Why the EN 50465 / SEC cogeneration methodology is fully consistent with the EED PES approach

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During the Technical and Impact Assessment Space and Water heaters WG1 meeting of 13 February 2020 the study team asked to demonstrate the fact that the proposed cogeneration calculation method for the SEC (Specific Energy Consumption) in EN 50465 Annex K complies with the PES (Primary Energy Savings) calculation formula from the EED (Energy Efficiency Directive 2012/27/EU) and is therefore consistent with the EED. This document answers this question.

The PES formula from the EED calculates the primary energy savings provided by cogeneration compared to separate heat and power production:

\[
PES = \left(1 - \frac{1}{\frac{\eta_{th} + \eta_{el}}{\eta_{eq} + \frac{CC}{1}}}ight) \times 100\% = 0
\]

Where the scope in the EED is heat and power together, this formula can also be applied to calculate the equivalent heating-only efficiency \(\eta_{eq}\) of a micro-CHP unit with a thermal efficiency \(\eta_{th}\) and an electrical efficiency \(\eta_{el}\) under the heating-only scope of ErP Lot 1 for use in Energy Labelling and Ecodesign (comparisons shall always be done based on the same outputs).

Solving the equation \(PES = 0\) with this PES formula derives the equivalent separate heating efficiency \(\eta_{eq}\) (or even better \(SEC = \frac{1}{\eta_{eq}}\)) for use in Lot 1 Ecodesign and Energy Labelling, which is the heating-only space heating efficiency with the same energy savings as the cogeneration appliance. This is exactly the “comparable information on the specific energy consumption” which is required by the framework Energy Labelling Regulation 2017/1369, recital 10.

The calculation is, using symbols from EN 50465 and efficiencies as fractional values:

\[
PES = \left(1 - \frac{1}{\eta_{th} + \frac{CC}{1}}\right) \times 100\% = 0
\]

\[
\frac{\eta_{th} + CC \cdot \eta_{el}}{\eta_{eq}} = 1<br>\Rightarrow <br>\frac{\eta_{th}}{\eta_{eq}} = 1 - CC \cdot \eta_{el}
\]

\[
\eta_{eq} = \frac{\eta_{th}}{1 - CC \cdot \eta_{el}}
or<br>SEC = \frac{1}{\eta_{eq}} = \frac{1 - CC \cdot \eta_{el}}{\eta_{th}}
\]

These are exactly the equivalent efficiency and SEC calculated in EN 50465:2015/A1:2019 clause 7.6.2.2 and Annex K, first formulas. This proves their consistency with the PES formula from the EED.

Because of this and because all the different methods described in the Task 1 report 4.7.2 give different results, the EN 50465 SEC method is the only one which is consistent with the PES formula in the Energy Efficiency Directive.
For higher values of $\eta_{el}$ the SEC of the mCHP part only without the supplementary heater gradually goes to 0 and even becomes negative. This only means that the primary energy saving of this part even exceeds the heat produced. In real installations this kind of mCHP’s however never operates without supplementary heater, either integrated or packaged or as an add-on. The negative value of the CHP part is always more than compensated by the positive value of the supplementary heater with a higher contribution to the total heat demand. So the final value of the package, which is the only one which really counts for the end user, will always be positive. For the accurate calculation of this positive value the negative SEC value of the small CHP-part is indispensable as an intermediate calculation result.