

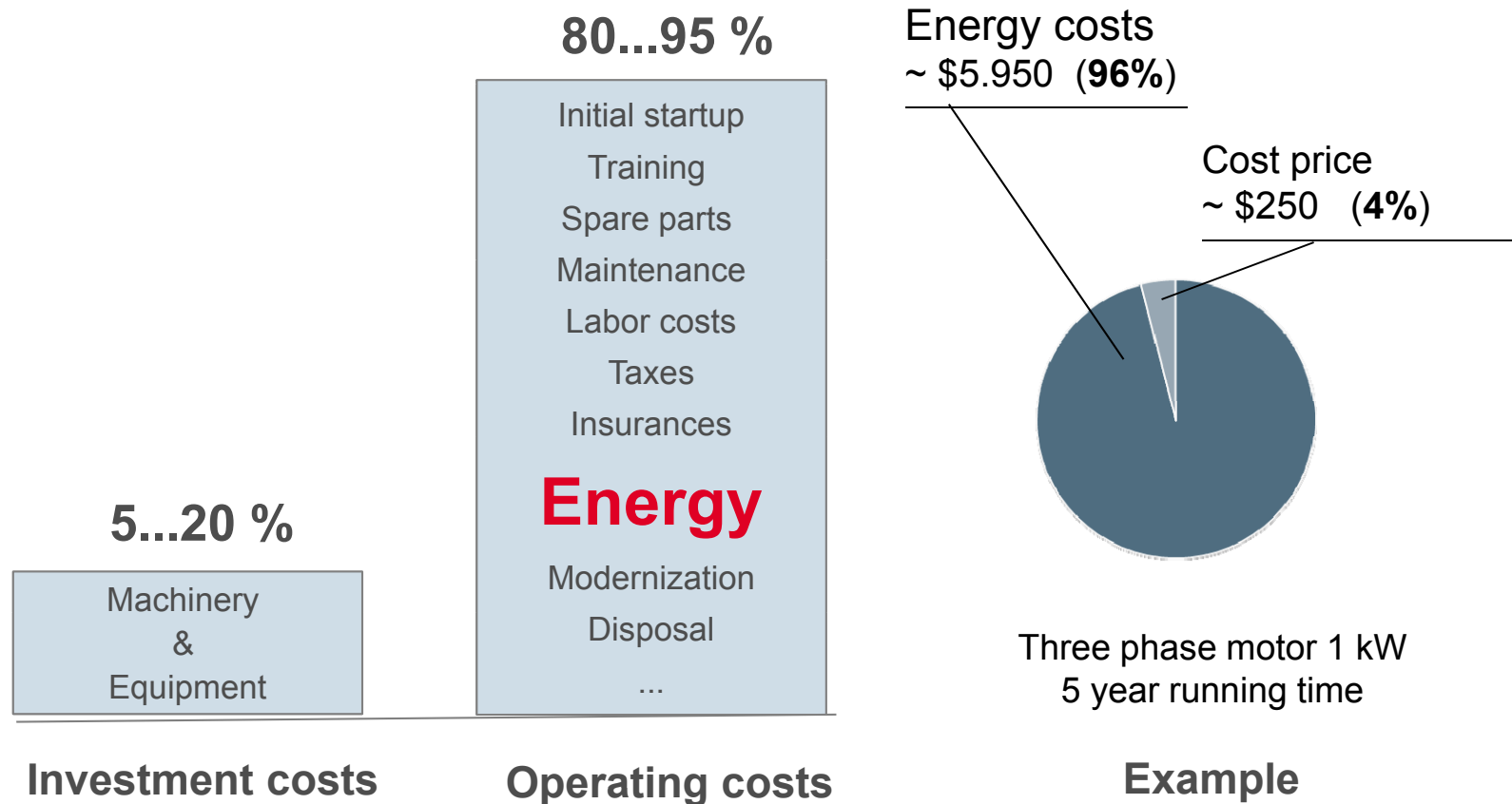


## Energy saving hydraulic drives



## Energy and the Environment – The Drivers

# Manufacturing systems life cycle costs (TCO)

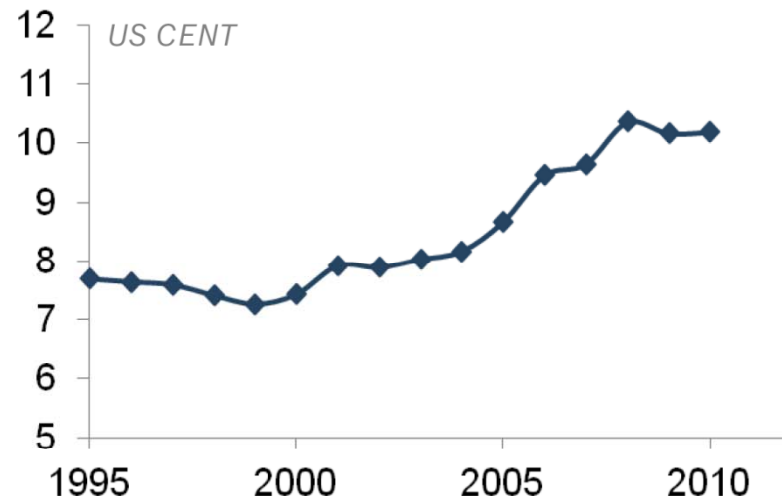


## Energy and the Environment – The Drivers

# Growth in energy costs will continue

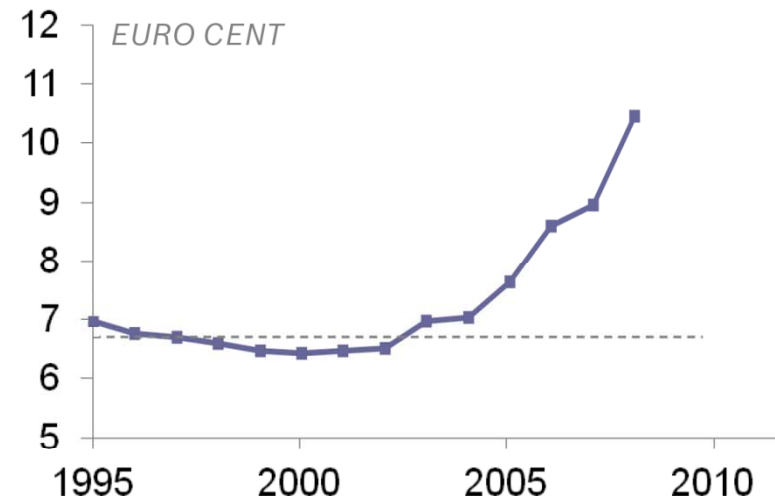
Average price electrical energy  
**USA**

Source: [www.eia.gov/electricity/data/state](http://www.eia.gov/electricity/data/state)




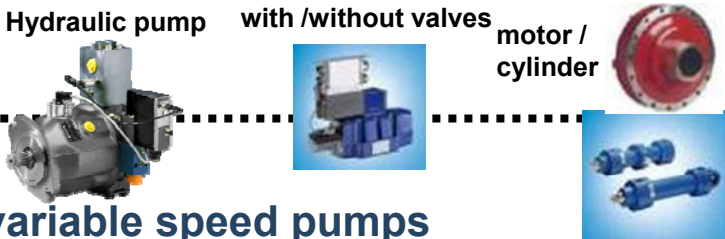




Average price electrical energy  
**European Union (EU 15)**

Source: Eurostat



# Technology Change and reduction in hydraulic expertise

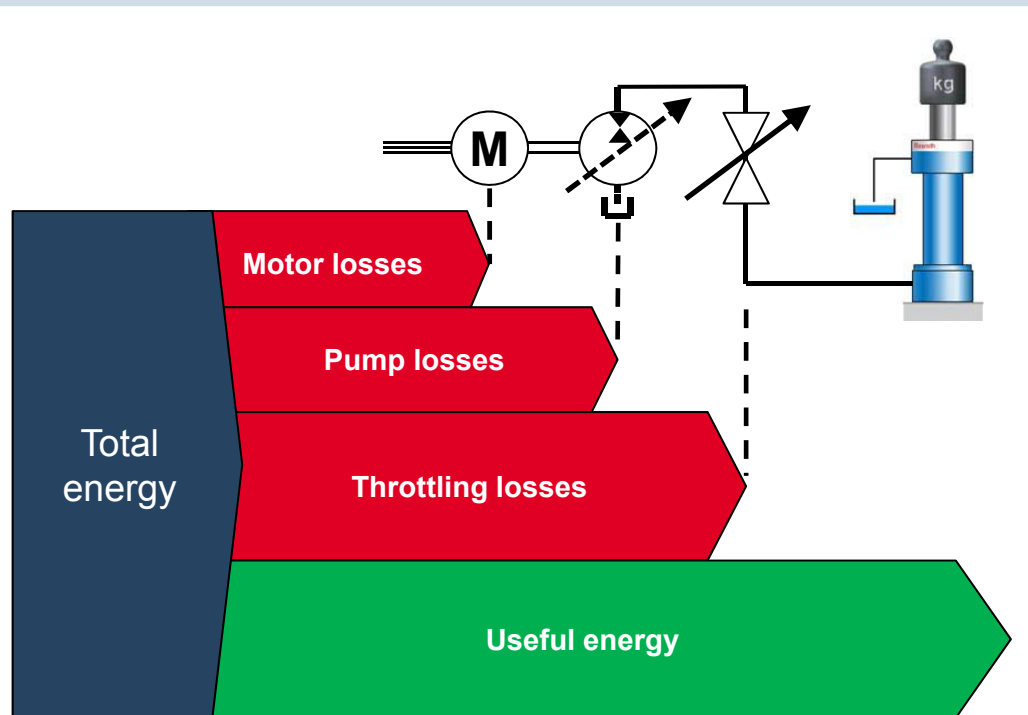
drive	power transmission	Properties
 <p>Constant speed electric motor</p>	<p>Hydraulic pump      control      motor / cylinder</p>  <p><b>classic hydraulics</b></p>	<p>☺ Power density, robustness Controllability Multiple consumers possible</p> <p>☹ Noise Energy efficiency</p>
 <p>Variable speed motor drive</p>	<p>Hydraulic pump      with /without valves      motor / cylinder</p>  <p><b>variable speed pumps</b></p>	<p>☺ Power density, robustness Controllability Multiple consumers possible Energy efficiency Noise</p>
 <p>Variable speed motor drive</p>	<p>Force transmission      Spindle drive</p>  <p><b>Electro-mechanic</b></p>	<p>☺ Controllability Noise Energy efficiency</p> <p>☹ Multiple consumers not possible (or very difficult) Power density</p>



## Technology Change

# Energy saving potential

- Classic Solution

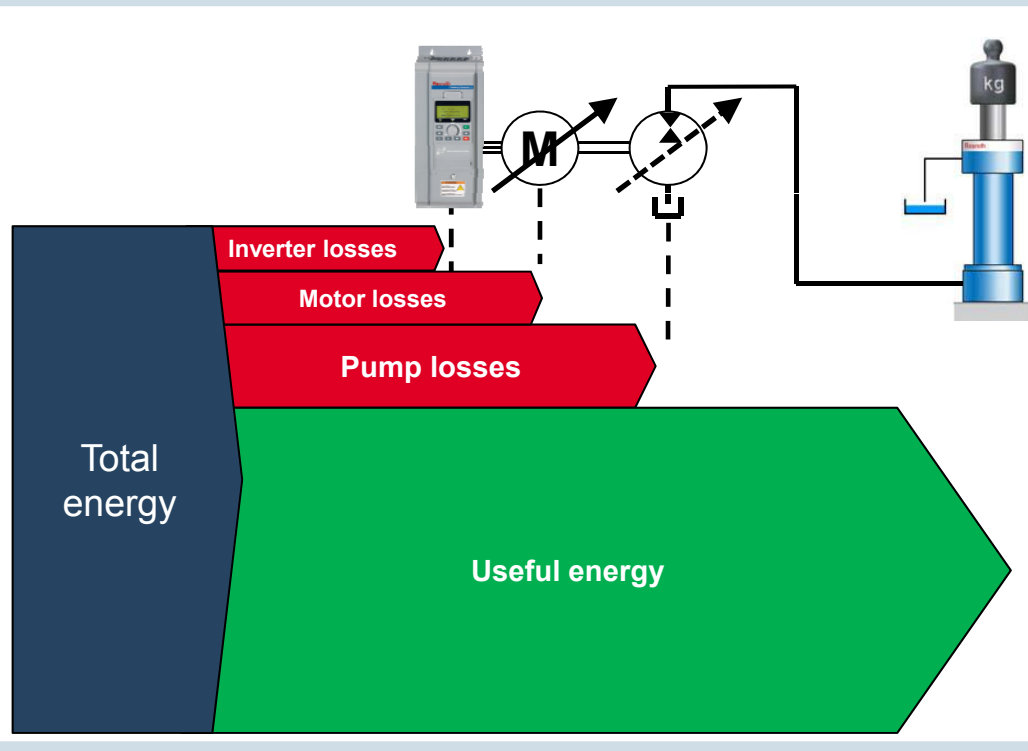


- Full motor speed during part load operation.
- Pump mechanical losses caused by high rotation speed
- Lower motor and pump efficiency during part load operation
- High throttling losses caused by proportional valves

## Technology Change

# Energy saving potential

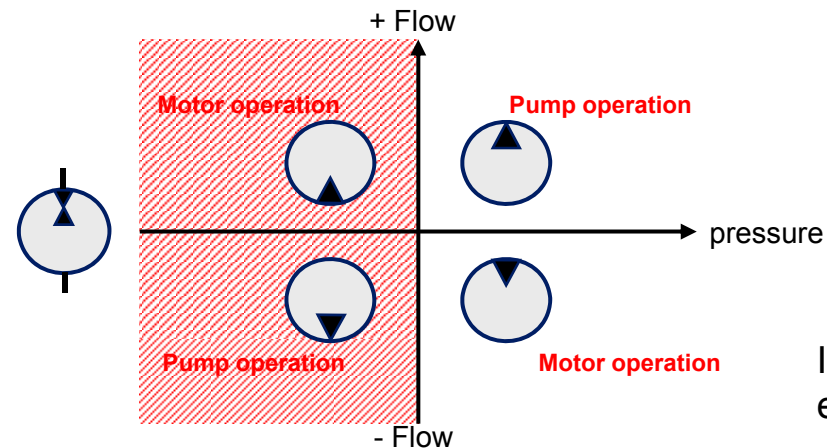
- Variable Speed Pump Drives



- No throttling losses from proportional valves
- 40-70% speed reduction during part load operation
- Increased pump and motor efficiency during part load operation
- Reduced pump losses by lowering average motor RPM
- Additional inverter losses

# Pump selection

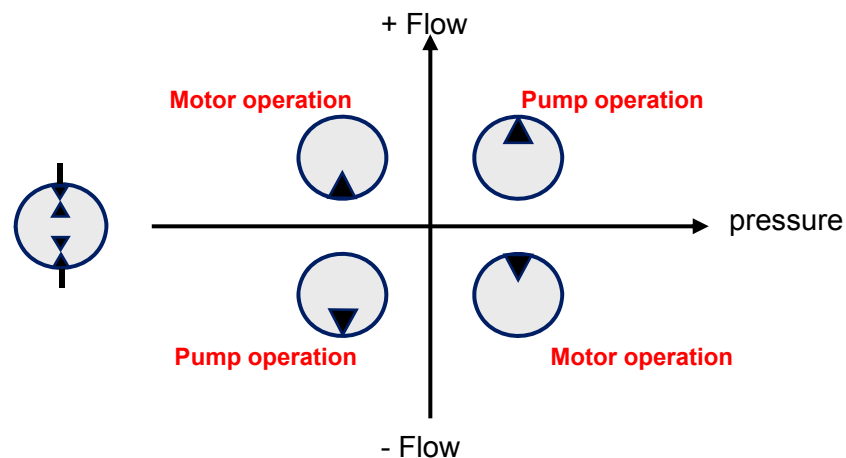
## Quadrants of operation



Internal gear pump  
e.g. PGH



Axial piston pumps  
e.g. A10 VZO



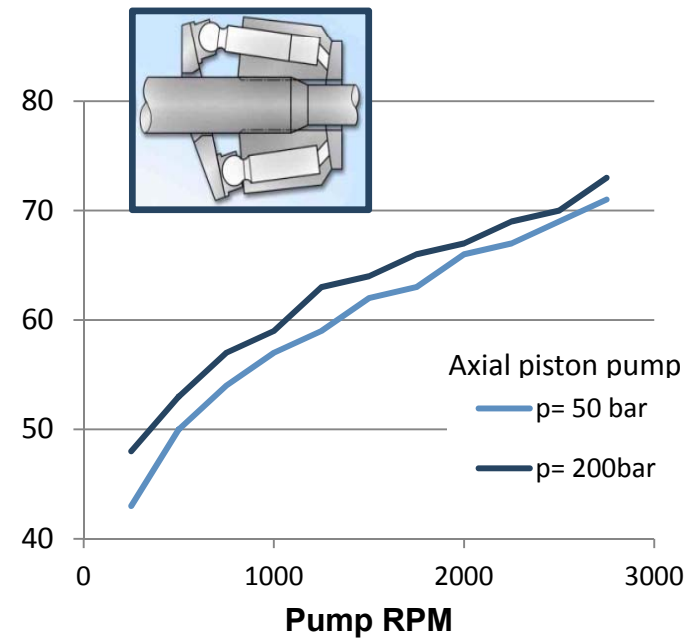
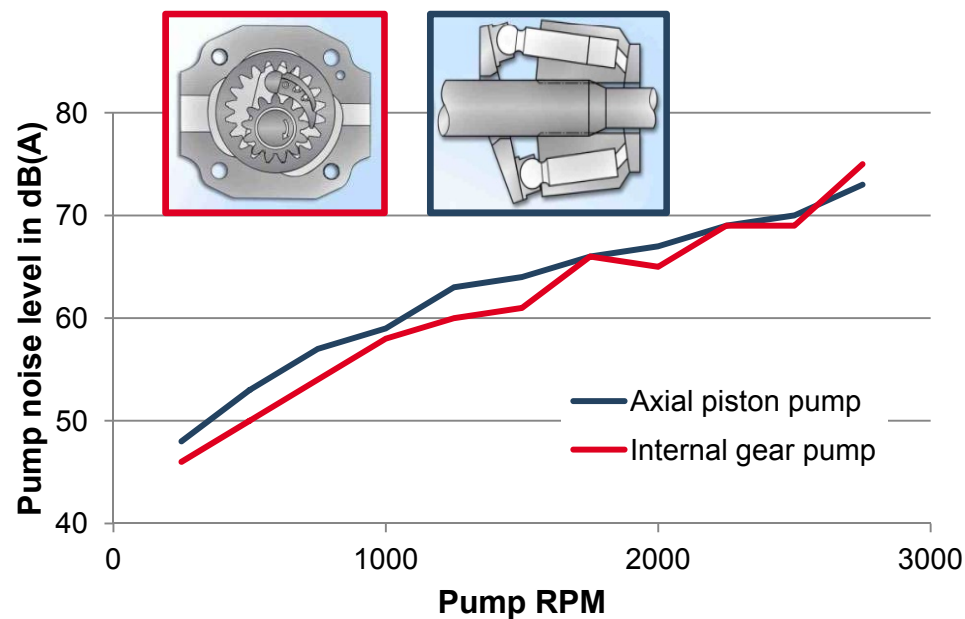
Axial piston pumps  
e.g. A10 FZG / VZG (for closed circuits)



## Noise Reduction

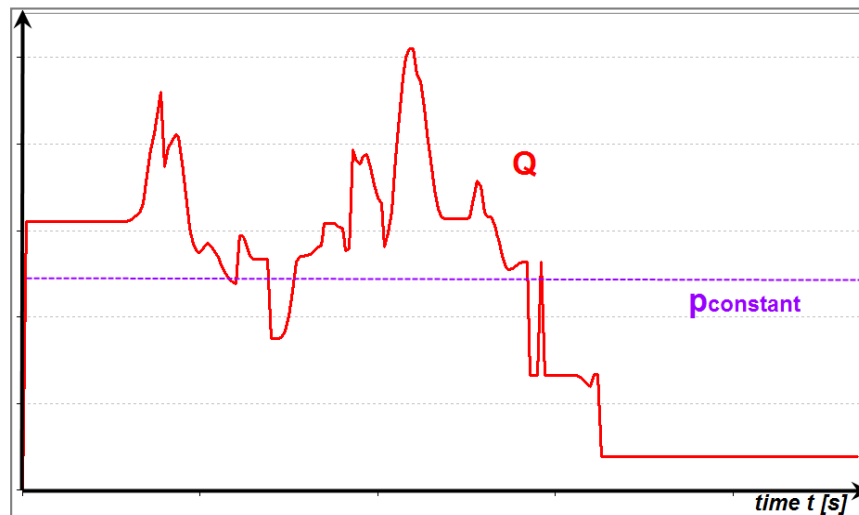
### Noise reduction

- Pump noise depends on:
  - Pump construction
  - Speed and pressure
  - ...



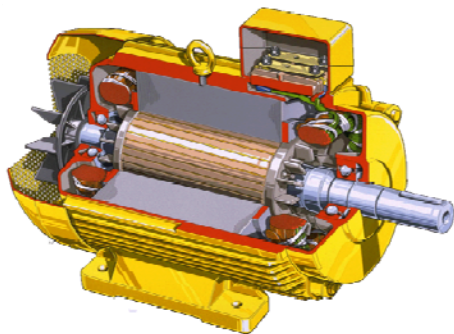
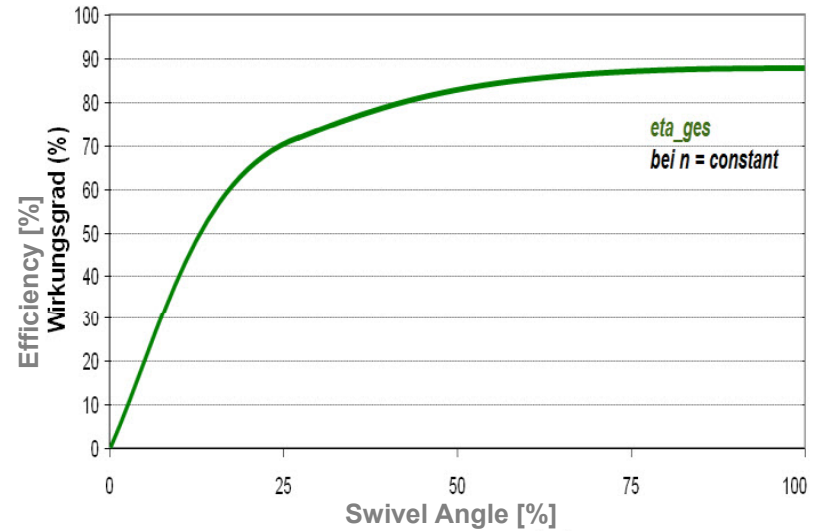
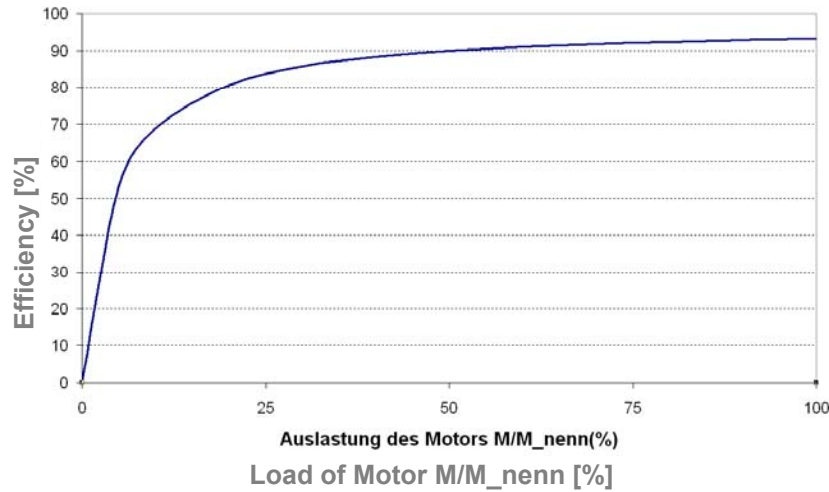
# Variable Speed Pump Drives for Industrial Machinery

Hydraulic applications for  $p_{constant}$ ,  
e.g. conventional technology for HPU's

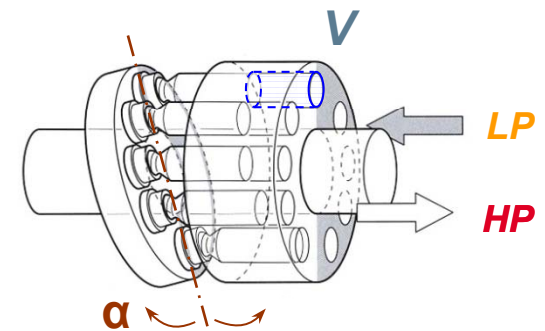


# Variable Speed Pump Drives for Industrial Machinery

## Traditional Pump Motor Group

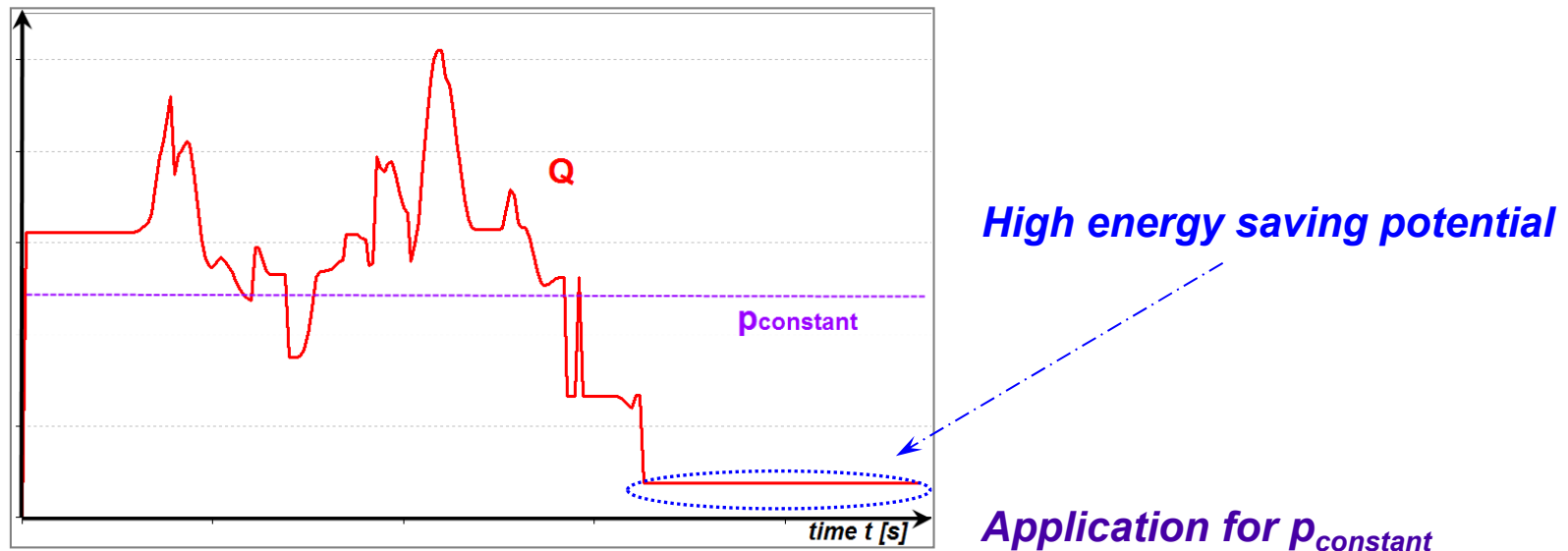


Swept volume    Swivel angle  
 $V \sim \alpha$



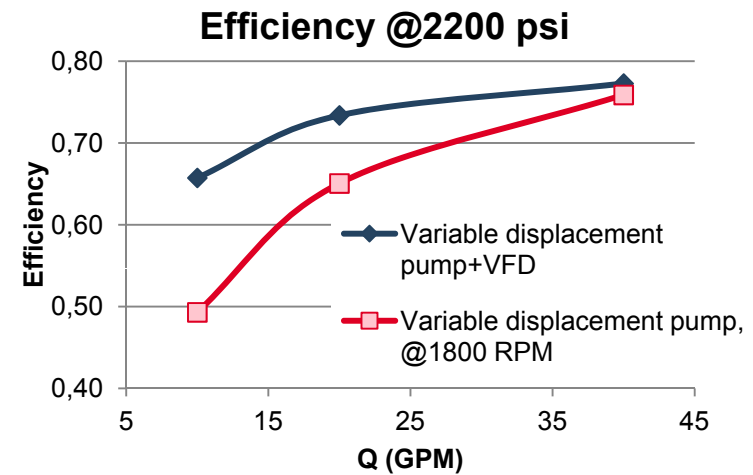
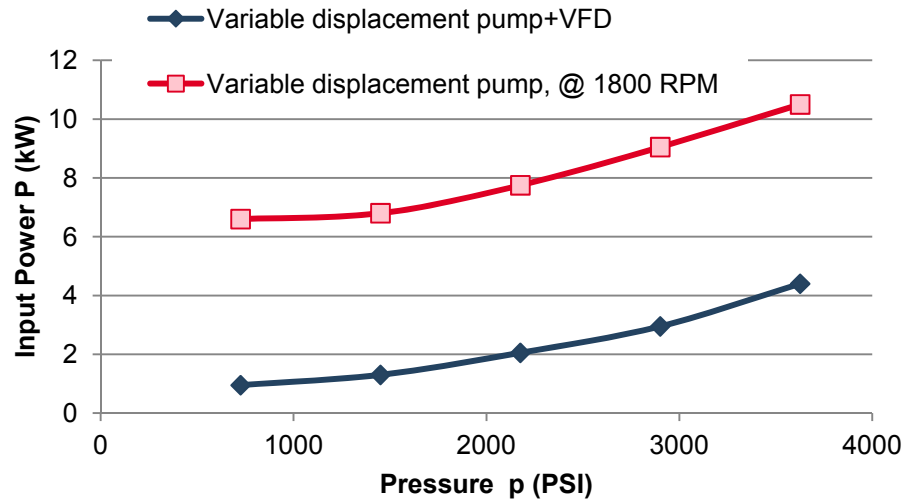
# Energy saving for constant pressure systems

- Typical flow rate profile for  $p_{constant}$  (e.g. technology for HPU's)
- High energy saving potential
  - Reduced motor speed → decreasing of installed energy
  - Using components in ideal degree of efficiency



## Energy Saving by Reducing Motor Speed

# Energy saving by reducing motor speed



Power consumption of electric motor during pressure holding (Q=0 GPM)

$$\eta = \text{Hydraulic Output Power} / \text{Electric Input Power}$$

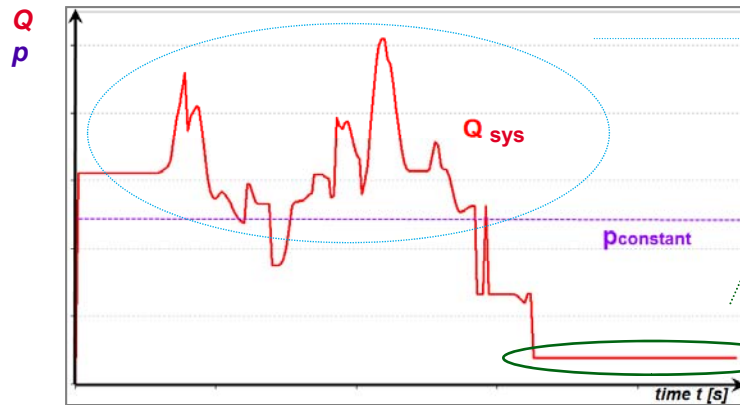
- pump A4 125cc
- 100 HP AC motor



Sytronix DFE 5000

# Sytronix - Variable Speed Pump Drives

## Potential for energy savings

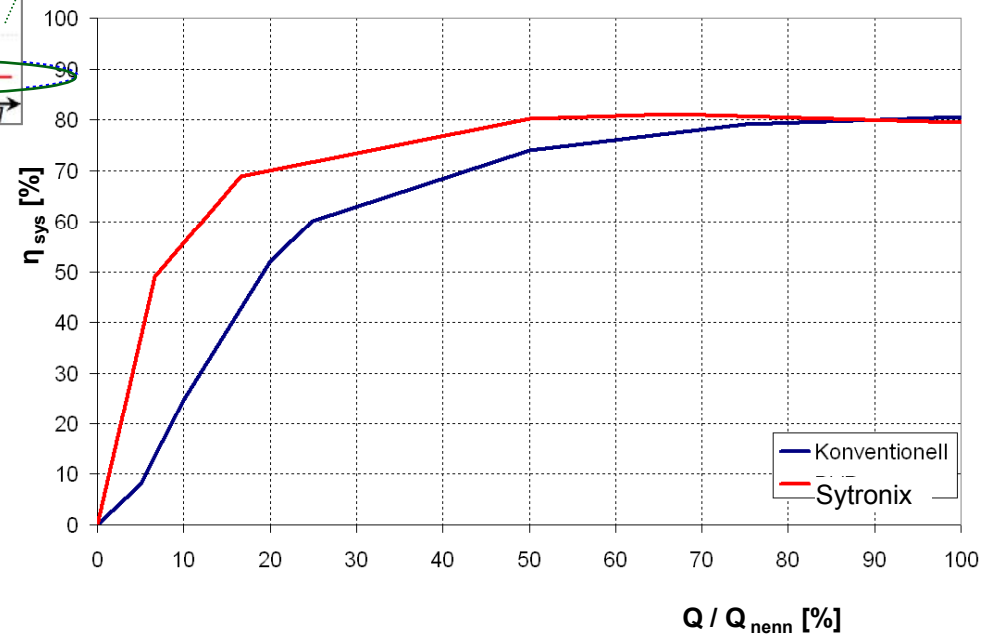


Pressure hold mode

$Q_{sys/min}$

Max. flow rate

$Q_{sys/max}$



### Comparison of conventional and variable speed drives:

Energy saving in pressure hold mode and reduced flow up to 80% (depends on cycle time and basic rate of  $Q_{sys/min}$  ).



## System Variants- SVP

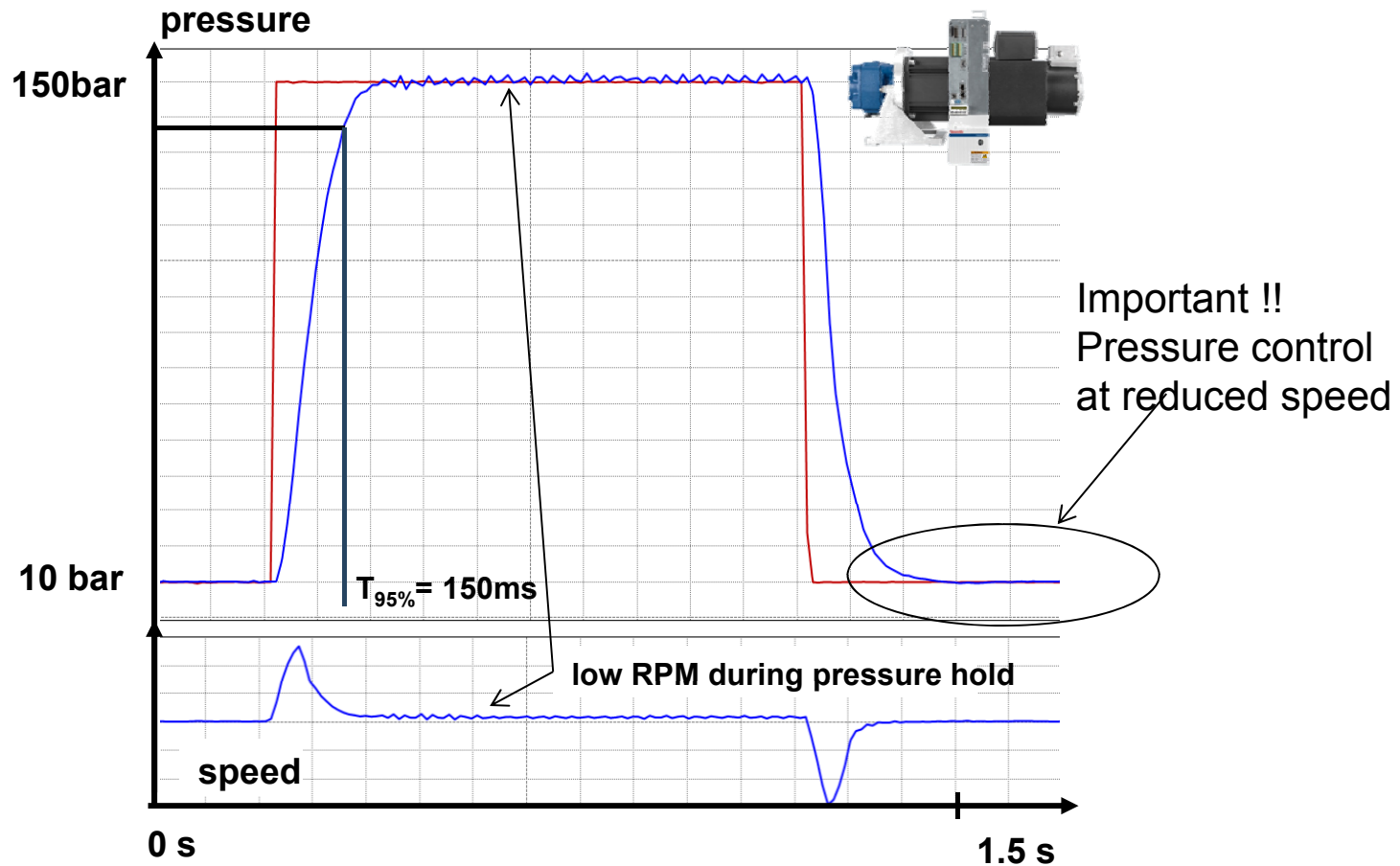
# SvP 7000 – High performance

performance																					
<div style="display: flex; justify-content: space-between;"> <div style="background-color: #0070C0; color: white; padding: 2px 5px; border-radius: 3px;">high dynamics</div> <div style="background-color: #70AD47; color: white; padding: 2px 5px; border-radius: 3px;">energy efficient</div> </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div style="background-color: #0070C0; color: white; padding: 2px 5px; border-radius: 3px;">high accuracy</div> </div>																					
control functions																					
<ul style="list-style-type: none"> <li><span style="color: green;">✔</span> pressure control</li> <li><span style="color: green;">✔</span> flow rate control</li> <li><span style="color: green;">✔</span> force control</li> <li><span style="color: green;">✔</span> speed control</li> <li><span style="color: green;">✔</span> position control</li> </ul>																					
quadrants																					
<p style="text-align: center;">pressure</p> <table border="1" style="margin: auto; text-align: center;"> <tr> <td style="width: 40px; height: 40px;"></td> <td style="width: 40px; height: 40px; border: 1px solid black;">2</td> <td style="width: 40px; height: 40px; border: 1px solid black;">1</td> </tr> <tr> <td></td> <td style="text-align: center;">↑</td> <td style="text-align: center;">↑</td> </tr> <tr> <td style="text-align: center;">←</td> <td style="text-align: center;">←</td> <td style="text-align: center;">←</td> </tr> <tr> <td style="width: 40px; height: 40px;"></td> <td style="width: 40px; height: 40px; border: 1px solid black;">3</td> <td style="width: 40px; height: 40px; border: 1px solid black;">4</td> </tr> <tr> <td></td> <td style="text-align: center;">↓</td> <td style="text-align: center;">↓</td> </tr> <tr> <td></td> <td style="text-align: center;">←</td> <td style="text-align: center;">→</td> </tr> <tr> <td></td> <td style="text-align: center;">←</td> <td style="text-align: center;">→</td> </tr> </table> <p style="text-align: center;">flow</p>		2	1		↑	↑	←	←	←		3	4		↓	↓		←	→		←	→
	2	1																			
	↑	↑																			
←	←	←																			
	3	4																			
	↓	↓																			
	←	→																			
	←	→																			

SvP 7000
system

sample application
<h3>injection molding machine</h3>
<p><b>Axis control</b></p> <ul style="list-style-type: none"> <li>▪ high performance required</li> <li>▪ pressure control</li> <li>▪ flow rate control</li> </ul>
press brake
<p><b>Axis control</b></p> <ul style="list-style-type: none"> <li>▪ high performance required</li> <li>▪ force control</li> <li>▪ speed control</li> <li>▪ position control</li> </ul>

## SvP 7000 – High performance



## DFE<sub>n</sub> – Advanced performance

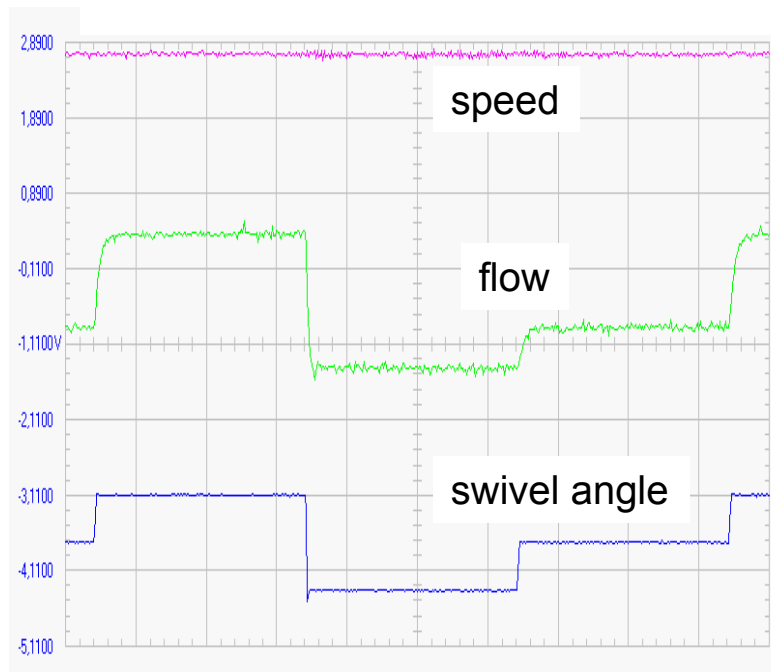
performance	
advanced dynamics	energy efficient
advanced accuracy	
control functions	
✓ pressure control	
✓ flow rate control	
✓ force control	
✓ speed control	
✓ position control	
quadrants	
<p>pressure</p> <p>flow</p>	

DFE <sub>n</sub> 5000	
<p>2 independent hydraulic circuits possible</p>	
system	

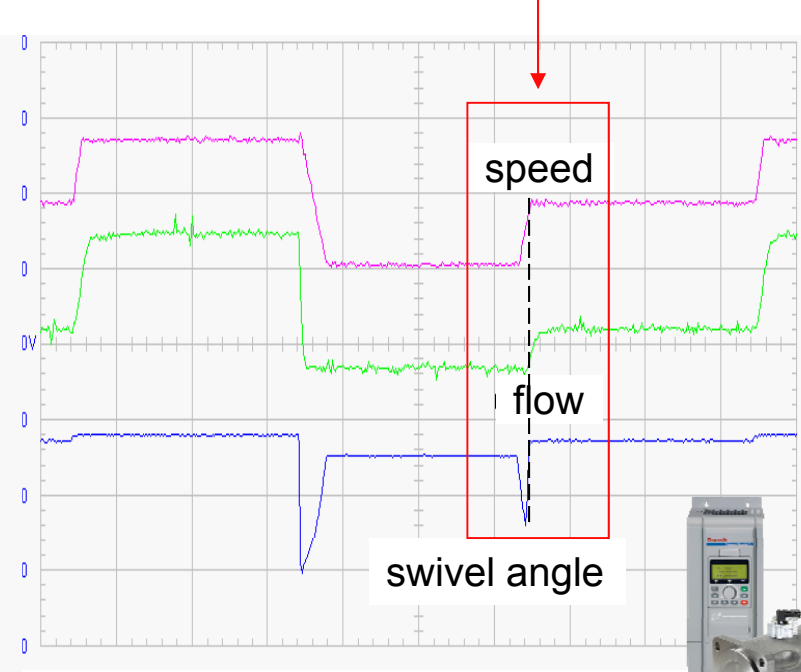
sample application	
injection molding machine	
<b>Axis control</b>	
<ul style="list-style-type: none"> <li>advanced performance required</li> <li>pressure control</li> <li>flow rate control</li> </ul>	
paper	
<b>constant pressure system</b>	
<ul style="list-style-type: none"> <li>advanced performance required</li> <li>pressure control</li> </ul>	

## Variable speed mode and constant speed mode

constant speed mode



variable speed mode



## Log loading device J. Lewis

**4EE**  
ENERGY  
EFFICIENCY



### Aggregate before retrofit

- Pressure  $p = 120$  bar by 60 l/min/pump with 120 l/min by 1800 rpm
- „Pressure controlling“ via pressure limitation valve

Energy consumption 44.000 kWh/a



### Sytronix SVP 7000

- Internal gear pump on servomotor via FU
- 4 Liter accumulator for safeguarding 97 bar
- selectable throttle point for min. speed of the pump

Energy consumption 4.000 kWh/a



Energy System Design



Efficient Components



Energy on Demand

Saving 40.000 kWh/a  
5.600 €/a \*\*

CO<sub>2</sub>-Saving\* 24,5 t/a

**- 71 %**

\* Energy mix, germany concerning GEMIS version 4.2 in the comparison year 2004: 0,613 kg CO<sub>2</sub>/kWh

\*\* Current price 0,14 €/KWh incl. 3,592 ct/KWh EEG-allocation, 24h/day, 260 days/year

Thank you for your  
attention!

**Rodney Trail**

Bosch Rexroth Canada  
Industry Sector Manager SET23  
Canadian Sytronix Manager



Sytronix DFE 5000