
WHAT ABOUT HEAT INTEGRATION? QUANTIFYING ENERGY SAVING POTENTIALS FOR GERMANY

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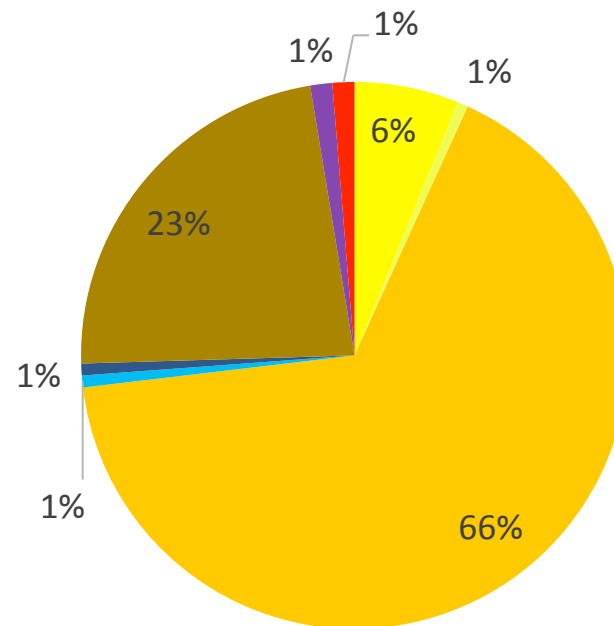
1. Background

- 28% share on final energy demand (717 TWh)

[AGEB (2017), ref. to 2016]

- 66% of above for process heat

[Rohde et al. (2017), ref. to 2016]



■ Space heating

■ Water heating

■ Process heating

■ Space cooling

■ Process cooling

■ Mechanical energy

■ Information/
communications

■ Lighting

Measures in the field of process heat are relevant for GHG reductions.

1. Background

Basic terms

Excess heat:

Side product: currently not utilized

- Inefficiencies of hardware
- Thermodynamic constraints

Utilization: benefits for industry and society

Heat integration:

- Thermal combinations of steady-state process streams or batch operations
- Purpose: heat recovery via heat exchange
- Energy efficiency measure

Excess heat and heat integration: tied terms.

2. State of research and aim

Excess heat:

- Process specific research on excess heat
[Hirzel et al. (2013), Pehnt et al. (2010)]
- Estimation of excess heat for countries, regions etc.
[Brückner et al. (2017), Pehnt et al. (2010)]

Heat integration:

- Numerous papers dealing with methodological aspects
[Klemeš und Kravanja (2013)]
- Numerous case studies
[Hackl et al. (2011),....]

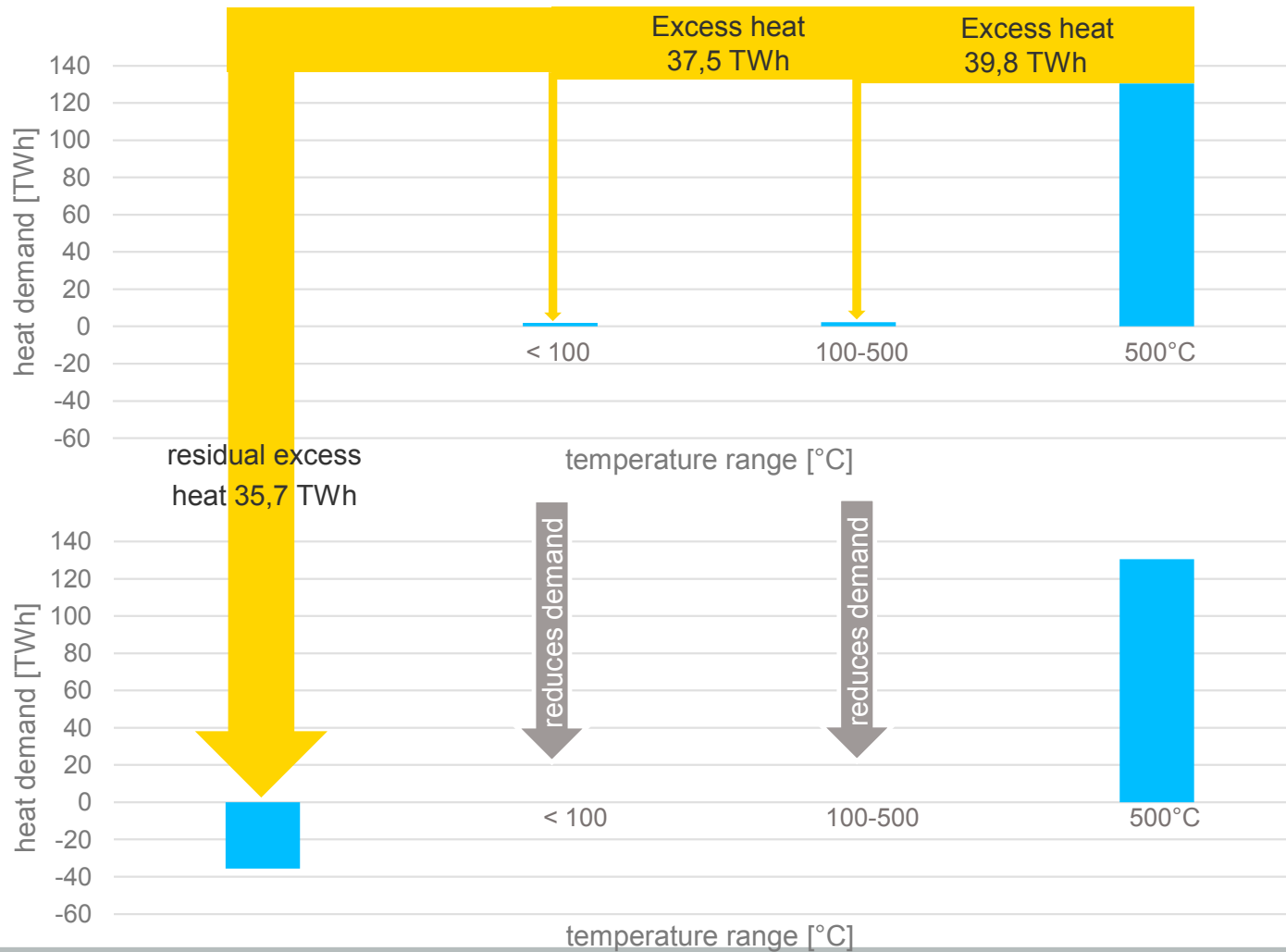
Aim: The objective of this paper is to estimate the potential energy savings through the use of excess heat with the measure of heat integration in Germany.

3. Methodological approach

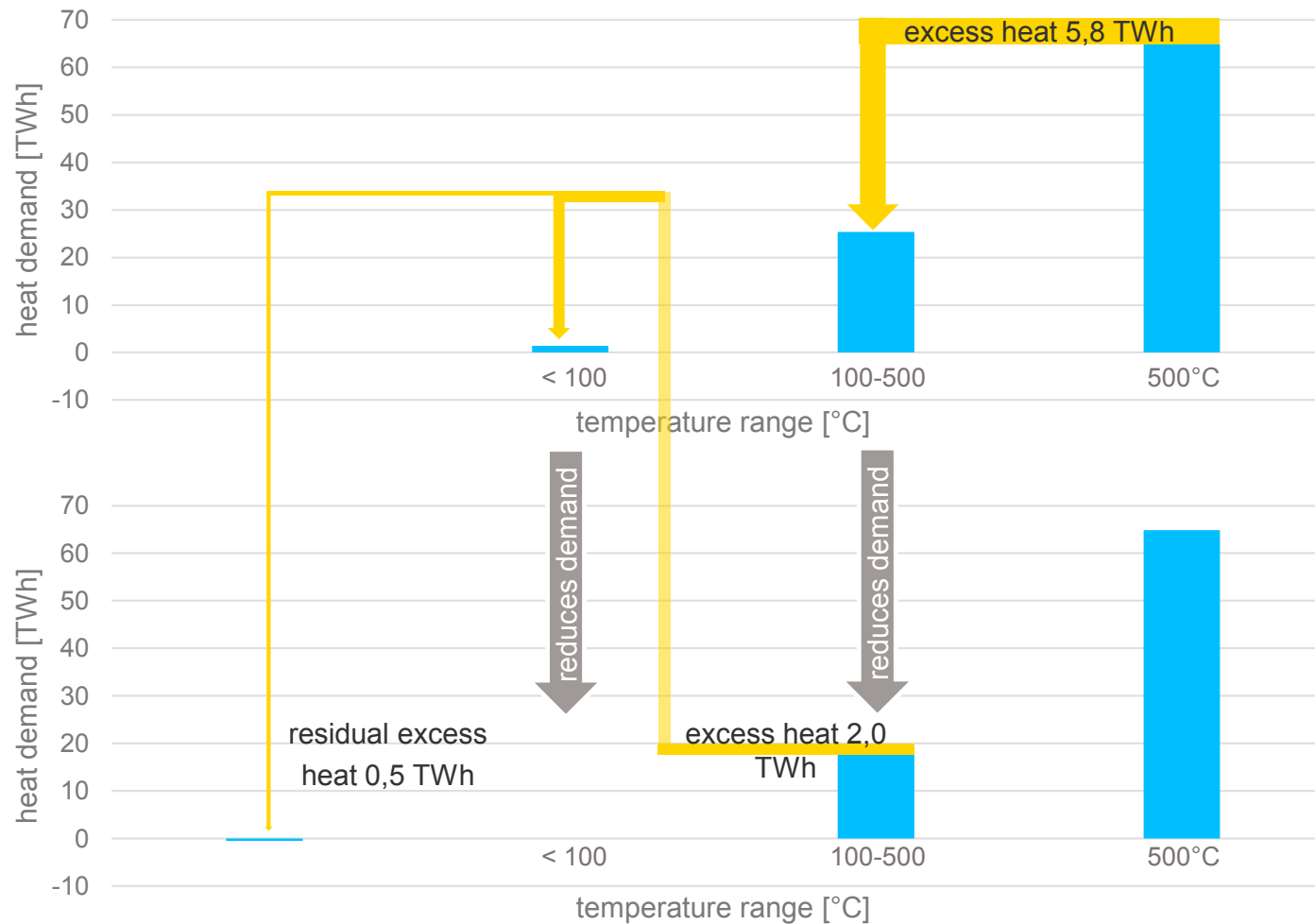
Top-Down

- Database: energy statistic
 - energy demand for fields of application
 - heat differentiated by temperature band and industry sector
- All steps carried out based on data for whole industry sectors
- Assumption: distribution of heat demand equals the database
- First step: Estimation of excess heat
 - figures from literature
 - Germany: circa 70 TWh (ref. to Brückner et al.(2017))
- Second step: Cascade balancing
 - results in energy savings by
 - intra-company heat integration and
 - inter-company heat integration

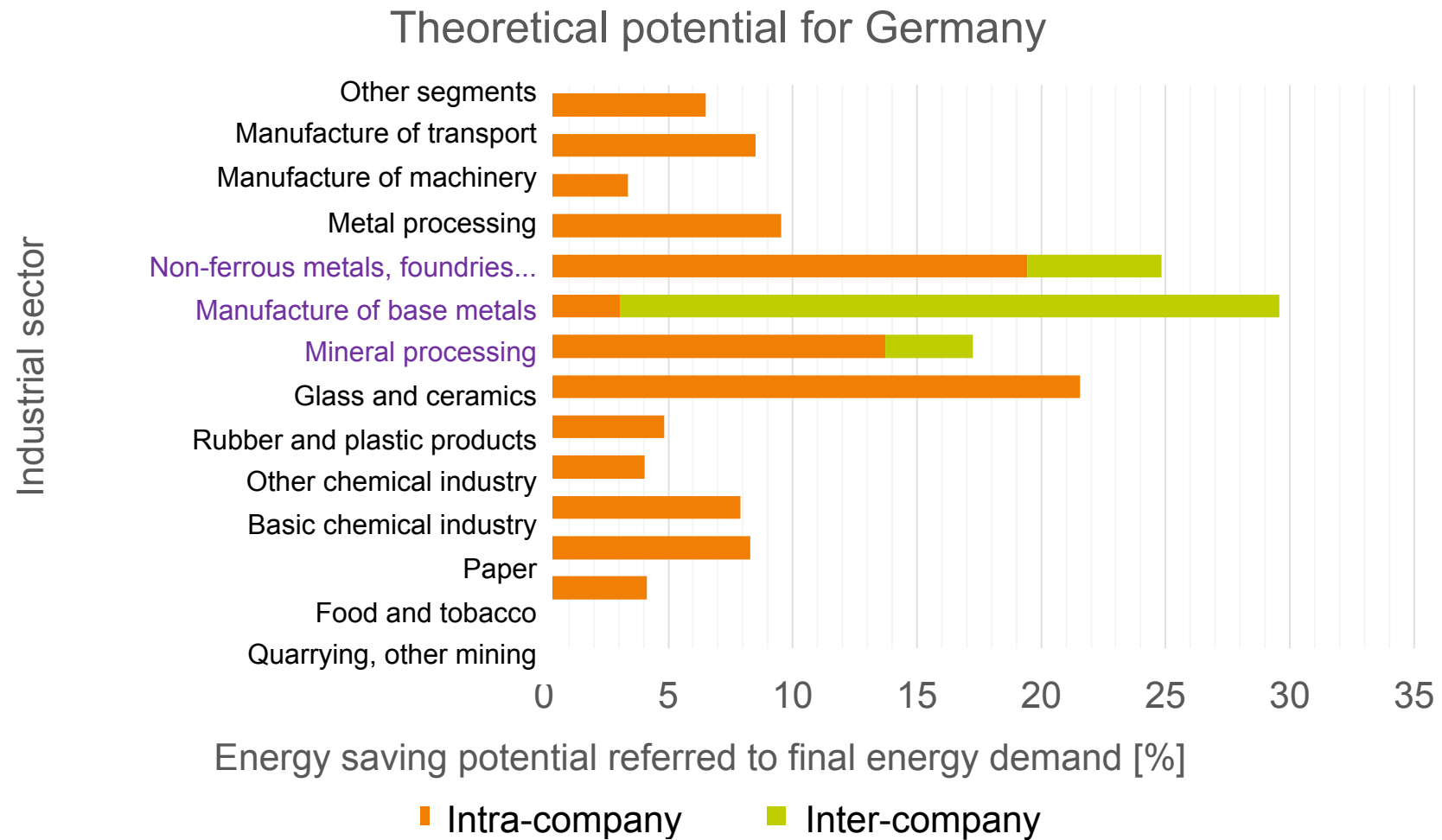
3. Methodological approach Manufacture of basic metals



3. Methodological approach Basic chemicals



4. Results



4. Results

- Energy saving potentials
 - intra-company heat integration approx. 56 TWh and
 - inter-company heat integration approx. 21 TWh
- Savings above added-up:
 - Btw. 10% and 11% (ref. FED in industry)
 - Btw. 5% and 6% (ref. FED), if 'manufacture of base metals' is excluded

4. Conclusion and discussion

The theoretical energy saving potentials through heat integration are probably not exhausted.

■ Why?

- technical / economic potentials by far lower ?
- “complicated” or “complex” energy efficiency measure ?
- barriers for heat integration ?
- criteria's for adaption?

■ Ideas

- Carry out analyses for samples and systematically examine the above-mentioned aspects?
- Design policy instruments based on analysis

Thank you !

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Literature

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- AG Energiebilanzen e.V.: Bilanzen 1990-2016. Hg. v. AG Energiebilanzen e.V. Online verfügbar unter <http://www.ag-energiebilanzen.de/7-0-Bilanzen-1990-2014.html>, zuletzt geprüft am 03.03.2017.
 - Aydemir, Ali; Rohde, Clemens; Ko, Dorothea (2016): Energy savings of inter-company heat integration: tapping potentials with spatial analysis. ECEEE Industrial Summer Study Proceedings 2016 (2-072-16).
 - Aydemir, Ali; Rohde, Clemens; Möhren, Simon (2016): Energy savings of intercompany heat integration - A methodological framework (part I). In: 14. Symposium Energieinnovation (Konferenzband), 10.-12.02.2016, Graz/Austria
 - Brückner et al. (2017): Industrial waste heat potential in Germany—a Bottom-Up analysis. In: Energy Efficiency 10 (2), S. 513–525. DOI: 10.1007/s12053-016-9463-6.
 - Hackl et al. (2011): Targeting for energy efficiency and improved energy collaboration between different companies using total site analysis (TSA). In: Energy 36 (8), S. 4609–4615. DOI: 10.1016/j.energy.2011.03.023.
 - Hiete et al. (2012): Intercompany Energy Integration. In: Journal of Industrial Ecology 16 (5), S. 689–698. DOI: 10.1111/j.1530-9290.2012.00462.x.
 - Hirzel et al. (2013): Industrielle Abwärmenutzung. Kurzstudie. Karlsruhe: Fraunhofer ISI.
 - Kemmler et al. (2017): Datenbasis zur Bewertung von Energieeffizienzmaßnahmen in der Zeitreihe 2005-2014: Sektor Industrie. Unter Mitarbeit von Prognos AG, Fraunhofer ISI und Ife/TU München. Hg. v. Umweltbundesamt.
 - Klemeš und Kravanja (2013): Forty years of Heat Integration. Pinch Analysis (PA) and Mathematical Programming (MP). In: Current Opinion in Chemical Engineering 2 (4), S. 461–474. DOI: 10.1016/j.coche.2013.10.003.
 - Rohde C (2017) Erstellung von Anwendungsbilanzen für die Jahre 2013-2016. <http://www.ag-energiebilanzen.de/>. Downloaded: 27. Januar 2016
 - Pehnt et al. (2010): Energieeffizienz. Ein Lehr- und Handbuch. Berlin, Heidelberg: Springer-Verlag Berlin Heidelberg.
 - Umweltbundesamt (2017): Nationales Treibhausgasinventar 2017, Endstand 04/2017. Umweltbundesamt. Dessau-Roßlau.
 - Umweltbundesamt (2011): Abwärmenutzung eines Kupolofens. Umweltbundesamt. Dessau-Roßlau.