Resource exergy analysis (REA)
A key to comprehensive technology assessment including solar heat networks

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Climate protection without sound assessment methods is like driving a car with a painted windscreen – accidents are inevitable.
Climate protection without a realistic and comprehensive assessment of technologies?

→ Greenwashing

→ Bad investments

→ More climate change
Why a new evaluation method?

- Current assessment systems are not sufficiently comprehensive

  - **Primary energy factors (fossil):** often indistinguishable for renewable energies

  - **Primary energy factors (total):** renewable energies and fossil energies almost the same

  - **Renewable energies:** no guarantee for climate protection (e.g. palm oil from rainforest clearance)

  - **Direct greenhouse gas emissions:** important, but not sufficient on their own
    - indirect emissions due to wastefulness: not considered
What is exergy?

- Energy is only converted. Exergy is consumed.
- \( \text{Exergy} = \text{energy} \cdot \text{energy quality} \)
- Exergy → valuable energy
Exergy: An analogy

Energy analysis: Accounting with coins

Exergy analysis: Accounting with money
Definition: Resource exergy

Resources

= energy and raw materials from the environment

→ measurable in exergy
• Considers exergy & sets consistent balance boundaries
  ▪ Energy & energy quality are considered (\(\rightarrow 1 \& 2\) law)
  ▪ Only directly storable energy flows are considered resources
  ▪ Goal: Help minimize waste of resources

• Over a decade of successful use in research and practice
  ▪ Used in government funded projects and internationally
  ▪ Enables realistic comparison of district heating and cooling with individual solutions
How REA helps reducing greenhouse gas emissions?

1. Energy - still partly fossil until the foreseeable future (electrification of industry, mobility and hydrogen)

2. Low-greenhouse gas energy
   - Expansion as fast as policy allows & use as much as the grids allow

3. Waste of resources
   - Increases the demand for energy resources - which are potentially high-carbon due to point 2
   - Indirect greenhouse gas emissions arise that are difficult to determine

4. REA makes waste of resources transparent
   - Wastefulness and associated indirect emissions can be minimised
Why REA comparison? Solar thermal vs. PV

- Primary energy analysis shows an unrealistic picture
- REA shows that solar thermal is 3x better suited than PV for direct building heating
  - CO2e would show only 2x
How can REA support solar thermal networks

- Support argumentation for solar thermal networks by quantifying its advantages

- Show that solar thermal networks already provide a green, resource saving solution
  - Cannot easily be provided by electrification with grid mix until it is carbon-free

- Helps considering solar thermal networks in comparison with other solutions (DH vs individual)

- Allow quality control of analysis results
  - Mitigate risk of greenwashing and costly mistakes
How can REA help with well-informed decision-making?

- Traffic lights and percentages of savings
  - easy to understand by non-technical people

- Reference for savings can be set freely
REA visualisation: exergy passes
What can authorities do?

- Inform their technical staff of the REA calculation guideline
  - Contains all explanations, equations and LCA data
- Get accustomed to resource exergy as a key metric for savings and efficiency
- Require REA for transformation plans at least as a quality check
  - especially when heating and cooling are included
- Contact me for information on how to apply it most easily
Heat and transformation plans without scientific validation are like a car without official approval (MOT / TÜV)

you can't rely on them.
If you have any questions on how to apply REA most effectively, or learn more about using exergy passes for faster decision-making, contact:

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REA vs. greenwashing?

- Renewable energies
  - Wastefulness becomes transparent even with low-greenhouse gas technologies including solar

- Use of hydrogen
  - Upstream chain and high energy quality are taken into account

- Combined heat and power – fossil, nuclear and renewable
  - Fair allocation to electricity and heat

- Solar thermal / geothermal / waste heat / heat pumps / thermal storage / direct cooling
  - Appropriate consideration of the energy quality of heat
REA compared to primary energy analysis?

- Takes into account not only the energy but also the energy quality
  - Differences in the value of heat and electricity can be determined physically

- Takes into account all losses from the resource to utilisation
  - Prevents externalisation of losses and "thinking too short"

- Unified overall system view
  - All systems can be compared comprehensively based on science
    - Consistent answers become available
  - Integration of sufficiency, efficiency and energy recycling
Example 1: Why REA? - Efficiency

- Stark differences in efficiency assessment!
- Energy analysis overlooks optimization potential…

Example: Space heating - gas boiler: 74 % Energy, 3 % Exergy

Space cooling - el. chiller: 112 % Energy, 1 % Exergy
Example 2: Why REA? - Indicators

Energy indicators:
- Often not comparable

Exergy indicators:
- Always comparable

Electricity
Cooling at 5°C
Steam at 195°C