Environmental Impacts by the Use of Geothermal Energy

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Agenda

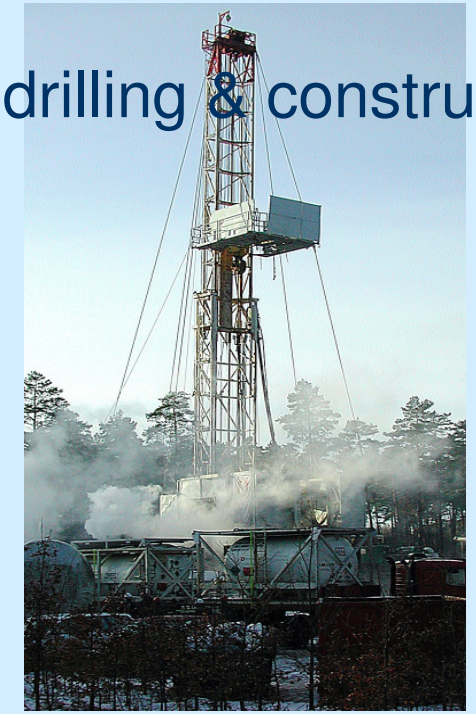
- Introduction
- Life cycle assessment (LCA)
- Local environmental impacts
- Conclusions

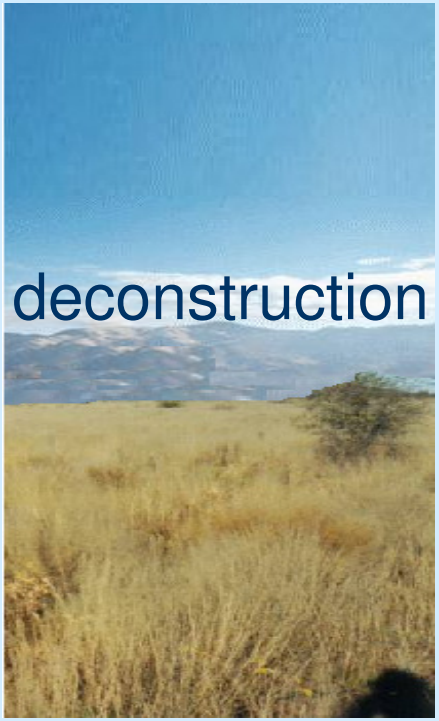
Introduction I

- Geothermal energy is a promising energy source.
- But no energy source is free of adverse impacts on the environment.
- A sustainable geothermal energy provision has to result in benefits for the environment – compared to other alternatives.
- Therefore environmental impacts need to be precisely assessed.
- Communicating environmental impacts and working on diminishing them is an integral part for further developing geothermal energy.
- „Environmental impacts of a geothermal electricity production“, study for the Federal Environmental Agency of Germany (Umweltbundesamt, project duration till March 2007)

Introduction II
Assessment of Environmental Impacts

3 relevant phases:





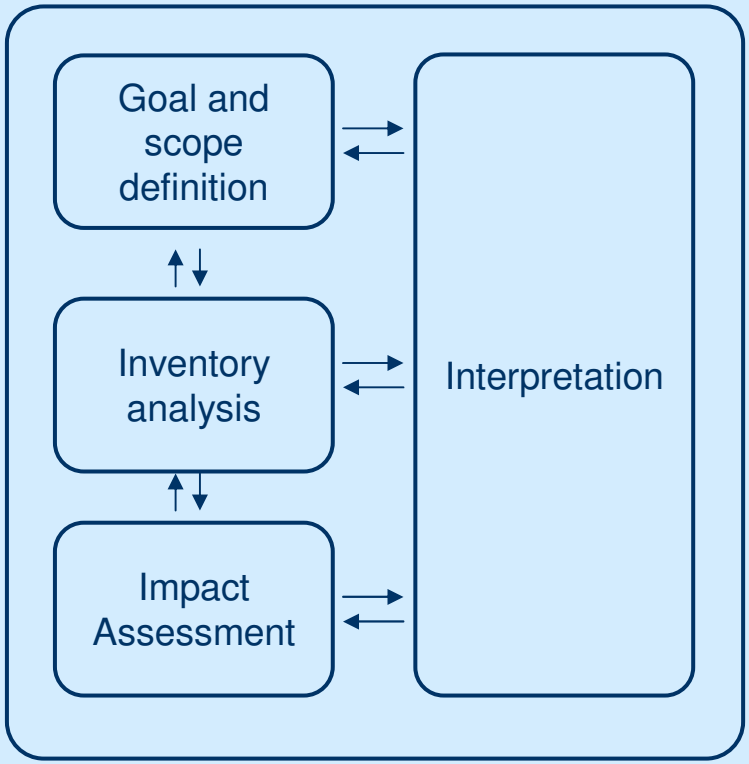
- Assessment of environmental impacts during the whole life cycle with the Life Cycle Assessment (LCA)
- Assessment of local environmental impacts

Life Cycle Assessment
- Methodology I -

- Environmental impacts of a product are not limited to the use of the product or the production process

  → substantial environmental impacts may also occur within the pre-chains.

- The most important instrument to fulfil the holistic approach is the so called Life Cycle Assessment (LCA) or eco-balance.



Life cycle assessment according to ISO 140 40/44

„From cradle to grave“

Life Cycle Assessment
- Methodology II -

Input	Product/System	Output
fuel		CO_2
steel		CH_4
water		N_2O
oil		SO_2
cement		CO
concrete		Dust
…		…

„From cradle to grave“

Life Cycle Assessment
- Methodology III -

- **"Consumption of finite energy carrier"**
  (i.e. sum of the overall fossil fuel input from natural gas, crude oil, hard coal, lignite and uranium)

- **"Anthropogenic greenhouse effect“ (CO_2-Equivalent)**
  (i.e. rated sum of carbon dioxide (CO_2), methane (CH_4, factor 21) and nitrous oxide (N_2O, factor 310) in CO_2-equivalents)

- **"Acidification of natural eco-systems" (SO_2-Equivalent)**
  (i.e. rated sum of sulphur dioxide (SO_2), nitrogen oxide (NO_x, factor 0,7), hydrogen chloride (HCl, factor 0,88), ammonia (NH_3, factor 1,88) and hydrogen fluoride (HF, factor 1,6) in SO_2-equivalents)

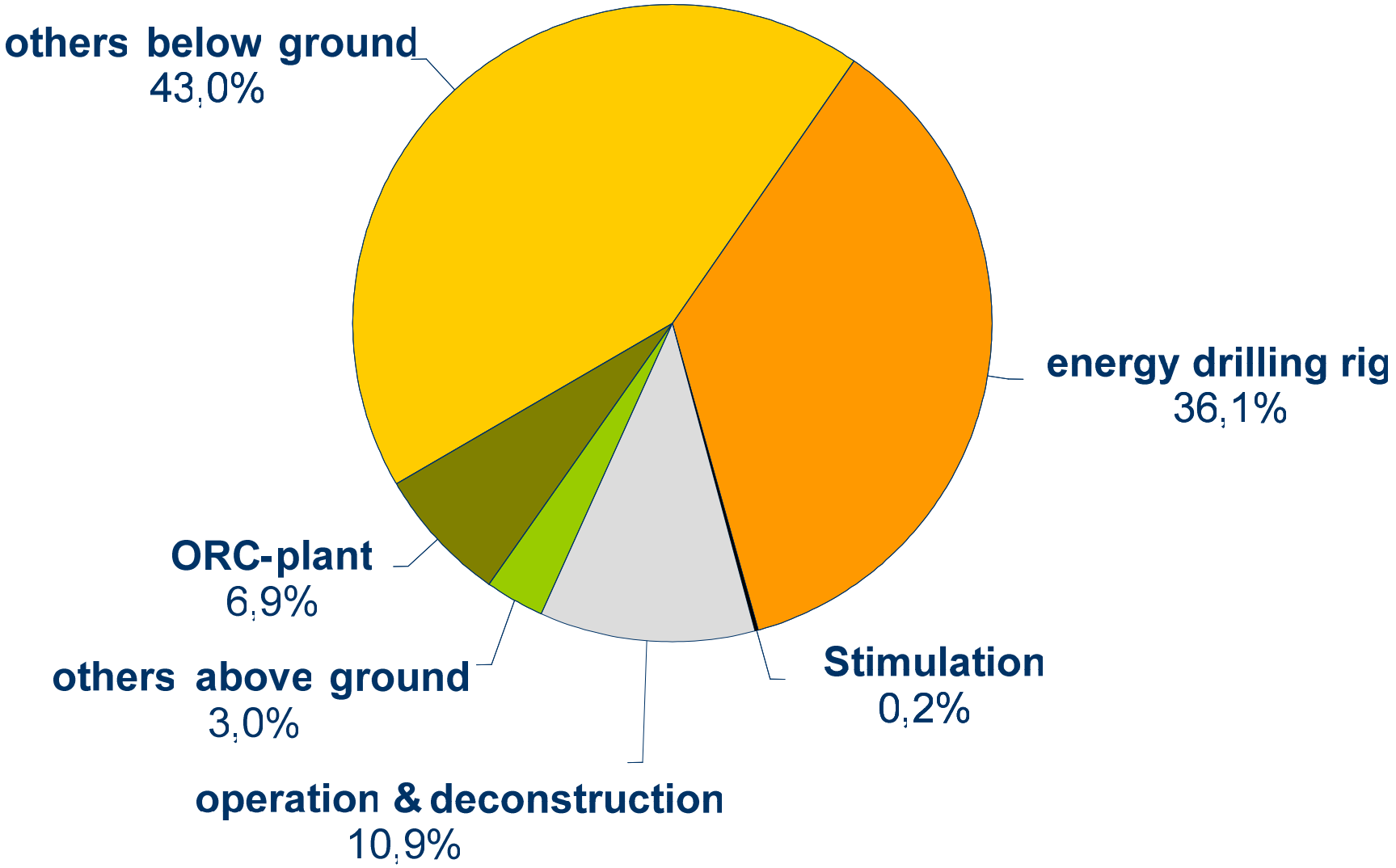
- …

Life Cycle Assessment
- Geothermal Basisdata -

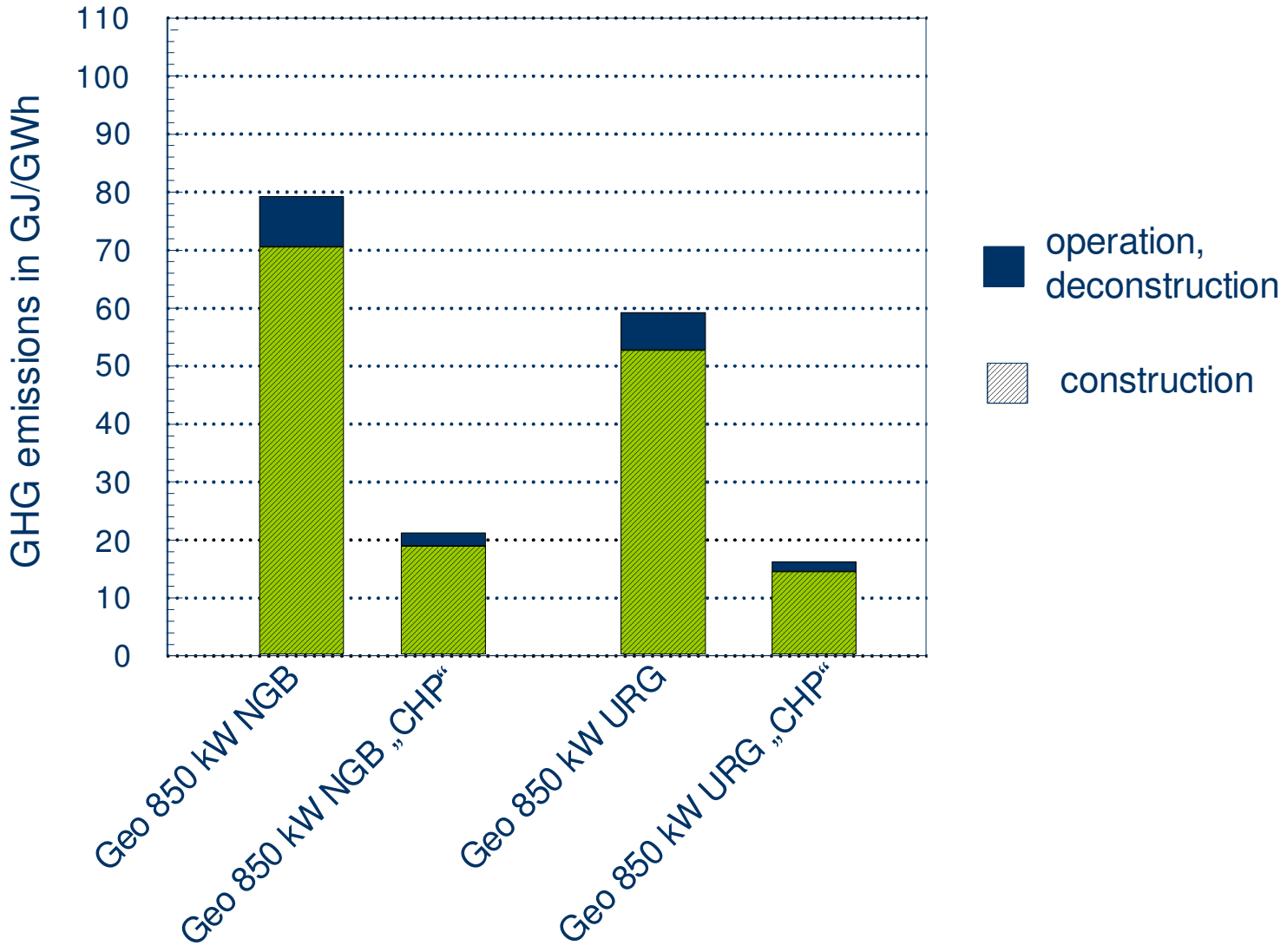
	Geothermal	Geothermal „CHP“
Plant concept	Dublette with ORC	Dublette with ORC and district heating*
Reservoir	Upper Rhine Graben (URG) North German Basin (NGB)	Upper Rhine Graben (URG) North German Basin (NGB)
Brine temperature	150 °C	150 °C
El. capacity	850 kW	850 kW
El. efficiency	11 %	11 %
Fullload hours	7,500 h/a	5,600 h_{el}/a 1,900 h_{th}/a

* flow temperature 70 °C, return temperature 45 °C

Life Cycle Assessment
- GHG Emissions of Geothermal Plants -



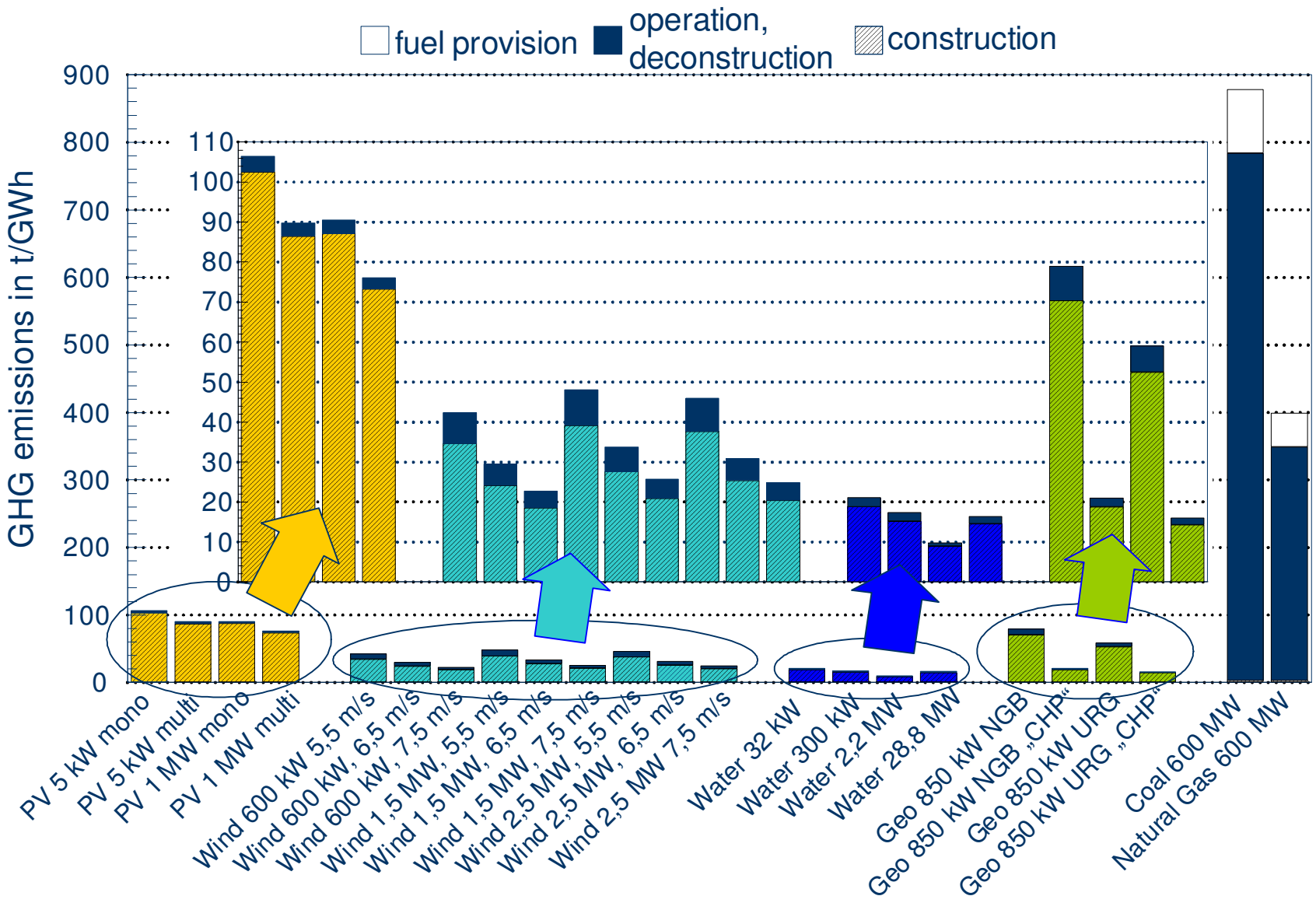
Life Cycle Assessment
- GHG Emissions of Geothermal Plants -



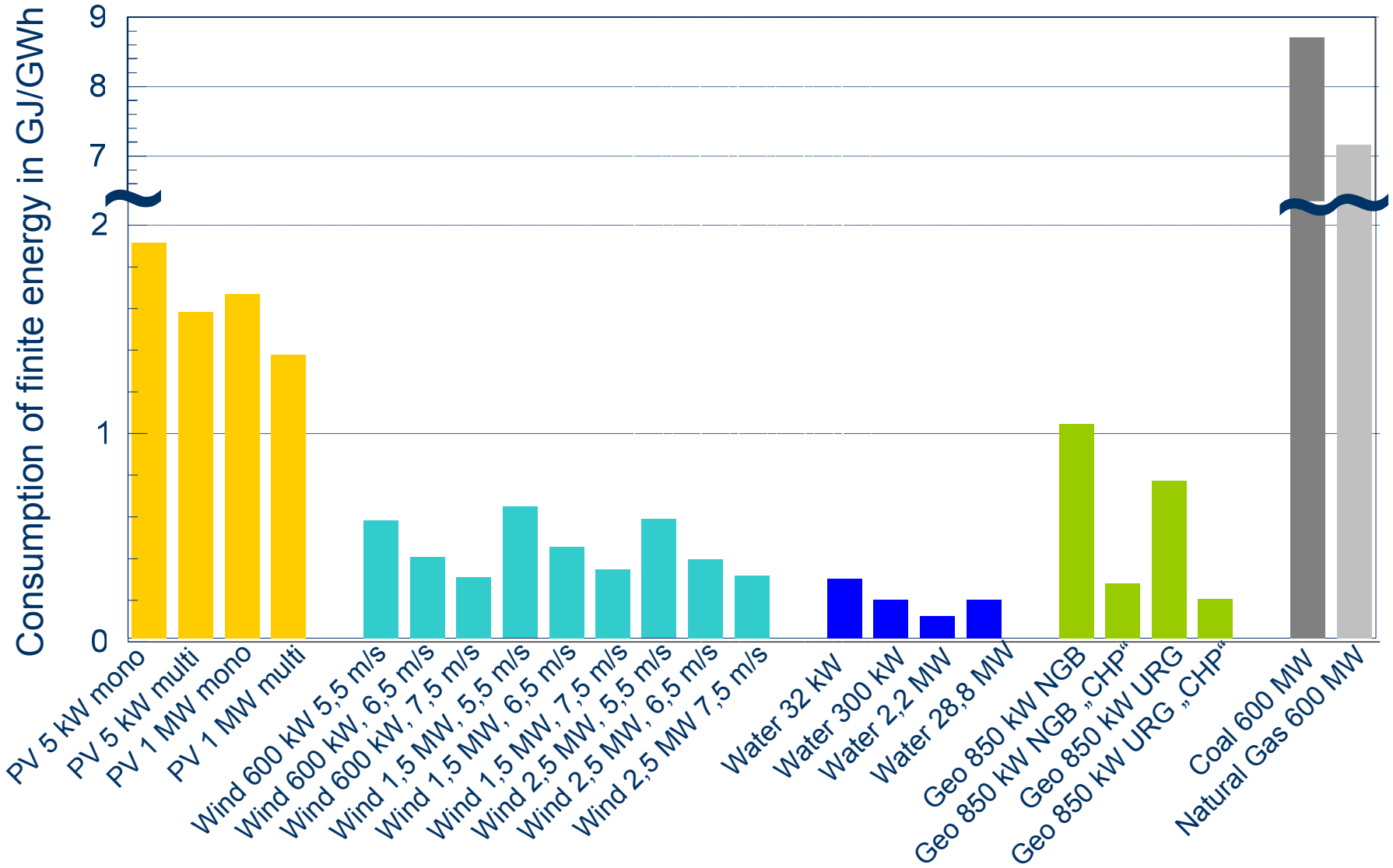
Life Cycle Assessment
- Basisdata -

	El. capacity	El. efficiency	Fullload hours
Geothermal	850 kW	11 %	7,500 h/a
Geothermal „CHP“	850 kW	11 %	5,600 h_{el}/a 1,900 h_{th}/a
Wind	600 kW, 1.5 MW, 2.5 MW		1,550 h/a
Water	32 kW – 28,8 MW		5,000 h/a
Photovoltaics	5 kW, 1 MW		800 h/a
Coal	600 MW	43 %	5,000 h/a
Natural gas	600 MW	58 %	5,000 h/a

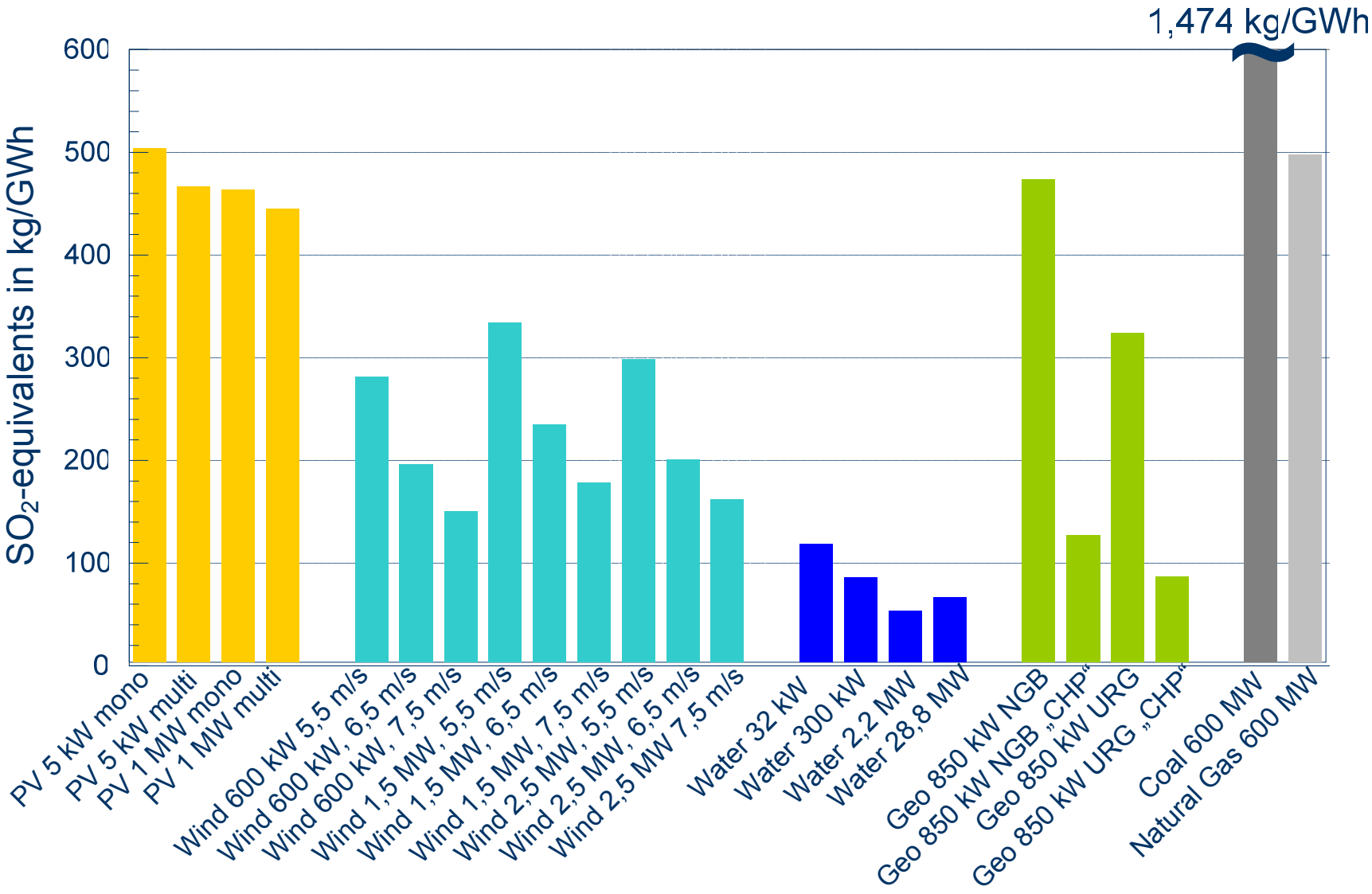
Life Cycle Assessment
- GHG Emissions -



Life Cycle Assessment
- Consumption of Finite Energy -



Life Cycle Assessment
- SO_2-Equivalents -

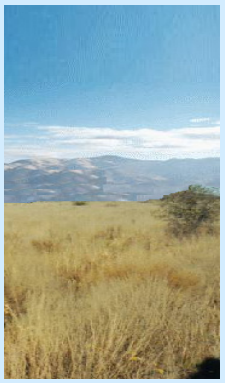


Local Environmental Impacts
- Survey of Possible Impacts -

- Land-slides

- waste heat
- ground-water, land subsidence
- thermal impact

- noise
- waste disposal
- chemical conta-mination
- hydraulic short circuit



- visual impact
- induced seismicity
- hydroth. eruption

- water use
- landuse
- airborne emissions

Local Environmental Impacts
- Methodology -

Environmental impacts are site-specific and need to be assessed individually:

- Probability of occurring → low, moderate, high, ….
- Duration of impact → short-term, long-term, continuous, periodic, …
- Severity of consequence → low, medium, high, reversible, irreversible, …
- Mitigation measures → primary measures, secondary measures, …
- …

Conclusions I

- The use of geothermal energy affects the environment. But respective mitigation measures do exist.
- The different effects have to be analysed within the overall life cycle as well as locally.
- Within the overall life cycle compared to other sources of energy geothermal energy is characterised by
  - low consumption of finite energy carrier,
  - low emissions of Greenhouse Gases,
  - low emissions with an acidification potential.

Conclusions II

- Locally geothermal energy can/does e.g.
  - cause noise,
  - induce seismicity,
  - cause vapour emissions,
  - etc.
- To minimise such environmental effects and to maximise local acceptance, these effects need to be tackled in order to strive for an also ecologically optimised project development.

Thank you very much for your attention!

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