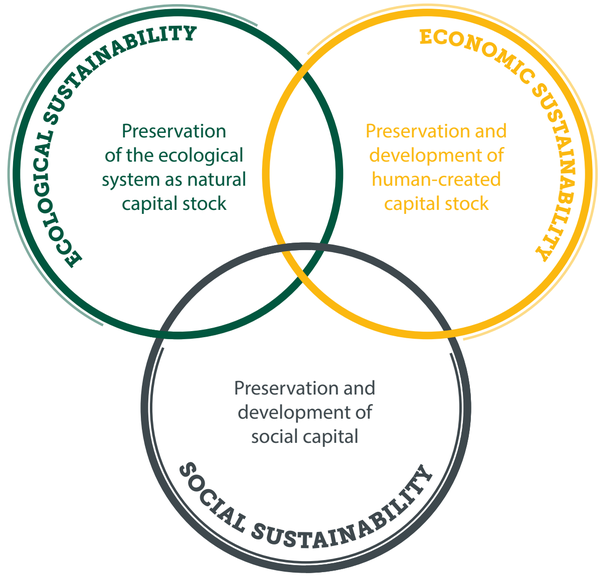
SUSTAINABLE INTRALOGISTICS WILL SHAPE THE FUTURE.

Material flow consulting for sustainability in the warehouse offers competitive advantages in terms of economic, environmental and social development.

JUNGHEINRICH

00 Contents.

01 Introduction: Sustainability as a key factor for the future.



This is one of the major issues of our time. And one that is of crucial importance for the future of companies: sustainability. According to a study conducted in 2022, 89 per cent of managers who were surveyed stated that sustainability and corporate success are closely linked[1]. This statement is also true for intralogistics. In our white paper, we describe the existing challenges and, more importantly, reveal the opportunities to create a more sustainable material flow in the warehouse.

But what exactly is meant by the term "sustainability"? A well-known definition from the Brundtland Report of 1987 summarises sustainability as follows:

"Sustainable development is development that meets the needs of the present without risking that future generations will not be able to meet their own needs".[2]

Currently, sustainability is evaluated using the three pillars of sustainable development or the triple bottom line approach. In these cases, sustainability is broken down into an ecological, an economic and a social dimension.

For intralogistics, this means that only those who focus on economic, ecological and social sustainability during planning and implementation can achieve true sustainably and a greener material flow. The important thing to remember is that ecological and social sustainability should not conflict with economic sustainability, but should go hand-in-hand with it.

In our white paper, we explain why it is essential for intralogistics companies to focus intensively on sustainability (Chapter 2). This is due in particular to social responsibility, the expectations of customers or business partners, ESG criteria and legal requirements.

Key information can be found in chapters 3 and 4 of the white paper. Here, we present solutions for a sustainable material flow in the warehouse, discuss how you can benefit from the services offered by our material flow consultancy, as well as providing an overview of our portfolio.

[1] No Planet B: How can Businesses and Technology Help Save the World? Oracle und Savanta, 2022: https://www.oracle.com/a/ocom/docs/applications/esg-study-no-planet-b-report.pdf, p. 9.
[2] Our Common Future (Brundtland Report). United Nations, 1987.

02 Existing challenges and the growing importance of sustainability.

2.1 Social responsibility and competitiveness.

The finite nature of resources and the effects of climate change are well documented and have led to a growing awareness of sustainability in companies. More and more companies are therefore introducing individual sustainability programmes and strategies, on their own initiative and out of a sense of social responsibility. However, legislators have also recognised the need for action and are increasingly issuing regulations to increase sustainability in the economy.

These changes can only be beneficial for companies. After all, greater sustainability is synonymous with economic success. On average, the EBIT margin of sustainable companies is six per cent higher than that of less sustainable competitors.[3] Companies are therefore more successful when economic, ecological and social sustainability are given equal consideration.

As a rule, sustainable companies are more successful: A meta-study by Oxford University[4] showed that companies that adhere closely to ESG (environmental, social and governance) criteria[5] have a competitive advantage. Of the sources analysed, 88 per cent came to the conclusion that these companies improved their operating performance.

"On average, the EBIT margin of sustainable companies is

6%

higher than those of less sustainable competitors.

2.2 Expectations of consumers and business partners.

It is not only social responsibility that makes companies act more sustainably. Customers, business partners and investors, who are attaching ever greater importance to sustainability, also have a major influence. This was one of the findings of the "No Planet B" study by Oracle and the Canadian management consultancy Savanta, which surveyed around 11,000 consumers and managers from 15 countries in 2022. 78 per cent[6] of respondents were frustrated by companies' lack of progress and 70 per cent said they would be willing to terminate their relationship with a brand that puts little emphasis on sustainability.[7]

If companies do not fulfil expectations in terms of sustainability, customers may turn their backs on them, or they may miss out on investment opportunities, as 75 per cent of institutional investors worldwide have now integrated ESG criteria into their investment process. In contrast, companies that organise their intralogistics sustainably can build long-term customer relationships and partnerships, creating a clear competitive advantage.

INSTITUTIONS

of institutional investors worldwide have integrated ESG into their investment process. (Source: Schroder Investment Management 2022)

[3] Note: Exemplary for the food and beverage industry in: Focus. Sustainability pays off – Society and companies in transition. LBBW, Strategy Research, 2018, p. 2.
[4] From the stockholder to the stakeholder: How sustainability can drive financial outperformance. University of Oxford/Arabesque Partners, Social Science Research Network, 2015.
[5] More on ESG criteria in chapter 2.4.
[6] No Planet B: How can businesses and technology help save the world? Oracle and Savanta, 2022: https://www.oracle.com/a/ocom/docs/applications/esg-study-no-planet-b-report.pdf, p. 7.
[7] Ibid., p. 15..

02 Existing challenges and the growing importance of sustainability.

69 %

of employees state that they would even leave their current employer to work for a company that focuses more strongly on ESG criteria.

2.3 Recruiting and employee satisfaction.

Another important consideration for sustainability is the employees themselves. In times of a shortage of skilled labour and in light of demographic trends, it is extremely important to find qualified employees and retain them in the long term to ensure the success of the company.

Recruiting and retaining employees has proven to be easier for future-proof and sustainable companies. The “No Planet B” study showed that 69 per cent[8] of people would even leave their current employer to work for a company that focused more strongly on ESG criteria. A sustainable approach therefore has a positive impact on the employer brand.

Social sustainability is very important to employees. There are numerous ways to safeguard and promote the health of employees in intralogistics workplaces – from using automation and process optimisation to simplify tasks, to designing workspaces ergonomically. Satisfied and motivated employees not only stay with the company longer, they also have a positive effect on the company’s success in a number of ways, for example taking fewer sick days or delivering better results. At the same time, employee retention alleviates the shortage of skilled labour.

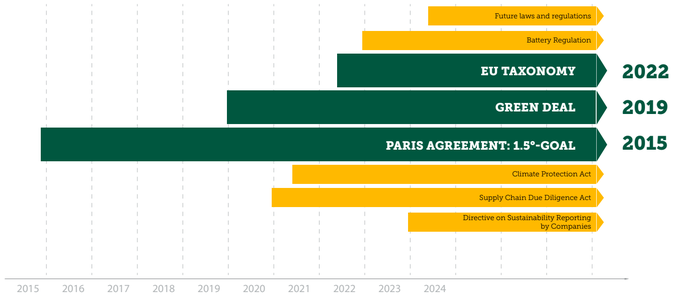
2.4 ESG criteria and legal requirements.

Governments around the world are increasingly focusing on environmental and social regulations. Companies have to take greater account of government requirements, for example in the form of statutory regulations and reporting obligations. Sustainability must therefore be firmly anchored in the corporate strategy in order to remain competitive in the future.

ESG criteria play a guiding role in international business:
ESG stands for environmental, social and governance. The ESG criteria are similar to the three-pillar model, but include more specific factors that are used to assess the sustainability performance of companies. Ultimately, companies are assessed according to environmental aspects, social responsibility and the quality of corporate governance.

In addition, companies working to improve sustainability are bound by an increasing number of specific laws and regulations, which define the framework for business activities: These include the EU Taxonomy Regulation (a system for classifying sustainable economic activities), the Battery Regulation and the Supply Chain Act, some of which are already in force or will become relevant in the near future.

The political and legal parameters are becoming more stringent.



[8] No Planet B: How can Businesses and Technology Help Save the World? Oracle und Savanta, 2022: https://www.oracle.com/a/ocom/docs/applications/esg-study-no-planet-b-report.pdf, p. 3.

02 Existing challenges and the growing importance of sustainability.

2.5 Cost pressure due to CO_2 emissions and energy consumption.

The industry is coming under increasing pressure from several sides with regard to its cost structure. Rising energy costs and the cost of reducing or offsetting carbon emissions are among the factors contributing to this. Depending on the energy source, inherent CO_2 emissions are directly linked to higher energy costs.

Four per cent of annual CO_2 emissions worldwide are produced by intralogistics.[9] For individual sectors and companies, however, the proportion of their supply chain allocated to intralogistics, and therefore the CO_2 emissions for which intralogistics is responsible, is significantly higher. As a rule, conventionally fuelled intralogistics locations can be expected to account for around 15 per cent of CO_2 emissions[10] in the respective supply chain.

With the recent steady rise in energy costs and carbon offsetting options, it is clear that companies need to take action.

Companies that operate sustainably and rely on energy-efficient solutions can save considerable costs by reducing CO_2 and energy usage and can enjoy a significant competitive advantage in the long term. It is therefore important for companies to optimise their material flow – from the buildings themselves to efficient warehouse processes.

4 %

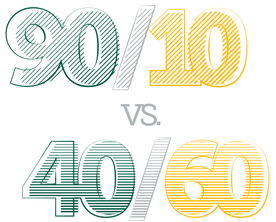
of annual CO_2 emissions worldwide are produced by intralogistics.

15 %

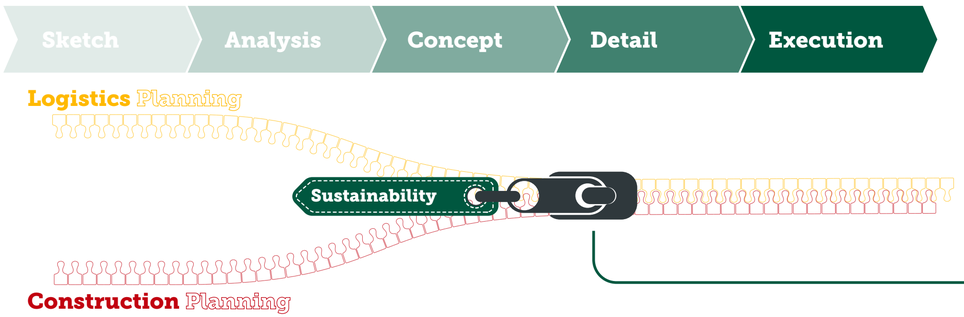
of CO_2 emissions on average are contributed by intralogistics in the supply chain.

[9] From own data and cf. Challenges to Standardizing Emissions Calculation of Logistics Hubs as Basis for Decarbonizing Transport Chains on a Global Scale. K. Dobers, V. Ehrler, I. Davydenko, D. Rüdiger, U. Clausen. Transport Research Record 2673 (9), 2015.
[10] Cf. ibid.

03 Paths to a more sustainable and future-proof material flow.



After ten years, the CO_2 emissions from the building still account for 90 %, after 30 years 40 %.



3.1 Sustainability planning using greenfield and brownfield approaches.

Companies that want to optimise the sustainability of their material flow have numerous options and must prioritise these in terms of objective. The question often arises as to whether a new building should be constructed or the existing building adapted.[11] From a sustainability perspective, the answer is clear: the longer a warehouse is used, the better the overall CO_2e measurement over its entire life cycle. A large proportion of the CO_2 emissions are generated when a warehouse is first built, and take years to diminish. Of course, a warehouse can be planned holistically when constructing a new building on a "greenfield site". However, when planning a new building and a brownfield development, which involves expanding or converting an existing warehouse, various measures can be taken to lay the foundations for the long-term operation of a sustainable warehouse and a sustainable material flow:

Warehouse layout: Considering the internal layout is essential for sustainability. The storage volume should be kept as small as possible and the warehouse should be structured in a purposeful way. Rather than one enormous hall, there needs to be a clear division into areas and personnel should only be deployed in specific areas so that heating costs or lighting, for example, can be reduced. Nevertheless, the layout must allow for extensions in the future.

Dimensioning: Ideally, capacities should be adapted to the current demand determined by analyses. This avoids overcapacity and maintains the efficiency of the machines. Instead of conveyor systems, for example, which allow rigid and fixed capacities, scalable solutions can be planned as required. One example of this would be mobile robots adapted to throughput.

Use of resources and energy sources: Newly constructed or converted warehouses can be optimised in terms of energy consumption. Proper insulation and the integration of renewable energy sources, such as solar or wind power plants, also reduce the environmental footprint.

Sound warehouse planning or the targeted development of existing locations enables long-term and sustainable operation. As the operating hours increase, the CO_2 emissions of the building account for a smaller proportion of the carbon footprint – after ten years the emissions still account for 90 per cent, after 30 years this reduces to just 40 per cent.[12] However, this also relies on optimal processes and technologies, not only during commissioning but over the entire lifespan of the location. Otherwise, it is not possible to achieve sustainable intralogistics.

A degree of flexibility is important, for example to incorporate technical trends in warehouse process organisation and technology, as well as changes in the customer's business. This skill and knowledge of the markets are the hallmarks of good logistics consulting and planning. In the case of a new building, these elements should even be planned during the construction design – the earlier in the planning process, the easier it is to align the entire warehouse building and the material flow with sustainability.

[11] According to the study "The state of European Supply Chains 2023" by JLL and Reuters Supply Chains 2023, 46 % of the surveyed supply chain managers are currently planning to renovate their facilities in favour of energy efficiency. https://www.verkehrsrundschau.de/nachrichten/transport-logistik/jll-studie-mit-nachhaltigkeit-und-technologie-zu-mehr-resilienz-3348640.

[12] Cf. Sustainable Logistics and Supply Chain Management: Principles and Practices for Sustainable Operations and Management. David B. Grant, Alexander Trautrims, Chee Yew Wong. Kogan Page, 2022.

03 Paths to a more sustainable and future-proof material flow.

3.2 Digitalisation of the material flow.

Digitalisation of the material flow is key to increasing efficiency and therefore also offers opportunities for greater sustainability. Overall, "digital solutions can help companies to operate in a more environmentally sustainable way".[13]

End-to-end digitalisation of the warehouse creates transparency in all processes. With the help of a warehouse management system (WMS), inventory, order picking processes and transport can be continuously improved and optimised in a coordinated manner according to demand. This allows the material flow to be organised as efficiently as possible.

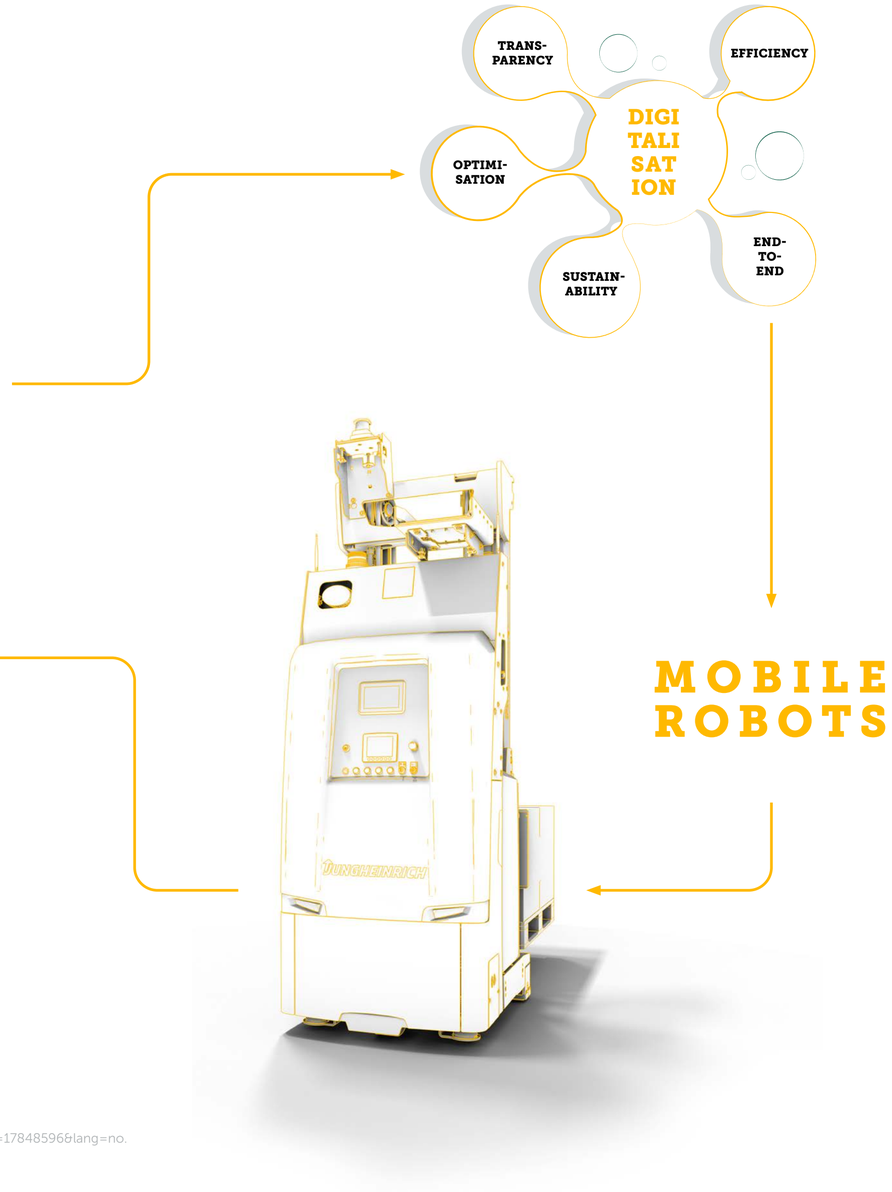
A new set of targets is applied: Efficiency is also determined by environmental sustainability. Optimum levels can be set, not only in terms of costs and economic effects, but also in terms of the ecological consequences. Individual outputs or feeds can be delayed by a few seconds or minutes in order to adjust the overall throughput and thus the energy requirement. Without digitalisation, optimisation strategies to achieve an overall optimum result would be impossible in most cases.

Warehouses are primarily digitalised to improve productivity or increase response times.[14] Digitalisation and the data-based transparency of processes also give companies a means of achieving ecological sustainability. For example, energy is saved by avoiding empty runs, congestion or detours. After all, anything that is efficient is, first and foremost, sustainable. Digitalisation makes it possible to use resources more efficiently, reduce emissions and avoid waste, e.g. by minimising errors and saving on consumables. Due to its ability to directly influence efficiency and sustainability, digitalisation is a deciding factor for the success of companies.

3.3 Automation and sustainability.

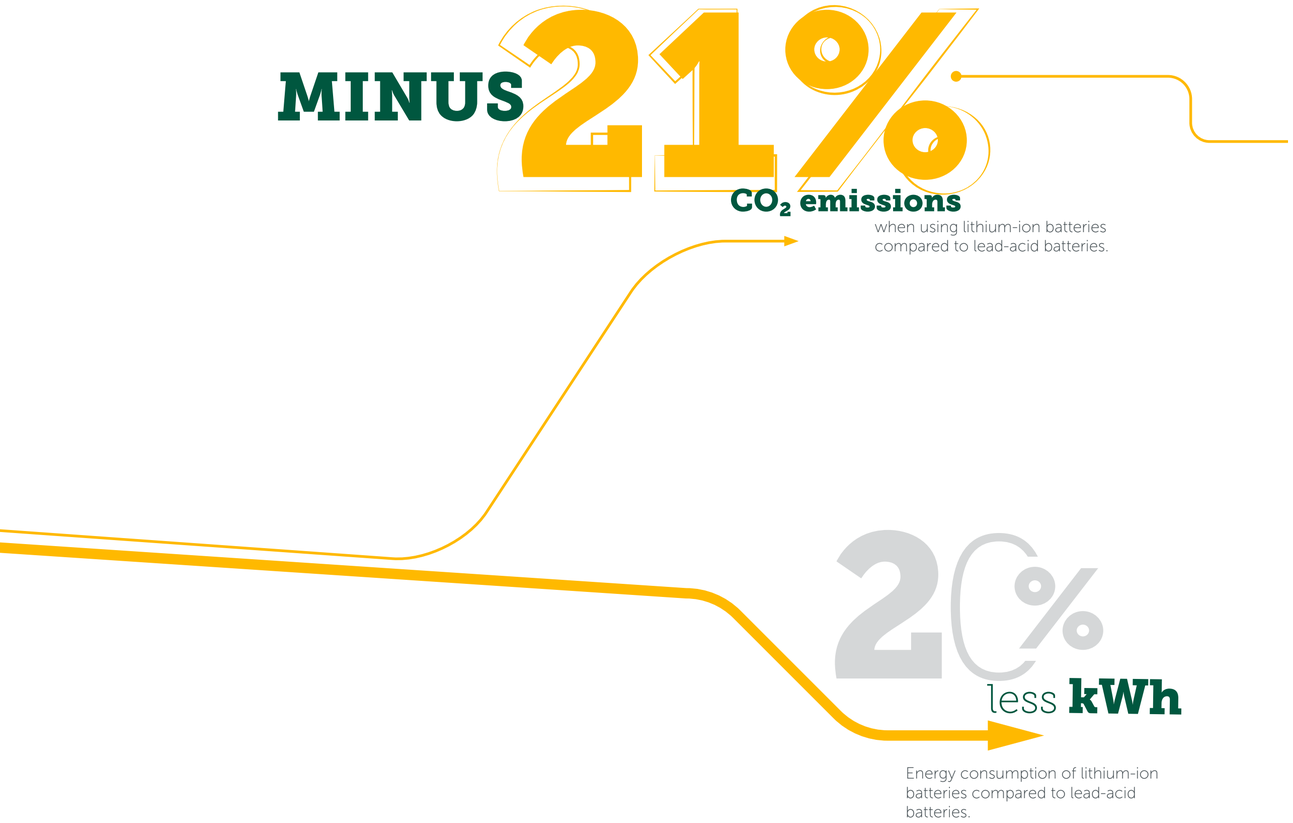
Digitalisation and automation go hand-in-hand in warehouses. Digitalisation creates the necessary transparency to make optimal automated decisions. Autonomous mobile robots, automated high-rack stackers or automated storage systems not only add dynamism and precision to the material flow, they also offer a number of advantages that can improve sustainability. Combining automation and digital processes efficiently improves workflows, energy consumption and space requirements. Greater sustainability relies on demand-driven performance and a reduced error rate achieved through automation. Less waste results in less energy usage and, therefore, lower CO_2 emissions. For example, the Norwegian company Bohus was able to reduce its energy consumption by 17 per cent by switching to automation.[15] Automated solutions can also improve ergonomics and health and safety (see 3.6) and reduce the workload of employees.

Automation in the warehouse is therefore another key component in achieving economic, ecological and social sustainability.



[13] Thinking sustainability and digitalisation together, Institute for Applied Ecology, https://www.oeko.de/en/news/latest-news/thinking-sustainability-and-digitalisation-together/.
[14] WMS Marktreport kompakt 2022. Fraunhofer-Institut für Materialfluss, S. 54.
[15] Cf. Vgl. Bohus reduserte energiforbruket gjennom automatisering, https://kommunikasjon.ntb.no/pressemelding/18022479/bohus-reduserte-energiforbruket-gjennom-automatisering?publisherId=17848596&lang=no.

03 Paths to a more sustainable and future-proof material flow.



3.4 E-mobility for increased energy efficiency in the warehouse.

Electric drives for industrial trucks have clear advantages in terms of sustainability. When we opt for an electric drive combined with the right battery and charging technology, the trucks achieve a high level of energy efficiency – particularly when the overall system comprising truck, battery and battery charger is optimally harmonised. This reduces operating costs and contributes to environmental protection.[15]

In terms of performance, electric trucks can now match conventional gas or diesel-powered combustion engines. However, when it comes to sustainability there are major differences even between battery variants: Lithium-ion batteries produce 21 per cent less CO_2 emissions than lead-acid batteries.

As with any material flow solution, in order to accurately assess the sustainability of electric trucks it is necessary to consider the entire life cycle of the batteries. From material acquisition to utilisation and recycling, all phases must be designed to conserve resources if batteries are to be considered a truly sustainable drive technology.

3.5 Energy management.

Energy management is of great importance in a sustainable material flow and is decisive in determining energy costs and energy-related CO_2 emissions. It is important to not just consider energy consumption[16] but to also manage energy production in a targeted manner. Energy production must equal the energy consumption at the respective location in terms of time and quantity and is therefore a further "flow" that must be considered in the optimal energy flow.

There are many options available: Solar energy can be generated during the day and used to charge the trucks at night. Alternatively, in-process charging strategies can be carried out using mobile robots. In this case, the energy is produced during charging which reduces the need for energy buffers or storage. In automated rack warehouses, any braking energy of the storage/retrieval units that is not used immediately can be stored in energy storage systems (SuperCaps). The energy stored in these systems can then be used to carry out the next travel command. Another option is to feed the energy generated back into the operator grid.

In order to establish a balance between energy production and consumption, an analysis of the current situation must be carried out at each location, i.e. there must be transparency regarding current consumption: what consumes energy, when and how much? These questions need to be answered before thinking about energy production or minimising consumption. Unfortunately, these are often unknown factors in today's brownfield sites. This is because there is currently little knowledge of actual consumption or load curves in individual areas of a warehouse location. Existing systems usually lack the necessary steady-state measurement technology. Providing greater transparency is often the first challenge for a professional energy consultant. By optimising process control, energy production can be managed effectively and energy peaks can be levelled out, resulting in an improvement in the overall energy balance.

[15] The potential for savings is illustrated by the fact that in a warehouse, 48 % of energy consumption is attributed to conveying, storage, and picking technology. See "Grünbuch der nachhaltigen Logistik". Gerald Gregori, Thomas Wimmer, p. 58.
[16] In addition to conveying, storage, and picking technology, a total of 40 % is attributed to heating, cooling, ventilation, and lighting, see "Grünbuch der nachhaltigen Logistik". Gerald Gregori, Thomas Wimmer, p. 58.

03 Paths to a more sustainable and future-proof material flow.

3.6 Safety as a sustainability factor.

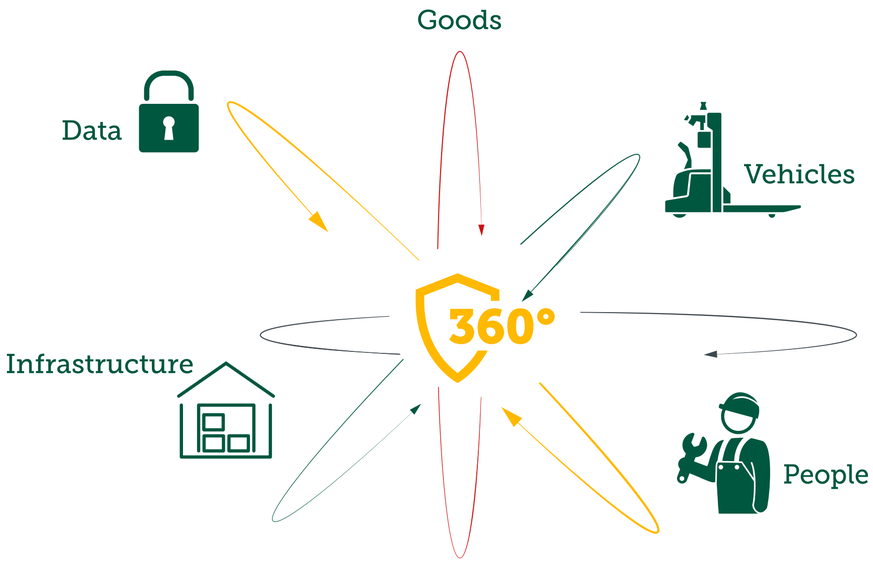
A reliable material flow has a significant impact on the sustainability of a company – economically, ecologically and socially. It is therefore crucial that the issue of safety is considered comprehensively, including the safety of employees, infrastructure, goods and data.

Protecting your own infrastructure and goods not only saves time and money, but also helps to conserve resources. Companies should therefore rely on comprehensive safety solutions to prevent accidents and damage in the warehouse.

Data security also has an impact on sustainability, particularly in economic terms. A lack of security can cost valuable resources and a great deal of money.

Employees should be the focus of a company's safety systems. A safe, ergonomic workplace is essential for the social sustainability of a company. At the same time, employee satisfaction increases the future security of the company.

In terms of sustainability, it is therefore worth investing in a holistic approach to warehouse safety, for example in robust and ergonomic industrial trucks, future-proof automation solutions, smart sensor and assistance systems, as well as IT security systems. Quality is always an important criterion for product solutions. High quality usually also means safety and sustainability. Through consistent implementation, companies can make an important contribution to achieving their own sustainability goals and to a more sustainable economy and society.



Consistently pursuing safety can increase a company's sustainability.

CONCLUSION

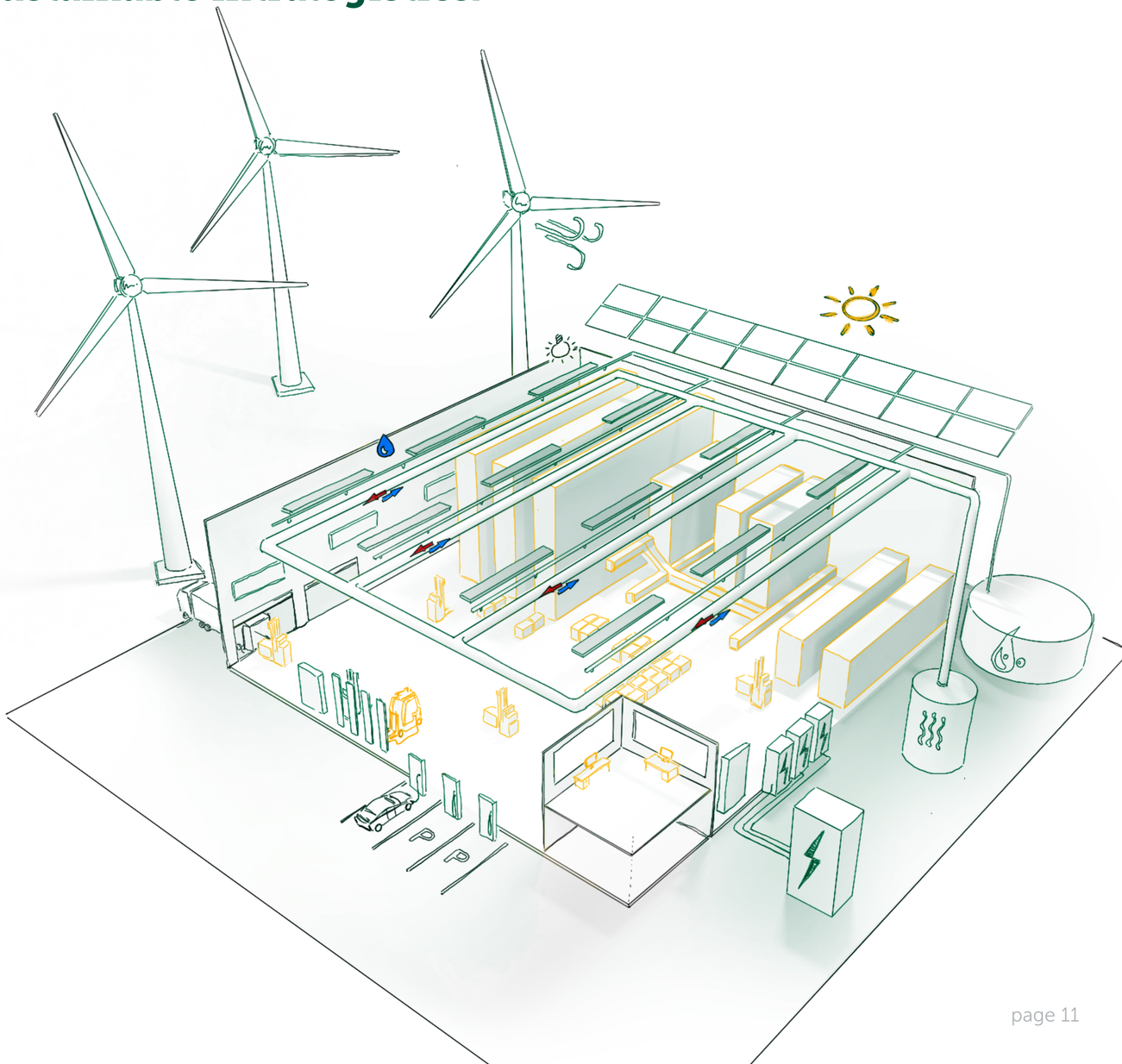
The opportunities for overcoming the current challenges and making their own material flow more sustainable in line with the triple bottom line approach can be clearly identified. In practice, however, companies often need a competent partner to identify and coordinate the most valuable measures for their individual warehouse. In the following chapter, we want to show which specific services and solutions can be used to support an intralogistics company.

04 Jungheinrich material flow consulting for more sustainable intralogistics.

Among staff at brownfield plants due for optimisation in terms of sustainability, there is often a lack of knowledge about the CO_2 emissions produced on site and their exact composition and origin. This lack of knowledge usually applies to an even greater extent to energy consumption in the individual functional areas of the plant.

The CO_2 emissions in the warehouse generally result directly from the use of energy in the form of electricity and heat, which are conventionally purchased from the network provider and are classified as Scope 2 and 1 under the Greenhouse Gas Protocol (GHG).[17] When it comes to energy, the main drivers of energy consumption are often not known. Companies normally only have information on total energy consumption and load curves for the overall location, which only represent the sum of past energy requirements.

This is where the analyses carried out by Jungheinrich material flow consultants can be key. As a partner, we support companies through every step of the process to achieve a more sustainable material flow – from the analysis to the implementation of solutions.



[17] Freight transports, especially with externally sourced transport services, are considered to be producers of Scope 3 emissions and are thus often seen as secondary from the perspective of warehouse operations, although globally of higher significance.

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4.1 Analysis process: Creation of transparency.

Jungheinrich material flow consultants create transparency in terms of energy consumption and CO_2 emissions through a comprehensive analysis. This involves a number of steps:

- First, the Jungheinrich experts carry out a preliminary analysis of the overall energy load curves, in which they form hypotheses about which factors could significantly influence energy consumption at the location. This could include, for example, technical building equipment, warehouse automation technology, industrial truck loading technology, lighting, or other aspects.
- Based on these hypotheses, the Jungheinrich specialist team determines effective measuring points at the location, e.g. switch cabinets in the sub-distributor. These measuring points are used to determine detailed energy consumption profiles over a longer period of time.
- The energy consumption measurement is correlated with process data from the WMS or EAP, e.g. the throughput rate of the respective area. Ideally, there will be a positive correlation between input (energy) and output (e.g. throughput). It is then possible to identify the areas in which energy may not be utilised to create added value and where there is a need for increased action in terms of throughput.
- Depending on requirements, process data, e.g. relating to incoming packaging material or to disposal or shipping volumes, is also analysed in order to determine a comprehensive carbon footprint that goes far beyond pure energy consumption. Based on this analysis, drivers other than energy usage can be recognised and classified.

Following the analysis, the fields of action can be identified, quantified and prioritised. Naturally, the customer is involved in this process, and not just the warehouse managers – for example, the customer's sustainability strategy managers also play a part.

Through this analysis process, Jungheinrich material flow consultancy creates transparency regarding energy use at the location.[18] This knowledge can then be used to develop and plan targeted optimisations.

[18] Furthermore, if significant additional CO_2 emissions are identified, e.g., from packaging material and waste, a CO2 balance for the site is also prepared according to the GHG standard.

04 Jungheinrich material flow consulting for more sustainable intralogistics.

4.2 Concept phase: Development of solutions.

In the next phase of our material flow consulting, be it in brownfield or greenfield projects, solutions are developed for the areas of action. These solutions are always compared with alternative options. For each solution, we analyse the technical and economic feasibility taking into account the general conditions at the location.

When aiming for sustainable optimisation, not only are economic aspects such as investments, operating costs, personnel requirements and maintenance quantified, but their ecological effects (CO_2 emissions) and social effects (e.g. ergonomics) are also identified. At the end of the process, the total cost of ownership (capex, opex) and CO_2 emissions are considered for each possible solution.

In close cooperation with the customer, a workshop is held to decide which options should be pursued in order to meet the sustainability targets. Through our extensive expertise in material flow solutions, i.e. process and technology in the warehouse, we offer guidance and transparent decision-making for the future optimisation of a location.

4.3. Solutions for enhanced sustainability.

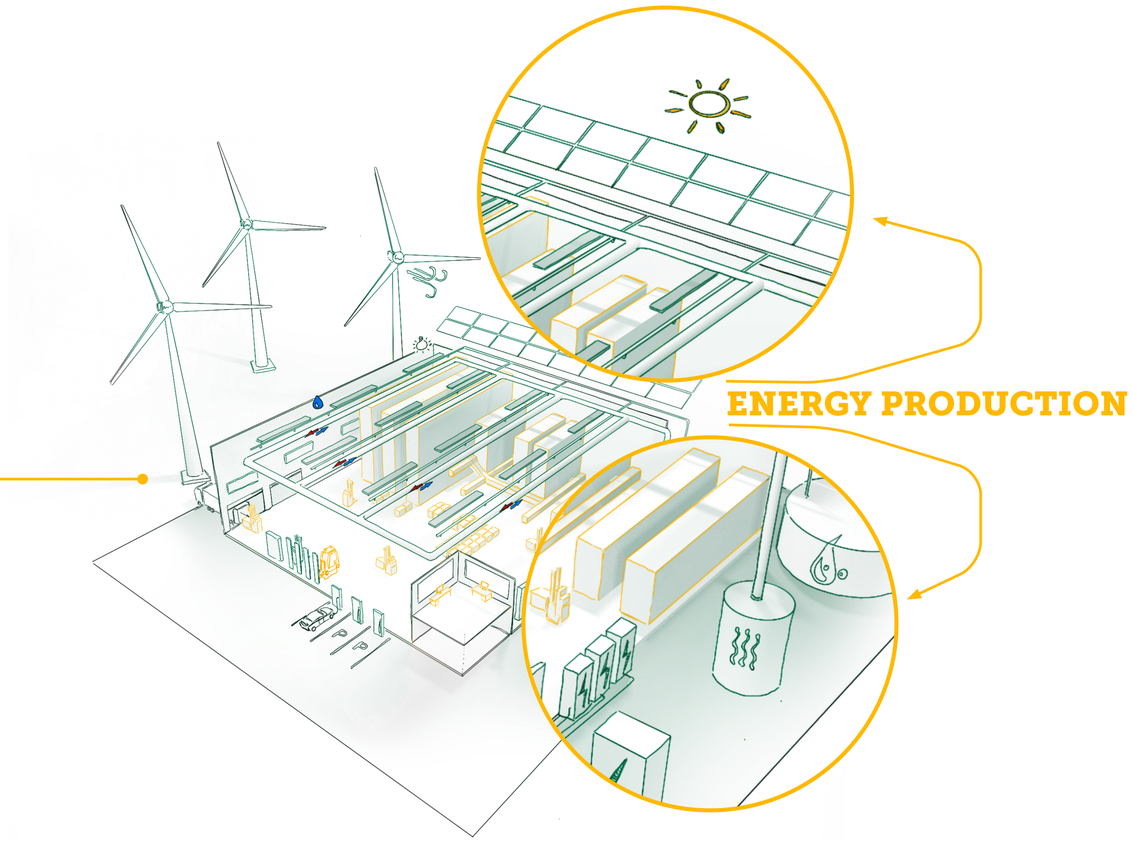
Jungheinrich's material flow consulting service forms the basis of a new concept, optimisations and adjustments. The concept is often centred around the following solutions:

Technical building equipment and energy production:

- Improving the control mechanisms for heat and electricity use, e.g. through lighting control.
- Increased efficiency through alternative technologies such as heat coupling, energy recovery, etc.
- Introduction of energy storage solutions, for the entire location or just for individual areas, for shaving off recurring peaks in demand or for bridging periods of seasonal energy production and seasonal demand.
- Utilisation of renewable energy sources, e.g. through the installation of PV systems or geothermal technology.

Material flow technology:

- Intelligent speed control, e.g. reduced travel speed at average capacity or below capacity to reduce energy consumption. It must be ensured that there is no negative influence on the overall performance required, e.g. reduced speed in the conveyor technology and/or a storage/retrieval unit.
- Adaptation of drive components, operating modes and control technology, e.g. a complete shutdown of the conveyor technology as opposed to using standby mode or the asynchronous initiation of actions to avoid peak loads.
- Solutions for energy recovery, e.g. using supercapacitors for subsequent feeding back into the system to reduce the cost-intensive connected load.



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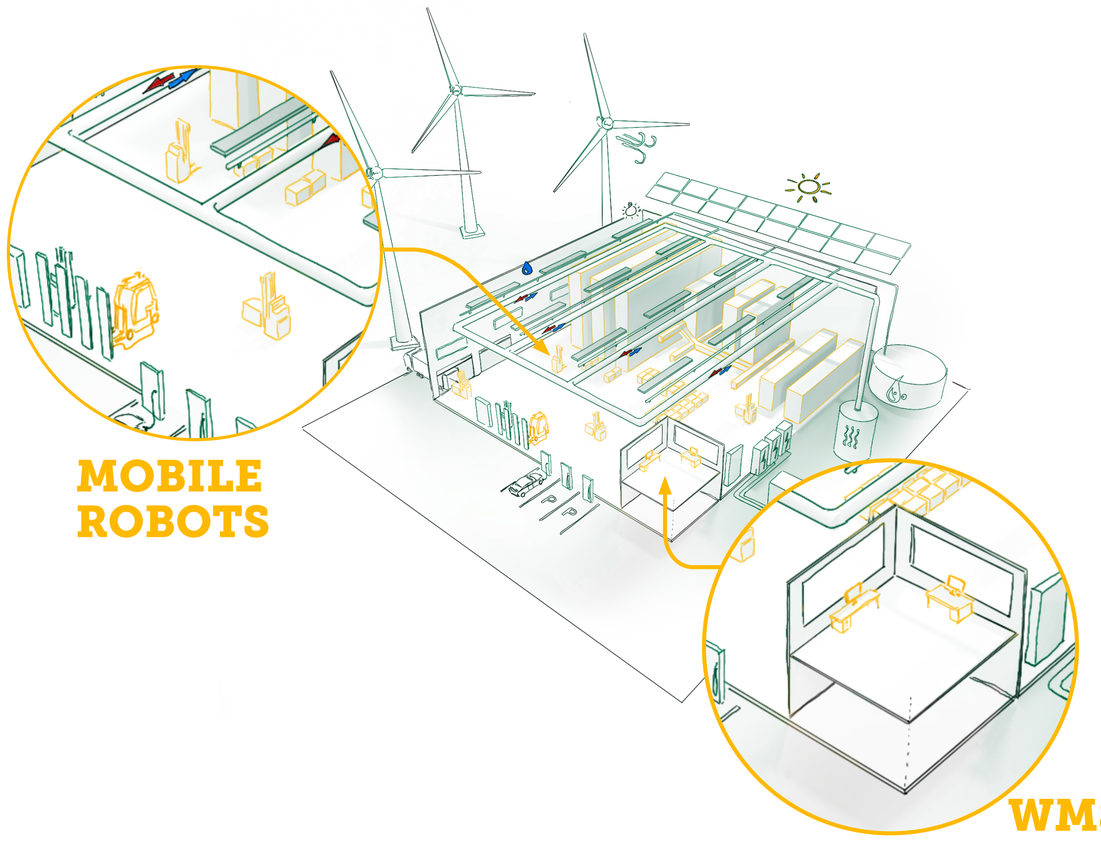

However, traditional approaches to process and layout design are also considered with the aim of optimising sustainability, and continue to be important:

Layout:

- Optimum utilisation of space and volume in the warehouse building by choosing suitable storage technology – e.g. better use of the available height on resource-poor land.
- Optimisation of the travel paths and the spatial arrangement of the functional areas to be integrated, particularly with regard to short transport routes
- Design of processing and movement areas to avoid obstacles, e.g. avoiding AGVs stopping, waiting and restarting due to frequent manual sub-processes crossing into the same area.
- Separation of areas with and without temperature or air conditioning requirements for the targeted use of energy, including thermal energy.

Process:

- Reduction of non-value-adding and, in particular, energy-consuming activities, e.g. empty runs.
- Introduction and expansion of autonomous processes, in particular through the automation of technology, but also the processes in the WMS.
- Definition of targeted batch sizes for the optimised execution of processes, e.g. transport orders in fleets or retrieval orders for picking in automated warehouses.

All solutions focus on the overall optimisation of the location. It is always necessary to weigh up whether an adjustment to an individual area is useful in an overall context. The use of particularly energy-efficient technology is only effective when used in conjunction with an optimised and efficient process. The options for reducing energy use alone, for example introducing efficient trucks with appropriate battery and charging technology, do not resolve the issue of sustainable warehouse logistics. It is more important to avoid empty runs and thus maximise capacity utilisation.

Jungheinrich material flow consultancy offers partnership-based support and concrete proposals in processes and technology. Our service is independent and extends beyond Jungheinrich's current product portfolio. We offer customers the opportunity to work together to implement the solutions presented and take a major step towards sustainable intralogistics.

05 Contact.

Can you see the benefits of sustainable warehouse operations but need support in implementing them?

Our specialist material flow consulting team would love to hear from you.

Talk to a material flow expert now and get tailored advice:

E-mail: **materialflowconsulting@jungheinrich.com**
Tel.: **+49 800 222 585858**

ISO 9001
ISO 14001

The German production facilities in Norderstedt, Moosburg, Landsberg and Kaltenkirchen are certified.

CE

Jungheinrich trucks conform to the European Safety Requirements.

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