

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*

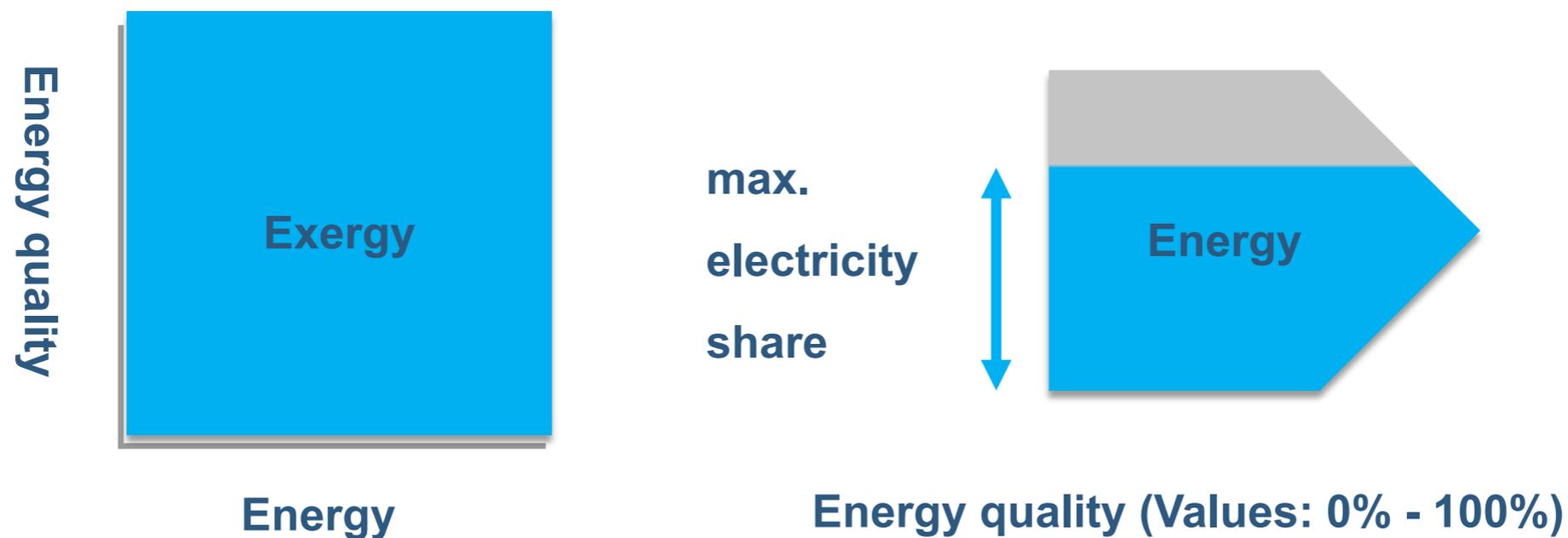
→ *Bad investments*

→ *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.
- $Exergy = energy \cdot energy\ quality$
- Exergy \rightarrow valuable energy

Exergy: An analogy

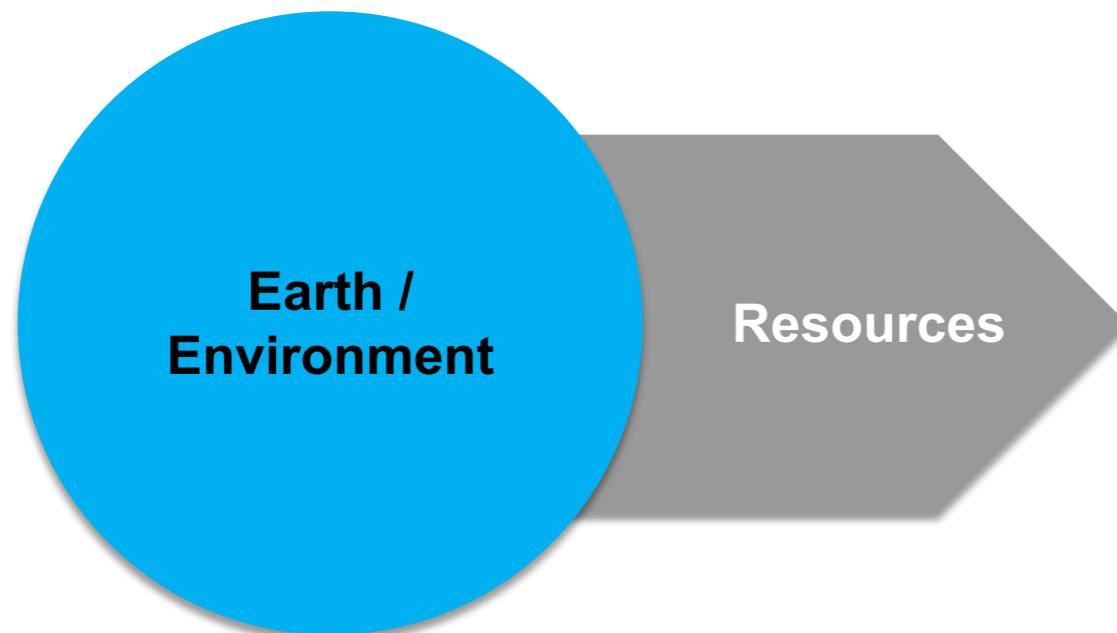
**Energy analysis:
Accounting with coins**



**Exergy analysis:
Accounting with money**



Definition: Resource exergy



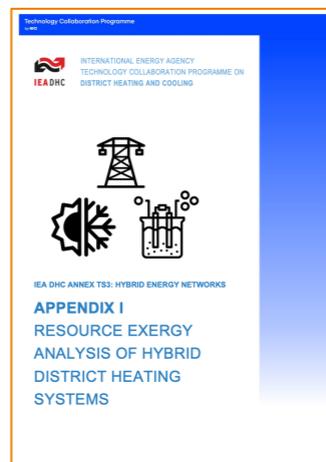
Resources

=

energy and raw materials from
the environment

→ measurable in exergy

REA - Resource exergy analysis



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

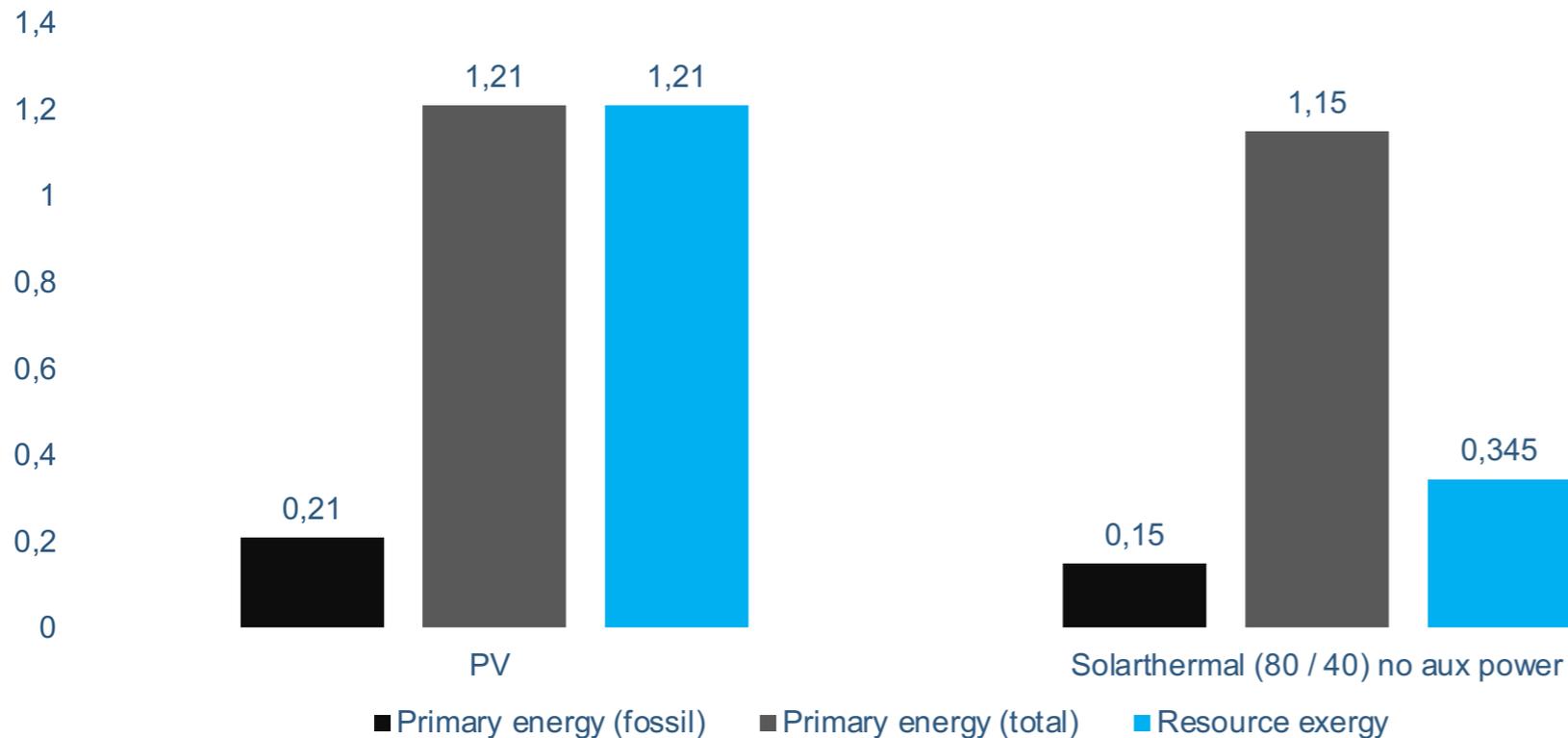
- Over a decade of successful use in research and practice
 - Used in government funded projects and internationally
 - **Enables realistic comparison of district heating and cooling with individual solutions**

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

Specific consumption per unit of energy output (kWh / kWh)

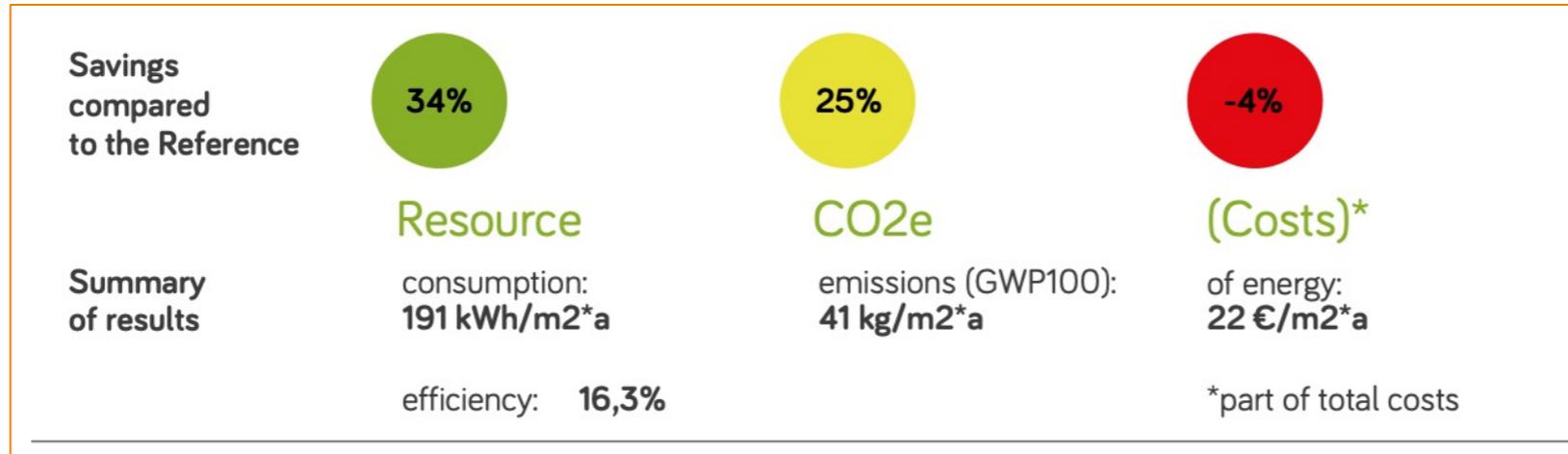


- Primary energy analysis shows an unrealistic picture
- REA shows that solar thermal is 3x better suited than PV for direct building heating
 - CO₂e would show only 2x

How can REA support solar thermal networks

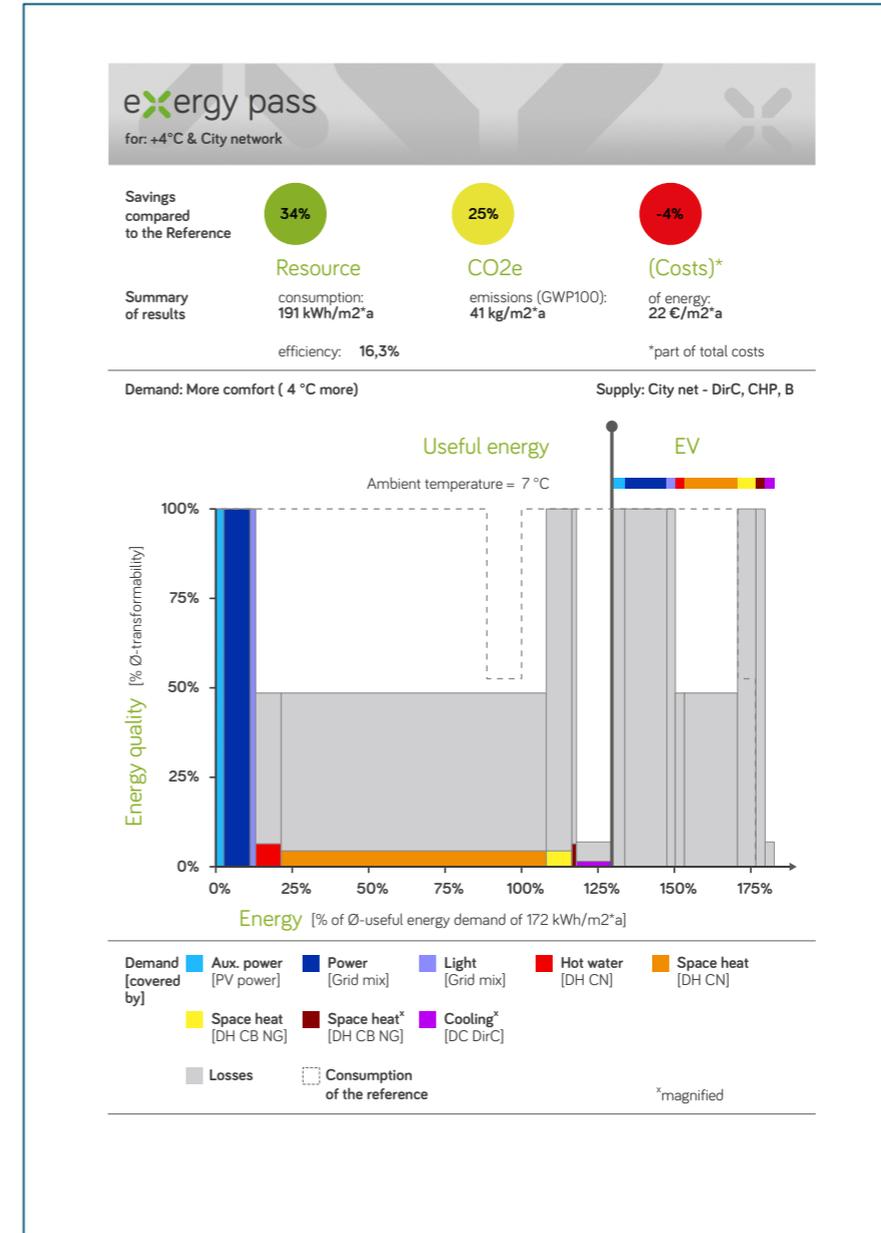
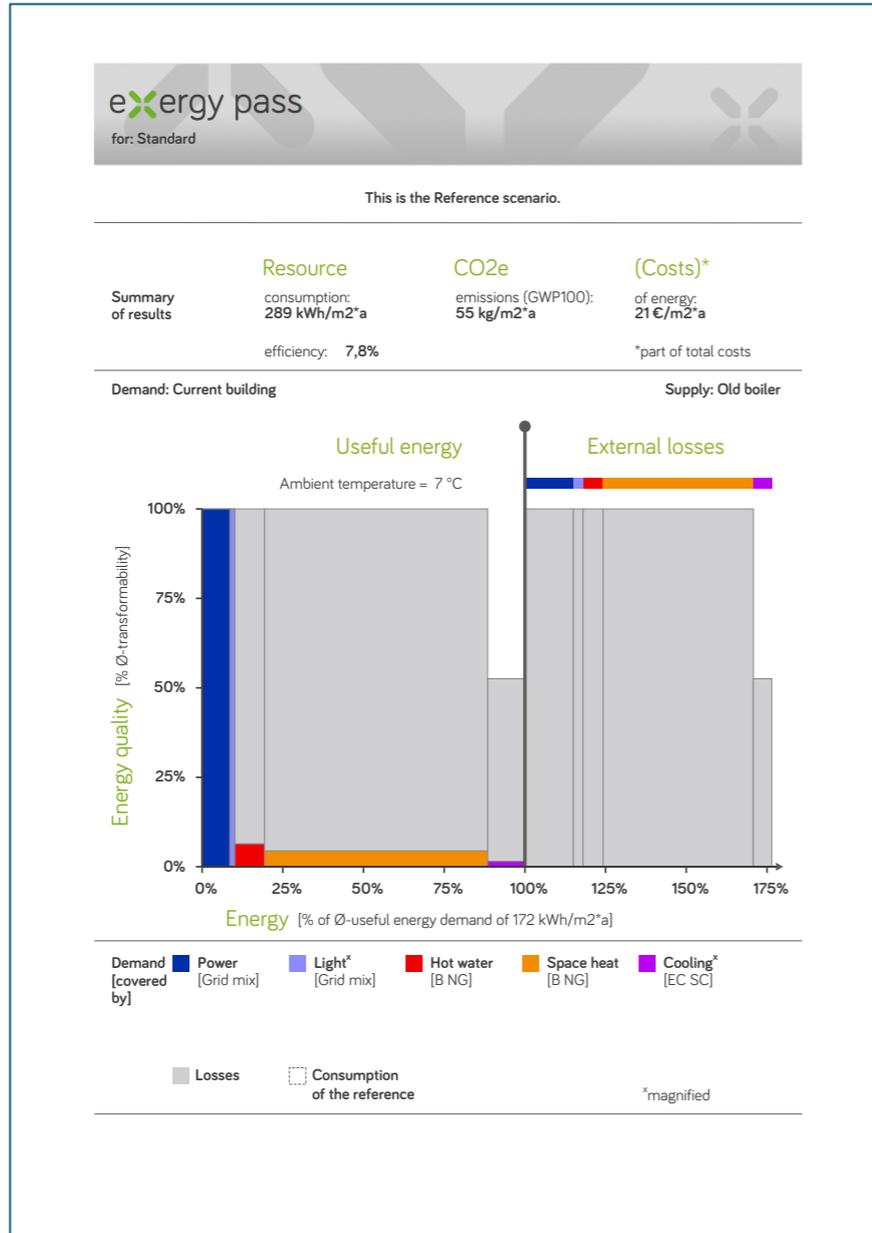
- Support argumentation for solar thermal networks by quantifying its advantages
- Show that solar thermal networks already provide a green, resource saving solution
 - Cannot easily be provided by electrification with grid mix until it is carbon-free
- Helps considering solar thermal networks in comparison 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?

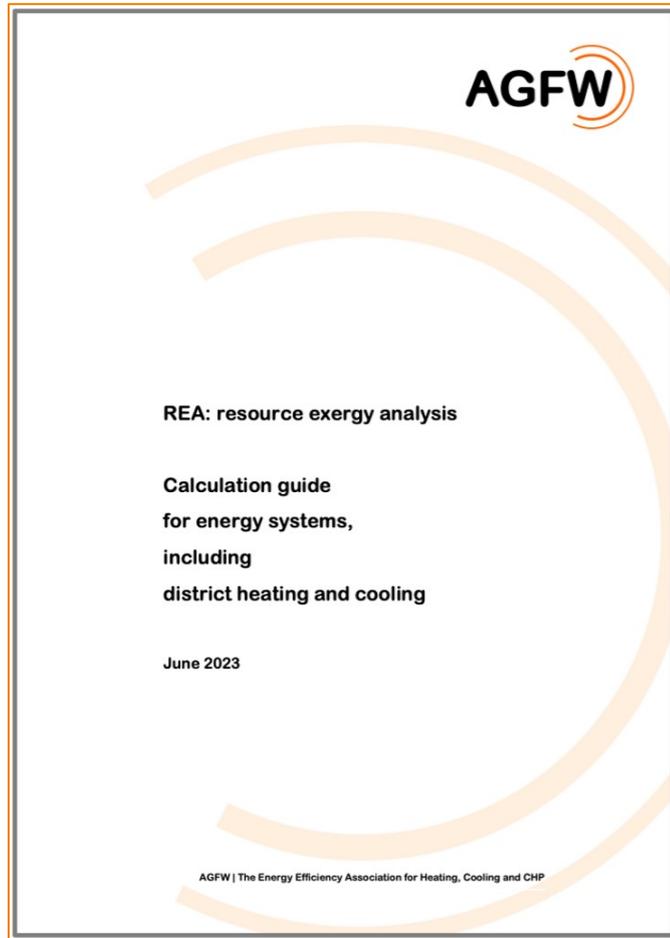


- **Traffic lights and percentages of savings**
 - easy to understand by non-technical people
- **Reference for savings can be set freely**

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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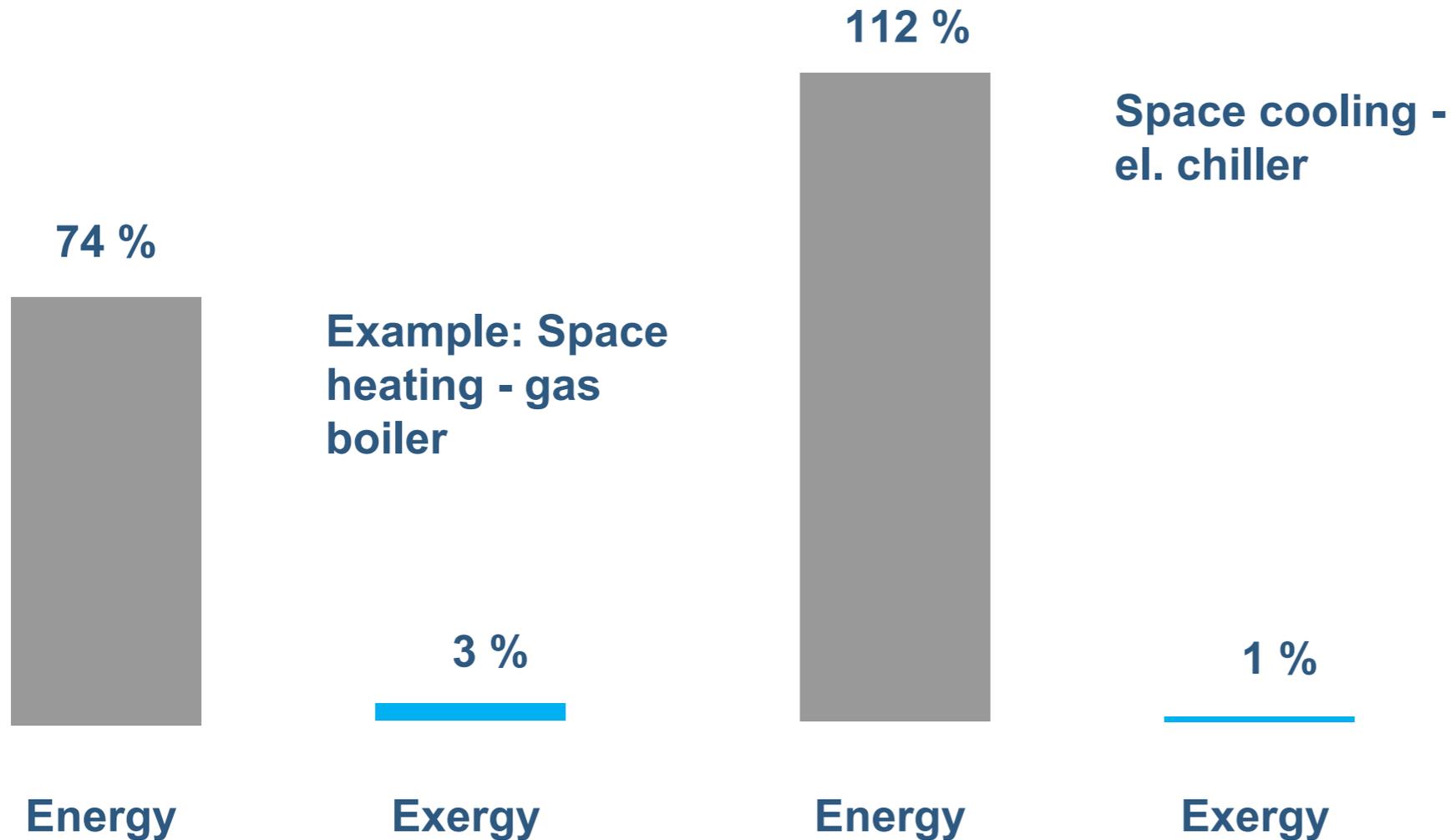
REA vs. greenwashing?

- 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 2: Why REA? - Indicators

