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Domestic and commercial hobs and grills included when incorporated in cookers

Task 7: Improvement potential

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ERA TECHNOLOGY

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7. TASK 7 – IMPROVEMENT POTENTIAL

The purpose of this task is to identify design options, their environmental costs and benefits, their monetary consequences in terms of Life Cycle Cost for the consumer, and in a second step, to pinpoint the solution with Least Life Cycle Costs (LLCC) and the Best Available Technology (BAT).

The assessment of monetary Life Cycle Cost is relevant to indicate whether design solutions might negatively or positively impact the total EU consumer's expenditure over the total product life (purchase, running costs, etc.). The distance between the LLCC and the BAT indicates – in the case where an LLCC solution is set as a minimum target – the remaining space for product-differentiation. The BAT indicates the medium-term target that would probably be more subject to promotional measures than restrictive action. The BNAT (subtask 7.5) refers to the long-term possibilities and helps to define the exact scope and definition of possible measures.

7.1. IDENTIFICATION OF DESIGN OPTIONS

This section presents the different improvement options applicable to each Base-case. The design option(s) should:

- not have a significant variation in the functionality and in the performance parameters compared to the Base-Cases and in the product-specific inputs;
- have a significant potential for Ecodesign improvement without significantly degrading other impact parameters; and
- not entail excessive costs, and Impacts on the manufacturer should be investigated.

For each of the improvement options, the modifications compared to the related Base-case are quantified by the changes in energy consumption, in the bill of materials (BOM) and in the product price.

The improvement potential of a particular improvement option or a combination of improvement options (i.e. scenario) is evaluated using the MEEuP EcoReport tool. Energy savings that result from different technologies cannot always be directly added when combining various improvement options.

This additive approach is here preferred to an approach where efficiencies are successively multiplied for convenience reasons as the differences in % of savings are within the uncertainty range related to the characterisation of the improvement options.

Some options overlap each other, and therefore the effect of implementing two or more of them would not be a simple addition of their respective savings. In such cases, specific explanations of the assumptions will be given.

As a first approach, the cost-effectiveness of an improvement option can be expressed in terms of payback time in years, defined as below:

Cost increase compared to the Base Case (€) / (Annual energy consumption difference in (kWh or MJ/year)*energy tariff (€/kWh or MJ))

Besides, the impacts on the **life cycle cost** for each implemented option can be calculated. On this basis, the combination of design options with the **least life cycle cost** can be identified later (subtask 7.4).

In Task 8, the scenarios will be investigated further as a basis for defining future Ecodesign requirements, taking into account, among other parameters, life cycle costs and technical constrains.

7.1.1. BASE-CASE 1: DOMESTIC ELECTRIC HOB

The potential improvement options for domestic electric hobs were identified and discussed further with stakeholders. They aim to reduce the total energy consumption (TEC) of the appliance, by reducing the electricity consumption during the use-phase. The options are presented in Table 7-1. The payback times are significantly higher than the product lifetime of 19 years.

In addition, a switch to induction technology is expected to continue in the coming years. This is not considered as a mere technical improvement option. The related energy savings and other environmental impacts are not directly quantified in Task 7 as the base-case is based on radiant technology which is the main current product. However, it is foreseen that 15% of energy could be additionally saved with this switch, based on the current EN standard. This issue will be further discussed in Task 8, when the Business-As-Usual scenario will be analysed.

Table 7-1: Identified energy saving options for domestic electric hobs

	Improvement Options	Energy consumption per cycle (kWh)	Annual energy consumption (kWh)	Comparison to Base-case		
				Energy savings (%)	Increase of product price (€)	Payback time (years)
Base-case		0.55	240			
Option 1	Heat output control accuracy (by electronic control)	0.53	232.8	3%	50€	42
Option 2*	Pot sensors	0.53	232.8	3%	35€	29
Option 3*	Cooking	0.49	216	10%	100€	25

	Improvement Options	Energy consumption per cycle (kWh)	Annual energy consumption (kWh)	Comparison to Base-case		
				Energy savings (%)	Increase of product price (€)	Payback time (years)
	sensors (automatic temperature control)					
Scenario A*	1+2+3	0.47	206.4	16%	160€	25
Scenario B*	2+3	0.48	208.8	13%	125€	24

(*) relates to options/scenarios which are user-dependent, therefore the related energy savings cannot be directly considered within test standards and MEPS.

Besides, it was assumed that the volume of the packaged domestic appliances is not changed although new (relatively small) components may be added.

7.1.1.1. Option 1: Heat output control accuracy (by electronic control)

- Environmental impacts: Additional electronic control would enable a better and more accurate regulation of the heat output and effectively eliminate the temperature fluctuations. Up to 3% of TEC saving is foreseen thereby.
- Costs: The electronic components to be integrated would represent an additional cost of 50€.
- Modification to the BOM: 300 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials.
- Technical constraints: none identified.

7.1.1.2. Option 2: Pot sensors

- Environmental impacts: The presence of pot sensors would save energy by switching off the hob when no pot is detected on the surface. As this aspect is strongly linked to the user behaviour, the share of potential energy saving is more difficult to assess. Based on available information from stakeholders, a 3% energy saving has been estimated.
- Costs: The additional cost of pot sensors is evaluated as 35€.
- Modification to the BOM: 300 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials.
- Technical constraints: Saving potential of pot sensors cannot be directly measured within the test standard of electric hobs since the saving are user-dependent.

7.1.1.3. Option 3: Cooking sensors (Automatic temperature control)

- Environmental impacts: The presence of cooking sensors would alert the user when their food is ready. Energy that is consumed during over-cooking events would be saved. Further savings could also be saved by avoiding overheating during cooking, especially simmering. When using a domestic electric hob, some manufacturers quantify a 10% energy saving potential for a "standard" event composed of:

  - heating-up 1 litre of water to the boiling point
  - 20 min of simmering
  - 10 min of overcooking.

  Such sensors would partly compensate for user misbehaviour by ensuring automatic power reduction and facilitating the use of a lid as frequent checking is no longer needed and the pan is less likely to boil over. Therefore, energy savings are further enhanced.

  Given that cooking sensors may not be applied to all kinds of food, a 10% energy saving potential has been estimated in the study.

- Costs: The additional cost of cooking sensors is evaluated to 100€.
- Modification to the BOM: 300 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials.
- Technical constraints: Saving potential of cooking sensors cannot be directly measured within the standard test of electric hobs since the saving are user-dependent. Moreover, some market products may require specific pots to be able to use this technology.

7.1.1.4. Scenario A

- Environmental impacts: This scenario combines the benefits of options 1, 2 and 3 which are perceived as independent options (without overlapping effects) when considering energy savings. It results in a 16% energy saving potential for Scenario A.
- Costs: It is assumed that some electronic components will be commonly used for the different improvement options. Therefore, a 160€ increase in the product price is foreseen (instead of 185€ if a direct aggregation were used).
- Modification to the BOM: Likewise, 800 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials, instead of 900g if a direct aggregation was used.
- Technical constraints: no additional constraint was identified, apart from the ones revealed at option level.

7.1.1.5. SCENARIO B

- Environmental impacts: This scenario combines the benefits of options 2 and 3 which are perceived as independent options (without overlapping effects) when considering energy savings.

  Compared to Scenario A, option 1 has been excluded as it strongly impacts on the overall product cost, compared to its energy savings potential. It results in a 13% energy saving potential.

- Costs: It is assumed that some electronic components will be commonly used for both improvement options. Therefore, a 125€ increase in the product price is foreseen (instead of 135€ if a direct aggregation were used).

- Modification to the BOM: 550g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials, instead of 600g if a direct aggregation were used.

- Technical constraints: no additional constraint was identified, apart from the ones revealed at option level.

7.1.2. BASE-CASE 2: DOMESTIC GAS HOB

The potential improvement options for domestic gas hobs were identified and further discussed with stakeholders. They aim to reduce the total energy consumption (TEC) of the appliance, by reducing the energy consumption during the use-phase. They are presented in Table 7-2. Options 1 to 3 are similar to the BC1 ones. Only option 4 stands as a new improvement possibility for BC2. The payback times are significantly higher than the product lifetime of 19 years, except in the case of Option 5.

Table 7-2: Identified energy saving options for domestic gas hobs

	Improvement Options	Energy consumption per cycle (kWh)	Annual energy consumption (kWh)	Comparison to Base-case		
				Energy savings (%)	Increase of product price (€)	Payback time (years)
Base-case		0.75	330			
Option 1	Heat output control accuracy (by electronic control)	0.73	320.1	3%	80€	139
Option 2*	Pot sensors	0.73	320.1	3%	40€	70
Option 3*	Cooking sensors (automatic temperature control)	0.675	297	10%	100€	52
Option 4	Individually controlled multiple crown	0.73	320.1	3%	40€	70

	Improvement Options	Energy consumption per cycle (kWh)	Annual energy consumption (kWh)	Comparison to Base-case		
				Energy savings (%)	Increase of product price (€)	Payback time (years)
	burners for wider output range					
Option 5	High efficient gas sealed burners with single outlet progressive gas valve	0.716	313.5	5%	2€	2
Scenario A*	1+2+3+4+5	0.61	267.3	24%	232€	50
Scenario B*	2+3	0.66	287.1	13%	130€	52
Scenario C	1+4+5	0.71	310.2	11%	122€	58

(*) relates to options/scenarios which are user-dependent, therefore the related energy savings cannot be directly considered within test standards and MEPS.

Besides, it was assumed that the volume of the packaged domestic appliances is not changed although new (relatively small) components may be added.

7.1.2.1. Option 1: Heat output control accuracy (by electronic control)

- Environmental impacts: Additional electronic control would enable a better and more accurate regulation of the heat output and effectively eliminate the temperature fluctuations. Up to 3% of TEC saving is thereby foreseen. Better heat control from design of the gas burner jets may also be possible but has not been included in this option.
- Costs: The electronic components to be integrated would represent an additional cost of 80€.
- Modification to the BOM: 300 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials.
- Technical constraints: none identified.

7.1.2.2. Option 2: Pot sensors

- Environmental impacts: The presence of pot sensors would save energy by switching off the hob when no pot is detected on the surface. As this aspect is strongly linked to the user behaviour, the share of potential energy saving is more difficult to assess. Based on available information from stakeholders, a 3% energy saving has been estimated. It is assumed that the electricity consumption induced by the use of such sensors is already accounted within these savings.

- Costs: The additional cost of pot sensors is evaluated to 40€.
- Modification to the BOM: 300 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials.
- Technical constraints: Saving potential of pot sensors cannot be directly measured within the test standard of gas hobs since the saving are user-dependent.

7.1.2.3. Option 3: Cooking sensors (Automatic temperature control)

- Environmental impacts: The presence of cooking sensors would alert the user when their food is ready. Energy that is consumed during over-cooking events would be saved.

  Similar to domestic electric hobs, a 10% energy saving potential has been further considered in the study. It is assumed that the electricity consumption induced by the use of such sensors is already accounted within these savings.
- Costs: The additional cost of cooking sensors is evaluated to 100€.
- Modification to the BOM: 300 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials.
- Technical constraints: Saving potential of cooking sensors cannot be directly measured within the standard test of gas hobs since the saving are user-dependent. Moreover, some market products may require specific pots to be able to use this technology.

7.1.2.4. Option 4: Individually controlled multiple crown burners for wider output range

- Environmental impacts: Multiple crown burners could be manually and individually controlled by gas valves in order to enable a wider output range and thereby more flexibility to the user. A 3% energy saving is foreseen here.
- Costs: The implementation of such option would add 40€ of cost.
- Modification to the BOM: There will be additional metal for the burner as it is larger as well as additional pipework and control valves. This extra-weight has been modelled as +500g of galvanised steel sheet in the EcoReport tool.
- Technical constraints: This option is to be implemented to maximum 2 of the 4 gas burners of the hob, in order to optimise the total hob output to around 12-13 kW. By implementing this option to the 4 gas burners, the total output would (up to 20kW) have important consequences for the overall system temperature with potential "yellowing" of the metal top.

7.1.2.5. Option 5: High efficient gas sealed burners with single outlet progressive gas valve

- Environmental impacts: Such burners have an optimised inclined flame that increases the transfer of heat to the pan and reduces heat loss in ambient temperature, while still complying with the safety guidelines regarding the emissions of carbon monoxide. A 5% energy saving is foreseen here.
- Costs: The implementation of such option would have limited cost impacts as the innovative change takes place at the design level and no additional components or materials are required. A 2€ additional cost is here foreseen in order to take into account the change in the production line.
- Modification to the BOM: None
- Technical constraints: none identified.

7.1.2.6. Scenario A

- Environmental impacts: This scenario combines the benefits of options 1, 2, 3, 4 and 5 which are perceived as independent options (without overlapping effects) when considering energy savings.

  It results in a 19% energy saving potential for the scenario.
- Costs: It is assumed that some electronic components will be commonly used for the different improvement options. Therefore, a 252€ increase in the product price is foreseen (instead of 282€ if a direct aggregation would have been considered).
- Modification to the BOM: Likewise, 800 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials, instead of 900g if a direct aggregation would have been implemented. The extra-weight of 500g of galvanised steel sheet remains from Option 4.
- Technical constraints: no additional constraint was identified, apart from the ones revealed at option level.

7.1.2.7. Scenario B

- Environmental impacts: This scenario combines the benefits of options 2 and 3 which are perceived as independent options (without overlapping effects) when considering energy savings.

  Compared to Scenario A, options 1 and 4 have been excluded as they strongly impact on the overall product cost, compared to their energy saving benefits. It results in a 13% energy saving potential.
- Costs: It is assumed that some electronic components will be commonly used for both improvement options. Therefore, a 130€ increase in the product price is foreseen (instead of 140€ if direct aggregation was used).

- Modification to the BOM: 550g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials, instead of 600g if direct aggregation was used.
- Technical constraints: no additional constraint was identified, apart from the ones revealed at option level.

7.1.2.8. Scenario C

- Environmental impacts: This scenario combines the benefits of options 1, 4 and 5 which are independent from the user behaviour. 11% energy saving is foreseen.

  Contrary to Scenarios A and B, Scenario C could be used as a reference when performing tests standards and identifying MEPS.
- Costs: a 122€ increase in the product price is foreseen (direct aggregation).
- Modification to the BOM: 300g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) as well as 500g of galvanised steel sheet are added to the Base-case bill-of-materials.
- Technical constraints: none identified.

7.1.3. Base-case 3: Commercial electric hob

The potential improvement options for commercial electric hobs were identified and discussed further with stakeholders. They aim to reduce the total energy consumption (TEC) of the appliance, by reducing the electricity consumption during the use-phase. The options are presented in Table 7-3. The payback times are very low compared to the product lifetime of 12 years.

In addition, a switch to induction technology is expected to continue in the coming years. This is not considered as a mere technical improvement option. The related energy savings and other environmental impacts are not directly quantified in Task 7 as the base-case is based on solid-plate technology which is the main current product. However, it is foreseen that at least 15% of energy could be additionally saved with this switch. This issue is even more relevant in the commercial sector than in the domestic sector and it will be further discussed in Task 8, when the Business-As-Usual scenario will be analysed.

Table 7-3: Identified energy saving options for commercial electric hobs

	Improvement Options	Annual energy consumption (kWh)	Comparison to Base-case		
			Energy savings (%)	Increase of product price (€)	Payback time (years)
Base-case		20,000			
Option 1*	Pot sensors	15,000	25%	60€	0.1
Option 2	Thermal insulation	19,000	5%	60€	0.4

	Improvement Options	Annual energy consumption (kWh)	Comparison to Base-case		
			Energy savings (%)	Increase of product price (€)	Payback time (years)
Scenario A*	1+2	14,000	30%	120€	0.1

(*) relates to options/scenarios which are user-dependent, therefore the related energy savings cannot be directly considered within test standards and MEPS.

Besides, it was assumed that the volume of the packaged commercial appliances is not changed although new (relatively small) components may be added.

7.1.3.1. Option 1: Pot sensors

- Environmental impacts: The presence of pot sensors would save energy by switching off the hob when no pot is detected on the surface. As this aspect is strongly linked to the user behaviour, the potential share of related energy saving is here significantly higher than with domestic cooking appliances, as end-users tend to leave the appliances on for continuous periods in restaurants and catteries. Based on available information from stakeholders, a 25% energy saving has been estimated.
- Costs: The additional cost of pot sensors is currently evaluated as 60€. This could correspond to the upper price range for such electronic materials and reduced cost prices may be expected when considering further economies of scale in the future, as stated by some stakeholders.
- Modification to the BOM: 500 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials.
- Technical constraints: Saving potential of pot sensors is user-dependent and would be difficult to measure and quantify within a test standard.

7.1.3.2. Option 2: Improved thermal insulation

- Environmental impacts: Improving the insulation to prevent heat losses in directions not towards the pot would reduce the energy consumption by 5%.
- Costs: Implementing this option is estimated to increase the product price by 60€. This could correspond to the upper price range for insulating materials (such as high-tech cellular glass)[1].
- Modification to the BOM: 1 kg of glass wool could be added to the BOM but due to a lack of related specifications in the Ecoreport tool, it will be considered negligible (1.2% of the total product weight).
- Technical constraints: none identified.

[1] The rather high value of this additional cost has very limited effect on the analysis as Option 2 will be identified as the LLCC option in section 7.4. (either alone or part of Scenario A).

7.1.3.3. Scenario A

- Environmental impacts: This scenario combines the benefits of options 1 and 2 which are perceived as independent options (without overlapping effects) when considering energy savings. It results in a 30% energy saving potential for Scenario A.
- Costs: Related costs (120€) result from a direct aggregation of the costs induced by options 1 and 2.
- Modification to the BOM: 500 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials.
- Technical constraints: no additional constraint was identified, apart from the one revealed at option 1 level.

7.1.4. Base-case 4: Commercial gas hob

The potential improvement options for commercial gas hobs were identified and discussed further with stakeholders. They aim to reduce the total energy consumption (TEC) of the appliance, by reducing the gas consumption during the use-phase. The options are presented in Table 7-4. The payback times are very low compared to the product lifetime of 12 years.

Table 7-4: Identified energy saving options for commercial gas hobs

	Improvement Options	Annual energy consumption (kWh)	Comparison to Base-case		
			Energy savings (%)	Increase of product price (€)	Payback time (years)
Base-case		35,000			
Option 1*	Pot sensors	26,250	25%	60€	0.1
Option 2	Electronic ignition (instead of pilot lights)	33,250	5%	30€	0.3
Option 3	Wider output range via independently controlled multi-ring burners and/or improved gas/air mixing	33,250	5%	80€	0.9
Scenario A*	1+2+3	22,750	35%	160€	0.2
Scenario B*	1+2	24,500	30%	80€	0.1
Scenario C	2+3	31,500	10%	110€	0.6

(*) relates to options/scenarios which are user-dependent, therefore the related energy savings cannot be directly considered within test standards and MEPS.

Besides, it was assumed that the volume of the packaged commercial appliances is not changed although new (relatively small) components may be added.

7.1.4.1. Option 1: Pot sensors

- Environmental impacts: The presence of pot sensors would save energy by switching off the hob when no pot is detected on the surface. As this aspect is strongly linked to the user behaviour, the potential share of related energy saving is here significantly higher than with domestic cooking appliances, as end-users tend to leave the appliances on for continuous periods in restaurants and catteries. Similar to Base-case 3, a 25% energy saving has been estimated. It is assumed that the electricity consumption induced by the use of such sensors is already accounted within these savings.
- Costs: The additional cost of pot sensors is currently evaluated as 60€. This could correspond to the upper price range for such electronic materials and reduced cost prices may be expected when considering further economies of scale in the future, as stated by some stakeholders.
- Modification to the BOM: 500 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials.
- Technical constraints: Saving potential of pot sensors is user-dependent and would be difficult to measure and quantify within a test standard.

7.1.4.2. Option 2: Electronic ignition

- Environmental impacts: Replacing gas pilot lights with high voltage spark ignition is considered to save 5% of energy consumption.
- Costs: Implementing this option is estimated to increase the product price by 30€.
- Modification to the BOM: 300 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials.
- Technical constraints: none identified.

7.1.4.3. Option 3: Wider output range via independently controlled multi-ring burners and/or improved gas/air mixing

- Environmental impacts: Improved gas burner design allowing a wider output range to adjust according to the pan size would enable a 5% energy saving potential.
- Costs: Implementing this option is estimated to increase the product price by 80€.
- Modification to the BOM: 1 kg of galvanised steel (labelled as 21-St sheet galv. in the MEEuP EcoReport nomenclature) is to be added to the BOM.
- Technical constraints: none identified.

7.1.4.4. Scenario A

- Environmental impacts: This scenario combines the benefits of options 1, 2 and 3 which are perceived as independent options (without overlapping effects) when considering energy savings. Thus, it results in a 35% energy saving potential for Scenario A.
- Costs: It is assumed that some electronic components will be commonly used for improvement options 1 and 2. Therefore, a 160€ increase in the product price is foreseen (instead of 170€ if direct aggregation was used).
- Modification to the BOM: 700g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials, instead of 800g if a direct aggregation was used. Additionally, 1 kg of galvanised steel (labelled as 21-St sheet galv.) is to be considered into the BOM.
- Technical constraints: no additional constraint was identified, apart from the one revealed at option 1 level.

7.1.4.5. Scenario B

- Environmental impacts: This scenario combines the benefits of options 1 and 2 which are perceived as independent options (without overlapping effects) when considering energy savings. It results in a 30% energy saving potential for Scenario B.

  Compared to Scenario A, option 3 has been excluded as the least "cost-efficient" option. Besides, that enables to save on the addition of galvanised steel.
- Costs: It is assumed that some electronic components will be commonly used for improvement options 1 and 2. Therefore, a 80€ increase in the product price is foreseen (instead of 90€ if a direct aggregation was used).
- Modification to the BOM: 700g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials, instead of 800g if a direct aggregation was used.
- Technical constraints: no additional constraint was identified, apart from the one revealed at option 1 level.

7.1.4.6. Scenario C

- Environmental impacts: This scenario combines the benefits of options 2 and 3 which are independent from the user behaviour. 10% energy saving is foreseen.

  Contrary to Scenarios A and B, Scenario C could be used as a reference when performing tests standards and identifying MEPS.

- Costs: a 110€ increase in the product price is foreseen (direct aggregation).
- Modification to the BOM: 300g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) as well as 1000g of galvanised steel sheet are added to the Base-case bill-of-materials.
- Technical constraints: none identified.

7.1.5. Base-case 5: Commercial electric fry-top

The potential improvement options for commercial electric fry-tops were identified and discussed further with stakeholders. They aim to reduce the total energy consumption (TEC) of the appliance, by reducing the electricity consumption during the use-phase. The options are presented in Table 7-5. The payback times are significantly lower than the product lifetime of 10 years.

Table 7-5: Identified energy saving options for commercial electric fry-tops

	Improvement Options	Annual energy consumption (kWh)	Comparison to Base-case		
			Energy savings (%)	Increase of product price (€)	Payback time (years)
Base-case		8,200			
Option 1	Zone isolation and separate control	7,380	10%	80€	0.63
Option 2	Thermal Insulation	7,544	8%	60€	0.59
Scenario A	1+2	6,724	18%	140€	0.61

Note: it was assumed that the volume of the packaged commercial appliances is not changed although new (relatively small) components may be added.

7.1.5.1. Option 1: Zone isolation and separate control

- Environmental impacts: Implementing zone separation can enable a more accurate control and the use of variable temperature throughout the grill surface. That would lead to a 10% energy saving.
- Costs: The additional cost of option 1 is evaluated as 80€.
- Modification to the BOM: 1kg of galvanised steel (labelled as 21-St sheet galv. in the MEEuP EcoReport nomenclature) as well as 500 g of electronics (labelled as 98-controller board) are added to the Base-case bill-of-materials.
- Technical constraints: none identified.

7.1.5.2. Option 2: Improved thermal insulation

- Environmental impacts: Improving the insulation to prevent heat losses in directions not towards the pot would reduce the energy consumption by 8%.

- Costs: Implementing this option is estimated to increase the product price by 60€. This could correspond to the upper price range for insulating materials (such as high-tech cellular glass)[2].
- Modification to the BOM: 1 kg of glass wool could be added to the BOM but due to a lack of related specifications in the EcoReport tool, it will be considered negligible (1.5% of the total product weight).
- Technical constraints: none identified.

7.1.5.3. Scenario A

- Environmental impacts: This scenario combines the benefits of options 1 and 2 which are perceived as independent options (without overlapping effects) when considering energy savings.
- It results in a 18% energy saving potential for Scenario A.
- Costs: Related costs (140€) result from a direct aggregation of the costs induced by options 1 and 2.
- Modification to the BOM: 1kg of galvanised steel (labelled as 21-St sheet galv. in the MEEuP EcoReport nomenclature) as well as 500 g of electronics (labelled as 98-controller board) are added to the Base-case bill-of-materials.
- Technical constraints: none identified.

7.1.6. Base-case 6: Commercial gas fry-top

The potential improvement options for commercial gas fry-tops were identified and discussed further with stakeholders. They aim to reduce the total energy consumption (TEC) of the appliance, by reducing the gas consumption during the use-phase. The options are presented in Table 7-6. The payback times are low compared to the product lifetime of 10 years.

Table 7-6: Identified energy saving options for commercial gas fry-tops

	Improvement Options	Annual energy consumption (kWh)	Comparison to Base-case		
			Energy savings (%)	Increase of product price (€)	Payback time (years)
Base-case		12,500			
Option 1	Zone isolation and separate control	11,250	10%	80€	1.2
Option 2	Thermal Insulation	11,500	8%	60€	1.1
Option 3	Electronic ignition	11,875	5%	30€	0.9

[2] The rather high value of this additional cost has very limited effect on the analysis as Option 2 will be identified as the LLCC option in section 7.4. (as part of Scenario A).

	Improvement Options	Annual energy consumption (kWh)	Comparison to Base-case		
			Energy savings (%)	Increase of product price (€)	Payback time (years)
Option 4	Improved combustion air control	11,250	10%	80€	1.2
Scenario A	1+2+3+4	8,375	33%	230€	1.0
Scenario B	2+3+4	9,625	23%	160€	1.0

Note: it was assumed that the volume of the packaged commercial appliances is not changed although new (relatively small) components may be added.

7.1.6.1. Option 1: Zone isolation and separate control

- Environmental impacts: Implementing zone separation can enable a more accurate control and the use of variable temperature throughout the grill surface. That would lead to a 10% energy saving.
- Costs: The additional cost of option 1 is evaluated as 80€.
- Modification to the BOM: 1kg of galvanised steel (labelled as 21-St sheet galv. in the MEEuP EcoReport nomenclature) as well as 500 g of electronics (labelled as 98-controller board) are added to the Base-case bill-of-materials.
- Technical constraints: none identified.

7.1.6.2. Option 2: Improved thermal insulation

- Environmental impacts: Improving the insulation to prevent heat losses in directions not towards the pot would reduce the energy consumption by 8%.
- Costs: Implementing this option is estimated to increase the product price by 60€. This could correspond to the upper price range for insulating materials (such as high-tech cellular glass)[3].
- Modification to the BOM: 1kg of glass wool could be added to the BOM but due to a lack of related specifications in the Ecoreport tool, it will be considered negligible (1.5% of the total product weight).
- Technical constraints: none identified.

7.1.6.3. Option 3: Electronic ignition

- Environmental impacts: Replacing gas pilot lights with high voltage spark ignition is considered to save 5% of energy consumption.
- Costs: Implementing this option is estimated to increase the product price by 30€.

[3] The rather high value of this additional cost has very limited effect on the analysis as Option 2 will be identified as the LLCC option in section 7.4. (as part of Scenario A).

- Modification to the BOM: 300 g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials.
- Technical constraints: none identified.

7.1.6.4. Option 4: Improved combustion air control

- Environmental impacts: An important part of the burner is the orifice plug where the gas escapes from the hose/pipe and enters the mixing bell of the burner. The hole in the orifice is very small to provide the correct gas flow and to provide sufficient velocity to ensure there is enough suction for the correct air inspiration. Improved combustion air control through orifice design optimisation would enable a 10% energy saving potential.
- Costs: Implementing this option is estimated to increase the product price by 80€.
- Modification to the BOM: No significant modifications on the BOM are currently foreseen.
- Technical constraints: none identified.

7.1.6.5. Scenario A

- Environmental impacts: This scenario combines the benefits of options 1, 2, 3 and 4 which are perceived as independent options (without overlapping effects) when considering energy savings. It results in a 33% energy saving potential for Scenario A.
- Costs: It is assumed that some electronic components will be commonly used for improvement options 1, 3 and 4. Therefore, a 230€ increase in the product price is foreseen (instead of 250€ if direct aggregation was used).
- Modification to the BOM: 700g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials, instead of 800g if a direct aggregation was used. Additionally, 1kg of galvanised steel (labelled as 21-St sheet galv.) is to be considered into the BOM.
- Technical constraints: none identified.

7.1.6.6. Scenario B

Environmental impacts: This scenario combines the benefits of options 2, 3 and 4 which are perceived as independent options (without overlapping effects) when considering energy savings. It results in a 23% energy saving potential for Scenario B.

Compared to Scenario A, option 1 has been excluded as the one of the least "cost-efficient" options. Besides, that enables to save on the addition of galvanised steel.

- Costs: It is assumed that some electronic components will be commonly used for improvement options 3 and 4. Therefore, a 160€ increase in the product price is foreseen (instead of 170€ if a direct aggregation was used).
- Modification to the BOM: 300g of electronics (labelled as 98-controller board in the MEEuP EcoReport nomenclature) are added to the Base-case bill-of-materials.
- Technical constraints: none identified.

7.2. IMPACT ANALYSIS

The aim of this subtask is to quantify the environmental benefits and impacts of the improvement options/scenarios. All relevant design improvements are investigated to see how they affect the output values of the EcoReport. It is likely that the impact assessment will reveal trade-offs between some impact categories for a given option.

7.2.1. BASE-CASE 1: DOMESTIC ELECTRIC HOB

The results of the environmental analysis of the improvement options for Base-Case 1 are presented in Table 7-7 and in Figure 7-1.

Scenario A provides the greatest improvement for many relevant impacts such as the energy consumption (around 14% saving) and GHG emissions (around 13% savings). Benefits can also be observed in terms of the reduction of non-hazardous waste (-9%), acidification to air (-13%) and the release of POP into the air (-9%). However, the addition of electronics have brought up an increase of hazardous waste (+24%), PAHs release into the air (+21%) and heavy metal contamination into waters (+31%).

Scenario B has comparable impacts to Scenario A, with similar energy saving (-12%) and reduction of GHG emissions (-11%). However, trade-offs are more compensated when looking at the impacts on hazardous waste (+15%), PAHs release into the air (+13%) and heavy metal contamination into waters (+20%), which are significantly lower than for Scenario A.

Table 7-7: Environmental Analysis of the improvements options for domestic electric hob (green: minimum impact / red: maximum impact)

Life-cycle indicators per product unit	unit	Base-Case 1	Option 1	Option 2	Option 3	Scenario A	Scenario B
OTHER RESSOURCES AND WASTE							
Total Energy (GER)	GJ	49,4	48,2	48,2	44,9	42,4	43,6
	% change with BC	0%	-2%	-2%	-9%	-14%	-12%
of which, electricity	primary GJ	48,5	47,2	47,2	43,8	41,2	42,5
	MWh	4,6	4,5	4,5	4,2	3,9	4,1
	% change with BC	0%	-3%	-3%	-10%	-15%	-12%
Water (process)	kL	3,6	3,7	3,7	3,5	3,6	3,5
	% change with BC	0%	2%	2%	-4%	-2%	-3%
Water (cooling)	kL	128,3	124,5	124,5	115,5	107,9	111,7
	% change with BC	0%	-3%	-3%	-10%	-16%	-13%
Waste, non-haz./ landfill	kg	79,4	78,5	78,5	74,6	72,4	73,5
	% change with BC	0%	-1%	-1%	-6%	-9%	-7%
Waste, hazardous/ incinerated	kg	1,5	1,6	1,6	1,6	1,8	1,7
	% change with BC	0%	11%	11%	6%	24%	15%
EMISSIONS (AIR)							
Greenhouse Gases in GWP100	t CO2 eq.	2,2	2,1	2,1	2,0	1,9	2,0
	% change with BC	0%	-2%	-2%	-9%	-13%	-11%
Acidification, emissions	kg SO2 eq.	13,0	12,7	12,7	11,9	11,3	11,6
	% change with BC	0%	-2%	-2%	-9%	-13%	-11%
Volatile Organic Compounds (VOC)	kg	0,0	0,0	0,0	0,0	0,0	0,0
	% change with BC	0%	6%	6%	1%	10%	5%
Persistent Organic Pollutants (POP)	µg i-Teq	0,5	0,5	0,5	0,4	0,4	0,4
	% change with BC	0%	-1%	-1%	-6%	-9%	-8%
Heavy Metals to air	g Ni eq.	1,3	1,3	1,3	1,2	1,2	1,2
	% change with BC	0%	0%	0%	-4%	-5%	-5%
PAHs	g Ni eq.	0,2	0,2	0,2	0,2	0,2	0,2
	% change with BC	0%	9%	9%	5%	21%	13%
Particulate Matter (PM, dust)	kg	1,1	1,1	1,1	1,1	1,1	1,1
	% change with BC	0%	1%	1%	0%	1%	0%
EMISSIONS (WATER)							
Heavy Metals to water	g Hg/20	0,7	0,8	0,8	0,8	1,0	0,9
	% change with BC	0%	13%	13%	10%	31%	20%
Eutrophication	kg PO4	0,0	0,0	0,0	0,0	0,0	0,0
	% change with BC	0%	13%	13%	12%	34%	23%

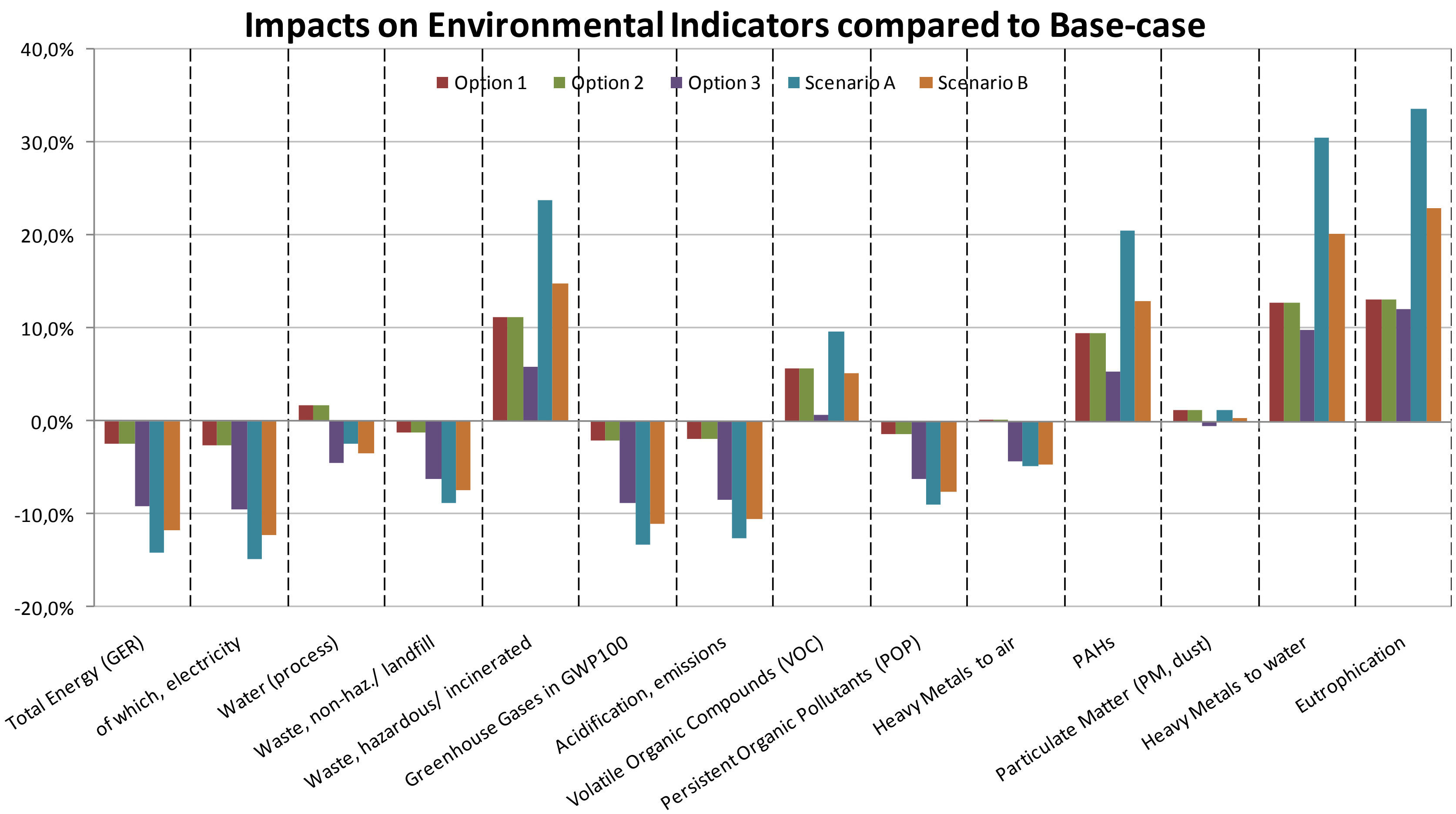
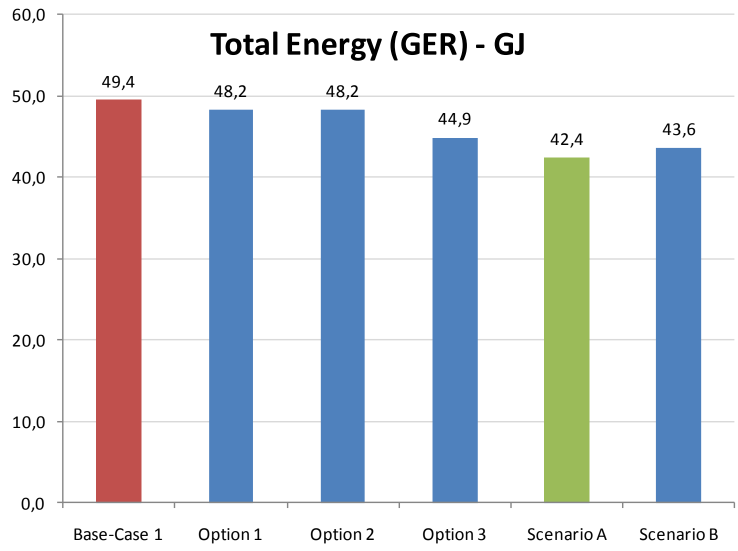


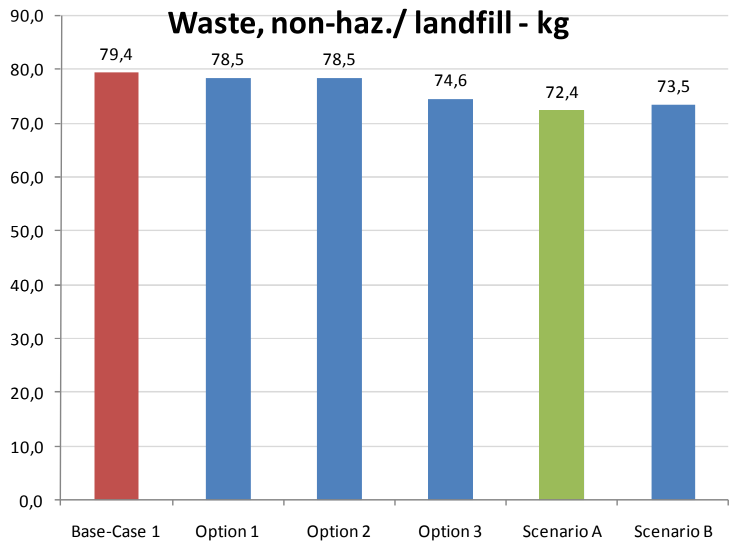
Figure 7-1: Relative impacts of improvement options for BC1 on environmental indicators

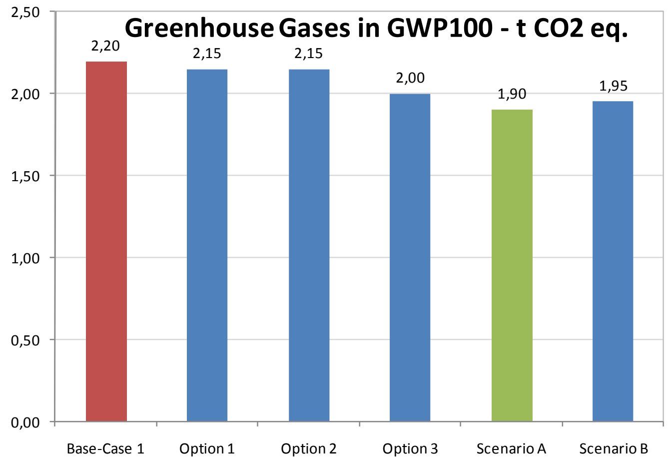
Figure 7-2 gives a visual representation of the quantitative impacts of the improvement options / scenarios for five main indicators for which significant variations are observed.

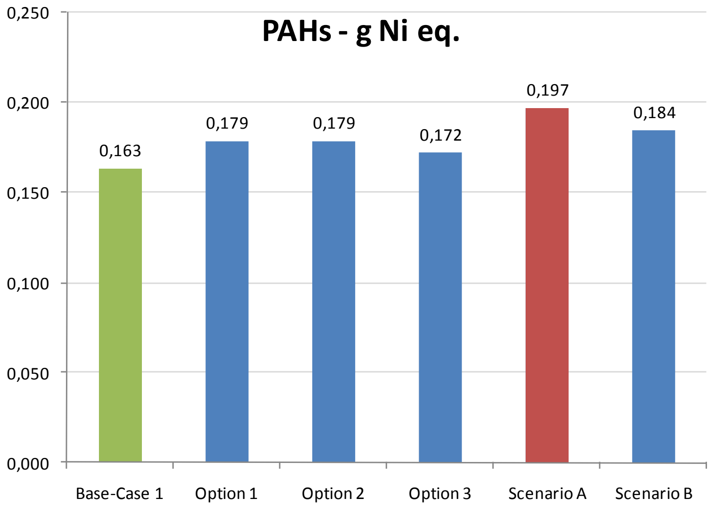
The two main trends can be clearly observed:

- Indicators for which the implementation of (combined) improvement options leads to an impact reduction (e.g. total energy, waste for landfill, greenhouse gases)
- Indicators for which the implementation of (combined) improvement options enhances negative environmental impacts (e.g. releases of PAHs into the air and heavy metals into water)









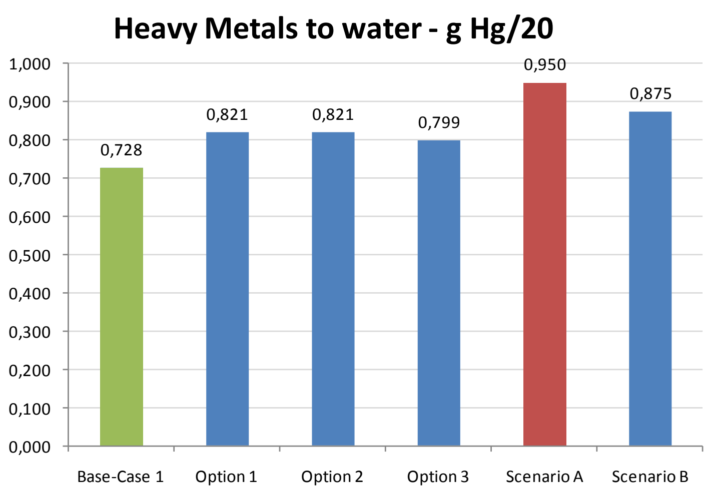


Figure 7-2: Comparison of the improvement options/scenarios' impacts on relevant environmental indicators (green: minimum impact / red: maximum impact)

7.2.2. BASE-CASE 2: DOMESTIC GAS HOB

The results of the environmental analysis of the improvement options for Base-Case 2 are presented in Table 7-8 and in Figure 7-3.

Similar to Base-Case 1, Scenario A provides the greatest improvement for two important indicators: the energy consumption (around 21% saving) and GHG emissions (around 20% savings).

However, they are the only benefits that can be observed. For all the remaining indicators, Scenario A has negative impacts, with notably +13% of non-hazardous waste, +5300% of hazardous waste, +44% of acidification to air, +66% of heavy metal emissions to air and +600% heavy metal emissions to water. This can be mainly explained by the introduction of electronics in the BOM and its rebound-effect. This is further confirmed when analysing the environmental impacts of Options 4 and 5 which do not require any additional electronics to the initial BOM and therefore do not induce large proportional increase of waste or emissions compared to the base-case. These large percentage variations should however be put in perspective as in quantitative terms, the environmental impacts are lower than the ones observed in the similar Scenario A of BC1 on domestic electric hobs.

Scenario B has comparable impacts to Scenario A, with lower energy saving (-11%) and reduction of GHG emissions (-11%) but still strong negative impacts on the remaining indicators.

Scenario C, which is user-independent, follows similar trends as Scenario B but at a significantly smaller scale with regard to the negative impacts. Generally, it does not differ much from its components (options 1 and 4).

Figure 7-4 gives a visual representation of the quantitative impacts of the improvement options / scenarios for five main indicators, for which significant variation can be observed.

The two main trends can be clearly observed:

- Indicators for which the implementation of (combined) improvement options leads to an impact reduction (only total energy and emissions of greenhouse gases)
- Indicators for which the implementation of (combined) improvement options enhances negative environmental impacts (releases of non-hazardous waste, heavy metals into water and acidification in the air)

Table 7-8: Environmental Analysis of the improvements options for domestic gas hob (green: minimum impact / red: maximum impact)

Life-Cycle indicators per product unit	unit	Base-Case 2	Option 1	Option 2	Option 3	Option 4	Option 5	Scenario A	Scenario B	Scenario C
OTHER RESSOURCES AND WASTE										
Total Energy (GER)	GJ	24,4	24,0	24,0	22,3	23,7	23,2	19,4	21,8	22,1
	% change with BC	0%	-2%	-2%	-9%	-3%	-5%	-21%	-11%	-10%
of which, electricity	primary GJ	0,06	0,23	0,23	0,23	0,1	0,1	0,5	0,4	0,2
	MWh	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0
	% change with BC	0%	304%	304%	304%	10%	0%	820%	557%	314%
Water (process)	kL	0,01	0,16	0,16	0,16	0,0	0,0	0,4	0,3	0,2
	% change with BC	0%	2715%	2715%	2715%	1%	0%	7241%	4977%	2716%
Water (cooling)	kL	0,05	0,08	0,08	0,08	0,0	0,0	0,1	0,1	0,1
	% change with BC	0%	67%	67%	67%	5%	0%	184%	124%	72%
Waste, non-haz./ landfill	kg	17,4	17,9	17,9	17,9	18,3	17,4	19,6	18,3	18,8
	% change with BC	0%	3%	3%	3%	5%	0%	13%	5%	8%
Waste, hazardous/ incinerated	kg	0,01	0,21	0,21	0,21	0,0	0,0	0,5	0,4	0,2
	% change with BC	0%	1989%	1989%	1989%	0%	0%	5304%	3647%	1989%
EMISSIONS (AIR)										
Greenhouse Gases in GWP100	t CO2 eq.	1,36	1,33	1,33	1,24	1,32	1,29	1,08	1,2	1,2
	% change with BC	0%	-2%	-2%	-9%	-3%	-5%	-20%	-11%	-9%
Acidification, emissions	kg SO2 eq.	0,61	0,73	0,73	0,70	0,60	0,59	0,87	0,8	0,7
	% change with BC	0%	20%	20%	15%	-1%	-3%	44%	32%	16%
Volatile Organic Compounds (VOC)	kg	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,0	0,0
	% change with BC	0%	7%	7%	1%	-2%	-4%	6%	7%	1%
Persistent Organic Pollutants (POP)	µg i-Teq	0,15	0,15	0,15	0,15	0,16	0,15	0,17	0,2	0,2
	% change with BC	0%	1%	1%	1%	9%	0%	12%	2%	10%
Heavy Metals to air	g Ni eq.	0,09	0,12	0,12	0,12	0,10	0,09	0,16	0,1	0,1
	% change with BC	0%	24%	24%	24%	3%	0%	66%	44%	27%
PAHs	g Ni eq.	0,04	0,05	0,05	0,05	0,04	0,04	0,09	0,1	0,1
	% change with BC	0%	50%	50%	50%	0%	0%	134%	92%	50%
Particulate Matter (PM, dust)	kg	0,37	0,38	0,38	0,38	0,38	0,37	0,40	0,4	0,4
	% change with BC	0%	2%	2%	2%	1%	0%	5%	3%	2%
EMISSIONS (WATER)										
Heavy Metals to water	g Hg/20	0,05	0,15	0,15	0,15	0,05	0,05	0,32	0,2	0,1
	% change with BC	0%	223%	223%	223%	4%	0%	600%	409%	227%
Eutrophication	kg PO4	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,0	0,0
	% change with BC	0%	191%	191%	191%	5%	0%	515%	351%	196%

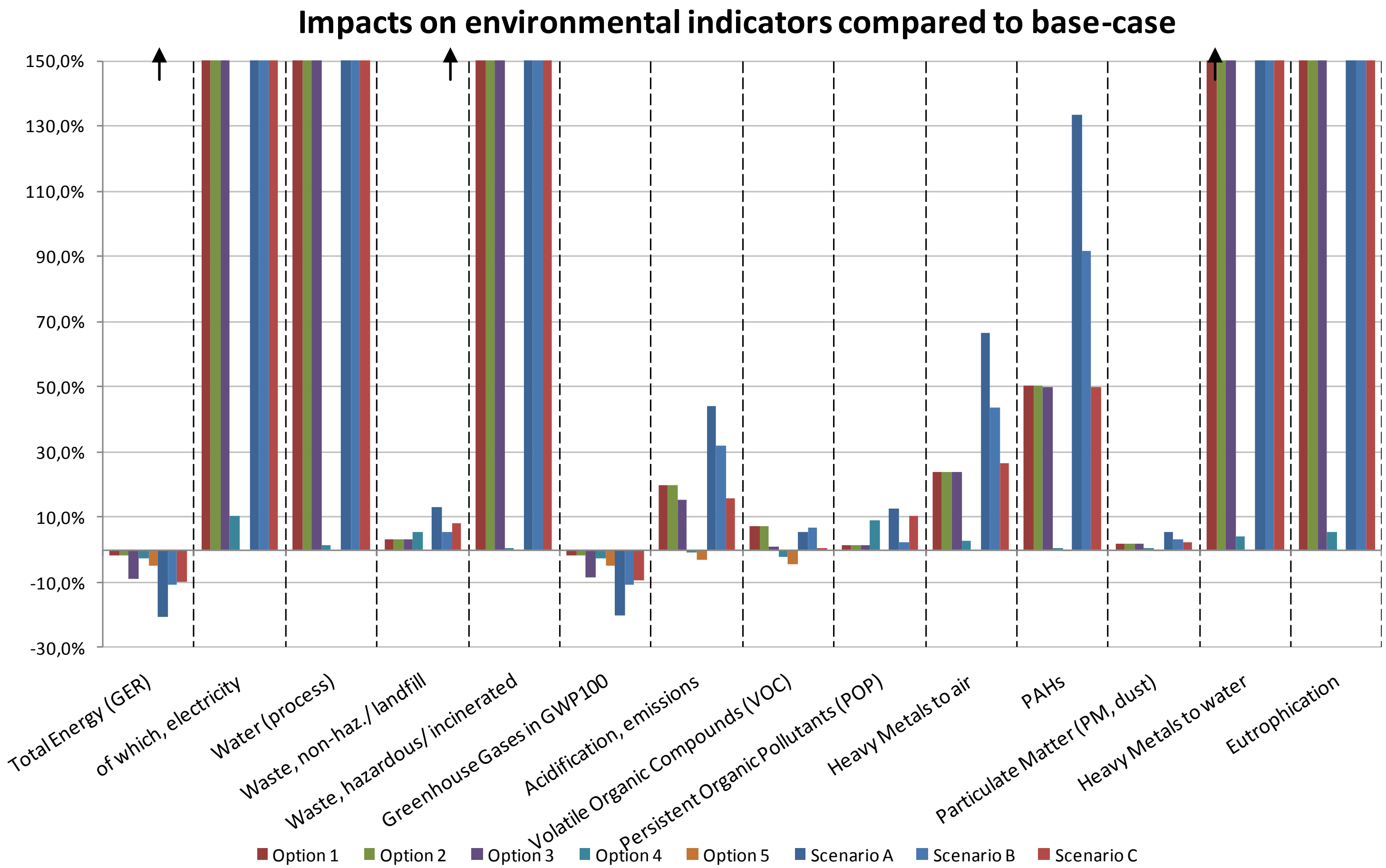
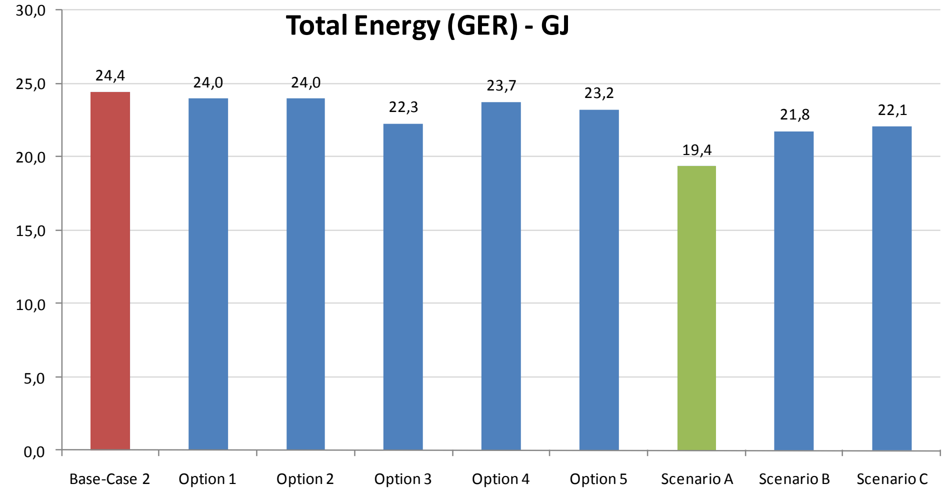
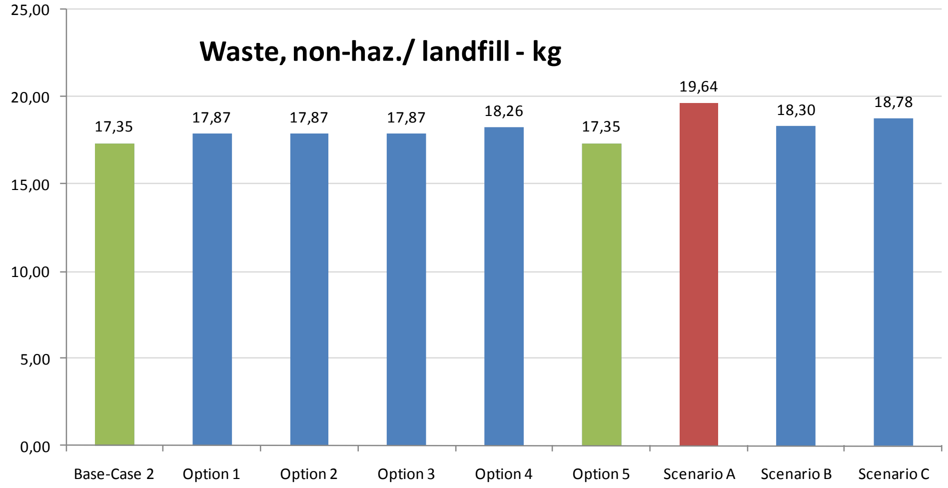
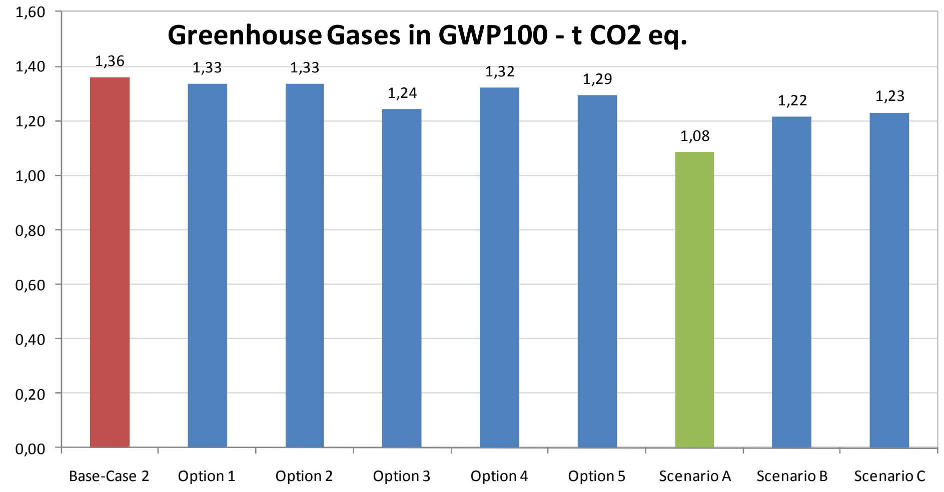
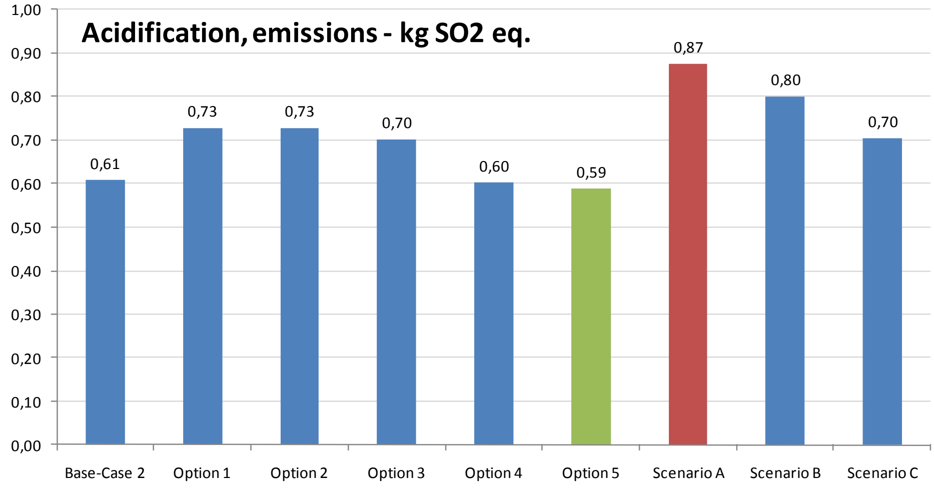


Figure 7-3: Relative impacts of improvement options for BC2 on environmental indicators


Total Energy (GER) - GJ
30,0
25,0
20,0
15,0
10,0
5,0
0,0
24,4
24,0
24,0
22,3
23,7
23,2
19,4
21,8
22,1
Base-Case 2
Option 1
Option 2
Option 3
Option 4
Option 5
Scenario A
Scenario B
Scenario C


Waste, non-haz./ landfill - kg
25,00
20,00
15,00
10,00
5,00
0,00
17,35
17,87
17,87
17,87
18,26
17,35
19,64
18,30
18,78
Base-Case 2
Option 1
Option 2
Option 3
Option 4
Option 5
Scenario A
Scenario B
Scenario C


Greenhouse Gases in GWP100 - t CO2 eq.
1,60
1,40
1,20
1,00
0,80
0,60
0,40
0,20
0,00
1,36
1,33
1,33
1,24
1,32
1,29
1,08
1,22
1,23
Base-Case 2
Option 1
Option 2
Option 3
Option 4
Option 5
Scenario A
Scenario B
Scenario C



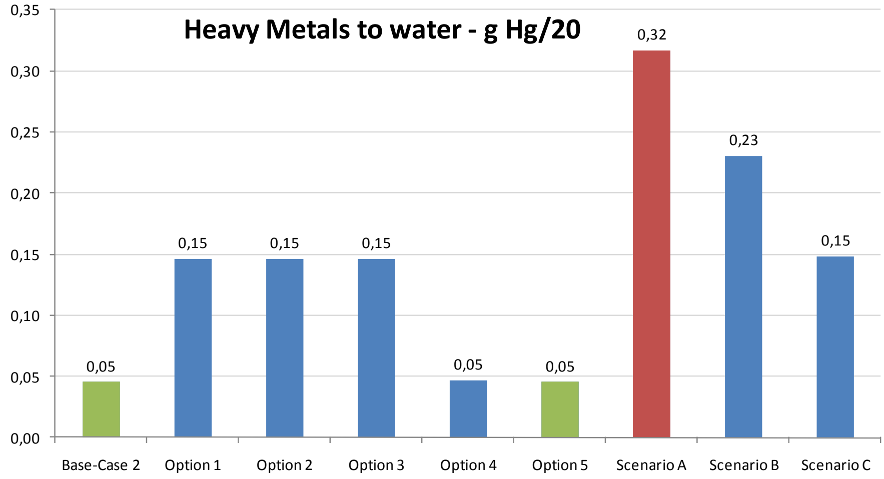


Figure 7-4: Comparison of the improvement options/scenarios' impacts on relevant environmental indicators (green: minimum impact / red: maximum impact)

7.2.3. BASE-CASE 3: COMMERCIAL ELECTRIC HOB

The results of the environmental analysis of the improvement options for Base-Case 3 are presented in Table 7-9 and Figure 7-5.

Scenario A provides the greatest improvement potential for all environmental indicators, especially for the energy consumption and GHG emissions (about 30%). Thus, the addition of electronics in the BOM does not bring out any environmental impacts which cannot be counteracted by the related savings due to a lower energy consumption.

Table 7-9: Environmental Analysis of the improvements options for a commercial electric hob (green: minimum impact / red: maximum impact)

Life-Cycle Indicators per product unit	unit	Base-case 3	Option1	Option2	ScenarioA
OTHER RESSOURCES AND WASTE					
Total Energy (GER)	GJ	2526,3	1897,7	2400,5	1771,9
	% change with BC	0%	-25%	-5%	-30%
of which, electricity	primary GJ	2517,6	1888,9	2391,8	1763,1
	MWh	239,8	179,9	227,8	167,9
	% change with BC	0%	-25%	-5%	-30%
Water (process)	kL	173,4	131,7	165,0	123,3
	% change with BC	0%	-24%	-5%	-29%
Water (cooling)	kL	6710,8	5033,6	6375,3	4698,1
	% change with BC	0%	-25%	-5%	-30%
Waste, non-haz./ landfill	kg	3016,2	2287,9	2870,3	2142,0
	% change with BC	0%	-24%	-5%	-29%
Waste, hazardous/ incinerated	kg	64,3	50,1	61,4	47,2
	% change with BC	0%	-22%	-5%	-27%
EMISSIONS (AIR)					
Greenhouse Gases in GWP100	t CO2 eq.	110,6	83,2	105,1	77,7
	% change with BC	0%	-25%	-5%	-30%
Acidification, emissions	kg SO2 eq.	653,0	491,2	620,6	458,8
	% change with BC	0%	-25%	-5%	-30%
Volatile Organic Compounds (VOC)	kg	1,0	0,8	1,0	0,7
	% change with BC	0%	-23%	-5%	-28%
Persistent Organic Pollutants (POP)	µg i-Teq	17,2	13,1	16,4	12,3
	% change with BC	0%	-24%	-5%	-29%
Heavy Metals to air	g Ni eq.	54,8	44,1	52,7	41,9
	% change with BC	0%	-20%	-4%	-24%
PAHs	g Ni eq.	5,5	4,3	5,2	4,0
	% change with BC	0%	-22%	-5%	-27%
Particulate Matter (PM, dust)	kg	25,2	21,7	24,5	21,0
	% change with BC	0%	-14%	-3%	-16%
EMISSIONS (WATER)					
Heavy Metals to water	g Hg/20	22,7	18,8	21,9	18,0
	% change with BC	0%	-17%	-4%	-21%
Eutrophication	kg PO4	0,3	0,2	0,3	0,2
	% change with BC	0%	-7%	-1%	-8%

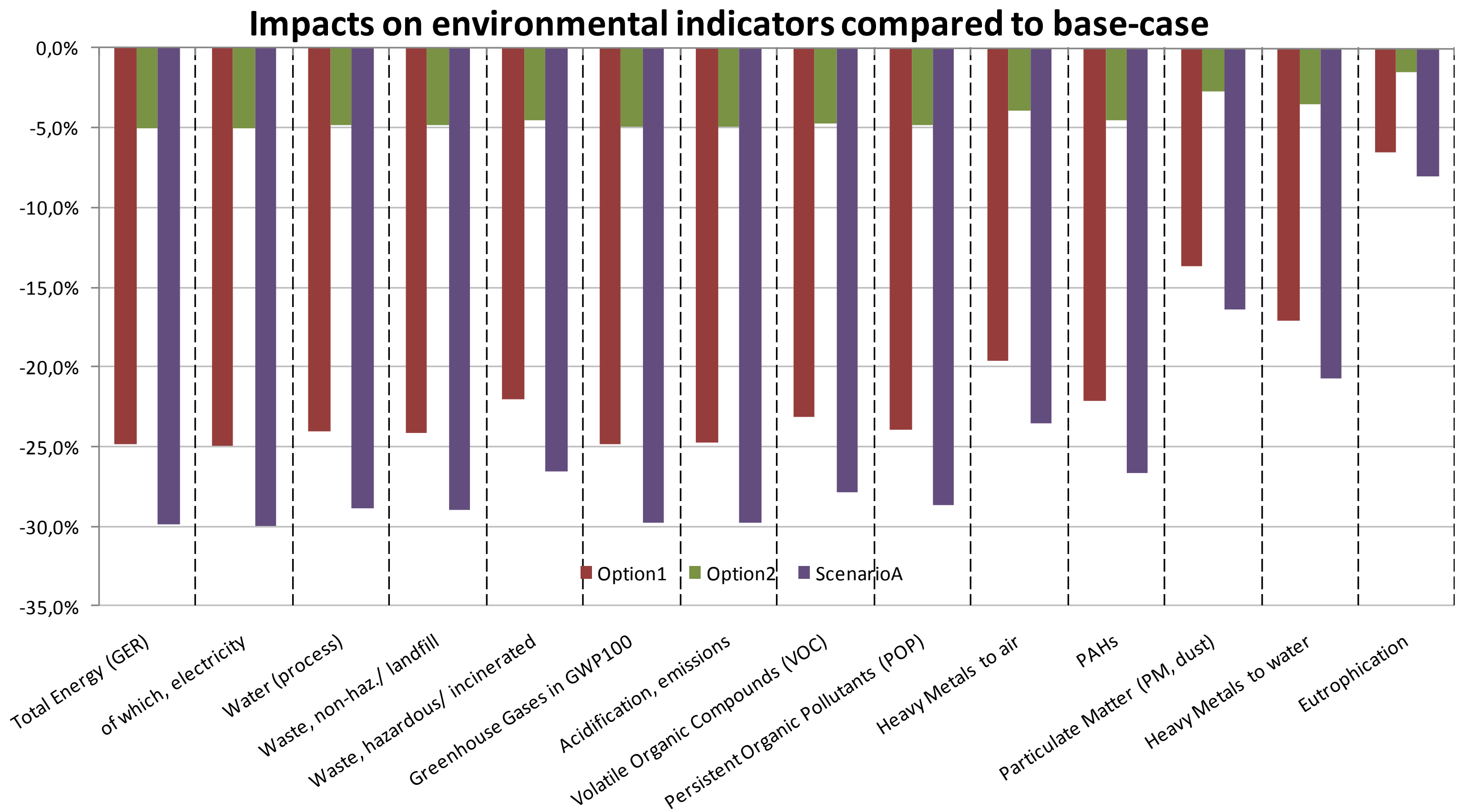


Figure 7-5: Relative impacts of improvement options for BC3 on environmental indicators

7.2.4. BASE-CASE 4: COMMERCIAL GAS HOB

The results of the environmental analysis of the improvement options for Base-Case 4 are presented in Table 7-10 and Figure 7-6.

Similar to Base-case 3, Scenario A provides the greatest improvement potential for the energy consumption and GHG emissions (about 35%).

However, negative impacts can also be observed, such as +6% of non-hazardous waste, +8% of hazardous waste, +14% of heavy metal emissions to water and +7% of eutrophication. These percentage variations should however be put in perspective as in quantitative terms, the environmental impacts are significantly lower than the ones observed in the similar Scenario A of BC3 on commercial electric hobs.

Thus, two main trends can be clearly observed:

- Indicators for which the implementation of (combined) improvement options leads to an impact reduction (notably total energy and emissions of greenhouse gases but also acidification and VOC emissions)
- Indicators for which the implementation of (combined) improvement options enhances negative environmental impacts (releases of (non)-hazardous waste, POPs, heavy metals into air and water and eutrophication)

Figure 7-7 gives a visual representation of the quantitative impacts of the improvement options / scenarios for five main indicators for which significant variations are observed.

Table 7-10: Environmental Analysis of the improvements options for a commercial gas hob (green: minimum impact / red: maximum impact)

Life-Cycle Indicators per product unit	unit	Base-case 4	Option 1	Option 2	Option 3	Scenario A	Scenario B	Scenario C
OTHER RESSOURCES AND WASTE								
Total Energy (GER)	GJ	1613,2	1211,7	1533,0	1532,9	1051,1	1131,4	1452,7
	% change with BC	0%	-25%	-5%	-5%	-35%	-30%	-10%
of which, electricity	primary GJ	0,6	0,9	0,8	0,6	1,0	1,0	0,8
	MWh	0,1	0,1	0,1	0,1	0,1	0,1	0,1
	% change with BC	0%	49%	30%	2%	71%	69%	32%
Water (process)	kL	1,4	1,6	1,5	1,4	1,7	1,7	1,5
	% change with BC	0%	19%	12%	0%	27%	27%	12%
Water (cooling)	kL	0,8	0,9	0,8	0,8	0,9	0,9	0,8
	% change with BC	0%	7%	4%	1%	10%	9%	4%
Waste, non-haz./ landfill	kg	51,0	51,9	51,5	52,9	54,3	52,3	53,5
	% change with BC	0%	2%	1%	4%	6%	3%	5%
Waste, hazardous/ incinerated	kg	5,5	5,8	5,7	5,5	6,0	6,0	5,7
	% change with BC	0%	6%	4%	0%	8%	8%	4%
EMISSIONS (AIR)								
Greenhouse Gases in GWP100	t CO2 eq.	89,3	67,1	84,9	84,8	58,2	62,7	80,4
	% change with BC	0%	-25%	-5%	-5%	-35%	-30%	-10%
Acidification, emissions	kg SO2 eq.	27,7	21,4	26,5	26,4	18,9	20,2	25,2
	% change with BC	0%	-23%	-4%	-5%	-32%	-27%	-9%
Volatile Organic Compounds (VOC)	kg	1,2	0,9	1,2	1,2	0,8	0,9	1,1
	% change with BC	0%	-24%	-5%	-5%	-33%	-29%	-9%
Persistent Organic Pollutants (POP)	µg i-Teq	0,5	0,5	0,5	0,5	0,5	0,5	0,5
	% change with BC	0%	1%	1%	6%	7%	1%	7%
Heavy Metals to air	g Ni eq.	3,1	3,1	3,1	3,1	3,2	3,2	3,1
	% change with BC	0%	1%	1%	0%	2%	2%	1%
PAHs	g Ni eq.	0,5	0,5	0,5	0,5	0,5	0,5	0,5
	% change with BC	0%	4%	3%	0%	5%	6%	3%
Particulate Matter (PM, dust)	kg	8,6	8,5	8,6	8,6	8,5	8,5	8,6
	% change with BC	0%	-1%	0%	0%	-1%	-1%	0%
EMISSIONS (WATER)								
Heavy Metals to water	g Hg/20	1,7	1,8	1,8	1,7	1,9	1,9	1,8
	% change with BC	0%	10%	6%	0%	14%	14%	6%
Eutrophication	kg PO4	0,0	0,1	0,0	0,0	0,1	0,1	0,0
	% change with BC	0%	5%	3%	0%	7%	7%	3%

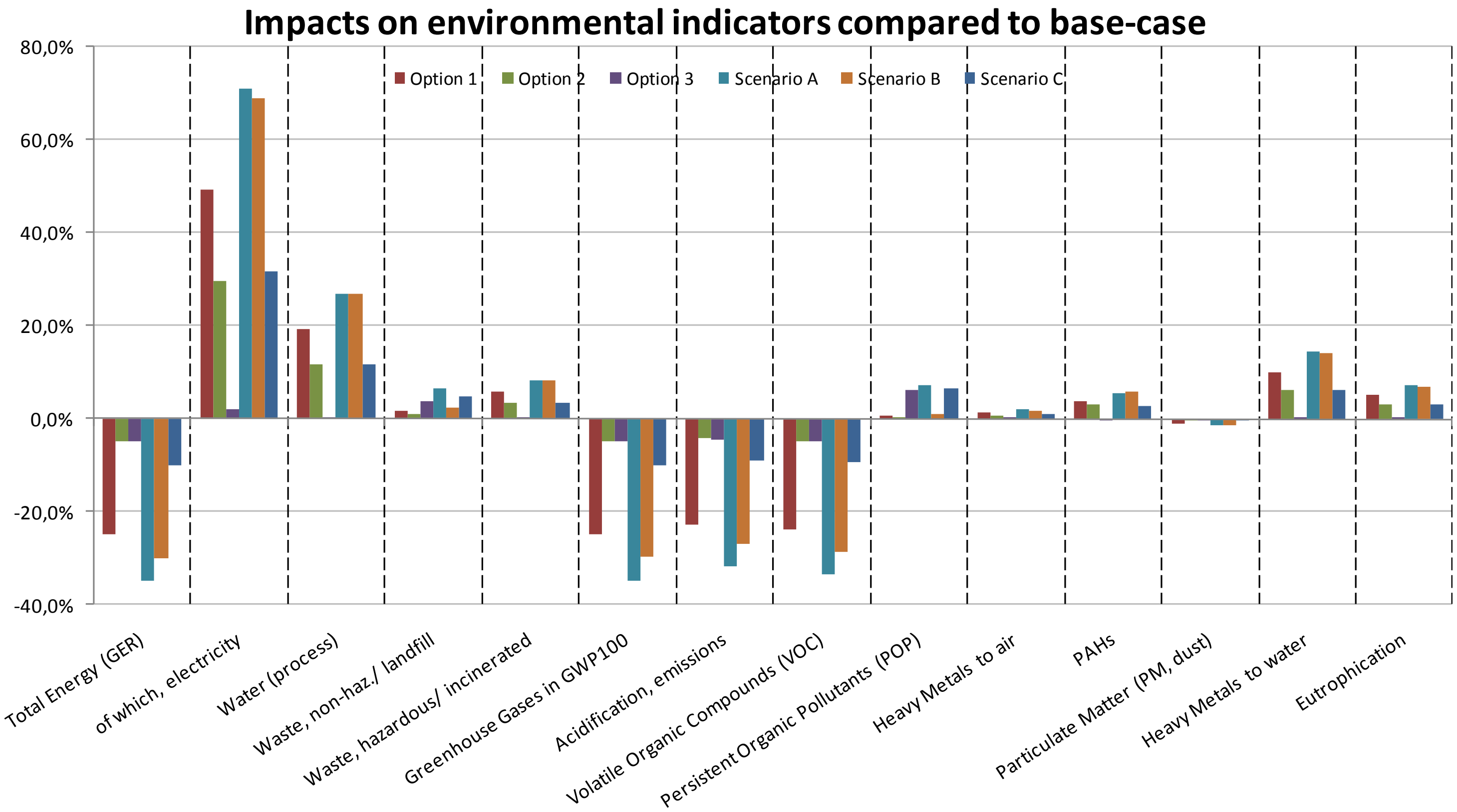
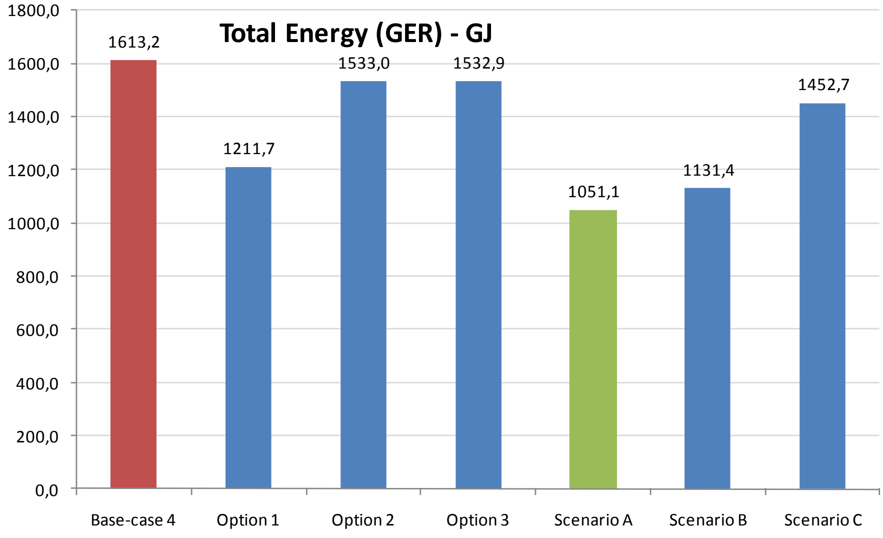
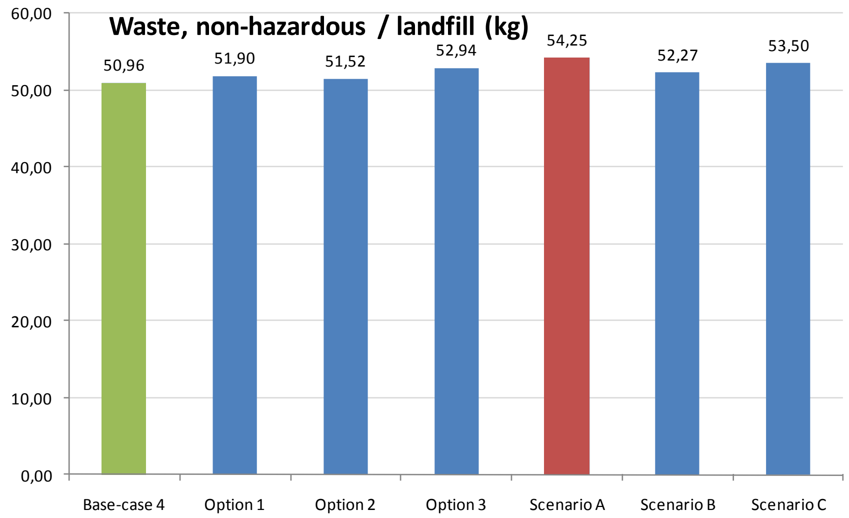
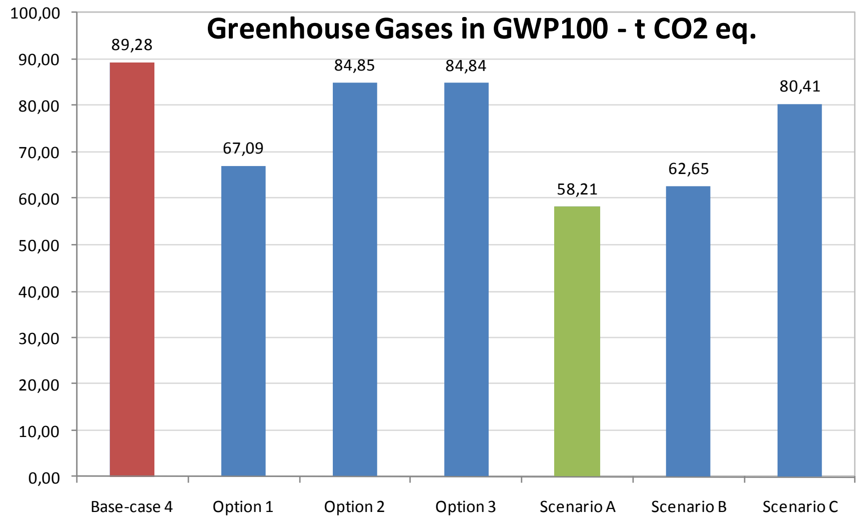
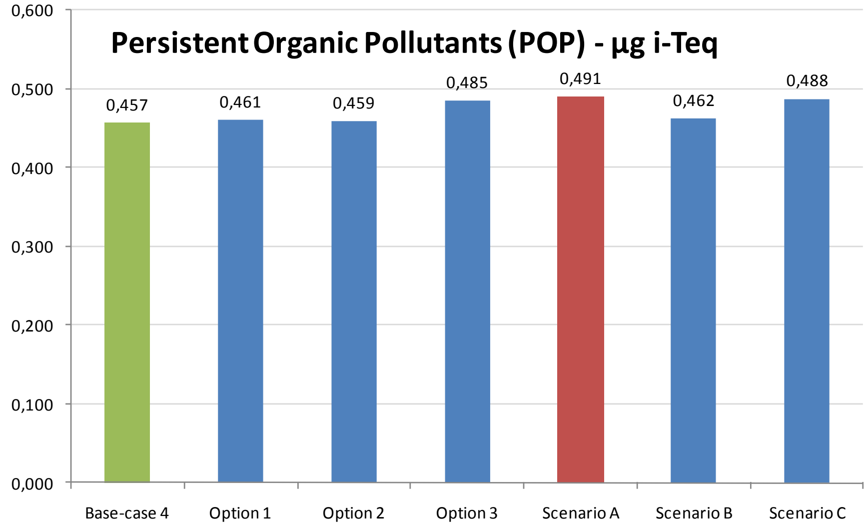


Figure 7-6: Relative impacts of improvement options for BC4 on environmental indicators


Total Energy (GER) - GJ
1800,0
1600,0
1400,0
1200,0
1000,0
800,0
600,0
400,0
200,0
0,0
1613,2
1211,7
1533,0
1532,9
1051,1
1131,4
1452,7
Base-case 4
Option 1
Option 2
Option 3
Scenario A
Scenario B
Scenario C


Waste, non-hazardous / landfill (kg)
60,00
50,00
40,00
30,00
20,00
10,00
0,00
50,96
51,90
51,52
52,94
54,25
52,27
53,50
Base-case 4
Option 1
Option 2
Option 3
Scenario A
Scenario B
Scenario C


Greenhouse Gases in GWP100 - t CO2 eq.
100,00
90,00
80,00
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
89,28
67,09
84,85
84,84
58,21
62,65
80,41
Base-case 4
Option 1
Option 2
Option 3
Scenario A
Scenario B
Scenario C



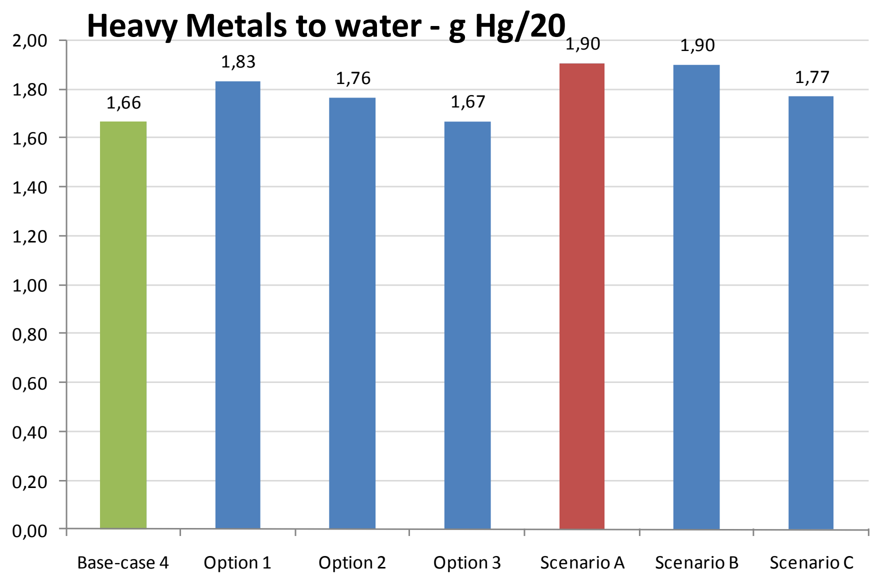


Figure 7-7: Comparison of the improvement options/scenarios' impacts on relevant environmental indicators (green: minimum impact / red: maximum impact)

7.2.5. Base-case 5: Commercial electric fry-top

The results of the environmental analysis of the improvement options for Base-Case 5 are presented in Table 7-11 and in Figure 7-8.

Scenario A provides the greatest improvement potential for all environmental indicators, especially for the energy consumption and GHG emissions (about 18%). Thus, the addition of electronics in the BOM does not bring out any environmental impacts which cannot be counteracted by the related savings due to a lower energy consumption.

Table 7-11: Environmental Analysis of the improvements options for a commercial electric fry-top (green: minimum impact / red: maximum impact)

Life-Cycle Indicators per product unit	unit	Base-case 5	Option 1	Option 2	Scenario A
OTHER RESSOURCES AND WASTE					
Total Energy (GER)	GJ	872,7	786,6	803,5	717,4
	% change with BC	0%	-10%	-8%	-18%
of which, electricity	primary GJ	865,9	779,7	796,7	710,6
	MWh	82,5	74,3	75,9	67,7
	% change with BC	0%	-10%	-8%	-18%
Water (process)	kL	60,6	55,1	55,9	50,4
	% change with BC	0%	-9%	-8%	-17%
Water (cooling)	kL	2307,4	2076,9	2122,9	1892,4
	% change with BC	0%	-10%	-8%	-18%
Waste, non-haz./ landfill	kg	1076,0	978,5	995,8	898,3
	% change with BC	0%	-9%	-7%	-17%
Waste, hazardous/ incinerated	kg	27,5	25,9	25,9	24,3
	% change with BC	0%	-6%	-6%	-12%
EMISSIONS (AIR)					
Greenhouse Gases in GWP100	t CO2 eq.	38,3	34,6	35,3	31,6
	% change with BC	0%	-10%	-8%	-18%
Acidification, emissions	kg SO2 eq.	225,8	203,8	208,0	185,9
	% change with BC	0%	-10%	-8%	-18%
Volatile Organic Compounds (VOC)	kg	0,4	0,3	0,3	0,3
	% change with BC	0%	-8%	-7%	-15%
Persistent Organic Pollutants (POP)	µg i-Teq	6,2	5,7	5,8	5,2
	% change with BC	0%	-9%	-7%	-16%
Heavy Metals to air	g Ni eq.	21,1	19,6	19,9	18,4
	% change with BC	0%	-7%	-6%	-12%
PAHs	g Ni eq.	2,4	2,3	2,3	2,1
	% change with BC	0%	-6%	-6%	-11%
Particulate Matter (PM, dust)	kg	14,5	14,1	14,2	13,7
	% change with BC	0%	-3%	-3%	-6%
EMISSIONS (WATER)					
Heavy Metals to water	g Hg/20	9,0	8,7	8,6	8,2
	% change with BC	0%	-4%	-5%	-9%
Eutrophication	kg PO4	0,1	0,1	0,1	0,1
	% change with BC	0%	0%	-2%	-2%

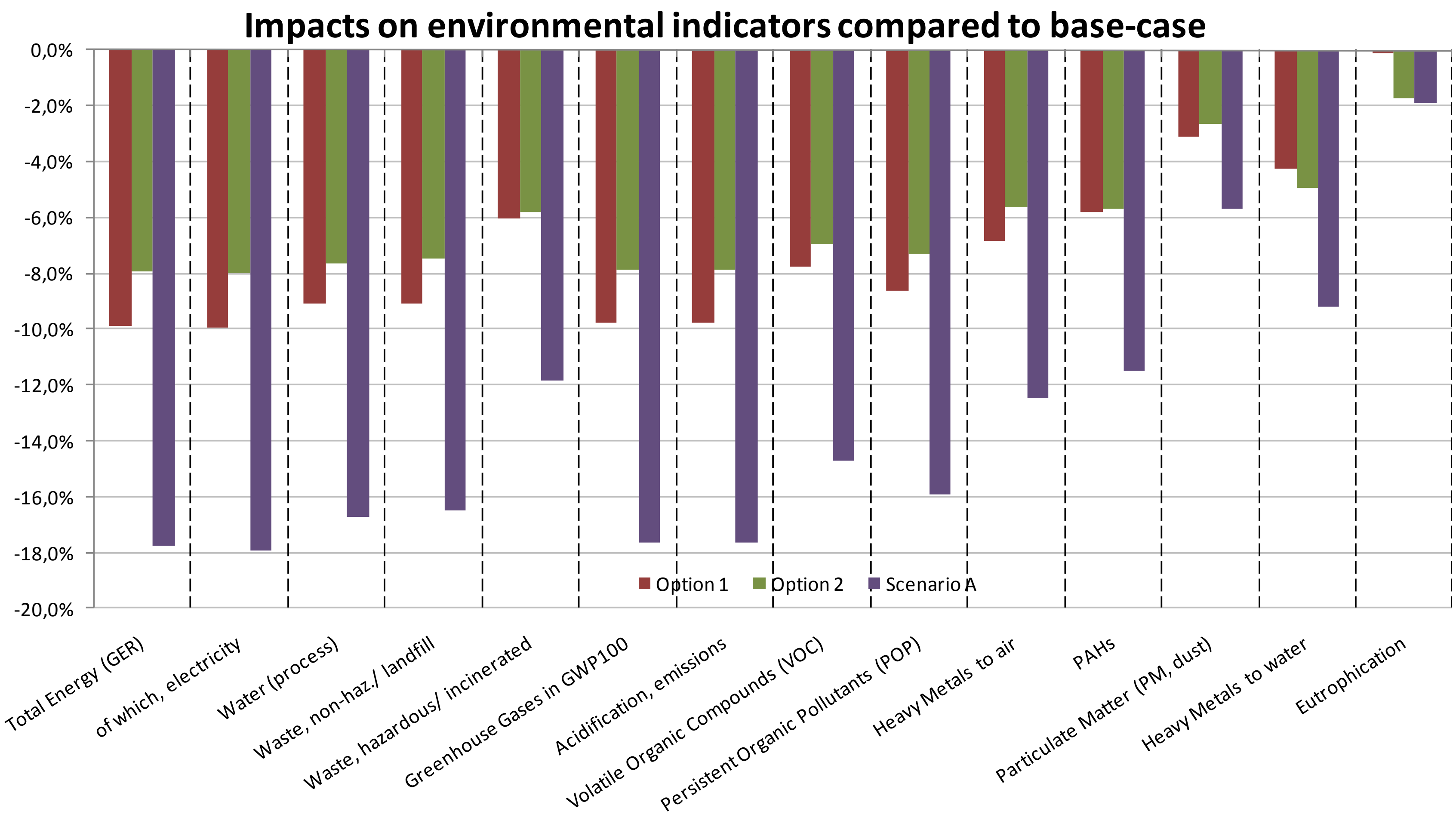


Figure 7-8: Relative impacts of improvement options for BC5 on environmental indicators

7.2.6. BASE-CASE 6: COMMERCIAL GAS FRY-TOP

The results of the environmental analysis of the improvement options for Base-Case 6 are presented in Table 7-12 and in Figure 7-9.

Similar to Base-case 5, Scenario A provides the greatest improvement potential for the energy consumption and GHG emissions (about 32%).

However, negative impacts can also be observed, such as +4% of non-hazardous waste, +8% of hazardous waste, +7% of heavy metal emissions to water and +4% of eutrophication. These percentage variations should however be put in perspective as in quantitative terms, the environmental impacts are significantly lower than the ones observed in the similar Scenario A of BC5 on commercial electric hobs.

Thus, two main trends can be clearly observed:

- Indicators for which the implementation of (combined) improvement options leads to an impact reduction (total energy, emissions of greenhouse gases, acidification and VOC emissions)
- Indicators for which the implementation of (combined) improvement options enhances negative environmental impacts (releases of (non)-hazardous waste, POPs, PAHS, heavy metals into air and water and eutrophication)

Figure 7-10 gives a visual representation of the quantitative impacts of the improvement options / scenarios for five main indicators for which significant variations are observed.

Table 7-12: Environmental Analysis of the improvements options for a commercial gas fry-top (green: minimum impact / red: maximum impact)

Life-Cycle Indicators per product unit	unit	Base-case 6	Option 1	Option 2	Option 3	Option 4	Scenario A	Scenario B
OTHER RESSOURCES AND WASTE								
Total Energy (GER)	GJ	486,4	439,0	448,2	462,8	438,6	329,2	376,6
	% change with BC	0%	-10%	-8%	-5%	-10%	-32%	-23%
of which, electricity	primary GJ	1,0	1,4	1,0	1,2	1,0	1,5	1,2
	MWh	0,1	0,1	0,1	0,1	0,1	0,1	0,1
	% change with BC	0%	29%	0%	17%	0%	40%	17%
Water (process)	kL	3,0	3,3	3,0	3,2	3,0	3,4	3,2
	% change with BC	0%	9%	0%	5%	0%	12%	5%
Water (cooling)	kL	1,1	1,1	1,1	1,1	1,1	1,2	1,1
	% change with BC	0%	5%	0%	3%	0%	7%	3%
Waste, non-haz./ landfill	kg	75,7	78,5	75,7	76,2	75,7	78,9	76,2
	% change with BC	0%	4%	0%	1%	0%	4%	1%
Waste, hazardous/ incinerated	kg	6,1	6,5	6,1	6,3	6,1	6,6	6,3
	% change with BC	0%	5%	0%	3%	0%	8%	3%
EMISSIONS (AIR)								
Greenhouse Gases in GWP100	t CO2 eq.	27,0	24,4	24,9	25,7	24,4	18,4	21,0
	% change with BC	0%	-10%	-8%	-5%	-10%	-32%	-22%
Acidification, emissions	kg SO2 eq.	10,9	10,3	10,3	10,6	10,1	8,7	9,2
	% change with BC	0%	-5%	-6%	-2%	-7%	-20%	-15%
Volatile Organic Compounds (VOC	kg	0,4	0,4	0,4	0,4	0,4	0,3	0,3
	% change with BC	0%	-8%	-7%	-4%	-9%	-27%	-19%
Persistent Organic Pollutants (POP	µg i-Teq	0,6	0,6	0,6	0,6	0,6	0,6	0,6
	% change with BC	0%	6%	0%	0%	0%	6%	0%
Heavy Metals to air	g Ni eq.	6,5	6,5	6,5	6,5	6,5	6,6	6,5
	% change with BC	0%	1%	0%	0%	0%	1%	0%
PAHs	g Ni eq.	0,8	0,8	0,8	0,8	0,8	0,8	0,8
	% change with BC	0%	4%	0%	2%	0%	5%	2%
Particulate Matter (PM, dust)	kg	10,6	10,6	10,5	10,6	10,5	10,5	10,5
	% change with BC	0%	0%	0%	0%	0%	0%	0%
EMISSIONS (WATER)								
Heavy Metals to water	g Hg/20	3,6	3,8	3,6	3,7	3,6	3,8	3,7
	% change with BC	0%	5%	0%	3%	0%	7%	3%
Eutrophication	kg PO4	0,1	0,1	0,1	0,1	0,1	0,1	0,1
	% change with BC	0%	3%	0%	1%	0%	4%	1%

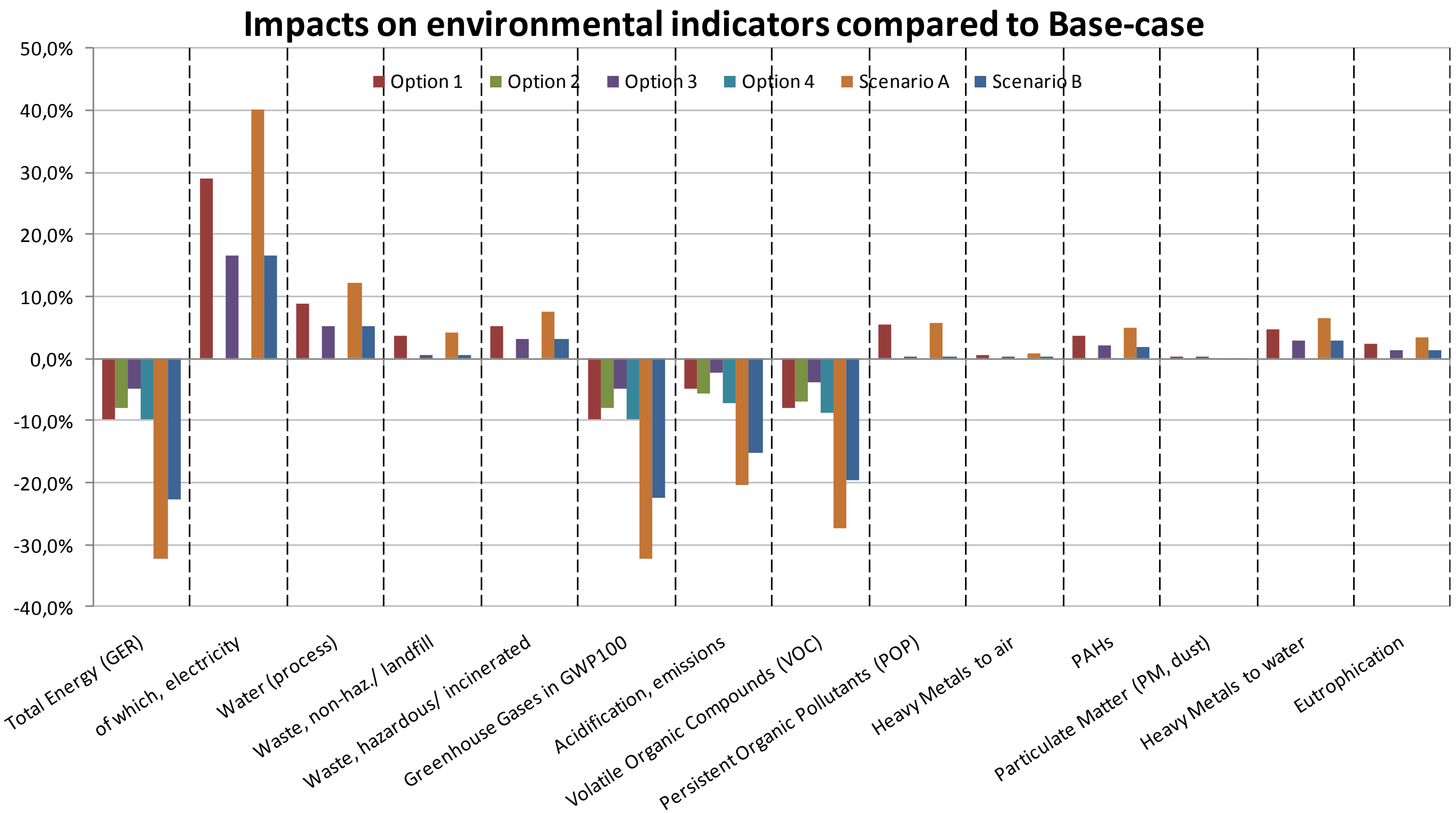
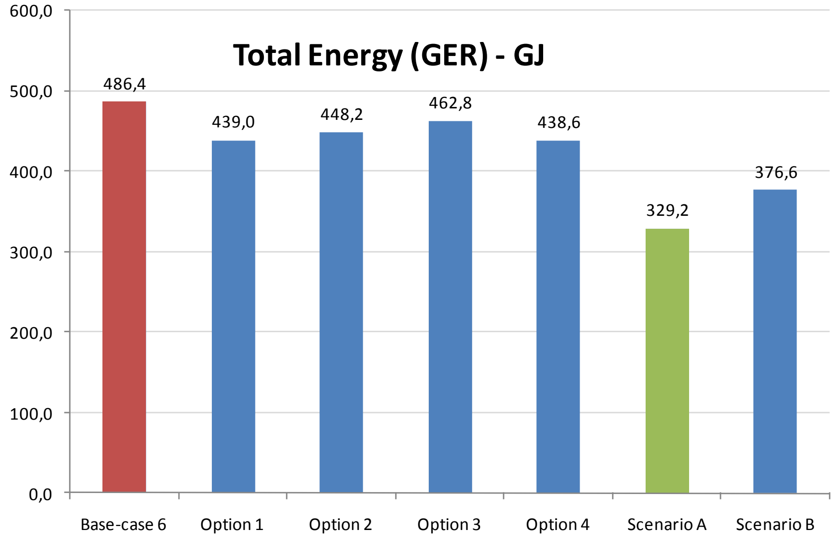
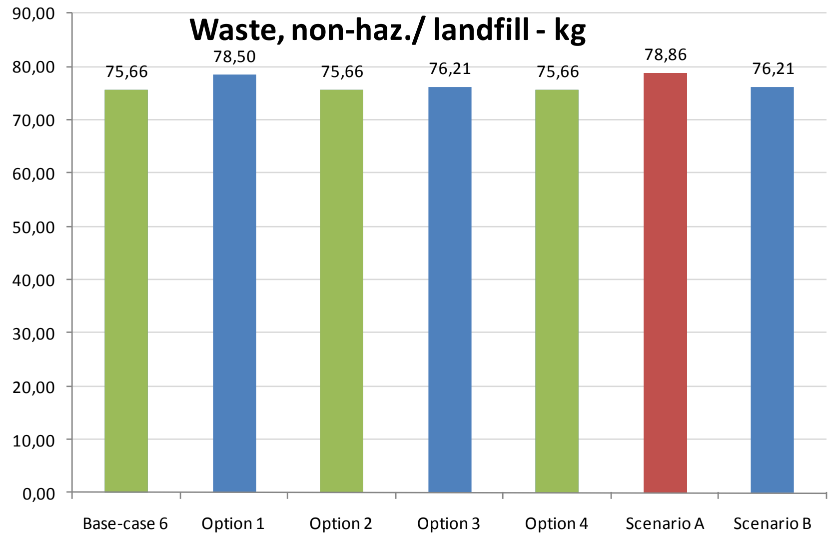
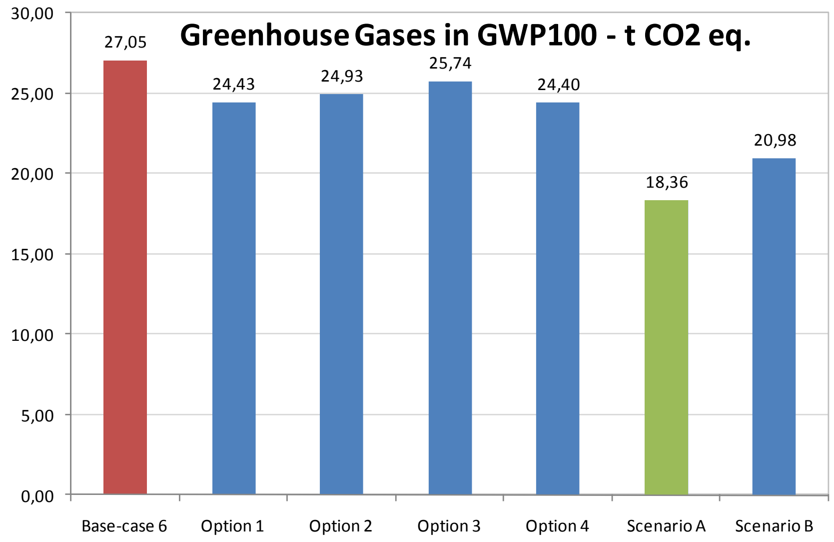
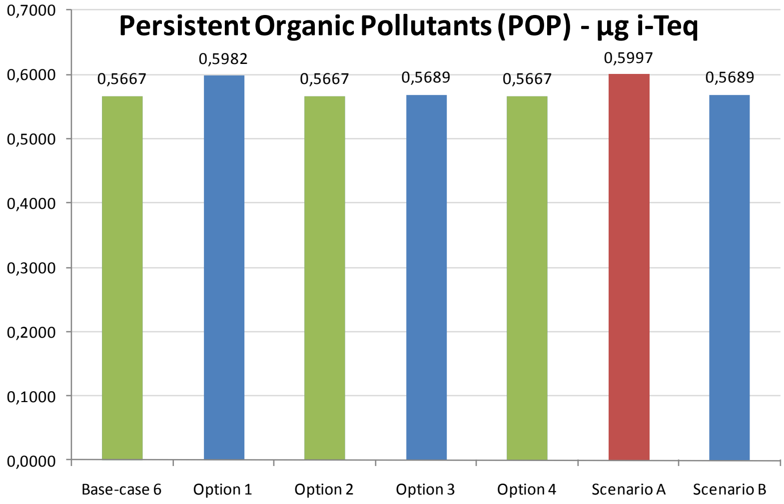


Figure 7-9: Relative impacts of improvement options for BC6 on environmental indicators


Total Energy (GER) - GJ
600,0
500,0
400,0
300,0
200,0
100,0
0,0
486,4
439,0
448,2
462,8
438,6
329,2
376,6
Base-case 6
Option 1
Option 2
Option 3
Option 4
Scenario A
Scenario B


Waste, non-haz./ landfill - kg
90,00
80,00
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
75,66
78,50
75,66
76,21
75,66
78,86
76,21
Base-case 6
Option 1
Option 2
Option 3
Option 4
Scenario A
Scenario B


Greenhouse Gases in GWP100 - t CO2 eq.
30,00
25,00
20,00
15,00
10,00
5,00
0,00
27,05
24,43
24,93
25,74
24,40
18,36
20,98
Base-case 6
Option 1
Option 2
Option 3
Option 4
Scenario A
Scenario B



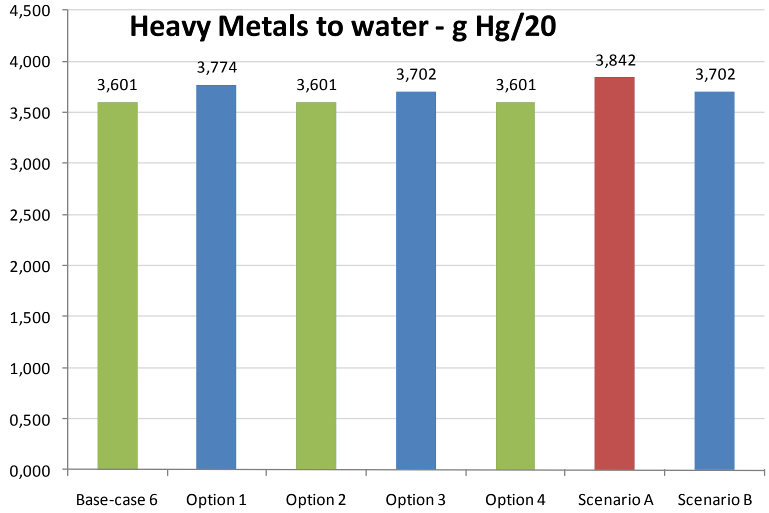


Figure 7-10: Comparison of the improvement options/scenarios' impacts on relevant environmental indicators (green: minimum impact / red: maximum impact)

7.3. COST ANALYSIS

The aim of this sub-task is to assess the LCC of each of the improvement options considered. In doing so the quantification will cover both the PP (purchasing price), the installation costs (if any), and the OE (operating expenses by consumers), as in Task 5.

The approach chosen, and deemed to be the most relevant for the type of options selected, is to consider the marginal costs due to the improvement options. The extent to which the various costs are expected to change from the LCC established for the base-cases in Task 5 is analysed through the EcoReport of the MEEuP. This approach is relevant here because the options considered constitute more an evolution or additional features than a complete technological revolution of the products.

7.3.1. BASE-CASE 1: DOMESTIC ELECTRIC HOB

After the EcoReport analysis (see Table 7-13), the three individual improvement options would result in a significant increase in the purchase price of Base-Case 1, ranging from 9 to 26%. Option 3 with the inclusion of cooking sensors is a particularly expensive technical adaptation. That leads to a Scenario A with a 42% increase, which could be a relevant deterrent for the consumer.

On the other hand, electricity costs are in parallel reduced but they do not offset the higher purchase price, resulting in LCC increases ranging from 2 to 8%. The minimum LCC increase is observed for Option 2 (with 2%). Therefore, the introduction of pot sensors seems like a reasonable cost-efficient option.

Figure 7-11 shows the distribution of costs for a domestic electric hob and the strong shares of the purchase price in Scenarios A and B, with respectively 55 and 53%.

Table 7-13: Life Cycle Cost for a domestic electric hob

Life-cycle indicators per product unit	unit	Base-Case 1	Option 1	Option 2	Option 3	Scenario A	Scenario B
LCC New Product							
Purchase price	€	380,0	430,0	415,0	480,0	540,0	505,0
	% change with BC	0%	13%	9%	26%	42%	33%
Installation / acquisition costs (if any)	€	0,0	0,0	0,0	0,0	0,0	0,0
	% change with BC						
Electricity costs	€	524,6	508,8	508,8	472,1	440,7	456,4
	% change with BC	0%	-3%	-3%	-10%	-16%	-13%
Maintenance and repair costs	€	0,0	0,0	0,0	0,0	0,0	0,0
	% change with BC						
Life-cycle cost	€	904,6	938,8	923,8	952,1	980,7	961,4
	% change with BC	0%	4%	2%	5%	8%	6%

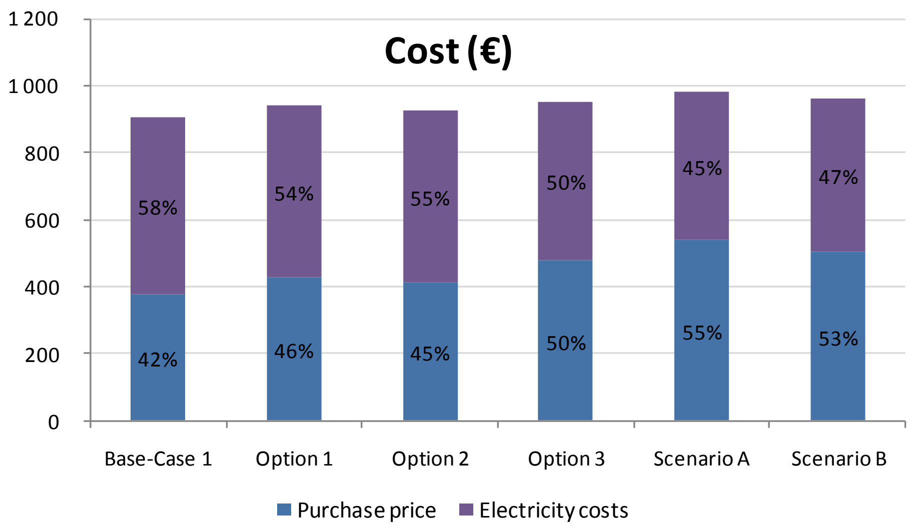


Figure 7-11: Distribution of Costs for a domestic electric hob

7.3.2. Base-case 2: Domestic gas hob

Based on the EcoReport analysis (see Table 7-14), the implementation of the improvement options would result in a significant increase in the purchase price of Base-Case 2, ranging from 15 to 37%, except for Option 5 where a 1% increase is only expected. Option 3 with the inclusion of cooking sensors is currently a particularly expensive technical adaptation. That leads to a Scenario A with a 87% increase in terms of purchase price, which is likely to be problematic for the consumer's purchasing power.

Furthermore, energy costs are reduced to some extent but do not compensate the higher purchase price, resulting in LCC increases from 6 to 14% for individual improvement Options 1 to 4 and 33% for Scenario A. In the case of Option 5, this cost compensation is foreseen with a -2% saving on the life cycle cost.

Table 7-14 shows the distribution of costs for a domestic gas hob and the strong share of the purchase price in Scenarios A and B, with respectively 72 and 65%.

Table 7-14: Life Cycle Cost for a domestic gas hob

Life-Cycle indicators per product unit	unit	Base-Case 2	Option 1	Option 2	Option 3	Option 4	Option 5	Scenario A	Scenario B	Scenario C
LCC New Product										
Purchase price	€	268,0	348,0	308,0	368,0	308,0	270,0	500,0	398,0	390,0
	% change	0%	30%	15%	37%	15%	1%	87%	49%	46%
Installation / acquisition costs (if any)	€	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	% change									
Fuel (gas, oil, wood)	€	251,3	243,7	243,7	226,2	243,7	238,7	191,0	218,6	223,6
	% change	0%	-3%	-3%	-10%	-3%	-5%	-24%	-13%	-11%
Maintenance and repair costs	€	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	% change									
Life-cycle cost	€	519,3	591,7	551,7	594,2	551,7	508,7	691,0	616,6	613,6
	% change	0%	14%	6%	14%	6%	-2%	33%	19%	18%

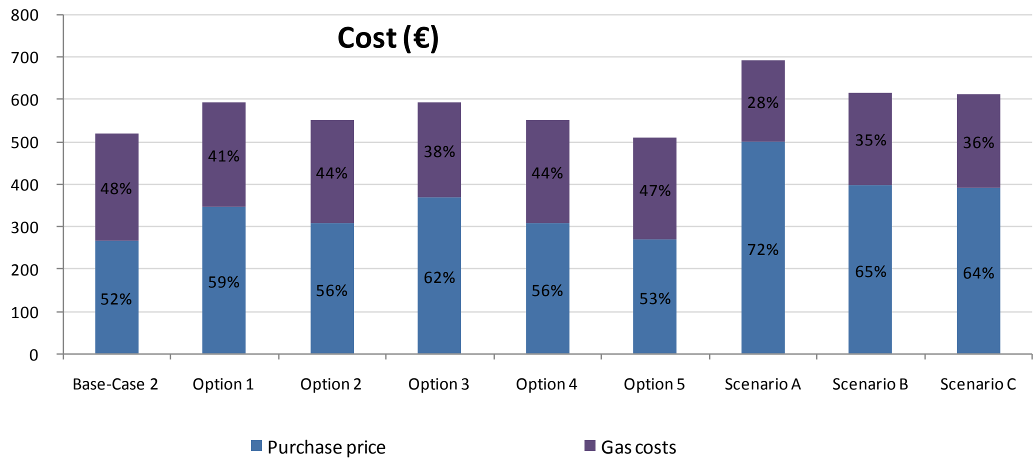


Figure 7-12: Distribution of Costs for a domestic gas hob

7.3.3. BASE-CASE 3: COMMERCIAL ELECTRIC HOB

After the EcoReport analysis (see Table 7-15), the two individual improvement options would result in a slight increase of 2% (each) in the purchase price of Base-Case 3. That leads to a Scenario A with a 4% increase.

On the other hand, electricity costs are in parallel significantly reduced. For both options and Scenario A, they largely offset the higher purchase price, resulting in LCC reductions of respectively -22%, -4% and -26%. The implementation of such (combination of) options seems like an adequate cost-efficient solution. Figure 7-13 shows the distribution of costs for a commercial electric hob and the strong shares of the electricity price in all cases, with a 84 to 89% range.

Table 7-15: Life Cycle Cost for a commercial electric hob

Life-Cycle Indicators per product unit	unit	Base-case 3	Option1	Option2	ScenarioA
LCC New Product					
Purchase price	€	2900	2960	2960	3020
	% change with BC	0%	2%	2%	4%
Installation / acquisition costs (if any)	€	60	60	60	60
	% change with BC	0%	0%	0%	0%
Electricity costs	€	29122	21842	27666	20385
	% change with BC	0%	-25%	-5%	-30%
Maintenance and repair costs	€	766	766	766	766
	% change with BC	0%	0%	0%	0%
Life-cycle cost	€	32849	25628	31452	24232
	% change with BC	0%	-22%	-4%	-26%

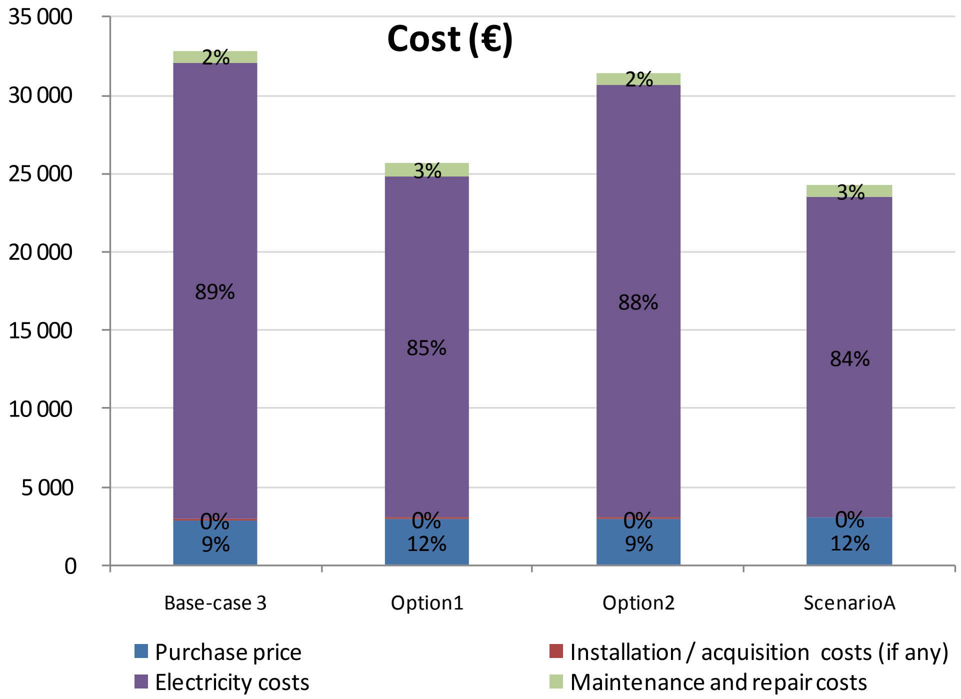


Figure 7-13: Distribution of Costs for a commercial electric hob

7.3.4. Base-case 4: Commercial gas hob

After the EcoReport analysis (see Table 7-16), the three individual improvement would result in a slight increase of 1 to 3% in the purchase price of Base-Case 4. That leads to a Scenario A with a 5% increase.

On the other hand, gas costs are in parallel significantly reduced. For all options and scenarios, they offset the higher purchase price, resulting in LCC reductions of from -4 to -29%. The implementation of such (combinations of) options seems like an adequate cost-efficient solution.

Figure 7-14 shows the distribution of costs for a commercial gas hob and the strong shares of the gas price in all cases, with a 77 to 84% range.

Table 7-16: Life Cycle Cost for a commercial gas hob

Life-Cycle Indicators per product unit	unit	Base-case 4	Option 1	Option 2	Option 3	Scenario A	Scenario B	Scenario C
LCC New Product								
Purchase price	€	2950,0	3010,0	2980,0	3030,0	3110,0	3030,0	3060,0
	% change with BC	0%	2%	1%	3%	5%	3%	4%
Installation / acquisition costs	€	60,0	60,0	60,0	60,0	60,0	60,0	60,0
	% change with BC	0%	0%	0%	0%	0%	0%	0%
Fuel (gas, oil, wood)	€	17451,0	13088,3	16578,5	16578,5	11343,2	12215,7	15705,9
	% change with BC	0%	-25%	-5%	-5%	-35%	-30%	-10%
Maintenance and repair costs	€	312,8	312,8	312,8	312,8	312,8	312,8	312,8
	% change with BC	0%	0%	0%	0%	0%	0%	0%
Life-cycle cost	€	20773,9	16471,1	19931,3	19981,3	14826,0	15618,6	19138,8
	% change with BC	0%	-21%	-4%	-4%	-29%	-25%	-8%

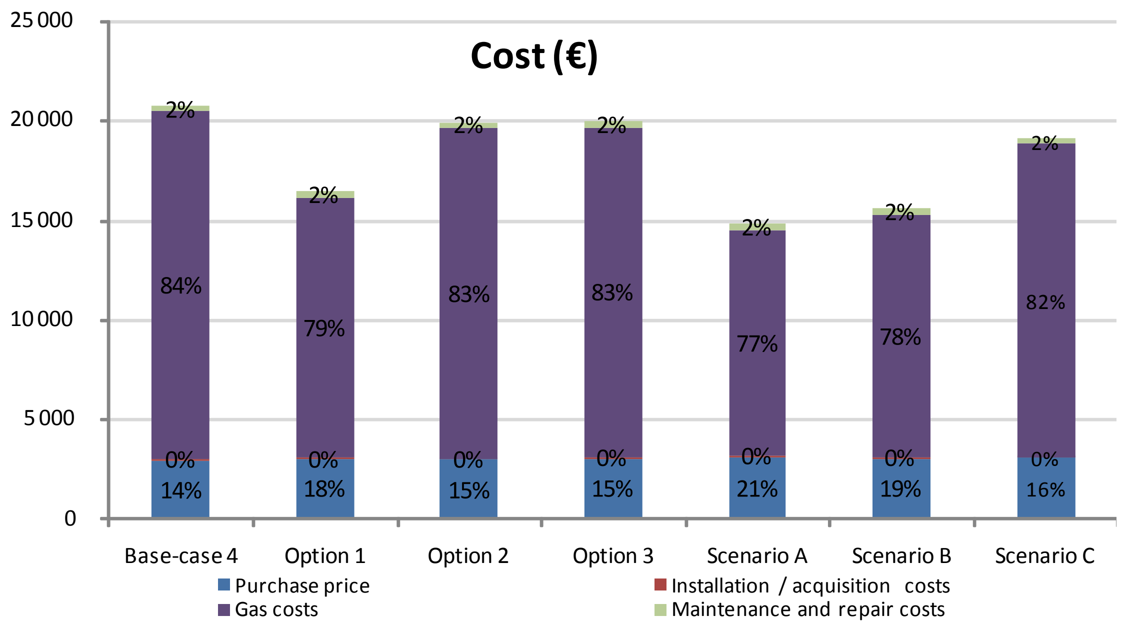


Figure 7-14: Distribution of Costs for a commercial gas hob

7.3.5. Base-case 5: Commercial electric fry-top

After the EcoReport analysis (see Table 7-17), the two individual improvement options would result in a slight increase of 3% (each) in the purchase price of Base-Case 5. That leads to a Scenario A with a 6% increase.

On the other hand, electricity costs are in parallel significantly reduced. For all options and Scenario A, they offset the higher purchase price, resulting in LCC reductions of respectively -7, -6 and -13%. The implementation of such (combinations of) options seems like an adequate cost-efficient solution.

Figure 7-15 shows the distribution of costs for a commercial electric fry-top and the strong shares of the electricity price in all cases, with a 72 to 77% range.

Table 7-17: Life Cycle Cost for a commercial electric fry-top

Life-Cycle Indicators per product unit	unit	Base-case 5	Option 1	Option 2	Scenario A
LCC New Product					
Purchase price	€	2300,0	2380,0	2360,0	2440,0
	% change with BC	0%	3%	3%	6%
Installation / acquisition costs (if any)	€	60,0	60,0	60,0	60,0
	% change with BC	0%	0%	0%	0%
Electricity costs	€	10381,9	9343,7	9551,4	8513,2
	% change with BC	0%	-10%	-8%	-18%
Maintenance and repair costs	€	746,2	746,2	746,2	746,2
	% change with BC	0%	0%	0%	0%
Life-cycle cost	€	13488,1	12529,9	12717,6	11759,4
	% change with BC	0%	-7%	-6%	-13%

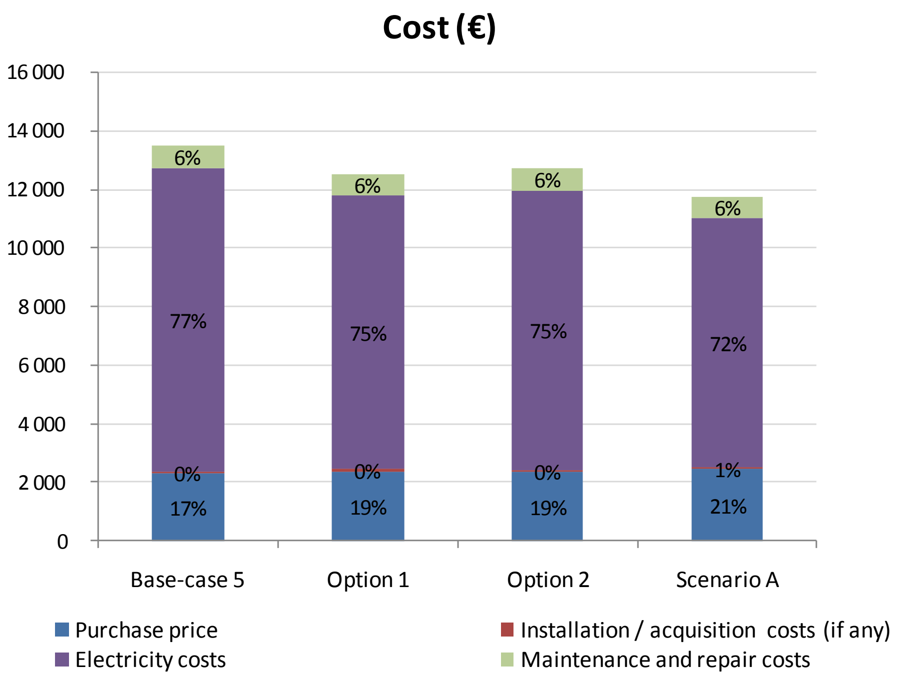


Figure 7-15: Distribution of Costs for a commercial electric fry-top

7.3.6. BASE-CASE 6: COMMERCIAL GAS FRY-TOP

After the EcoReport analysis (see Table 7-18), the four individual improvement options would result in a slight increase of 1 to 3% in the purchase price of Base-Case 6. That notably leads to a Scenario A with a 10% increase.

On the other hand, gas costs are in parallel significantly reduced. For all options and scenarios, they offset the higher purchase price, resulting in LCC reductions of from -3 to -18%. The implementation of such (combinations of) options seems like an adequate cost-efficient solution.

Figure 7-16 shows the distribution of costs for a commercial gas fry-top and the strong shares of the gas price in all cases, with a 50 to 61% range.

Table 7-18: Life Cycle Cost for a commercial gas fry-top

Life-Cycle Indicators per product unit	unit	Base-case 6	Option 1	Option 2	Option 3	Option 4	Scenario A	Scenario B
LCC New Product								
Purchase price	€	2400,0	2480,0	2460,0	2430,0	2480,0	2630,0	2560,0
	% change with BC	0%	3%	3%	1%	3%	10%	7%
Installation / acquisition costs	€	60,0	60,0	60,0	60,0	60,0	60,0	60,0
	% change with BC	0%	0%	0%	0%	0%	0%	0%
Fuel (gas, oil, wood)	€	5386,3	4847,7	4955,4	5117,0	4847,7	3608,9	4147,5
	% change with BC	0%	-10%	-8%	-5%	-10%	-33%	-23%
Maintenance and repair costs	€	916,5	916,5	916,5	916,5	916,5	916,5	916,5
	% change with BC	0%	0%	0%	0%	0%	0%	0%
Life-cycle cost	€	8762,9	8304,2	8392,0	8523,6	8304,2	7215,4	7684,0
	% change with BC	0%	-5%	-4%	-3%	-5%	-18%	-12%

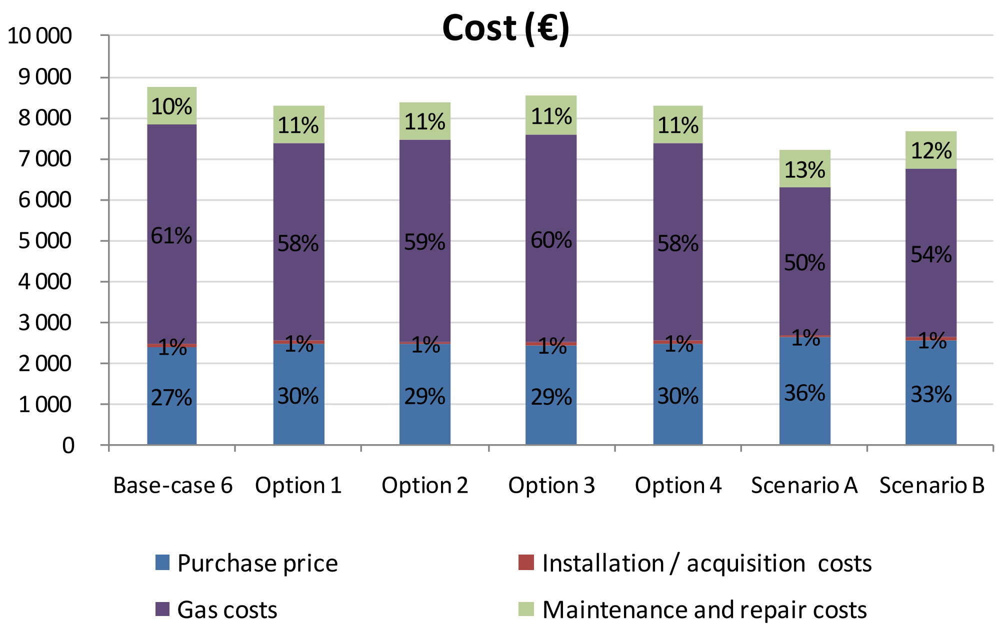


Figure 7-16: Distribution of Costs for a commercial gas fry-top

7.4. ANALYSIS BAT AND LLCC

The design options that were identified in the technical, environmental and economic analysis in subtasks 7.1 to 7.3 will be further compared to characterise the Best Available Technology (BAT) (defined in subtask 6.1) and the Least Life Cycle Cost (LLCC) option. Drawing of a LCC-curve (Y1-axis=environmental impact, Y2-axis=LCC, X-axis=options) allows clear identification of these LLCC and BAT points.

The figures in the following subsection show on the one hand the total primary energy consumed over the whole life cycle of the products and the life cycle costs on the other hand. Primary energy was chosen here as the most important and representative environmental indicator, given the importance of the use phase and the energy consumption during this phase.

7.4.1. BASE-CASE 1: DOMESTIC ELECTRIC HOB

Figure 7-17 shows that the LLCC for domestic electric hob is the Base-case. After, the ranking is as follows: Option 2, Option1, Option 3 Scenario B and Scenario A.

Scenario A is identified as the BAT product as it offers the most energy savings, but from an economic point of view, the implementation of all combined options does not seem beneficial and easy to accept for the consumer. Scenario B, with lower saving potential than Scenario A but also lower costs, could stand as a potential compromise for a mid-term target, to be further investigated in the Task 8 scenario analysis.

When considering only user-independent options/scenarios, option 1 will stand as the new BAT.

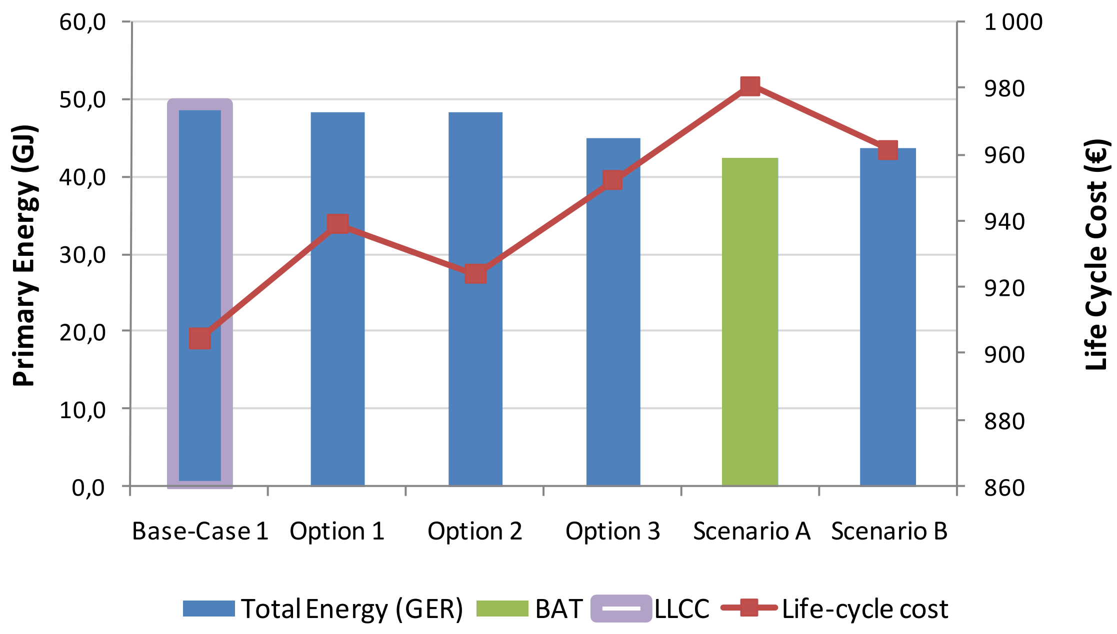


Figure 7-17: Identification of BAT and LLCC for domestic electric hobs

7.4.2. Base-case 2: Domestic gas hob

Figure 7-18 shows that the LLCC for domestic gas hob is Option 5. After, the ranking is as follows: Base-Case, Options 2 or 4, 1, 3 and Scenarios C, B and A.

Scenario A is identified as the BAT product as it offers the most energy savings, but from an economic point of view, the implementation of all combined options does not seem beneficial.

When considering only user-independent options/scenarios, Scenario C will stand as the new BAT.

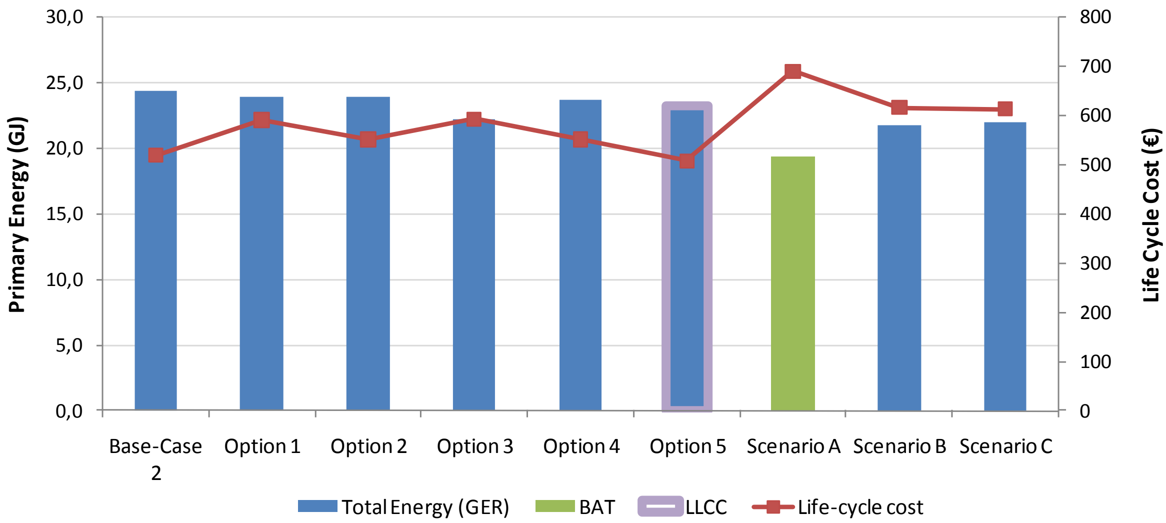


Figure 7-18: Identification of BAT and LLCC for domestic gas hobs

7.4.3. Base-case 3: Commercial electric hob

Figure 7-19 shows that the LLCC for commercial electric hob is Scenario A. After, the ranking is as follows: Option 1, Option 2 and the initial Base-case. In short-term considerations, the implementation of pot sensors (Option 1) shows great potential in term of energy savings.

Scenario A is also identified as the BAT product as it offers the most energy savings. As the implementation of all combined options does seem beneficial and therefore likely to be well-accepted by the consumer, it could stand as a reachable long-term target.

When considering only user-independent options/scenarios, Option 2 will stand as the new BAT/LLCC.

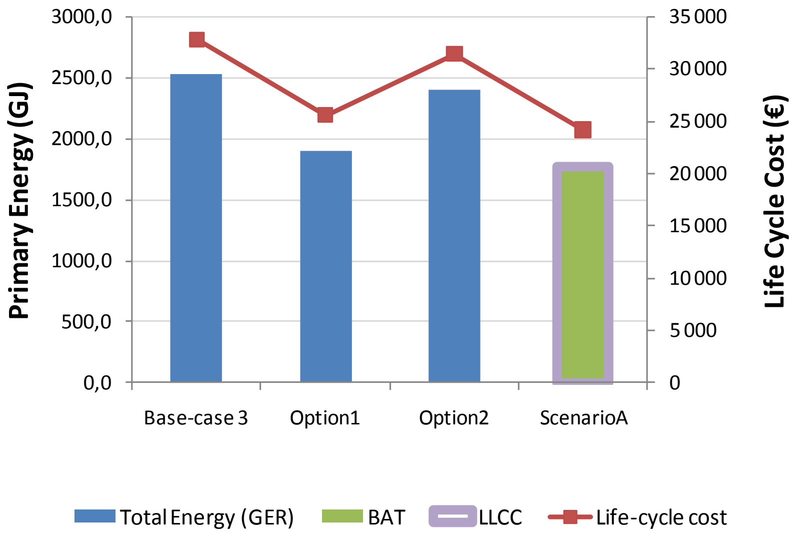


Figure 7-19: Identification of BAT and LLCC for commercial electric hobs

7.4.4. Base-case 4: Commercial gas hob

Similar to Base-case 3, Figure 7-20 shows that the LLCC for commercial gas hob is Scenario A. After, the ranking is as follows: Scenario B, Option 1, Options 2 and 3 and the initial Base-case. In short-term considerations, the implementation of pot sensors (Option 1) shows great potential in term of energy savings.

Scenario A is also identified as the BAT product as it offers the most energy savings. As the implementation of all combined options does seem beneficial and therefore likely to be well-accepted by the consumer, it could stand as a reachable long-term target.

When considering only user-independent options/scenarios, Scenario C will stand as the new BAT/LLCC.

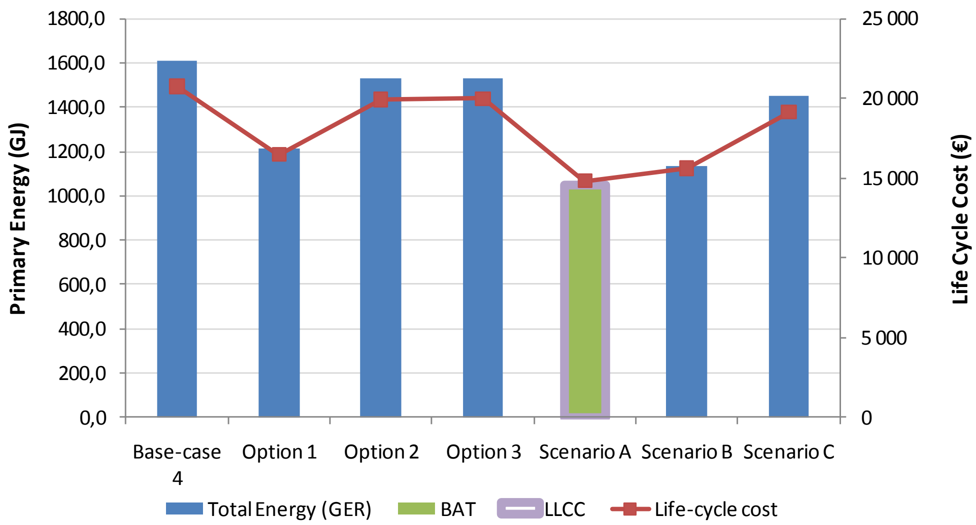


Figure 7-20: Identification of BAT and LLCC for commercial gas hobs

7.4.5. Base-case 5: Commercial electric fry-top

Similar to Base-case 3, Figure 7-21 shows that the LLCC for commercial electric fry-top is Scenario A. After, the ranking is as follows: Option 1, Option 2 and the initial Base-case. In short-term considerations, the implementation of zone isolation/separation (Option 1) shows great potential in term of energy savings.

Scenario A is also identified as the BAT product as it offers the most energy savings. As the implementation of all combined options does seem beneficial and therefore likely to be well-accepted by the consumer, it could stand as a reachable long-term target.

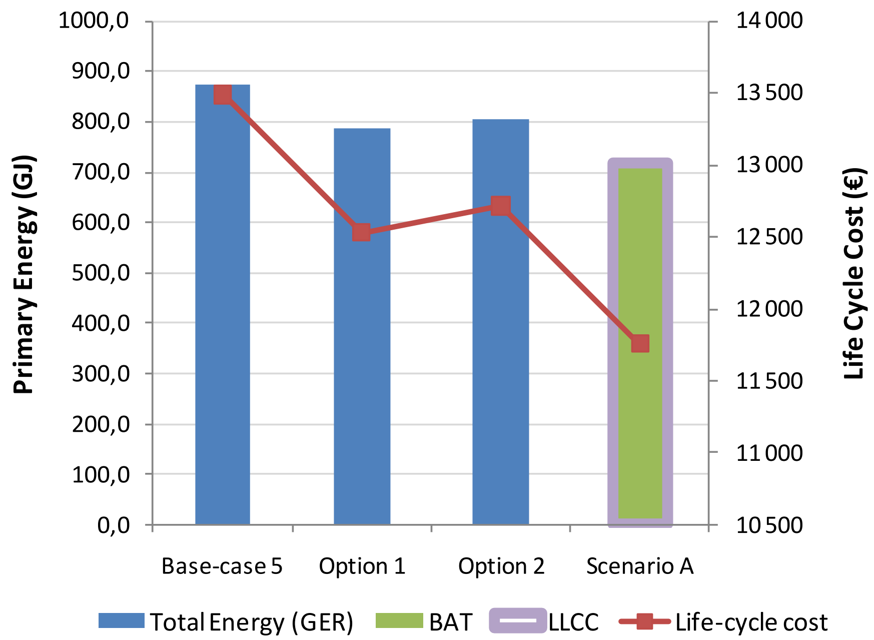


Figure 7-21: Identification of BAT and LLCC for commercial electric fry-tops

7.4.6. Base-case 6: Commercial gas fry-top

Similar to Base-case 5, Figure 7-22 shows that the LLCC for commercial gas fry-top is Scenario A. After, the ranking is as follows: Scenario B, Option 1, Option 4, Option 2, Option 3 and the initial Base-case. In short-term considerations, the implementation of zone isolation/separation (Option 1) shows high potential in term of energy savings.

Scenario A is also identified as the BAT product as it offers the most energy savings. As the implementation of all combined options does seem beneficial and therefore likely to be well-accepted by the consumer, it could stand as a reachable long-term target.

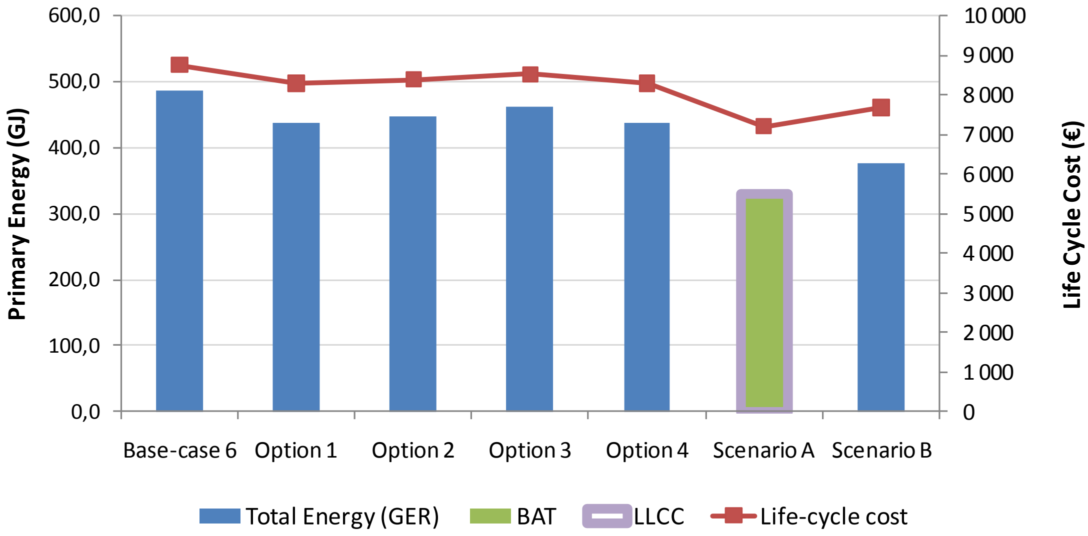


Figure 7-22: Identification of BAT and LLCC for commercial gas fry-tops

7.5. LONG-TERM TARGETS (BNAT)

Not all possible improvement options were considered in the preceding sections. Some are still prohibitively expensive or not yet widely available. Such options can be described as BNAT and considered as potential long-term targets.

Predicting the technological status over such a long period (a horizon of 2020/2025) is not possible with a high level of accuracy. Technology roadmaps tend to have a time horizon of 10-12 years at most, describing mid-term targets but often without specifying which particular technologies will be used to achieve those targets.

Due to potential economies of scale, some BNAT options are likely to become less costly to manufacturers in coming years especially if stronger competition and energy label incentives are expected. They would thus become applicable to products on the market, although it is difficult to make any reliable predictions as manufacturers are hesitant to disclose detailed information about research and development activities. As listed in Task 6, improvement options or available technologies mentioned by manufacturers that have not yet been applied to domestic and commercial hobs and grills are further described in this section.

Moreover, at the market level, Task 2 identified that environmental awareness is increasing and consumers also have economic motivation to reduce energy consumption. These trends drive changes in use patterns and consumer choice over time although product price is currently of primary importance to consumers in many EU States.

- **For electric hobs / grills:**

- Advanced automatic cooking including electronic control of cooking temperature to avoid over-heating. That would prevent poor control by users but its impact would be difficult to be measured by a credited EN standard.

- **For gas hobs / grills:**

- Optimised mass of the pan support which should be achieved in compliance of the safety requirements.
- Reduced excess air at burner with the need to ensure that carbon monoxide is not generated.

7.6. CONCLUSIONS

The most energy-demanding phase for hobs and grills is the use phase. Any action to reduce the related energy consumption implies the addition of complementary components that currently significantly contribute to an increased purchase price for the domestic sector. However, in the long run, it is likely that the cost impacts would be lowered due to expected economies of scale.

Regarding domestic hobs, the LLCCs refer to the base-case for the electric appliance and the implementation of Option 5 (high efficient gas sealed burners) for the gas appliance. In the former case, there is hardly room for improvement that would not entail additional life cycle costs to consumers, while in the latter case, some cost compensation is foreseen. For both cases, the implementation of pot sensors (Option 2) which offers 3% energy saving but has moderate impact on the LCC (respectively 2% and 6 % increase for the electric and gas appliances) can stand as a reasonable short-term target.

Scenarios A which directly compile the benefits from 3 (electric hob) or 5 (gas hob) technical options are identified as BAT. However, in the case of gas hobs, that implies the introduction of electronic components that have side environmental impacts (notably on hazardous waste, acidification to air and heavy metal emissions to air and to water) compared to the base-case scenarios, but they are still in line with the domestic electric hob's environmental impacts.

Scenarios B, which only consider pot and cooking sensors, seem to be more cost-efficient and reasonable solutions than Scenarios A for both base-cases and would less affect the competitiveness of the market compared to Scenario A. This issue will be considered during Task 8 scenario analysis and the development of any regulation. It should also be highlighted that energy saving potential related to cooking and pot sensors are user-dependent, and therefore, they cannot be directly measured within the test standards of electric hobs or gas hobs. In that regard, different LLCCs and BATs could be defined for each base-case according to their dependency on user-behaviour (see Table 7-19).

For commercial appliances, the increased purchase price induced by the addition of (electronic) components would be easily compensated by the money savings related to energy cuts. For hobs, pot sensors seem to be the most promising improvement potential – even more than in the domestic sector as hobs tend to be continuously operating in the commercial facilities - and they stand as easy-to-implement short-term ecodesign features. Regarding grills, zone isolation and separate control would enable significant energy savings. For all commercial base-cases, the BAT solution combines several options and is always identified as LLCC, which could therefore be targeted in the short term.

Besides, user-dependent and user-independent scenarios have been introduced in order to differentiate the potential savings related the use of pot and cooking sensors.

Related savings (as well as costs) are more delicate to assess with no clear consensus from stakeholders and cannot be directly measured within a test standard.

Finally, it should be remembered that such results are based on various assumptions including the price and energy consumption of the base-cases, the choice and estimated size of improvement options, and the energy tariff. The prices of options may represent initial market entry prices for high-end models with few sales whereas if these options are widely adopted for hobs, economies of scale and competition are likely to reduce these to some extent.

Table 7-19: Summary of LLCCs and BATs for Lot 23 appliances.

Base-case	LLCC		BAT	
	Dependent on user-behaviour	Independent on user-behaviour	Dependent on user-behaviour	Independent on user-behaviour
BC1 : Domestic electric hob	Base-case	Base-case	Scenario A	Option 1
BC2 : Domestic gas hob	Option 5	Option 5	Scenario A	Scenario C
BC3 : Commercial electric hob	Scenario A	Option 2	Scenario A	Option 2
BC4 : Commercial gas hob	Scenario A	Scenario C	Scenario A	Scenario C
BC5 : Commercial electric grill/fry-top	Scenario A	Scenario A	Scenario A	Scenario A
BC5 : Commercial gas grill/fry-top	Scenario A	Scenario A	Scenario A	Scenario A