Re/genT Note[1]:15424 / CE16 / V1	Technical Note
Project	Ecodesign & Labelling Review Household Refrigeration, preparatory/review study
Subject	CECED Comments to Interim report (14.11.2015) Topic: Design options and LCC (chapter 12)
Date	11-12-2015
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To	CECED WG Cold and Review study team

1. Introduction

1.1. Document revision history

Release date	*Author*	*Version*	*Remark / document change*
9-12-2015	MJ	D1	First draft for internal discussion with ad-hoc group
10-12-2015	MJ	D2	Incorporation of comments of the ad-hoc group
11-12-2015	MJ	V1	Version for publication

1.2. General

The EU commission, DG Energy has ordered a review study of current eco-design requirements (regulation 643/2009) and labelling (delegated regulation 1060/2010) for cold appliances. A study team lead by VHK, the Netherlands, has presented a second interim report (dated 14-11-2015) which is to be discussed in a second stakeholder meeting, planned to be held in Brussels, 14-12-2015.

This notes collects observations from CECED, based on an analysis performed on chapter 12 dealing with design options and life cycle costs calculations.

The method applied is a classical method of choosing a number of energy saving options, estimate incremental costs and saving potential for given base case appliances, sorting the options by means of simple payback periods (lowest value first) and then cumulatively applying each option to the base case. Obviously cross effects between options must be considered.

A few issues have been noted with the technical model, these have been outlined in Re/genT note 15423 / CE15 / V2. In the analysis presented in this note these issues have been taken into account.

This note is accompanied with a spreadsheet model, which contains the model as used in the report together with the proposed modifications by CECED.

[1] The last digits refer to the version number of this note

The report introduces a number of energy saving options, which in principle are all energy saving options with some limitations as already addressed correctly in table 45. Obviously each option may result in different energy saving levels and costs, depending on the product.

There are a number of additional concerns:

1. The use of PCM is a questionable option on many products as this is normally not an easy option to apply as it requires proper solidification/melting during the cycle. The option and proposed savings have nevertheless been retained in this analysis.
2. Options as PCM and the use of a fan inside the appliance (F1) does also lead to a volume reduction. This has not yet been considered in the model.
3. Introducing a fan inside the product may give some (limited) saving on possibly a base case appliance. For a more efficient appliance this is more problematic given the energy consumption of the fan (released into the cabinet) versus the saving potential (possibly constant in relative sense, but less in absolute energy). Actually the report confirms this since option F1 is for all categories beyond the minimum LCC.
4. Option F2 (fan for the condenser) also has its limitation. Finding reliable fans at a level of 0.68 W is already challenging. In combination with e.g. a VSD with prolonged run times, it will work out negatively.
5. Increasing the insulation is generally not possible in all outward directions as is done in option I1, I2 and I3, given certain standardisation in depth and width direction (e.g. width of 59 and 69 cm are typical). The more realistic approach is to increase the height to compensate the get back the original volume. However, the effect on the calculation results will be small.
6. While increasing the insulation, in the report the evaporation temperature increases as well as the condenser temperature. However, in reality the heat load on the evaporator reduces resulting in a lower evaporation temperature, if the compressor capacity is maintained. The effect on the condenser is marginal but a small reduction on temperature is also possible there. This temperature effect has not yet been corrected for in this analysis, but it should be taken into account.
7. The effect of the vacuum panel insulation depends on the wall thickness of the appliance, where the effect is smaller the thicker the PU insulation. This seems to be taken properly into account in the model in the report.
8. For the glass doors there is probably some misfit in the data as for double glazing, E-Coating, krypton filled glass door (option D1) an incremental price of 66 EUR is more appropriate (with the conductivity of 1.3) compared to the base case. A better option is to use a triple glazing E-coating, argon filled door with conductivity of 1.1 and an incremental price of 46 EUR (assuming a ratio of 4 between manufacturing selling price and final unit price). This number has been used in the analysis in this note.
9. Also for the triple glazing E-coating, krypton fill the costs cannot be confirmed, and a value around 200 EUR in the end user price is more appropriate.

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3. LLCC of Category 1

The following remarks are made to table 49:

1. Option C3 uses a compressor of 1.98 nominal COP. Such compressor is only available at higher capacities, of interest to note is that due to this the energy saving with this compressor is smaller than with the lower efficient compressor C2, which is a realistic effect.
2. Option VSD is penalised by the lower COP value at the nominal capacity of 31 W. Again, this is realistic.
3. The insulation options are carried out with constant appliance volume by adding to height, width and depth the extra wall thickness of the foam. This is a correct approach for the analysis, though difficult to realise in praxis. Option I3 can be seen as “over insulated” as the thickness is very close to the optimal wall thickness for this product (85 mm).
4. Table 47 column Cold1 is not identical to table 49 column Cold1. The mistake is in the heat load calculation in table 47. Table 49 is further used as reference.

The following remarks are about table 59 (ranking) and 64 (cumulative):

1. Table 59, column LCC is not correct. Following the lifetime and the electricity costs reported (16 years and 0.205 EUR/kWh) the baseline product should have an LCC of 869 EUR. In table 64 column BC the correct value is given.
2. The ranking of saving options in table 59 is not the same as in table 64. A recalculation has been done showing that the order of options in table 64 looks more appropriate with the exception of option F2. This is presented as the first energy saving option while it has a higher simple payback time (SPB) than other options.
3. The EEI data reported as last row in table 64 is not correct. The base case has an index of 0.36 while the next columns have higher indices, which is not possible.

The calculations have been repeated with a slightly different order of options than in the report leading to the following chart:

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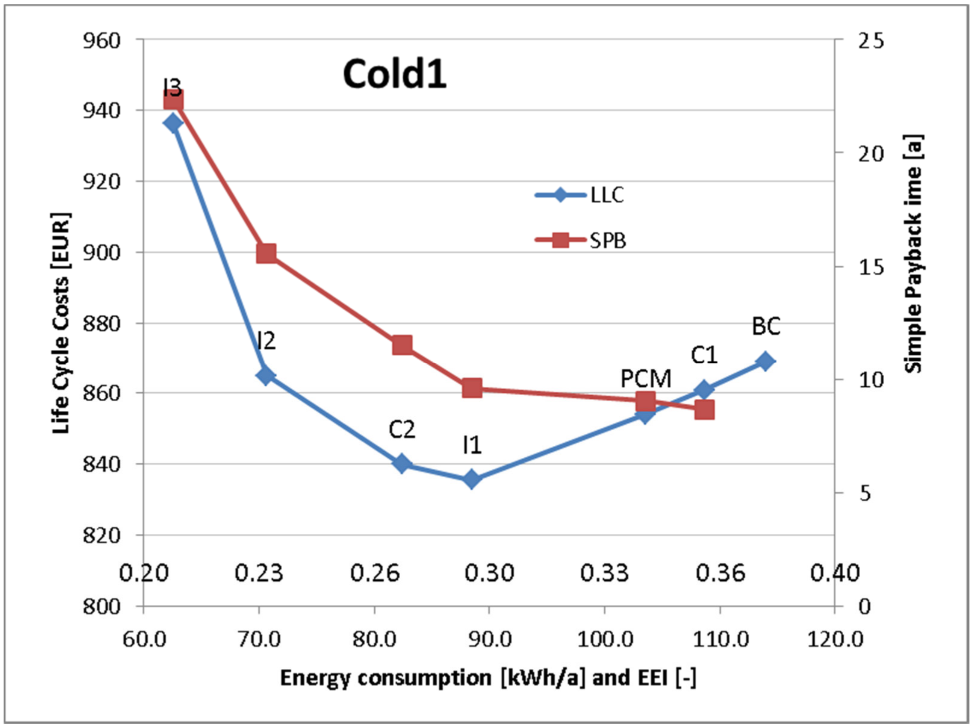


The final conclusion is not very different from the one in the report, the minimum value (LLCC) is around 830 EUR resulting in an index around 0.3 and a saving of app. 25 % in energy. Note that payback times are quite high.

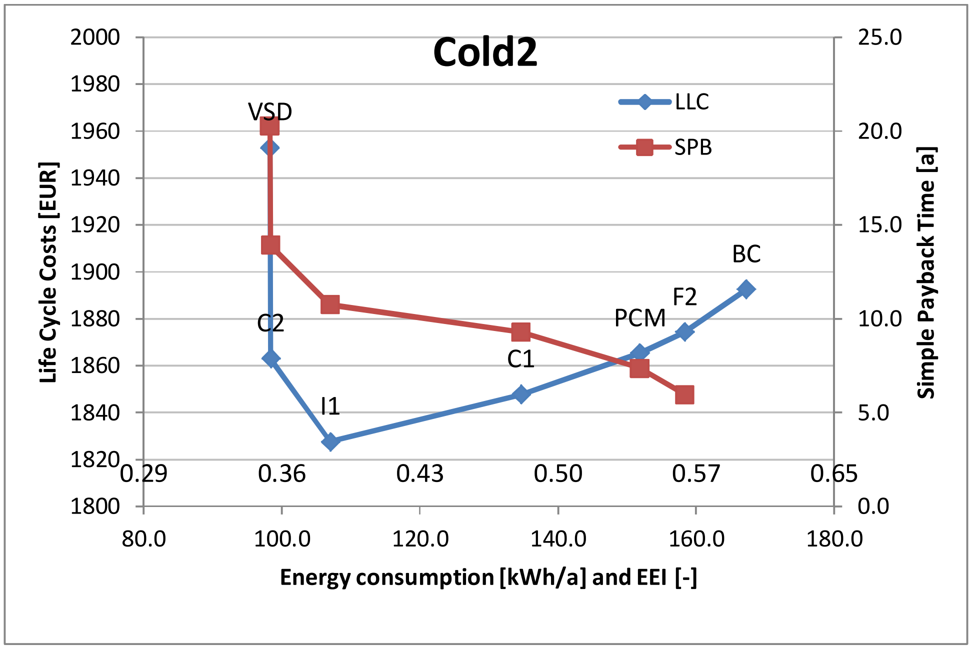
4. LLCC of Category 2

For the wine cooler the calculations of the base case have been carried out with a low wall thickness in the base case to represent an average appliance (20 mm). This is confirmed.

The following remarks are about table 60 (ranking) and 66 (cumulative):

1. The ranking of options in table 60 and 64 are not the same.
2. The base line product has an energy efficiency index of 0.60 instead of 0.56.

The calculations were repeated:



The minimum LCC is found here around an index of 0.40 instead of 0.31 in the report. The difference is mainly because of the index calculation of the base case. and by the fact that option D2 is not seen as an option. The saving is approximately 36 % in energy.

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5. LLCC of Category 7

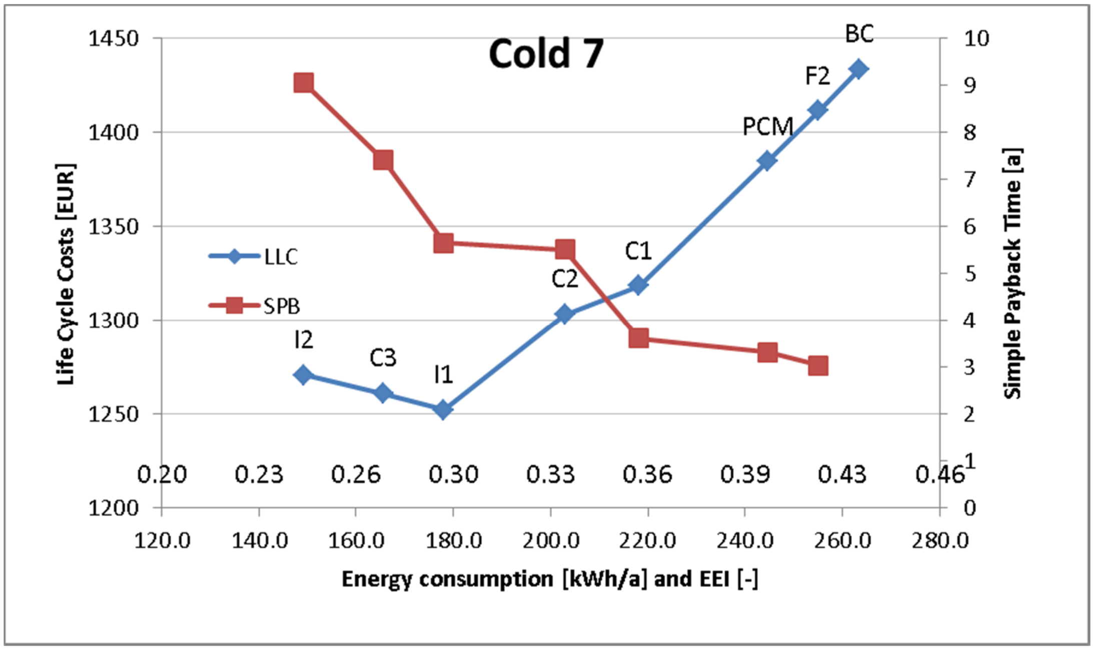
The following remarks are made to table 51:

1. Option I3 can be seen as over insulated as the thickness is over the optimal wall thickness for this product (99 mm) and difficult to produce.

The following remarks are about table 61 (ranking) and 66 (cumulative):

1. The EEI value reported in table 66 for the base case (0.33) does not seem to be OK. Following the data in the report (237 kWh for a volume of 309 dm3) the EEI is 0.384. This shifts all EEI values in the bottom row of table 66 as well as the anchor points on top of the table.
2. The volume of the base case model could not be confirmed with the model used in chapter 9. Following this model the volume should have been 297 dm3. This brings the index of the base line product to 0.392.
3. The ranking in table 61 is not the same as in table 66.

The calculations were repeated using the modified model for the combi described in Re/genT note 15423 / CE15 / V2. Note that due to this model change the base case product increased in consumption from 237 kWh/a to 263 kWh/a (or in terms of EEI from 0.39 to 0.42). This led to the following results:



The minimum LCC is found here at an EEI of approximately 0.3 whereas the report finds the minimum around 0.23. This difference is partly caused by the difference in the model, but also for a part due to a possible mistake in the EEI calculation in the report. The energy saving is app. 32 %.

6. LLCC of Category 8

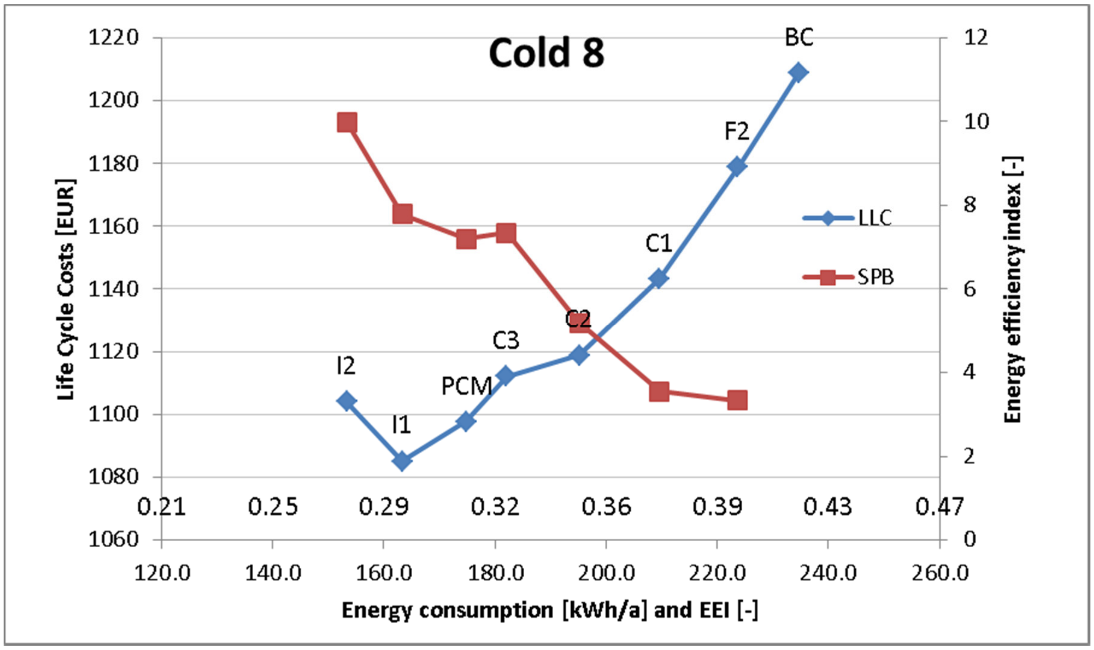
The following remarks are made to table 52:

1. Option I3 can be seen as over insulated as the thickness is over the optimal wall thickness for this product (99 mm) and difficult to produce.

The following remarks are about table 62 (ranking) and 67 (cumulative):

1. Table 62 and 67 show different values for the LCC value of the base case. Table 67 shows the correct value.
2. The ranking of saving options in the two tables is not the same (option F1 and option VSD).
3. The row with EEI values in table 67 does not seem to be correct (consequently also not the anchor points on top of the table). The base line case has index 0.42 instead of 0.36.

The calculations have been repeated with a slightly different order of options (excluding F1) than in the report leading to the following chart:



The final conclusion is different from the one in the report where the minimum value (LLCC) is around 1050 EUR at an index of 0.23 while here the minimum is 1085 EUR at index 0.29 with a saving of 30 % in energy.

7. Concluding remarks

On average for category 1, 7 and 8 energy savings of 30 % at LLCC level seem feasible to the base cases. The base cases used are A+ appliances with indices close to the limit of A+ (at least if the corrections proposed on the index are accepted).

For the wine cooler in category 2 a savings of app. 36 % at LLCC level seems feasible with a base case at index 60.

Category 9 has not been evaluated, but it is expected that similar findings as for category 8 would result.

The note in the report (page 147) about no-frost appliances is confirmed. All options except for the fan option (F1) can be applied. Note however, that option F1 was always beyond the minimum LCC value for all categories.

Regarding build-in the option of insulation is more limited. However, it should also be noted that only option I1 has been used to reach the minimum LLCC while specifically the other insulation options (I2 and I3) would be more difficult to realise in a built-in situation.

The time for review of the LLCC approach has been limited; a second review after the stakeholder meeting would be very useful.

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