What it means in technical terms

- the work done so far with Ecopump -

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Presented at the EUROPUMP roundtable

Brussels, October 6, 2011

by Prof. Dr. Bernd Stoffel

Outline

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- **The role of pump systems for energy consumption**
- **Minimum Efficiency Index (MEI) for pumps**
- **Extended Product Approach for pumps**

Types of pump systems

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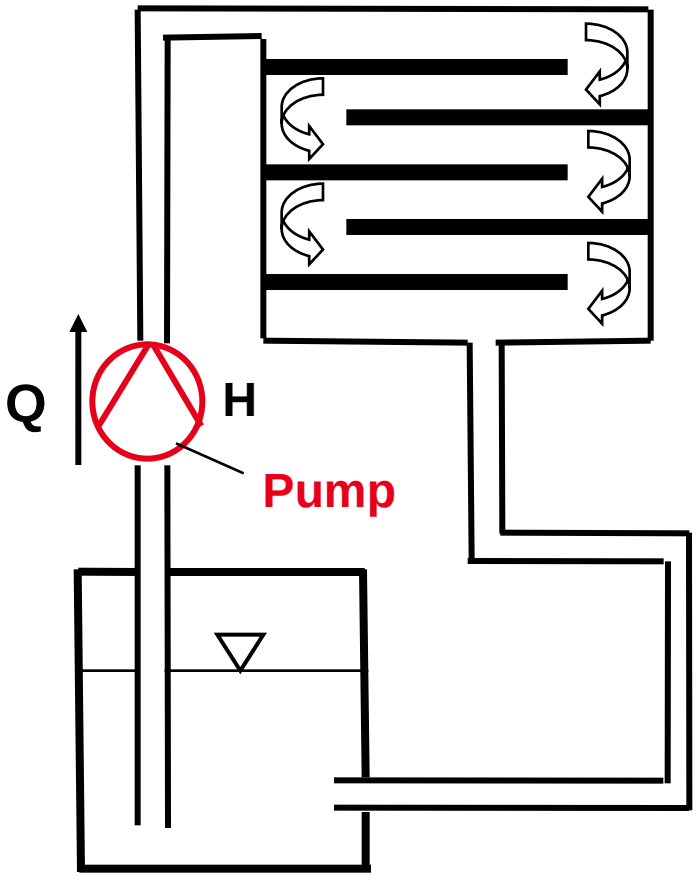
closed loop



Process:
circulation of liquid

Need of the process:

- **flow rate Q ,**
- **pump head H*)**

***) pump head H: measure for the usable energy transfered to the liquid**

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Types of pump systems

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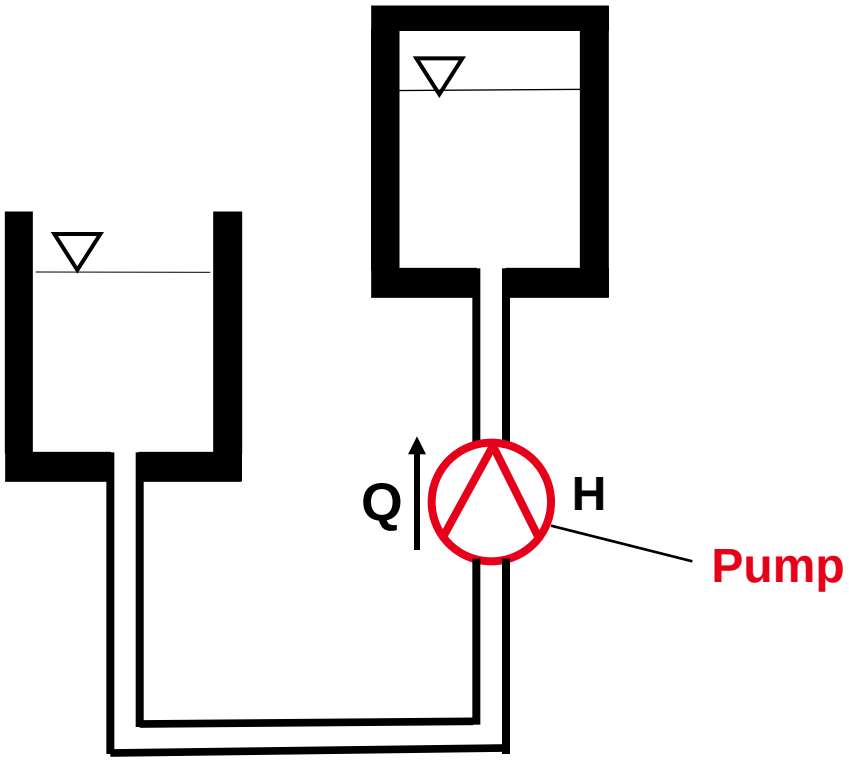
open loop



Process:

Transport of liquid to

- **other location,**
- **higher elevation**
- **and/or higher pressure**

Need of the process:

- **flow rate Q**
- **pump head H**

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Power need of pump systems

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Need of the process:
- **flow rate Q**
- **pump head H**

→ **hydraulic power**
$P_{hyd} \sim Q \cdot H$

↓

pump efficiency η_{pump} → **pump power input**
$P_{pump} \sim (Q \cdot H) / \eta_{pump}$

↓

electric drive efficiency η_{drive} → **electric power input**
$P_{el} \sim (Q \cdot H) / (\eta_{pump} \cdot \eta_{drive})$

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Pumps and applications in the focus of work

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EUROPUMP / Ecopump work

- **already done**
- **presently in progress**

focuses on

- **pump types**
- **pump applications**

with

- **highest contribution to energy consumption**
- **highest potential for energy saving**

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Pumps and applications in the focus of work

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Pumps in the focus:

- circulators
- water pumps

Examples of **relevant applications**:

- Commercial buildings, drinking water supply, agriculture
- Heating, ventilation, air condition (HVAC)
- Water distribution, pressure boosting in high buildings

Pumps as EuP´s

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Need of application:
- **flow rate Q**
- **Pump head H**

→ **hydraulic power**
$P_{hyd} \sim Q \cdot H$

↓

Improvement !

pump efficiency η_{pump} → **pump power input**
$P_{pump} \sim (Q \cdot H) / \eta_{pump}$

↓

electric drive efficiency η_{drive} → **electric power input**
$P_{el} \sim (Q \cdot H) / (\eta_{pump} \cdot \eta_{drive})$

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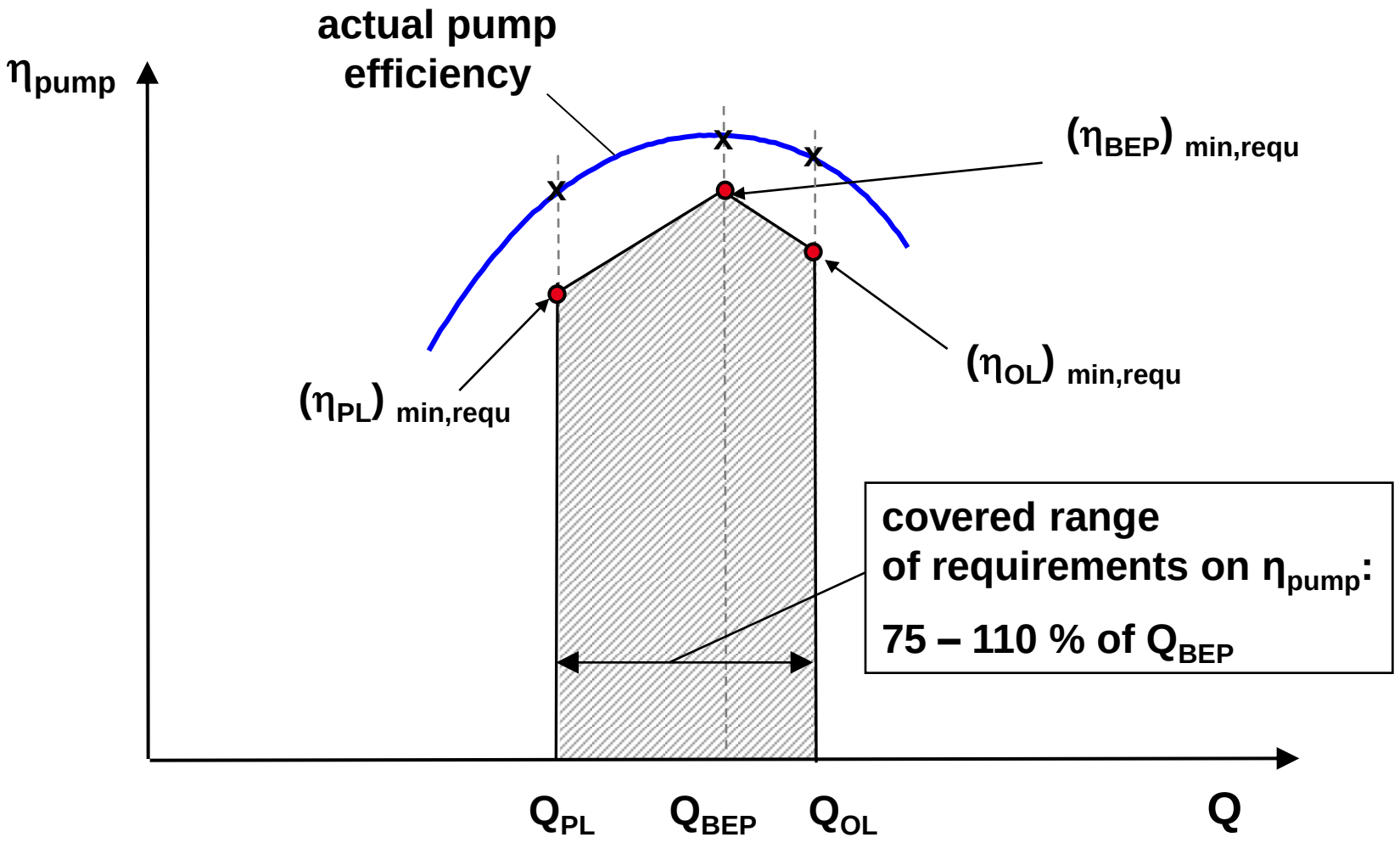
Requirements on pump efficiency



Minimum required pump efficiency

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Values of minimum required pump efficiency

- **were elaborated by a study at TU Darmstadt**
- **are based on**
  - **statistical evaluations of data of nearly 2.400 „state of the art“ pumps of European manufacturers**
  - **general fluiddynamic laws and technological aspects**

Minimum required pump efficiency

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Values of minimum required pump efficiency

- **are dependent on**
  - **pump type (ESOB, …..)**
  - **pump nominal speed n_N**
  - **pump size (Q_{BEP})**
  - **pump specific speed n_s (characterizing impeller shape)**
  - **the Minimum Efficiency Index (MEI)**

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Minimum Efficiency Index (MEI)

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MEI

- **is a decimal number < 1.0**
- **serves for EU regulation on water pumps**
- **has a competitive effect on the market**
- **quantifies the „cut-off effect“**

Minimum required pump efficiency

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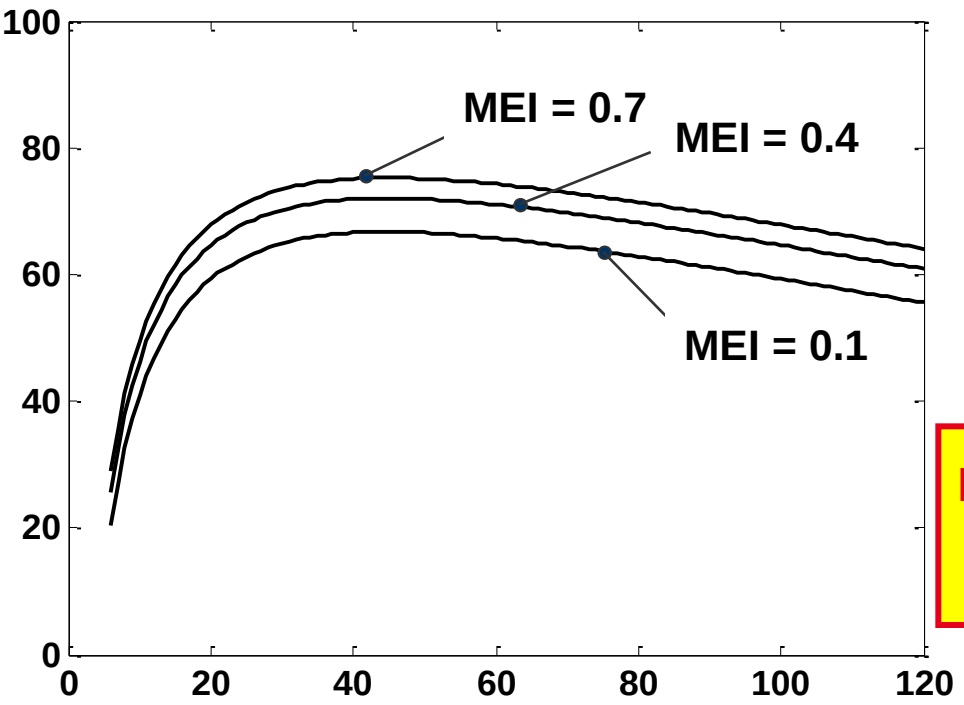
$(\eta_{BEP})_{min,requ}$

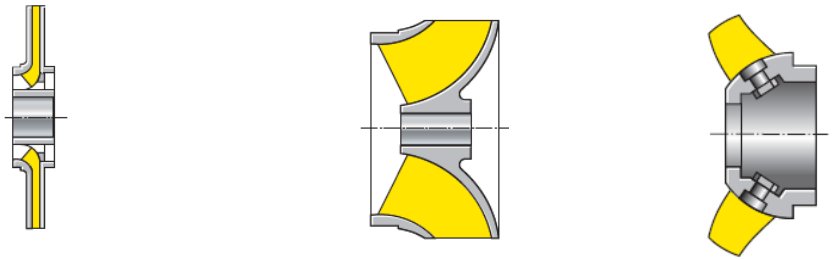


n_s [min^{-1}]

Diagram valid for:
pump type ESOB
n_N = 2900 rpm
Q_{BEP} = 32 m³/h

MEI = 0.1→ MEI = 0.4:
Δη ≈ 5 %

corresponding Impeller shape:



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Minimum Efficiency Index (MEI)

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Standardization for MEI

- Draft Standard elaborated by EUROPUMP WG
  - defines MEI
  - describes methodology of qualification and verification
- EN standard
  - procedure in progress
  - publication expected in 2012

Typical features of relevant applications

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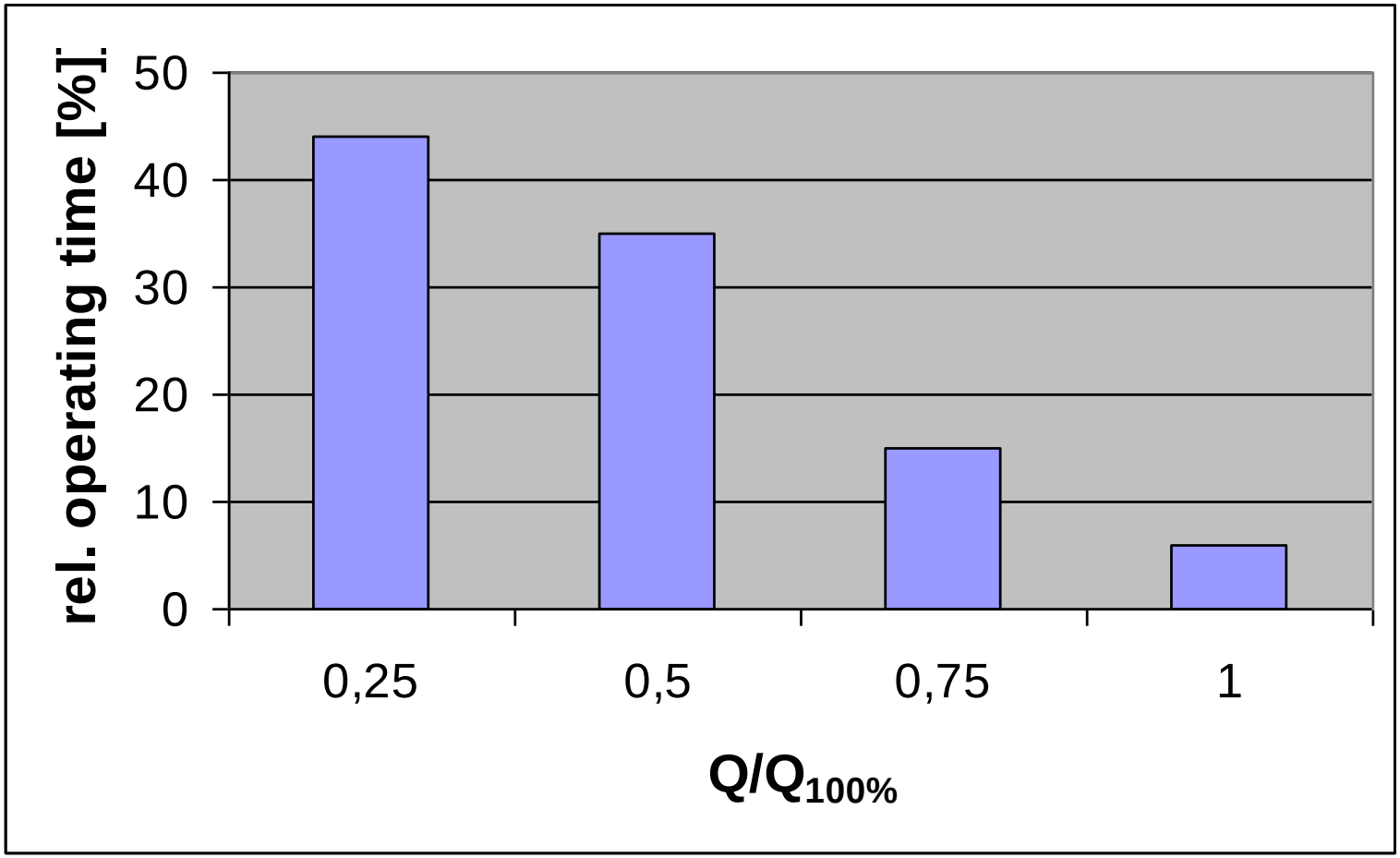
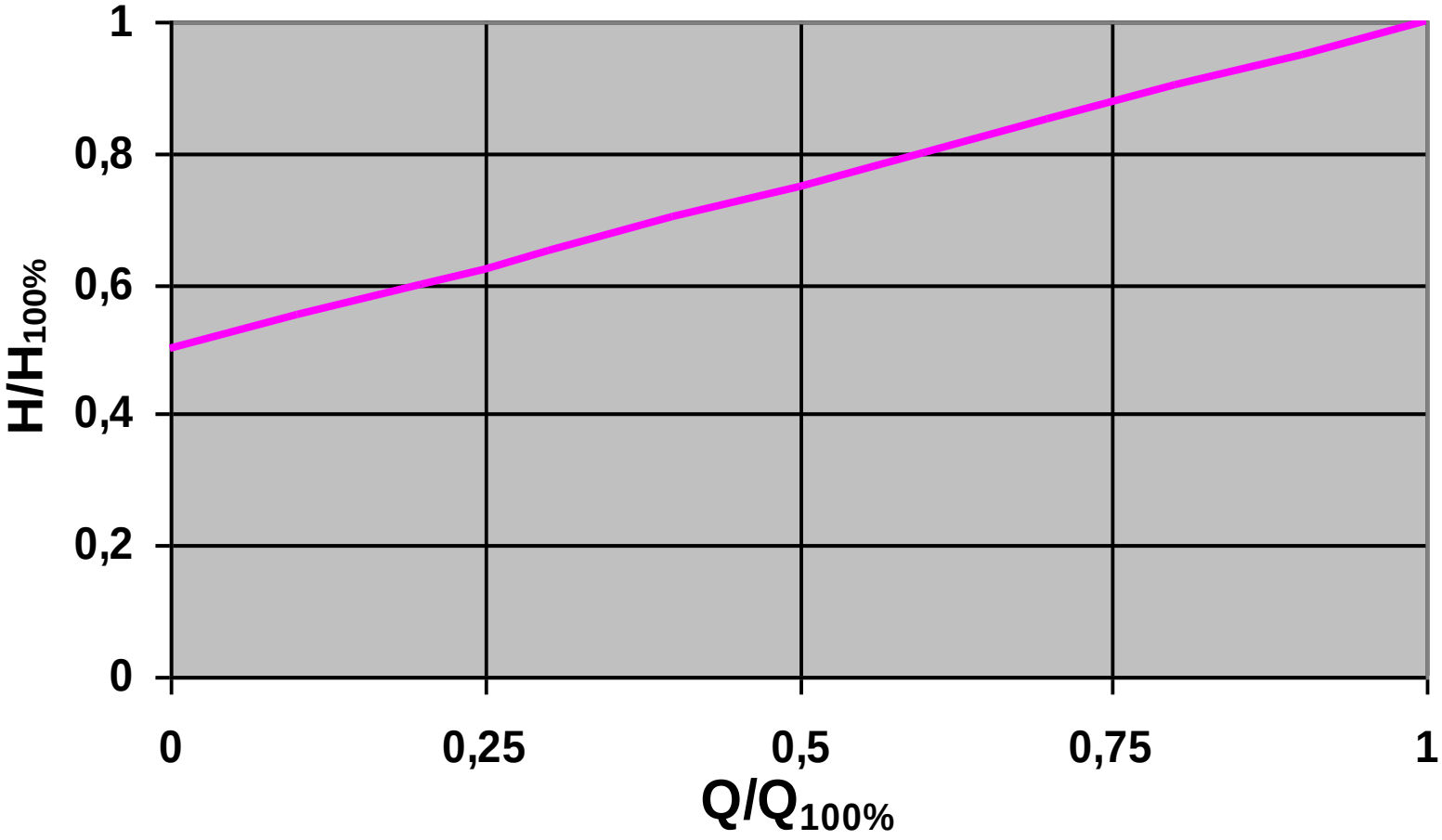
For applications in the focus

- **at most part of operating time, the needed flow rate < $Q_{100\%}$**
- **the head $H_{process}$ needed by the process decreases with decreasing flow rate Q**
- **representative „load profiles“ (time fractions at $Q/Q_{100\%}$) can be defined**
- **representative „control curves“ $H_{process} = f(Q)$ can be defined**

Load profile representative for HVAC



Process control curve representative for HVAC



Typical pump characteristics

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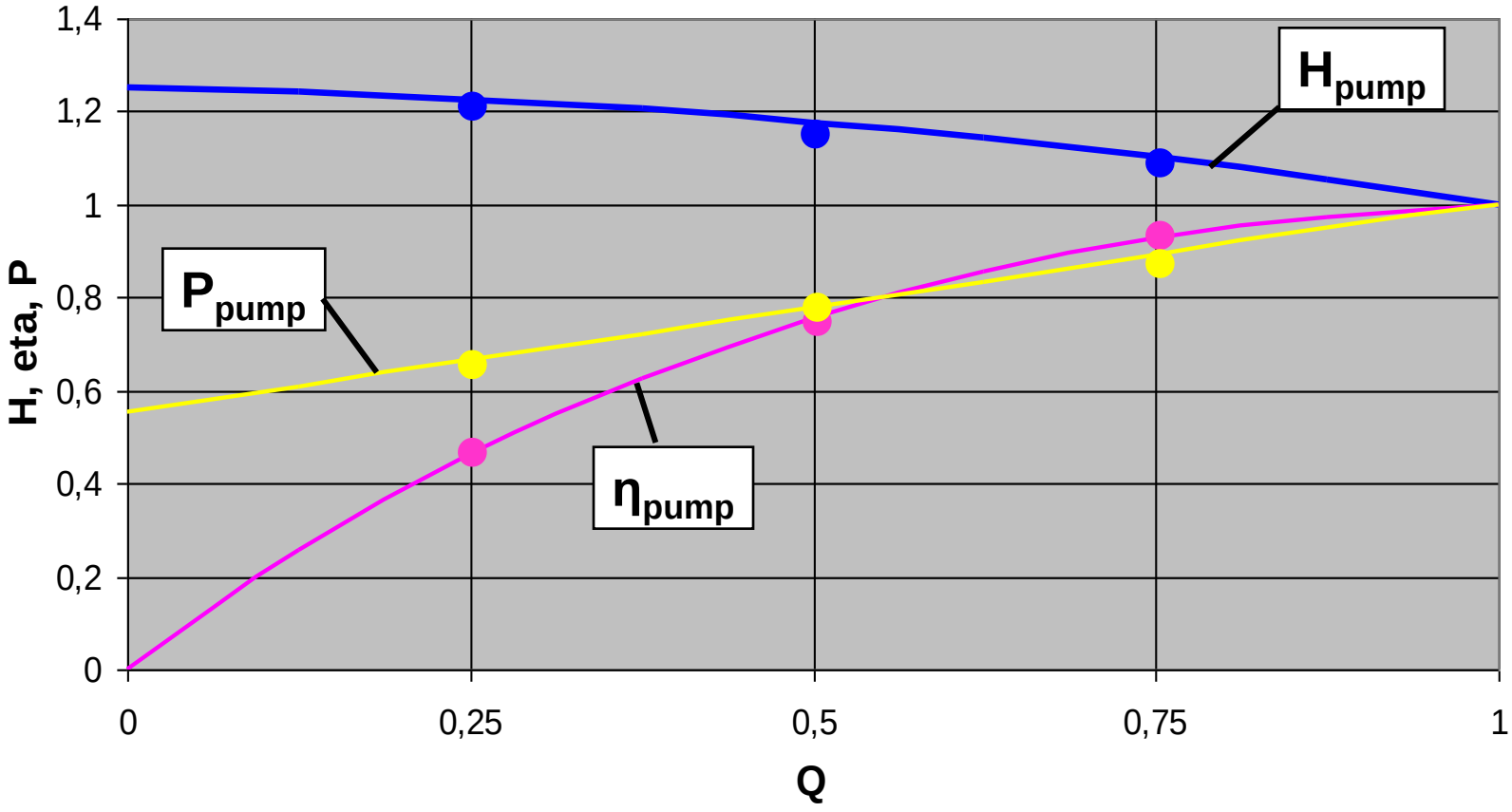
Typical pump characteristics at constant rotational speed (related values)



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Extended Product Approach (EPA)

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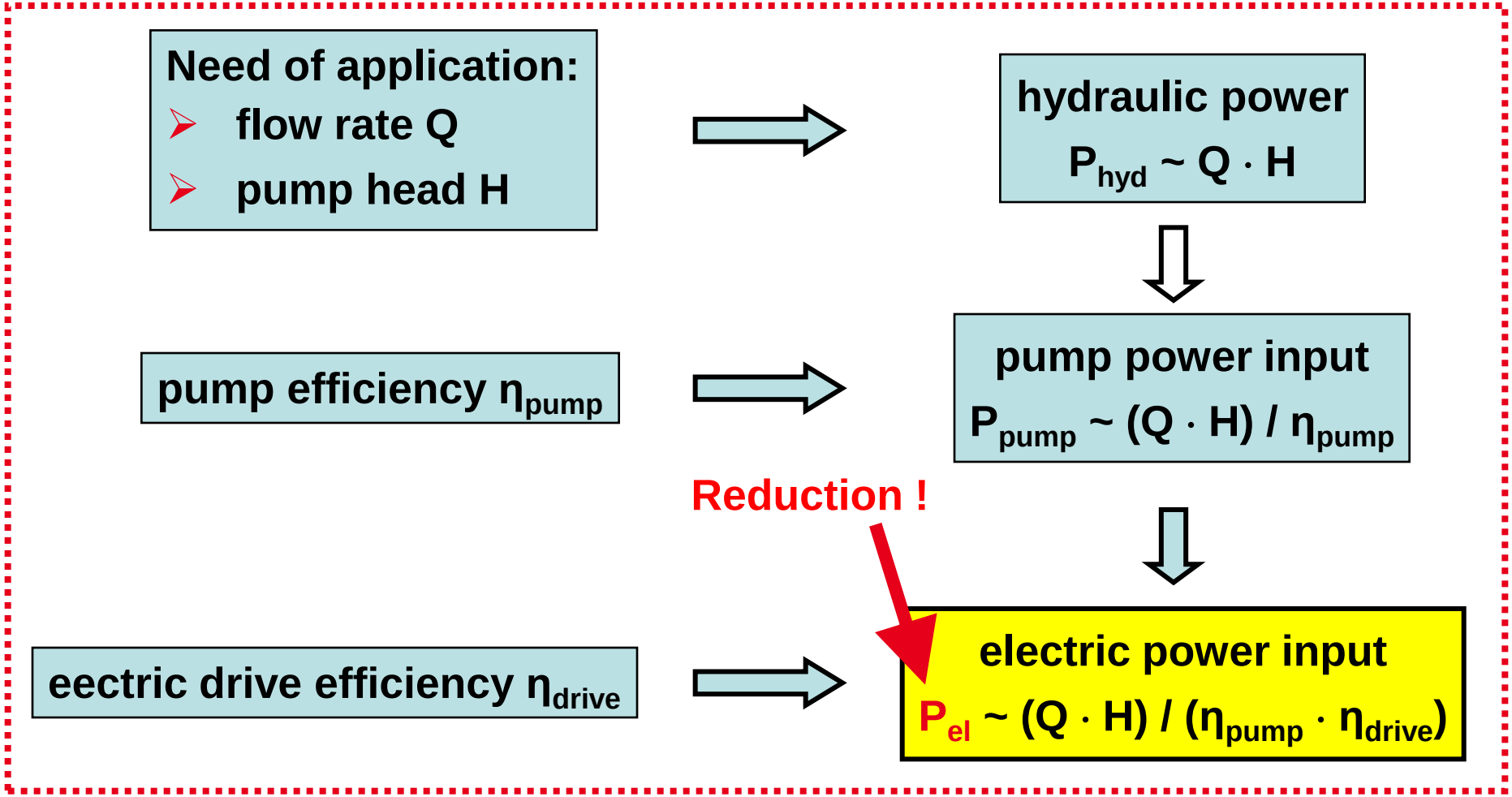

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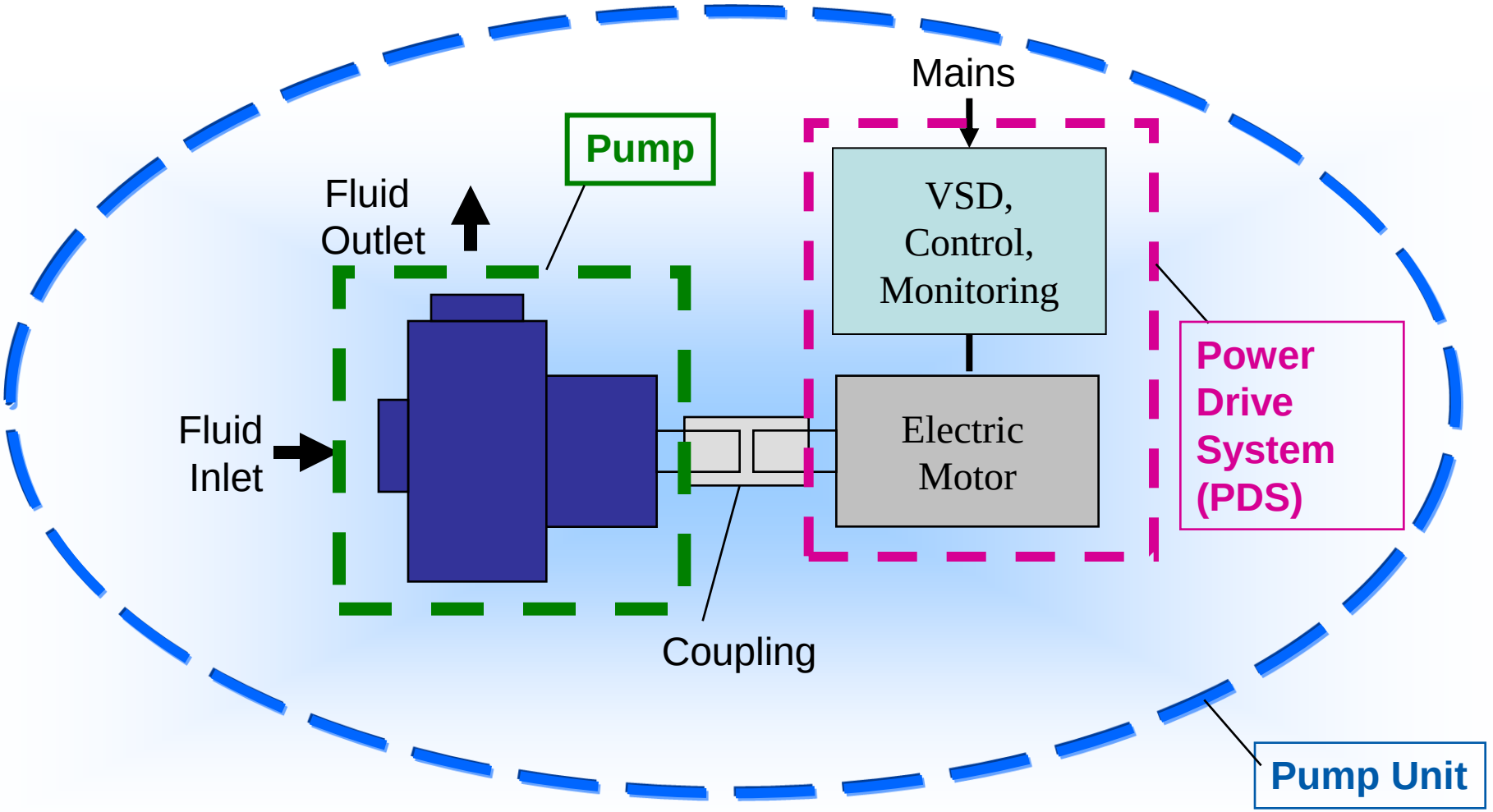
Pump units as Extended Products



Ratio of electrical power input

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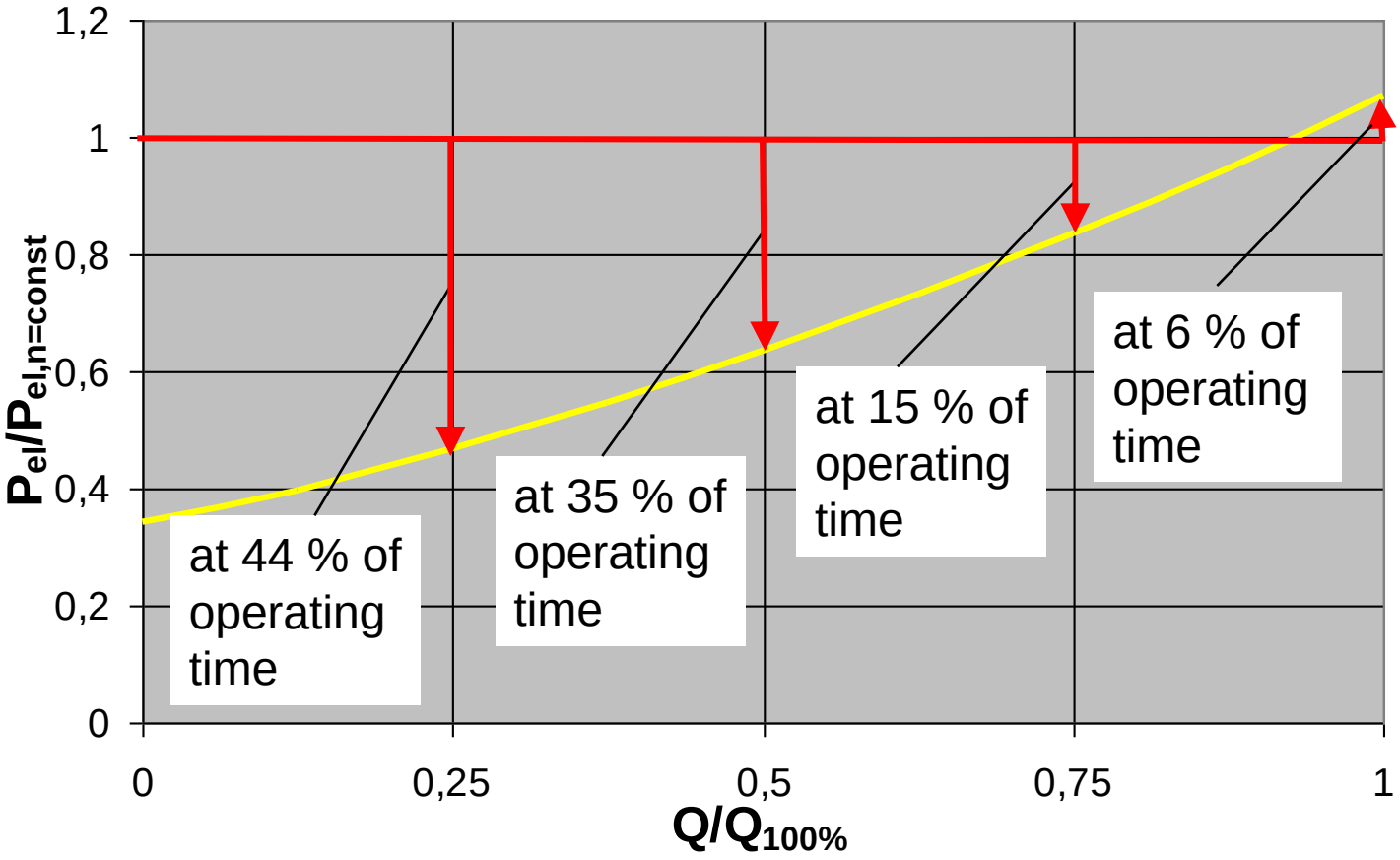
Ratio of electrical power input $P_{el}/P_{el,n=const}$



typical example for HVAC applications of water pumps

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Energy Efficiency Index (EEI)

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Quantification of energy efficiency of pump units:

Energy Efficiency Index

$$EEI = \frac{P_{el,avg}}{P_{el,ref}}$$

- EEI already established in EN-Standardization and EU-Regulation for circulators
- determination of $P_{el,avg}$, $P_{el,ref}$ for pump units to be standardized

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Energy Efficiency Index (EEI)

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Project of EUROPUMP Working Group with TU Darmstadt

on development and validation of EEI methodology for water pump units

- **started Jan. 2011**
- **shall be finished end of 2013 with Draft Standard**

Thank you for your attention