Life cycle cost analysis of (LT)DH projects

1 Introduction

1.1 Problem and aim

- Overall question: LTDH vs. DH - which is the less expensive solution over a whole life cycle?
- Presumption of conventional infrastructure, e.g. fossil fuel driven DH system:
    - Less expensive at the beginning (initial investment)
    - More expensive during their life cycle due to higher operating, maintaining, and end-of-life costs
- Presumption of environmentally friendly infrastructure, e.g. LTDH system:
    - High upfront investment costs due to newer technologies
    - Less expensive during the life cycle
- Method is needed to find out which is true and to ensure profound decisions on future developments

➔ Life cycle cost analysis can be suitable method for determining life cycle costs of different project alternatives

1.2 Definition of terms

1.2.1 Life cylce cost analysis

- Also known as Life Cycle Costing (LCC)
- methodology for systematic economic evaluation of life-cycle costs over a certain period of time, considering [1]:
    - Construction
    - Maintenance
    - Operation
    - End of life

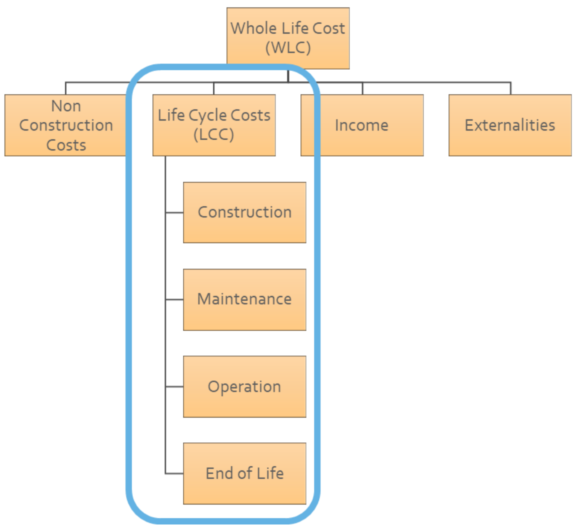

Fig. 1: Components Life cycle costs (based on [1] p. 7

1.2.2 Life cycle costs

Costs of an asset or its parts throughout its life cycle while fulfilling the performance requirements [1]

1.2.3 End-of-Life

- Last stage of Life-Cycle, including:
    - Decommissioning
    - Deconstruction or leaving components on site
    - If deconstruction:
        - Disposal or
        - Recycling

2 Performing Life Cycle Cost Analysis

2.1 Calculation method

- Net present value method for calculating life cycle costs
- Time of consideration: life cycle length
    - If object of consideration will be compared to another system alternative: same life cycle length as alternative
    - If no comparison or input will be done, tool will automatically choose the longest technical lifetime of components list as life cycle length
    - Max. 100 years
- Either LCC = I + A + R + E (if end-of-life scenario is known):
    - LCC = life cycle costs
    - I = construction costs (initial investment)
    - A = annual operating & maintaining costs
    - R = reinvestment costs
    - E = end-of-life costs
- Or LCC = I + A + R – Res (if end-of-life scenario is not known):
    - Res = residual value

2.2 Needed information for calculating [2]

- Input 0: general input
    - Discount rate: used for calculating the present value of the investment
    - Optional: lengthof considered life cycle. Only needed if life cycle length is already known or comparison with system alternative with known life cycle length is known.
- Input 1: construction costs
    - Additional costs
    - All construction parts, each with year of commissioning, specification, technical lifetime, quantity, price per unit. Optional: information on dimension / size
- Input 2: operation & maintenance
    - Costs for fuel or purchased heat: happens by selecting 1-3 heat sources. Depending on which type of heat source is selected, the tool will automatically choose a suitable type of fuel. The user has to define the purchase price of the fuel and its expected cost increase per year.
    - General operating expenses (without fuel costs): include both costs for operating the planned project (incl. electricity, insureance, taxes) and staff costs but no costs for fuel or purchased heat. Either blanket [€] or dependent upon the value of the investment [%].
    - Maintenance: costs per year, either blanket [€] or dependent upon the value of the investment [%], as well as the year from which the costs for maintenance shall be noticed of and the expected cost increase per year.
    - General operating system data
        - Hours of full utilisation of DH system per year
        - average heat losses of DH system (transmission losses)
        - Increase in heat capacity is necessary when heat-generating plants are added to the DH system step by step, gradually, or when buildings (users) are not connected to the grid at the same time.
        - Allocation of distributed heat to generating plants when more than one generating plant is producing heat and its thermal efficiency (if CHP-plants are in use, then the electrical efficiency as well)
- Input 3: end-of-life scenario
    - Either consideration of residual value after end of life-cycle
    - Or detailed information on end-of-life scenario is known for each construction part:

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- Decommissioning costs
- Costs for either deconstruction or left on-site
- If deconstruction: costs for either disposal or recycling of construction parts

2.3 Results

The tool calculates the total costs at the of one life cycle, e.g. 80 years, and the levelized costs of energy, i.e. heat, per MWh.

construction costs (initial investment)	169.717 €
operation costs	891.206 €
maintenance costs	25.799 €
residual value	-128.971 €
total life cycle costs after 80 years	**957.751 €**
levelized costs of energy, i.e. heat (LCOE) per MWh	**14 €**

Fig. 1: main results, example, own graphic [2]

The life cylcle costs are further determined for each life cycle stage: construction, operation, maintenance, and end-of-life or residual value.

3 Conclusion

- Tool is able to determine Life Cycle Costs of (LT)DH systems. The results can be sed for comparison with system alternatives by creating a new excel file for each alternative.
- Transparent method that uses standard calculation methods of business economy and works with MS Excel. No special knowledge of programming or coding is necessary.
- Time value of money is being considered.
- Own adjustesments are still possible.
- If comparisons with other system alternatives are done, the same framework conditions have to be applied (e.g. life cycle length, discount rate, etc.)
- Results do not refelect the reality but give a predicition on life cycle costs.
- Period of consideration is limited to 100 years.

Sources

[1] ISO 15686-5:2017-07, „Buildings and constructed assets - Service life planning - Part 5: Life-cycle costing".

[2] Project output, [online] http://www.lowtemp.eu/what-we-do/ Available at Financing Schemes and Business Models [Last access on 25th March 2021].

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