



Yellow is the new green

Jungheinrich Environmental Report

 **JUNGHEINRICH**



Ladies and Gentlemen,

The demand for highly efficient technologies, sustainable designs and for greater use of regenerative and climate neutral energy sources predates current concerns about climate change. The pioneering sector of intralogistics is set to play a key role as global trade increases.

Jungheinrich is an international company that works hard to achieve economic success for its customers and itself whilst protecting the environment. The company was quick to embrace energy efficiency and environmental protection. The environment is now central to a corporate philosophy shared by all our manufacturing and service sectors. Environmental impact is an integral part of the design and development of a stacker so we plan subsequent recycling of individual vehicle parts at the design stage. Manufacturing and service meet environmental standards that go beyond statutory provisions. We use raw materials and energy frugally and recover all recyclable material for further use.

We are constantly on the lookout for potential improvements and have managed to reduce output of emissions in several manufacturing units and bring down vehicle fuel consumption. Jungheinrich is really playing its part in environmental protection.

We are of course aware that there is still a lot to do and it therefore goes without saying that we do not just maintain our already high environmental standards across the group but constantly seek to improve them.

Yours,

H. G. Frey

Hans-Georg Frey
Chairman of the Board of Management

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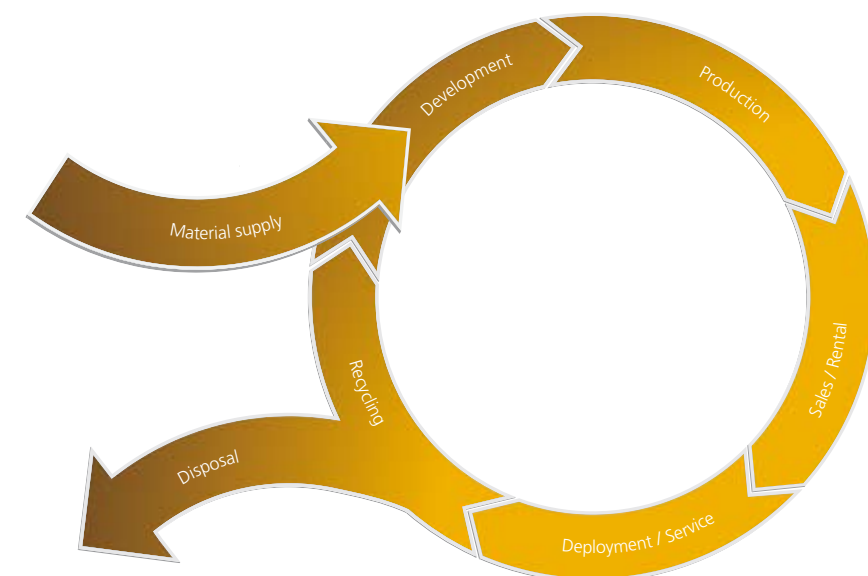
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Vehicle life cycle

The Jungheinrich concept covers a vehicle's full life cycle. This includes recycling alongside development, production, deployment and service. In this way we protect the environment and conserve its natural resources.



Thinking and acting environmentally

Environmental protection is part of our corporate philosophy.

Jungheinrich promises to use natural resources sustainably, to promote environmental issues and to act responsibly for the coming generations. Our environmental guidelines will drive this strategy across all business sectors.



Environmental guidelines

1. Responsibility

Jungheinrich is mindful of its corporate environmental responsibility in all areas of its business activity. This includes providing regular information and in-service training to our employees and encouraging them to think environmentally within their area of responsibility.

2. Facing the future

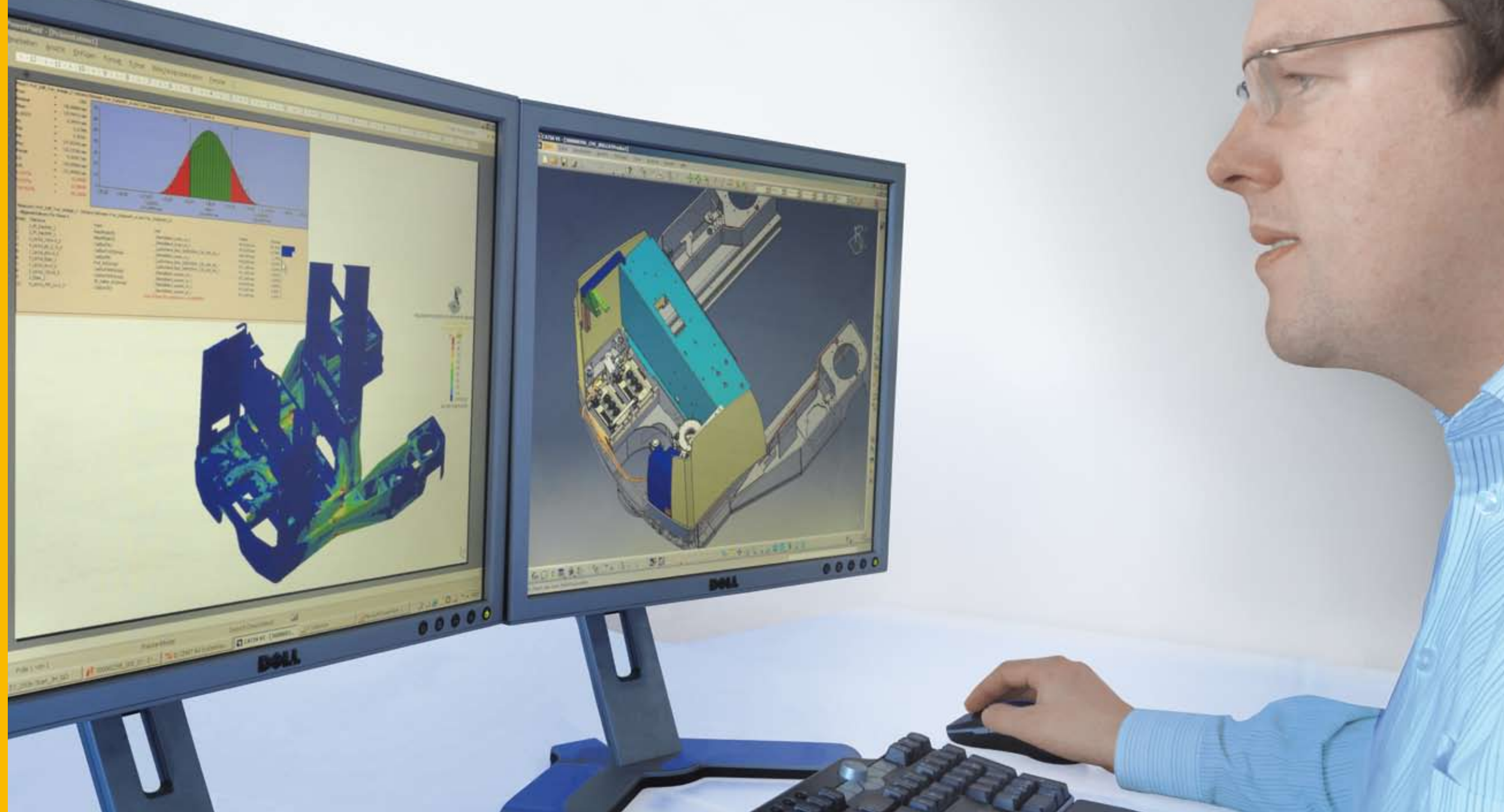
Jungheinrich applies tomorrow's environmental standards by working tirelessly to reduce the environmental footprint of our products, processes and services. We already offer products that go beyond statutory requirements for environmental impact, safety and quality. We design our products so we can use economic and environmental resources sustainably in manufacturing, operation and de-commissioning.

3. Transparency and dialogue

Jungheinrich works transparently and will continue to do so in the future. We are keen to involve all our business partners in ongoing dialogue about enhanced environmental protection. We openly exchange ideas with appropriate organizations, support the media and work with national and local authorities, associations and institutions.

4. Monitoring and evaluation

Jungheinrich keeps the implementation of its environmental policy under constant review, subjecting it to both environmental and economic assessment. In this way we identify and eliminate shortcomings. We use the knowledge gained to achieve optimum results with the latest technology.



Objective

From basic design to the materials used: boosting efficiency, conserving resources, cutting emissions and reducing the stress on people are all part of green thinking.

Sustainable development

Environmental thinking from the word go

Jungheinrich is among the leaders in research and development of new technology in the fork lift sector. For example Jungheinrich was an early adopter of low energy and low maintenance 3-phase AC technology and a pioneer in safety and ergonomics. We harness our experience and innovative drive to improve existing and develop new

processes and products. Establishing the energy saving potential and testing environmental impact are an integral part of the development process.

Special corporate guidelines stipulate not only the detection and evaluation of adverse environmental impact in manufacturing but also measures to re-

duce them. We devote particular attention to potential problems when storing and using hazardous substances, to types and volumes of waste, energy consumption and the use of natural resources. We also focus on reducing water consumption and noise and on cleaning waste water and extracted air. What is more our engineers are work-

ing hard to ensure our vehicles can be dismantled and recycled. Jungheinrich is already using mainly materials with a high recycling rate. Parts are tagged for ease of separation that simplifies subsequent retrieval of recyclable and hazardous material.

We assess our suppliers' environmental management

We also demand stringent environmental impact and recycling standards from our suppliers. We carry out audits to ensure that suppliers manage their resources in a manner appropriate to their location.



Greening the production process

Power consumption down 34 per cent

Thinking and acting environmentally is an integral part of our corporate philosophy. Special corporate guidelines specify environmentally sound use of energy and resources whilst clearly defined energy management ensures the reduction of energy consumption, assesses categories of environmental impact and derives sustainable measures from them. Our environmental standards for manufacturing are far more stringent than the already strict

legal provisions. We are thrifty in our use of raw materials and energy; recyclables are fed back into the production process. This has helped us achieve a considerable cut in energy consumption at our production facilities in Norderstedt and Lüneburg (both near Hamburg) and Moosburg (near Munich). We have reduced heating consumption by 24 per cent, electricity by as much as 34 per cent since 2000.

Small effort, big reward

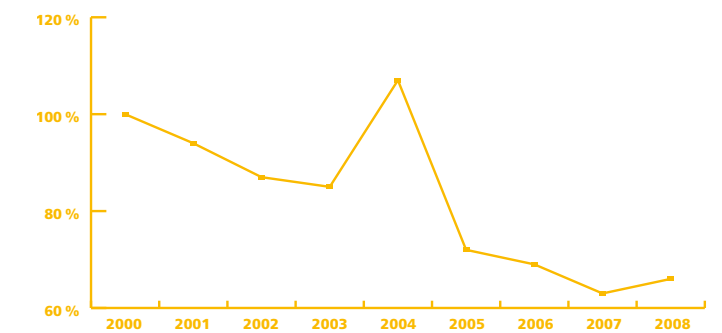
Thermal insulation and a new ventilation system with energy recovery have been used, for example, to reduce consumption of heating gas at the Norderstedt plant. A new groundwater cooling system in two halls at the Moosburg plant keeps the ambient temperature constantly cool in summer. What is more the new compressor room on the site is equipped in such a way that any heat produced

is fed directly back into the heating system. Careful use of energy by our employees boosts our energy efficiency as does the change to low energy bulbs in the hall lighting systems in our manufacturing plants. In the cylinder plant in Norderstedt about 7,000 litres of coolant were used every year to machine the hydraulic cylinders; it was subsequently disposed of as hazardous waste. We have retooled the machines to work with minimal

lubrication and they are now producing hardly any hazardous waste. By changing to water-based paints in the vehicle paint shop in Moosburg we have reduced the amount of solvent required. The commissioning of the new powder shop has further reduced the use of solvents.

Jungheinrich signs up to the maxim that prevention and recycling are better than disposal. We therefore

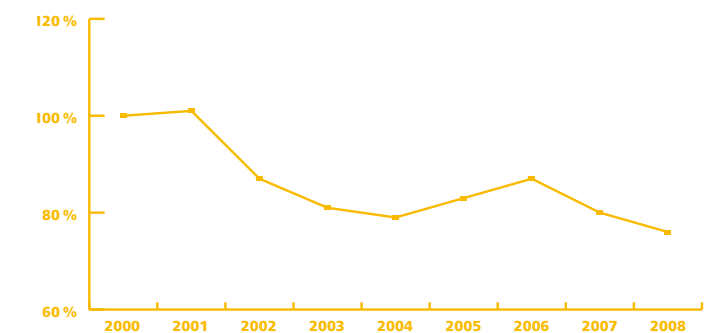
demand that our suppliers, like our own manufacturing operations, avoid waste and achieve a high rate of recycling in the materials used. We therefore tag all parts and use biodegradable synthetic ester hydraulic oil. Moreover we have moved to a system of re-usable containers for our spare parts.



Electricity consumption per manufactured vehicle*

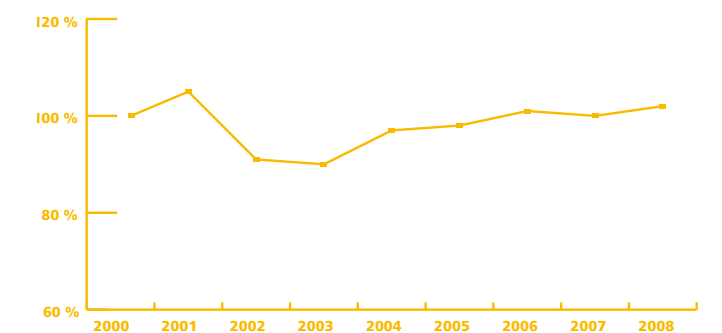
Since 2000 we have managed to reduce electricity consumption in manufacturing by 34 per cent. The short-lived bump in 2004 was due to an increase in production at the Moosburg plant.

(* compared with overall electricity consumption in all plants taken together)



Consumption of thermal energy per cubic metre of interior space

The switch to new heating systems in manufacturing facilities has reduced the relative consumption of thermal energy by 24 per cent since 2000.



Water consumption in our plants

Water consumption has been basically steady despite a marked increase in production.

Solutions for energy and efficiency

Recent generation 3-phase AC technology

Possible energy savings

- 3-phase AC technology
- Engine design
- Control technology
- Software
- Energy recovery

Green products use less material and fewer resources, consume less energy when operating and produce lower emissions. As early as the development phase we identify and use energy-saving potential. Our research engineers are working hard to improve existing drive systems and to develop new ones.

Jungheinrich decided over ten years ago to adopt low energy 3-phase AC technology; we improved it technically and have since constantly set the standard.



Jungheinrich now produces the electric motors, controls and software in-house. This guarantees optimum coordination and communication between components. Any improvements therefore benefit the whole system. Today we are one of the leading global suppliers of green 3-phase AC technology. Fork lift trucks with 3-phase AC technology are quick and robust and nearly match the performance of trucks with internal combustion engines. What is more they produce no emissions when operating, use less energy and offer energy reclamation thanks to regenerative braking and load lowering. This extends operating times and reduces energy costs. Jungheinrich fork lift trucks with 3-phase AC drive have enclosed motors. This allows their flexible use internally or externally.

Diesel and LPG drive. Improved performance lower consumption

Jungheinrich fork lift trucks that use combustion engines are high-performance and very efficient because they can be used around the clock. Diesel fork lifts can be refuelled in a matter of minutes and it takes only a moment to change the gas cylinder in LPG trucks.

The use of modern LPG and diesel technology boosts the efficiency of these vehicles and sharply reduces emissions. The key to top performance and maximum energy efficiency is the system control that uses software developed by Jungheinrich in-house. We also use hydrostatic drive technology. Hydrostatic direct drive has few moving parts and therefore runs smoothly at all rotation speeds.

The vehicle achieves full functionality yet remains easy to service and low maintenance. By using modern engines from long production runs in the car industry, Jungheinrich is aiming to achieve good performance and low environmental impact in vehicles driven by internal combustion. Both the diesel (DFG) and the LPG (TFG) models are very quiet, have low fuel consumption and extremely low emissions.



The current state of the art

Electronic control systems make modern engines what they are. The performance and environmental advantages are:

- Optimally enhanced performance with consistently low fuel consumption.
- Low exhaust emissions that are well below the maximums stipulated in the EU-Exhaust Directive.
- Low noise at all rotation speeds and less maintenance thanks to direct drive without wearing parts such as clutches, differentials and gears.



Innovative battery management.

For electrically powered pallet trucks, stackers and pickers Jungheinrich has the right battery and corresponding charger. It does not matter if the batteries are wet or maintenance free, whether the plant is working a one, two or three shift system, if the power supply is 3-phase or single phase, or whether the loads are low or high or if there is back-up charging, Jungheinrich offers

a carefully matched system of innovative chargers tailored to the specific needs of every battery design and every type of vehicle. As one of the leading manufacturers of chargers Jungheinrich attaches great importance to energy efficiency. Modern chargers are so efficient that they can save up to 30 per cent compared to the energy used in traditional battery charging systems.



Long-lived and environmentally friendly

Strict quality standards for battery design give them a long life span as they can be cycled many times without degeneration. All Jungheinrich batteries can be re-cycled. We offer environmentally sound disposal of returned batteries through our comprehensive service network.

Further information available at:
www.jungheinrich.com/battery



Warehouse navigation

Using warehouse navigation the picker approaches the pallet location provided by the warehouse management system via the shortest route. The sequence of the loading stations is established so that vehicles drive the most direct route to complete the whole picking order.

Use of RFID

Using automatic pallet identification via RFID (Radio Frequency Identification) considerably reduces the time required to pick up pallets.

Further information available at:
www.jungheinrich.com/logistic-systems

Logistics systems. Efficient production and stock control

Reducing fleet energy consumption

Boosting energy efficiency and the allied reduction in energy consumption are central when planning new storage systems or improving existing systems. For example by optimizing material flow we achieve better utilization of vehicle capacity. Optimum deployment in terms of route and drive time reduces operating periods and therefore reduces the fleet's overall energy consumption. By applying

material flow analysis and capacity calculations for all vehicles we can improve the configuration of the storage areas, the routing and the number of fork lift trucks. Avoidance of unnecessary trips automatically reduces energy consumption.

By factoring energy consumption into our planning we use modern technology for stacker and material flow control to

achieve further energy savings in warehousing operations. Using a data transmission system the "Jungheinrich Warehouse Management System" always knows where each pallet is. This reduces search routines and empty runs. All stackers concentrate on their "core business" and operate optimally. The Jungheinrich stacker control system issues targeted transport orders to the stacker that is

closest. This avoids unnecessary empty runs. The sequence of the orders can be arranged so that every stacker travels the least distance. Strategies to optimize routing can be established and applied consistently.

Thanks to technologies such as RFID (Radio Frequency Identification) and warehouse navigation "non-core" activities of stack-

er operators (scanning, searching etc.) are avoided or automatically carried out by the fork lift truck or the systems. The time that such tasks would have required can be devoted to the core tasks (identification, transport, picking). The efficiency of the whole warehouse vehicle fleet is improved, fewer stackers are required and fleet consumption goes down.



Pedestrian pallet truck ERE 225

Electric high level combination picker/stacker

The high rack stackers EKX 513/515 provide top performance in the high end range for the narrow aisle warehouse. Judicious combination of 80 volt 3-phase AC technology and control systems facilitates good turnaround and dynamic vehicle movement with greatly improved energy use. Generative braking and load lowering provides dual energy reclamation during operation which in turn means longer operating periods with a single battery charge. Under normal operating conditions the Jungheinrich Kombi-stacker can operate for up to two shifts. In addition it has an active energy and battery management system that uses predictive technology to optimize energy flows for each deployment. Further efficiency gains come from the RFID warehouse navigation system that uses vehicle location recognition. The warehouse

management system transmits picking orders to the appropriate vehicle. After clearance from the driver the required shelf location is approached via the shortest route at optimum speed and lowest energy consumption.

Further information available at:
www.jungheinrich.com/eks

Energy economy

Dual energy reclamation from regenerative braking and load lowering. This provides for longer operating periods with just one battery charge (up to two shifts).

Energy management for the entire fleet

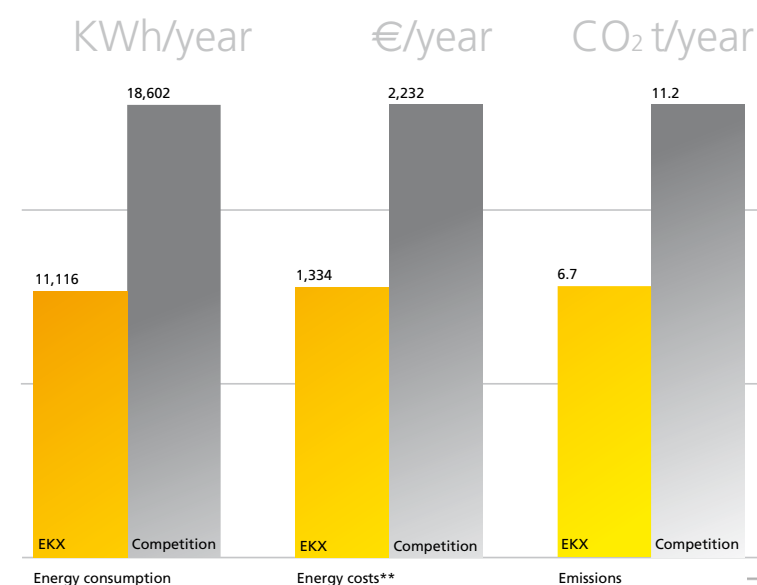
Cost effective loading and unloading

Jungheinrich's electric pedestrian pallet truck ERE 225 with a fixed ergonomic platform provides a high-performance energy-efficient solution for fast and efficient loading and unloading of trucks and for transporting large loads over long distances. The vehicle comes with Jungheinrich 3-phase AC technology as standard and in addition the control electronics SpeedControl produce safe and above all energy-saving driving

behaviour. The required speed is maintained in all driving conditions, including gradients and slopes. When reducing speed the brakes generate power that is fed back into the battery. High battery capacity up to 465 Ah and good energy efficiency also mean long operating times for the ERE 225.

Further information available at:
www.jungheinrich.com/ere

Operating cycle*. 1,000 operating hours/year



* Pallet collection from/return to transfer point 1.5t; max. 56m distance travelled; max. 9m hoisting of pallet and return journey.

** Based on average industry electricity price of € 0.12/KWh



High-rack stacker EKX 513/515



Counterbalanced trucks EFG 213 / DFG 425s

Diesel and LPG fork lift truck with hydrostatic drive

The new Jungheinrich DFG/TFG 425s-435s diesel and LPG trucks with hydrostatic drive provide the best turnaround with lowest consumption compared with the competition; they are environmentally sound because of their low emissions. Modern TDI engines with Volkswagen's fully electronic engine management and a software system developed by Jungheinrich ensure top performance

thanks to maximum energy efficiency and least possible exhaust emissions. The hi-tech trucks combine all the advantages of the hydrostatic drive system "made in Germany". With or without a cabin the vehicles are much quieter than comparable equipment. As the drive unit is isolated from the driver's position on the frame, the operator's exposure to vibration is reduced to a minimum.

Calculation of CO₂-emissions based on fuel consumption

Model*	Consumption in litres according to VDI 60	CO ₂ -emission in grams per cycle
425s	3.2	141.3
430s	3.5	154.6
435s	3.7	163.4

* load: 2,500, 3,000, 3,500 kg

Pure energy – the new electric counterbalanced trucks

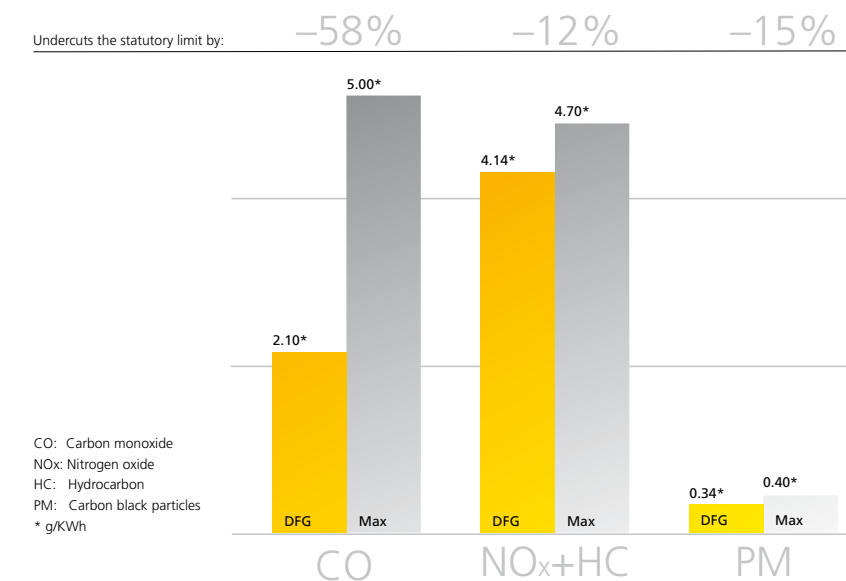
Jungheinrich is setting new standards for energy efficiency with its new electric counterbalanced trucks EFG 213-220 and 316-320. As they use environmentally friendly 3-phase AC technology these electric trucks are efficient and consume little energy. Energy consumption is further reduced by energy reclamation from braking, electric steering, dry brakes and short supply lines for power and oil, so that for most applications the

batteries do not need to be charged for two shifts. Flexible on-the-move charging anywhere and low-impact charging can be achieved with the optional integrated charger with battery controller known as the "On board charger". This increases battery life and efficient charging saves energy.

Further information available at: www.jungheinrich.com/efg

Low emissions

Emission 97/68 EG level 3 a (only DFG diesel engine)



Intelligent engine control
With simultaneous engine and hydrostatic control the engine always operates at its optimum RPM. This reduces noise, emissions and wear and tear.

Further information available at: www.jungheinrich.com/hydrostat



Drive systems of the future

Lithium-ion battery

Jungheinrich's "Concept 08" vehicle is the fruit of many years of experience in drive technologies. It comes with ground breaking battery and drive design. Lithium-ion batteries plus direct drive could bring further energy savings in future over and above those currently achieved by Jungheinrich's standard 3-phase AC technology.

The lithium-ion battery has twice the life and can store three times the energy of a lead-acid battery. Use of this technology ensures that in future far less energy will be needed – from storage to use – which is a major contribution to climate protection. This clearly thriftier use of energy is made possible by a new approach to its storage. Lithium-ion batteries are far more efficient when charging and releasing power com-

pared to traditional lead-acid batteries; they last twice as long and are maintenance free. Special battery management guarantees constant monitoring of the cells. Mobile phones and laptops as well as advanced testing in the automotive industry confirm that lithium-ion technology will become widespread.

"Concept 08" that Jungheinrich launched at "CeMAT 2008", the leading exhibition for internal logistics, combines this technology with direct drive. Direct drives are gearless electric motors that are integrated into the wheels and which operate at a high level of efficiency. The efficient direct drive is a further development of the existing and efficient 3-phase AC technology that is currently used in nearly all Jungheinrich

electric trucks. When used in conjunction with lithium-ion batteries direct drive means greater drive distances and shorter charging times than in the past. This system saves about 15 per cent energy compared with traditional electric vehicles. This puts it among the most efficient drive systems of the near future. The new battery technology gives a more compact vehicle layout with improved ergonomics.



Fuel cell

In addition to its own R&D Jungheinrich also works with several universities and research institutes. For example intensive research is underway with the Jülich research centre into new energy design using the direct-methanol fuel cell. Unlike the hydrogen fuel cell that is currently being researched in the automotive industry, the direct-methanol fuel cell can be used to produce low-level power. This fuel cell technology could be used in electric pallet trucks and electric pedestrian controlled trucks. Hydrogen

must be stored, transported and supplied to the vehicle at high pressure and this is currently expensive. Methanol as an alternative source of power for fuel cells can be handled as easily as petrol or diesel. With a direct-methanol fuel cell the driver needs only a few minutes to refuel his vehicle and what is more a full tank lasts twice as long as the capacity of a traditional battery. The facilities for refuelling with methanol can be installed quickly and cheaply compared with hydrogen supply.

Trend-setting technology
 The direct-methanol fuel cell combines the advantages of electric drive with longer range and rapid refuelling.

Comparing drive technologies

		Energy costs	Overall costs	Range/performance	Quick refuelling	Emission free	CO ₂ footprint
Diesel / LPG trucks	Diesel	●	●	●	●	●	●
	Hybrid	●	●	●	●	●	●
	Lead-acid battery	●	●	●	●	●	●
Electric fork lift trucks	Fuel cell	●	●	●	●	●	●
	Lithium-ion battery	●	●	●	●	●	●

● High / Bad ● Medium ● Low / Good

Hybrid drive

Hybrid drive is a combination of combustion engine and electric drive. The advantages over a purely combustion system are: braking energy can be reclaimed, stored in an additional battery and retrieved on demand. Thanks to the battery the vehicle can drive for limited periods without producing any

emissions, for example in an enclosed building. Not only does this reduce fuel consumption, but the vehicle may be used more effectively indoors and outdoors. Jungheinrich is conducting research into hybrid drives. Patents have already been granted for Jungheinrich's key research findings.



Environmental service

- Disposal: used components fed into a controlled disposal system
- Oil: expert oil change and customized recycling
- Battery service: expert and environmentally sound testing and maintenance of batteries

Customer service

Stacker services

Jungheinrich offers a pan-European service network of more than 800 sales consultants and around 3,500 mobile service engineers who provide comprehensive, competent advice and full service. Jungheinrich faces the challenge of efficient manpower planning for both planned maintenance and un-

planned repairs. Intelligent software is used to control service availability and plan engineers' visits. By prioritizing and bundling appointments and careful route optimization the driving times and distances to clients have been reduced thus reducing the energy consumption of our service engineers.

Environmental service: ring in the old

The legal provisions for disposal of old components are becoming stricter and broader. The Jungheinrich environmental service is willing to take on this task and disposes on demand of all old components in compliance with current law.

Regular exhaust tests on combustion trucks are vital to protect our employees and the environment. For example

LPG professional associations stipulate a test every six months. We oversee the timetable and expertly carry out the statutory measurements.

Hydraulic oils in particular are subject to extremely high forces so regular and expert hydraulic oil change is one of the most important maintenance tasks on a fork lift truck. This is the only way to guarantee peak perform-

ance and longevity. The Jungheinrich oil service ensures the oil is changed at the right time and the used oil is disposed of environmentally. Our oil experts use specialized oil service vehicles to meet all environmental laws.

As part of the Jungheinrich battery services the truck's "heart" is expertly tested and maintained.



Expert and environmental component reclamation.

As early as the design stage we plan for later recycling of a vehicle's components and parts: after careful examination and grading the parts are either reconditioned and reused or expertly recycled.

Professional reconditioning

Reconditioning is carried out according to Jungheinrich's own quality standards and in compliance with the law; we look at the optics, technology, safety and overall state of repair of used vehicles.

Further information available at:
www.jungheinrich.com/used

Used trucks

Intelligent recycling of vehicles

Jungheinrich carefully plans further use of vehicles. Since 2006 we have run a central processing plant in Klipphausen (near Dresden) where Jungheinrich's used fork lift trucks are reconditioned for the European market.

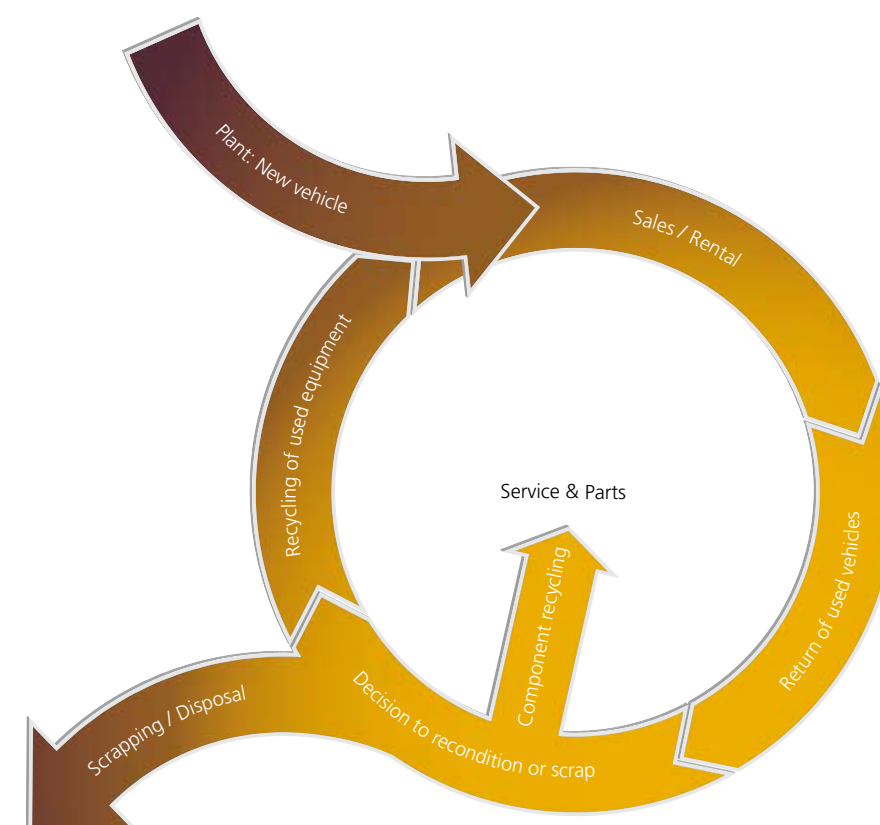
We have stated our willingness to take back all our vehicles and test them for continued use. The decision

about whether a vehicle may "live on" is based on environmental and economic factors. We have set ourselves the standard that only vehicles with high energy efficiency that can be refurbished without expending too many resources may be reconditioned. Vehicles whose state of repair would use up too many resources or whose future use would consume too

much energy by modern standards are scrapped expertly and environmentally by specialized groups. Raw materials and equipment such as hydraulic oils are reconditioned and returned to the production process and recycled by certified experts. The production in Klipphausen uses industrial reconditioning methods via efficient and flexible line production.

Prospects for a second life

The concept: new fork lift trucks are sold or rented. After their "first life" many vehicles are returned to Jungheinrich which is when the decision on a "second life" is taken. If the decision goes its way the vehicle will be industrially reconditioned and sold.



Highlights



Acting sustainably

- Investment in the latest technology
- Recycling materials
- Certified environmental management system
- Improving environmental awareness of our employees

Environmentally friendly investments

It makes economic and environmental sense to use state-of-the-art machines. We have applied this lesson for example at our manufacturing facility in Moosburg. Two new paint shops have brought a big drop in emissions and lower heating bills. In the powder paint shop frames are coated semi-automatically and this means we completely avoid the environmental impact of solvents. An additional heat recovery system uses the energy that remains after curing the powder to heat the whole

hall. If the energy required for powder coating components is economically and environmentally unfavourable, wet paints are used. By converting to water-based paint we have reduced emission of contaminants by 87 per cent.

Sustainable design

Our overall concept for sustainable environmental protection takes account of a vehicle's complete life cycle. Clearly this includes the recycling of used vehicles. Since 2006 Jungheinrich has run a central reconditioning plant in Klipphausen near Dresden where used Jungheinrich fork lift trucks are reconditioned for the European market. We declare our basic willingness to take back all of our own vehicles and test them for further use.

Environmental audit Motivation brings success

In 2008 a further external environmental audit was carried out. The report produced by accredited and independent inspectors certified that Jungheinrich's environmental management system in plants such as Norderstedt, Lüneburg and Moosburg and at many Jungheinrich sales centres had been introduced and continuously maintained in compliance with ISO 14001: 2004. This backs our claim to professionalism and competence in environmental issues.

When pursuing our environmental policy it is important that every employee feels responsible for the environmental impact of his work. Fundamental to this is training used to deepen, broaden and renew knowledge and environmental awareness. Individual motivation is the key to success.

We also apply this commitment to our customers and suppliers so we can win their enthusiastic support for environmental protection. Thus our actions stem not only from our own ideas but are our response to society's desire to safeguard our environment for future generations.



Jungheinrich
Plants, Sales and
Services Europe
ISO 9001/ ISO 14001



Jungheinrich trucks
conform to the European
Safety Requirements.

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