Life Cycle Costs of (LT)DH projects

Introduction and application of a calculation method

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LowTEMP training package - OVERVIEW

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Introduction

- Intro Climate Protection Policy and Goals
- Intro Energy Supply Systems and LTDH
- Energy Supply Systems in Baltic Sea Region

Energy Strategies and Pilot Projects

- Methodology of Development of Energy Strategies
- Pilot Energy Strategies – Aims and Conditions
- Pilot Energy Strategy – Examples
- Pilot Testing Measures
- CO_2 emission calculation
- LCA calculation

Financial Aspects

- Life cycle costs of LTDH projects
- Economic efficiency and funding gaps
- Contracting and payment models
- Business models and innovative funding structures

Technical Aspects

- Pipe Systems
- Combined heat and power (CHP)
- Large Scale Solar Thermal
- Waste & Surplus Heat
- Large Scale Heat Pumps
- Power-2-Heat and Power-2-X
- Thermal, Solar Ice and PCM Storages
- Heat Pump Systems
- LT and Floor heating
- Tap water production
- Ventilation Systems

Best Practice

- Best Practice I
- Best Practice II

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1. Introduction

Problem, aim and definitions of terms

Problem and aim

Overall question: LTDH vs. DH - which is the less expensive solution over a whole life cycle?

- 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
- Environmentally friendly infrastructure, e.g. LTDH system:
  - High upfront investment costs due to newer technologies
  - Less expensive during the life cycle

→ Is this true? If so, promotion for LTDH systems!

- Tool for performing LCCA & determining life cycle costs of LTDH projects
- Stakeholders:
  - LowTEMP's project partners
  - Public authorities
  - DH suppliers & operators
  - investors
  - planners
  - engineers

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Definition of terms

Life Cycle Cost Analysis (LCCA)

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

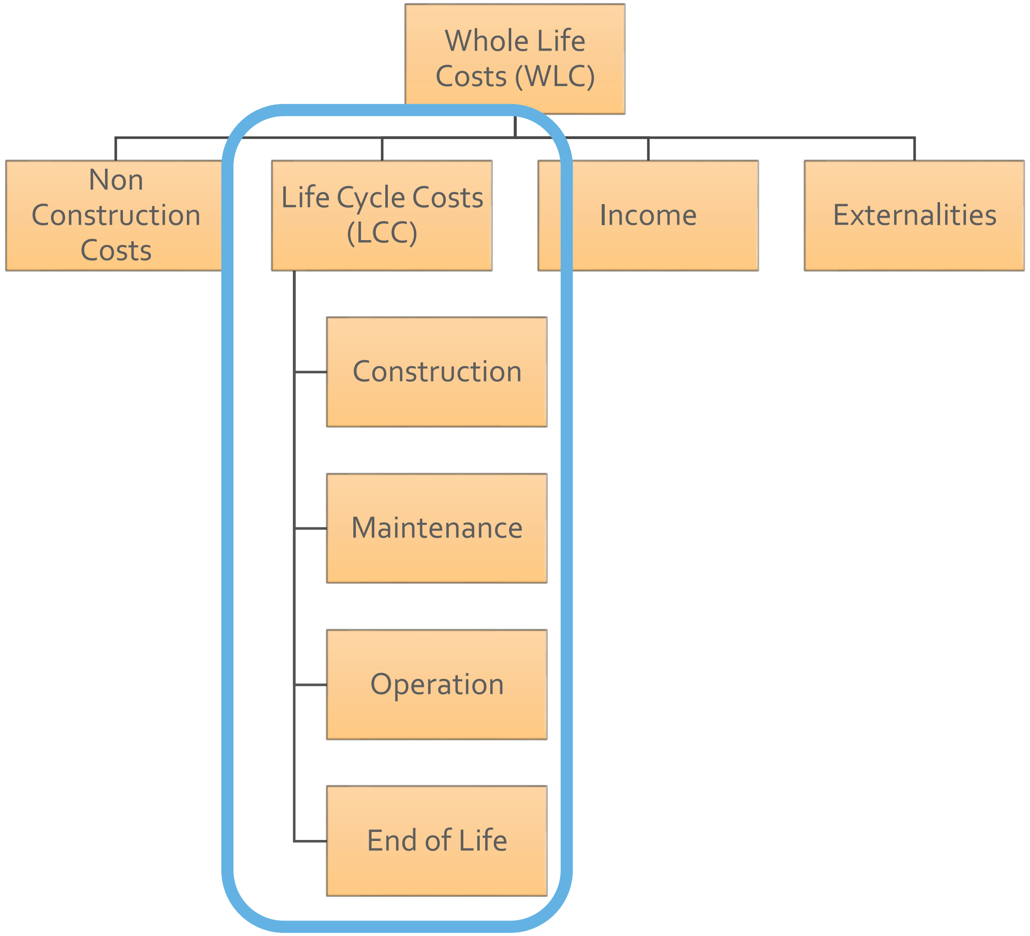

Fig. 1: Components Life cycle costs (based on [1] p. 7

Definition of terms

Life Cycle Costs

costs of an asset or its parts throughout its life cycle while fulfilling the performance requirements (1)

End-of-Life

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

Discount rate

interest rate used in dynamic techniques to calculate the present value of future cash flows

2. Implementation

Output, structure of the tool, calculation method, example of application, needed information and results

Output

- Analysis of LCCA and LCCA of DH systems (pdf, for further information on topic)
- Calculation tool for performing LCCA for DH systems (excel tool)
- Manual on performing LCCA, possible sources of information, and comparing different systems (pdf, in use with excel tool)

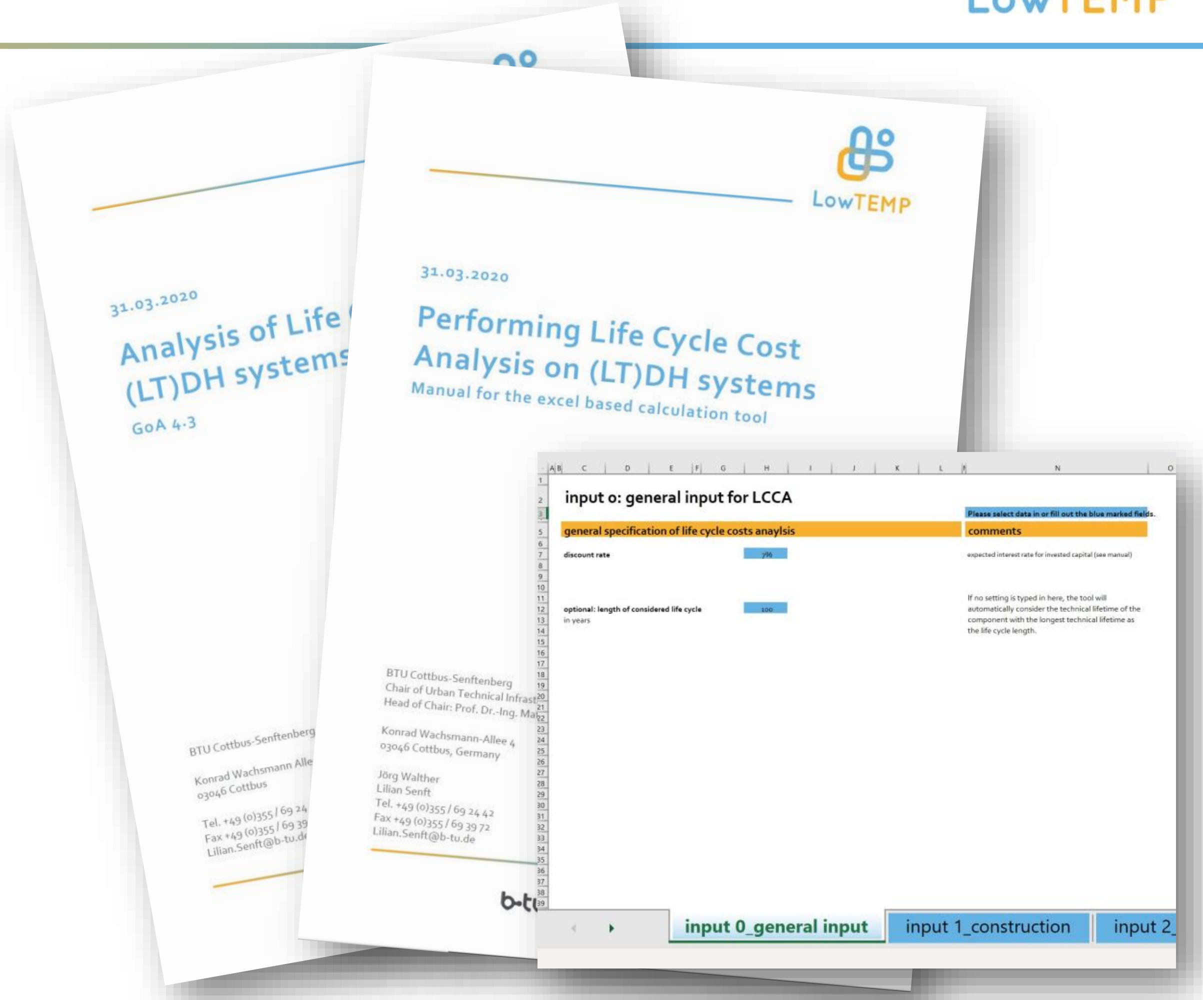

Fig. 2: Examples Output concerning LCCA, own graphic [2]

Structure of the tool

- Excel based tool
- Several spreadsheets:
  - Input spreadsheets 0-3: information on project is needed on general information, construction & initial investment, operating & maintaining, and end-of-life scenario
  - Add. Calc. 1-2: additional calculations, works automatically. No input required
  - Results: statement on life cycle costs
  - Background data: contains drop down menues, references, and text blocks. Input possible.
  - Version: informative, no input required.

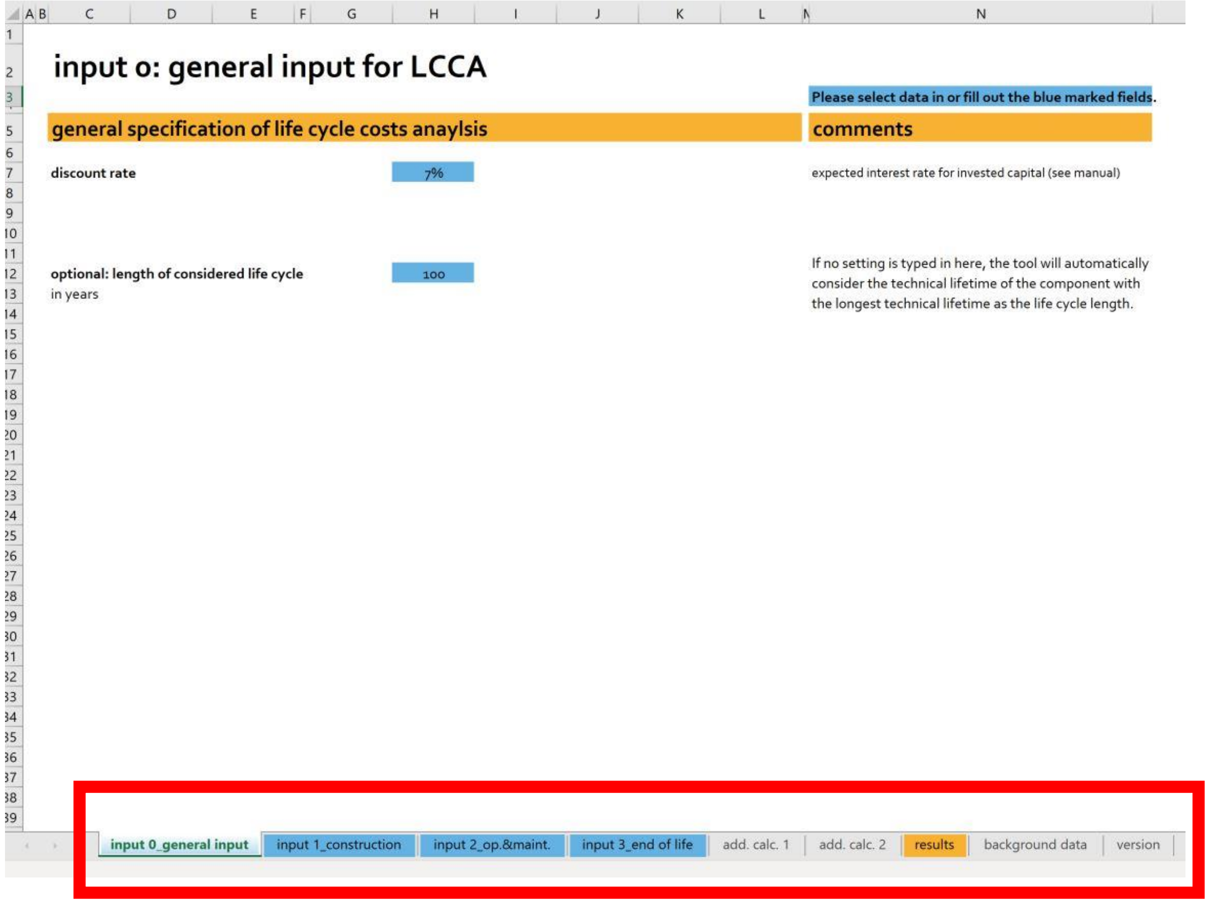

Fig. 3: Screenshoot Exceltool, own graphic [2]

Calculation method

Life Cycle Costs

- 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

Net Present Value

- Method: Net Present Value (NPV)
- Calculation: $NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+k)^t}$
  - NPV = net present value [€]
  - n = lifespan of the investment of the measure [years]
  - t = time index number, a certain year of the investment [w.d.]
  - CFt = cash flow in year t or in other words the difference between costs and incomes in year t [€]
  - k = discount rate [%]

Prerequesites

What information do users need?

- Object of consideration
- If comparison with other DH systems: life cycle length
- construction costs (initial investment)
- Costs for operating and maintaining
- If available: costs on end-of-life scenario
- Technology data

(all costs and revenues without VAT)

Prerequisites – object of consideration

- Whole (LT)DH systems
- Accounting boundaries: including everything that is needed to fulfill project objective
- Considering largest accounting boundaries possible (see figure)

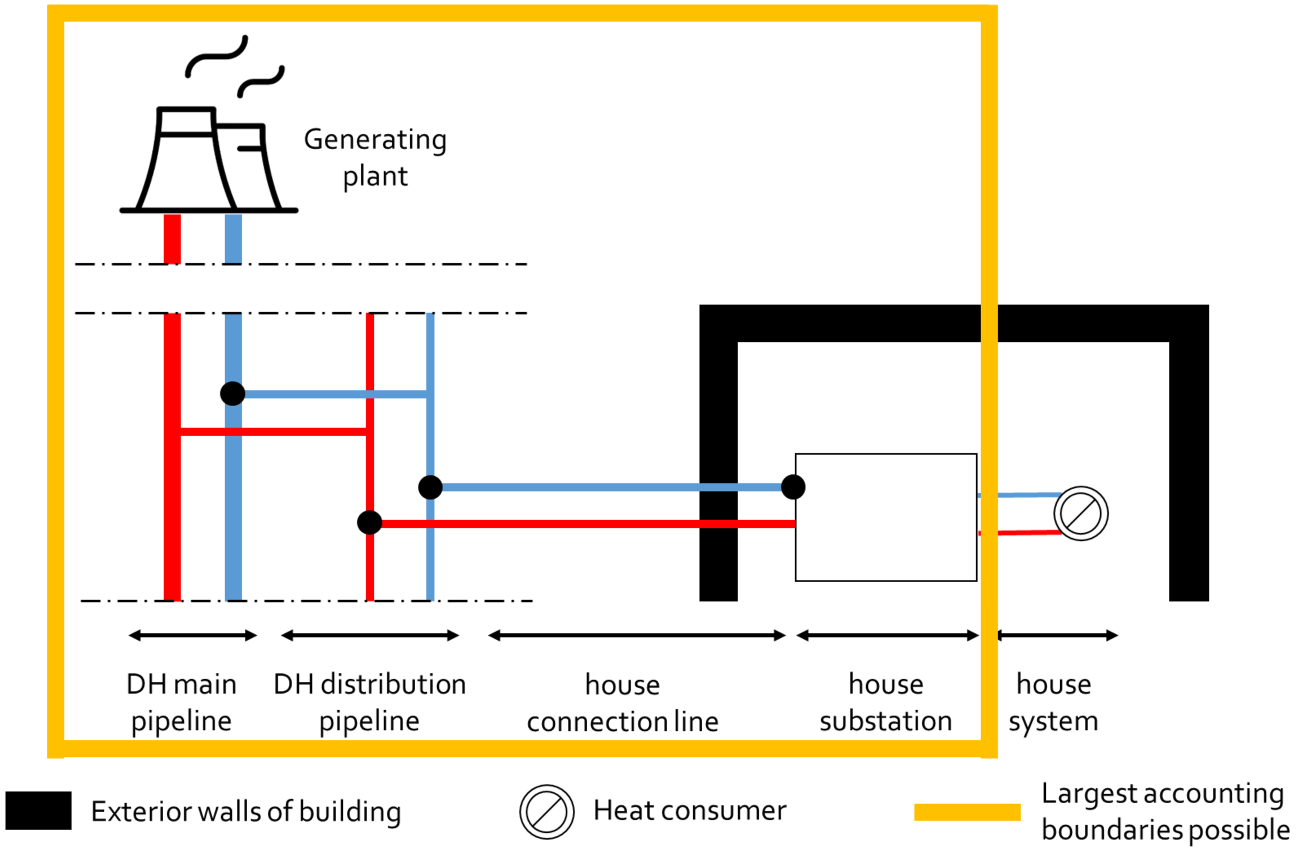

Fig. 4: Largest accounting boundaries possible for the tool [3]

Prerequisites – general information and costs

Discount rate

- Manual gives recommendation for choosing discount rate according to EU regulations and recommendations

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

construction (initial investment)

- components that are necessary to build the project objective including their
  - Year of commissioning
  - Costs
  - Technical lifetime
- Additional costs
- Manual with detailed list of possible investment costs parameters and usual technical lifetime

Prerequisites – costs and further information

Costs for operating and maintaining

- Operating costs
  - Fuel costs
  - General operating costs as x % of heat production in €/MWh or lump sum in €/a
- Costs for maintaining
  - X % of investment or lump sum in €/a
  - Expected cost increase in %/a

Technology data

- Heat distribution
  - Hours of full utilization in h/a
  - Average heat losses of the DH system in %
- Heat capacity
  - Year of installation or deinstallation of generating plant
  - Performance in kW or amount of generated heat in MWh/a
- Allocation of distributed heat to generating plants
  - Thermal efficiency in %, if heat pumps are used then COP or SPF
  - If CHP is used: electrical efficiency
  - If more than one generating plant is used: share in work

Prerequisites –end-of-life scenario

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End-of-life scenario

- If detailed information on the end-of-life scenario is known to the user, costs for
  - decommissioning
  - deconstruction or leaving components on site
  - If deconstruction: disposal or recycling
- If no detailed information on the end-of-life scenario is known to the user, the tool will automatically determine the residual value of the whole system

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Example of calculation: Gulbene pilot measure

- Installation of local heating system in 2019
- Providing heat for 3 municipal buildings, generated by biomass boiler (199 kW_{th})
- Distribution via small local heat grid
- Smart metering system within all buildings that are provided with heat from small local heating system

Fig. 5: Utility room LT local heating system, Photo: Sandis Kalniņš [4]

Example of calculation: Gulbene pilot measure

Accounting boundaries

- Project objective: installation of a local heating system
- Accounting boundaries including:
  - Biomass boiler
  - Small local heat grid
- Not considered: smart metering system because:
  - not necessary for project objective (installation of a local heating system) → System would run without smart metering system
  - component falls outside the accounting boundaries

Live-Demonstration of inputs via the tool

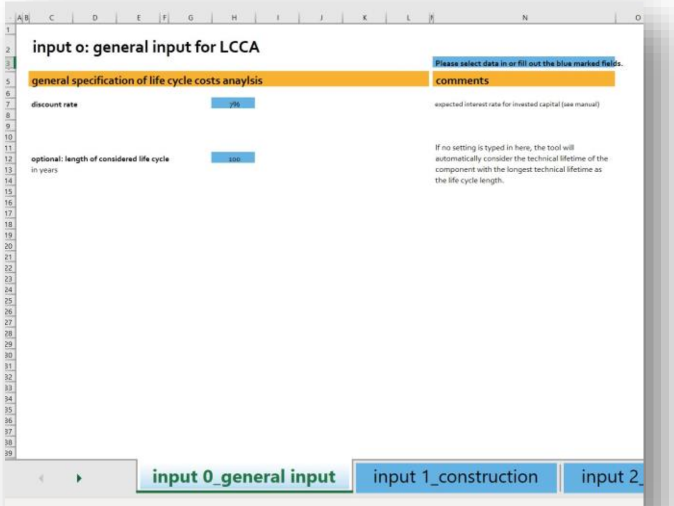

Fig. 3: Screenshoot Exceltool, own graphic [2]

3. Conclusion

Conclusion

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Possibilities

- Users are enabled to
  - Determine Life Cycle Costs of a (LT)DH systems
  - Compare with system alternatives (creating new excel file)
- Transparent calculation methods following state of technology and knowledge
- Considering time value of money
- Own adjustments are possible

Limitations

- So far…
  - Longest life cycle length = 100 years
  - 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 reflect the reality but give a prediction on life cycle costs

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Sources

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2. Project output, [online] http://www.lowtemp.eu/what-we-do/ Available at Financing Schemes and Business Models [Last access on 25th March 2021].
3. Largest accounting boundaries possible for the tool, own source following BAFA, 2017, p. 5 and Nuclear Power Plant by By Viktor Ostrovsky from the Noun Project [Online]. Available at https://thenounproject.com/icon/792572/ [Last access on 25th March 2021].
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