# SHIP Egypt

## Session 03

## How to perform an energy audit

**Wolfgang Glatzl | AEE INTEC**
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# Warm Up

- **[1 @ board /or/ brainstorm w cards]**

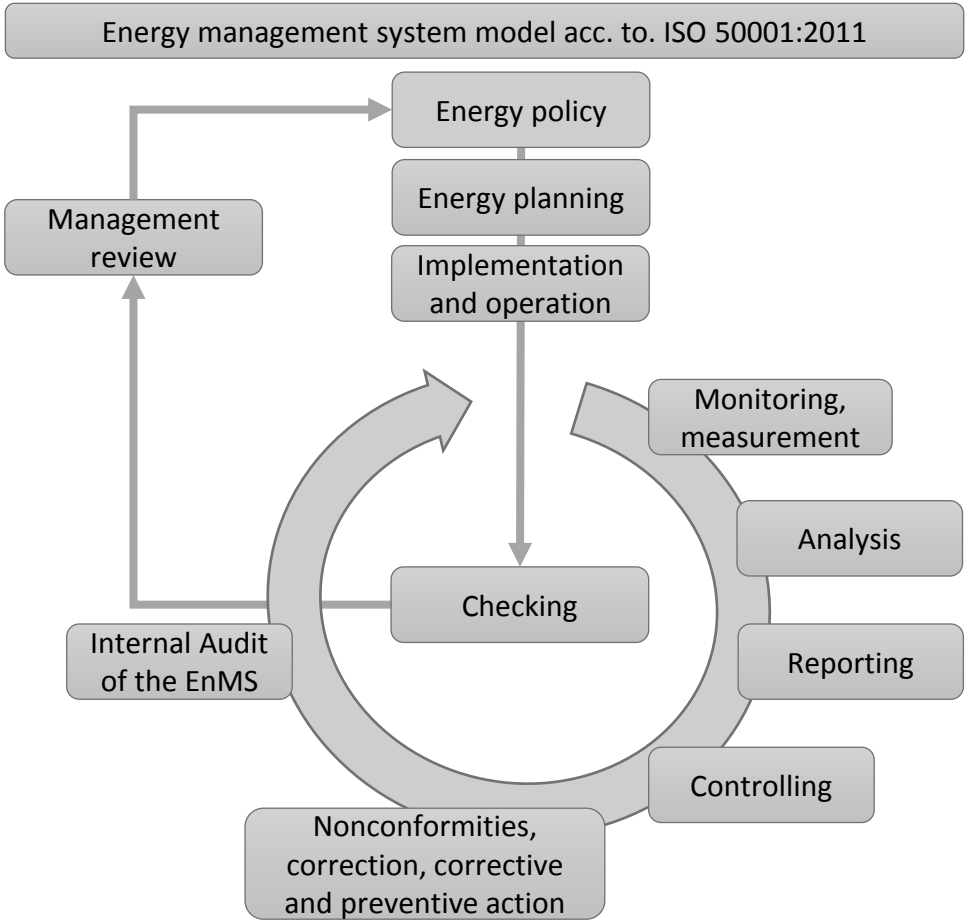
- **Where is the word "AUDIT" coming from?**
  - ⇨ Synonyms? Antonyms?
  - ⇨ What tells a dictionary?

- **Latin: audire = to hear**

# Overview

- **Standardisation**
- **Audit steps**
  - ⇨ Pre-audit
  - ⇨ Audit
  - ⇨ Evaluation status quo
  - ⇨ Evaluation of optimisation potential
- **Preparation of company and auditor**
- **Objectives of the audit**
- **Types of data**
- **Summary**

# Audit – which one?



# Energy Audit Standards

- **ISO 50002 Standard on „Energy Audits“**
  - ⇨ Level I: Walk-Through Energy Audit (WTEA)
  - ⇨ Level II: Detailed Energy Audit (DEA)
  - ⇨ Level III: Investment Grade Energy Audit (IGEA)

- **EN 16247: European countries have adopted EN 16247 for standardising EA processes in their countries**
  - ⇨ Part 1: General requirements
  - ⇨ Part 2: Buildings
  - ⇨ Part 3: Processes
  - ⇨ Part 4: Transport

# Goals

- **Clearly identify types and costs of energy use.**
- **Understand how energy is being used and possibly wasted.**
- **Identify and analyse more cost -effective ways of using energy.**
- **Improved operational techniques - new equipment, new processes or new technology.**
- **Perform an economic analysis on those alternatives and determine which ones are cost -effective for your business or industry.**
- **Develop a action plan with responsibilities, timelines and budgets for implementation.**

# EN 16247 - introduction

- **EN 16247 defines characteristics of a high-level energy audit as well as requirements and obligations**
  - ⇨ Part 1: general requirements
  - ⇨ Part 2: buildings
  - ⇨ Part 3: processes
  - ⇨ Part 4: transport

  - ⇨ CEN/CLC/JWG 1 – energy audits
  - ⇨ CEN/CENELEC – CWA – CEN Workshop Agreement within project EINSTEIN
- **Linked to ISO 50001, 50002 but more detailed and focussed on thermal energy demand**

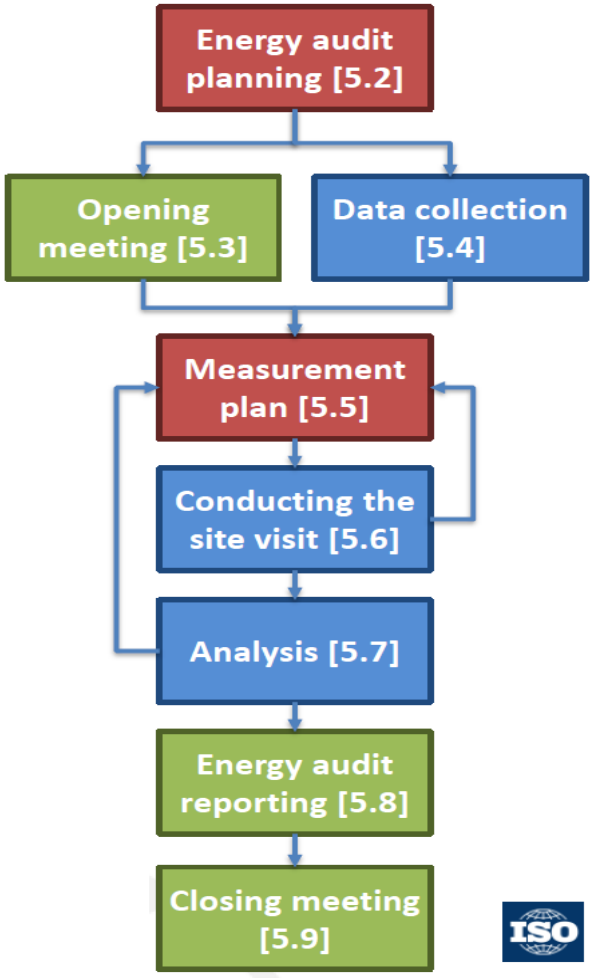
# Energy audit

- **An energy audit can support the**
  - ⇨ energy review and energy planning of an EnMS
  - ⇨ can facilitate monitoring, measurement and analysis as described in ISO 50001
  - ⇨ or it can be used independently.
- **ISO 50002, which is based on the EN 16247, are standards that specify the process requirements for carrying out an energy audit in relation to energy performance.**
- **They are applicable to all types of establishments and organizations, and all forms of energy and energy use. These standard apply to commercial, industrial, residential and public-sector organisations, excluding individual private dwellings.**

# ISO 50002

## Content and flow of ISO 50002

- 5.1 General
- 5.2 Energy audit planning
- 5.3 Opening meeting
- 5.4 Data collection
- 5.5 Measurement plan
- 5.6 Conducting the site visit
- 5.6.1 Management of field work
- 5.6.2 Site visits
- 5.7 Analysis
- 5.7.1 General
- 5.7.2 Analysis of current energy performance
- 5.7.3 Identification of improvement opportunities
- 5.7.4 Evaluation of improvement opportunities
- 5.8 Energy audit reporting
- 5.8.1 General
- 5.8.2 Energy audit report content
- 5.9 Closing meeting





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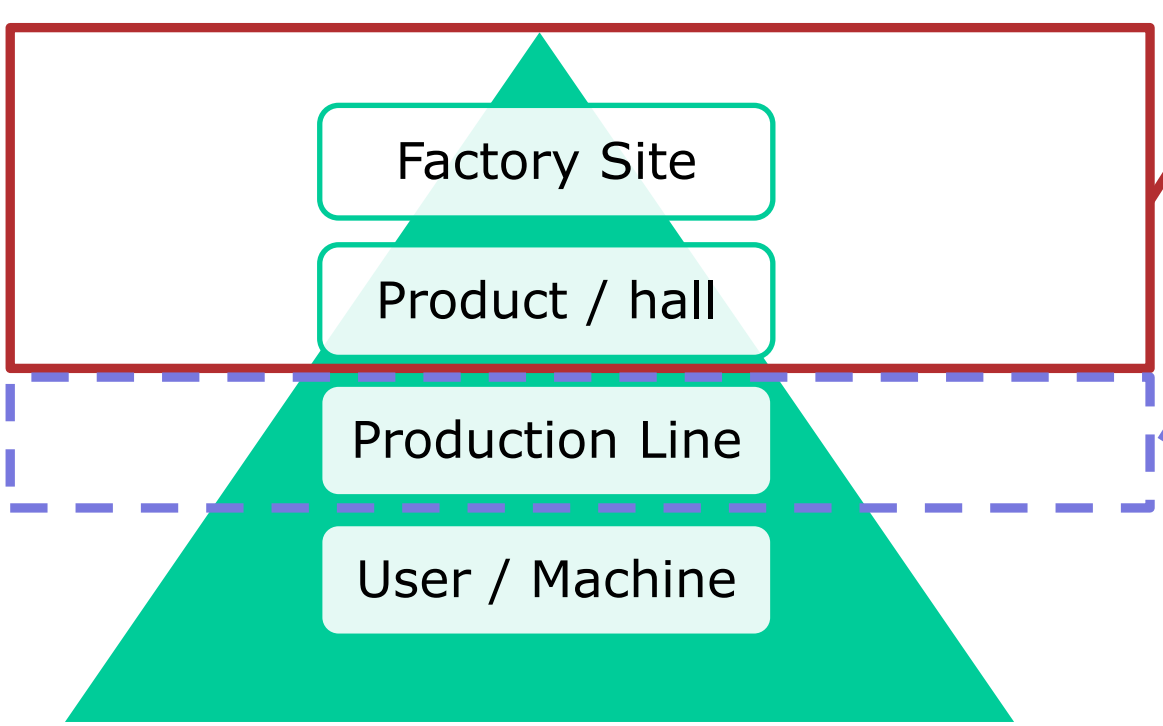
# Levels of Energy Audits (acc. ISO 50002)

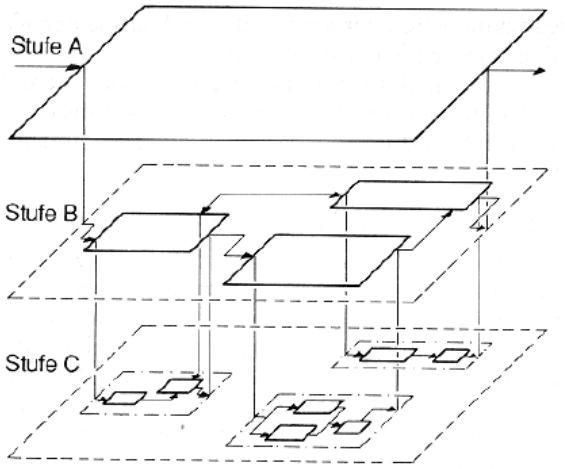
| LEVEL I | LEVEL II | LEVEL III |
|---|---|---|
| WALK-THROUGH ENERGY AUDIT | DETAILED ENERGY AUDIT | INVESTMENT GRADE AUDIT |
| • Walk through familiarization<br>• Desk top analysis<br>• Generate Energy Intensity<br>• Recommend "low/no-cost" energy saving measures<br>• Written Report with broad conclusion | • Follow up from Level I audit where available; a comprehensive audit<br>• A minimum 7 days logging & metering on major energy consuming equipment of building services or industrial equipment/systems<br>• Review system design, installation, operations and maintenance<br>• Detailing system energy inputs and energy use<br>• Identify sources of inefficiency<br>• Compute Specific Energy Consumption Index<br>• Generate load apportioning<br>• Provide Energy Performance Indicators<br>• Recommend "no-cost", "medium cost" and "high cost" ESM<br>• Written report and presentation | • Inclusive of all scope of works of Level I & II with the exception where only EA on specific systems are requested<br>• A minimum of 7 days logging and metering on major energy consuming equipment of Building services or industrial equipment/systems<br>• Detailed review of processes<br>• Comfort study, if relevant<br>• Detailed recommendation on comprehensive ESMs<br>• Detailed investment plan using NPV methodology against life cycle<br>• Include Indoor Air Quality report to ensure system is not affected (if chiller audit)<br>• Written report and presentation |

# From meta to micro




Energy data of all types and media

Energy data of all electr. & compressed air

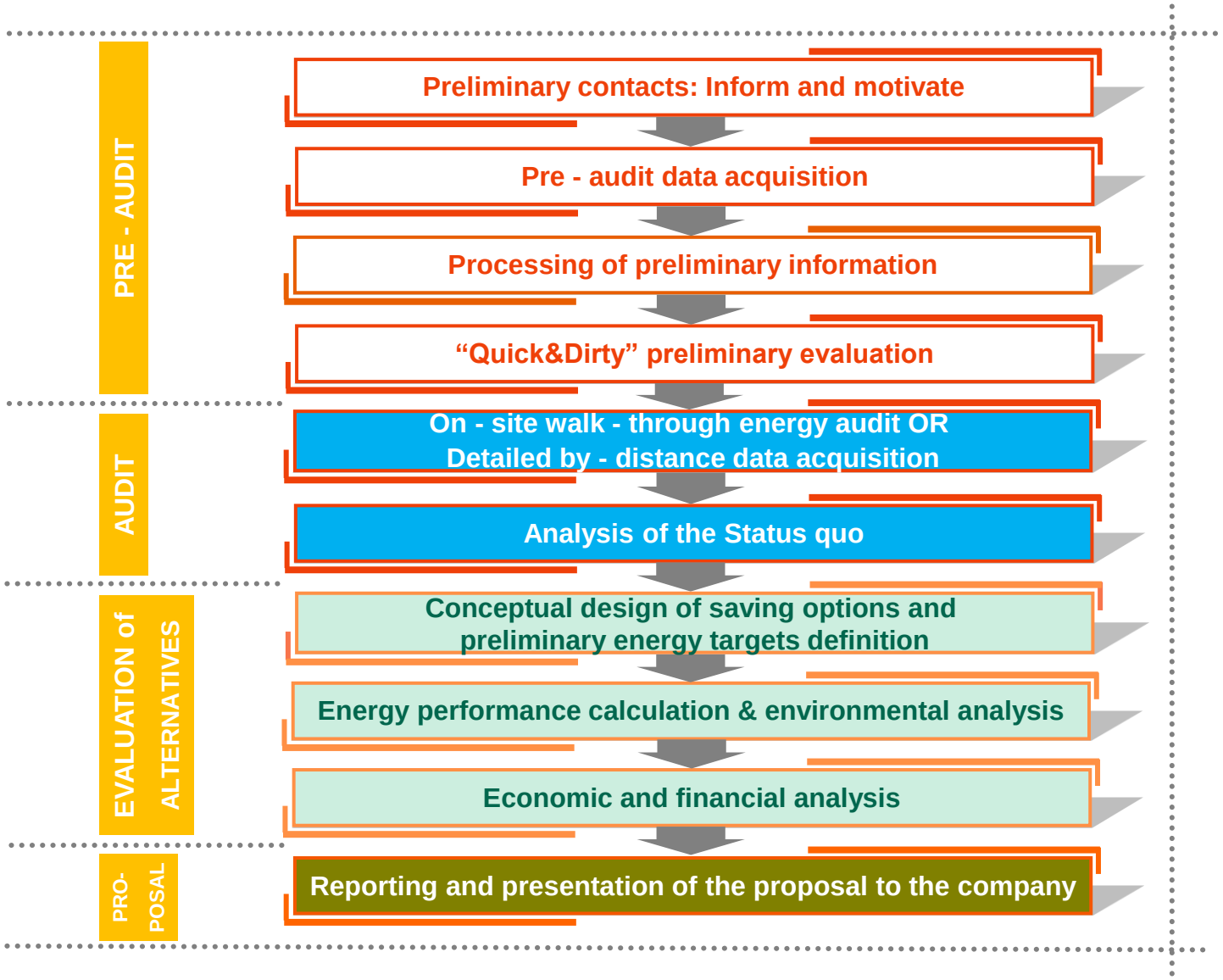



Quelle: VW EnMS, Thierfelder, 2014

# GREENFOODS audit methodology

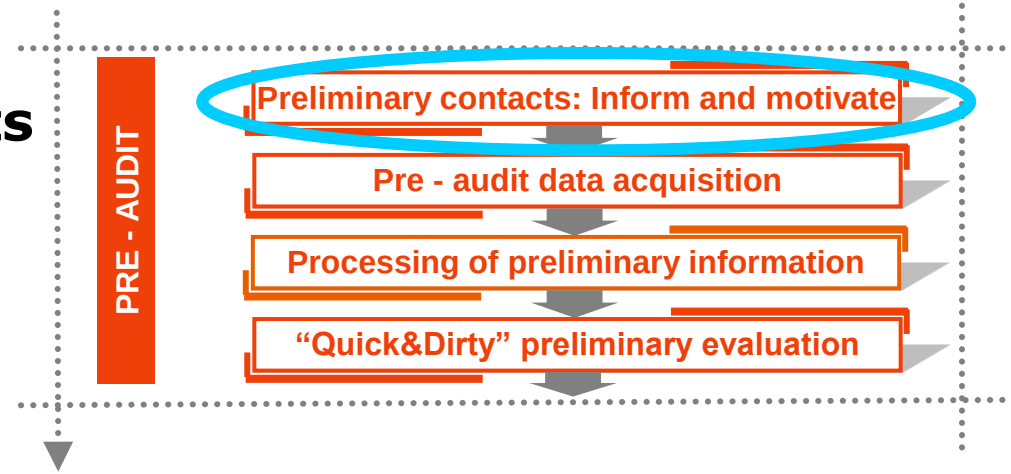
- **GREENFOODS audit methodology is based on**
  - ⇨ EINSTEIN audit steps (IEE project EINSTEIN I & II)
  - ⇨ EN 16247
- **Pre-audit**
- **Audit**
- **Evaluation**
- **Proposal**
- **EINSTEIN linked to EN 16247**
  - ⇨ Terms similar, EINSTEIN more detailed
  - ⇨ 7 audit steps from EN 16247 can be found in 10 EINSTEIN audit steps → GREENFOODS audit methodology

# 10 Audit steps



# PRE-Audit – Step 1

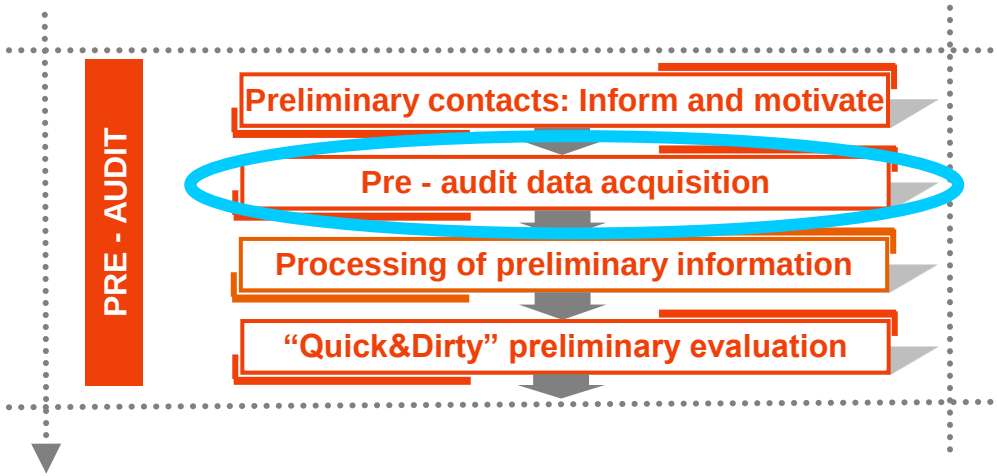
- **Preliminary contacts - Inform and motivate**




- ⇨ Promotional material
- ⇨ Possibility of self-checking
- ⇨ Make sure you find out who is the right person to address

# PRE-Audit – Step 2

- **Data acquisition**



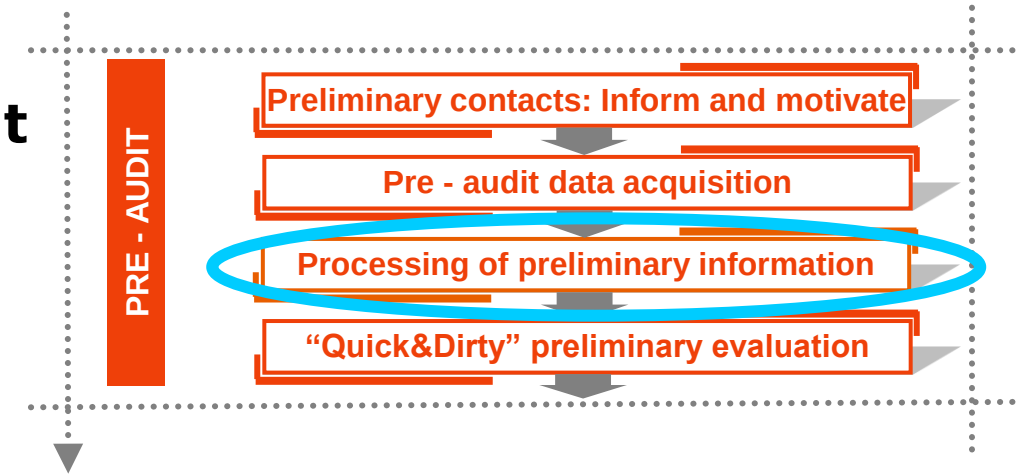

⇨ Prepare the company

⇨ Prepare yourself

⇨ Collect basic data by distance

# PRE-Audit - Step 3

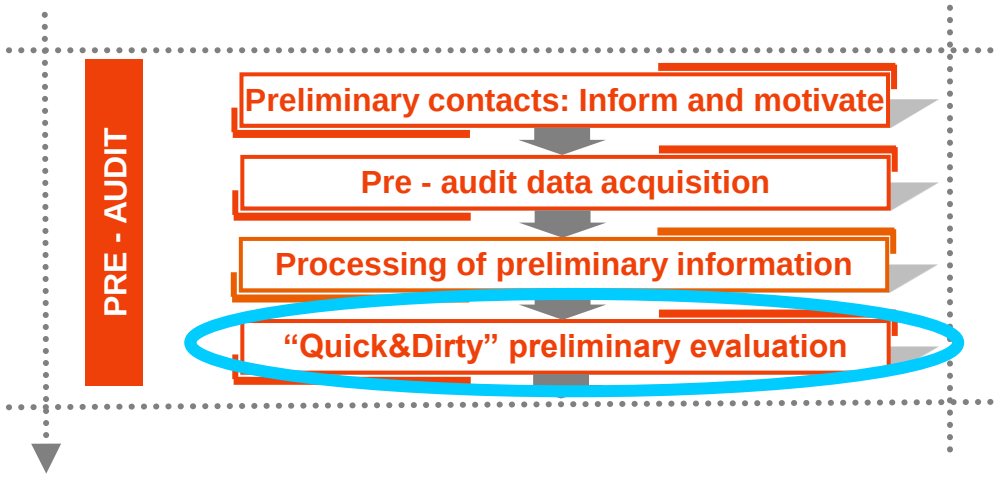
- **Preparation of audit - Processing of preliminary information**




- ⇨ Process pre-audit data
- ⇨ Call the company to check data
- ⇨ Compare with benchmark data
- ⇨ Learn about specific processes/companies
- ⇨ Identify possible measures
- ⇨ Fix priorities for audit

# PRE-Audit - Step 4

- **"Quick-and-dirty" pre-evaluation report**




⇨ Create pre-evaluation report

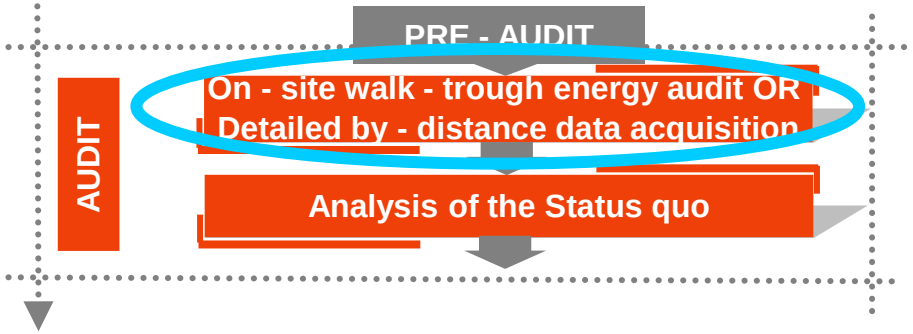
- **Identifies most significant processes**
- **First quantitative demand figures**
- **Identifies possible options & sizes**
- **Estimate of expected savings**

⇨ Optional: present to company

- **May convince company to go ahead with audit**
- **Do not promise too much at the beginning !**
- **Results depend on local conditions and information accuracy**

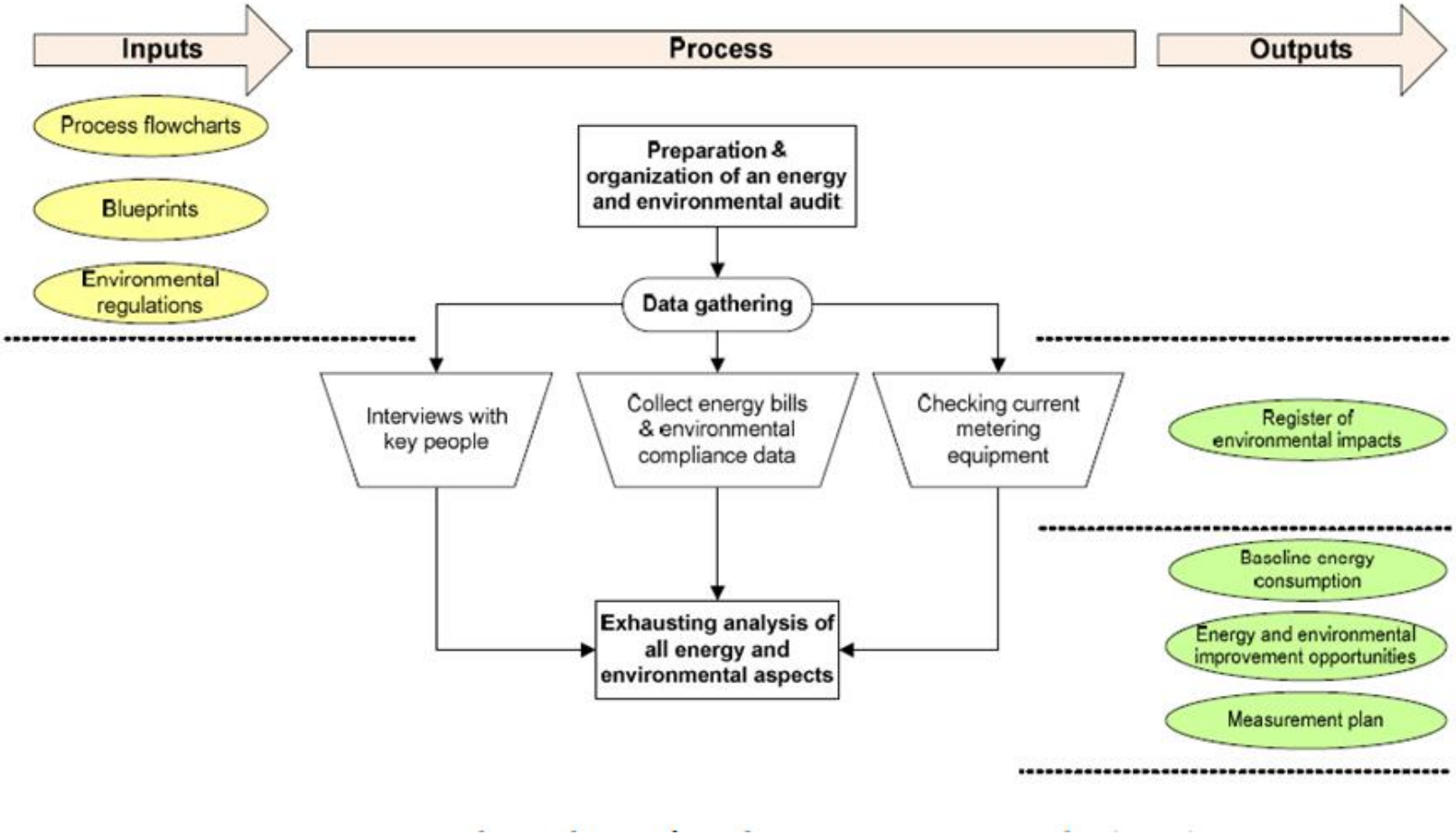
# ENERGY-Audit – Step 5

- **On - site walk – through audit**

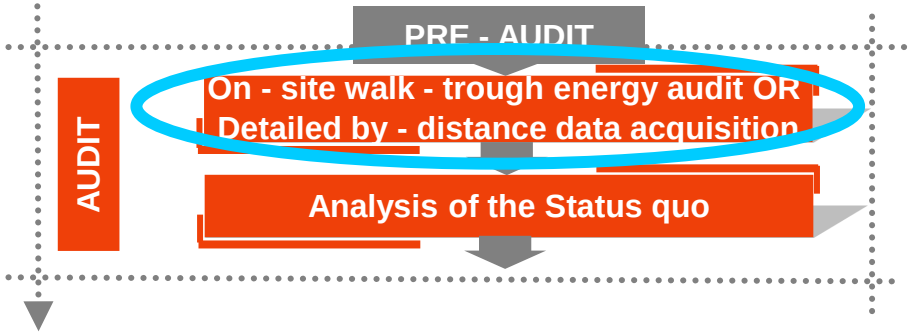



- ⇨ Present to company quick-and-dirty study
  - **First impressions: possible measures & unsuitable measures**
- ⇨ Make interviews and visit the site
  - **Timeframe for further data & report**
- ⇨ Fast check of new data
- ⇨ Take measurements
- ⇨ Define measurement program
- ⇨ Discuss new understanding

# Summary of WTEA



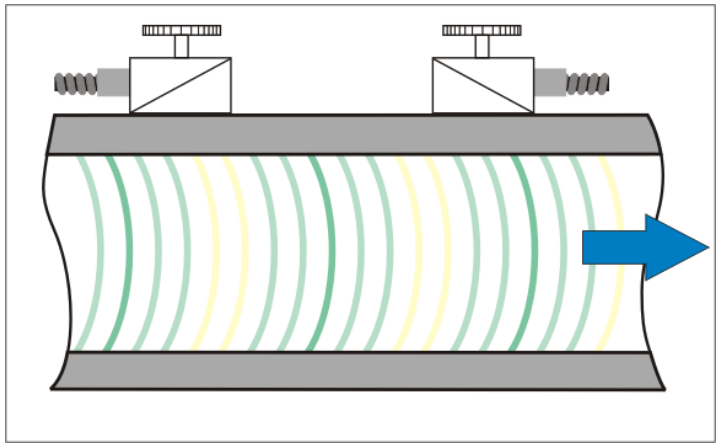
# ENERGY-Audit – Step 5

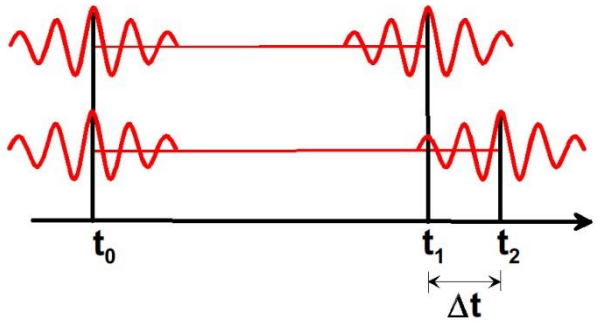



- **On - site walk – through audit**

⇨ Take measurements

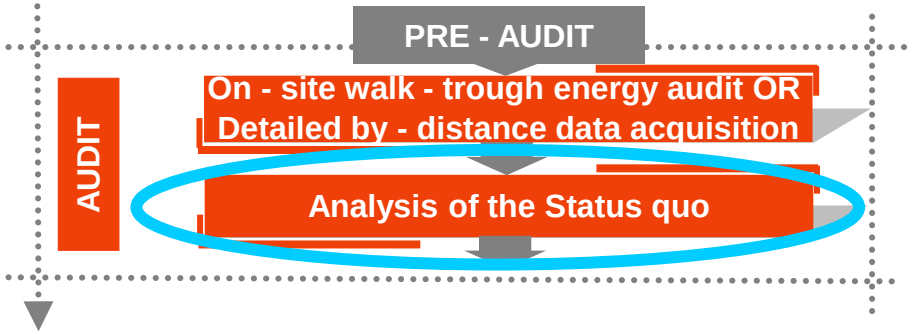
- **Measurement device**
  - PORTABLE ULTRASONIC FLOWMETER
  - Time difference correlation principle





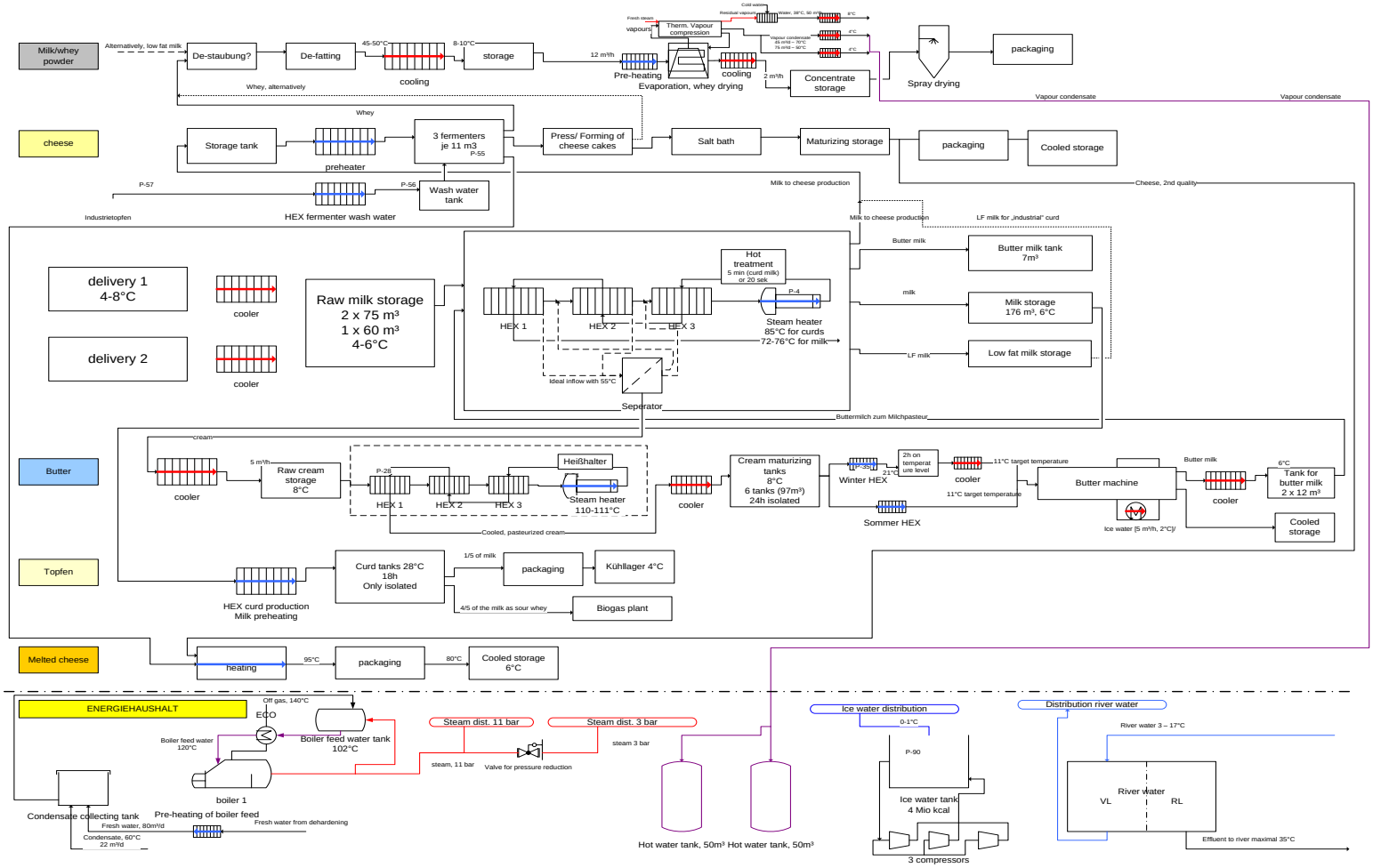
# ENERGY-Audit – Step 6

## ➢ Analysis of status quo

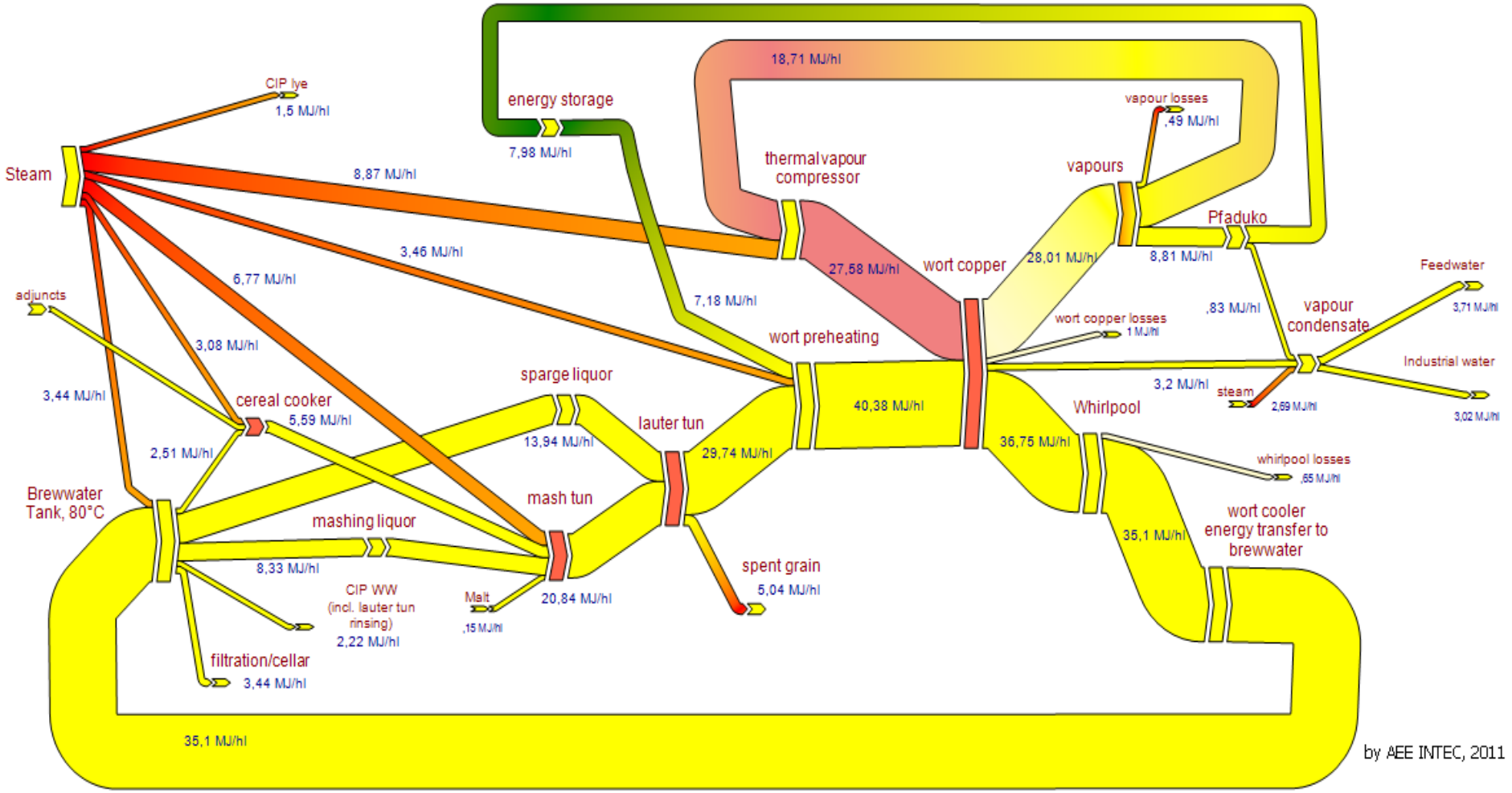



- ⇨ Consistency check of data
- ⇨ Estimate and/or acquire missing information
- ⇨ Breakdown of consumption
- ⇨ Real equipment performance
- ⇨ Comparison with benchmarks

# ENERGY-Audit – Step 6
# Flow sheet

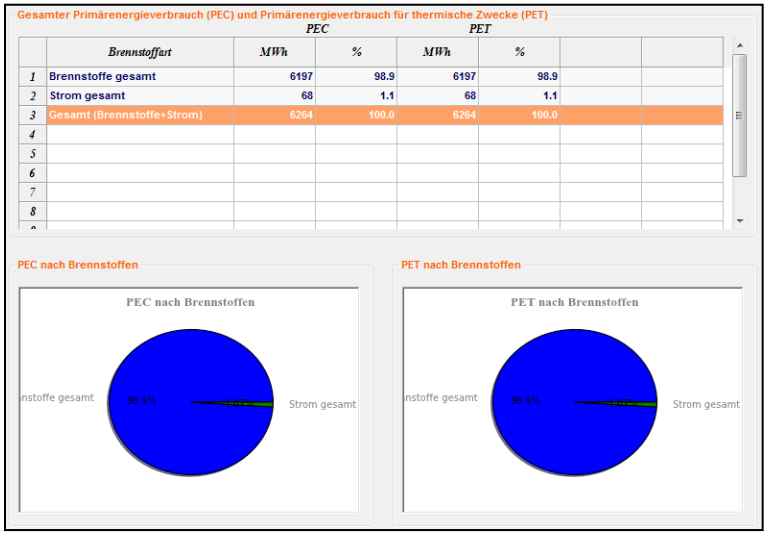


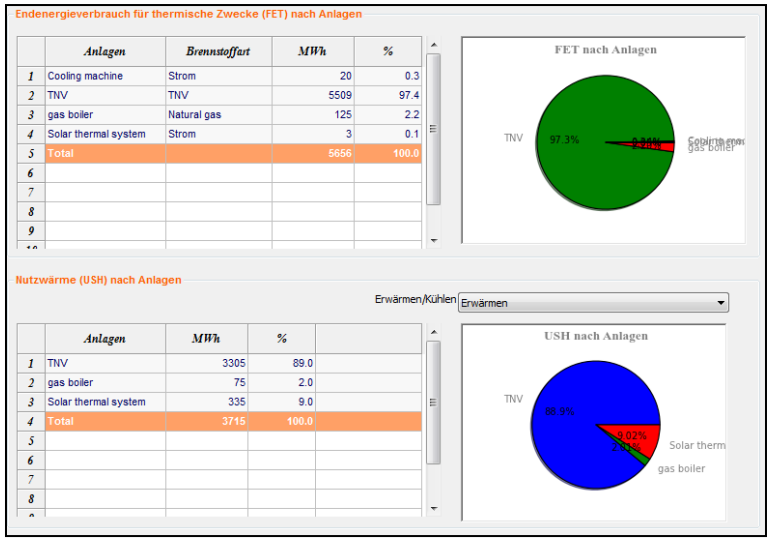
# ENERGY-Audit – Step 6
# Sankey diagram

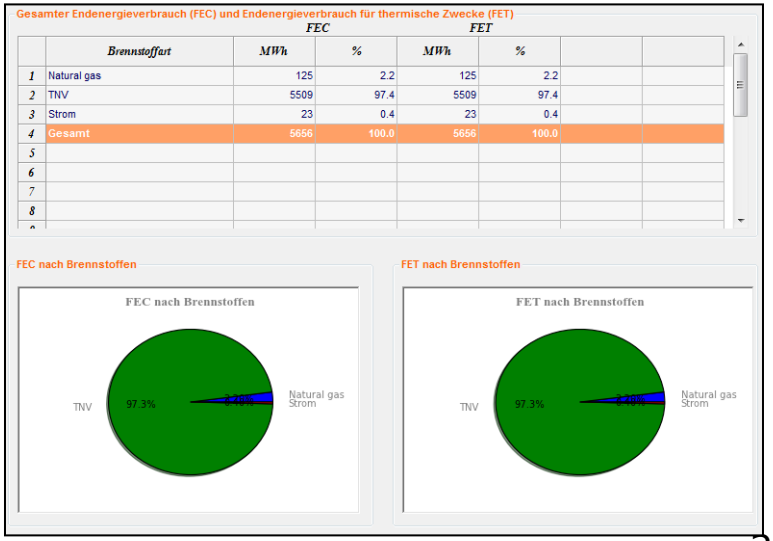


# ENERGY-Audit – Step 6
# Evaluation of the present state (1)

- **Primary energy consumption**
  - ⇨ Total
  - ⇨ By fuel
  - ⇨ By equipment

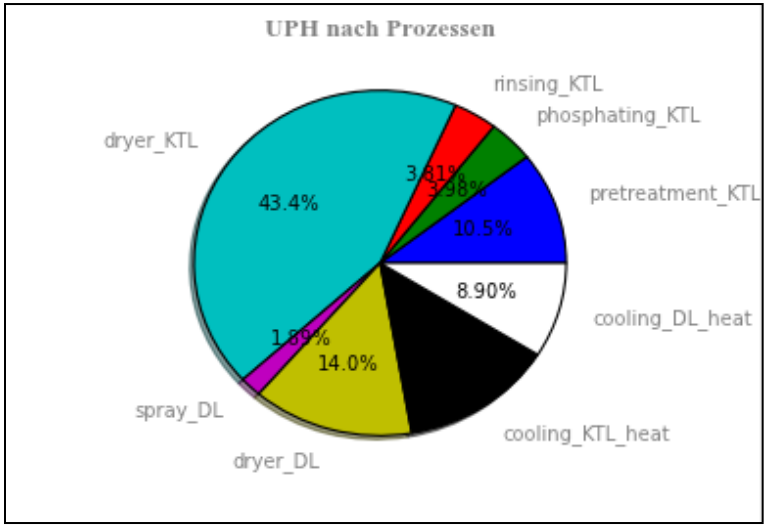


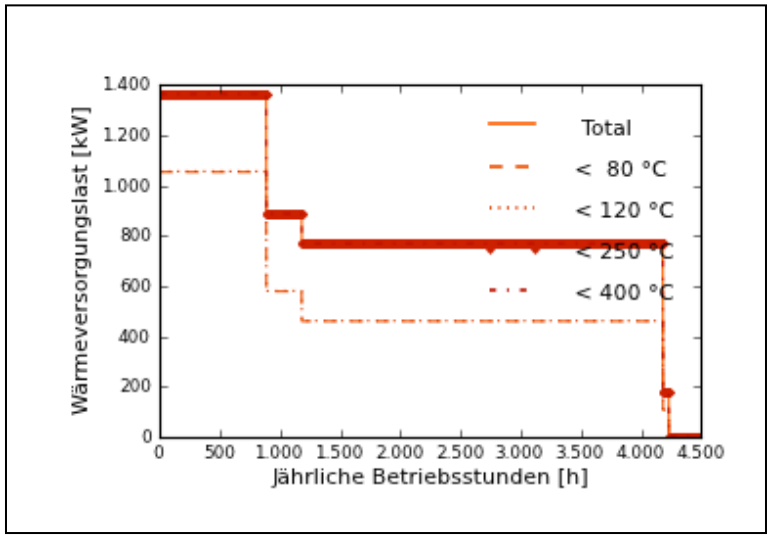



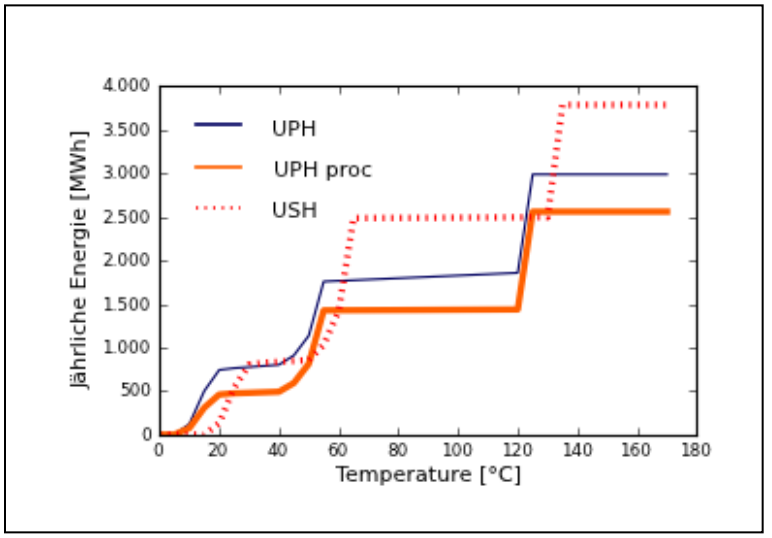



# ENERGY-Audit – Step 6
# Evaluation of the present state (2)

- **Heat and cold demand**
  - ⇨ By processes
  - ⇨ By temperature levels
  - ⇨ By time demand

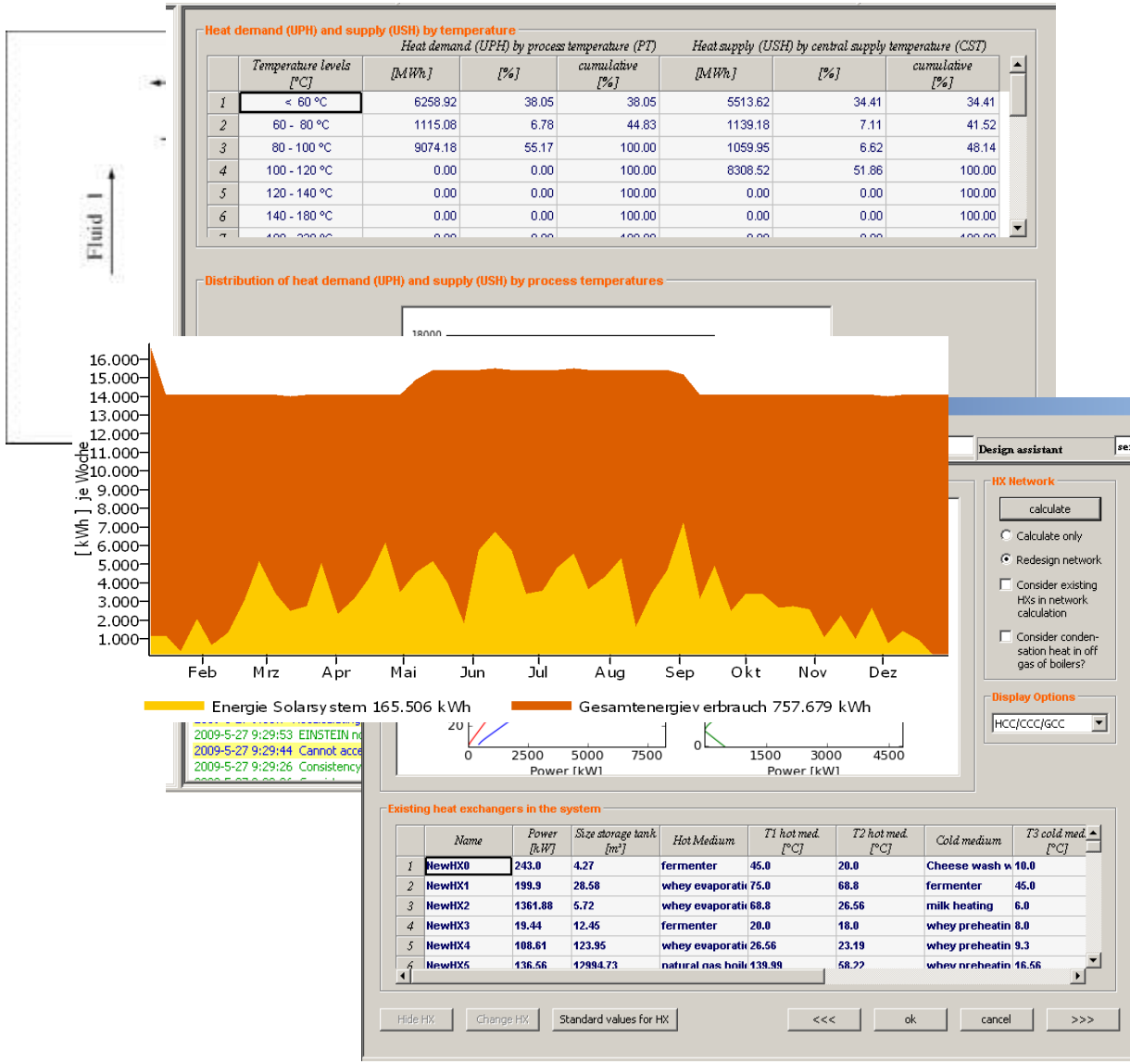


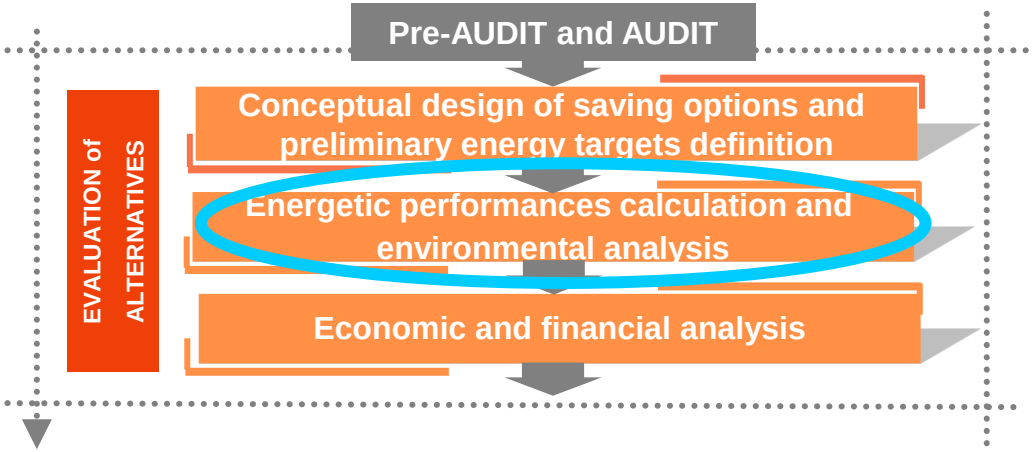
# EVALUATION OF ALTERNATIVES - STEP 7

- **Development of optimized alternatives**
- ⇨ Exergetic analysis – temperature dependency of heat demand and processes
- ⇨ Optimized heat and mass transfer
- ⇨ System optimization - Design of heat exchanger network and Storage management
- ⇨ Solar simulation and detail calculation and design



# EVALUATION OF ALTERNATIVES
# STEP 8

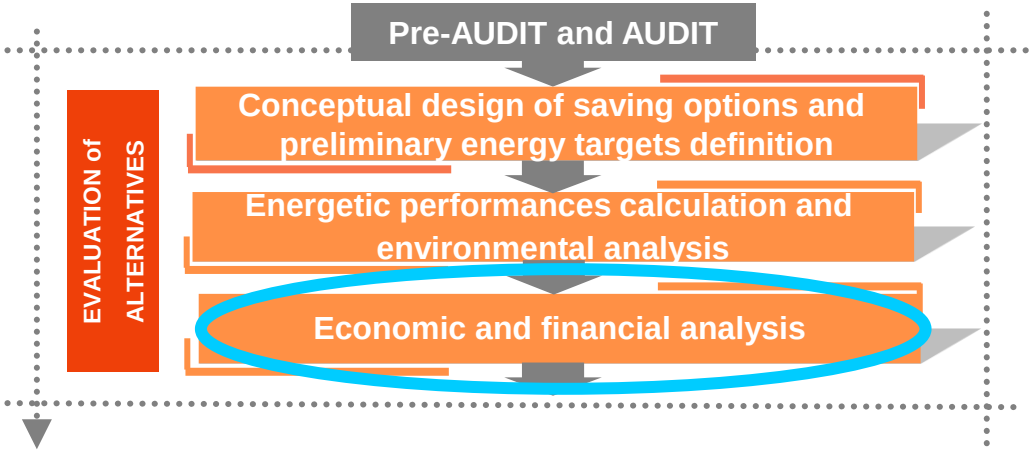
- **Energetic performance calculation and environmental analysis**




- ⇨ Fast calculation
- ⇨ System simulation with specific external software
- ⇨ Energetic and environmental analysis

# EVALUATION OF ALTERNATIVES
# STEP 9

- **Economic and financial analysis**




- ⇨ Calculate main economic parameters
- ⇨ Assess possibilities of funding and financing
- ⇨ Elaborate an appropriate financing scheme

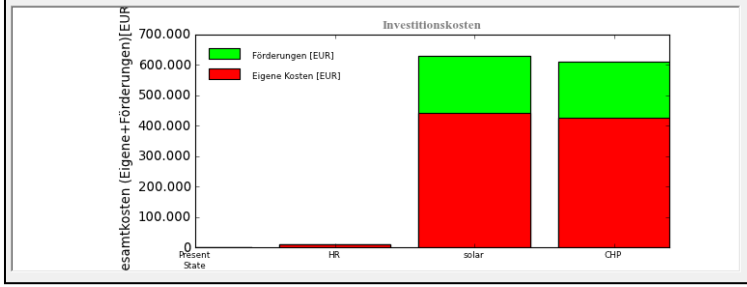
# Step 9 - Results

- **Comparison present state and proposals**
  - ⇨ Primary energy consumption
  - ⇨ Energetical evaluation
  - ⇨ Environmental evaluation
  - ⇨ Economical evaluation
- **Report generation**

Investitionskosten

| | Alternative | Gesamtkosten [EUR] | Eigene Kosten [EUR] | Förderungen [EUR] |
|---|---|---|---|---|
| 1 | Present State (checked) | | | |
| 2 | HR | 10000.00 | 10000.00 | 0.00 |
| 3 | solar | 630000.00 | 441000.00 | 189000.00 |
| 4 | CHP | 610000.00 | 427000.00 | 183000.00 |
| 5 | | | | |
| 6 | | | | |

Relative Investitionskosten

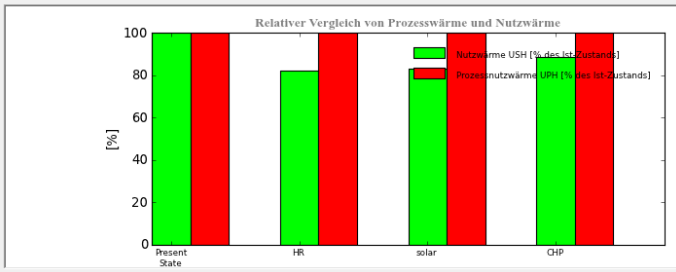



Prozessnutzwärme und Nutzwärme (UPH und USH)

Erwärmen/Kühlen: Erwärmen

| | Alternative | Prozessnutzwärme (UPH) [MWh] | Einsparungen (UPH) [MWh] | Nutzwärme (USH) [MWh] | Einsparungen(USH) [MWh] |
|---|---|---|---|---|---|
| 1 | Present State (checked) | 2988.62 | | 4470.79 | |
| 2 | HR | 2988.62 | 0.00 | 3680.65 | 790.14 |
| 3 | solar | 2988.62 | 0.00 | 3715.29 | 755.49 |
| 4 | CHP | 2988.62 | 0.00 | 3959.70 | 511.09 |
| 5 | | | | | |

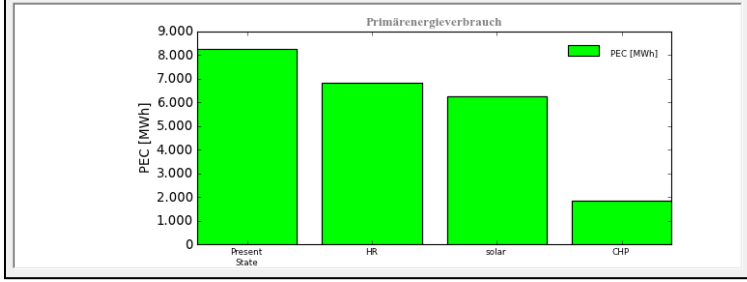
Relativer Vergleich von Prozessnutzwärme und Nutzwärme



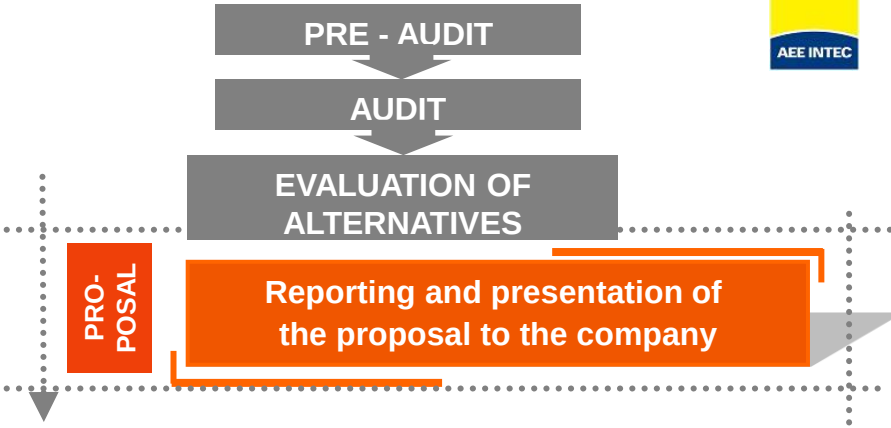

Primärenergieverbrauch (PEC)

| | Alternative | Primärenergie Verbrauch [MWh] | Einsparungen [MWh] | Einsparungen [%] |
|---|---|---|---|---|
| 1 | Present State (checked) | 8252.56 | | |
| 2 | HR | 6805.56 | 1447.00 | 17.53 |
| 3 | solar | 6264.22 | 1988.34 | 24.09 |
| 4 | CHP | 1848.98 | 6403.58 | 77.60 |
| 5 | | | | |
| 6 | | | | |

Relativer Vergleich des PEC



# STEP 10 - PROPOSAL




- **Reporting and presentation to the company**

  - ⇨ Elaborate short-and-clean audit report
  - ⇨ Present to the company

# Step 10 - Follow-up: From the audit to the installation of a new system

- **Follow-up is as important as audit itself !**
- **Objective**
  - ⇨ Try to convince the company to realise the proposed investment and install new energy efficient systems
  - ⇨ If your proposals are realised: compare your predictions with the real behaviour
- **Learn also from negative responses: call and try to get information why your proposal was not realised**

## Summary - Practical work

- Go through check list and collect company data
- Fill in questionnaire
- Draw flow sheet
- Identify missing data
- Select important data
- Plan for missing data acquisition
- Process optimisation
- System optimisation
- Efficient and renewable supply

# SHIP Egypt

## Session 03

## How to perform an energy audit

**Wolfgang Glatzl | AEE INTEC**
**Josef Buchinger | ConPlusUltra**