# *LCoH Calculation Method: Comparison Between Task 54 and Solar Heat WorldWide*

**INFO** Sheet A013

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| Description: | *Comparison of the levelized cost of heat calculation methods for solar thermal applications in IEA-SHC Task 54 (LCoHs) and in Solar Heat Worldwide (LCoH)* |
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| Download possible at: | http://task54.iea-shc.org/ |

## Introduction

In the framework of the IEA-SHC Task 54, the levelized cost of heat (LCoH) has been chosen to evaluate the costs of the heat produced by solar thermal systems over their life time. This enables the comparison of different designs and technological solutions. Other works ([1], [2], [3]) also use the notion of LCoH for solar thermal systems, but they have considered different assumptions for the definition of the terms of the LCoH equation. So a direct comparison of the values obtained from the different methods is not applicable. To avoid confusion, new acronyms were introduced in Task 54 (see Info Sheet A.1): LCoHs for the "substituted" (by solar) heat, LCoHc for the "conventional" heat and LCoHo for the "overall" system. The LCoH from the reference work of Solar Heat Worldwide (SHWW) is to be compared with LCoHs.

This info sheet aims at comparing the methodology of IEA-SHC Task 54 (Task54) and the methodology of Solar Heat Worldwide (SHWW). The method of Task 54 is described in info sheet A.1 (based on the FRoNT project [1]). The method of SHWW is described in the Solar Heat Worldwide report [3]. This info sheet shows a detailed analysis of the differences between both approaches illustrated by examples.

## Definition

As described in detail in the info sheet A.1, the LCoH for solar thermal applications is defined by the formula presented in Table 1. The formula is simplified, as depreciation $DEP_t$ and residual value $RV$ are not considered in Task 54. For comparison, the formula and nomenclature used in SHWW is presented in the same table.

## Comparison

The main difference between the two calculation methods is the definition of the **solar energy contribution**: the energy yield from the solar thermal system. In the IEA SHC Task 54, the LCoHs is based on the *saved final energy*: the amount of final energy (energy demand at end-user) substituted by solar energy. In the Solar Heat Worldwide report the LCoH is based on the *solar energy yield*: the amount of thermal energy delivered by the solar thermal collector in kWh per m² gross collector area installed (thermal losses in solar loop piping and thermal energy storage not considered). Thermal losses are very much dependant on the configuration of the solar system, the backup system and the load profile of the user. Therefore SHWW choses to base the calculation on the gross solar contribution –no thermal losses are allocated to the solar part (best case scenario, independent from the backup system)–, whereas Task 54

assumes a distribution of the losses between solar and conventional by defining in details a reference system.

There are other differences regarding the economic assumptions. In the initial investment, Task 54 considers a "**credit for conventional storage**", which is not taken into account in SHWW. This difference is also due to the fact that the backup system is not considered in the SHWW LCoH calculation.

*The economic hypotheses also affect the calculation:* ***discount rate*** *r,* ***life time*** *T or* $t_{ges}$*,* ***maintenance costs*** $C_t$ *or* $A_t$*.*

Table 2 summarises the comparison of hypotheses in both calculation methods. The values given as example correspond to the reference case of Domestic Hot Water in a single family house in Austria (DHW-SFH-A, Info Sheet 04).

The diagram on Figure 1 shows the sensitivity analysis of the LCoHs with Task 54 method. It shows the impact on the LCoH of each hypothesis which is different in SHWW. This enables to visualize where the differences originate from.

Comparing the values in various cases shows that the LCoH from SHWW are often higher, but not systematically. This is illustrated in Table 3, comparing the Austrian reference systems. The results from both methods can strongly differ, depending on the cases: for Domestic Hot Water, Task 54 method is in these cases more optimistic, but for Combi system (combined solar domestic hot water and solar space heating), both methods give in this case similar LCoH.

## References

[1] Baez, M.J., Larriba Martínez, T., (2015). *"Technical Report on the Elaboration of a Cost Estimation Methodology"*, No. D.3.1. Creara, Madrid, Spain.

[2] Mauthner, F., Herkel, S., (2016). "*Technology and demonstrators - Technical Report Subtask C – Part C1*". AEE Intec, Gleisdorf, Austria.

[3] IEA-SHC, 2017. "*Solar Heat Worldwide*". URL: http://www.iea-shc.org/solar-heat-worldwide (Accessed 21.12.2017).

*Table 1 Comparison of the formula for the calculation of LCoH in Task 54 and Solar Heat Worldwide*

| **Solar Heat Worldwide** | **IEA SHC Task 54** |
|---|---|
| $$LCoH_{SHWW} = \frac{I_0 + \sum_{t=1}^{t_{ges}} \frac{A_t}{(1+r)^t}}{\sum_{t=1}^{t_{ges}} \frac{SE}{(1+r)^t}}$$ | $$LCoHs_{Task54} = \frac{I_0 - S_0 + \sum_{t=1}^{T} \frac{C_t}{(1+r)^t}}{\sum_{t=1}^{T} \frac{E_t}{(1+r)^t}}$$ |
| where:<br>$LCoH_{SHWW}$: levelized cost of heat [€/kWh]<br>$I_0$: specific solar thermal system costs incl. installation (excl. VAT and subsidies) [€/m²$_{gross}$]<br>$A_t$: fixed and variable O&M expenditures in the year $t$ [€/m²$_{gross}$]<br>$SE$: solar energy yield in the year $t$ [kWh/m²$_{gross}$]<br>$r$: discount rate in %<br>$t$: year within the period of use (1,2,…$t_{ges}$)<br>$t_{ges}$: period of use (solar thermal system life time in years) [a] | where:<br>$LCoH_{Task54}$: levelized cost of heat in €/kWh<br>$I_0$: initial investment in €<br>$S_0$: subsidies and incentives in €<br>$C_t$: operation and maintenance costs (year t) in €<br><br>$E_t$: saved final energy (year t) in kWh<br>$r$: discount rate in %<br><br>$T$: period of analysis in years |

*Table 2 Comparison of hypotheses in LCoH calculation methods from Task 54 and Solar Heat Worldwide. Hypothesis that differ are emphasized in italic. Example values refer to the reference case Domestic Hot Water in single family house in Austria (DHW-SFH-A, Info Sheet A04)*

| | **Solar Heat Worldwide** | **IEA SHC Task 54** |
|---|---|---|
| | All costs are excluding value added tax. | All costs are excluding value added tax. |
| Investment $I_0$ | *Solar system costs refer to end-user (customer) prices.*<br>Example: 5740 €/6 m² | *Solar system end-user cost, with credit for the costs of the conventional storage.*<br>Example: 5025 € |
| Operation and maintenance costs $C_t$ | *0.5 % of investment costs $I_0$*<br><br>Example: 29 €/6 m² | *Electricity costs for pump operation and 2 % of $I_0$*<br>Example: 108 € |
| Discount rate *r* (nominal) | *3 %* | *0 %, because 0 % of inflation is considered* |
| Technical life time *T* | *25 years* | *25 years (AT), 20 years (DE)* |
| Energy yield *Et* | *Solar collector yield in kWh/m² gross area (thermal losses are not considered, because they are very much system dependent)*<br>Example: $E_t$ = 2409 kWh/6 m² | *Saved final energy (actual saved energy thanks to the solar system, which depends on the system thermal losses and the backup system efficiency )*<br>Example: $E_t$ = 2594 kWh |
| Inflation *i* | No inflation considered 0 % | No inflation considered 0 % |
| Depreciation $DEP_t$ | Not considered | Not considered |
| Subsidies $S_0$ | No subsidy considered | No subsidy considered |
| Residual value RV | No residual value considered | No residual value considered |
| **LCoH solar part** | **$LCoH_{SHWW}$**<br>**Example: 0.149 €/kWh$_{th}$** | **$LCoHs_{Task54}$**<br>**Example: 0.119 €/kWh$_{th}$** |

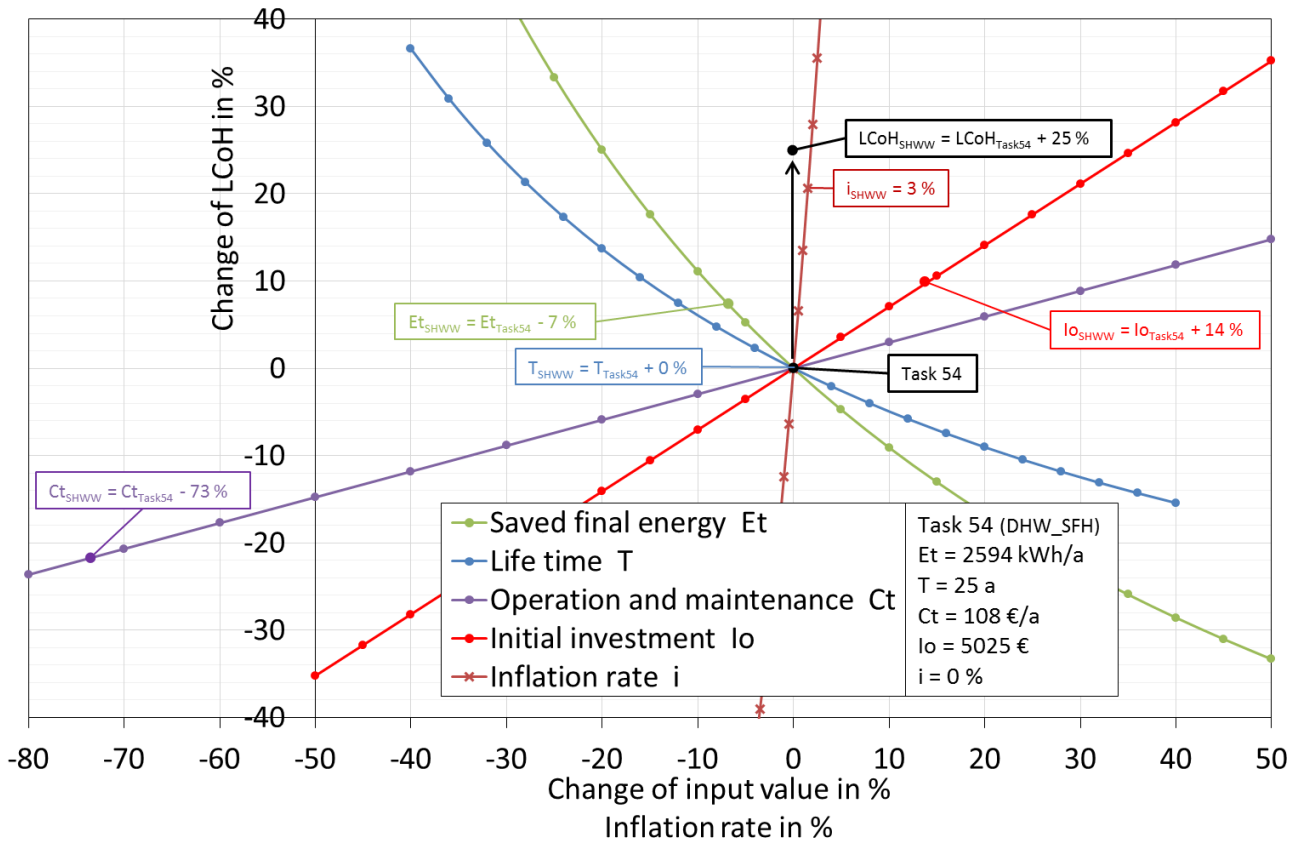


*Figure 1: Sensitivity of LCoH with Task 54 method and influence of the different hypotheses in SHWW. Values are given for the reference case of Domestic Hot Water in a single family house in Austria (DHW-SFH-A, Info Sheet A04)*

*Table 3: Comparison of LCoH with Task 54 and SHWW methods for different cases.*

| Reference cases | Task 54<br>LCoHs (€/kWh$_{th}$) | SHWW<br>LCoH (€/kWh$_{th}$) | Difference in %<br>(SHWW in comparison to Task 54) |
|---|---|---|---|
| DHW-SFH | 0.119 | 0.149 | 25% |
| Combi-SFH | 0.152 | 0.147 | -3% |
| DHW-MFH | 0.0564 | 0.0793 | 41% |

Cases: DHW-SFH: solar Domestic Hot Water in Single Family House
Combi-SFH: solar Domestic Hot Water + solar space heating in Single Family House
DHW-MFH: solar Domestic Hot Water in Multi Family House

[1] To avoid confusion with the results of other works ([1], [8], [9]) also using the notion of LCoH for solar thermal systems, new acronyms were introduced in this Info Sheet. As previous studies have considered different assumptions for the definition of the terms of the LCoH equation, it does not make sense to compare the values they obtained with the LCoHs, LCoHc and LCoHo values defined here. A detailed explanation of the differences between the approaches chosen in the framework of IEA-SHC Task 54 and in the Solar Heat Worldwide report [9] can be found in Info Sheet A13 [10].