

# *Preparatory study*

## *Lot 7 Steam boilers*

### Task 3: Users

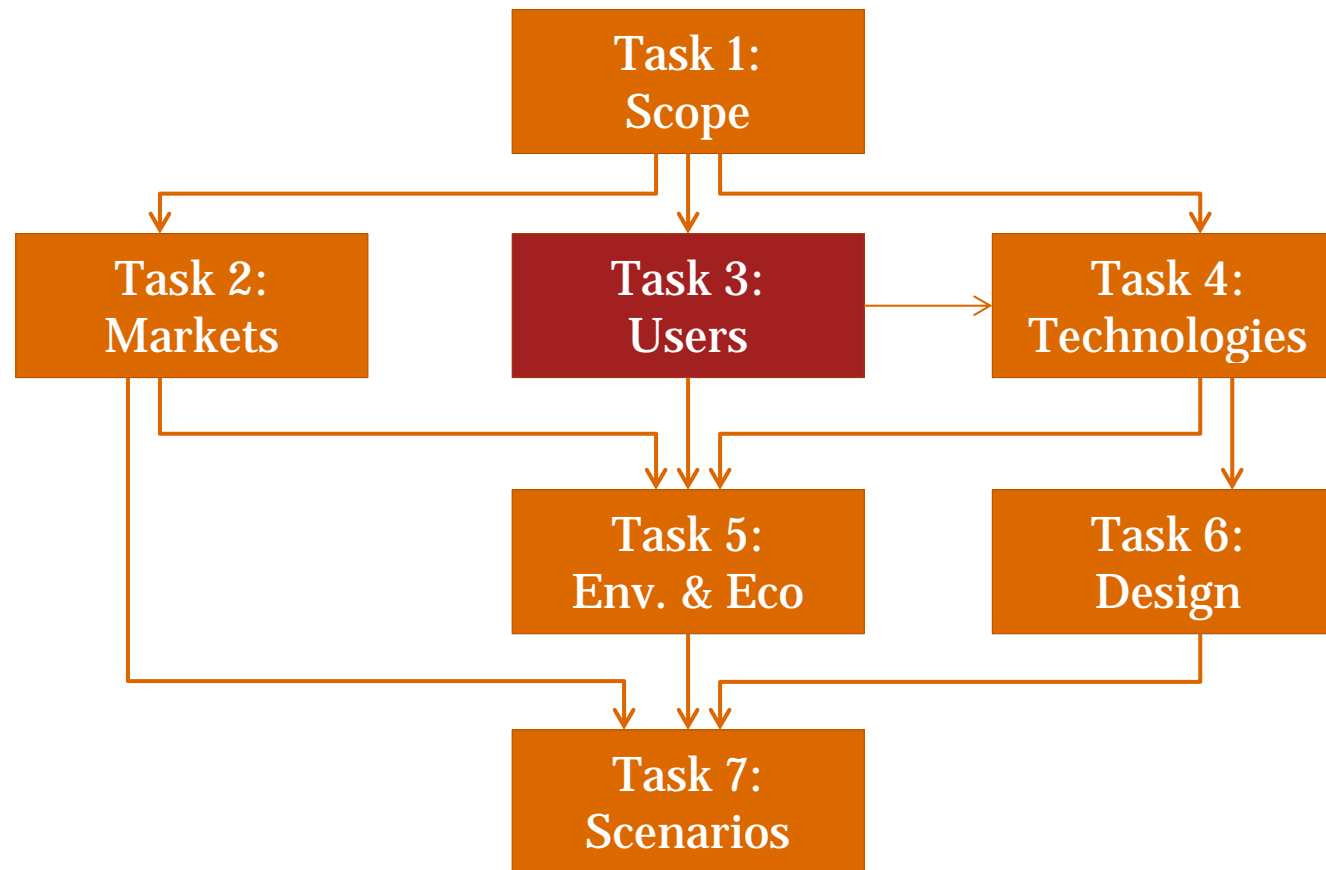
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Innovation Research ISI



Source: Chemical pulp mill from Wikipedia, the free encyclopedia

# ***Tasks' structure***



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## ***Task 3: Users***

- **Subtask: System aspects of the use phase for ErPs with direct impact**
- Subtask: System aspects of the use phase for ErPs with indirect impact
- Subtask: End-of-life behavior
- Subtask: Local infrastructure
- **Subtask: Recommendations**

**Scope: Report on the environmental & resources impacts during the use phase for ErP.**

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# ***Contents***

## **Part 1: Branches and Industries**

## **Part 2: Product scoping**

- i. Strict product scope
- ii. Extended product approach
- iii. Technical system approach
- iv. Conclusions

## **Part 3: Open points**

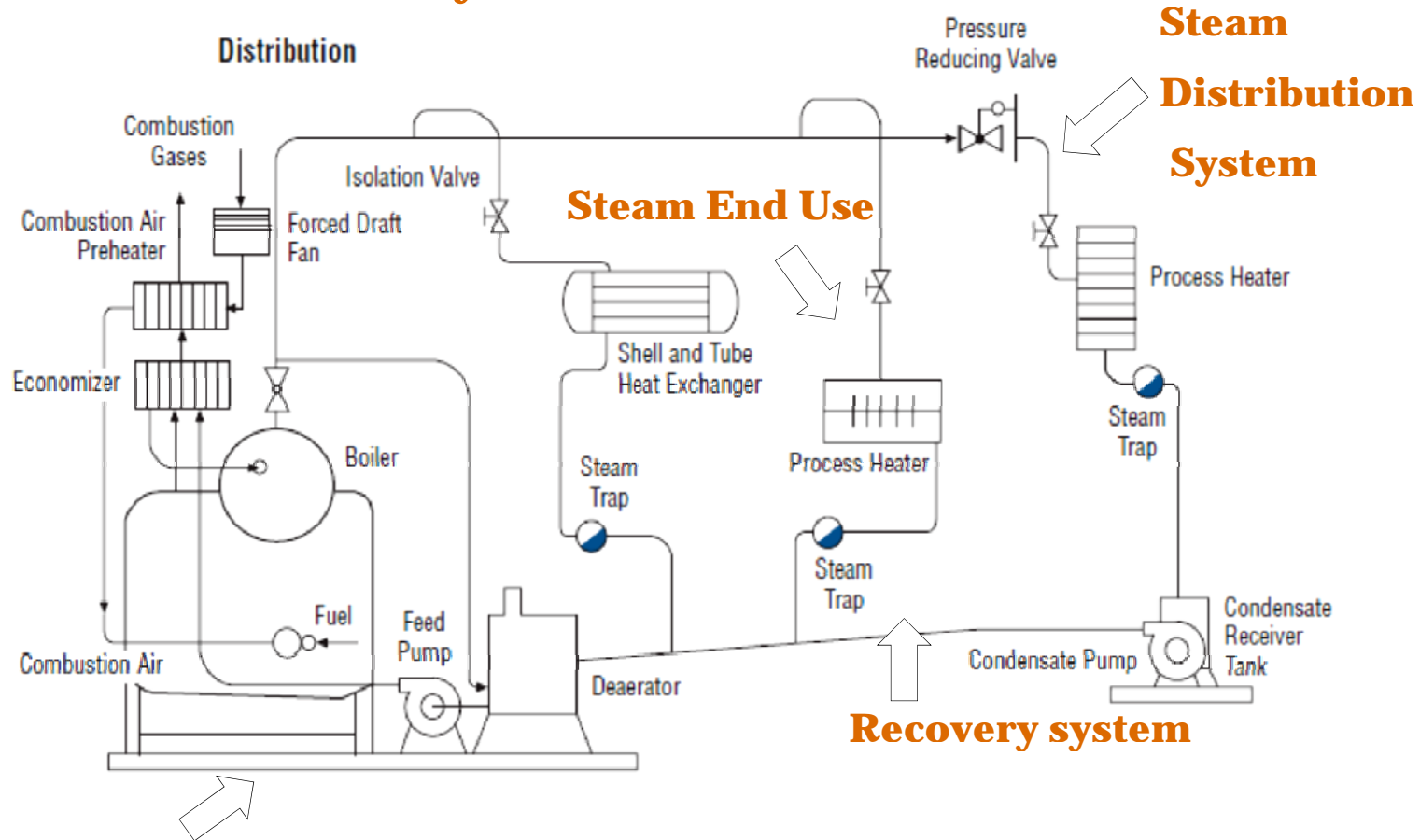
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# *Part 1: Branches and Industries*

# *1*

# 1. Branches and Industries

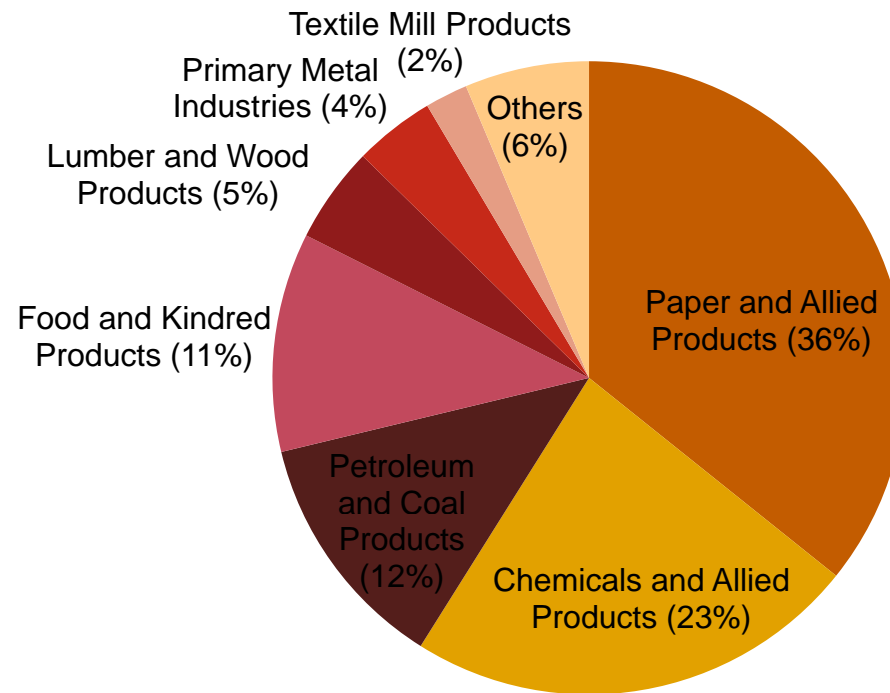
## Steam Generation System Overview



### Steam Generation System

# 1. Branches and Industries

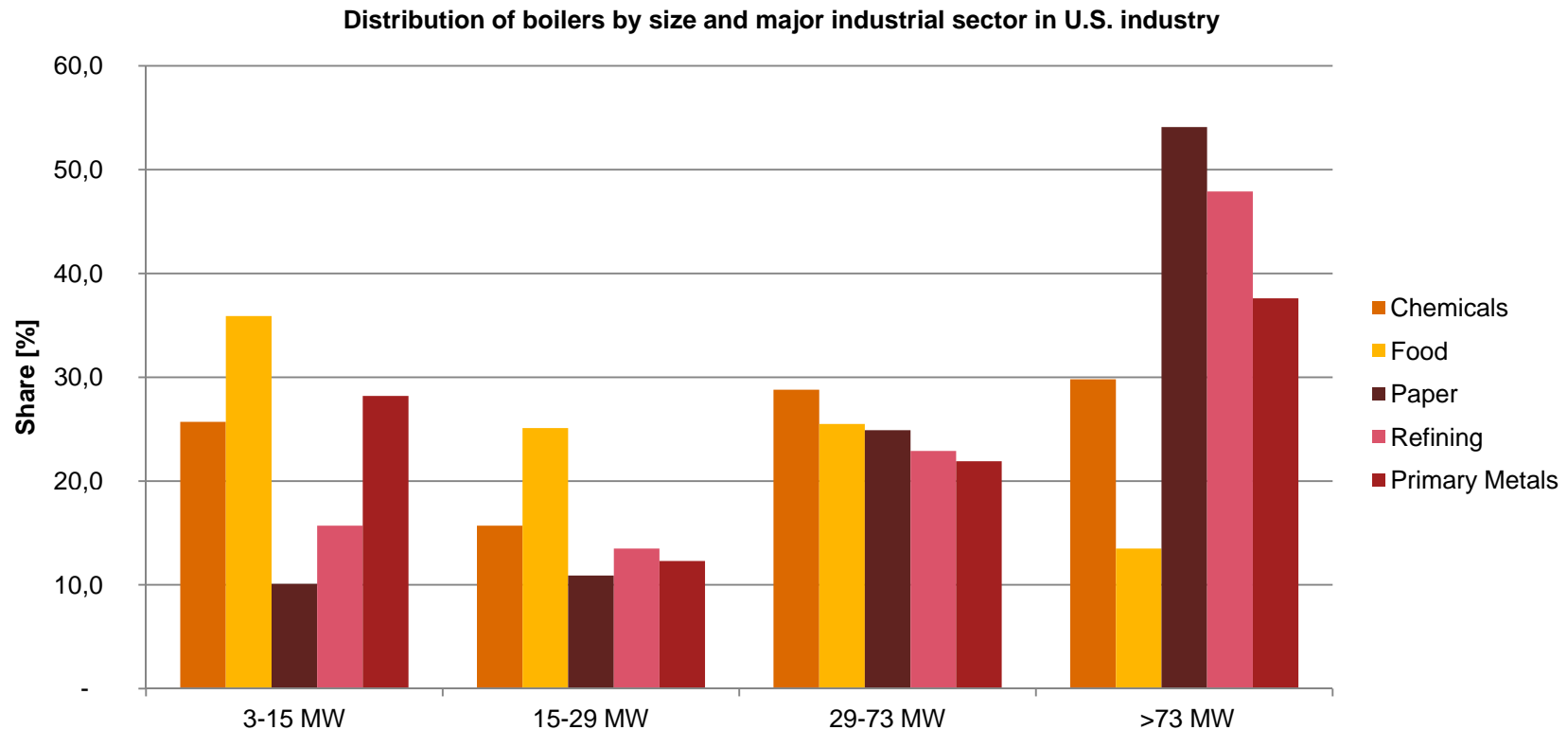
## Distribution of energy consumption in the U.S. (n=6311 PJ)



**Source: Einstein et al. (2001): Steam systems in industry: Energy use and energy efficiency improvement potentials, <http://escholarship.org/uc/item/3m1781fl>.**

# 1. Branches and Industries

## Size distribution of steam boiler population in the U.S.



Source: Einstein et al. (2001): Steam systems in industry: Energy use and energy efficiency improvement potentials, <http://escholarship.org/uc/item/3m1781fl>.



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# ***1. Branches and Industries***

## **End Use**

- Fractionation (rectification), Distillation
- Drying
- Power generation or drive for other rotating machinery
- Evaporation, Concentration
- Heating
- Sterilization,
- etc.
- => diverse in terms of pressure, temperature and mass flow

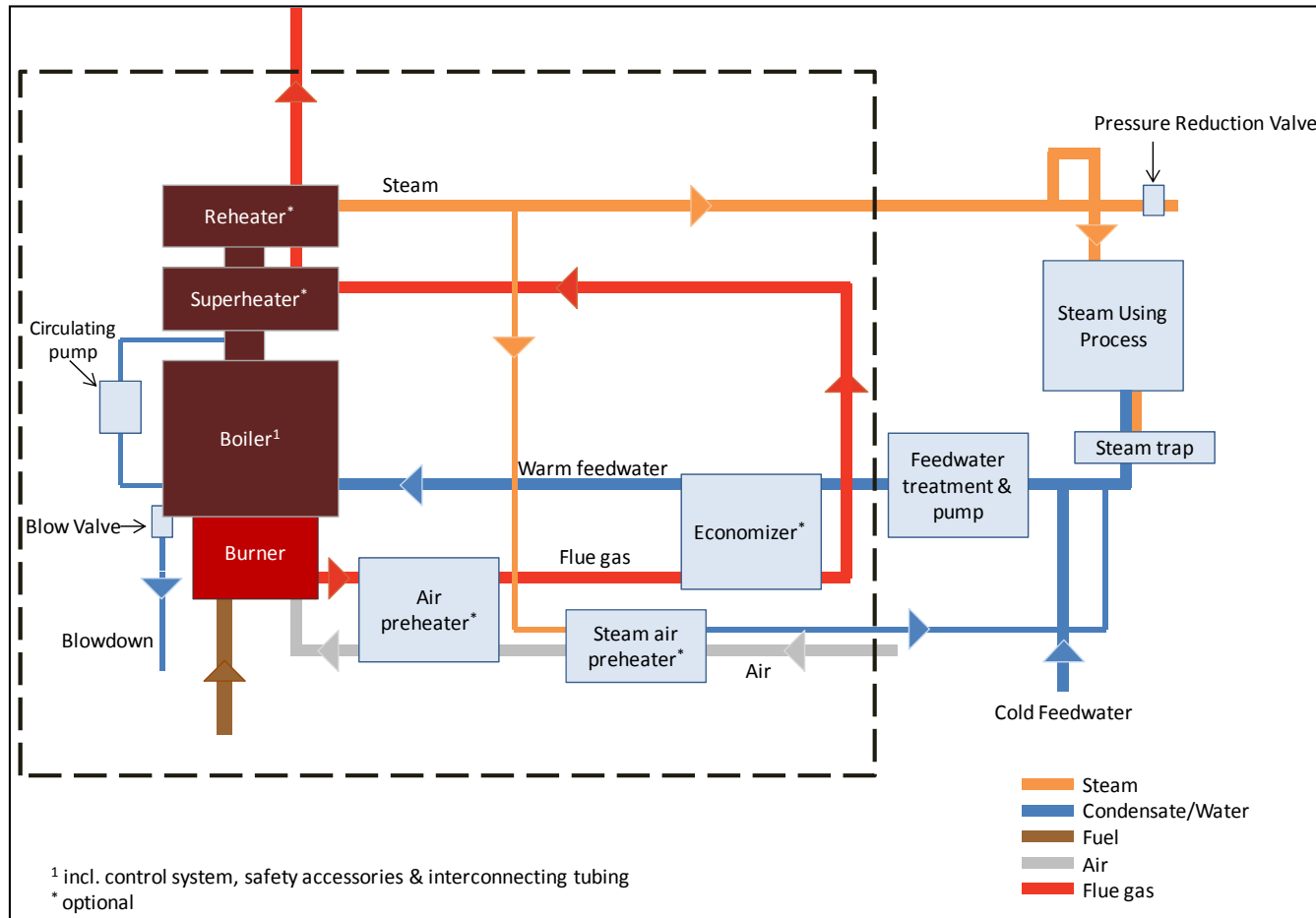
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***Part 2: Product scoping***  
***Strict product scope***

**2.1**

## 2. Product scoping

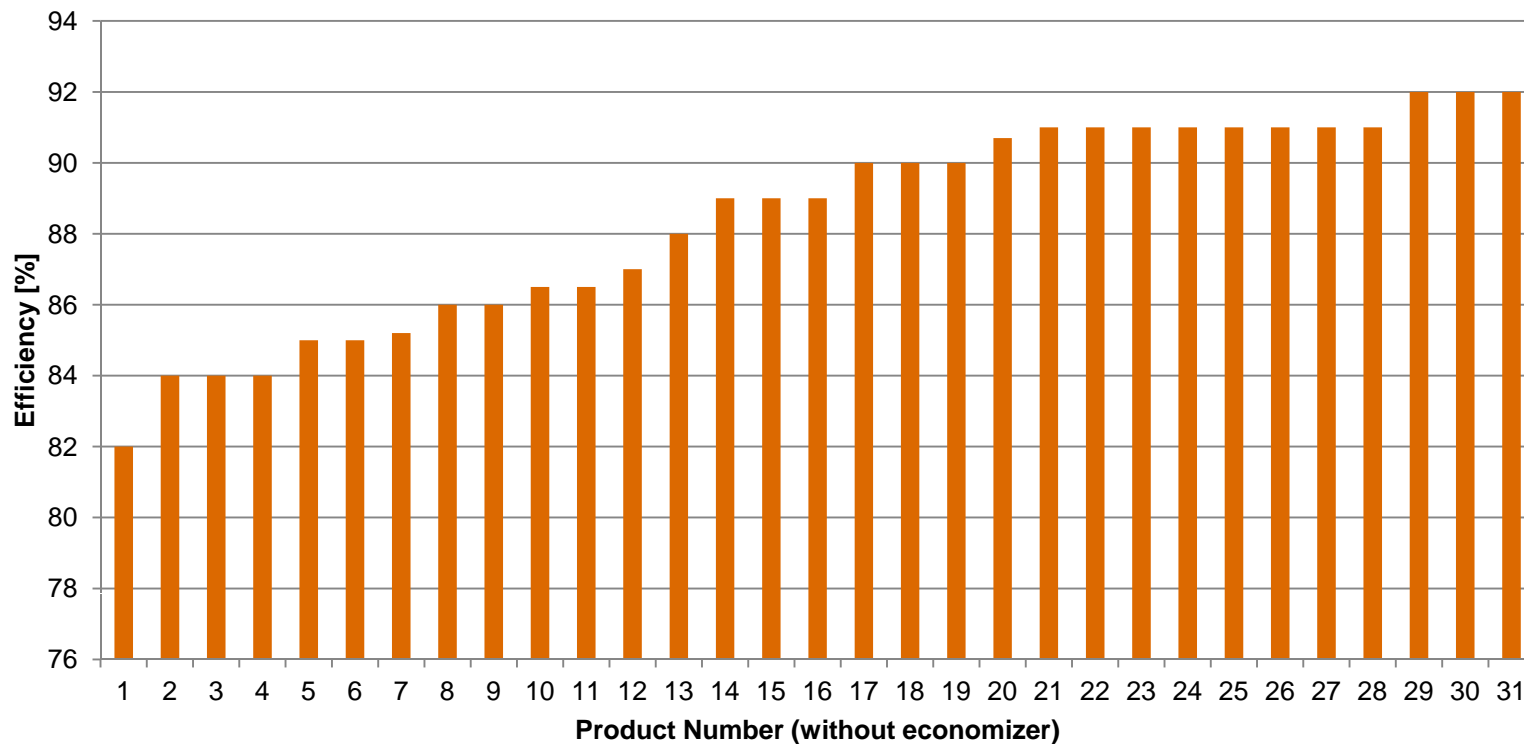
### Strict product scope



## 2. Product scoping

### Extract of efficiencies of industrial steam boiler without economizer

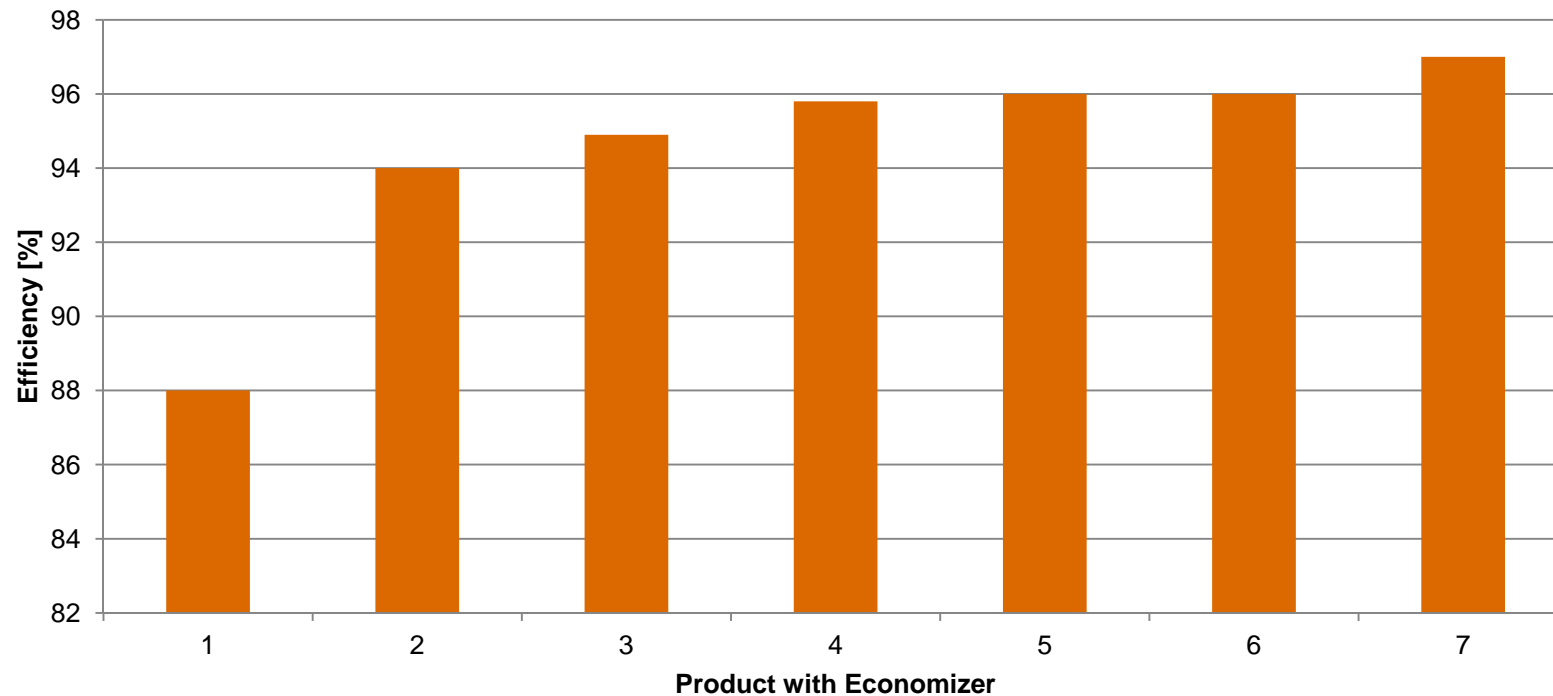
**Remark: Products are not comparable as the appropriate loads are unknown and/or not the same.**



## 2. Product scoping

### Extract of efficiencies of industrial steam boiler with economizer among our sample values

**Remark: Products are not comparable as the appropriate loads are not known and/or not the same.**



**Source: Data sheets or online advertising from Viessmann, Cleaver Brooks , AB&Co.**

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***Part 2: Product scoping***  
***Extended product scope***

**2.2**

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## ***2. Product scoping***

### **Extended product approach**

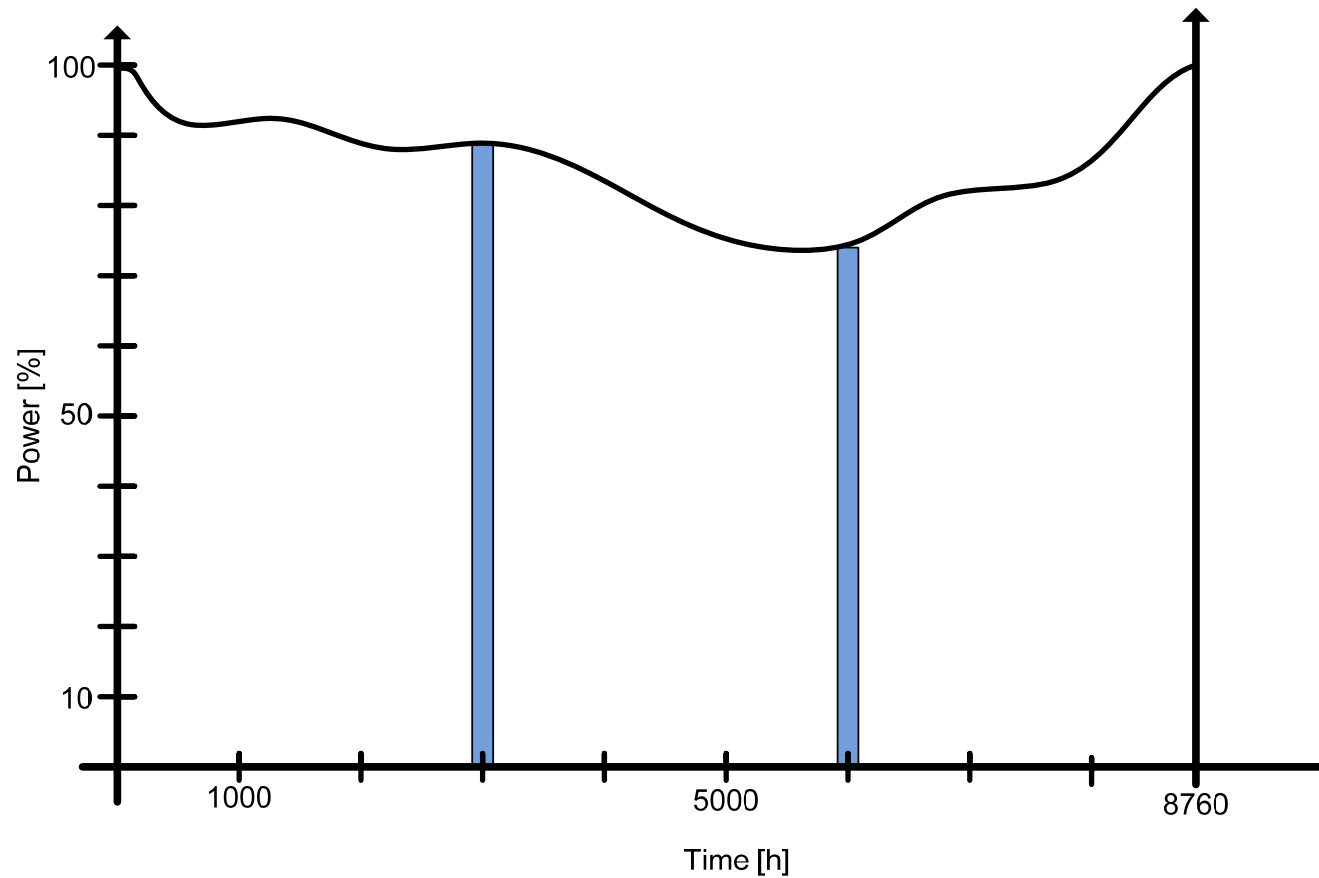
#### **Varying loads:**

- Operation hours
- Frequency of load changes
- Part load behavior
- Start up behavior
- Pressure and Steam flow ranges
- Economizer (feed-water pre-heating)

## 2. Product scoping

### Extended product approach – Operation hours

#### Example load profile for a brewery



Source: Viessmann (2011), Planning manual on steam systems, p.17



## 2. Product scoping

### Extended product approach – Capacity factor 1

$$CF_{i,j} = \frac{Q_{i,j}}{C_{i,j} \cdot 8760 \cdot h}$$

$Q_{i,j}$  = Sum of thermal energy consumption of estimated boiler population in year j of industry i [MWh].

$C_{i,j}$  = Sum of capacity of estimated boiler population in year j of industry i [MW].

=> Represent average usage rate of industrial steam boilers within an industry.

## 2. Product scoping

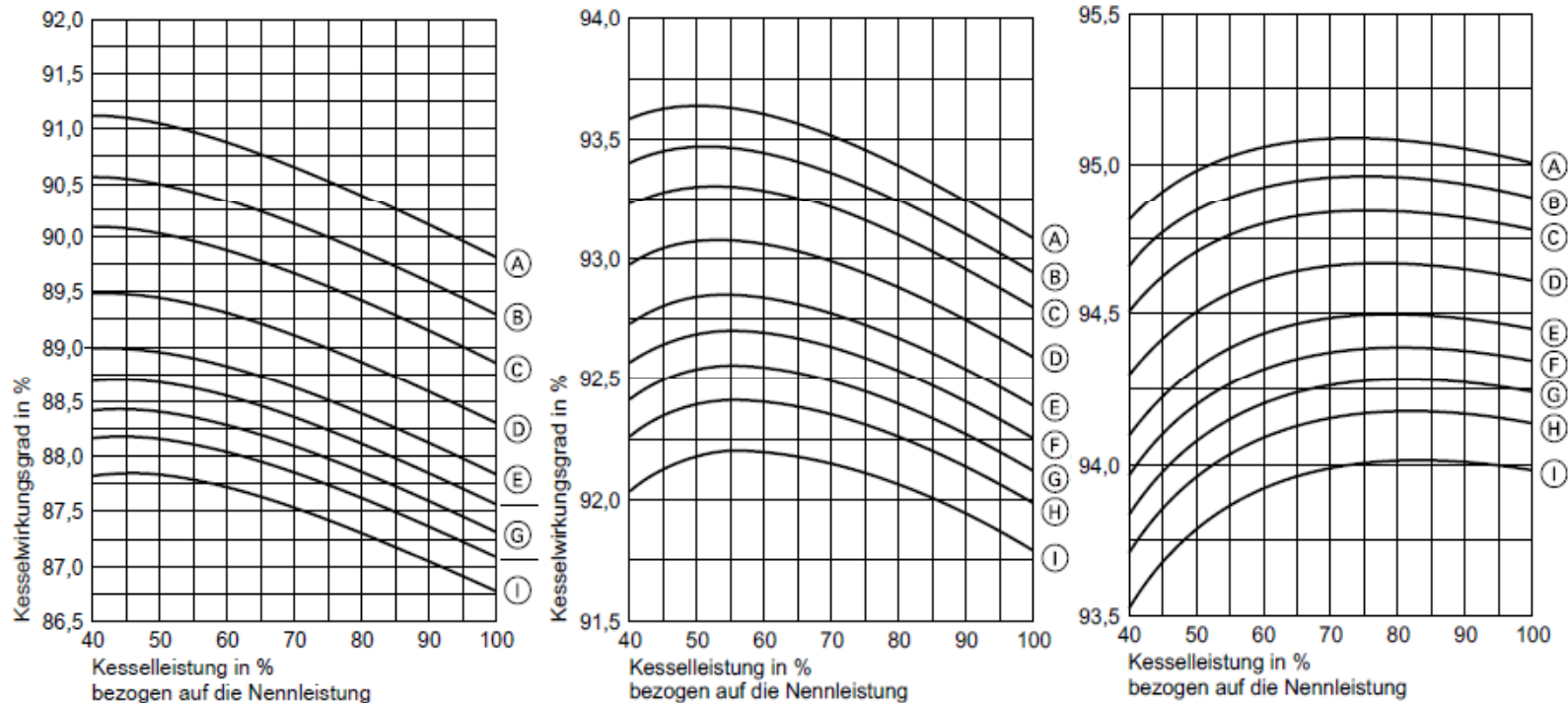
### Extended product approach – Capacity factor 2

Industry	Capacity factor [%]	Comment
Food	31	Low capacity factor due to seasonal nature of some production facilities.
Paper	66	Large industry with highest share on overall consumption in the U.S.
Chemicals	50	High number of large and small boilers. Large boiler mainly in large integrated facilities and small boilers mainly in facilities producing niche products. Complex and diverse industry sector.
Refining industry	25	-
Primary metals industry	47	Higher integrated steel mills are more dominant in steam usage (e.g. for on-site power generation).
Other manufacturing	29	-

## 2. Product scoping

### Extended product approach – Part load behavior

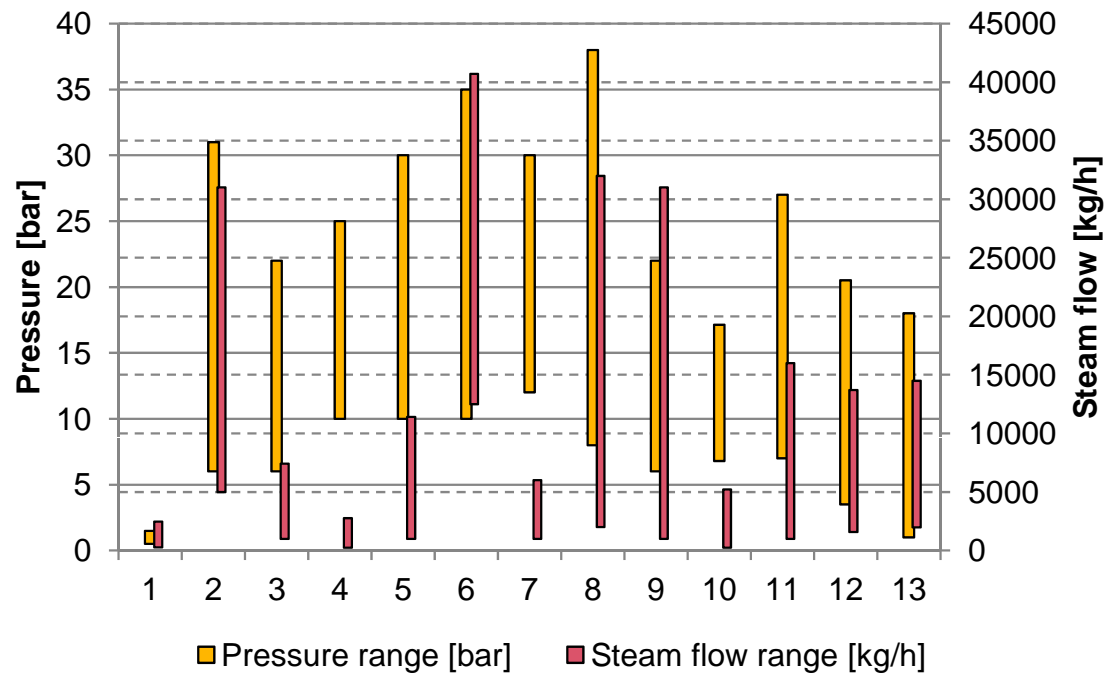
Three efficiency curves of one data sheet among our sample, the three curves represent different, optional designs, left: without economizer, middle: with "smaller" economizer, right: with "larger" economizer



## 2. Product scoping

### Extended product approach – pressure ranges

Pressure ranges of 17 fire-tube boiler derived from public available data



Source: Date sheets or online advertising from Viessmann, Babcock Wanson, Cannon Bono Energia, Magnabosco, Eresan, ByWorth, Cleaver Brooks

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## ***2. Product scoping***

### **Extended product approach**

#### **Summary**

- Operation hours differ between industries
- Frequency of load changes cannot be predicted
- Low efficiency changes in part load among sample
- Start up behavior might play a role due to safety reasons
- Pressure and steam flow ranges are wide
- Economizer are maybe common

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***Part 2: Product scoping***  
***Technical system approach***

**2.3**

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## ***2. Product scoping***

### **Technical system approach – excursus**

**Where are energy efficiency potentials within steam systems ?**

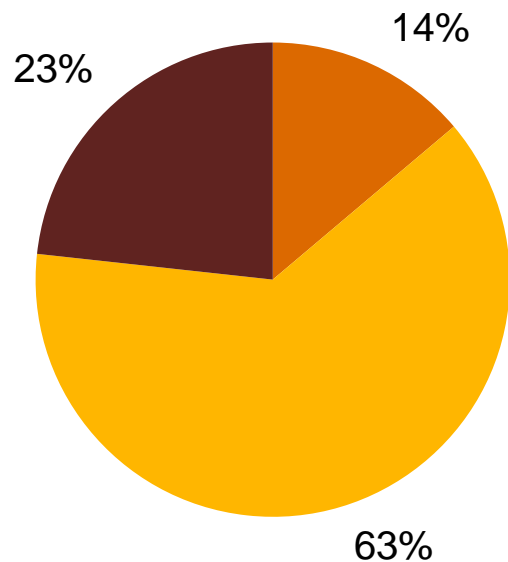
- IAC Database
  - Generation
  - Distribution/Recovery
  - Overall System
  - Organizational measure
  - Technology Add-on
  - Technology replacement

## 2. Product scoping

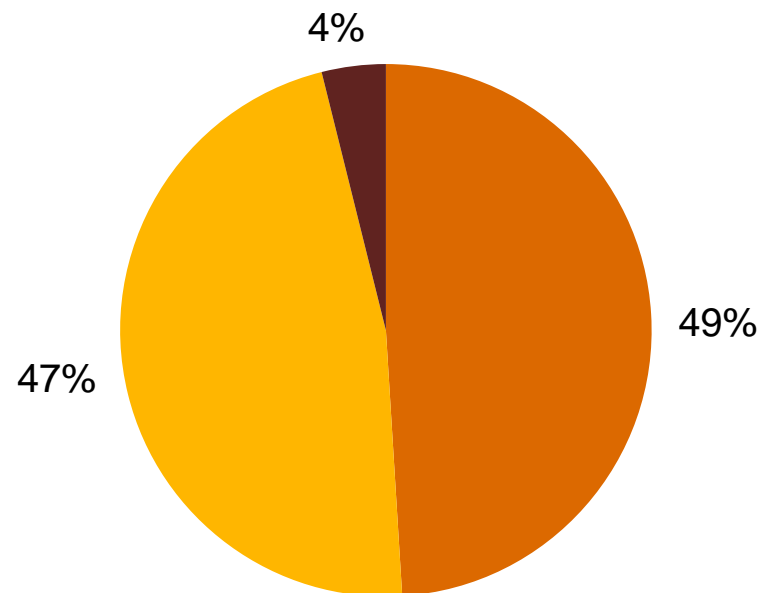
### Technical system approach – excursus

Distribution of recommendations by category (left) and by type for measure (n=9202)

- Distribution / Recovery
- Generation
- Overall System



- Organizational Measure (incl. Maintenance )
- Technology Add-On
- Technology Replacement





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***Part 2: Product scoping  
Conclusions***

**2.4**

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## ***2. Product scoping***

### **Conclusions**

- Wide range of applications
- Energy efficiencies: 87% of products without economizer  $\geq 85\%$ \* within sample
- Systemic evaluation
- Scope of delivery

**\* As stated public by manufacturer for products without economizer. However the underlying calculation formula has not been stated in most public available data sheets.**

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# *Part 3: Open points*

# 3

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### ***3. Open points***

**Stakeholder input is necessary to back up assumptions  
(-> in combination with Task 4)**

- Operation hours per year ?
- Is the frequency of load changes relevant ?
- Assumptions for the starting time ?
- Load point for the cases ?
- **Scheme to define cases ?**

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## ***Discussion-Questions***

**Thank you for your attention!**