IMPULSE PAPER
TASK FORCE SUSTAINABILITY

Sustainable production: actively shaping the ecological transformation with Industrie 4.0

Imprint

Publisher
Federal Ministry for Economic Affairs and Energy (BMWi)
Public Relations
11019 Berlin
www.bmwi.de

Status
November 2020

This publication is available for download only.

Design
PRpetuum GmbH, Munich

Picture credits
ABB (p. 14)
alekseyvanin – Adobe Stock (p. 6)
Altran Deutschland S.A.S. & Co. KG, NicoElNino (p. 21)
AndreyPopov – iStock (p. 18)
Asha Sreenivas – Adobe Stock (p. 20)
BAM GmbH (p. 19)
BDI (p. 12)
C-ECO/Bosch (p. 26)
Deutsche Bundesstiftung Umwelt (p. 15)
Dr. Carsten Polenz (p. 27)
EDUR-Pumpenfabrik (p. 24)
Festo (p. 11)
flaticon (p. 6, 9, 10, 17, 18, 23)
gorodenkoff – iStock (p. 25)
ilyast – iStock (title)
kynny – iStock (p. 23)
metamorworks – iStock (p. 18)
MrJub – iStock (p. 10)
VDMA (p. 12)
willyam – Adobe Stock (p. 7)
Yevgeniy Sambulov – iStock (p. 28)
ZVEI, Bitkom e.V. (p. 13)

Central ordering service for publications
of the Federal Government:
Email: publikationen@bundesregierung.de
Tel.: +49 30 182722721
Fax: +49 30 18102722721

Contents

Abstract

In its 2030 Vision, Germany's Plattform Industrie 4.0 identifies sustainability as a key field of action. With this in mind, the platform's Sustainability Task Force has discussed how Industrie 4.0 can contribute to a climate-friendly and resource-efficient future. The initial findings are presented in this impulse paper. Three development paths emerged from the analysis. They are leading towards a digital, networked and sustainable manufacturing industry of the future:

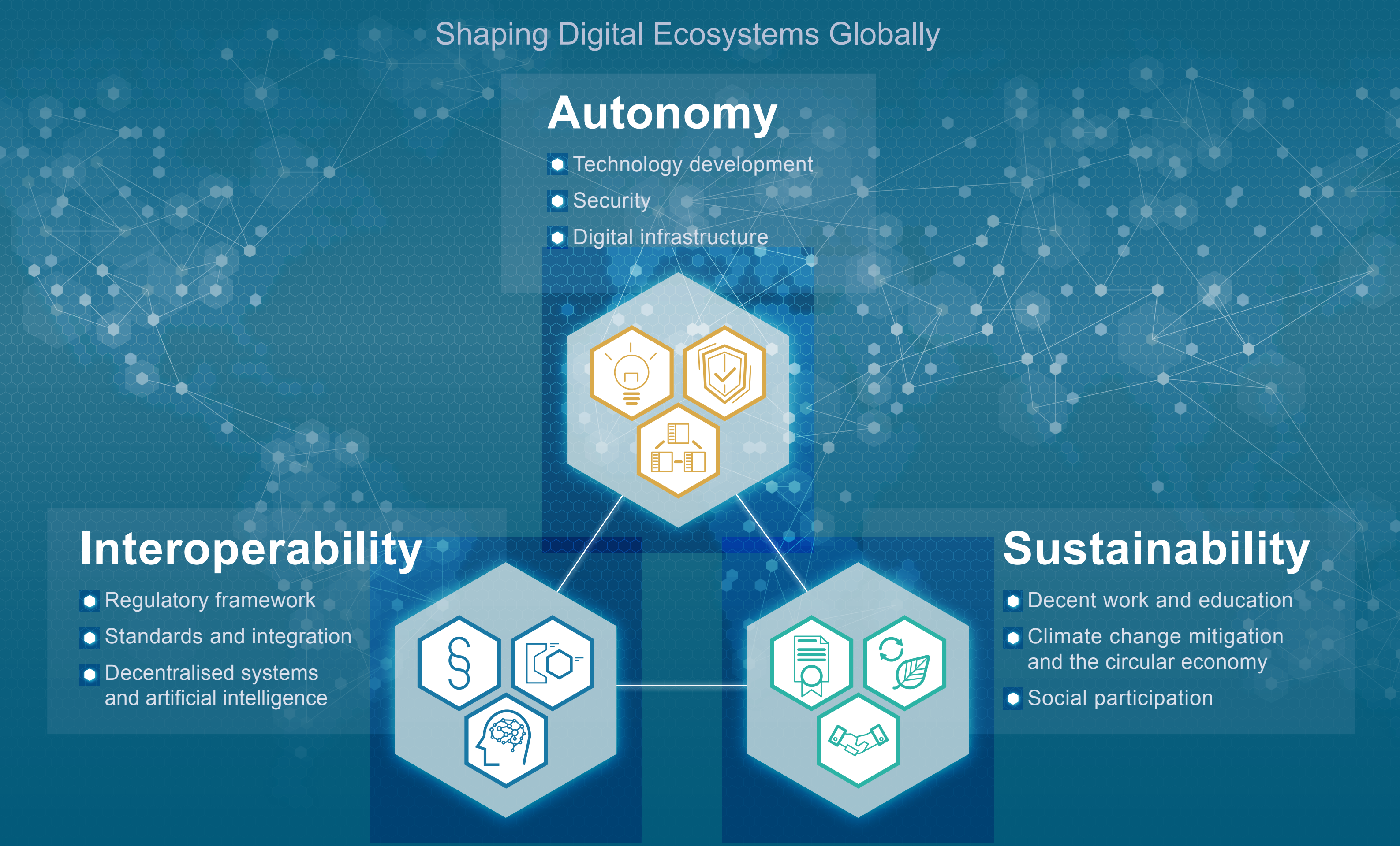
Path 1: Reduce consumption, increase impact: towards resource-efficient and carbon neutral, digitalised manufacturing.

Path 2: From mass production to transparent service offerings: how a changed value proposition influences digital business models.

Path 3: Sharing and networking sustainable digital business means cooperating and operating in circular economic systems.

An analysis comprising over 60 business examples demonstrated that Industrie 4.0 enables ecological sustainability within companies. Selected project and company examples, interviews and excursions illustrate the development paths leading towards a future-orientated, competitive and sustainable industry.

2030 Vision for Industrie 4.0



Source: Plattform Industrie 4.0

Background

The 2030 Vision and the SDGs as a general framework

Sustainability is one of three key fields of action presented in Plattform Industrie 4.0's **"2030 Vision for Industrie 4.0"**. Alongside autonomy and interoperability, the focus on sustainability clearly highlights that economic, environmental and social sustainability are a fundamental pillars. This works in two directions: firstly, sustainability is being embedded in Industrie 4.0, and secondly, Industrie 4.0 helps to drive forward the implementation of sustainability goals. Key aspects of sustainability in an industrial, digital ecosystem include decent work and education, climate change mitigation and a circular economy, as well as social participation.

The 2030 Vision closely corresponds to the 17 Sustainable Development Goals of the United Nations ("SDGs"). For Industrie 4.0, the following goals are particularly relevant. They present specific challenges and objectives for our society, politics and economy.

Three development paths for Industrie 4.0 and sustainability

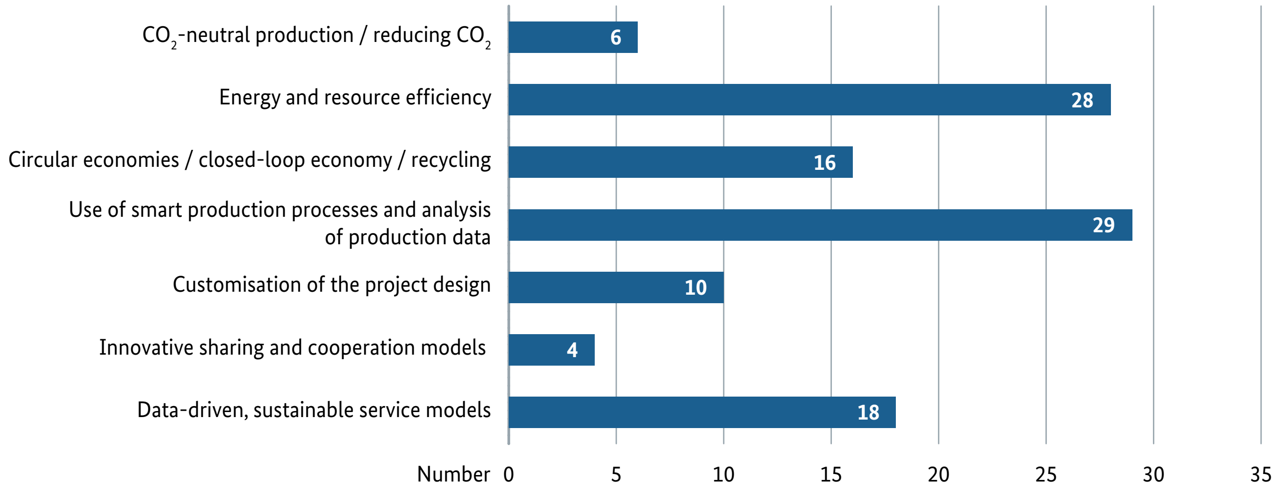
With its 2030 Vision, Plattform Industrie 4.0 has set itself a goal: Industrie 4.0 should be closely linked to environmental and social sustainability. Social sustainability has formed an integral part of our work ever since the launch of the platform. In this respect, the dialogue between the social partners in the **Working Group on "Work, Education and Training"** plays a central and pivotal role (see below). To address ecological sustainability, the temporary "Sustainability Task Force" ("Task Force Nachhaltigkeit") was established at the end of 2019 (see page 30). The task force draws together experts from Plattform Industrie 4.0 and external stakeholders from science, industry, politics and trade unions. Its areas of work thus span the interface between sustainability, digitalisation and industry. The experts all agree that Industrie 4.0 will make a key contribution towards ensuring a climate-friendly and resource-conserving future.

Sustainable Development Goals

8 DECENT WORK AND ECONOMIC GROWTH	Decent work and economic growth	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	Industry, innovation and infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Responsible production and consumption	Ensure sustainable consumption and production patterns
13 CLIMATE ACTION	Climate action	Take urgent action to combat climate change and its impacts

Source: United Nations https://www.globalgoals.org/resources

The sustainability priorities indicated in the >60 received company examples

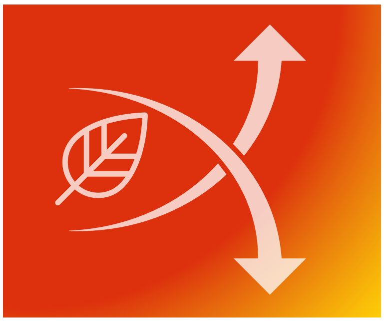


Number (multiple answers possible; individual allocation)

Survey of the Sustainability Task Force of Plattform Industrie 4.0

During several workshops and numerous bilateral discussions, the task force participants gathered ideas, company examples and diverse points of view in relation to the topic "Industrie 4.0 and ecological sustainability". This paper collates the initial findings and has a clear focus on the ecological sustainability component of Industrie 4.0.

>60 company & research examples were received



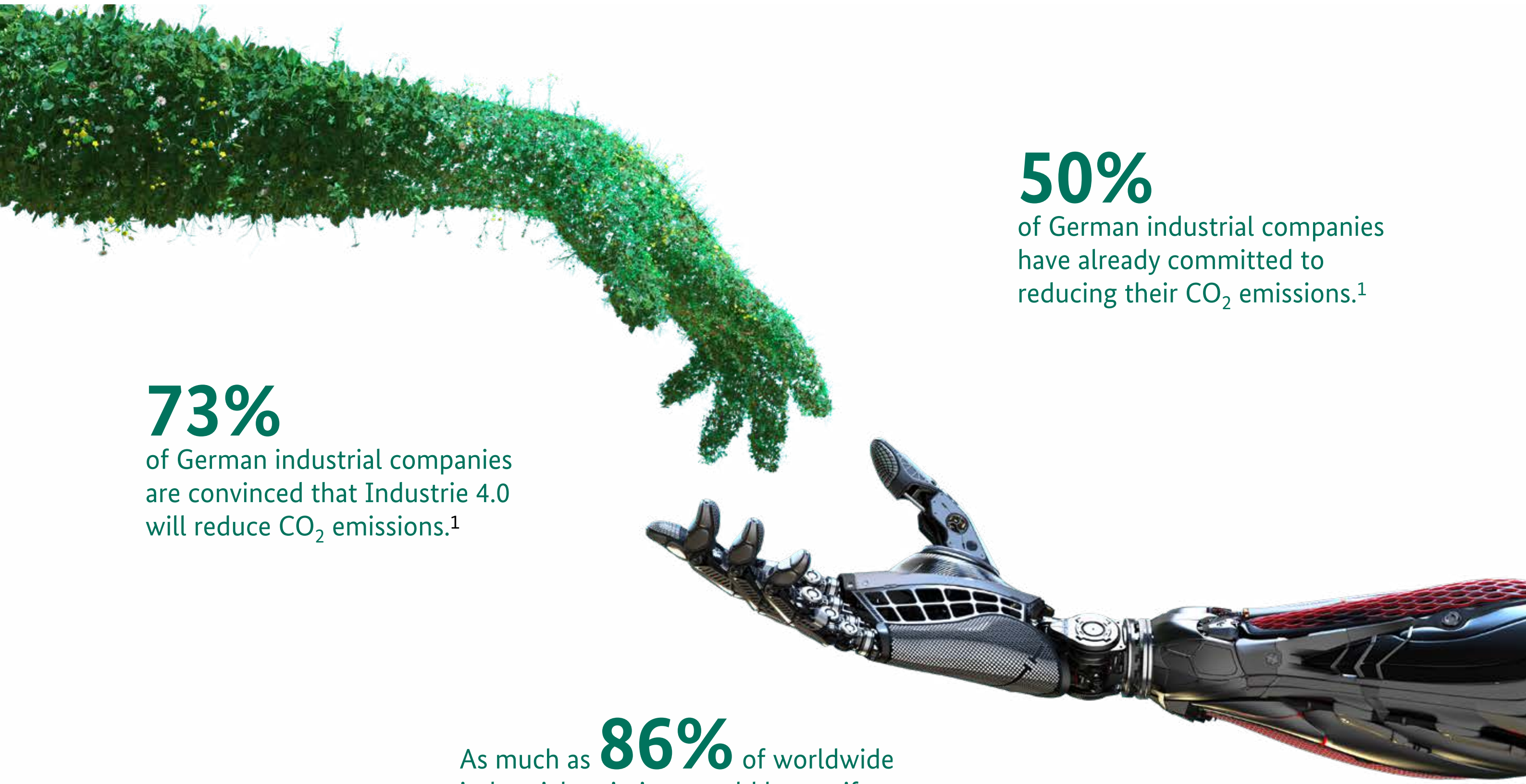
Path 1: Reduce consumption, increase impact: towards resource-efficient and carbon neutral, digitalised manufacturing.

Path 2: From mass production to transparent service offerings: how a changed value proposition influences digital business models.

Path 3: Sharing and networking sustainable digital business means cooperating and operating in circular economic systems.

An analysis of the practice examples revealed three approaches by which networked industries could contribute to achieving greater sustainability. The approaches are not only a stocktaking exercise but much more besides. This is because they reveal development paths to a digital, networked and sustainable manufacturing industry of the future while, at the same time, ensuring industrial competitiveness. We can regard sustainability as an integrative approach for companies. Sustainability can bring real added value to companies, customers and employees. Companies have the unique opportunity to organise themselves holistically and position themselves credibly on the international market. Join with us in taking a look from an analogue factory shop floor into the digital future that awaits us in 2030.

This paper represents the start of a discussion process on Industrie 4.0 and sustainability. Plattform Industrie 4.0 and the Sustainability Task Force will continue with the work intensively. The platform and its partners are advancing steadily into the implementation phase. Having tried out and tested their ideas during the past few years, they are now extensively implementing them in practice. Issues are being identified and channelled into competitive structures. The 2030 Vision provides the framework for this. With regard to the sustainability field of action, we will be addressing in detail the particular subjects of interoperability, industrial processes, data economy and business models.



50%
of German industrial companies have already committed to reducing their CO_2 emissions.[1]

73%
of German industrial companies are convinced that Industrie 4.0 will reduce CO_2 emissions.[1]

As much as **86%** of worldwide industrial emissions could be cut if machinery manufacturers offer green technologies to their industry customers.[2]

1 Representative study on the digitalisation of German industry, conducted on behalf of the digital association, Bitkom, that surveyed 552 industrial companies with more than 100 employees

2 BCG, VDMA (2020) For Machinery Makers, Green Tech Creates Green Business

Path 1:
Reduce consumption, increase impact

On the path towards resource-efficient and carbon neutral, digitalised manufacturing

We have a huge appetite for resources. An equivalent of two planet Earths would be necessary to cover humanity's current requirements for energy and raw materials on a long-term basis. But we only have one planet Earth. This makes it imperative that we conserve our available resources. Efficiency is an essential tool for achieving this: by using resources more sparingly and with greater effectiveness, we can shrink consumption and, at the same time, reduce negative effects such as CO_2 emissions. Industry has an important role to play in this process.

Where do we want to get to?

From energy management to resource efficiency

In the future, intelligent resource management will replace basic energy management in companies. The goal is to ensure efficient use of all raw materials. A range of Industrie 4.0 technologies will help to achieve this: intelligent sensors and augmented reality, predictive maintenance, smart meters, and Industrial Internet of Things (IIoT) platforms. Comprehensive data capture and monitoring tools ensure that all material flows and energy processes are simultaneously monitored and aligned to each other. This produces the greatest possible synergy effects. Integrated data capture and analysis enables rapid decision-making that allows for energy efficient control of the systems. Where necessary, AI-based data-analysis services can provide additional aid to help ensure that all resources are used as economically, effectively and profitably as possible.

Targeted data processing, not more computer capacity

Storing data in data centres consumes huge amounts of energy. The green computing of the future will look very different: paying attention to outsourcing costs (externalities) also spotlights the costs of the 'ecological rucksack' of rapidly growing data centres. Companies will respond in a variety of ways:

- The actual benefit of the relevant data will be made a central factor in their decision-making. What added value is to be gained from processing the data? In the future, effective business management of the data will help companies to evaluate the costs and expected benefits of the data.

- Companies will store data more efficiently and effectively. This will be achieved by implementing technical measures on the one hand, as well as through standardisation. Publishing universal standards will help to ensure efficient data storage. If data are interoperable and stored in a uniform manner, it will not be necessary to spend large amounts of time and effort making the data compatible with each other.

- Industry will give greater consideration to resource-efficient algorithms and computer architectures: How many layers does a software architecture really need? What is pure convenience? Alongside the dimensions of scalability, performance and data consistency, resource-efficiency will also be a design dimension for the software of the future, both in data centres as well as in embedded systems.

In addressing this issue, companies will be able to draw upon existing use cases. Cloud concepts will help to expedite this rethink. With the aid of the cloud, the amount of energy consumed by data centres can be clearly determined and allocated to the companies using the energy.

CO_2-neutral = normal

In order to address the climate crisis, CO_2-neutrality must become the new normal – even for industrial manufacturing. This is an ambitious goal but it is still achievable. Intelligent resource management is a vital step along the path towards CO_2-neutral factories. Even the logistical flows into the factories will be taken into consideration in the future. To ensure that entire energy chains are organised efficiently, businesses will need to rely, for example, on renewable energy or on combined heat and power plants providing in-house power generation. In this respect, IIoT technologies can help to achieve greater reductions in CO_2 emissions and thus drive the energy revolution forward. Thus, for example, the Tübingen-based ebök Institute is conducting a research project to investigate how a digitalised industrial production process can simplify electricity trading in virtual power plants (see below). Similarly, having simple processes aids the transition to internally economical systems.

The sustainability ledger

In the future, sustainability figures will form an integral component of financial accounting. Like the tax ledger and other subsidiary ledgers, every company will have a sustainability ledger that will provide, for example, information on the CO_2-emissions of products and services, as well as on their recyclability. Companies will also use their sustainability ledger to record the resource consumption and emissions associated with the production process and intermediate products. By doing this, different options for improving sustainability within their businesses can then be evaluated and compared from a financial perspective. It will thus be possible to perform a future-orientated, predictive calculation that already factors in, for example, future price increases in CO_2 certificates. The DIBICHAIN project provides a basis for this (see below).

Energy efficiency at Festo

A visit to FESTO

Reducing energy and resource consumption holistically with Industrie 4.0

Festo SE & Co KG
Industry sector: automation technology
Link: https://www.festo.com/group/en/cms/10486.htm

For many years, Festo has been working to develop innovative solutions that enable efficient use of energy and resources – not just for its own business operation but also for its customers. This is because, while analysing CO_2-emissions, the automation specialists from Esslingen am Neckar made this discovery: only a very small portion of the CO_2-footprint was generated during the manufacture of its own products in the Festo factories. The largest portion by far is generated during the day-to-day operation of the systems at the customer sites.

Hence, Festo is firstly using smart products to support its customers on their journey towards CO_2-neutral production. For example, the company has introduced digitalisation into pneumatic systems by means of the Festo Motion Terminal VTEM. To achieve this, pneumatic functions were implemented using software in the form of Motion Apps. This also includes new energy saving functions that permit efficient motion sequences. Hardware no longer needs to be swapped in order to convert a system to handle new products. Another possibility is a remote diagnostic system for monitoring leaks.

Alongside these energy efficiencies, networked products also help Festo's holistic, digitally assisted service offering to increase the energy efficiency of the systems and reduce CO_2 emissions. To this end, Festo has developed the "Festo Energy Saving Service".

"Industrie 4.0 offers us solutions that we can use to optimally unlock the energy-savings potential within pneumatic systems, by means of sensor-assisted systematic data capture and cloud-based analytical tools."

Peter Post, Vice President of Festo

At the component level, sensors provide all of the necessary data. The design and operation of the system can be checked in very fine detail; weak points can be identified and options for optimisation can be developed. With the right design and optimal operation, the compressed air consumption can be reduced.

As much as **60%** of the energy consumed by the pneumatic drive systems used in production plants could be saved, according to Festo.

This example demonstrates how Industrie 4.0 can deliver energy savings by enabling data-driven, sustainable service models.

4 questions for the associations

Iris Plöger,
Member of the executive board of BDI

Hartmut Rauen,
Deputy Managing Director at VDMA

Ms Plöger, with its "Green Deal", the EU wants to reduce its greenhouse gas emissions to zero by 2050 and become the first climate-neutral continent. Can we achieve this?

The "European Green Deal" is without doubt one of the most important future-oriented projects in the European Union. The challenges are immense: it will involve an extensive restructuring of the European Economy, which will require investments running into the trillions. In terms of technology, we believe it is possible to become climate-neutral by the middle of the century. And German industry is an international leader for many types of climate-protection technologies, especially when it comes to integrating individual technologies into complex systems. This applies equally to Industrie 4.0. However, achieving success will depend critically on the extent to which policy-makers can develop an ambitious mix of climate-policy instruments. If such a comprehensive support framework can be provided in connection with the Green Deal, then I can also see opportunities for Germany as an industrial centre.

Green technology and digitalisation play an important role in the transition to more efficient and greener production processes. Mr Rauen, can we actually afford it?

First of all, it is important to consider how to go about setting ambitious targets in relation to the Green Deal or the Sustainable Development Goals (SDGs). However, they also need to be achievable and affordable. Our recent study entitled "For Machinery Makers, Green Tech Creates Green Business" shows that this is possible. We have identified the technical lever that mechanical engineering companies can use to improve the ecological footprint of their customers. If there is comprehensive distribution and use of these technologies, which are already economically viable today, this would result in a 37% reduction in global greenhouse gas emissions. This will also bring dividends for companies: The market potential of decarbonisation by 2050 is worth more than 300 billion euros per year. In order to realise this ecological and economic potential, companies and politicians will need to signpost the way.

Dr. Wolfgang Weber,
Chairman of the Board at ZVEI

Melissa Kühn,
Sustainability Advisor, Bitkom e.V.

Mr Weber, in many industrial companies the digital transformation is still in its infancy. What needs to be done to accelerate the digitalisation process and facilitate industrial sustainability?

In many areas, our member companies are already very well positioned. However, scalability is still an obstacle at present. We are appealing for a significantly greater number of industrial companies to prepare their sites and machinery for end-to-end wireless digitalisation based on "5G campus networks". The Digital Nameplate, which was co-developed by ZVEI, offers another example of efficient digitalisation. This is a fully digitalised version of the traditional name plate that replaces the paper documentation found enclosed with many products. The advantages are clear: The nameplate conserves resources and makes paper documentation redundant. This has been made possible by the Asset Administration Shell of Plattform Industrie 4.0, as it ensures the necessary interoperability during exchanges of data. It will initially be implemented and brought to life in this cross-company use case. The ideas have already been conceived and must now be introduced into companies.

Ms Kühn, Industrie 4.0, green IT and sustainability fit well together. Does this mean they will be a surefire success?

The majority of German industrial companies are convinced that Industrie 4.0 will make production processes more efficient and allow for increased sustainability. Digitalisation will play a key role in this process: sensors and smart machines can reduce energy requirements to a minimum, while 3D printing minimises the use of materials and intelligent logistics shorten transport routes.

However, it is also important to ensure that digitalisation is itself implemented in the most climate-friendly manner possible. The energy mix must be impelled quickly and consistently in the direction of renewable energy sources. Moreover, the energy efficiencies of data centres must be increased further. The electricity requirement of data centres in Germany currently amounts to more than 12 billion kilowatt hours per year – almost as much as Berlin consumes annually. Data centres generate heat, which could also be fed into district heating systems. The pending decommissioning of the coal-fired and nuclear power stations makes this even more relevant. With the right framework conditions in place, German industry can become a pioneer in the field of climate-friendly production processes.

The Lüdenscheid site: a state-of-the-art, largely CO_2-neutral and energy self-sufficient factory of the future

Visits to Bosch and ABB

Creating CO_2-neutral company sites with Industrie 4.0

ABB Ltd
Industry sector: Energy and automation technology
Bosch GmbH
Industry sector: Conglomerate
Links: https://new.abb.com/mission-to-zero/de/technology https://www.bosch-presse.de/pressportal/de/en/how-bosch-factories-are-driving-climate-action-214848.html

At present, industry accounts for approximately one fifth of the carbon dioxide emissions in Germany. Companies such as Bosch and ABB can change this. Their aim is to achieve climate-neutral manufacturing through the use of Industrie 4.0 technologies. They demonstrate how this can work in their own production plants.

According to company statements, the Robert Bosch GmbH sites in Germany have been climate-neutral since the end of 2019. To achieve this, Bosch has been pursuing a multi-faceted approach, with a focus on energy efficiency at its own sites. Networked production makes a significant contribution to this process. For example, Bosch is already using the Energy Platform within its own Industrie 4.0 portfolio at over 100 production plants and sites across the globe. In this respect, intelligent algorithms can help to predict energy consumption flows and avoid peak loads, or identify and correct anomalies in the consumption patterns of machinery. This helps to further reduce carbon dioxide emissions from factories.

According to Bosch, emissions at the Industrie-4.0 lead plant in Homburg shrank, over a two-year period, by a good **10%**.

The Industrie 4.0 approach: maximum transparency and technical innovation. With the aid of approximately 12,000 measuring points, data from the systems are amalgamated in Bosch's own energy management platform. Its employees can thus monitor the consumption of each individual machine and regulate it to ensure optimal consumption. The technical solutions include demand-oriented regulation of the factory ventilation system, waste heat recovery from various processing procedures and, last but not least, the shutdown management for the systems.

As part of its "Mission to Zero", the energy and automation technology group, ABB, has also set itself the goal of achieving a CO_2-neutral future. The company demonstrates how it is accomplishing this at its production site in Lüdenscheid: According to the company, the local production plant of the ABB subsidiary company, Busch-Jaeger, operates in an almost energy self-sufficient and CO_2-neutral manner with the aid of Industrie 4.0 technology.

"The ABB solution in Lüdenscheid demonstrates, for example, how the typical requirements of an entire industrial site can be met in a resource-conserving manner."

At the heart of this smart and sustainable comprehensive solution lies the OPTIMAX energy management system. The smart system controls not only the energy consumption but also the power generation and storage in a scalable and flexible manner. Using predicted data, OPTIMAX calculates the optimal energy flow and corrects deviations in real time. In doing so, the self-learning system functions in a largely autonomous manner.

630 tonnes CO_2 are saved each year at the Lüdenscheid site, according to ABB

Industrie 4.0 thus facilitates energy savings through networking and transparency.

A glimpse into the future with the ebök Institute

Digital power for virtual power stations

Prof. Dr. Debora Coll-Mayor (Reutlingen University) and Prof. Dr. Claus Kahlert (ebök Institute, r.) present the "Virtual Power Plant" to DBU General Secretary Alexander Bonde.

How can digitalisation drive forward the energy revolution? A project being conducted by the Tübingen-based ebök Institute for Applied Efficiency Research and Reutlingen University should provide answers to these questions. It is being sponsored by Deutsche Bundesstiftung Umwelt (DBU, the German Federal Environmental Foundation). The researchers are investigating how Industrie 4.0 technologies can simplify electricity trading in virtual power stations.

Virtual power stations consist of many small, decentralised electricity generators and current collectors. The flexible collectors and local generators work together with the aid of intelligent networking. This enables them to respond appropriately to the frequently fluctuating electricity supply from renewable energy sources and thus stabilise the local network. The project is investigating how the concept of the virtual power station aligns with the extensive digitalisation of industrial production. "In the future, all machines and processes will be linked to each other via the internet. The requirements of the power grid and companies can be coordinated with the aid of a blockchain", states Prof. Dr. Claus Kahlert, Project Leader at the ebök Institute, explaining the Industrie 4.0 approach. According to him, a continuous exchange of data and analysis of the processes leads to significant increases in the amount of useful power that can be obtained from renewable sources. This reduces emissions.

For further information see:
https://www.dbu.de/123artikel37589_2430.html

Where are we now?

In 2016, industry accounted for more than 41% of worldwide power consumption. According to a recent study conducted by the VDMA and the Boston Consulting Group, the OECD and BRIC countries generate 35 gigatonnes of CO_2 equivalent each year: While only 0.2 gigatonnes of this amount is emitted by the mechanical engineering industry itself, its technologies have a definite impact on the greenhouse gas emissions of nearly every sector of industry – from the energy sector to agriculture. Most of this greenhouse gas is generated by the production industry (16.7 Gt), followed by the construction industry (6.7 Gt), and transport (5,7 Gt).

Studies, such as those conducted by the VDMA, have shown that use of digital technologies leads to significant savings potential in terms of costs and emissions, particularly with respect to energy consumption. But for many companies, even now, energy management simply means ensuring that energy flows – and these alone – are organised efficiently with a view to reducing costs. Reducing consumption is a secondary benefit but, generally speaking, it is not the driving factor.

Companies that collect and record consumption data often do so without any clear strategy. They simply collect whatever can be collected. In the first instance, storing large data volumes in data centres drives up costs and energy consumption. On the other hand, however, a targeted and systematic data collection and management strategy will enable companies to reap greater returns from productivity and innovation. Moreover, such data serve as the basis for developing more-sustainable production processes and products. Strategic data management ultimately saves resources and energy.

41,6 % of global electricity consumption and **79,8 %** of global coal consumption can be attributed to industry.[3]

Key figures on resource consumption and energy efficiency are rarely to be found in the sustainability reports being published by more and more companies. In their reports, these companies also comment on their activities in relation to the United Nations Sustainable Development Goals. However, these sustainability criteria have not so far been holistically integrated into the companies' financial accounting and cost accounting systems.

3 Riazi, S.; Bengtsson, K.; Bischoff, R.; Aurnhammer, A.; Wigstrom, O.; Lennartson, B. (2016): Energy and peak-power optimization of existing time-optimal robot trajectories. Source: 2016 IEEE International Conference on Automation Science and Engineering, pp. 321–327.

Path 2: From mass production to transparent service offerings

How a changed value proposition influences digital business models

As we currently understand the concept, "buying something" means owning and possessing a product after purchasing it, (exclusively) using it and then disposing of it at some later date. Digital business models can help to change this concept of value and thus stimulate transition towards a sustainable approach, whereby customers purchase services instead of articles. Let us consider car tyres as an example: vehicle fleet operators could, for instance, purchase a licence to use the tyres instead of the tyres themselves. In addition, they would receive a comprehensive service commitment guaranteeing functional tyres and an end-to-end tyre management service that would include the placement of orders, fitting, and also condition monitoring via an IoT platform.

Where do we want to get to?

Lifecycle Management

In the future, Lifecycle Management will replace sales based on the "sell-and-forget" principle. The manufacturer's responsibility for its products will last throughout the entire lifecycle of a product. Even during the development phase, factors affecting sustainability, such as material consumption and recyclability, are now assuming much greater importance than in the past – fully in keeping with the concept of "sustainability by design". Throughout the entire value added system, manufacturers, suppliers and repairers will be redefining how they allocate the work and responsibilities between themselves. And even the relationship between sellers and customers will change. In future, instead of the actual product, the purchaser will often acquire "only" the service associated with the given product, such as data or a maintenance service for a device. In this way, the manufacturer will be able to monitor the condition of its product throughout its full lifecycle. It will be able to intervene, as and when necessary, in order to optimise resource consumption and profitability, and ensure the utility benefit for the customer. Digital processes and business models such as leasing or "pay per use" can aid the transition to Lifecycle Management.

Sustainable Twins

In the future, every product will be assigned a "sustainable twin". The sustainable twin builds on the concept of the digital twin and extends this concept to include the aspect of sustainability. Like the digital twin, the sustainable twin is also a virtual image of a physical object. Both objects, i.e. the original and the twin, are linked to each other via data and information connections. In this way, the sustainable twin can collect and provide information concerning the real product throughout the entire production cycle – from the primary materials, the parts list and the work plan to the general production conditions and the details of the components. The sustainable twin accompanies its physical counterpart during the entire value added process and can provide helpful information in every "life phase". For example, when it comes to refurbishing or re-manufacturing at the end of the use cycles, such usage information can, along with the dismantling processes, serve as a valuable decision-making aid. The Asset Administration Shell functions as an important basis for the twin (see page 18).

Material Pass

Physical products of the future will have their own identity card: their material pass. In contrast to the sustainable twin, this material pass will not remain with the manufacturer but will instead accompany the product from point to point throughout its entire life cycle. As it progresses along the value added chain, the material pass will continuously collect information, such as details about the material, the recycling requirements or information about the environmental footprint. Not only will the producer be able to provide the user with information about the product but also vice-versa. The user can also add information about the status and usage of the product to the material pass. Common standards ensure that the information can be exchanged between the material pass and the sustainable twin. In this way, a product's movements and status can be precisely tracked at all times with the aid of digital solutions; by way of example, one option would involve using blockchain technology to facilitate transparent and consistent access to data and facts.

Re-Manufacturing

Classic maintenance contracts will be replaced in the future by a predictive, continuous maintenance system. Manufacturers will thus assume responsibility for their products throughout the entire value added chain. Instead of being disposed of at the end of their lifecycles, products will instead undergo a process of automated re-manufacturing During this "re-manufacturing" process, used devices will be reprocessed and brought back to the quality standard for new devices. To give an example, it is already current practice to re-manufacture aircraft components; after reprocessing, they are as good as new parts in terms of their function, safety and quality.

The next step is holistic manufacturing. Here, the original products undergo a transformation during the reprocessing procedure. They make technological leaps and are thus "living" products that adapt themselves to their particular current use. For example, the functions of product can be expanded or adjusted to reflect new circumstances by means of a software update. It will also be possible to reconfigure machines and product constellations.

Reverse logistics

The concept of reverse logistics supplements the linear supply chains that are currently in use to include the aspects of return and recycling. According to this concept, customers will return goods to the supplier for recycling at the end of their normal service life. A returnable system is thus developing out of the one-way logistics systems that have dominated until now. In a best-case scenario, this will be a circular system. This will also lead to increased resource efficiency. Completed product loops are referred to as "closed-loop supply chains". Digital processes can drive forward developmental advances; for example, artificial intelligence can support smart disassembly operations. New business models are emerging throughout the areas of disposal logistics, returns logistics and repair logistics.

Excursion: the Asset Administration Shell and the relevance of standards and norms

Repairing a machine or product is a difficult task if the relevant information is not available. For example, what are the correct replacement parts to be using? Analysing the environmental footprint of a product or production process is equally difficult without access to the relevant data. The general picture can easily become lost in the many links of the supply and production chains. So how can we go about pinning vital data to products and machines in the industry of the future?

This is where the Asset Administration Shell comes into play. This is the digital image that will be assigned to each relevant asset in a networked production process. All essential properties of an asset are stored in the Asset Administration Shell. This includes, for example, physical properties (weight, size), process values, configuration parameters, states and capacities. The Asset Administration Shell is not just a storage facility but also a communication interface – it acts as the conduit through which assets can be integrated into the network-based Industrie 4.0 production process. All of the information relating to the asset can be accessed and monitored. It is therefore possible to check, for example, the availability, status and consumption rate of a machine. The Asset Administration Shell is therefore an important basis for the sustainable twin (see page 17).

In a networked production process, it is essential that all components speak the same language. All hardware and software, the user and supplier industries, and everything from product design to recycling must be conceived and designed according to a common set of standards. Only in this way can diverse components interoperate seamlessly within a digital ecosystem (key word: interoperability) while also amalgamating sustainability data.

The Working Group "Reference Architectures, Standards and Norms" of Plattform Industrie 4.0 is developing the bases for uniform, open standards and channelling their ideas into international standardisation processes.

Complex functional parts made of plastic from the range of the online configurator on mipart.com

A visit to BAM

mipart: components on demand, starting from a batch size of 1

BAM GmbH
Industry sector: precision manufacturing, special machine construction and digital services
Link: www.mipart.com/en / www.bam.group/en

"No matter what component you want: if you can design it, we can produce it." This is the promise made by BAM GmbH to its customers. With mipart.com, the digital contract manufacturer based in Weiden in der Oberpfalz has created an AI-based platform that makes it possible to produce customised components at economically viable prices – on demand and starting from a batch size of 1.

With just a click of the mouse, customers can upload their CAD model to the online shop, obtain a price calculation in real-time and then immediately place an online order for the desired product. But mipart is not a manufacturers' network: all ordered components are manufactured by BAM itself at its own production plant.

37,000
component calculations were executed on mipart.com during the first year, according to BAM

This digitalisation of price calculations and work plans reduces processing and delivery times, which means that customers get their products more quickly. And the environment also benefits from digital on-demand manufacturing.

The benefits can be clearly seen in the example of B and C parts in the spare parts business: Typically speaking, parts in the B and C group have a lower value in comparison to A parts. To keep prices low, parts are often manufactured in larger production runs than are actually required. The resultant excess quantities are held in stock. After a few years they are written down and then ultimately disposed of at some later date. This makes no sense in either economic or ecological terms. By digitally optimising procurement and manufacturing processes, mipart can produce components economically, from a batch size of 1, and offer them at competitive market prices. At the same time, this also reduces resource consumption.

Alongside the B2B sector, mipart also gives B2C customers access to industrially manufactured components of industrial quality on economic terms. The online configurator thus opens up the possibility of repairing, improving upon, recycling or manufacturing items from the most diverse areas of daily life – all in the spirit of sustainability considerations. This company example demonstrates how, in the context of Industrie 4.0, smart production processes and the analysis of production data can lead to sustainable solutions.

A glimpse into the future with the DIBICHAIN research project

Closed-loop systems based on blockchain

Closing material loops makes enormous sense. Nature shows us the way. By emulating nature, industry can not only avoid wasting resources and energy but also prevent waste production. But logistics are challenging. Up to now, the process of digitally modelling production loops has met with only partial success. One of the problems being encountered here is the issue of how to collect product lifecycle data in a way that allows the product development process to proceed in a manner that is fair, secure, and economical.

There is a new approach that can help in this respect. With the aid of blockchain, data can be stored in decentralised manner without independent control rights. In most cases, however, current blockchain models are too slow when it comes to scaling up to large data volumes. This is where the "DIBICHAIN" project research comes into play. DIBICHAIN is investigating possibilities for decentralised data storage. The project aims to create a knowledge base that can be used to enhance blockchain for the circular economy.

A software demonstrator should include, among others, the following application scenarios:

- (Reverse-)tracking of selected materials, from extraction of raw the materials to feedback into the materials cycles.
- Ensuring compliance with social and ecological standards across the entire product lifecycle.
- Blockchain for integrated lifecycle analyses as well as for use as a basis (Data Backbone) for Sustainability Driven Design Applications.
- Clear identification and traceability of products throughout the entire product lifecycle.

In order to achieve this, there are five partners collaborating on the project: Airbus SE, Altran Technologies S.A., Blockchain Research Lab gGmbH, Chainstep GmbH, CircularTree GmbH und iPoint GmbH. The project is being sponsored by the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung).

For further information, visit:
https://innovative-produktkreislaeufe.de/resswinn/en/Projects/DIBICHAIN.html

Where are we now?

At present, the sale of goods usually takes place according to the "sell and forget" principle. The manufacturer's responsibility ends as soon as a product has been handed over to its new owner. The best-case scenario is when sellers see their products again for maintenance work. Consequently, traditional supply chains have a linear structure: input, production, output.

At present, sustainability considerations a rarely a factor in the "traditional" value promises companies make to their customers. When making a purchase, for example, relevant product information is often lacking. If an item breaks down after expiry of the warranty period, the question then arises: should I repair it or replace it? When users opt for a repair, they generally do not contact the manufacturer at all. Instead, they simply take the item to a repair shop. In some cases, it proves very costly to have equipment repaired there. In many cases, however, a repair will not seem worthwhile and the defective product will simply be replaced by a new one. The aim for the future is to generate a new concept of value, with sustainability as an integral component.

3 questions for: Andreas Kötter, DIBICHAIN

Andreas Kötter,
Advanced Business
Manager T&I, Altran

1 The DIBICHAIN project aims to create a technology that will enable modern, decentralised data storage. Why is this so important for a functioning circular economy?

In spite of all the idealism, we continue to operate in a market that is driven by economic interests. This is not going to change, even in the circular economy. Blockchain-based systems offer the opportunity to build trust. This is important in the current situation, where there is no trust, nor any desire for an individual market participant to have total control over a system. If all of the relevant data necessary to realise this goal were to be stored centrally, one participant would have complete operational control. This would mean that it could alter information to serve its own interests. However, once the entire system has been decentralised, this dependency will have been completely eliminated.

2 How and where could the technology developed by the DIBICHAIN project help, in very specific ways, to advance the processes within your company?

Let me give you an example: At present, information concerning the Life Cycle Assessment (LCA) for a specific product or process has to be laboriously collected in each individual company. We can see the future potential for suppliers to contribute to a component's LCA information. This would make LCAs more reliable and transparent, cheaper, faster and more comprehensive. Moreover, since LCAs have value, there would be an incentive for companies to generate them.

3 What is the research project's current state of progress? In your estimate, when will the new technology be ready for use?

We will be commencing the development work on the prototype at the end of this year. Developing and completing the initial components will take approximately six months. Depending on what other use cases emerge from the subsequent developed model phases, we can expect an initial demonstrator to be available during Q3/2021.

Path 3:
Sharing and networking

Sustainable digital business means cooperating and operating in circular economic systems

In order to consistently align future economic systems to sustainability, completely new ways of thinking will be necessary. Since digitalisation does not stop at organisational boundaries, cooperation is becoming an increasingly important factor. And it will be equally important to think of the economic system as a circular system rather than a one way street.

Where do we want to get to?

Circular value added networks

In the future, value added networks will replace value added chains. This will make production processes less vulnerable to disruptions. This is because the networking concept also means that individual companies and systems will no longer have such extremely high levels of specialisation and, in the future, machines will be more flexible in terms of their deployment potential. It will therefore be possible, for example, to deploy them in different production processes on demand. It will also be possible to meet individual customer requirements more easily through the use of flexible machines in digital networks.

4.5 trillion US dollar of additional economic output could be generated globally by circular economy by 2030.[4]

Circular value added networks go one step further: they enable efficient use of resources and make it possible to close materials cycles and control the value creation process in a transparent manner. With the aid of IIoT platforms, entire production processes can thus be designed for greater sustainability.

Over **7 billion tonnes** of natural raw materials will be lacking by 2030, unless we move to smart circular economy.[4]

4 Accenture (2015) growth spurt circular economy

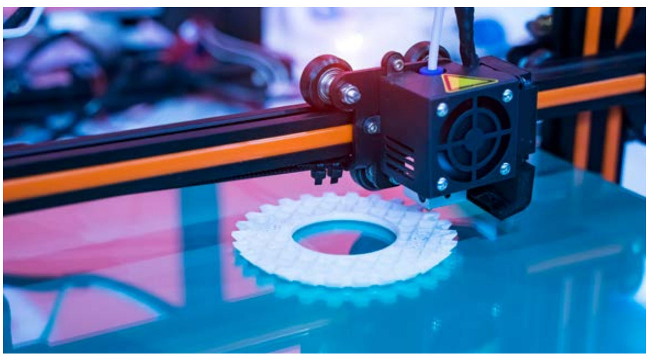
From the (proprietary) production plant to the shared value added factor

In the future, digital production platforms will bundle relevant production processes together. Manufacturers of entirely different types will be able to access these platforms and use them as sites for their production operations. Value added factors and product data will be shared on these platforms and used by all.

To reduce vulnerability to disruptions, the platforms will not be centralised but will instead be arranged in the form of regional clusters. This creates flexible, modular, regional – and hence resilient – production networks. Some manufacturers are already sharing digital platforms today and producing their respective models on them.

Even manufacturers involved in physical production processes are benefiting from shared factories and production capacities. This is because pooled production sites allow for attractive prices due to the resulting economies of scale. If companies share specific parts of the production process, this ensures high utilisation of the equipment and machines. In addition, clusters of machines can be used optimally. At the same time, a high degree of specialisation and customisation is possible. Pooling production sites also increases resource efficiency. This is because raw materials no longer have to be distributed to many different production sites and then stored there simultaneously. Digital production platforms can, for their part, be modernised relatively easily and also be regularly adapted to meet the latest requirements. This expedites the transformation to sustainability.

The "use, don't own" principle frees up resources within companies, thus enabling them to focus on the relevant areas of value creation. For example, companies will no longer have to keep spare parts stockpiled at their own production plants. When needed, they can be manufactured using networked 3D printers.




Digitalised workplace in the assembly of the EDUR pump factory

A visit to EDUR-Pumpenfabrik (pump factory)

The road to a digital factory

EDUR-Pumpenfabrik Eduard Redlien GmbH & Co. KG

Link: www.edur.com/en

The former EDUR-Pumpenfabrik workshop has grown to become a global specialist in pump technology. The company focuses on customised production, efficiency and sustainability. The consistent digitalisation of all EDUR business units underpins this development and ensures transparent and flexible processes.

Until recently, the information processes used in production were still organised along traditional lines. The employees working in the production and assembly departments would receive their work assignments in paper form. This method did not provide a transparent overview of the actual work status of a pump or the real-time quantities of components held in stock. This approach led to inefficiencies due to the frequent need for coordination, high error rates, data redundancies and, last but not least, high levels of paper consumption.

In order to organise the flow of information more transparently and thus improve the efficiency of the production process, the company converted every work station in the production workshop into a "digital workplace". Existing systems were extended to include the relevant personnel, interfaces to other software systems were developed and information was merged in an effective manner. All employees now have digital access to the specific data that they require to perform their work activity. Upon completion of the particular work process, relevant information, e.g. on the work hours or the components retrieved, is fed directly back into the system.

By introducing digital workplaces, the EDUR production management gained **one extra work day per week**, which it can devote to other activities.

The significant improvements in the processes were already clear from as early as the implementation phase. The clarity and up-to-date status of the data helps to increase information transparency for the employees and also helps to avoid errors. The Industrie 4.0 approach demonstrates that networked collaboration conserves resources and reduces the consumption of materials.

Wir fördern Wirtschaft

EU.SH

Landesprogramm Wirtschaft: Gefördert durch die Europäische Union - Europäischer Fonds für regionale Entwicklung (EFRE), den Bund und das Land Schleswig-Holstein

Schleswig-Holstein. Der echte Norden

The project is sponsored by Landesprogramm Wirtschaft, using funds from the European Regional Development Fund (ERDF).

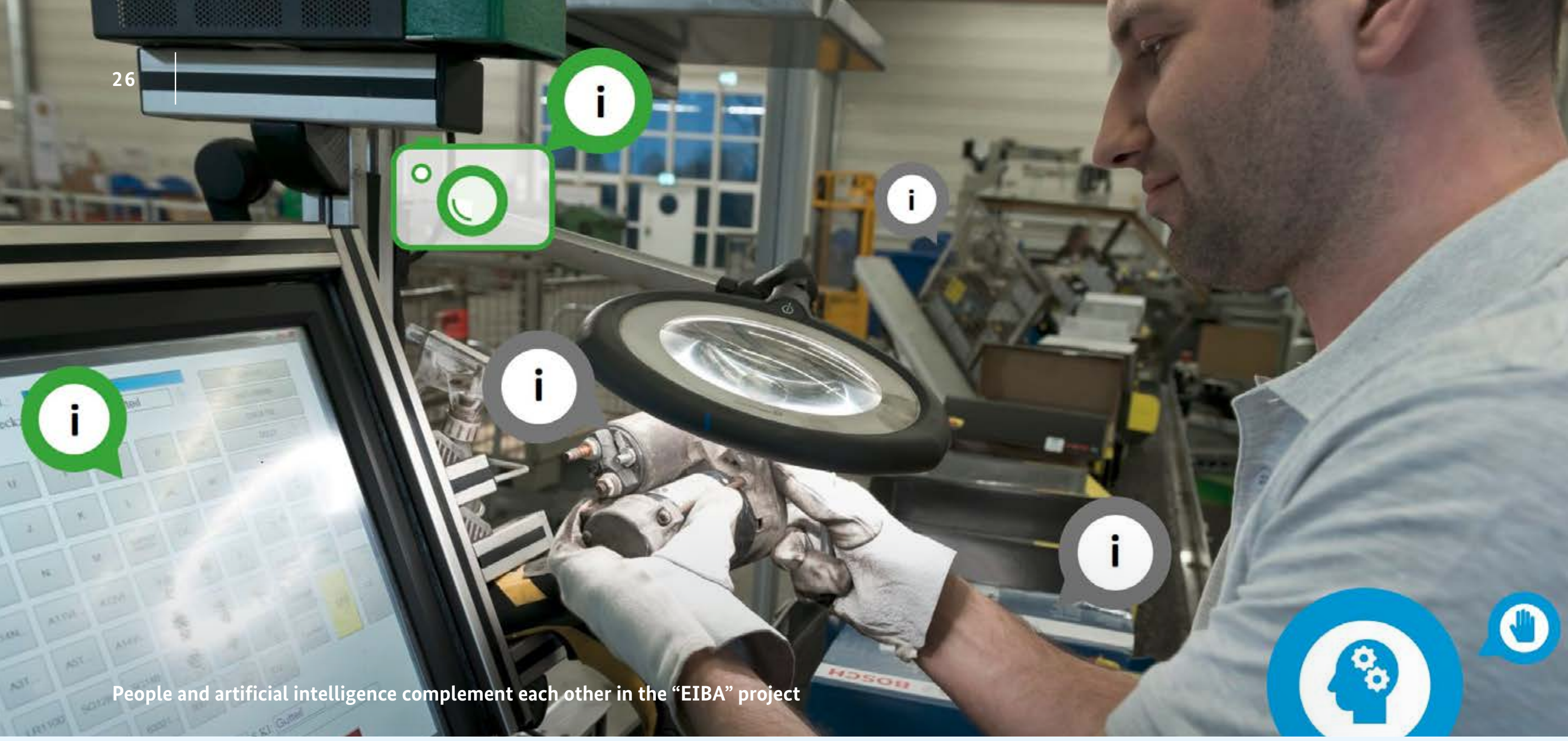
Excursion: The Collaborative Condition Monitoring use case

Solving puzzles is an everyday activity in German industry: a single supplier of components produces many individual parts. These individual parts are delivered to a machine supplier, which manufactures a machine from all the different parts. A factory operator uses many different machines in the production system running in its factory. The pieces of the puzzle fit together to form a large picture.

But what can be done to ensure that the components and machines function reliably and for long periods? This is where Condition Monitoring (CM) can help. Classic CM involves the collection and analysis of operating data. But at present, these data are only shared bilaterally, e.g. exclusively between the machinery supplier and the factory operator. The drawbacks are clear: In each case, the parties see only their pieces of the puzzle but not the overall picture. Optimising the overall system is very difficult.

This is where Collaborative Condition Monitoring (CCM) comes into play. By contrast with CM, data are not just shared bilaterally; instead they are shared multilaterally across the entire value added networks: Having common puzzles leads to holistic service offerings. If all data are available on a manufacturer-independent, digital platform, it is then possible to optimise the overall system. This increases, for example, the service life of a machine or component. Not only does everyone benefit from this, all along the value added chain, but it also boosts sustainability.

In addition, the Plattform Industrie 4.0 use case also demonstrates how digital ecosystems can be organised autonomously. This is because, in the context of Industrie 4.0, data, digital technologies and digital infrastructure acquire a strategic importance for the production industry. Autonomy is essential for a sustainable German and European Industry. Hence, CCM can also serve as a use case for the GAIA-X data infrastructure project.


People and artificial intelligence complement each other in the “EIBA” project

A visit to Circular Economy Solutionss

Artificial Intelligence for the circular economy: The EIBA pilot project

Circular Economy Solutions GmbH (C-ECO)
Project partner: Fraunhofer Institute for Production Systems and Design Technology • Technische Universität Berlin, Assembly and Handling Technology Department • acatech – National Academy of Science and Engineering
Link: https://innovative-produktkreislaeufe.de/resswinn/en/Projects/EIBA.html

Re-manufacturing, i.e. the reprocessing and recycling of used (industrial) products, is an important part of the circular economy. One of the greatest challenges encountered in connection with re-manufacturing is to reliably identify and assess the condition of industrial products that have been returned from the market. By means of the EIBA project, Circular Economy Solutions GmbH is developing, in collaboration with its partners, an AI-based system for identifying and assessing used parts.

Remanufacturing can save **85%** of raw materials and **55%** of the energy can be saved by re-manufacturing parts instead of producing new ones.

Many industrial products are already suitable for the circular economy today. But up until now, companies have often lacked the incentives and necessary know-how to actually have the relevant parts returned and recycled. This is where C-ECO’s Industrie 4.0 business model comes into play. It develops services for retrieving the recyclable parts from the market in a structured manner at the end of their service life and then assessing them. According to its own statements, C-ECO thus returns approximately three million used parts per year via a global network of 22 logistics bases. At present, identification of the parts is still mainly done manually. The greatest challenge is to ensure that uniform global standards and assessment criteria are established for the individual parts.

What does a product consist of? What is usable? What is the appropriate reprocessing strategy? In order to answer these questions, products must be clearly identified and assessed. The specialist will often have only a few seconds in which to do this. However, in many cases the differences distinguishing the models are only very minor and the presence of dirt or wear and tear makes the assessment task even more difficult.

Artificial Intelligence (AI) should help with this process in the future. The project is developing a machine that also examines and assesses the product. Sensor systems such as depth cameras or a weighing machine identify the used parts and assess their condition. “To achieve this, we first feed existing data into the AI system”, explains Markus Wagner, Project Manager at C-ECO. “The database then continues to grow continuously during the process and the AI can acquire additional knowledge.”

EIBA showcases how Artificial Intelligence can be part of an Industrie 4.0 business model and thus help to drive advancements in circular economies and recycling.

3 questions for Dr. Carsten Polenz

1 Dr. Polenz, in your assessment, have sustainability trends such as "use, don't own" or "value added networks, not value added chains" already become an everyday feature in industrial companies?

Many production processes still have a linear structure but there is certainly a clear trend towards value added networks. In an increasingly globalised economy, this is the only possible solution since the various suppliers and components within the individual industry sectors are already very closely linked to each other. Companies can, and should, continue to develop this trend and make strategic use of value added networks in order to become more resilient. There are some initial signs of this. Similarly, the "use, don't own" principle is not a new one – just think of leasing models. But even here, the primary focus is now on further development and expansion into other areas. For example, shared production sites, whether they are physical or digital, can help in terms of conserving resources and combining strengths. However, it is also clear that an approach such as this requires a completely new way of thinking, as well as a new understanding of competition. In many companies, this transition will have to happen first.

2 What is your current assessment of the general conditions for a sustainable digital transformation of production patterns?

Industrie 4.0 is making inroads into ever more industry sectors. This shows that the increased resource efficiency is not just a mere windfall effect from this development but rather an integral part of it. Naturally, when it comes to developing a targeted strategy for achieving greater resource efficiency through digitalisation, large companies are often already one step ahead of many small and medium-sized enterprises (SMEs). Policy makers therefore have an important duty, focusing particularly on SMEs, to further expand the relevant advisory services and link them together.

Dr. Carsten Polenz, Vice President of SAP SE, member of the Plattform Industrie 4.0 Steering Committee and Head of the Sustainability Task Force

3 Dr. Polenz, there is huge potential for optimisation throughout entire product lifecycles. What roles do digital technologies have to play in terms of unleashing such potential?

Digital technologies can contribute in a variety of ways to the task of conserving energy and resources throughout the entire lifecycle of a product. On the other hand, there may also be adverse, negative consequences such as, for example, if the manufacture and use of digital devices consumes greater amounts of materials and energy. It is therefore important, when using modern enabling technologies such as digitalisation, additive manufacturing or 3D printing, to scrutinise them very closely. We should never treat technological progress as an end in itself. Instead, the overall system needs to be optimised.

A glimpse into the future with OptiRoDig

Optimising raw materials productivity

Chips, punching waste, material residues – processing metal produces vast quantities of scrap metal. Foundries, and steel and smelting works can reuse this scrap metal as a cheap raw material for their smelting processes.

Foundry and steel industries are already covering approximately

45%

of their raw materials requirements with secondary raw materials.

To increase the recycling rate, the smelting works have to know the exact composition of the available scrap types and purchase these specifically. The Industrie 4.0 project "OptiRoDig" can help with this. The aim is to develop a digital network system that facilitates the exchange of data between the recycling industry and steelworks, thus enabling optimised smelting processes.

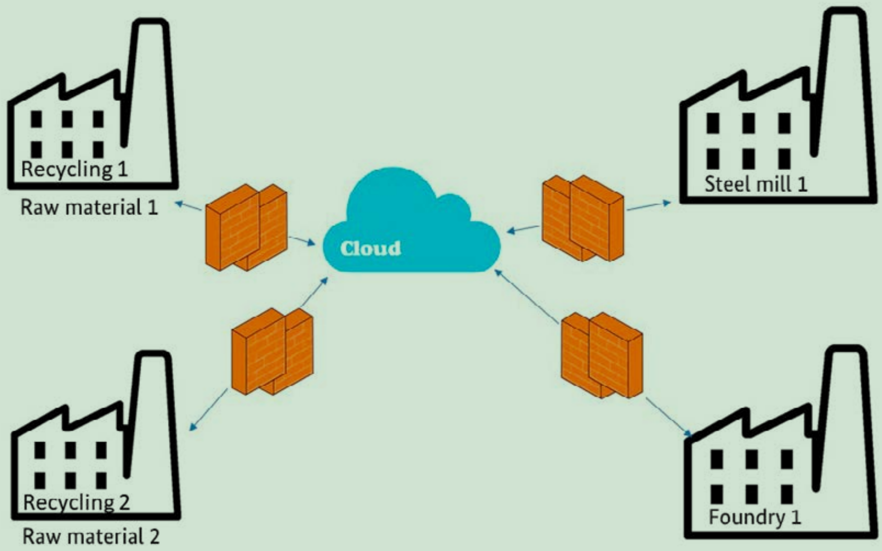
OptiRoDig is intended to establish a digital network system between the recycling industry and the smelting plants. The system will contain extensive analytical data on the available scrap metals. In this way, the smelting plants can procure the appropriate scrap metal for their needs, optimise their smelting processes and thus achieve a targeted increase in the portion of raw materials sourced from secondary raw materials. To this end, an innovative digital system is being developed as part of the OptiRoDig project. All of the raw materials data and process requirements will be available to the participants along the entire process chain. Digitalisation and networking, as well as defined interfaces and standardised data formats ensure that the planning software can receive these data directly and evaluate them immediately with the aid of mathematical processes.

The coordinator of the OptiRoDig joint project is the scrap metal trade company, MAI Metal Alloy Impex GmbH, based in Mühlheim. The Witten-based smelting works, Friedr. Lohmann GmbH, acts as the representative for the OptiRoDig joint project. Academic support for the project is provided by the Institut für Technologien der Metalle (Institute of Metals Technologies) at the University of Duisburg-Essen (UDE) as well as by the Kempten University of Applied Sciences. The joint project thus draws together the key operators in the supply chain linking the scrap metal collection points to the steel production plant.

Once the development phase has been completed, the digital solution could, for example, be made available as a cloud solution for additional, selected companies operating in either the recycling industry or the foundry and steel industry. The project clearly demonstrates that smart production processes and the analysis of production data enables innovative, Industrie 4.0 sharing and cooperation models that lead to higher raw materials productivity.

For further information, visit:
https://innovative-produktkreislaeufe.de/resswinn/en/Projects/OptiRoDig.html

Cross-location raw material optimization



Source: RHM Rohstoff-Handelsgesellschaft mbH

Where are we now?

In our present economic system, production processes and supply chains still have a linear structure in many cases. This can be clearly seen, for example, in the automobile industry, where every manufacturer collaborates with different suppliers. These suppliers often align their production processes and plants completely to the customer's requirements and specialise exclusively on individual substeps. As the production stages along the pathway to a completed car build upon each other, the different suppliers are just as dependent upon each other as the manufacturer is upon its supplier companies. If a link in the chain breaks down, this will have consequences for the entire production process and every company involved in it. However, a systematic approach for monitoring and controlling the chain is not yet envisaged and would be relatively complex. The situation is similar in other industry sectors.

At the same time, technologies and business models are increasingly evolving away from chains towards networks. This is because it is clear that the individual partners and components that are necessary to produce an optimal end product have long since ceased to be in a mere linear relationship with each other. During the course of the value added process, they inter-connect with each other, creating networks – time and again, the individual parameters need to be checked and readjusted as necessary.

"Digitalisation is turning the economy upside down. Times have never been so favourable as they are today for starting to build a liveable future."

Henning Banthien,
Secretary General of Plattform Industrie 4.0

Plattform Industrie 4.0 and the Sustainability Task Force

Plattform Industrie 4.0

Plattform Industrie 4.0 is the central network in Germany for the advancement of the digital transformation towards Industrie 4.0. In close cooperation with politics, industry, science, associations and trade unions, over 350 stakeholders from more than 150 organisations are actively involved in the platform. The platform supports German companies in implementing Industrie 4.0 with information services, examples of company practice, and action recommendations. The platform's numerous international cooperations underscore its leading role in international discussions on Industrie 4.0.

For more information, visit: www.plattform-i40.de/PI40/Navigation/EN/Home/home.html

The Sustainability Task Force

At the invitation of Plattform Industrie 4.0, the temporary Working Group "Sustainability Task Force" ("Task Force Nachhaltigkeit") has been exchanging ideas in relation to the ecological sustainability field of action, in the course of numerous workshops held since the end of 2019. It has been highlighting the contribution Industrie 4.0 can make to the issue of ecological sustainability. The task force draws together experts from the platform and external stakeholders – from science, industry, politics and trade unions. Its areas of work thus span the interface between sustainability, digitalisation and industry.

Organisations participating in the task force:
ABB STOTZ-KONTAKT GmbH, the Federation of German Industries (Bundesverband der Deutschen Industrie e.V., BDI), the German Federal Association for Information Technology, Telecommunications and New Media (Bundesverband Informationswirtschaft, Telekommunikation und neue Medien e.V., Bitkom), Deutsche Telekom AG, ESR Pollmeier GmbH Servo Drive Technology, Festo SE & Co. KG, the Fraunhofer Institute for Production Systems and Design Technology (Fraunhofer-Institut für Produktionsanlagen und Konstruktionstechnik IPK), the Fraunhofer Institute for Systems and Innovation Research ISI (Fraunhofer-Institut für System- und Innovationsforschung ISI), IG Metall, the The Institute for Advanced Sustainability Studies (Institut für transformative Nachhaltigkeitsforschung e.V., IASS), the Institute IWAR at the Technical University of Darmstadt (Institut IWAR der Technischen Universität Darmstadt), nachhaltig.digital | The competence platform for sustainability and digitalisation in small and medium-sized enterprises, PTKA Project Management Agency Karlsruhe (PTKA Projektträger Karlsruhe), Robert Bosch GmbH, SAP SE, the VDI Centre for Resource Efficiency (VDI Zentrum Ressourceneffizienz GmbH), VDMA – the German Engineering Federation (Verband Deutscher Maschinen- und Anlagenbau e.V.), ZVEI – the Central Association of the Electrical Engineering and Electronics Industry (Zentralverband Elektrotechnik- und Elektronikindustrie e.V.)

In addition, the Federal Ministry of Economic Affairs and Energy, the Federal Ministry of Education and Research, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, and the Federal Environment Agency (UBA) also participated.

The Working Group on "Work, Education and Training"

Social sustainability has been an integral part of Plattform Industrie 4.0's work since the launch of the platform. In this respect, the dialogue between social partners in the Working Group on "Work, Education and Training" plays a central and pivotal role.

Industrie 4.0 is changing the world of work. New work areas are emerging, long-established areas are changing. Education and training are being transformed, along with employment models. New agile forms of working are emerging. Artificial Intelligence and robotics are in use – working alongside people.

The transition to a networked industry and a decent future world of work can succeed only if everyone is included in the change process – from the employers to the employees. To this end, the Plattform Industrie 4.0 experts bring together education managers from management boards and works councils, to discuss key questions in relation to work, education, and training.

The goal of the Working Group on "Work, Education and Training" is to shape the impending changes proactively and in a spirit of social partnership. Making recommendations for action and best practices, the Working Group shows how this can work. In a spirit of cooperation between social partners, it serves as a practical "sounding board" and pioneering thinker for the future industrial world of work.

For more information, visit: www.plattform-i40.de/PI40/Navigation/EN/ThePlatform/Structure-Organization/PlatformWorkingGroups/Work-Education-Training/work-education-training.html

Opportunities to participate and contacts

Are you interested in the work of Plattform Industrie 4.0 and/or the Sustainability Task Force?
Get in touch with us and take part!

Contact details for the Plattform Industrie 4.0 secretariat

Bülowstraße 78
10783 Berlin
Tel.: 030/2759 5066-50
Fax: 030/2759 5066-59
Email: geschaeftsstelle@plattform-i40.de
www.plattform-i40.de/PI40/Navigation/EN/ThePlatform/Participation/participation.html
Twitter: @plattform_i40
LinkedIn: Plattform Industrie 4.0

Sustainability Task Force contact person

Dr. Carsten Polenz,
Vice President of SAP SE,
member of the
Plattform Industrie 4.0
Steering Committeet.
Email: c.polenz@sap.com

Recommended reading and further information:

Path 1: Reduce consumption, increase impact

Digital Summit 2019: Video – Panel III – More sustainability through digitalisation I

BDI (2020): Für ein nachhaltiges und wettbewerbsfähiges Europa. Zur Mitteilung der Kommission: Der europäische Grüne Deal (For a sustainable and competitive Europe. Regarding the Communication from the Commission: The European Green Deal) (COM (2019) 640)

Fraunhofer IML (2020): "E²Log: Energieeffizienz in Logistik und Produktion", ("E²Log: Energy Efficiency in Logistics and Production")", research project at the Fraunhofer Institute for Material Flow and Logistics IML

Grischa Beier, Silke Niehoff, Ortwin Renn (2019): Industry 4.0 – taking efficiency to new heights? IASS, Potsdam

Jan Bieser, Ralph Hintemann, Severin Beucker, Stefanie Schramm, Lorenz Hilty (2020): Klimaschutz durch digitale Technologien – Chancen und Risiken (Protecting the Climate with Digital Technologies – Opportunities and Risks) (Short study). Bitkom e.V., Berlin

Liselotte Schebek, Jan Kannengießer, Alessio Campitelli, Julia Fischer, Eberhard Abele, Christoph Bauerdick, Reiner Anderl, Sebastian Haag, Alexander Sauer, Jörg Mandel, Dominik Lucke, Ivan Bogdanov, Anne-Kathrin Nuffer, Rolf Steinhilper, Johannes Böhner, Gerald Lothes, Christoph Schock, Detlef Zühlke, Christiane Plociennik, Simon Bergweiler (2017): Ressourceneffizienz durch Industrie 4.0. Potenziale für KMU des verarbeitenden Gewerbes. (Making efficient use of resources with Industry 4.0. Opportunities for SMEs in the manufacturing industry.), VDI, Berlin

Markus Lorenz, Martin Lüers, Max Ludwig, Simon Rees, Hartmut Rauen, Matthias Zelinger und Robert Stiller (2020): For Machinery Makers, Green Tech Creates Green Business. Boston Consulting Group & VDMA

Siegfried Behrendt, Edgar Göll (2018): Grüne Industrie 4.0? Von Potenzialen zur Umsetzung. Im Rahmen des Projekts Evolution2Green – Transformationspfade zu einer Green Economy. (Green Industry 4.0? From opportunities to implementation. In the context of the Evolution2Green Project – Transformation pathways to a green economy). adelphi, Borderstep, IZT, Berlin

Umweltbundesamt (Hrsg.) (2020): Kohlendioxid-Emissionen (Internet-Artikel). Umweltbundesamt, Dessau (Carbon Dioxide Emissions) (Internet Article). Federal Environment Agency (UBA), Dessau

ZVEI – Zentralverband Elektrotechnik- und Elektroindustrie e.V. (Hrsg.) (2020): Klimaschutz durch Elektrifizierung und Digitalisierung (Climate protection through electrification and digitisation) (Position Paper), ZVEI, Berlin

Path 2: From mass production to transparent service offerings

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Hrsg.) (2020): Digital Policy Agenda for the Environment (Website). Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Berlin

David Karl, Immanuel Zitzmann (2018): Smart und Sustainable? Industrie 4.0 aus der Perspektive der Nachhaltigkeit. (Smart and Sustainable? Industrie 4.0 from the Perspective of Sustainability), FIS University of Bamberg, Bamberg

nachhaltig.digital (2020): sustainable.digital Buidling Blocks. B.A.U.M, DBU

Plattform Industrie 4.0 (2018-2020): Diverse publications on digital business models. Federal Ministry of Economic Affairs and Energy, Berlin

Plattform Industrie 4.0 (2018-2020): Diverse publications on the Asset Administration Shell. Federal Ministry of Economic Affairs and Energy, Berlin

Path 3: Sharing and networking

Bits & Bäume – Die Bewegung für Digitalisierung und Nachhaltigkeit (The Movement for Digitalisation and Sustainability) (Website)

Federal Environment Ministry (Hrsg.) (2020): Digital Policy Agenda for the Environment (Website). Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Berlin

Grit Walther (2010): Nachhaltige Wertschöpfungsnetzwerke. Überbetriebliche Planung und Steuerung von Stoffströmen entlang des Produktlebenszyklus. (Sustainable Value Added Systems. Inter-company planning and management of material flows along the product lifecycle.), Wiesbaden

ifok (2020): Kooperation 4.0 – Ein neues digitales Miteinander (Cooperation 4.0 – A New Digital Cooperation) (Blog article). Ifok, Berlin

Martina Fromhold-Eisebith, Ulrike Grote, Ellen Matthies, Dirk Messner, Karen Pittel, Hans Joachim Schellnhuber, Ina Schieferdecker, Sabine Schlacke, Uwe Schneidewind (Lead Author) (2019): WBGU Annual Report "Towards our Common Digital Future", German Advisory Council on Global Change (WBGU), Berlin

Öko-Institut (Hrsg.) (2019): Transformation = [nachhaltig + digital]. Dokumentation der Jahrestagung des Öko-Instituts 2019, (Transformation = [sustainable + digital]). Documentation for the meeting of the Oeko-Institut 2019, Öko-Institut e.V., Freiburg

Plattform Industrie 4.0 (2020): Fortschreibung der Anwendungsszenarien der Plattform Industrie 4.0. (Updating the Plattform Industrie 4.0. Application Scenarios) Federal Ministry of Economic Affairs and Energy, Berlin

Plattform Industrie 4.0 (2020): KI in der Industrie 4.0 – Orientierung, Anwendungsbeispiele, Handlungsempfehlungen. (AI in Industrie 4.0 – Orientation, Application Examples, Recommendations for Action). Federal Ministry of Economic Affairs and Energy, Berlin

Pragmatic Industries (2020). Nachhaltigkeit und Industrie 4.0 – Chance oder Widerspruch? (Sustainability and Industrie 4.0 – An Opportunity or a Threat?)

German Council for Sustainable Development (Hrsg.) (2017): Die intelligente Kreislaufwirtschaft (The Intelligent Circular Economy) (Internet Article). German Council for Sustainable Development, Berlin

German Council for Sustainable Development, ifok (2016): Industrie 4.0 und Nachhaltigkeit: Chancen und Risiken für die Nachhaltige Entwicklung. (Industrie 4.0 and Sustainability: Opportunities and Risks in Sustainable Development) Berlin

www.plattform-i40.de