Aspects of energy efficient use of port installations

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fml – Institute for materials handling, material flow, logistics
Prof. Dr.-Ing. Dipl.-Wi.-Ing. W. A. Günthner
Technische Universität München

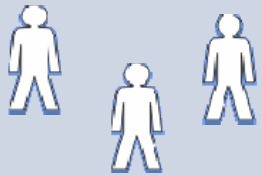
Agenda

- **The chair for materials handling, material flow, logistics**
- **Why to aim an energy efficient use of equipment**
- **Selected examples of technical equipment for energy-efficient handling**
- **Comparison of handling appliances used in transhipment with the regard to productivity and energy use**

fml – Chair for
materials handling, material flow, logistics

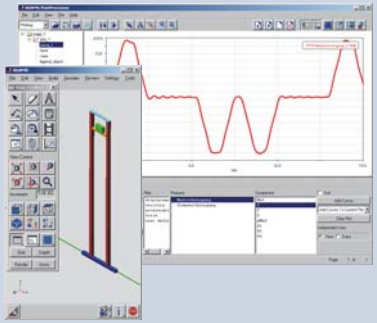
42 members of staff

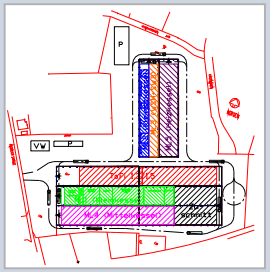
- 18 established post
- 24 third-party funds employees

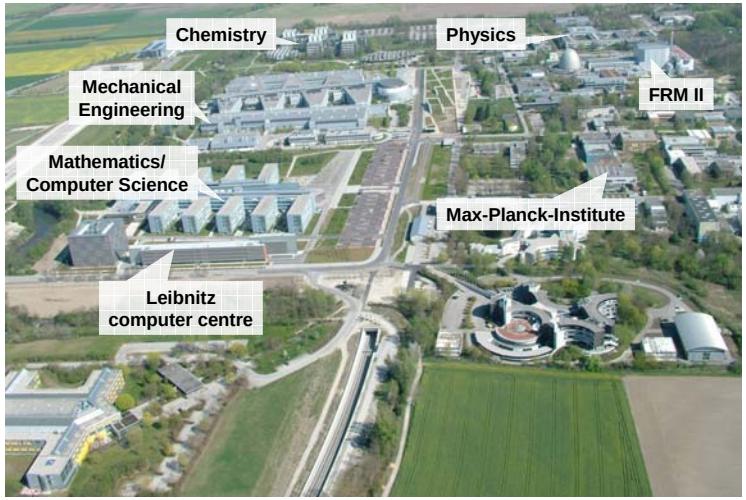


Responsibilities

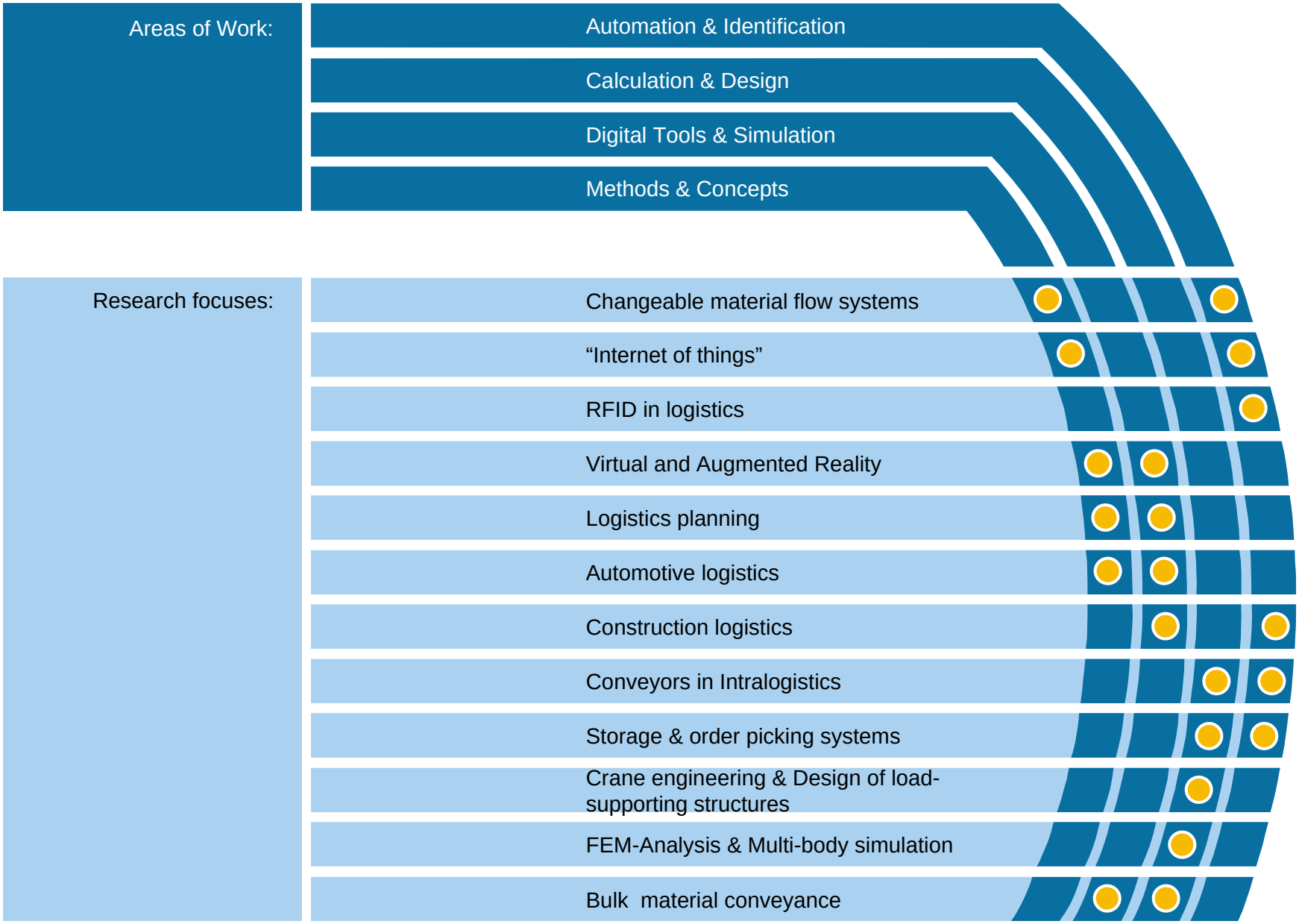
- Research
- Teaching
- Industrial projects







Research profile

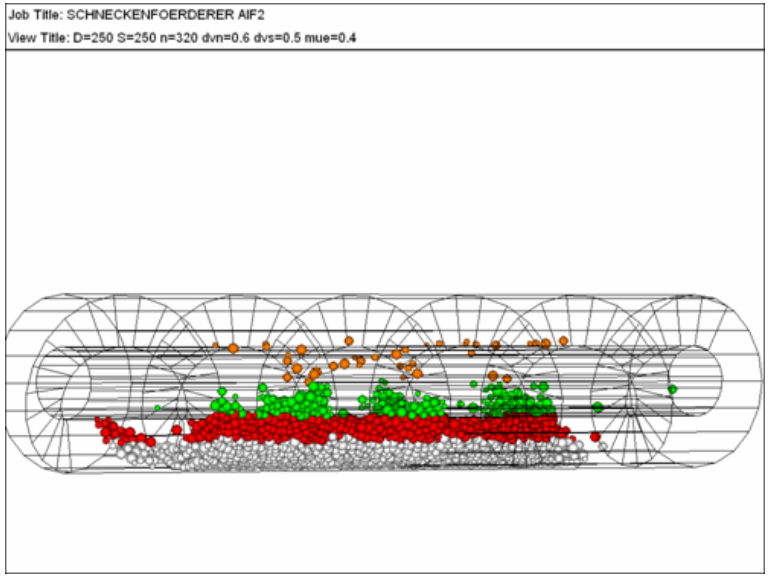


Research profile

Areas of Work:

- Automation & Identification
- **Calculation & Design**
- **Digital Tools & Simulation**
- Methods & Concepts

Research focuses: **Bulk material conveyance**



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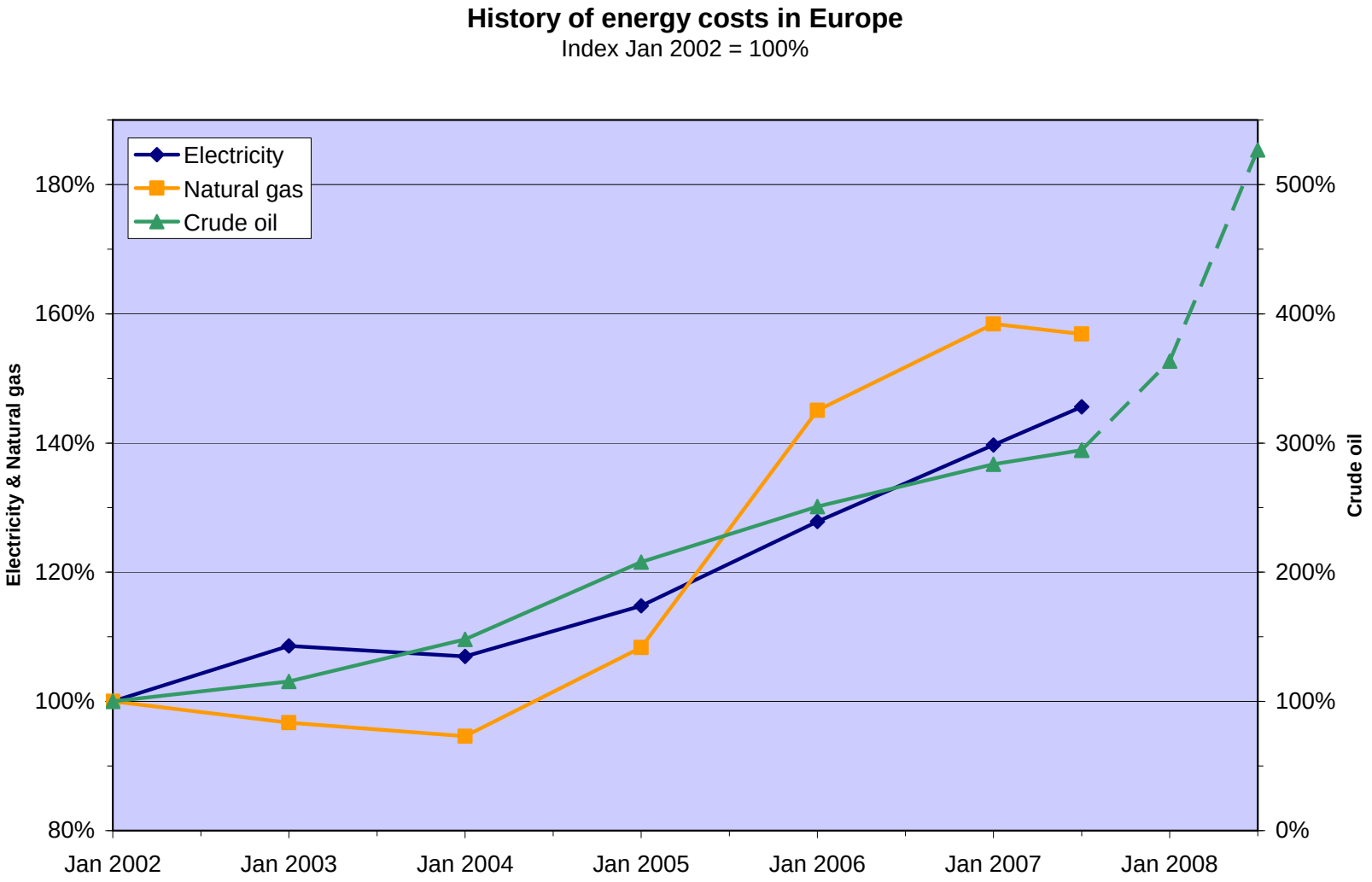
Increasing of energy costs



References: OPEC, eurostat

Greenhouse gas CO_2

If we don‘t reduce the CO_2-output by 50% until 2050, parts of earth will possibly be uninhabitable

Since begin of industrialisation the CO_2 in our atmosphere increased by 30%, half of it since 1970!

Most of our energy sources consist of carbon

The most important way to protect our climate is an efficient use of energy! Thus climate protection is also self-interest

The increase of the CO_2-concentration is linked to the expected climate change

In the Kyoto Protocol the industrial countries committed bindingly to reduce greenhouse gases in the EU by 8% between 2008 and 2012 under the 1990 level.

If everyone reduces his climate contamination by 10%, this will relate to the total amount of Spain and Finland together

References: Max-Planck-Gesellschaft, BayLfU

Container handling:

German Seaport, 5.3 Mio TEU annual handling volume

- Diesel e.g. for the use of industrial trucks
- Consumption about 3.4 l/TEU (about 0.36 l/t)

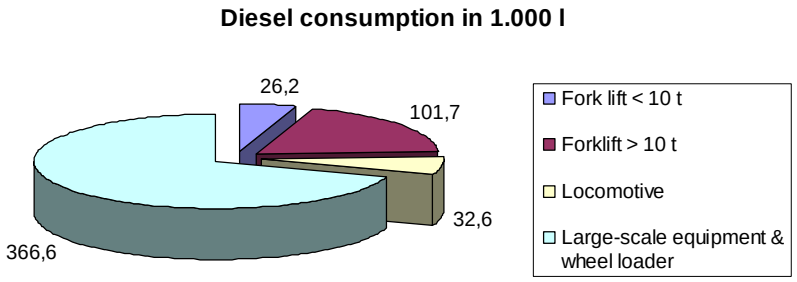
- Electricity, e.g. gantry crane, lightning
- Consumption about 16.7 kWh/TEU (about 1.76 kWh/t)

Bulk cargo handling:

German Seaport, 2.4 Mio t annual tonnage

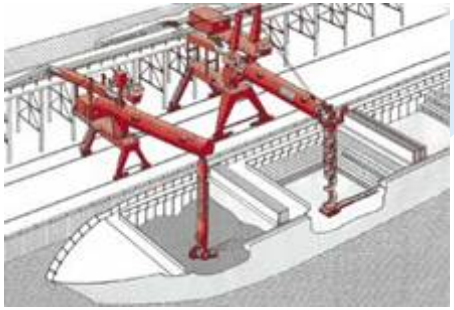
- Diesel e.g. for the use of industrial trucks and wheel loader
- Consumption about 0.22 l/t

- Electricity, whole port facility
- Consumption about 2.7 kWh/t



References: ZDS

Energy users in harbours



Ship discharge

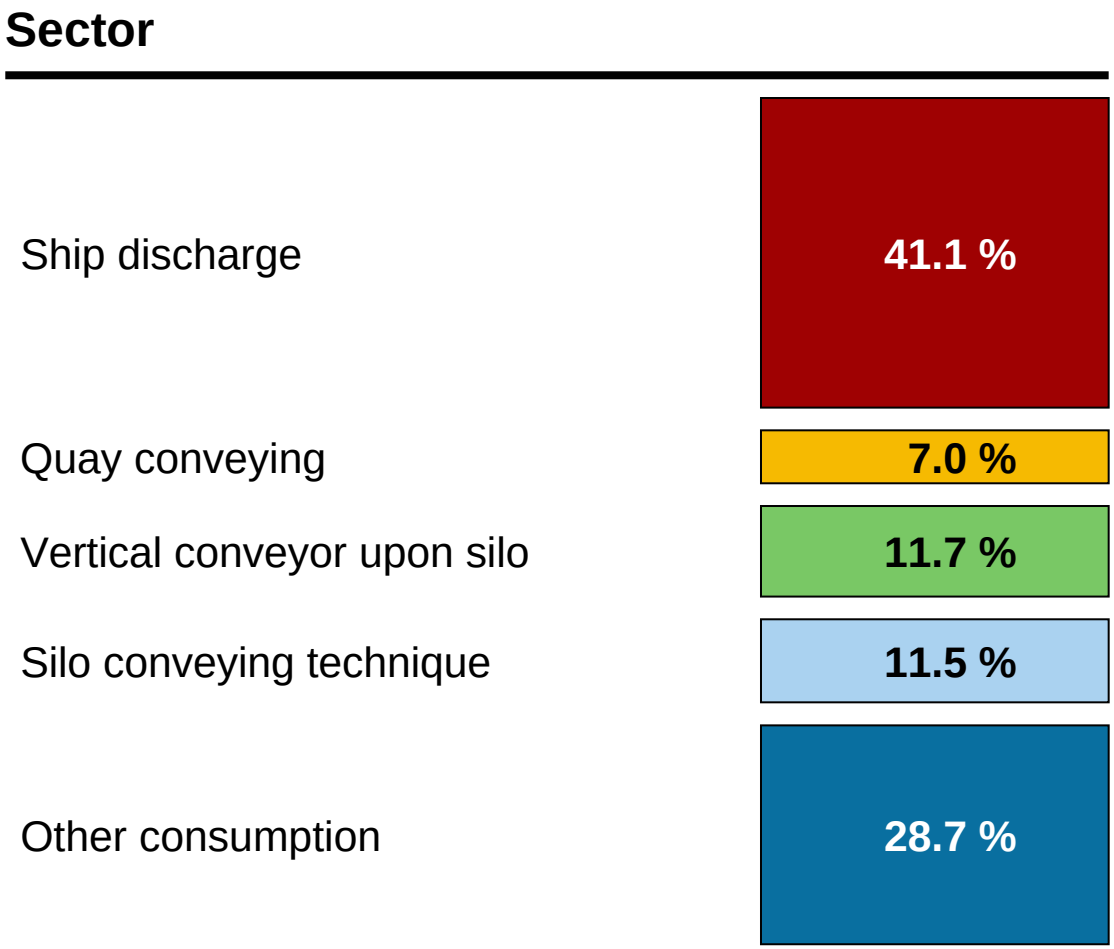
Quay conveying

Conveying upon silo

Other consumption

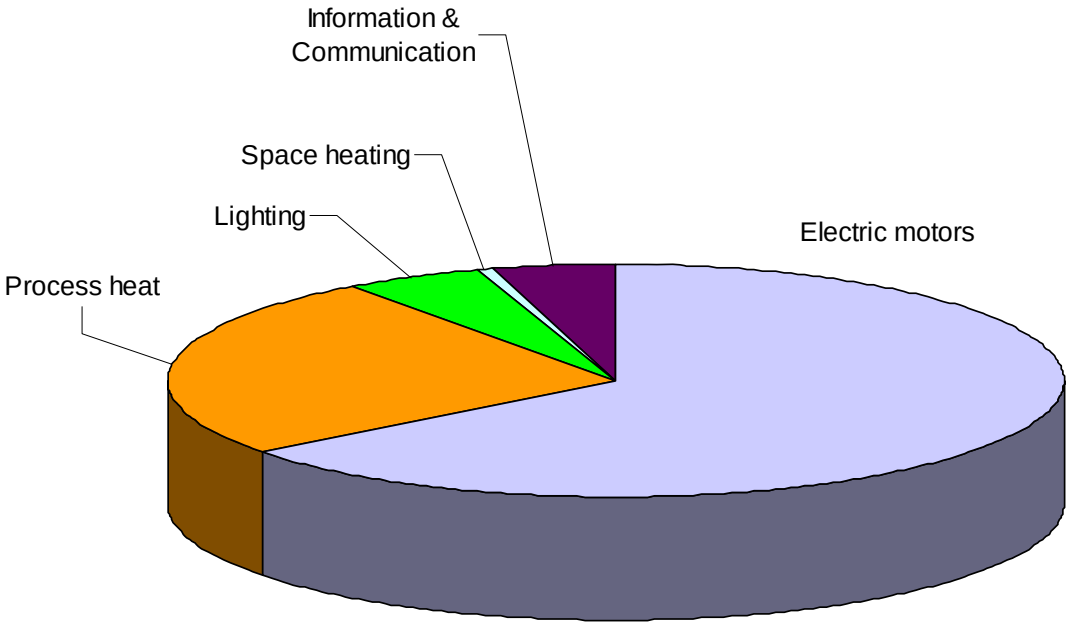
Silo conveying technique

Power consumption of a storekeeper for agribulk commodities



As percentage of the total energy consumption

Example Germany:



→ **Electricity as main energy source is used in electric motors by over 60%**

References: Umweltbundesamt

About 25% of the current consumption of electric motors can be saved by economic profitable actions (RoI < 2 or 3 years)!

→ **Altogether about 10% of the total current consumption of Germany and so operating costs can be saved!**

In decisions for electric motors the Life Circle Costs must be noted!

→ **Less than 3% of the TCO are acquisition costs, more than 95% are energy costs!**

→ **Investments in energy efficient motors are amortized in few years.**

References: Umweltbundesamt, BayLfU

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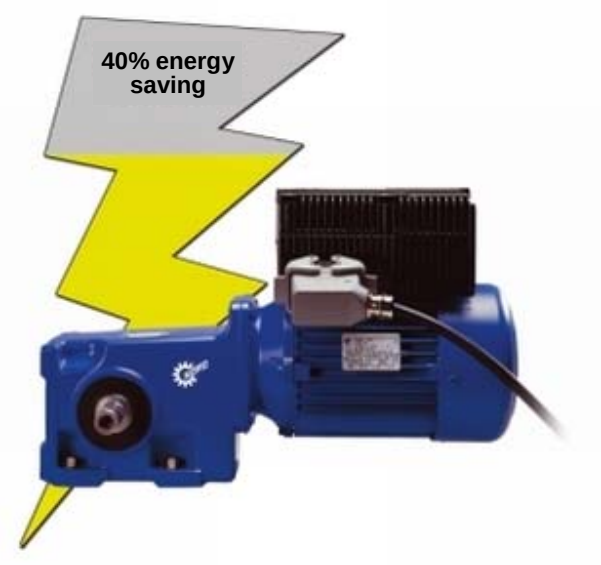
Energy efficient electric motors



- New winding technology and alloys for stator sheets
- Improvement of electric motor efficiency from 75% (normal) to 85% (excellent)
- Gearing optimal staged depending on use
- Efficiency optimization over the whole drive chain
- „Soft-Drivemanagement“ and „Power-Save-Strategy“

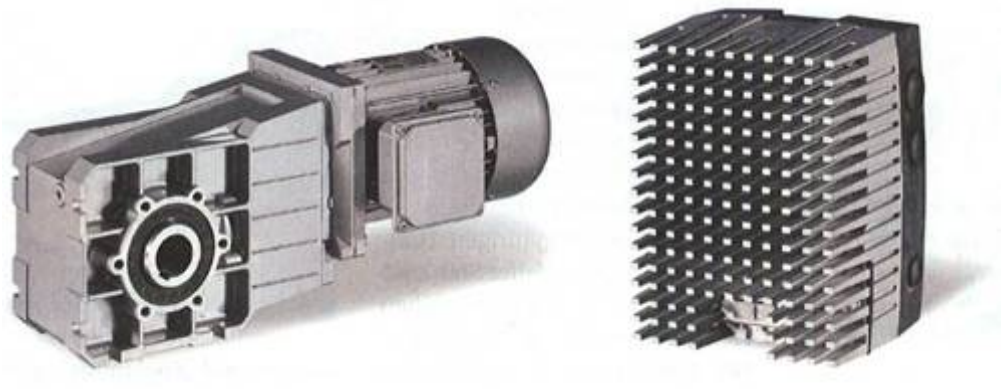
→ **Reduce of operating costs by 40%**

→ **Power consumption at electric motors are 98% of the total operating costs**

References: Getriebebau Nord, F+H

- **Conventional three-phase current drive**

→ **Connection power** → **Effective power**
→ **Idle power**



- **Frequency converter operated electric drive**

→ **Power consumption depending on demand**

References: F + H

Examples

Belt conveyor in brown coal industry

30% energy saving by change-over to frequency converter

Elevator technique

References: Thyssen, RWE

40% energy saving by change-over to frequency converter

New diesel engines

- Multiple injection
- Engine characteristic map controlled
- Modern control electronic
- Aerator engine demand-driven

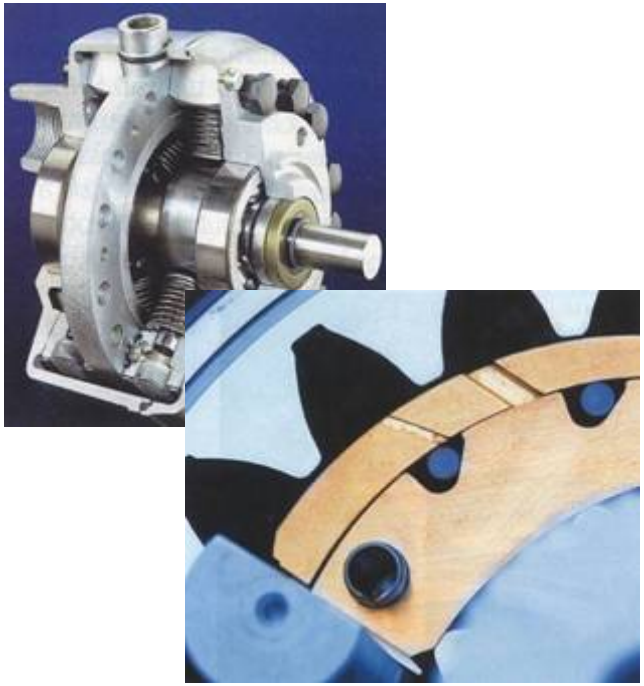
→ **Optimisation of fuel consumption**

→ **Reduction of exhaust emission by 50 %**

→ **Noise reduction**

References: F + H

Improved hydraulic power units



- Reduced leakage current with volumetric efficiency of 95%
- Mechanical efficiency of 85%
- Adjusted globe valves and manometric switches design

- Broad optimum of efficiency over rotation speed
- Downsizing electric motor and pump
- Reducing of cooling

→ **Hybrid hydraulic power units combine rotation speed variable, controlled electric motors with hydraulic pumps**

→ **Saving of energy in operation**

References: KEM

Efficiency in energy and data transfer

- Secured energy supply and data transfer
- „Monitored“ energy chains
- Reduced electrical and mechanical resistors

→ **Reliability increased**

→ **Saving of energy**

References: F + H

Hybrid technology for forklifts to reduce consumption and CO_2 emission

- Hybrid forklift
- Energy recovery at breaking and load lowering
- Energy storage with better efficiency and power density
- Example:
  RX70Hybrid / Still 2.5 l Diesel/h
  (2.5 t, 60 cycles/h as per VDI 2198 new)

1990 – 2008:

→ **Reduce of energy consumption of electrical forklifts by 20%**

→ **Reduce of energy consumption of diesel forklifts by 30%**

References: Still

Hybrid technology for forklifts to reduce consumption and CO_2 emission

- 5 Driving programs for optimal initial setting
- Speed control for long distances
- Characteristic curves optimisation of drive
- Intelligent activating of electric components
- Super-Caps as storage for electrical power out of mechanical power

References: Still

Dockside cranes with reduced energy consumption

- Anti-swinging-system
- Intelligent drive control „Eco-Drive“

→ **Reducing of diesel consumption up to 30%**

- Optimised hydraulic control
- Demand-driven drive control

→ **Less energy consumption**

References: F + H, Sennebogen

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Energy efficiency of continuous conveyor at bulk cargo handling

- Only motional and climbing resistances to overcome
- Permanent start-up and breaking procedures of discontinuous conveyors are omitted

→ **For bulk cargo handling the continuous conveyors are energetically unbeatable!**

Comparison of continuous ship unloader

	Chain Type	Screw Type	Pneumatic	Belt Type
Power consumption for conveying [kWh/t]	0.25	0.7–0.8	> 1	0.24
Total Power consumption [kWh/t]	0.4	0.9–1.0	> 1	0.4
Availability of unloader	Very high	High	Medium	Low
Average Capacity	Up to 85%	75%	55–65%	60–70%
Material Breakage	Very low	High	Very high	Medium
Dust emission	None	None	None	High
Noise emission	Very low	Low	Very high	Low

Comparison of energy costs

Annual unloading volume:	900.000 t	Nominal Capacity:	600 t/h	
Energy costs:	0.1 €/kWh	Reliability:	90 %	
Operational hours per day:	22 h	Personal costs per day:	247.5 €	(5 €/hour)
Tie-Up Costs per day:	39.500 €	Material:	Grain	

	Chain Type	Screw Type	Pneumatic	Belt Type
Average efficiency	80 %	75 %	60 %	65 %
Annual Unloading days	95 d	101 d	126 d	117 d
Total annual personnel costs	23.438 €	25.000 €	31.250 €	28.846 €
Power consumption per ton	0.40 kWh/t	0.95 kWh/t	1.00 kWh/t	0.40 kWh/t
Total annual energy costs	36.000 €	85.500 €	90.000 €	36.000 €
Total annual Tie-Up costs	3.740.530 €	3.989.899 €	4.987.374 €	4.603.730 €
Total annual operating costs	3.799.968 €	4.100.399 €	5.108.624 €	4.668.576 €
Unloading costs per ton	**4.22 €/t**	**4.56 €/t**	**5.68 €/t**	**5.19 €/t**

Energy savings in the industry are available up to 30% today

- **Efficient devices and efficient installation**
  → Saving potential: 10% to 15%

- **Optimized usage of installation and devices**
  → Saving potential: 5% to 15%

- **Controlling, monitoring and audit**
  → Saving potential: 2% to 8%

Let's do it!

Save the world and make money!

Thank you for your attention!