International Cooperation for Know-How Transfer

# IEA IETS ANNEX 15 INDUSTRIAL EXCESS HEAT RECOVERY

René Hofmann and Anton Beck

20.3.2018, Highlights der Energieforschung, TUtheSky, Wien

## Annex Manager

Prof. Thore Berntsson (Energy and Environment, Chalmers University of Technology)

http://www.iea-industry.org/ongoing-annexes/annex-15.html

**ExCo Delegate** Elvira Lutter, Klimafonds, Österreich

## Participating Countries

Denmark, Germany, Norway, Austria, Portugal, Sweden, (Canada, France, Italy)

## Phase 2 started 10/2016-09/2018; Subtasks

**Subtask 1**: In-depth evaluation and inventory of excess heat levels

**Subtask 2**: Methodology on how to perform an inventory in practice

**Subtask 3**: Possible policy instruments and the influence on future use of excess heat

**Subtask 4**: Technology Development

## National partners - Project Team:

- Project management national: AIT Center for Energy, René Hofmann, Anton Beck, Veronika Wilk, Christoph Zauner, Sabrina Dusek, www.ait.ac.at

- Technische Universität Wien, Institut für Energietechnik und Thermodynamik, Markus Haider, www.iet.tuwien.ac.at

- AEE - Institut für Nachhaltige Technologien, Christoph Brunner, Jürgen Fluch, Wolfgang Glatzl, Anna Grubbauer, Petra Königshofer, www.aee-intec.at

## Subcontractor:

- Energieinstitut - JKU, Simon Moser, Horst Steinmüller, www.energieinstitut-linz.at

## Situation:

### Climate goals

- Progress in energy-related technologies is of great importance for the achievement of collective goals of energy security, environmental protection and economic and social development.

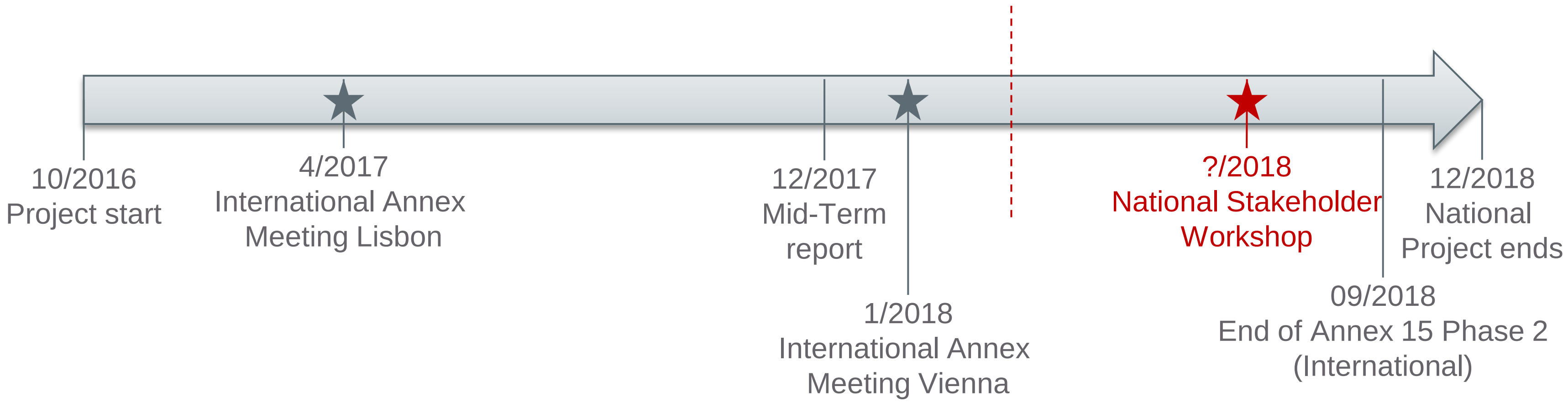
### Visibility and Know-How Transfer

- Participation allows access to valuable know-how as well as increased visibility in an international environment. At the international level, the industrial location of Europe is strengthened through close cooperation and the transfer of knowledge.

### Goals and Methods

- Integrate Austrian research institutions into the international network.
- Information exchange.
- Initiation of international projects
- Development of new cooperations / partnerships in industry / research.
- Offer and expand existing know-how.

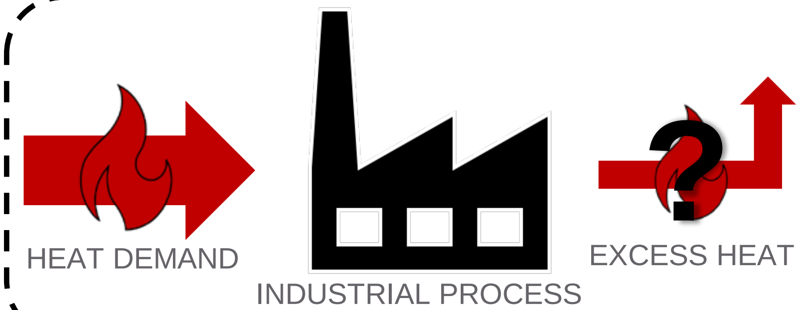
# Annex Time-Line




**Stakeholder Workshop:**

Target groups: industry, technical bureaus, process automation, public decision makers, funding agencies, consulting agencies, etc.

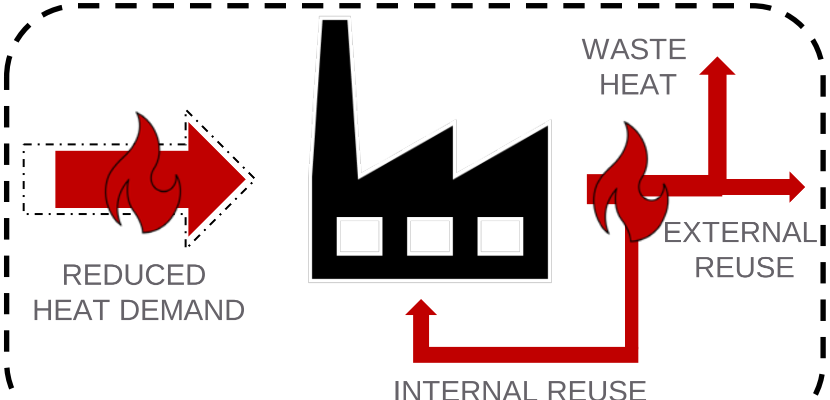
Date: TBA




How to perform an **inventory**?

How to **derive potentials** for excess heat usage?


**Impact of Policy-Instruments** on Excess Heat and its usage?



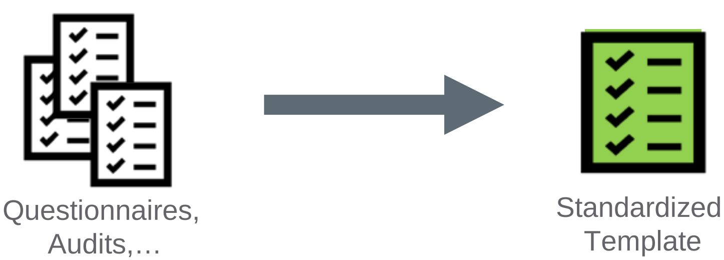

**Technologies** for excess heat usage

# National contributions to the Annex

## How to perform an **inventory**?

**Development of a standardized evaluation template for industrial excess heat**

- Based on available excess heat potential studies
    - Checklist for energy audits (based on IEE projects EINSTEIN and GREENFOODS, linked to EN16247)
    - Excess heat cadaster Graz and Styria methodology
    - Method developed on statistical data (project IntegrCiTy)
    - Comparison with international studies (mainly Germany and Sweden) with different approaches as basis for potential standardized template



## National contributions to the Annex

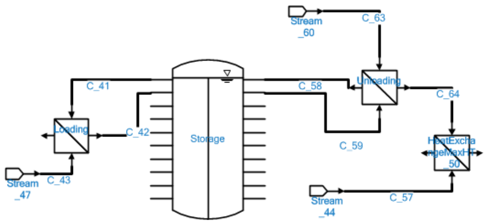
IEA Industrial Energy-related Technologies and Systems

How to **derive potentials** for excess heat usage?

AEE INTEC

### SOCO - Storage Optimization Concept
### SolarSOCO – Integration of system supply

- ✓ System design based on processes and time depending load profiles
- ✓ Identification, simulation and design of HEN + storages
- ✓ Integration of renewable energies



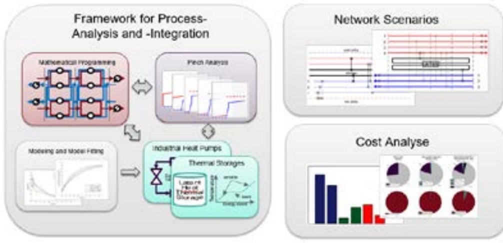

© AEE INTEC

*SOCO – Storage Optimisation Concepts in Industries, Commerce and District Heating Businesses
Jürgen Fluch*, Christoph Brunner, Bettina Muster-Slawitsch; CHEMICAL ENGINEERING TRANSACTIONS; (2012)
*Based on Tool SOCO – Model and Measures Identified; Juergen Fluch, Christoph Brunner, Bettina Muster-Slawitsch, Christoph Moser, Hermann Schranzhofer, Richard Heimrath; CHEMICAL ENGINEERING TRANSACTIONS; (2013)

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

### Process Integration Framework

- ✓ Multi-Period Heat Integration
- ✓ Cost-optimal design of heat exchangers
- ✓ Cost-optimal design of heat storages and heat-pumps
- ✓ Retrofitting, DH integration




© AIT

*A. Beck, R. Hofmann: "*A Novel Approach for Linearization of a MINLP Stage-Wise Superstructure Formulation*"; Computers & Chemical Engineering, 112 (2018), 112; S. 17 - 26.
*A. Beck, R. Hofmann: "*How to* tighten *a commonly used MINLP superstructure formulation for simultaneous heat exchanger network synthesis*"; Computers & Chemical Engineering, 112 (2018), 112; S. 48 - 56.

# National contributions to the Annex

iets
IEA Industrial Energy-related Technologies and Systems

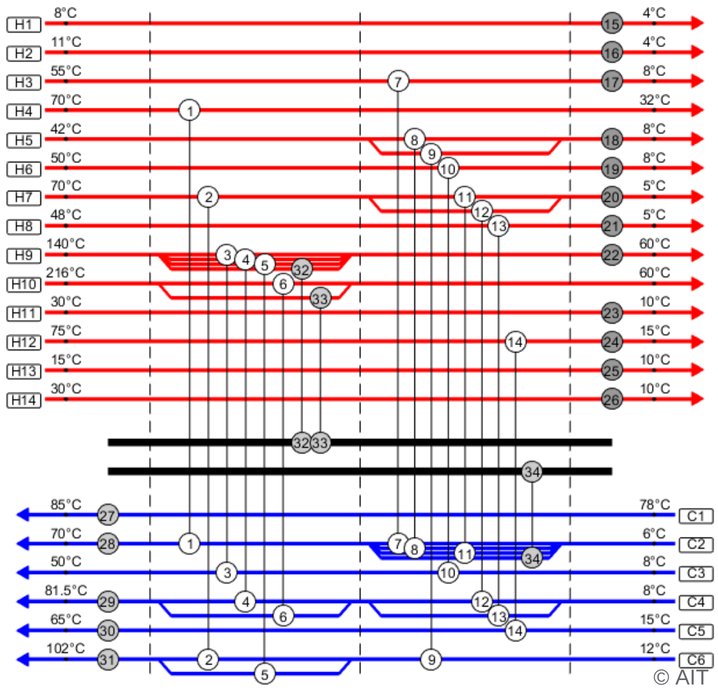
How to **derive potentials** for excess heat usage?

## Example: Dairy Factory (AEE INTEC)

Comparison of AIT PI Framework (Mathematical Programming) & (Solar)SOCO

- 37 Process streams
- Changing operating states
- Stream data for 3 weeks

- Storage integration
- Heat exchanger network synthesis




TAC = 189643 €/a; Storage Mass: 16.39 t - m³

How to **derive potentials** for excess heat usage?

## Annex 15/2 Workshops on Pinch-Methodology

27. SEPTEMBER 2017 & 25. JANUARY 2018 - AIT

**Program:**

- Advanced pinch methods for analysis of industrial process energy systems.
- Applications for identifying opportunities for
  - internal heat recovery;
  - excess heat usage;
  - heat pumping;
  - thermal energy storage

## **Impact of Policy-Instruments**
## on Excess Heat and its usage?

### Target: Development of tailor-made policy instruments for the optimised enforcement of excess heat recovery in industry

- Identification of currently applied policy instruments concerning the enforcement of excess heat recovery in industries based on previous projects from AEE INTEC and ENERGIEINSTITUT
- **Internal recovery** and **External usage**
- Analysis is conducted for the EU and IEA IETS Annex 15 member states; Austria in more detail
- Result: listing identified policy instruments by category, including (when applicable) relevant design details

### Assessment matrix

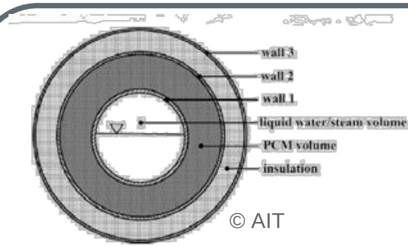
- Definition of dimensions/criteria for the assessment of policy instruments enforcing excess heat recovery
- Evaluation of the individual and combined application of policy instruments based on microeconomic theory
- Application of the assessment matrix to identified policy instruments
- Input of achieved results in the survey conducted (AEE INTEC)

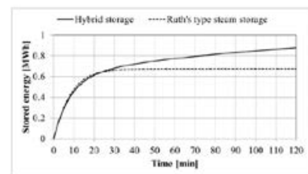
# National contributions to the Annex

## **Technologies** for excess heat usage

## Thermal Energy Storages

### Hybrid Energy Storage




30% more stored energy in the hybrid storage compared to Ruth's steam accumulator

*S. Dusek, R. Hofmann: “A Hybrid Storage Concept for Improving Classical Ruths Type Steam Accumulators”, TALK SDEWES 2017, 12th Conference on Sustainable Development of Energy, Water and Environment Systems – SDEWES Conference, Dubrovnik, ISSN 1847-7178.

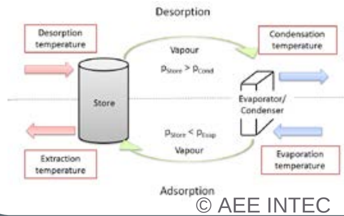
### Latent Heat Energy Storages

PCM: HDPE (Tmelt ~ 135ºC)

*C. Zauner, F. Hengstberger, B. Mörzinger, R. Hofmann, H. Walter: "*Experimental characterization and simulation of a hybrid sensible-latent heat storage*"; Applied Energy, 189 (2017), 506 - 519.

*C. Zauner, F. Hengstberger, M. Etzel, D. Lager, R. Hofmann, H. Walter: "*Experimental characterization and simulation of a fin-tube latent heat storage using high density polyethylene as PMC*"; Applied Energy, 179 (2016), 237 - 246.

### Seasonal Sorption Storage




Summer – desorption
Winter – adsorption
High energy density, only losses while charging/discharging

# National contributions to the Annex

## **Technologies** for excess heat usage

## Thermal Energy Storages

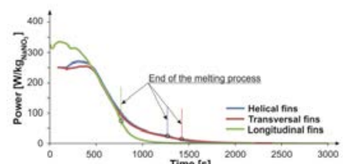
K-Project GSG – GreenStorageGrid

### Active Fluidization Technology


**Fluidization of Fine Particle Powders**
**Self stabilizing Nozzle-Distributor Floor**
**Modular Design**


### Latent Heat Energy Storages






© TU WIEN

### Passive Regenerators



Heating power: P = 15 kWth
Max. temperature: Tmax = 300 ° C
Max. volume flow: Vmax = 100 m3/h

*P. Steiner, K. Schwaiger, M. Haider, H. Walter, L. Krassini1, J. Gatterer : Experimental Investigations on a 280 kWth Fluidized Bed Heat Exchanger SolarPACES Conf 2017.

*Mayrhuber, H. Walter, M. Hameter: "Experimental and Numerical Investigation on a Fixed Bed Regenerator"; in: "Proceedings of the 10th International Conference SEEP", ISBN: 978-961-286-061-5.

*M. Koller, H. Walter, M. Hameter: "Transient Numerical Simulation of the Melting and Solidification Behavior of NaNO3 Using a Wire Matrix for Enhancing the Heat Transfer"; ENERGIES, 9 (2016).

*H. Walter, A. Beck, M. Hameter: "Influence of the Fin Design on the Melting and Solidification Process of NaNO3 in a TES System"; J.of Energy & Power Eng., 9 (2015).

# THANK YOU

AIT, Center for Energy, Thermal Energy Systems
Giefinggasse 2 | 1210 Vienna | Austria
Rene.Hofmann@ait.ac.at | www.ait.ac.at