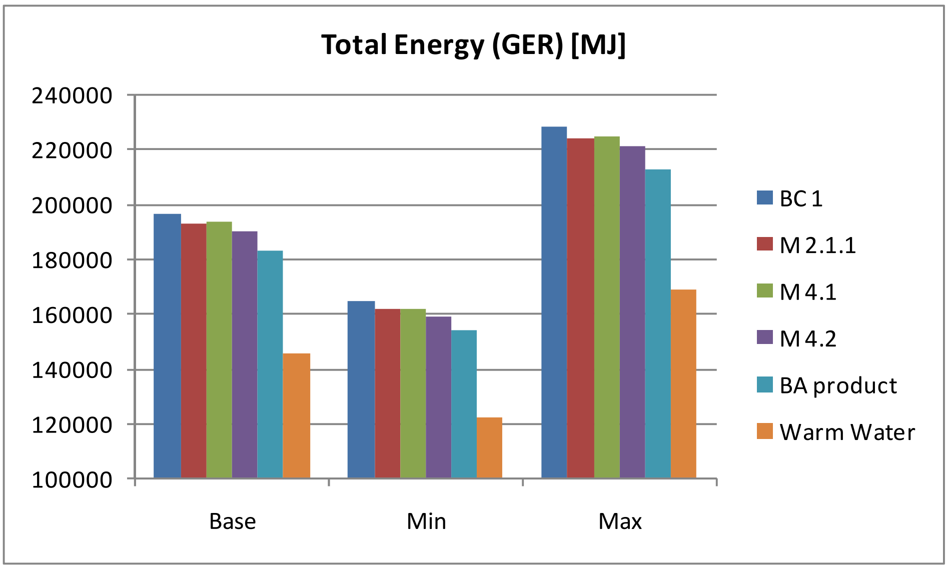

Figure 4-49 Base case 1 and improvement options – impact of lifetime on total energy over lifetime by product

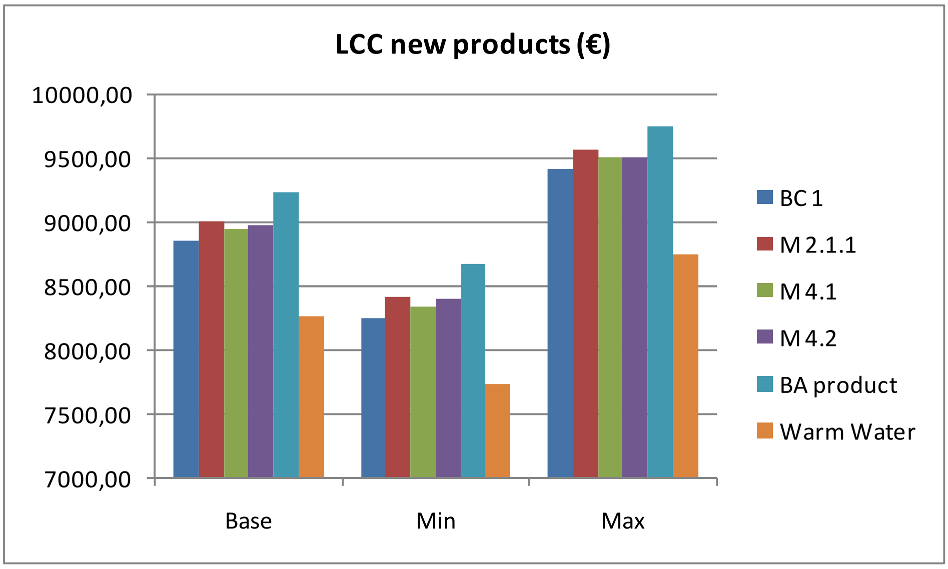

Figure 4-50 Base case 1 and improvement options – impact of lifetime on LCC by product

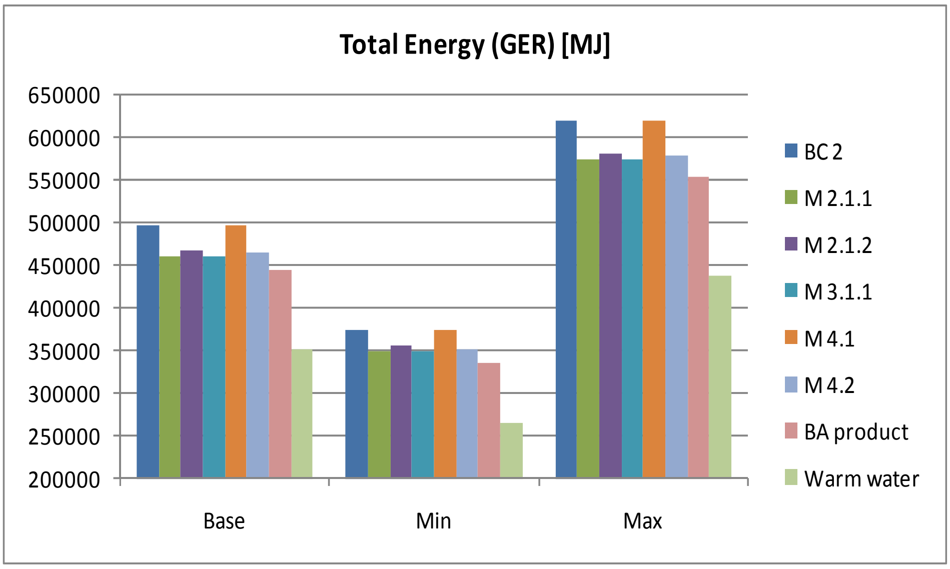

Figure 4-51 Base case 2 and improvement options – impact of lifetime on total energy over lifetime by product

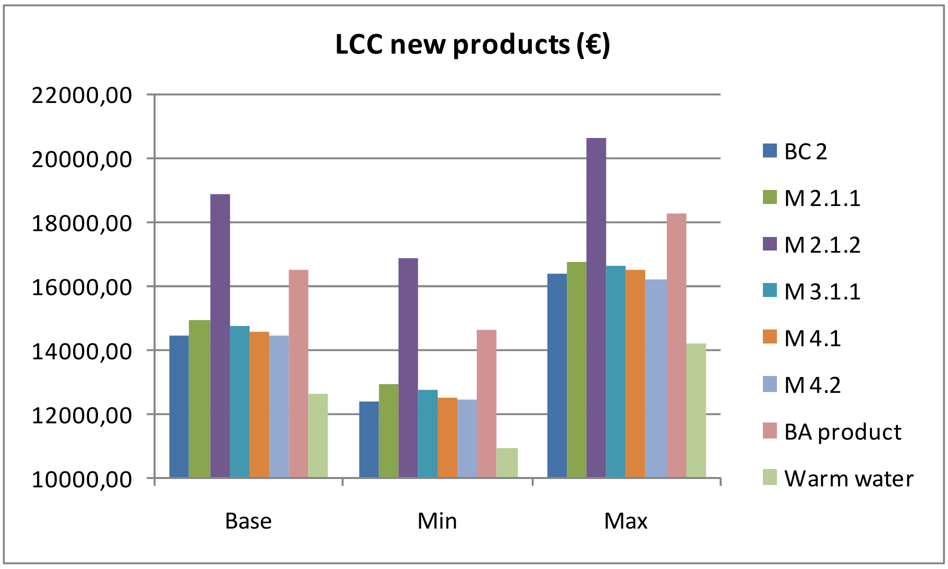

Figure 4-52 Base case 2 and improvement options – impact of lifetime on LCC by product

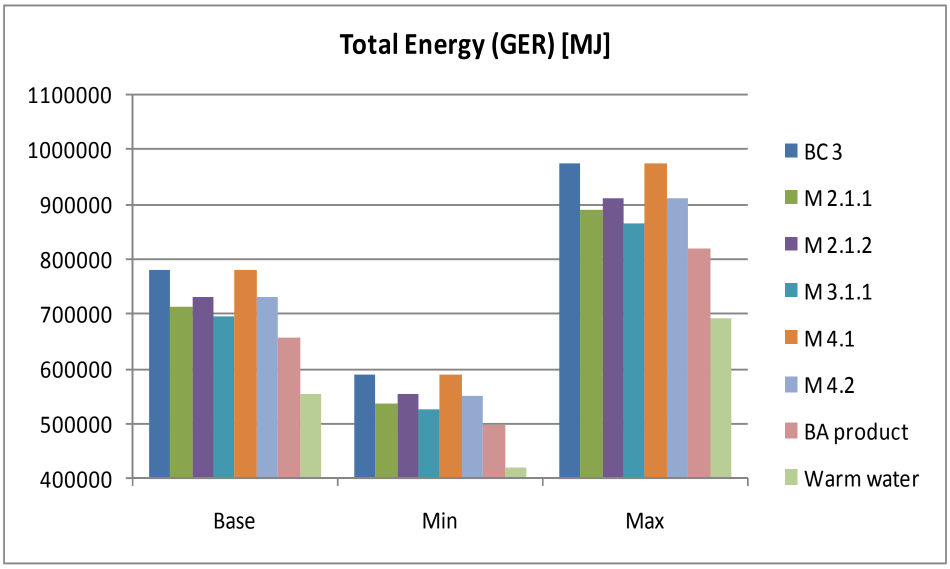

Figure 4-53 Base case 3 and improvement options – impact of lifetime on total energy over lifetime by product

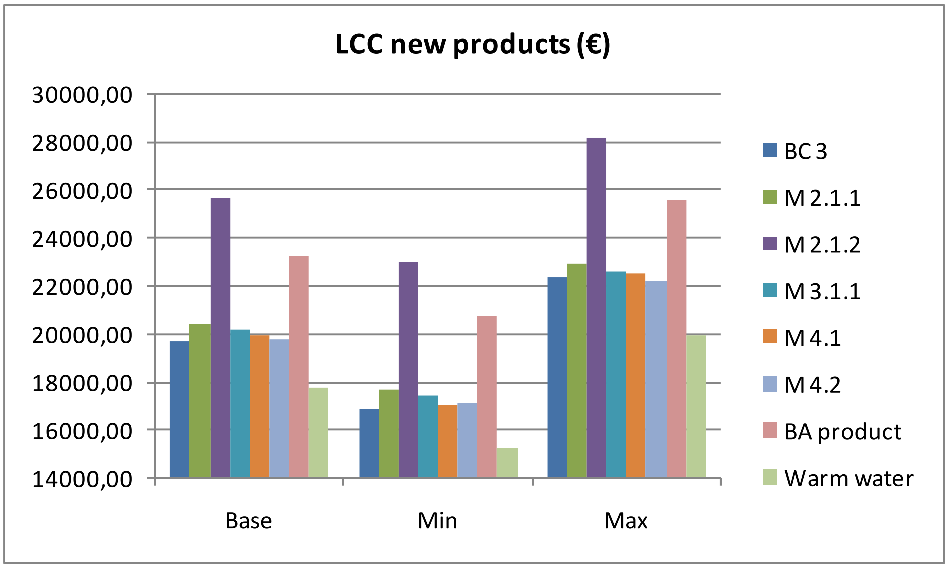

Figure 4-54 Base case 3 and improvement options – impact of lifetime on LCC by product

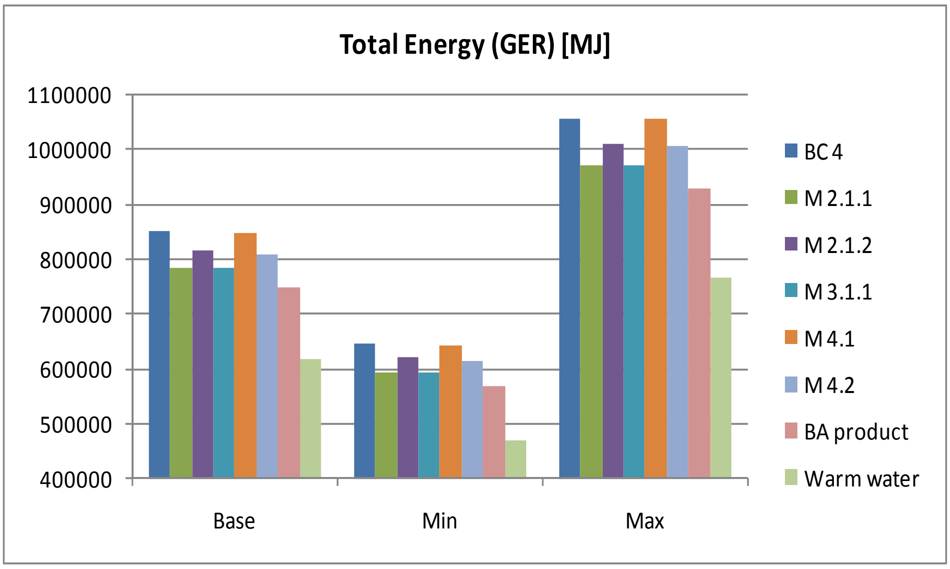

Figure 4-55 Base case 4 and improvement options – impact of lifetime on total energy over lifetime by product

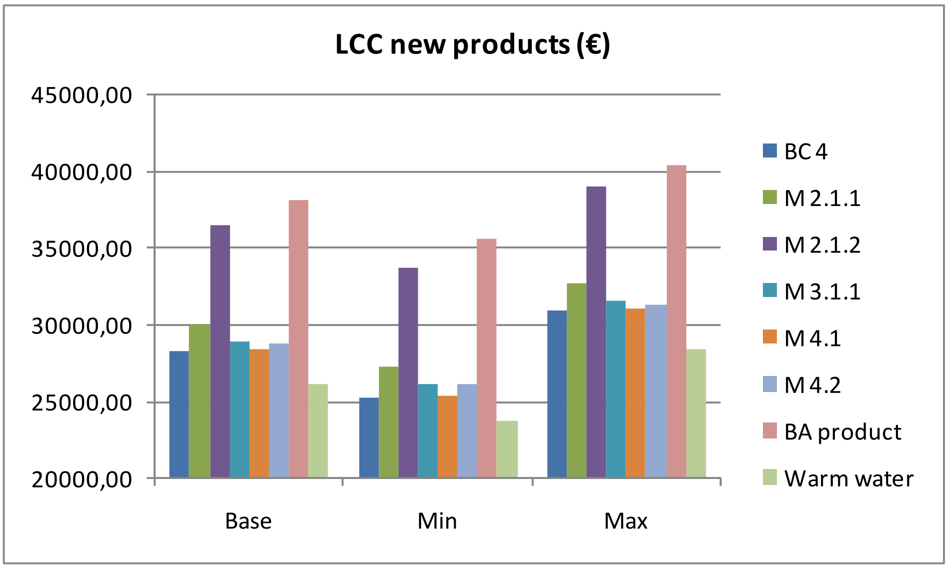

Figure 4-56 Base case 4 and improvement options – impact of lifetime on LCC by product

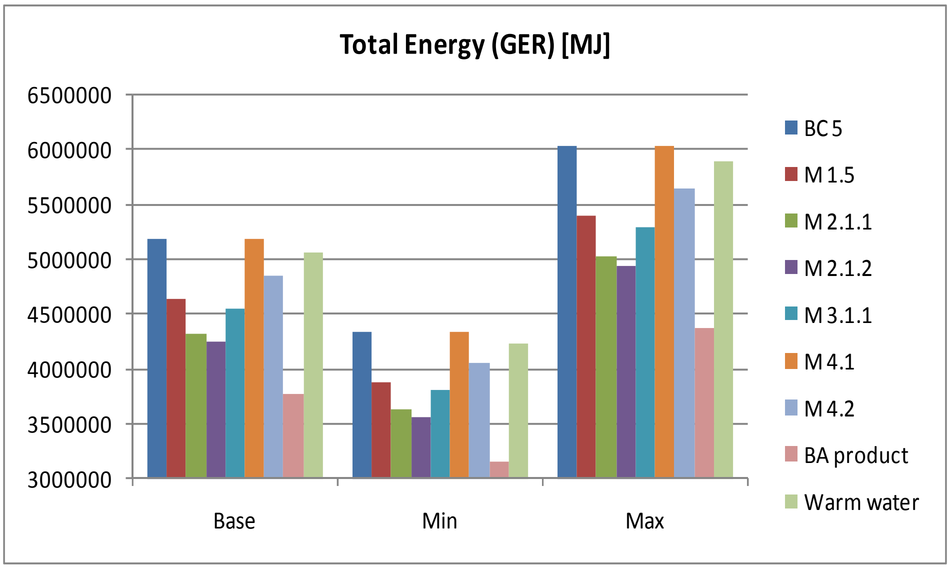

Figure 4-57 Base case 5 and improvement options – impact of lifetime on total energy over lifetime by product

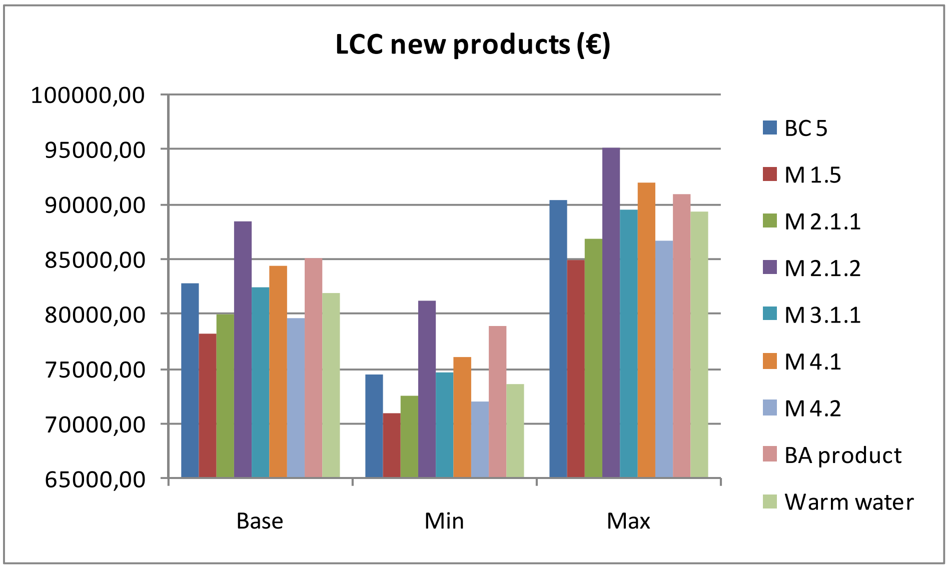

Figure 4-58 Base case 5 and improvement options – impact of lifetime on LCC by product

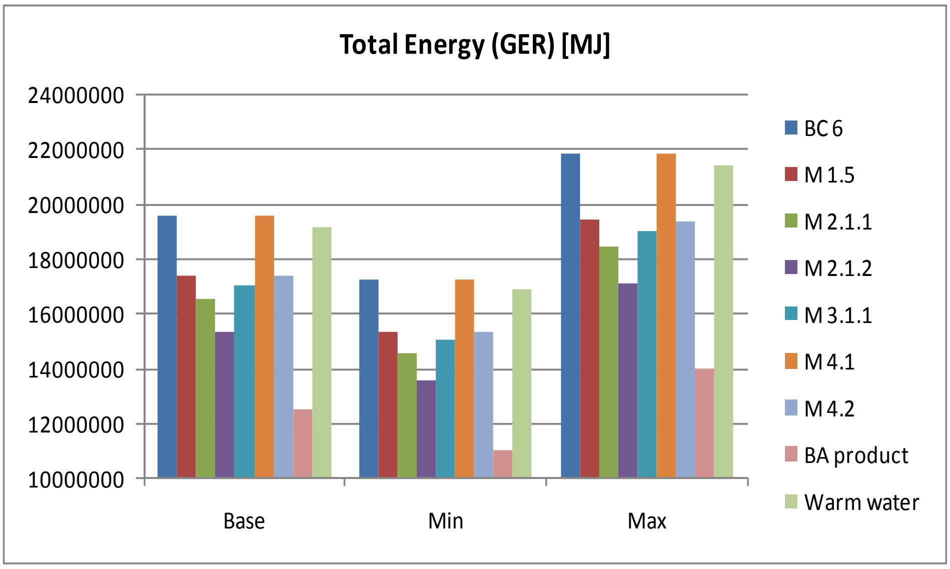

Figure 4-59 Base case 6 and improvement options – impact of lifetime on total energy over lifetime by product

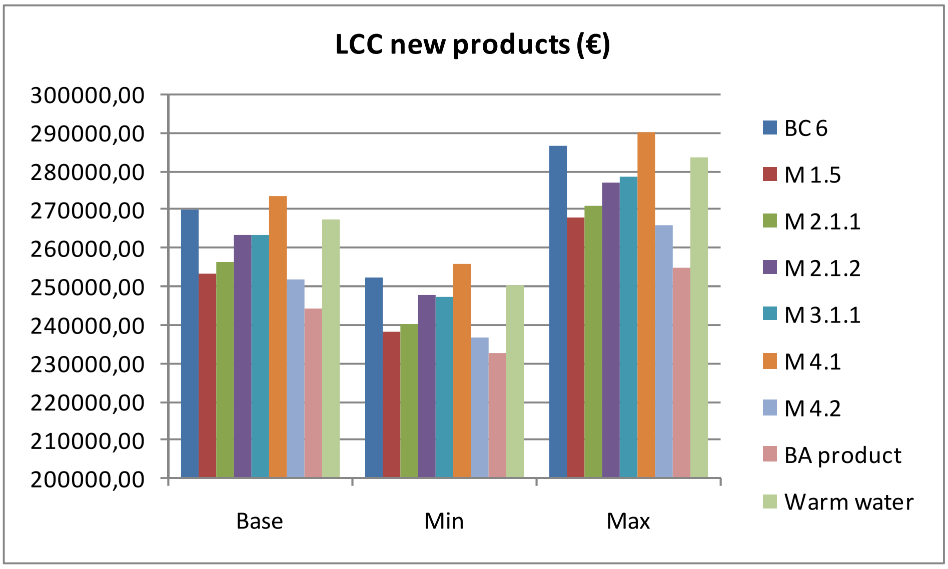

Figure 4-60 Base case 6 and improvement options – impact of lifetime on LCC by product

4.4 Resources and consumable rates

4.4.1 Assumptions

Table 4-9 and Table 4-10 present the ranges for the resources and consumables prices that will be used for the sensitivity analysis. These parameters only have an economic influence on the outcomes so that only the influence on LCC is displayed in Figure 4-61 to Figure 4-78. The minimum and maximum electricity values correspond to the extreme values found in Eurostat statistics (see Task 2); for water, they were also extracted from extreme values found during the estimation of the EU average price (see Task 2); for detergent, a wide range was deliberately chosen given the high variability of prices found during the internet market research (see Task 2).

Again, we use average EU prices for all calculations but there are significant differences between Member States.

Table 4-9 Electricity rate ranges for the sensitivity analysis

Base case	Base electricity rate (€/kWh)	Min	Max
1. Undercounter water-change	0.138	0.071 (Estonia)	0.185 (Slovakia)
2. Undercounter one-tank			
3. Hood-type	0.105	0.059 (Estonia)	0.160 (Cyprus)
4. Utensil/Pot			
5. One-tank conveyor-type	0.090	0.055 (Estonia)	0.144 (Cyprus)
6. Multi-tank conveyor-type			

Table 4-10 Water and detergent rates ranges for the sensitivity analysis

Item	Base price (for all case-cases)	Min	Max
Water	2.64 €/m^3	1.11 €/m^3 (Rome)	4.91 €/m^3 (Berlin)
Detergent	3.0 €/kg	2.0 €/kg	4.0 €/kg

4.4.2 Results

For base cases 1 and 4, the variations of the resources rates have no influence on the relative ranking of options.

For base case 2, M 4.2 is not the LLCC option anymore when the minimum value of electricity rate, or water or detergent rate is used: the base case product becomes the most economic product.

For base case 3, on the contrary, the base case loses its position of LLCC at the expense of option M 4.2 when the maximum rates of electricity, water or detergent are used. Besides, the option M 3.1.1 almost gets a lower LCC than the base case product as well when the maximum electricity rate is considered.

For base case 5, the BA product becomes economically beneficial in comparison with the base case with the maximum electricity rate while M 3.1.1 loses this status with the minimum value. Concerning the detergent rate, the BA product gets a lower LCC than option M 4.1 with the maximum value used.

For base case 6, option M 4.2 becomes the LLCC option with the minimum electricity rate at the expense of the BA product (option M 1.5 also gets a smaller LCC than the BA product). M 2.1.2 is not economic compared to the base case product with the minimum electricity rate.

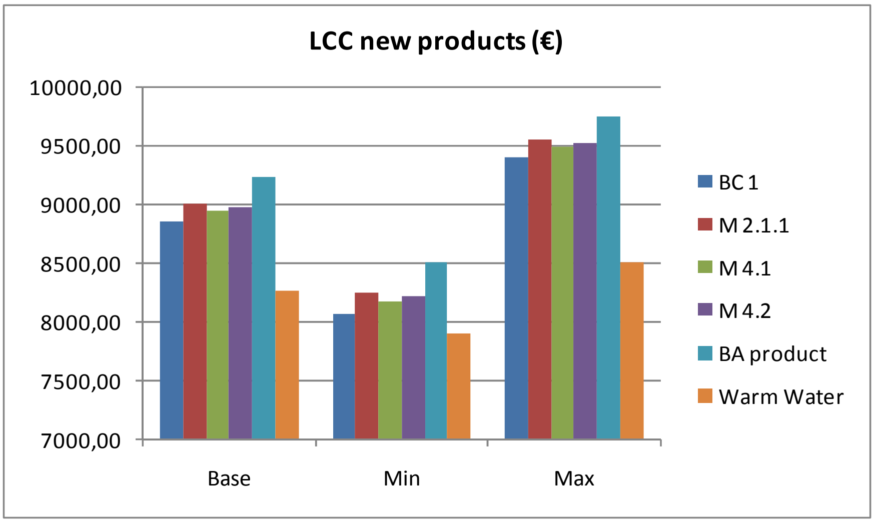

Figure 4-61 Base case 1 and improvement options – impact of electricity rate on LCC by product

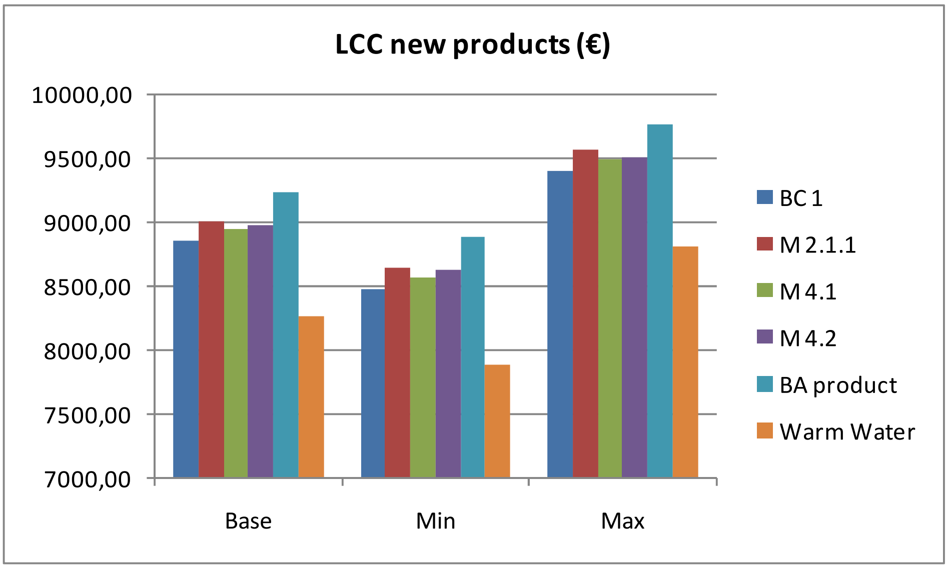

Figure 4-62 Base case 1 and improvement options – impact of water rate on LCC by product

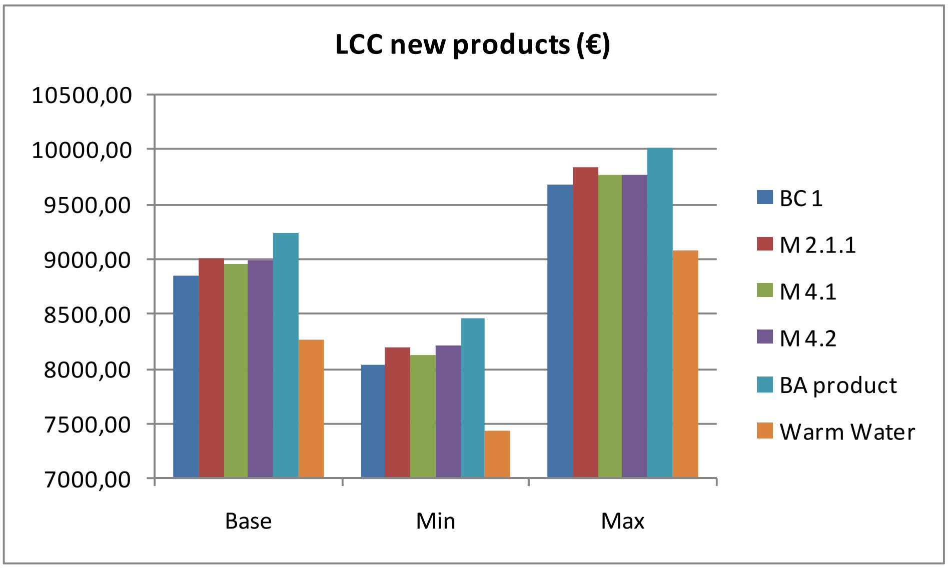

Figure 4-63 Base case 1 and improvement options – impact of detergent rate on LCC by product

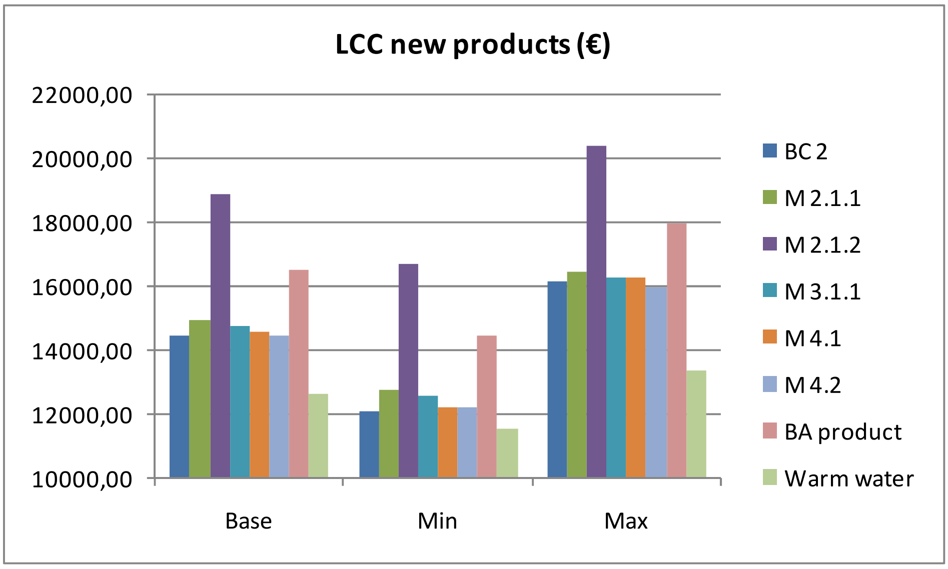

Figure 4-64 Base case 2 and improvement options – impact of electricity rate on LCC by product

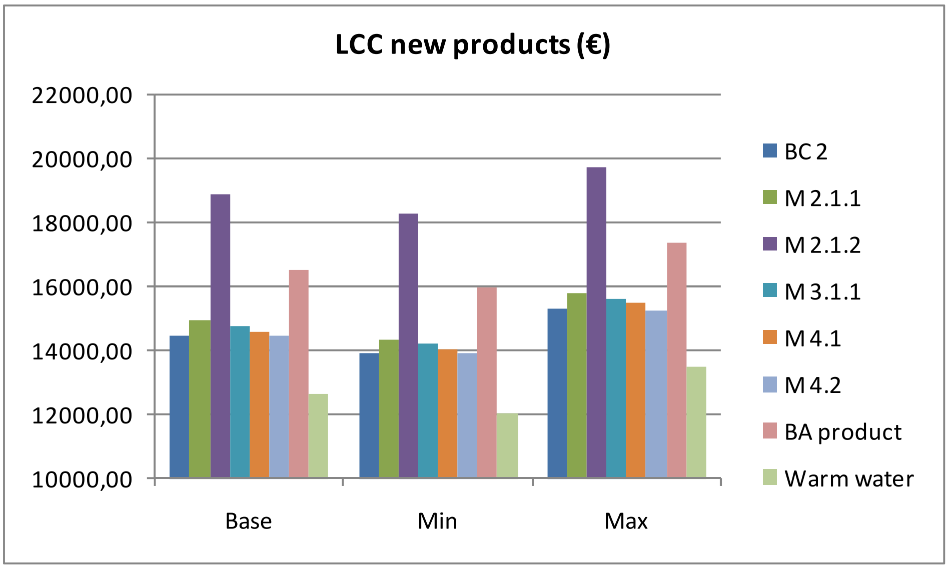

Figure 4-65 Base case 2 and improvement options – impact of water rate on LCC by product

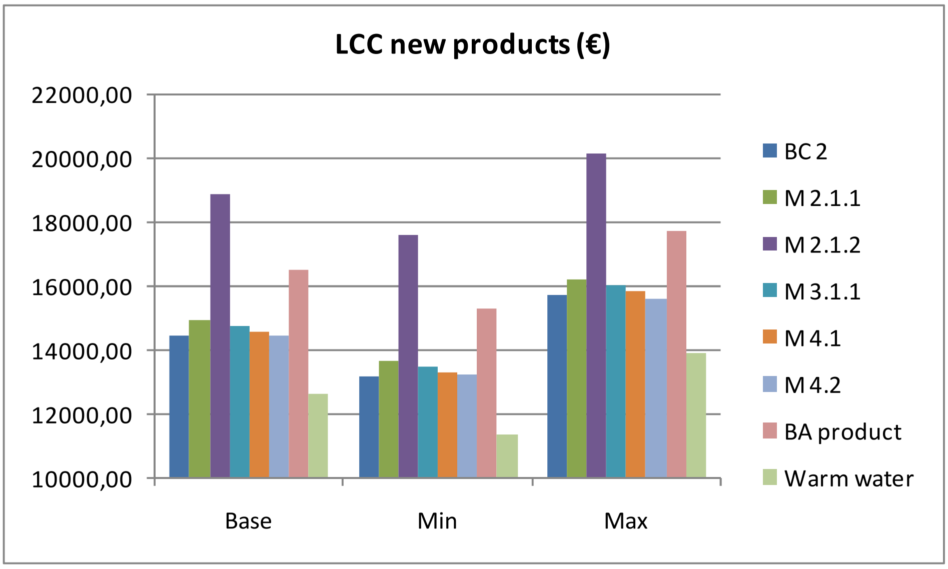

Figure 4-66 Base case 2 and improvement options – impact of detergent rate on LCC by product

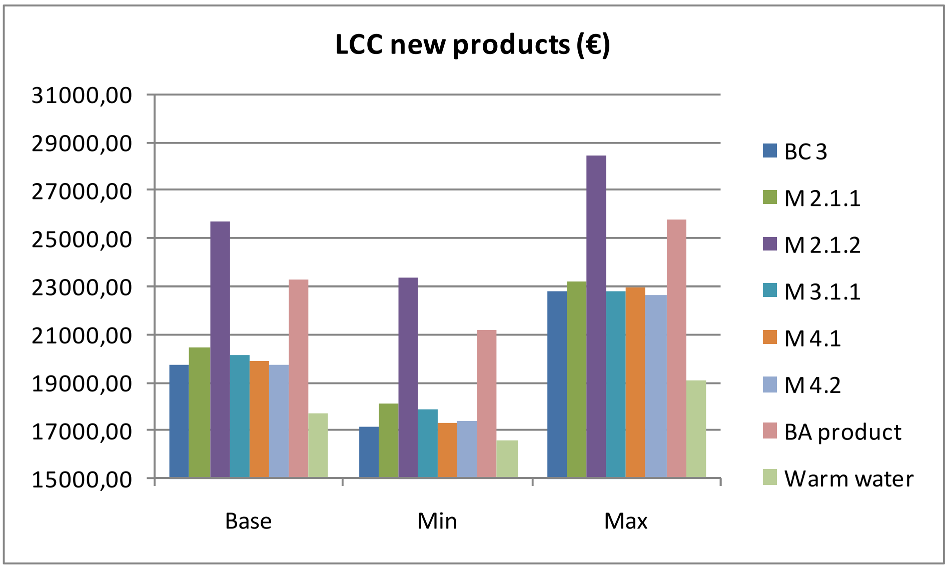

Figure 4-67 Base case 3 and improvement options – impact of electricity rate on LCC by product

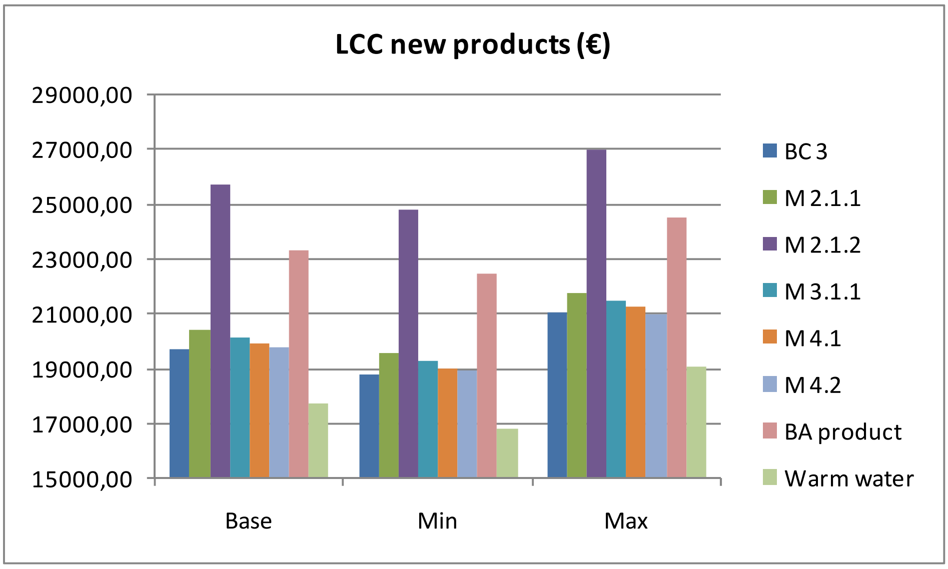

Figure 4-68 Base case 3 and improvement options – impact of water rate on LCC by product

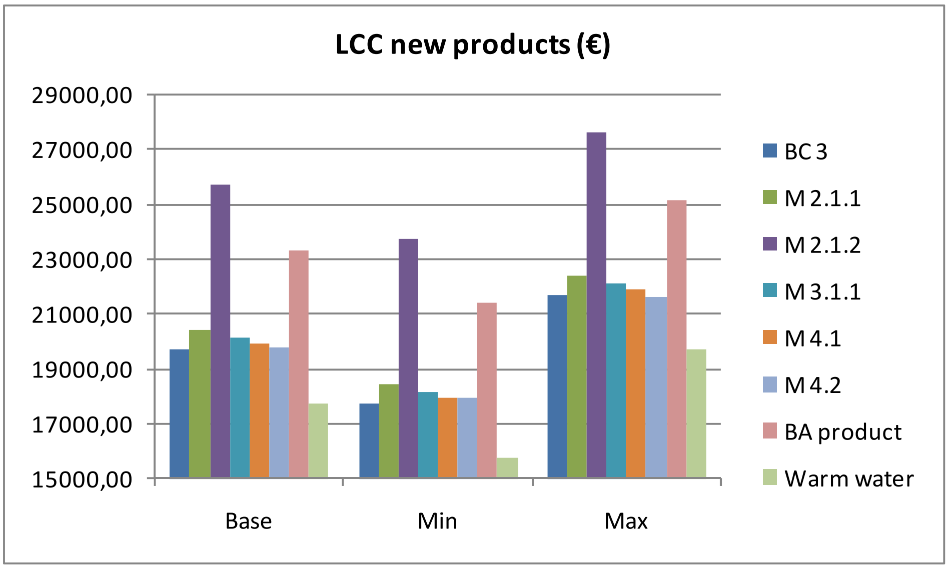

Figure 4-69 Base case 3 and improvement options – impact of detergent rate on LCC by product

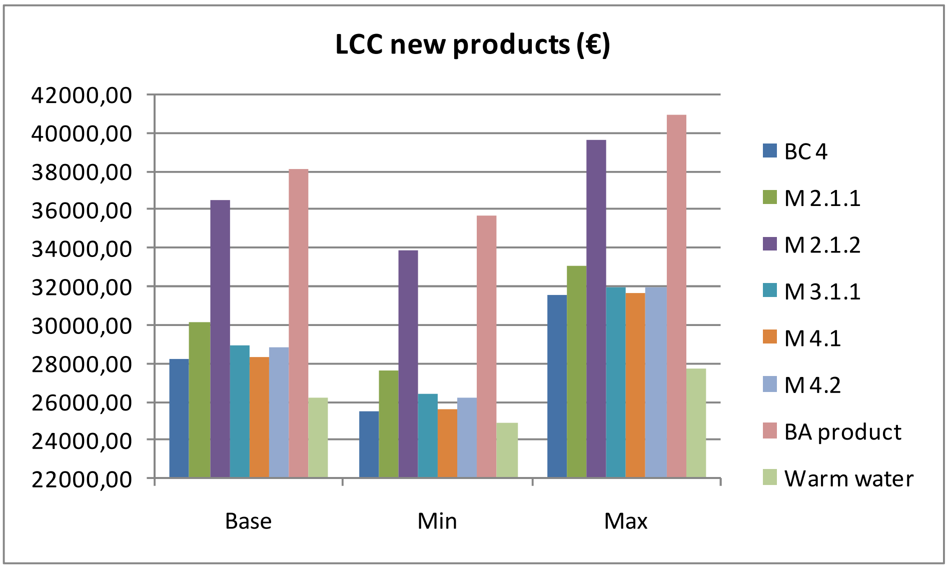

Figure 4-70 Base case 4 and improvement options – impact of electricity rate on LCC by product

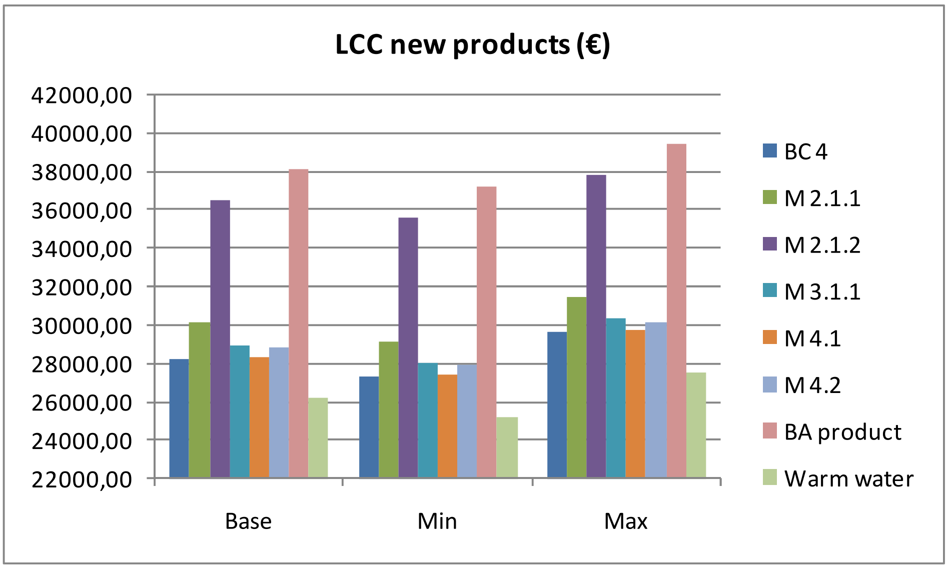

Figure 4-71 Base case 4 and improvement options – impact of water rate on LCC by product

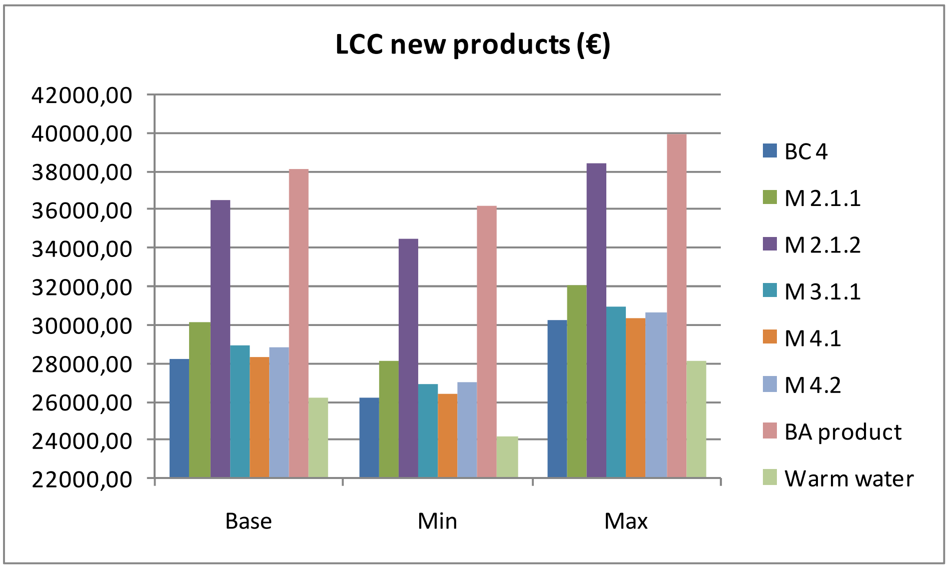

Figure 4-72 Base case 4 and improvement options – impact of detergent rate on LCC by product

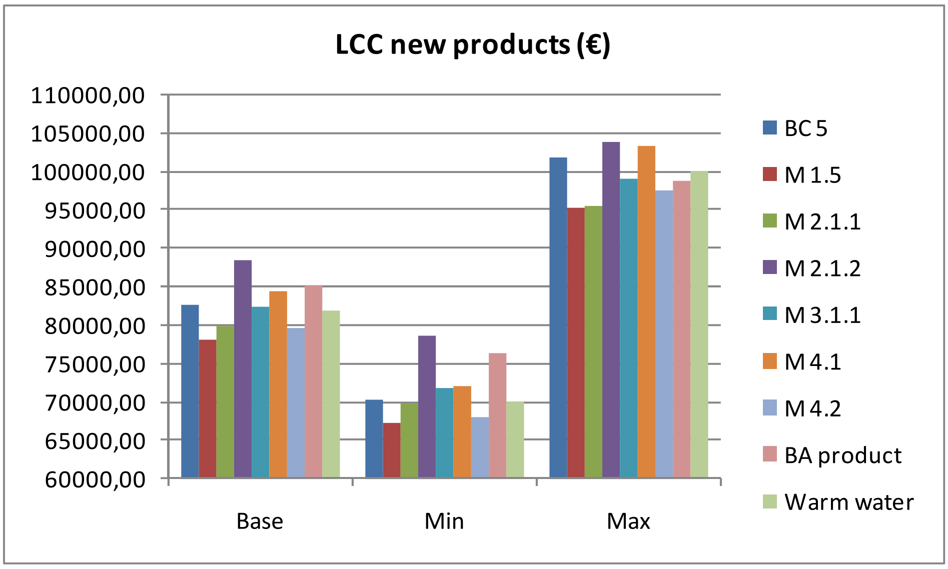

Figure 4-73 Base case 5 and improvement options – impact of electricity rate on LCC by product

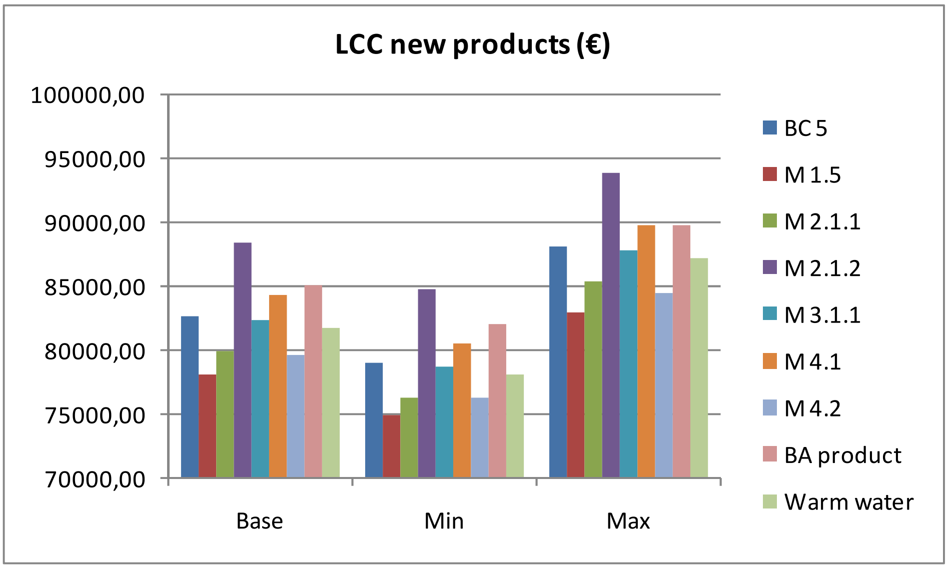

Figure 4-74 Base case 5 and improvement options – impact of water rate on LCC by product

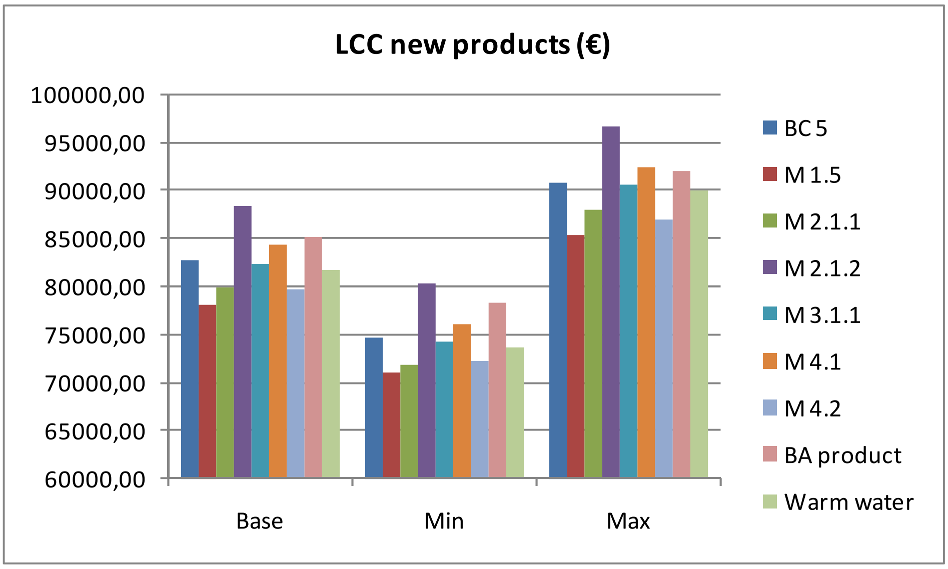

Figure 4-75 Base case 5 and improvement options – impact of detergent rate on LCC by product

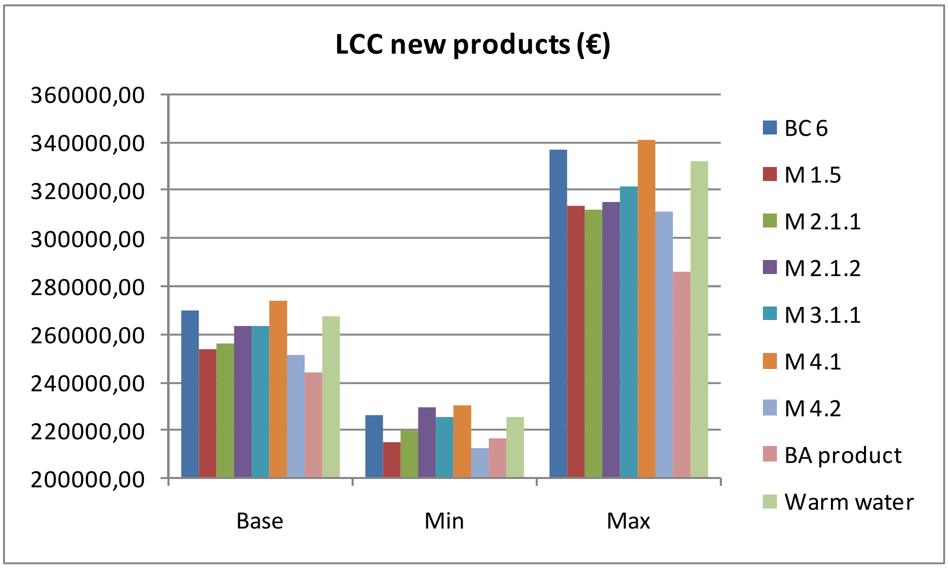

Figure 4-76 Base case 6 and improvement options – impact of electricity rate on LCC by product

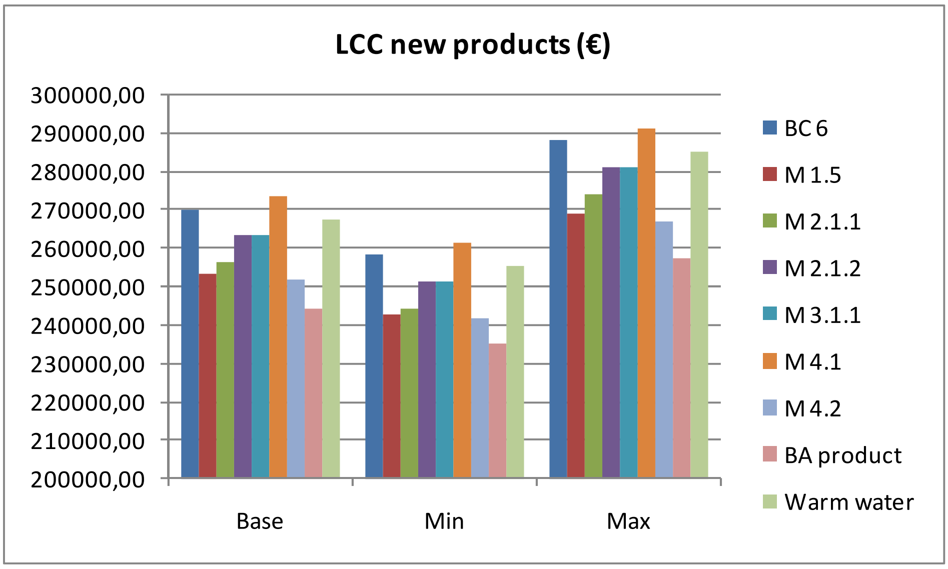

Figure 4-77 Base case 6 and improvement options – impact of water rate on LCC by product

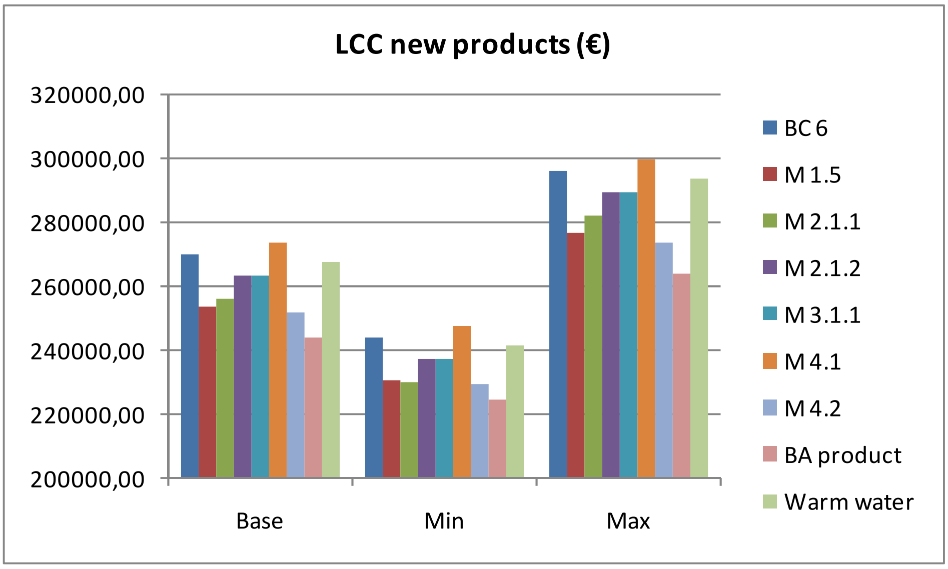

Figure 4-78 Base case 6 and improvement options – impact of detergent rate on LCC by product

4.5 Product purchase price

4.5.1 Assumptions

The product purchase price is a major parameter for the calculation of the LCC. Table 4-11 presents the ranges which will be studied for the sensitivity analysis (20% error margin[15]). Figure 4-79 to Figure 4-84 show the influence that this parameter has for the different base cases.

As the improved products' purchase prices are directly linked to the base cases' prices, the same error margin is applied to the purchase prices of the improved products.

Table 4-11 Purchase prices ranges for the sensitivity analysis

Base case	Base purchase price (in €)	Min	Max
1. Undercounter water-change	3 200	2 560	3 840
2. Undercounter one-tank	3 500	2 800	4 200
3. Hood-type	4 700	3 760	5 640
4. Utensil/Pot	10 500	8 400	12 600
5. One-tank conveyor-type	15 000	12 000	18 000
6. Multi-tank conveyor-type	45 000	36 000	54 000

[15] This error margin was discussed and agreed during the final stakeholder meeting, 9 December 2010 in Paris.

4.5.2 Results

No variation in the ranking of the different options is visible for base cases 1, 2 and 4.

For base case 3, the option M 4.2 becomes the LLCC instead of the base case product for the minimum price used.

For base case 5, the BA product becomes economical in comparison with the base case for the minimum value while option M 3.1.1 loses this situation when the maximum price is used.

For base case 6, options M 3.1.1 gets a lower LCC than option M 2.1.2 with the maximum value.

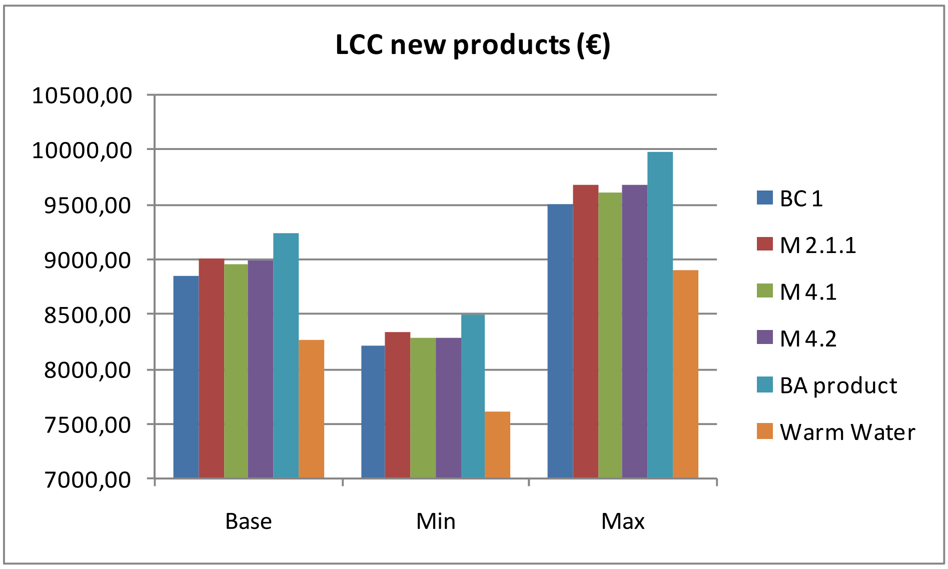

Figure 4-79 Base case 1 and improvement options – impact of purchase price on LCC by product

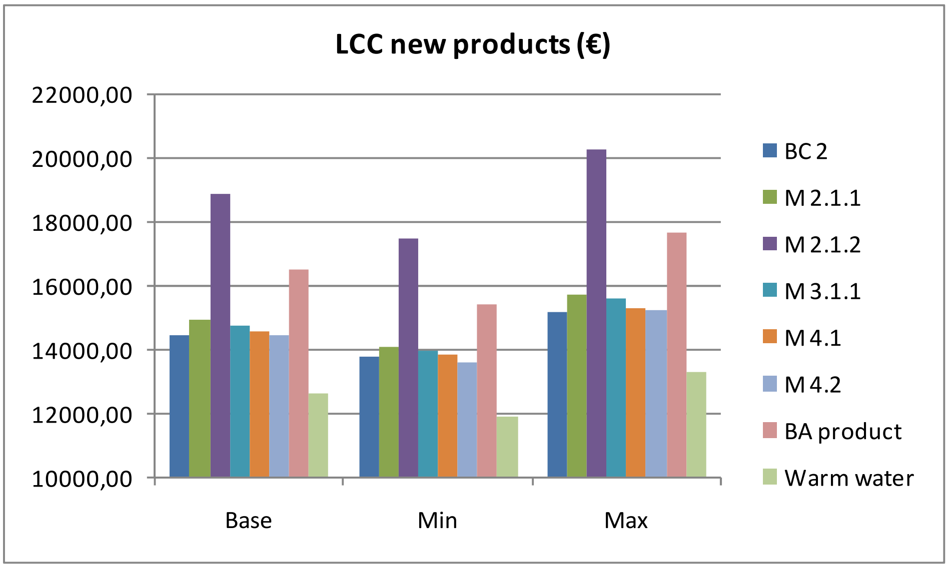

Figure 4-80 Base case 2 and improvement options – impact of purchase price on LCC by product

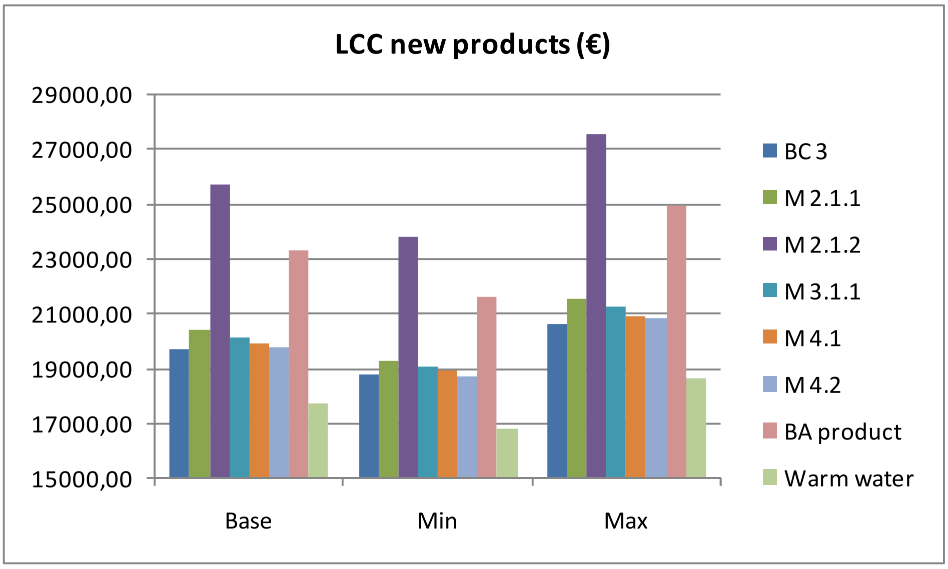

Figure 4-81 Base case 3 and improvement options – impact of purchase price on LCC by product

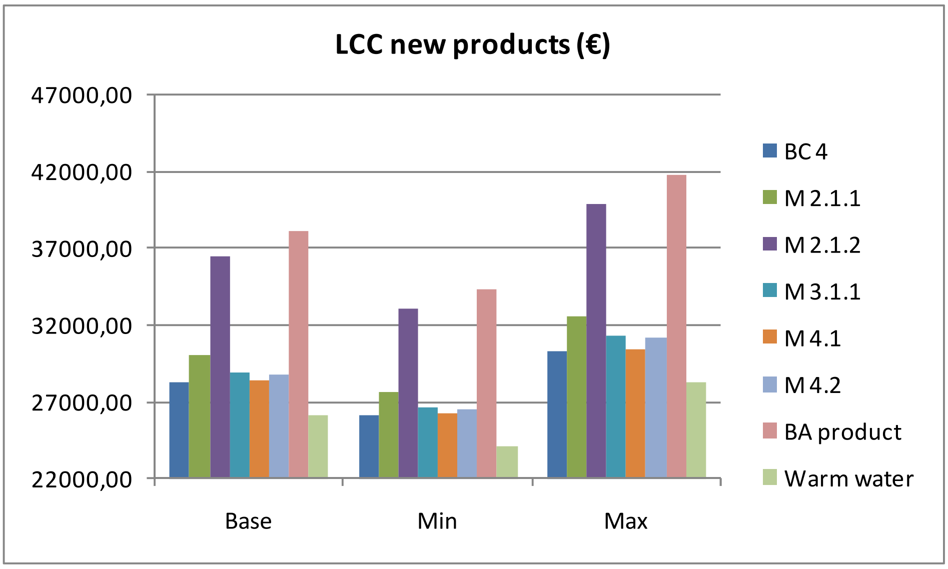

Figure 4-82 Base case 4 and improvement options – impact of purchase price on LCC by product

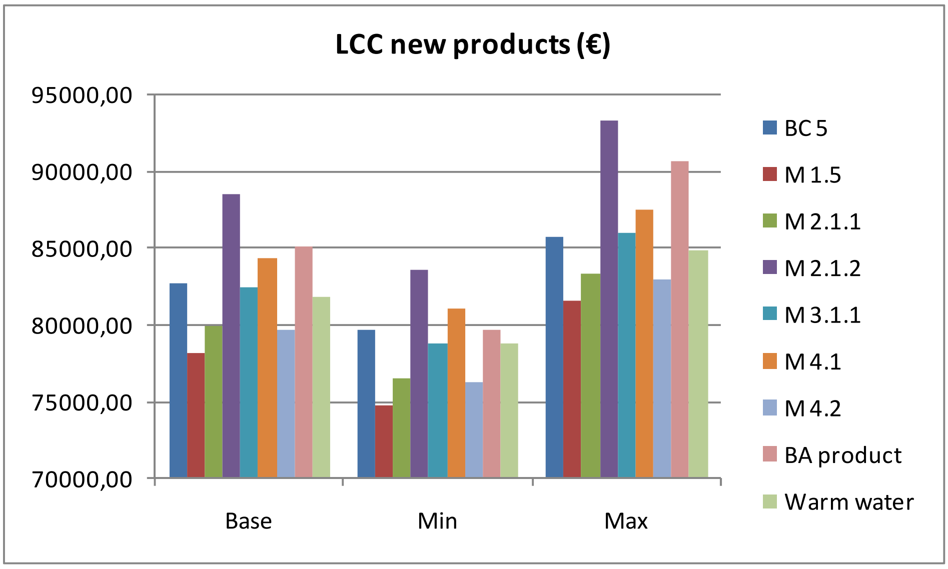

Figure 4-83 Base case 5 and improvement options – impact of purchase price on LCC by product

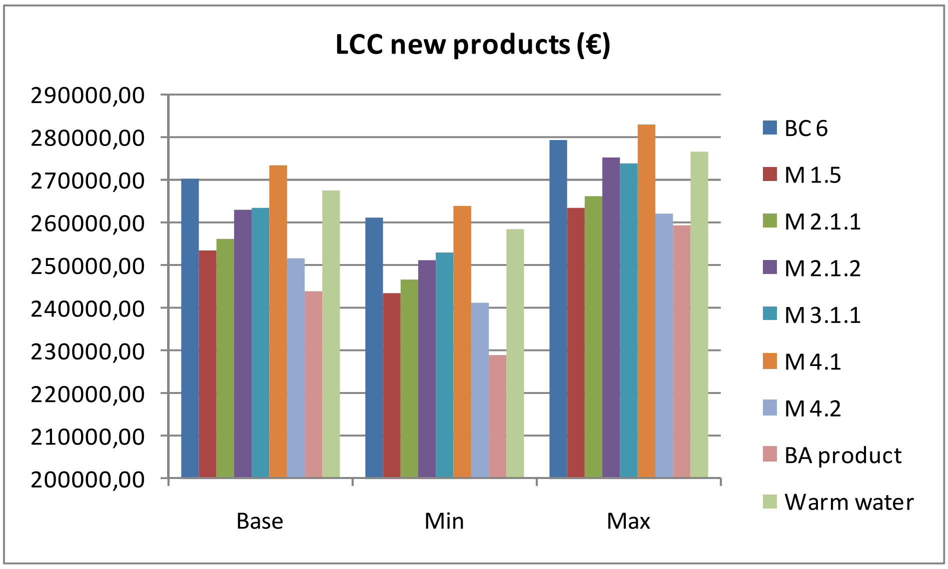

Figure 4-84 Base case 6 and improvement options – impact of purchase price on LCC by product

4.6 Discount rate

4.6.1 Assumptions

The discount rate value was provided by the European Commission and the range 2-6% will be studied in the sensitivity analysis.

Table 4-12 Discount rate range for the sensitivity analysis

Base case	Base discount rate	Min	Max
All base cases	4%	2%	6%

4.6.2 Results

Figure 4-85 to Figure 4-90 show that the variations to the minimum and maximum values of the discount rate do not induce any major changes in the options' rankings from an economic point of view.

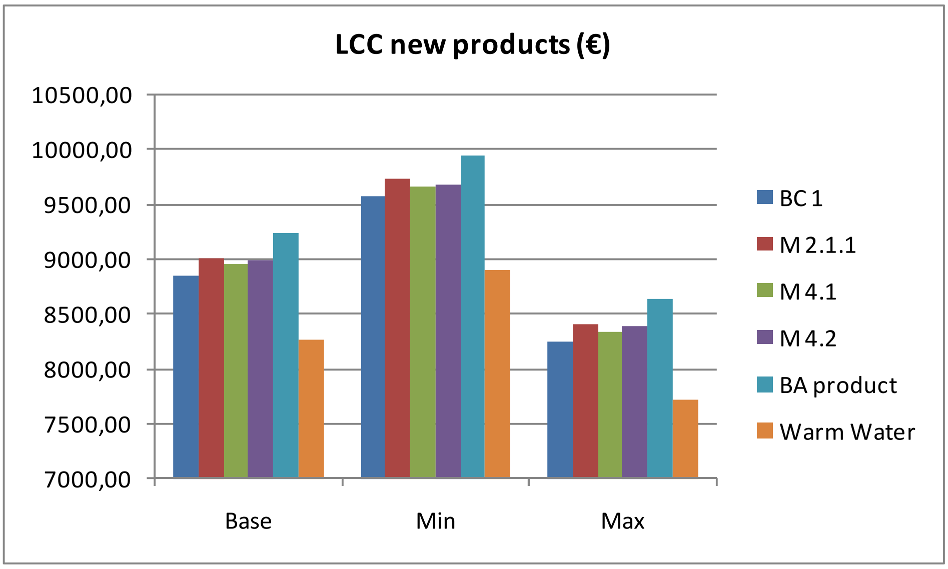

Figure 4-85 Base case 1 and improvement options – impact of discount rate on LCC by product

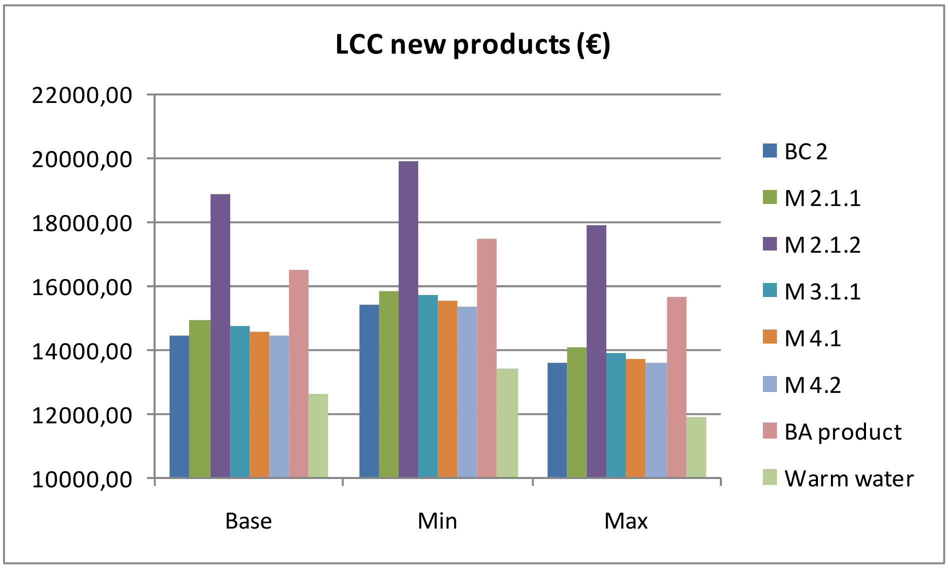

Figure 4-86 Base case 2 and improvement options – impact of discount rate on LCC by product

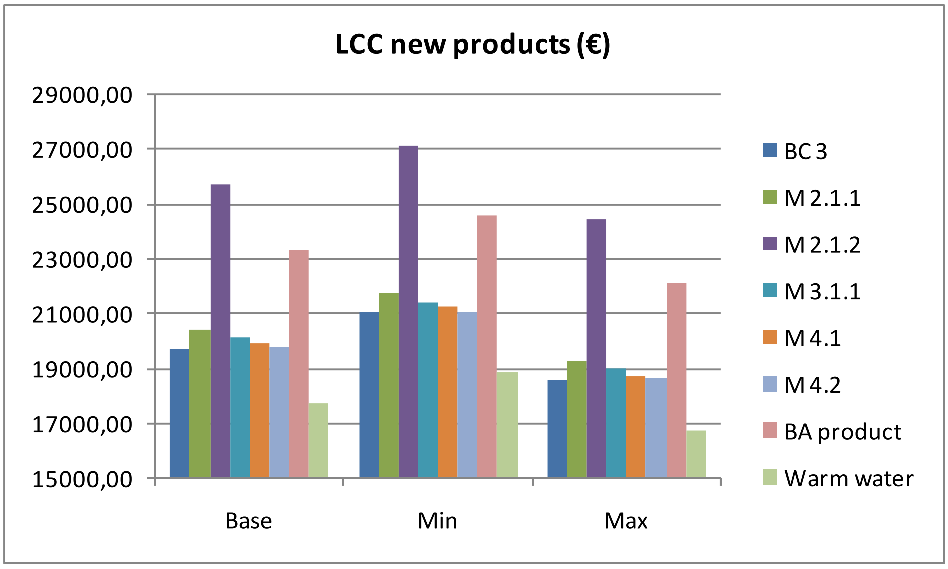

Figure 4-87 Base case 3 and improvement options – impact of discount rate on LCC by product

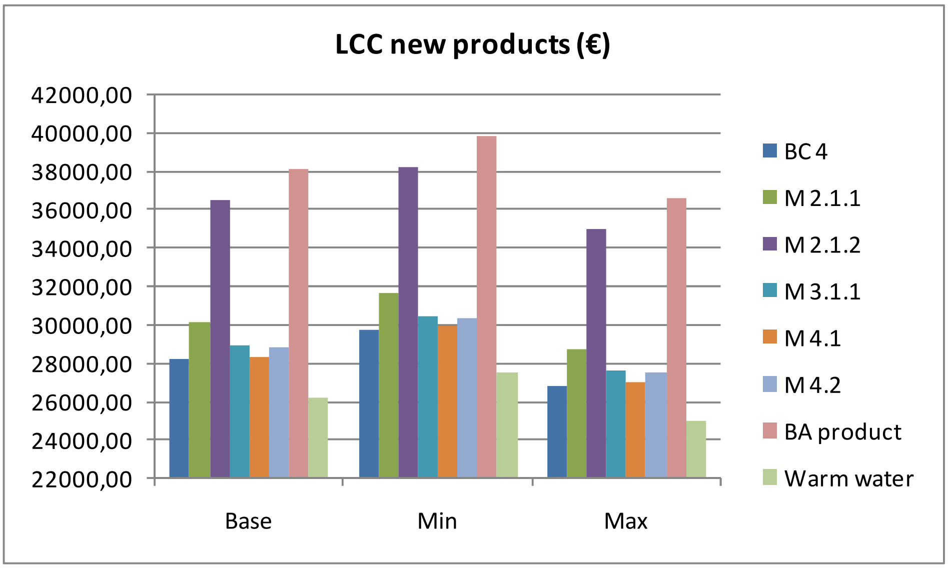

Figure 4-88 Base case 4 and improvement options – impact of discount rate on LCC by product

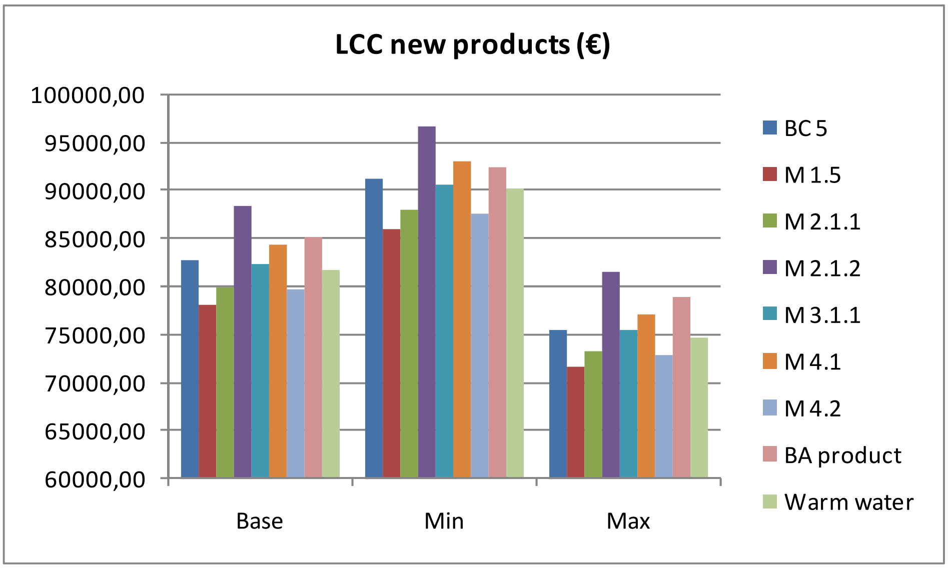

Figure 4-89 Base case 5 and improvement options – impact of discount rate on LCC by product

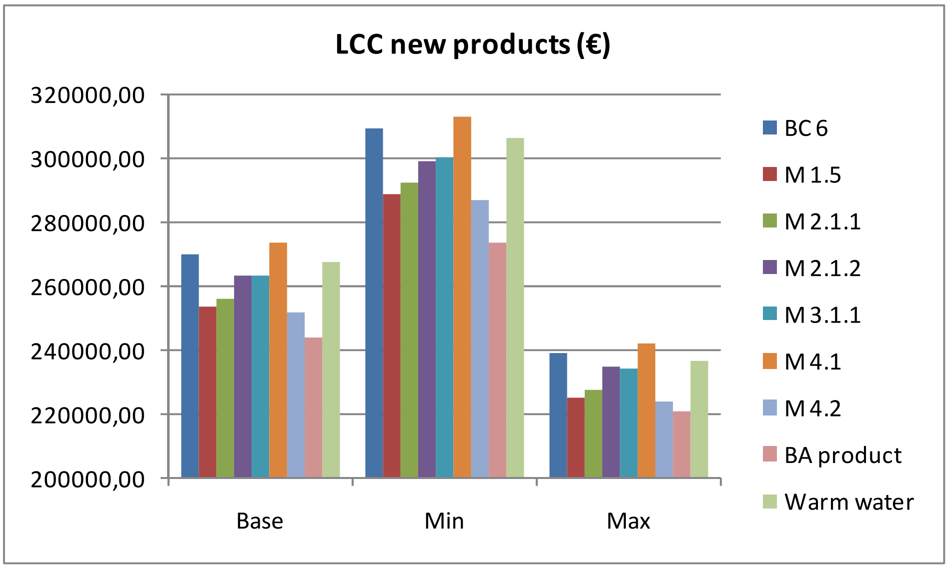

Figure 4-90 Base case 6 and improvement options – impact of discount rate on LCC by product

4.7 Combined parameters

4.7.1 Assumptions

In this subsection, all previous parameters will vary simultaneously in a common direction in order to build two extreme sets of parameters:

- The “Minimum” set minimises the importance of the use phase in the lifetime results: lowest intensity of use, lowest lifetime, lowest consumables and resources rates, highest purchase price and highest discount rate.
- The “Maximum” set maximises the importance of the use phase in the lifetime results: highest intensity of use, highest lifetime, highest consumables and resources rates, lowest purchase price and lowest discount rate.

Table 4-13 to Table 4-18 remind the parameters that will be used for the “minimum” and “maximum” sets. The error margins considered are the same that the ones presented for the sensitivity analysis of separate parameters.

Table 4-13 Use intensity range for the combined sensitivity analysis

Base case	Base typical use intensity (number of dishes per year)	Minimum set	Maximum set
1. Undercounter water-change	24 000	19 200	28 800
2. Undercounter one-tank	237 600	190 080	285 120
3. Hood-type	345 600	276 480	414 720
4. Utensil/Pot	9 000	7 200	10 800
5. One-tank conveyor-type	1 515 900	1 212 720	1 819 080
6. Multi-tank conveyor-type	4 009 500	3 207 600	4 811 400

Table 4-14 Product lifetime ranges for the combined sensitivity analysis

Base case	Base product lifetime (years)	Minimum set	Maximum set
1. Undercounter water-change	12	10	14
2. Undercounter one-tank	8	6	10
3. Hood-type	8	6	10
4. Utensil/Pot	8	6	10
5. One-tank conveyor-type	12	10	14
6. Multi-tank conveyor-type	17	15	19

Table 4-15 Electricity rate ranges for the combined sensitivity analysis

Base case	Base electricity rate (€/kWh)	Minimum set	Maximum set
1. Undercounter water-change 2. Undercounter one-tank	0.138	0.071 (Estonia)	0.185 (Slovakia)
3. Hood-type 4. Utensil/Pot	0.105	0.059 (Estonia)	0.160 (Cyprus)
5. One-tank conveyor-type 6. Multi-tank conveyor-type	0.090	0.055 (Estonia)	0.144 (Cyprus)

Table 4-16 Water and detergent rates ranges for the combined sensitivity analysis

Item	Base price (for all case-cases)	Minimum set	Maximum set
Water	2.64 €/m^3	1.11 €/m^3 (Rome)	4.91 €/m^3 (Berlin)
Detergent	3.0 €/kg	2.0 €/kg	4.0 €/kg

Table 4-17 Purchase price ranges for the combined sensitivity analysis

Base case	Base purchase price(€)	Minimum set	Maximum set
1. Undercounter water-change	3 200	3 840	2 560
2. Undercounter one-tank	3 500	4 200	2 800
3. Hood-type	4 700	5 640	3 760
4. Utensil/Pot	10 500	12 600	8 400
5. One-tank conveyor-type	15 000	18 000	12 000
6. Multi-tank conveyor-type	45 000	54 000	36 000

Table 4-18 Discount rate range for the combined sensitivity analysis

Base case	Base discount rate	Minimum set	Maximum set
All base cases	4%	6%	2%

4.7.2 Results

In general, no major changes occur concerning primary energy consumption (only two parameters have an influence on this: the intensity of use and the product lifetime).

For base case 1, the situation for the minimum set is the same as for the default values. However, in the maximum set, the option M 4.2 becomes the LLCC option as it has a lower LCC than the base case product. The BA product also has a lower LCC than the base case.

For base case 2, the base case product is the LLCC option for the minimum set while the option M 4.2 had been identified as the LLCC for the default parameters. In the maximum set, several options become economical in comparison with the base case (M 2.1.1, M 3.1.1, M 4.2) and option M 4.2 remains the LLCC.

The situation is very similar for base case 3: for the minimum set and the default values, no option seems interesting compared to the base case from an economical point of view. However, for the maximum set, three options have a lower LCC than the base case (M 2.1.1, M 3.1.1, M 4.2) and M 4.2 becomes the LLCC.

Again, the same influence appears for base case 4. For the minimum set and the default values, no option seems interesting compared to the base case from an economical point of view. However, for the maximum set, two options have a lower LCC than the base case (M 3.1.1, M 4.2) and M 4.2 becomes the LLCC. Option M 4.1 also has a LCC close to the base case LCC.

For base case 5, the base case product is the LLCC for the minimum set; option M 1.5 is the LLCC for the default values and the BA product if the LLCC option for the maximum set. For this maximum set, all options except M 4.1 appear more economical than the base case product over the lifetime, even option M 2.1.2 heat pump.

For base case 6, three options appear more economical than the base case with the minimum set (M 2.1.1, M 4.2 and M 1.5) and M 2.1.1 if the LLCC. For the default set, the BA product is the LLCC and all options appear economical except option M 4.1. the situation is the same for the maximum set of values, except that the gaps in that case are much more important: the LCC of the BA products is worth 120 000 € less than the base case LCC (only 25 000 € in the default set).

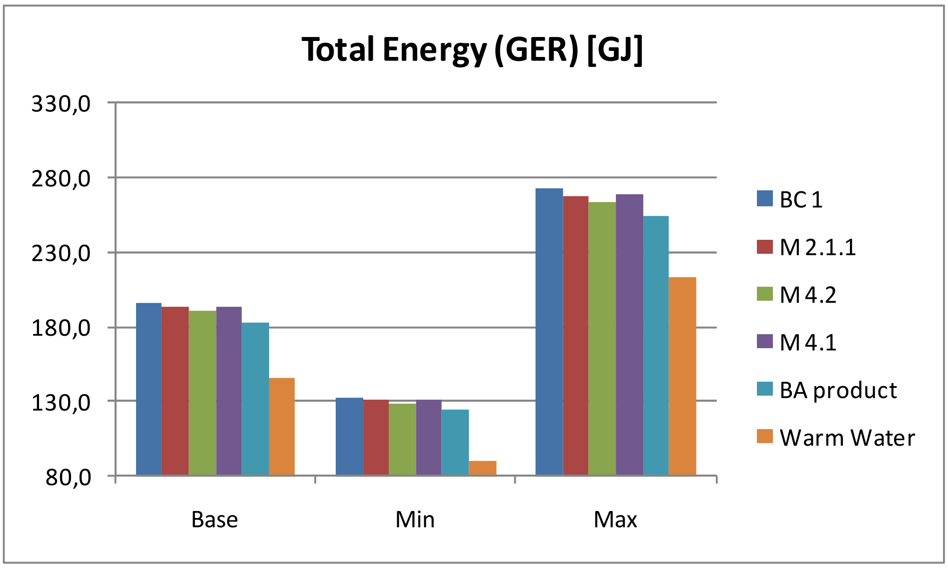

Figure 4-91 Base case 1 and improvement options – impact of combined parameters on total energy over lifetime by product

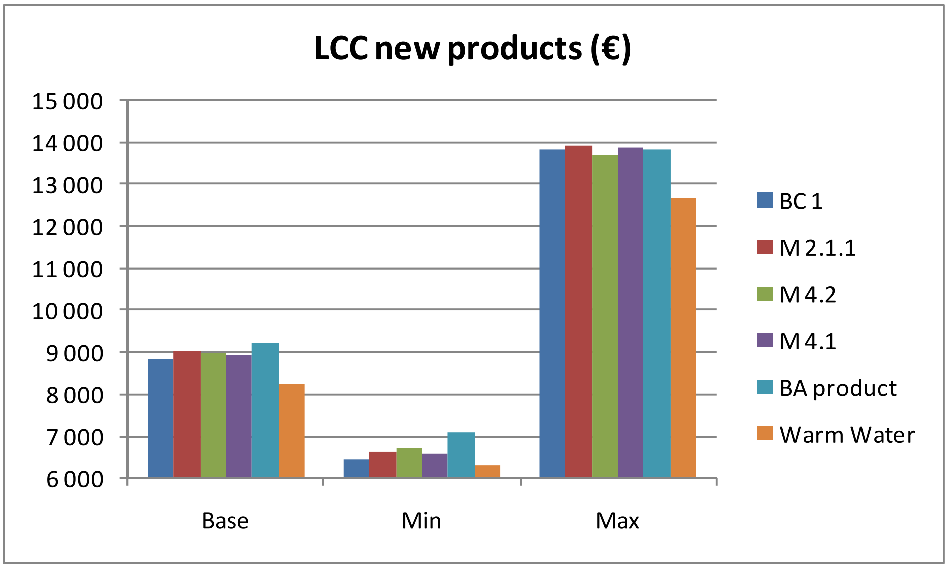

Figure 4-92 Base case 1 and improvement options – impact of combined parameters on LCC by product

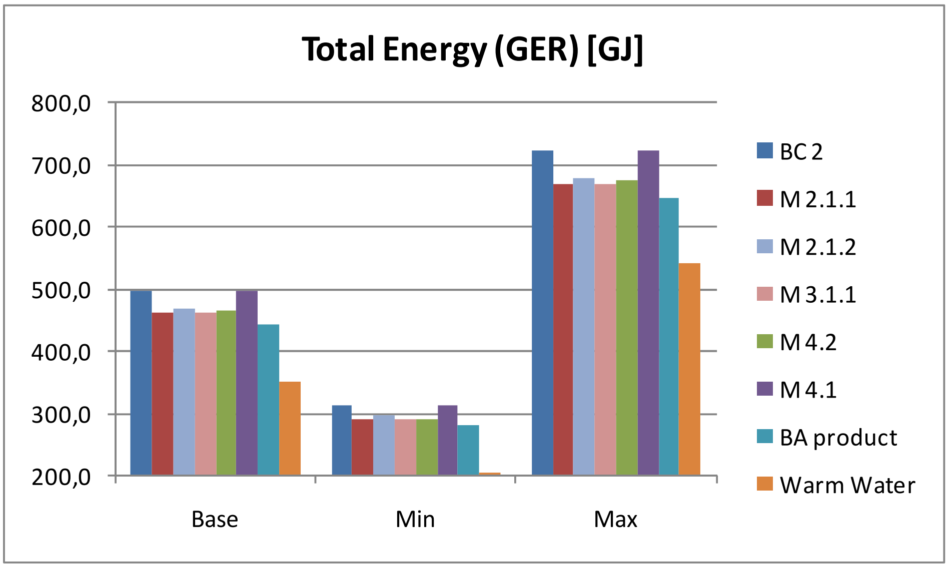

Figure 4-93 Base case 2 and improvement options – impact of combined parameters on total energy over lifetime by product

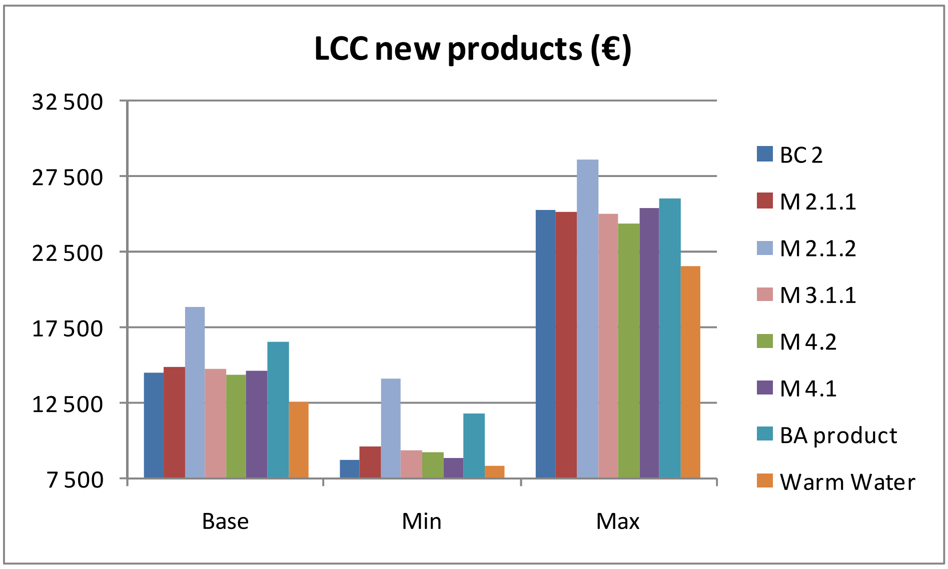

Figure 4-94 Base case 2 and improvement options – impact of combined parameters on LCC by product

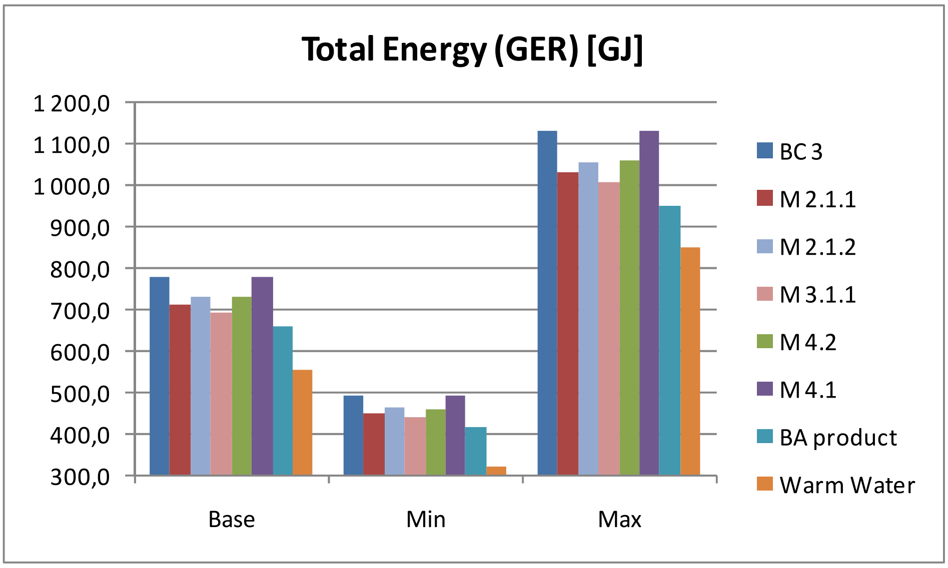

Figure 4-95 Base case 3 and improvement options – impact of combined parameters on total energy over lifetime by product

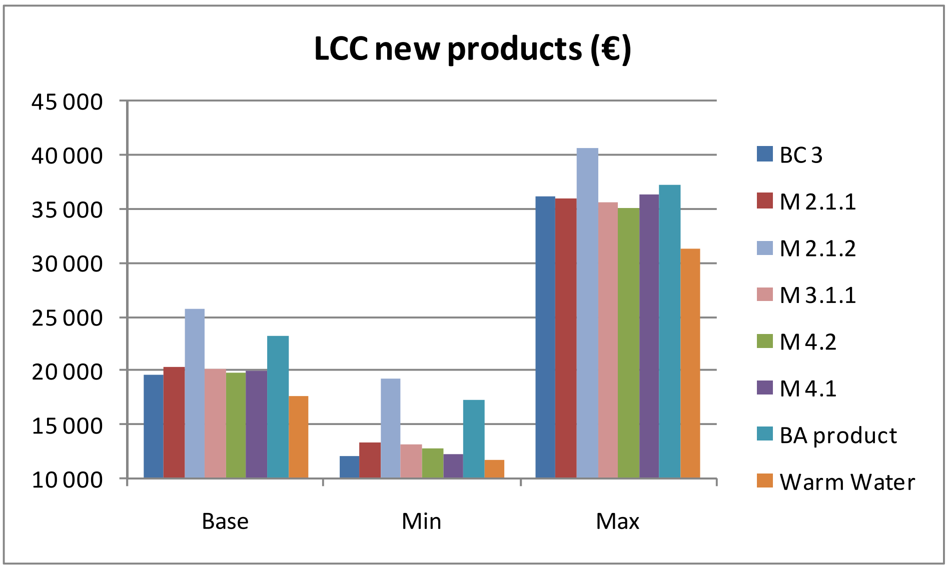

Figure 4-96 Base case 3 and improvement options – impact of combined parameters on LCC by product

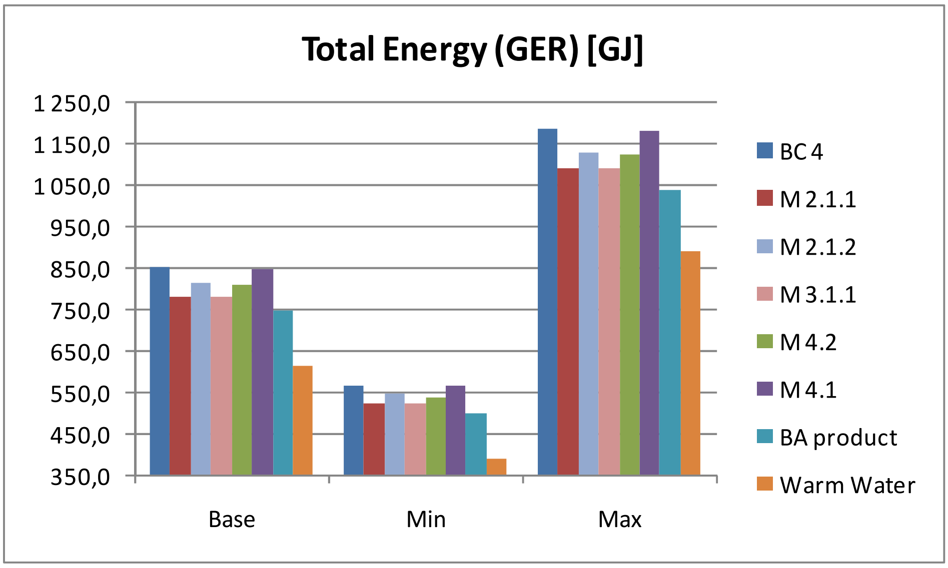

Figure 4-97 Base case 4 and improvement options – impact of combined parameters on total energy over lifetime by product

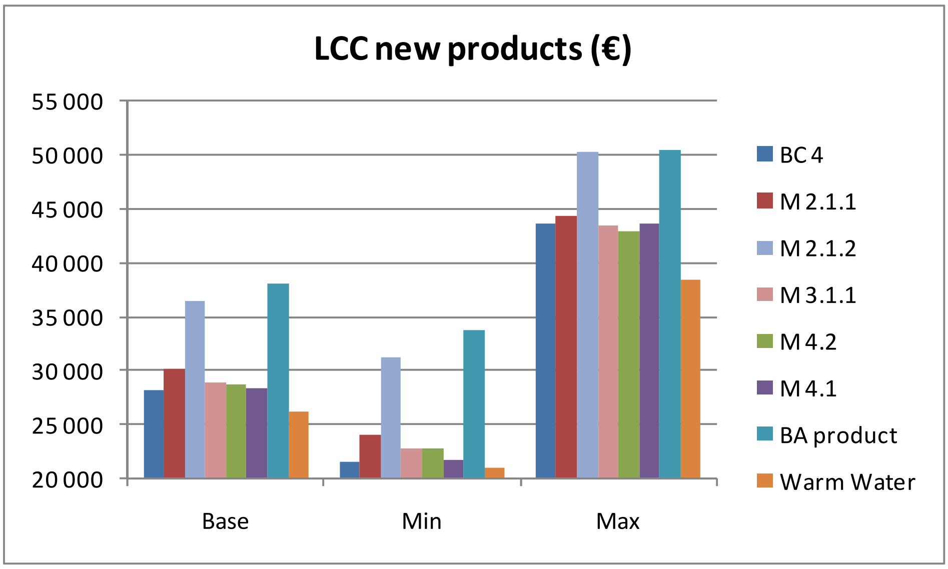

Figure 4-98 Base case 4 and improvement options – impact of combined parameters on LCC by product

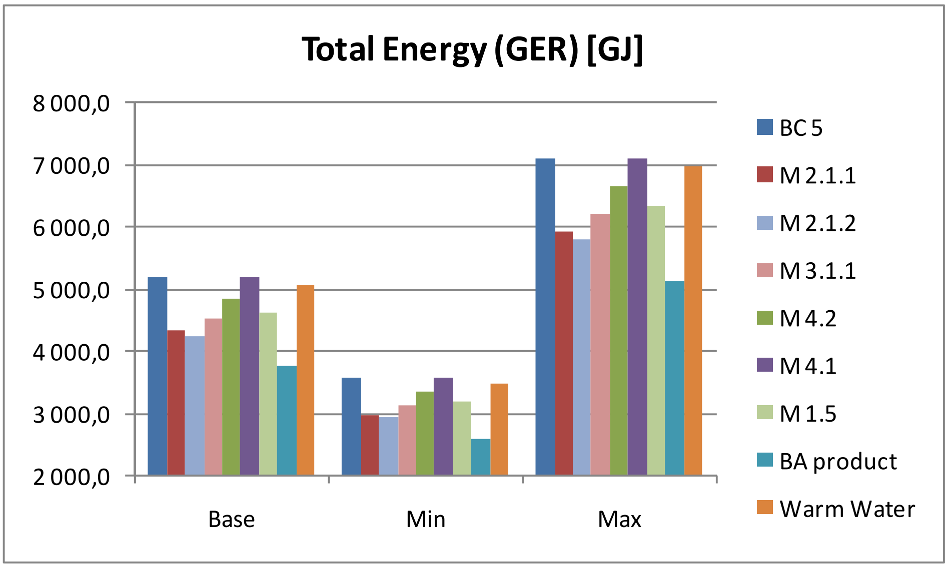

Figure 4-99 Base case 5 and improvement options – impact of combined parameters on total energy over lifetime by product

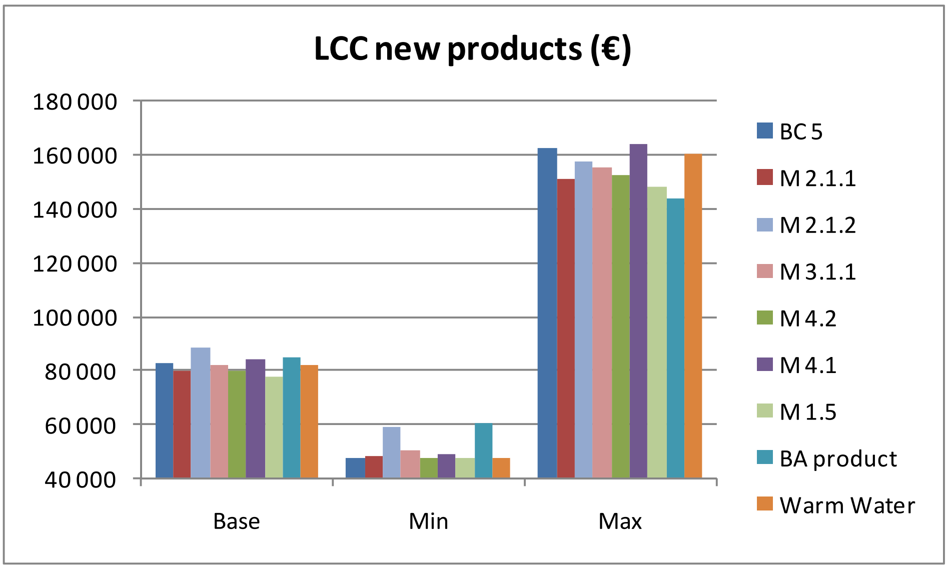

Figure 4-100 Base case 5 and improvement options – impact of combined parameters on LCC by product

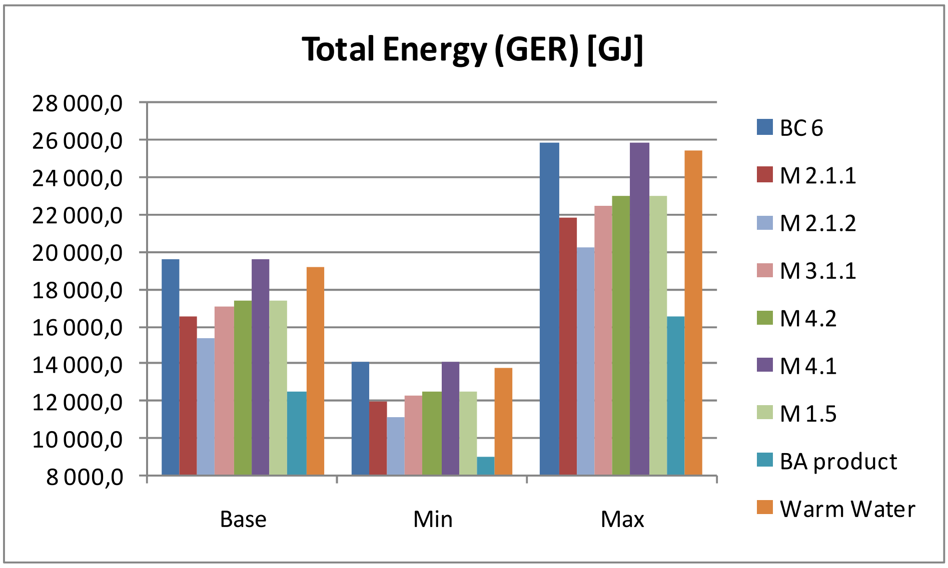

Figure 4-101 Base case 6 and improvement options – impact of combined parameters on total energy over lifetime by product

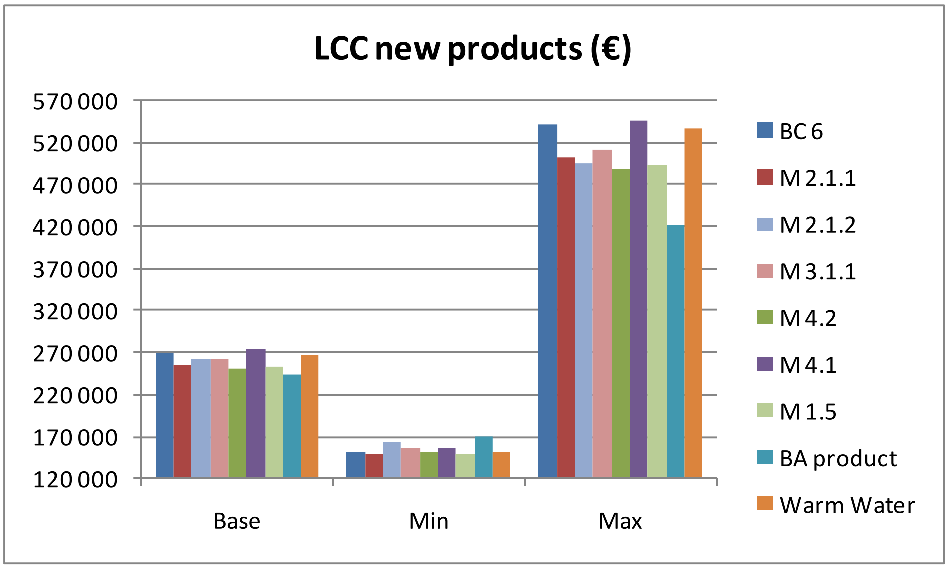

Figure 4-102 Base case 6 and improvement options – impact of combined parameters on LCC by product

5 Conclusions

Task 8 summarises the outcomes of the economic and environmental analysis of the study and puts them in the context of policy implementation.

Generic eco-design requirements are proposed, such as the general provision of information related to the performance of different programmes and modes available for a given product. Together with the definition of a 'standard programme' for each dishwasher category clearly being understandable by the users, the information might help overcoming the additional consumption due to the influence of consumer behaviour. The significant water consumption based on consumer behaviour during manual pre-cleaning of dishes and cleaning of the dishwashing machines might be addressed by accompanying eco-design requirements on the use of efficient pre-rinse spray valves or tapware.

The overall need for harmonised standards for testing and measuring the performance of professional dishwashers is seen as the most necessary step before implementing any further specific eco-design requirements like a labelling programme, benchmarking values or Minimum Energy Performance standards in the EU. Based on the combined economic and environmental analysis made in Task 7, specific eco-design requirements (Minimum Energy Performance Standards, MEPS) are suggested. However, these proposals are mostly indicative, given the uncertainty of the input data and their influence on the results. However, they show that there is room for improvement in each product category.

In the sensitivity analysis, it is shown that the variation of single or combined parameters can change the ranking of the options in terms of life cycle cost. Thus, for example, an improvement option that is worth implementing in one Member State for a given product and sector might not be a relevant solution in a different situation or location.

Task 8 also presents a scenario analysis that compares four scenarios: Business-as-Usual (BAU), Least Life cycle Cost (LLCC), Best Available Technology (BAT) and Minimum Energy Performance Standards (MEPS). The MEPS and LLCC scenarios are very similar, both in terms of energy savings and total expenditure. Over the period 2010 to 2025, the MEPS scenario would enable the saving of 3.9% (116 PJ, i.e. 32.2 TWh) of primary energy consumption compared to BAU and 1.0% of total expenditure. The energy savings of the BAT scenario amount to 8% (237 PJ, i.e. 65.8 TWh) in comparison with BAU.

These scenarios finally indicate the remaining improvement potential that could be encouraged through further policy options such as Green Public Procurement requirements.