Energy Efficiency in Production Processes

Stefan M. Büttner, EEP
Energy Efficiency in Production Processes

- A Hub of Industrial Energy Efficiency
- Setting the Scene
- The first fuel
- Optimizing operations
- How to do it
- Making it happen
A Hub of Industrial Energy Efficiency
We implement highly innovative solutions for our customers in future-oriented industries to enable sustainable production at the technology location Germany.

We support the expertise and the interdisciplinary teamwork of our employees as the engine for qualitative growth.

We focus on our customers’ demand in our integrated research and development activities to enhance their competitive advantage.
Research Environment in Stuttgart

- Solid State Research
- Intelligent Systems

Fraunhofer Institutes in Stuttgart: IPA, IAO, IGB, IBP

- Engineering Design, Production & Automotive Engineering
- Energy, Process & Bio-Engineering

University of Stuttgart

Max Planck Institutes
- Solid State Research
- Intelligent Systems

Institute for Energy Efficiency in Production

German Aerospace Center

Hahn-Schickard-Gesellschaft e.V. Institute for Microsystems Technology
Setting the Scene
Energy efficiency - worldwide growing energy end use

- 44% of the difference between CPS and NPS worldwide are based on industrial energy efficiency measures until 2035

T. Bauernhansl, Energieeffizienz in Deutschland - eine Metastudie, Stuttgart: Springer Vieweg, 2014
The First Fuel
Increasing energy efficiency

- Avoiding unnecessary consumption
- Use of beneficial energy sources
- Reducing specific net energy demand
- Increasing the efficiency of energy converters
- Energy recovery

Sauer & Losert, 2013
Energy saving potential of German industry-majority of efficiency potential is left unexploited

- Current efforts will just induce savings of 51 PJ each electrical and thermal energy
- Overall possible saving potential which can be economically tapped has a value of 160 PJ (electric) and 111 PJ (thermal)
Energy saving potentials could lead to high monetary savings

- An investment of 5 billion € would return 20 billion € by 2020, adding another 3 billion € by 2030 would yield total savings of 67 billion €
- Other studies suggest that investments of 24 billion € could induce a return of 100 billion € by 2050

[BMWi 2010]
Optimizing Operations
Tackling potentials

- ISO 50001
- EMAS
- ISO 14001 plus energy chapter
- Energy Audits
- EE-Networks
- SpaEfV
- Energy advice services
Overview

- reducing energy consumption (electricity and gas) in production processes and process periphery

**Project-management**
- Throughout the project

**Macro-analysis**
- Measuring energy flows and energy usage on plant level
  - On-site plant inspection
  - Capturing of approximate potentials

**Micro-analysis**
- Detailed analysis of selected areas (process level)
  - Deriving performance indicators

**Evaluation – Energy Efficiency Measures**
- Identifying energy efficiency measures
- Quantifying saving Potentials

Joint priorisation of areas of interest

Kick-Off  6-8 weeks in  4 months in,
6 months in evaluation,
3-5 days on-site
documentation
and project results

Final Presentation
Macro Analysis

Corporate Level – Organisational Framework
• basis for action
• system alignment
• structures
• Processes

Site Level – Operative System
• operational energy management
• measures
• implementation
Sauer & Losert, 2013
From Macro Analysis to Definition of Measures

**I. Input**
- Own sources/generation
- Relevant sources of supply (electricity, heat, etc.)

**II. Assignment**
- Assigning energy consumption to individual areas, process chains, plants -> identifying essential energy consumers and areas
- Identifying substantial parameters influencing the energy input

**III. Output**
- Production figures
- Turnover
- Feeding-in Energy

**III. Deriving improvement measures**
Collection and analysis of energy use

Aim:

- Finding and implementing "low hanging fruits"
- Evaluation of areas and machinery that need detailed investigation

Quelle: Dr. Jörg Meyer, Siemens AG. Vortrag im Rahmen der Veranstaltung „Energieeffizienz und Energiemanagement in Industrieunternehmen“, Oktober 2010, Wiesbaden
Technical building systems

- Gas/oil
- Water

Cooling/heating

Defined production conditions (temperature, purity, humidity)

Media
- Compressed air, steam
- Hot water, steam

Heat loss/exhaust air

Production machines

Electricity

Local climate

Sauer & Losert, 2013
overall structure

building structure

area structure

production workplace

overall system – consumption analysis plant

subsystem I – consumption analysis factory hall

subsystem II – consumption analysis process

element – consumption analysis production system

Sauer & Losert, 2013
1. peripheral
2. peripheral
3. peripheral

cumulated value added energy
production process A
thermal energy
energy losses
electric energy
thermal energy
energy losses

cumulated value added energy
production process B

cumulated value added energy

Sauer & Losert, 2013
1. periphery
- waste processing
- waste removement
- providing tools

2. periphery
- reducing working fund
- stocking consumables
- providing and removing consumables
- providing and removing work pieces
- main process
- process control
- energy supply
- generating compressed air
- sanitary/sociality

3. periphery
- stocking material
- manufacturing tools
- heating/ventilation
- maintenance

Sauer & Losert, 2013
energy intensity [kWh/piece]

partial load  optimal Operating point  overload

production phase

energy savings

Sauer & Losert, 2013
influence on energy efficiency of the system

identifying losses in energy efficiency

effort of change

influenceability

development construction start-up operation
How to do it
Sauer & Losert, 2013

Increasing the efficiency of the drive up to 30% (cf. [Neh11])
Increasing the efficiency of the main process by 10% (cf. [Neh11], example: component of a pc)

-45% energy demand for heating of tool possible (cfr. [Neh11])

Sauer & Losert, 2013
cumulated value added energy

Injection moulding

-50% energy demand for heating of tool possible (cf. [Neh11])

Sauer & Losert, 2013
Identification and selection of measures

**Basic technologies:**
- Motors/ electr. power units
- Ventilators
- Pumps

**Process independent Measures**
- Stand-by
- Material utilisation

**Cross-process technologies**
- Heat recovery
- Compressed air
- Lighting

**Prozess specific Measures**
- Injection moulding e.g. insulation of melting aggregates
Collection and analysis of energy use

Aim:

- Finding and implementing „low hanging fruits“

- Evaluation of areas and machinery that need detailed investigation

Quelle: Dr. Jörg Meyer, Siemens AG. Vortrag im Rahmen der Veranstaltung „Energieeffizienz und Energiemanagement in Industrieunternehmen“, Oktober 2010, Wiesbaden
Recuperation-dominance of power vs. dominance in energy

- Dominance of power: distinctive gap between medium and maximum power
- Dominance in energy: relatively small distinctive gap between medium and maximum power
- Short cycles
Smoothing of peaks in demand

- Power rating of a production plant is determined on the base of ist load profile
- Smoothing peaks in demand in the load profile in order to reduce the power rating
Highlights
Power Industry – Storage Systems for Electric Power
FastStorage BW

Task

- Development of novel high-performance and high-power storage cells (power caps) with a long service life and ultrafast charge, which is highly secure; development of the respective production processes
- Defining application fields for energy recovery and efficiency increase in industry and e-mobility

Services provided by EEP and Fraunhofer IPA

- New production methods for nanomaterial (graphene nanoplatelets) and electrodes with high potential for power storage
- Development of a innovative, solvent-free dry coating method for better processing
- Up-scaling wet chemical dispersion and application technology for a higher energy density
Highlights of Fraunhofer IPA
Energy-efficient Painting of Car Bodies InnoCaT 5

- The energy consumed by the painting process exceeds half of the total car body production.
- Most energy consumed in the painting process has to do with conditioning the spray booths and with the paint dryers.
- Coating techniques that do not damage paintwork as a prerequisite for minimizing the amount of energy and material used in spray painting.
- New drying concepts for energy-efficient operation are being developed.
- Modular product/painting strategy fragments the painting process and enables the flexible manufacturing of multi-substrate car bodies.
Ultra efficiency plant
holistic approach towards sustainable production
Evaluation of measures

- Generating improvement measures:
- Derivation of concrete guidances
- Control of implementation

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<td>Energiereduktion</td>
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Making it Happen
The path to unleash industrial EE

- Unleashing action towards increasing energy efficiency in industry requires: comparable, objective information to reduce unknowns and to reduce risks
  - To inform companies where they are and what they can do
  - To inform legislators if their instruments are effective and what type of instruments are required
  - To enable financial institutions to assess risk & potential better and to show up what financial instruments are lacking
Investment Drivers & Levers for Energy Efficiency

Investment drivers for energy efficiency measures

- Energy efficiency as main reason for investment (35%)
- Energy efficiency as side effect of other investments (65%)

In 2013, % of the responding companies identified important levers towards an increase in energy efficiency in

In 2014, % of the responding companies identified important levers towards an increase in energy efficiency in
Energy efficiency is the main driver for investments in the following categories:

- Microenterprises: 27.4%
- Small enterprises: 36.1%
- Medium enterprises: 37.0%
- Big enterprises: 43.3%

In contrast, energy efficiency is a side effect of other investments in the following categories:

- Microenterprises: 72.6%
- Small enterprises: 63.9%
- Medium enterprises: 63.0%
- Big enterprises: 56.7%
Companies that use the total cost of ownership (TCO) as evaluation criterion implement significantly more efficiency measures.
Identification and harnessing of energy efficiency potentials is organised...

- Internally:
  - Microenterprises: 71.3%
  - Small enterprises: 47.5%
  - Medium enterprises: 65.6%
  - Big enterprises: 60.0%

- Externally:
  - Microenterprises: 30.0%
  - Small enterprises: 20.0%
  - Medium enterprises: 18.8%
  - Big enterprises: 15.0%

- Both:
  - Microenterprises: 22.5%
  - Small enterprises: 8.7%
  - Medium enterprises: 15.6%
  - Big enterprises: 25.0%
The required investment sum is too high

- **big enterprises**
  - fully applies: 12.2%
  - applies: 41.5%
  - does rather not apply: 22.0%
  - does not apply: 24.4%

- **medium enterprises**
  - fully applies: 19.4%
  - applies: 38.9%
  - does rather not apply: 27.8%
  - does not apply: 13.9%

- **small enterprises**
  - fully applies: 10.8%
  - applies: 32.5%
  - does rather not apply: 19.3%
  - does not apply: 37.3%

- **microenterprises**
  - fully applies: 16.7%
  - applies: 23.6%
  - does rather not apply: 17.4%
  - does not apply: 42.4%
The payback period is too long

- **big enterprises**: 12.8% fully applies, 46.2% applies, 28.2% does rather not apply, 12.8% does not apply
- **medium enterprises**: 16.7% fully applies, 25.0% applies, 33.3% does rather not apply, 25.0% does not apply
- **small enterprises**: 13.1% fully applies, 19.0% applies, 23.8% does rather not apply, 44.0% does not apply
- **microenterprises**: 11.7% fully applies, 23.4% applies, 23.4% does rather not apply, 41.6% does not apply
Concerns regarding production downtimes and product quality

- **big enterprises**
  - Fully applies: 2.5%
  - Applies: 17.5%
  - Does rather not apply: 32.5%
  - Does not apply: 47.5%

- **medium enterprises**
  - Fully applies: 2.7%
  - Applies: 21.6%
  - Does rather not apply: 27.0%
  - Does not apply: 48.6%

- **small enterprises**
  - Fully applies: 0.0%
  - Applies: 10.6%
  - Does rather not apply: 20.0%
  - Does not apply: 69.4%

- **microenterprises**
  - Fully applies: 5.6%
  - Applies: 7.6%
  - Does rather not apply: 21.5%
  - Does not apply: 65.3%
We do not have any or enough skilled staff for planning and execution

- **big enterprises**
  - Fully applies: 12.2%
  - Applies: 26.8%
  - Does rather not apply: 26.8%
  - Does not apply: 34.1%

- **medium enterprises**
  - Fully applies: 8.6%
  - Applies: 37.1%
  - Does rather not apply: 34.3%
  - Does not apply: 20.0%

- **small enterprises**
  - Fully applies: 16.1%
  - Applies: 20.7%
  - Does rather not apply: 29.9%
  - Does not apply: 33.3%

- **microenterprises**
  - Fully applies: 15.5%
  - Applies: 24.6%
  - Does rather not apply: 16.2%
  - Does not apply: 43.7%
Lacking subsidy programmes

- **big enterprises**
  - Fully applies: 10.5%
  - Applies: 42.1%
  - Does rather not apply: 21.1%
  - Does not apply: 26.3%

- **medium enterprises**
  - Fully applies: 6.1%
  - Applies: 18.2%
  - Does rather not apply: 45.5%
  - Does not apply: 30.3%

- **small enterprises**
  - Fully applies: 7.8%
  - Applies: 19.5%
  - Does rather not apply: 26.0%
  - Does not apply: 46.8%

- **microenterprises**
  - Fully applies: 11.3%
  - Applies: 18.8%
  - Does rather not apply: 18.8%
  - Does not apply: 51.1%
Application process for subsidies is too complicated and time consuming

- **big enterprises**
  - fully applies: 10.3%
  - applies: 35.9%
  - does rather not apply: 25.6%
  - does not apply: 28.2%

- **medium enterprises**
  - fully applies: 6.1%
  - applies: 24.2%
  - does rather not apply: 33.3%
  - does not apply: 36.4%

- **small enterprises**
  - fully applies: 22.9%
  - applies: 26.5%
  - does rather not apply: 10.8%
  - does not apply: 39.8%

- **microenterprises**
  - fully applies: 22.9%
  - applies: 21.4%
  - does rather not apply: 13.6%
  - does not apply: 42.1%
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