Field of tension between Energy Efficiency and Flexibility

Enerday 2016

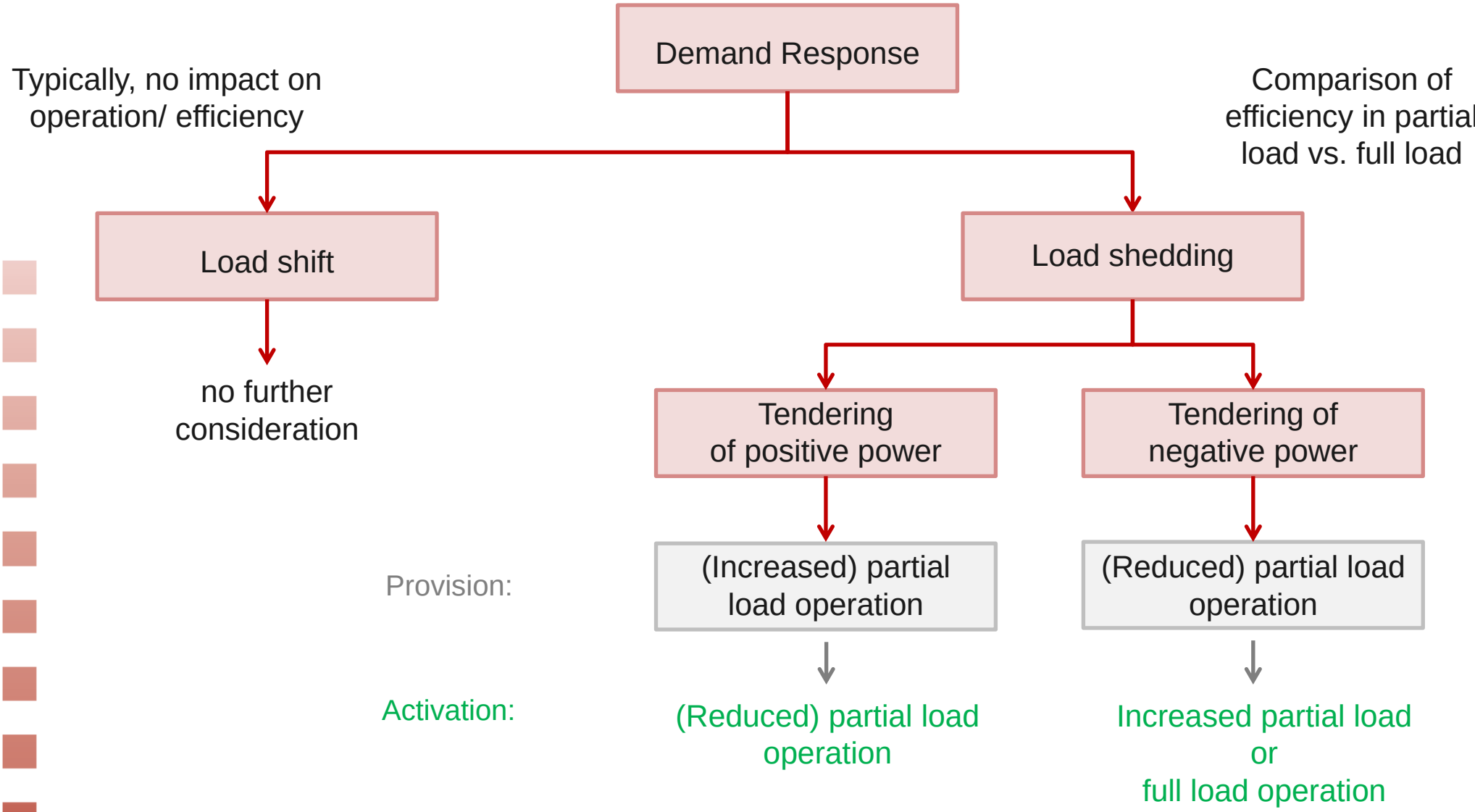
11TH Conference on Energy Economics and Technology
Dresden

Agenda

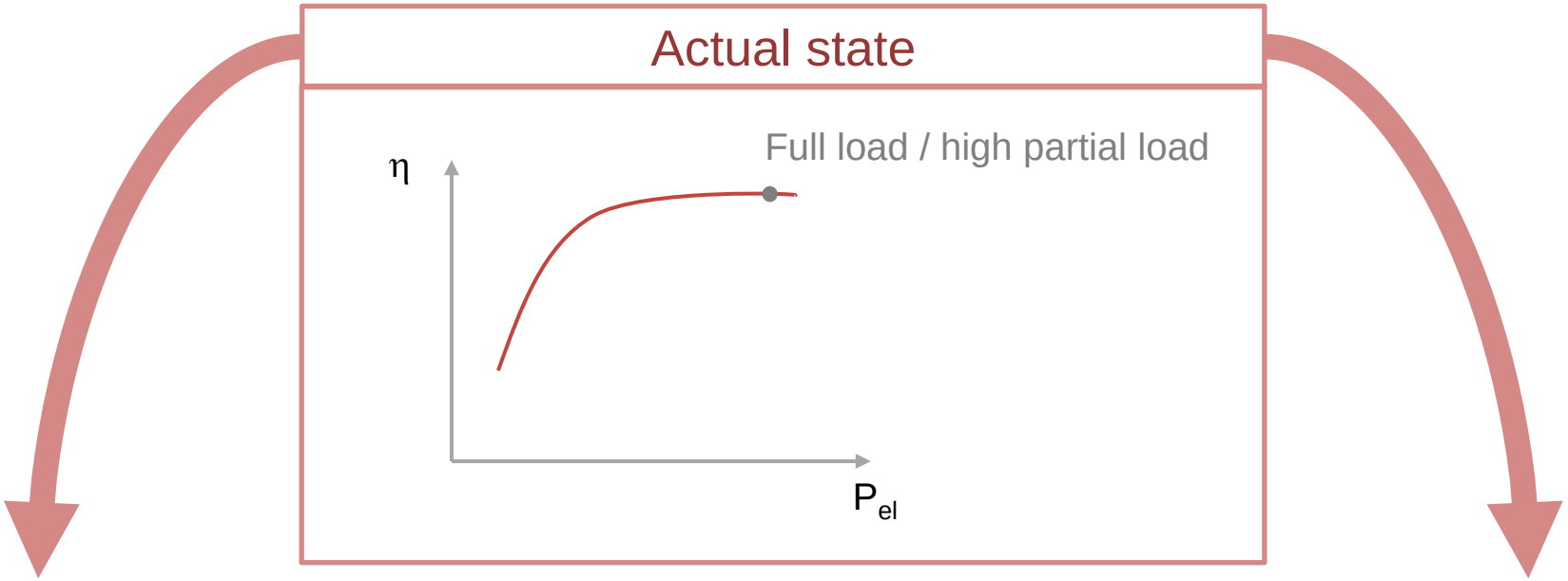
1. Influence of flexibility measures on energy efficiency
2. Effects of efficiency improvements on flexibility potentials
3. Reasons for flexibility

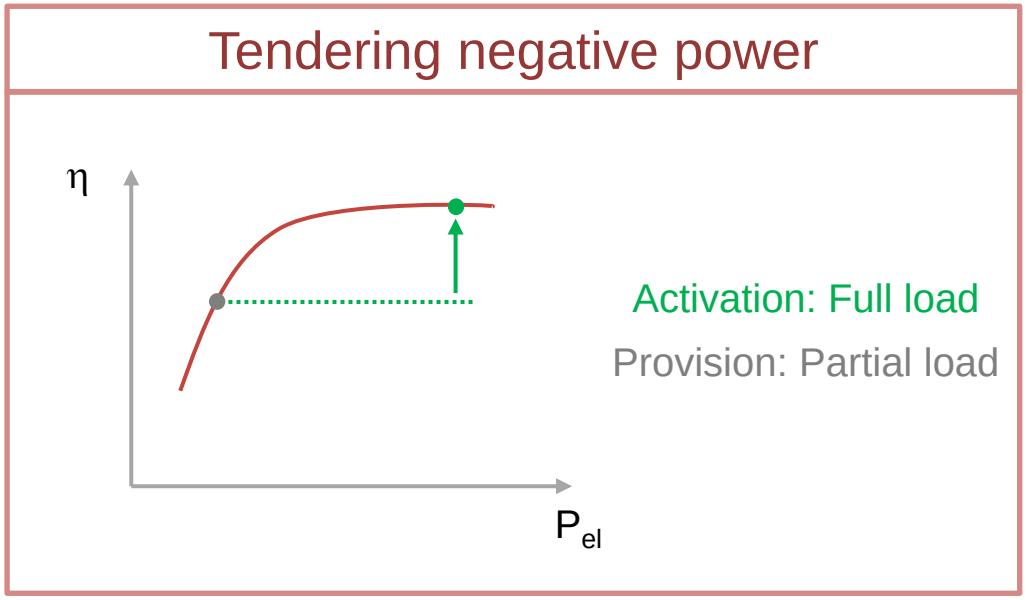
Influence of flexibility measures on energy efficiency

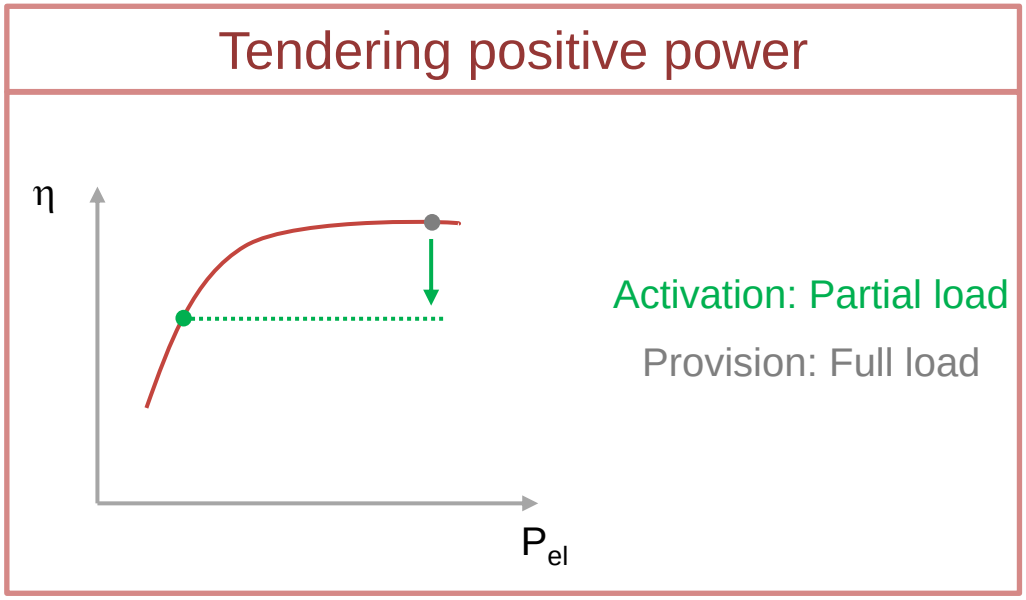
Influence of tendering flexibility on energy efficiency



Shifting of the operating point through tendering of positive or negative power

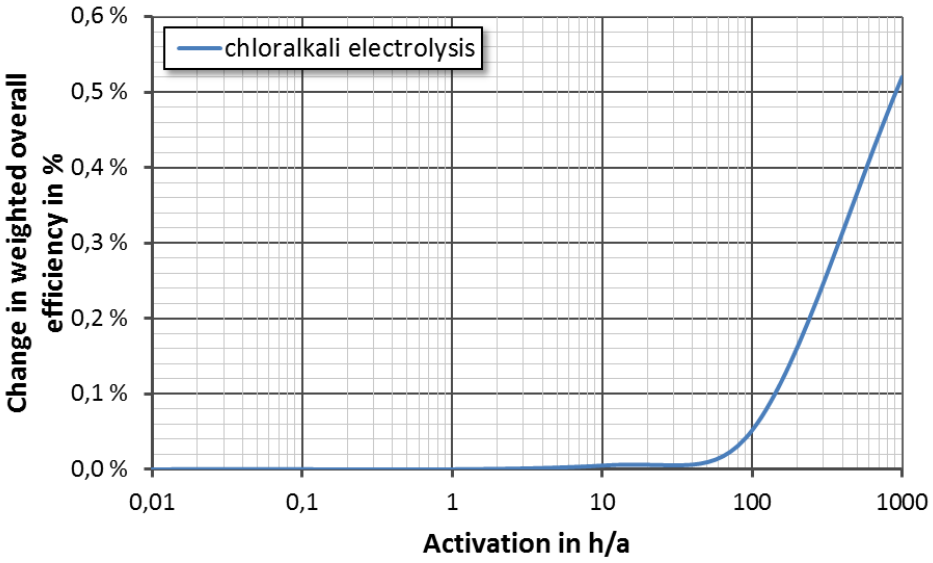






Chloralkali electrolysis for tendering of positive power

- Input data for exemplary calculation*
  - Power approx. 20 MW
  - Full load operation: increased specific electricity consumption by 5…10 %
  - Activation: reduced partial load operation (60 % electrical power)
  - Backlog demand to achieve the same production volume at the end of the year
  - Backlog demand is covered through partial load operation (normal operating state)



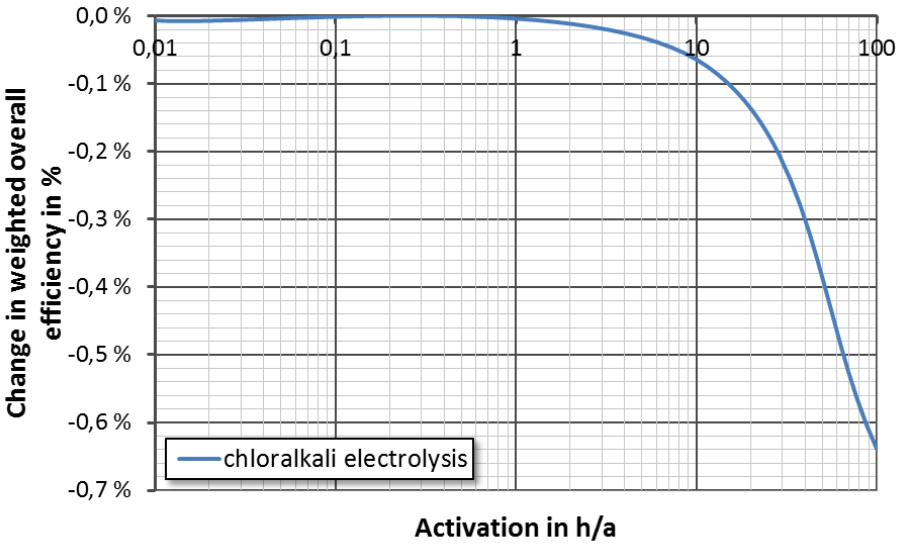
Change in weighted overall efficiency		Operating period = provision in h/a			
		4,000	5,000	6,000	7,000
Activation in h/a	10	< 0.1 %	< 0.1 %	< 0.1 %	< 0.1 %
	100	< 0.1 %	< 0.1 %	< 0.1 %	< 0.1 %
	1,000	< 1 %	< 1 %	< 1 %	< 1 %

→ Activation of 1,000 h/a increases weighted overall efficiency about 0.5 %

* Provision duration 7,000 h/a

Chloralkali electrolysis for tendering of negative power

- Input data for exemplary calculation*
  - Power approx. 20 MW
  - Full load operation: increased specific electricity consumption by 5…10 %
  - Activation: reduced partial load operation (85 % electrical power)
  - No backlog demand (annual quantity covered)
  - → High partial load operation results in increased specific electricity consumption



Change in weighted overall efficiency		Operating period = provision in h/a			
		4,000	5,000	6,000	7,000
Activation in h/a	10	<-0.1 %	<-0.1 %	<-0.1 %	<-0.1 %
	100	<-0.1 %	<-0.1 %	<-0.1 %	<-0.1 %
	1,000	<-1 %	<-1 %	<-1 %	<-1 %

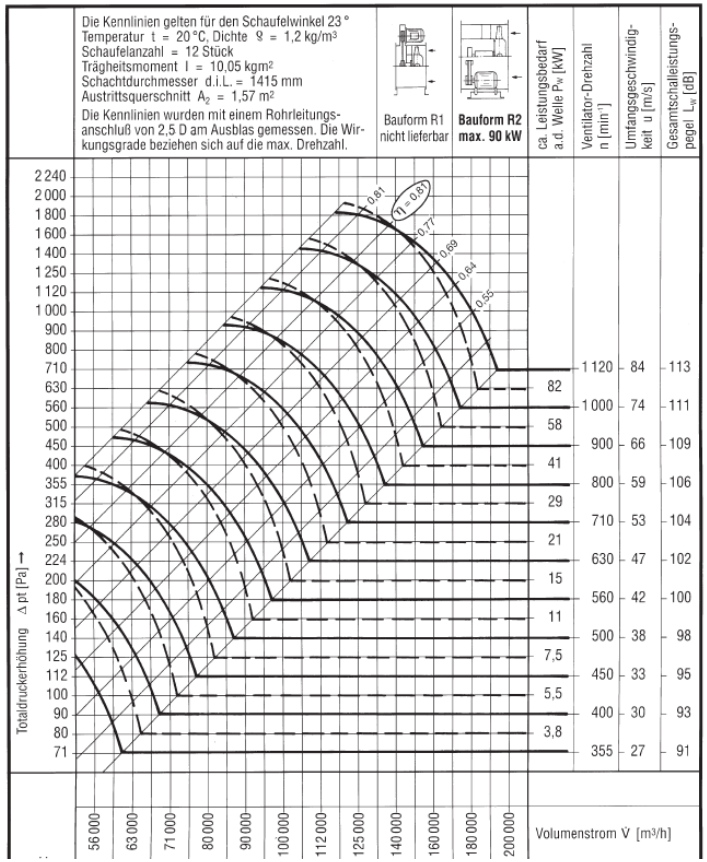
→ Activation of 1,000 h/a reduces weighted overall efficiency about 0.6 %

* Provision duration 7,000 h/a

Influences on overall efficiency – cross-sectional technologies

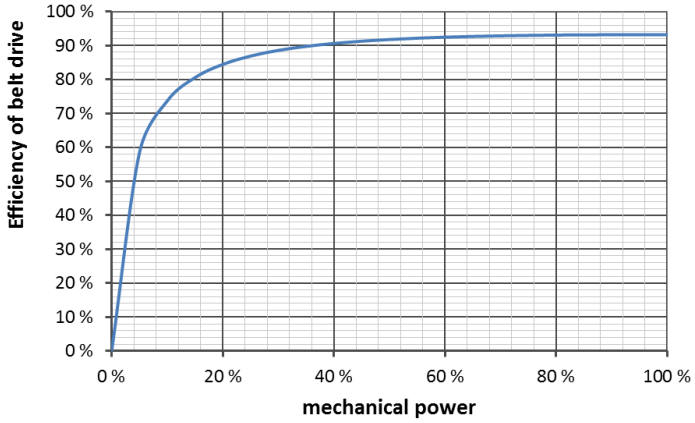
1 Efficiency of technology

- Pump
- Fan
- …



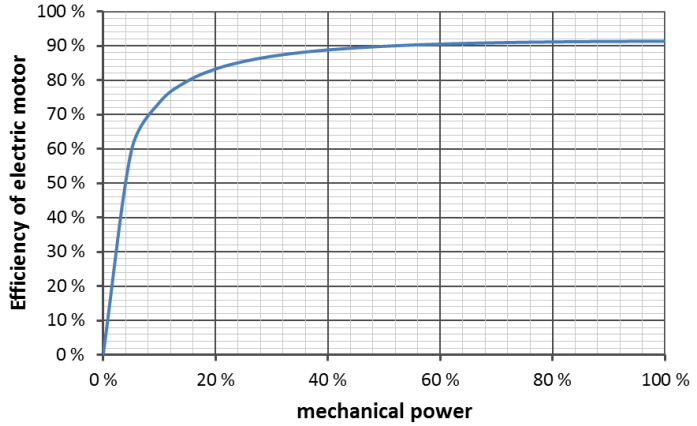
2 Efficiency of power transmission

- V-belt
- Flat belt
- …



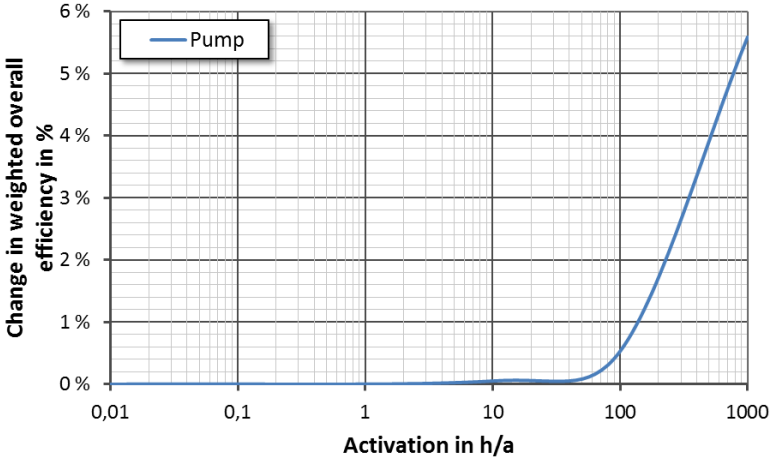
3 Efficiency of electrical engine

- IE Class
- Operating point



Pumps for tendering of positive power

- Input data for exemplary calculation
  - Nominal volume flow 400 m³/h
  - Reduction of nominal volume flow during activation to around 2/3 of initial flow rate
  - Backlog demand (full load), to transport away waste heat
- Results
  - Overall efficiency is slightly reduced (deterioration of individual efficiency of transmission system and engine, efficiency of pump stays constant)
  - In partial load operation significantly lower pressure losses have to be overcome, thus significant lower power consumption (pressure drop changes proportionally to the square of power consumption)



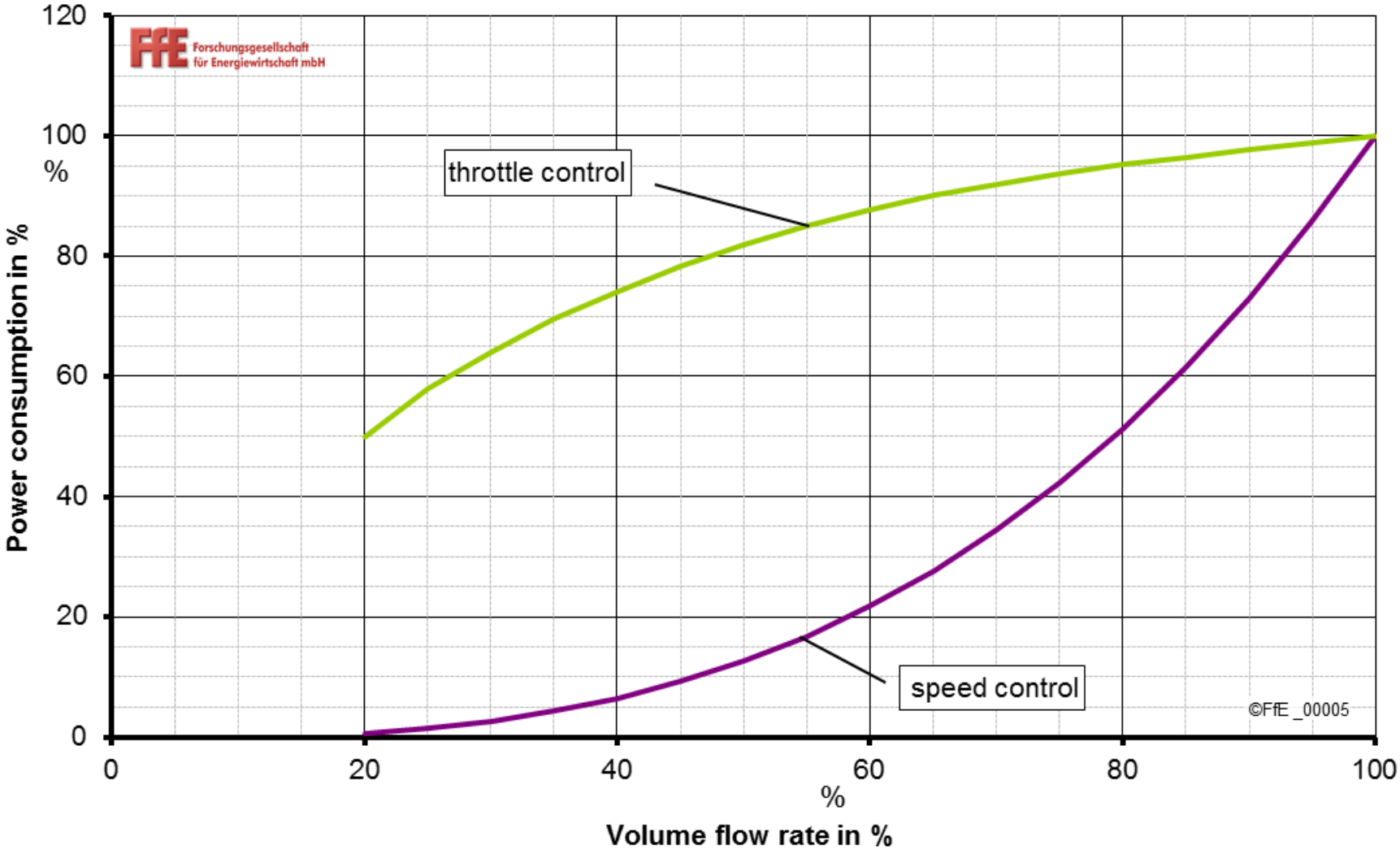
Change in weighted overall efficiency		Operating period = provision in h/a			
		4,000	5,000	6,000	7,000
Activation in h/a	10	< 0.1 %	< 0.1 %	< 0.1 %	< 0.1 %
	100	< 1 %	< 1 %	< 1 %	< 1 %
	1,000	< 15 %	< 10 %	< 10 %	< 10 %

→ Measure increases energy efficiency in principle

→ requirements (constant flow rate and flow and return temperatures) to be considered

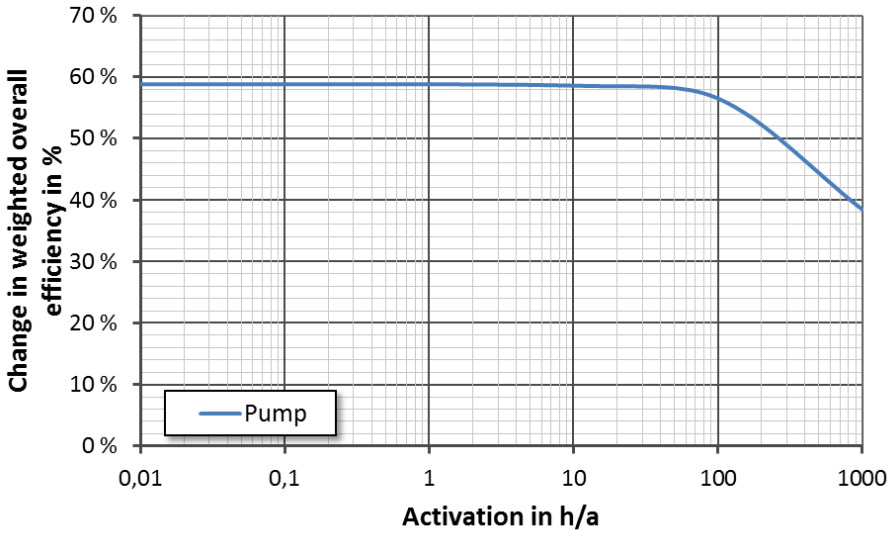
→ Activation of 1,000 h/a improves weighted overall efficiency by about 5.6 %

Power consumption subject to volume flow rate in throttle control and speed control



Pumps for tendering of negative power

- Input data for exemplary calculation
  - Nominal volume flow 400 m³/h
  - Provision requires partial load operation at about 2/3 of nominal volume flow
  - Activation leads to load increase to inital state
- Results
  - Overall efficiency improves slightly (improvement of individual efficiency of transmission system and engine, efficiency of pump stays constant)
  - During full load operation significantly higher pressure drops have to be overcome
  - → Significantly reduced power consumption through provision (pressure drop changes proportionally to the square of power consumption)
- With an activation of 1,000 h/a the weighted overall efficiency improves by about 40 %



Change in weighted overall efficiency		Operating period = provision in h/a			
		4,000	5,000	6,000	7,000
Activation in h/a	10	<60 %			
	100	<60 %			
	1,000	<40 %			

Time to recover too short

Conclusions

provision: 7.000 h/a pump & compressed air: 4000 h/a		activation in h/a					
		10		100		1000	
		influence on					
allocation	technology	pos. potential	neg. potential	pos. potential	neg. potential	pos. potential	neg. potential
electricity intensive process	aluminium electrolysis	< -0.1 %	< -5 %	< -1 %	< -5 %	0 %	< -5 %
electricity intensive process	chloralkali electrolysis	< 0.1 %	0 %	< 0.1 %	0 %	< 1 %	< -0.1 %
electricity intensive process	electric arc furnace	< -0.1 %	0 %	< -1 %	0 %	< -5 %	< 0.1 %
cross sectional technology	fan (ventilation system)	< 0.1 %		< 1 %		< 5 %	
cross sectional technology	pump	< 0.1 %	< 60 %	< 1 %	< 60 %	< 10 %	< 40 %
cross sectional technology	compressed air	< -0.1 %	< -10 %	< -0.1 %	< -10 %	< -1 %	< -5 %

- = decreasing overall efficiency

+ = increasing overall efficiency

→ Influences of flexibility on energy efficiency are negligible

→ In most applications and activation frequencies the impact on the efficiency level is less than 1 % and therefore below typical measuring accuracy.

→ Considerable efficiency changes may occur at pumps and air compressors with yearly activation times of more than 1,000 hours.

Effects of efficiency measures on flexibility potential

Influence of energy efficiency on flexibility potential

Cross sectional technologies

1 Identification of measures

> Typical energy efficiency measures for each technology

2 Action plan for each technology

> Selection of measures with a high probability of implementation

3 Impact on installed capacity?

> Assessment of the impact on the installed capacity (e.g. smaller engine-sizing)

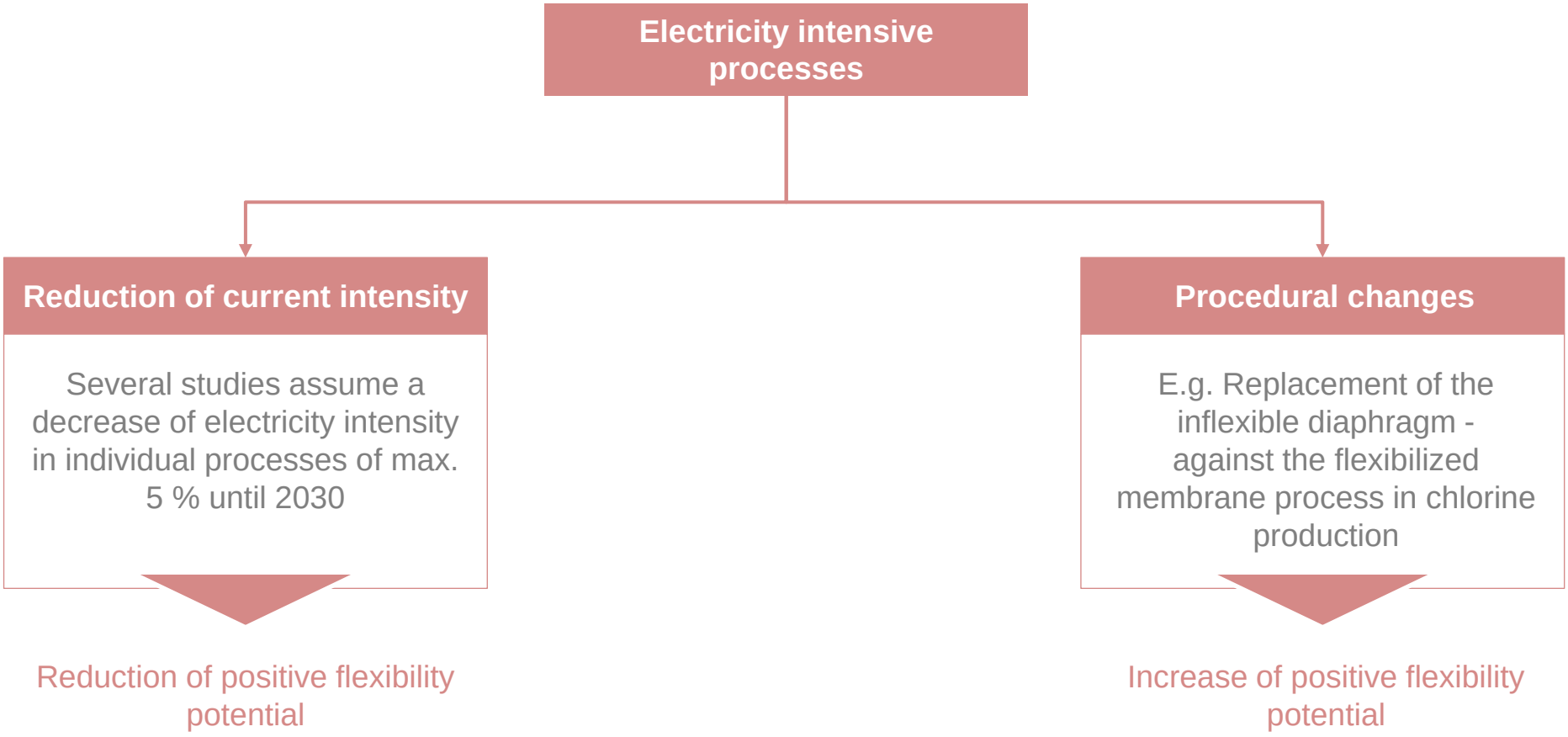
4 Impact on flexible power?

> With lower installed capacity[1]: reduction of pos. potential (e.g. air compressors, fans, lighting)

> By making units adjustable: improvement of degree of utilization and increase of negative potential (e.g. pumps, cooling machines)

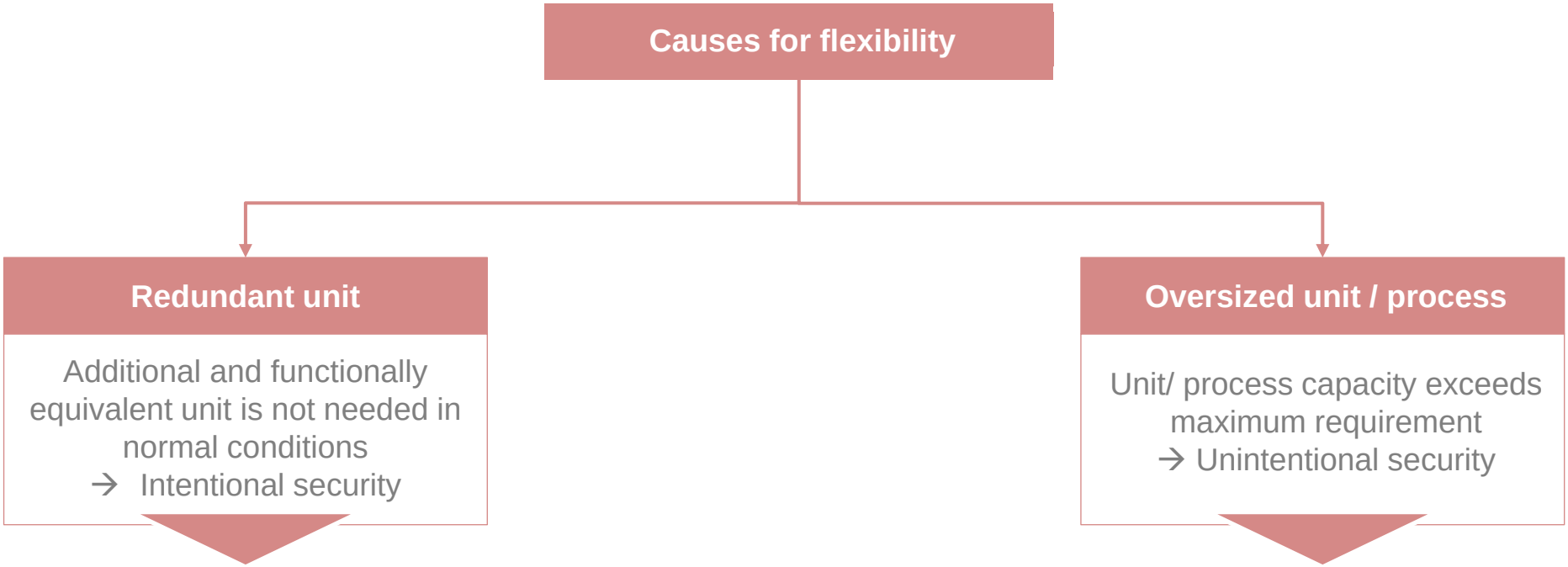
[1] the same applies for low average load, but longer period

Influence of energy efficiency on flexibility potential



Reasons for flexibility

Overcapacity



Technologies with redundancies:

- Pumps
- Boiler
- Cooling machines
- Air compressors

→ Possibility to use the redundancy as flexibility?

- Different reasons for oversizing
  - Planner
  - Industrial enterprise
  - Producer

→ Crucial for the future potential: Oversizing is intentional / unintentional?

Conclusions

1. Influence of flexibility on energy efficiency: usually negligible,
   Exception: speed control and deviation of optimized operating point
2. Influence of energy efficiency on flexibility: reduction of the installed capacity leads to a diminished positive potential
3. Influence of energy efficiency on flexibility: Making units adjustable results in increased negative potential and improved degree of utilization
4. Conflicting objectives of flexibility and energy efficiency: current tendency to reduce oversizing of units (boosting energy efficiency)
5. Conflicting objectives of flexibility and energy efficiency: Intentional oversizing could increasingly be used for flexibility

Thank you for your attention.

Contact:
Dipl.-Ing. (FH) Anna Gruber
+49 (89) 158121-62
AGruber@ffe.de

Forschungsgesellschaft für Energiewirtschaft mbH
Am Blütenanger 71
80995 München
www.ffegmbh.de