Online Training Series

Resource Efficiency for Businesses

VDI Zentrum Ressourceneffizienz

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

GREEN GROWTH Knowledge Partnership

Strategies, Measures and Real-World Experience

GREEN GROWTH
Knowledge Partnership

Green Growth Knowledge Platform

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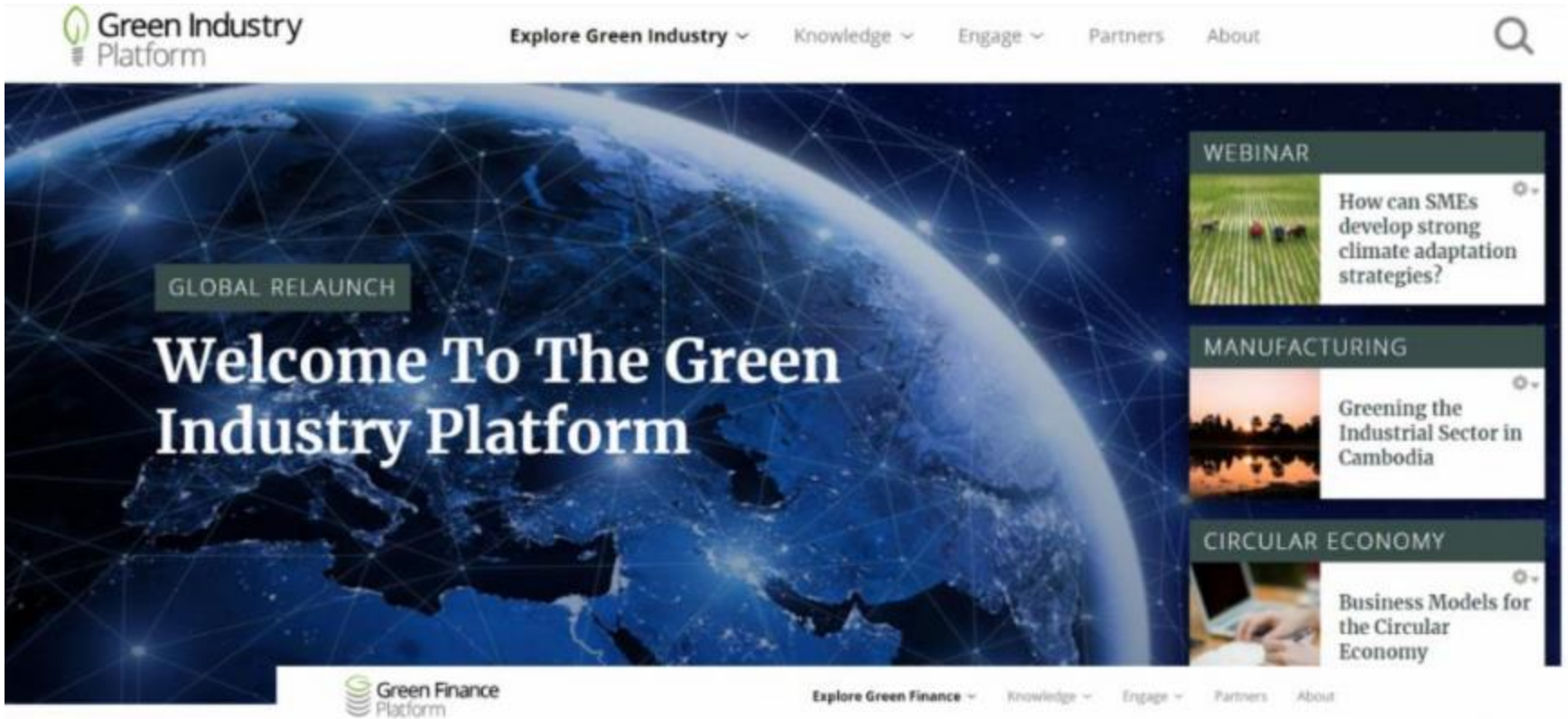
www.ggkp.org



Green Industry Platform

greenindustryplatform.org

Green Finance Platform

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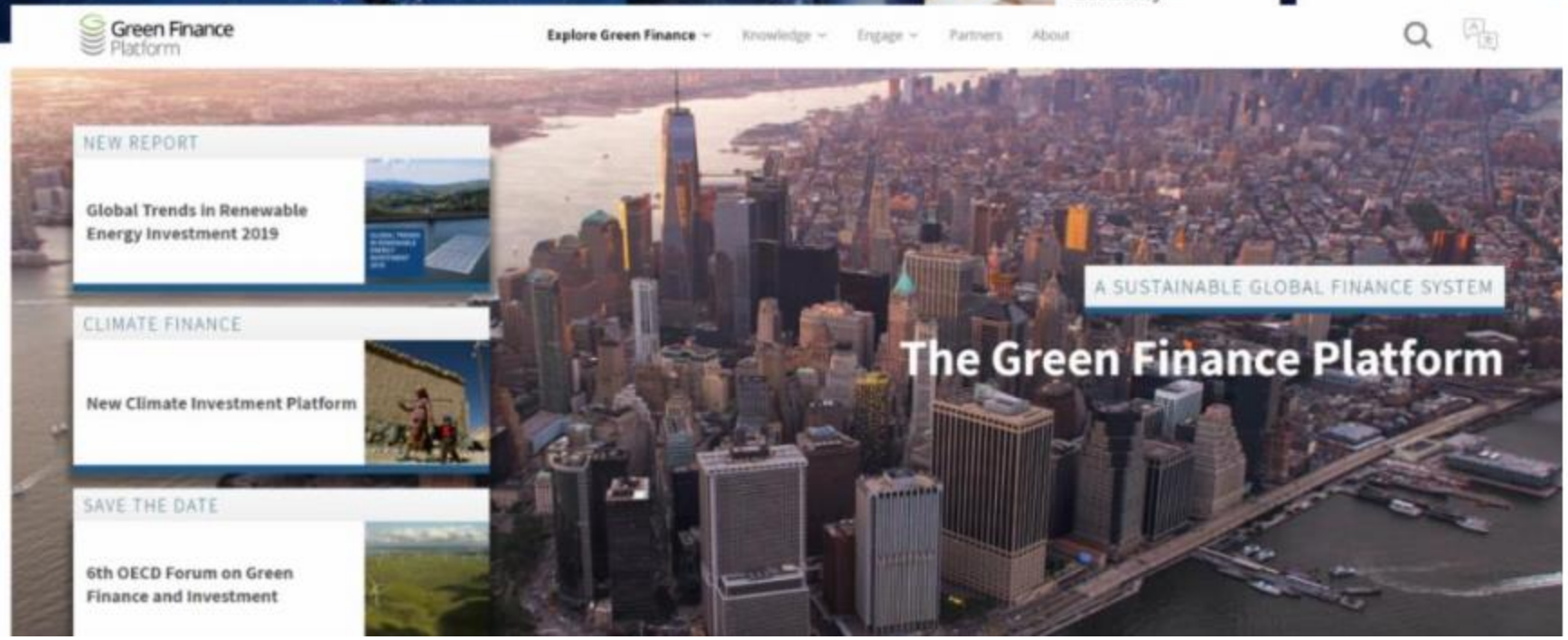

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Scientific Officer /
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Project Manager EU &
International Affairs

VDI Centre for Resource Efficiency (VDI ZRE)

VDI Centre for Resource Efficiency (VDI ZRE)

- Focuses on Resource Efficiency in operational practice through connection to VDI
- Competence Centre for demand-driven technical knowledge on Resource Efficiency in SMEs
- Development of standards through VDI guidelines for Resource Efficiency in cooperation with VDI

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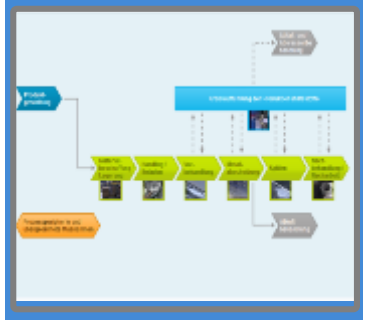
Tools & Services of VDI ZRE

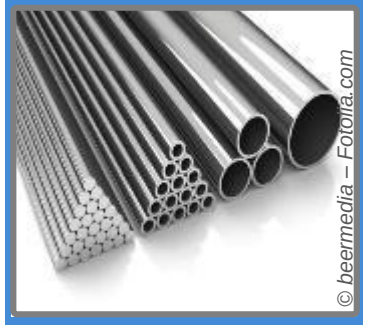
Process chains



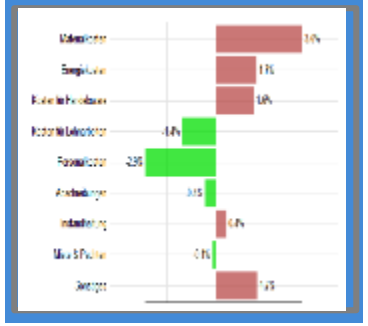
Resource checks

Innovation radar

Studies



Cost calculator

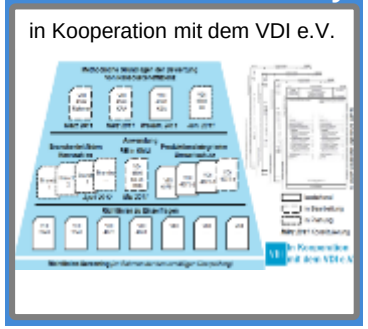


Videos

Training courses

VDI guidelines on Resource Efficiency

in Kooperation mit dem VDI e.V.



Initiative for Resource Efficiency and Climate Action

- Contributes to a more sustainable management of resources and, through that, to the reduction in GHG emissions related to resource use
  - Raising awareness about existing potentials and strengthening national and international dialogues
  - Supporting international networking and cooperation and contributing to its operationalization
  - Strengthening capacities of key stakeholders
  - Providing consultancy for identifying and tapping of potentials for enhanced resource efficiency and climate protection
- Focus: Emerging Economies within G20

Resource Efficiency Online Training Series

Webinar 1: The Business Case for Resource Efficiency - 19 February (3pm CET)

- Methodical principles and motivations for introducing resource efficiency in SMEs
- Interactive discussion: Drivers and barriers for resource efficiency

Webinar 2: The Resource Efficiency Roadmap for Businesses - 26 February (3pm CET)

- A roadmap for implementation of resource efficiency strategies
- Interactive discussion: The role of employees before and during implementing resource efficiency

Webinar 3: Strategies, Measures and Real-World Experience - 4 March (3pm CET)

- Product- and process-related strategies for improved resource efficiency and examples of good practice
- Interactive discussion: Digitisation and “Industry 4.0” technologies for increasing resource efficiency

Resource Efficiency Online Training Series

Resource Efficiency Strategies, Measures and Real-world Experience

Resource Efficiency Strategies, Measures, and Real-world Experience

Which product-related, process-related and product- and process-independent resource efficiency strategies exist?

What effort is to be expected by implementing resource efficiency measures?

How can digitisation and “Industry 4.0“ technologies support the implementation of resource efficiency in companies?

AGENDA

- Introduction into development of improvements
- Product-related strategies and measures
- Process-related strategies and measures
- Product- and process-independent strategies and measures
- Resource efficiency through Digitisation & Industry 4.0

Introduction into development of improvements

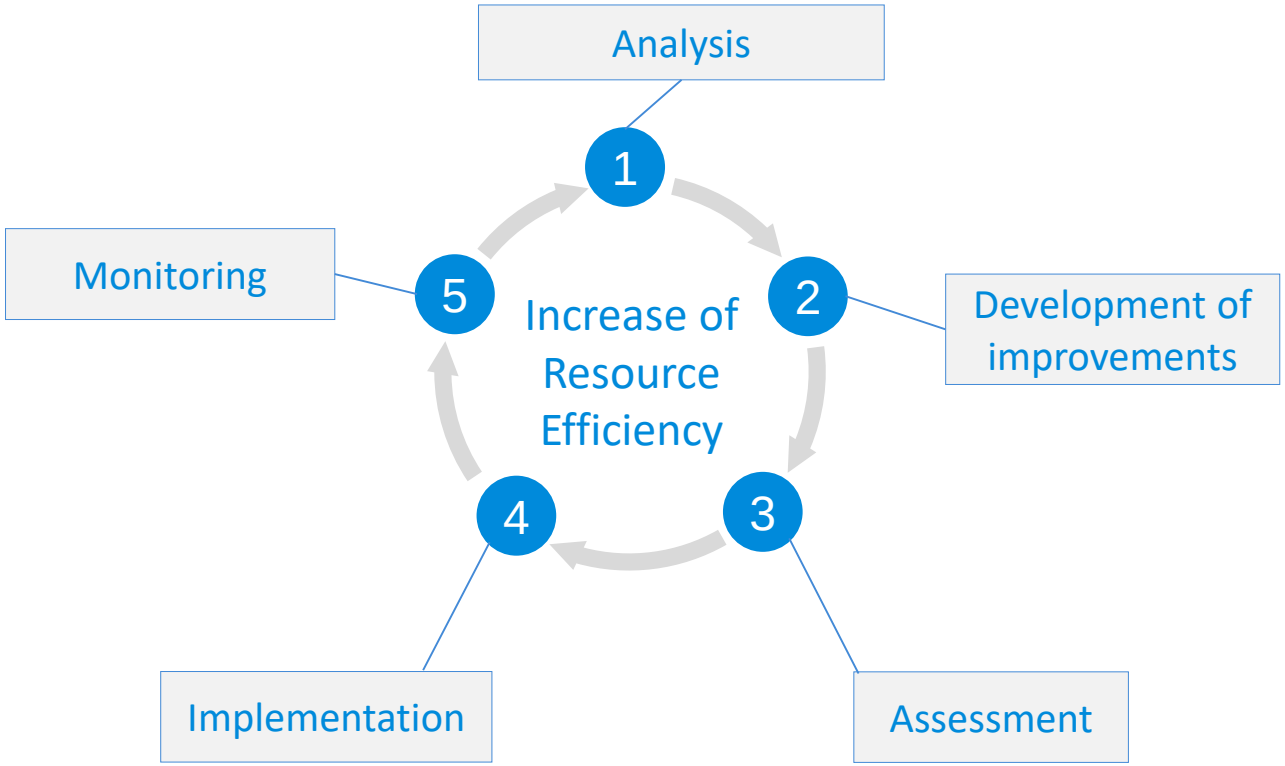
Where are savings potentials for natural resources in the company?

What strategies exist to improve resource efficiency in the company?

At which system level can resource efficiency strategies be implemented?

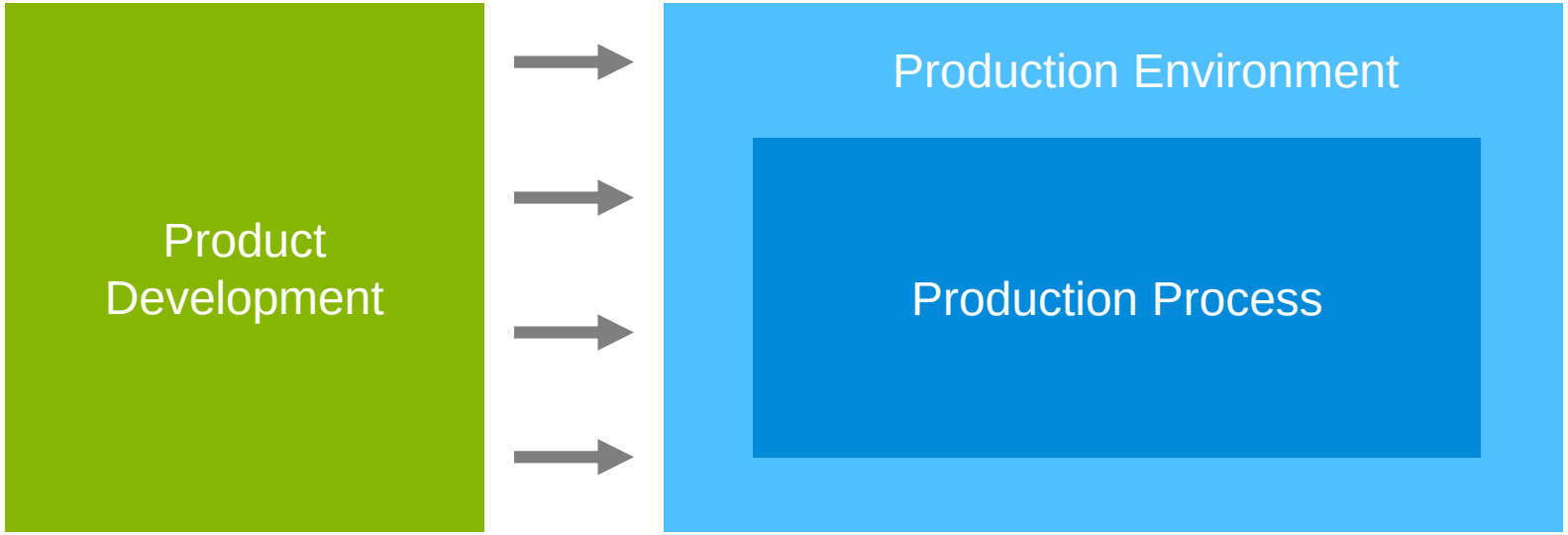
Roadmap “Resource Efficiency”

Steps toward an implementation of resource efficiency measures



Resource efficiency approaches for companies

- Where are savings potentials for **material**, **energy** and **water** in the company?

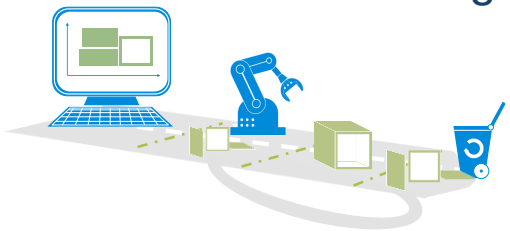


Development of improvements

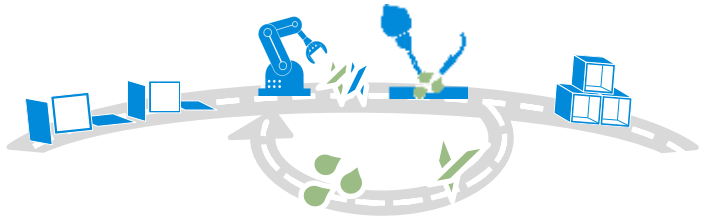
Strategies and measures to increase resource efficiency

The starting point for developing solutions can be divided into three categories:

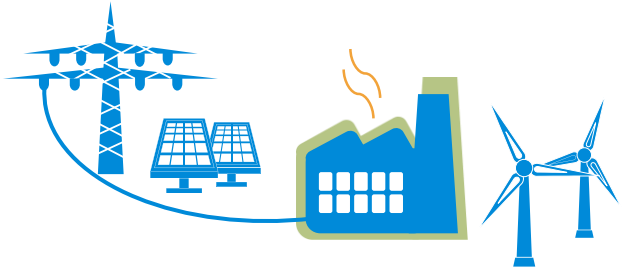
Product-related solutions



Process-related solutions



Product- and process-independent solutions



Overview of strategies and measures for increasing RE

VDI guideline 4800 Part 1 Resource efficiency

			Related to		Influential parties in the company						Life phases with relevant effects					Life cycle analysis		
	No.	Strategy	product	production	product development	factory planning	operations planning	purchasing/procurement	production	sales	raw material processing	product manufacturing	use	recovery/disposal	transport	required	conditionally required	not required
product-related	1	Material choice/material substitution	●		●						●	●	●	●	●	●		
	2	Lightweight design	●		●						●		●		●		●	
	3	Mission match and safety	●		●						●		●					●
	4	Miniaturisation	●		●						●	●	●	●	●	●		
	5	Production-oriented product design	●		●		●		●			●					●	
	6	Use-oriented product design	●		●								●		●	●		
	7	Extension of technical lifetime	●		●						●	●				●		
	8	Extension of product service life	●		●						●	●					●	
	9	Product service systems (dematerialisation)	●		●						●	●	●		●		●	
process-related	15	Manufacturing process selection and optimisation		●		●	●		●			●					●	
	16	Equipment dimensioning		●		●						●						●
	17	Minimisation of machining volume		●	●	●	●		●			●					●	

Source: VDI 4800 Part 1 Resource efficiency - Methodological principles and strategies (2016)

Overview of strategies and

VDI guideline 4800 Part 1 Resourc

	No.	Strategy	Influential parties in the company: product development	factory planning	operations planning	purchasing/procurement	production	sales	Life phases with relevant effects: raw material processing	product manufacturing	use	recovery/disposal	transport	Life cycle analysis: required	conditionally required	not required
product-related	1	Material choice/material substitution	●		●						●	●	●	●	●	●		
	2	Lightweight design	●		●						●		●		●		●	
	3	Mission match and safety	●		●						●		●					●
	4	Miniaturisation	●		●						●	●	●	●	●	●		
	5	Production-oriented product design	●		●		●		●			●					●	
	6	Use-oriented product design	●		●								●		●	●		
	7	Extension of technical lifetime	●		●						●	●				●		
	8	Extension of product service life	●		●						●	●					●	
	9	Product service systems (dematerialisation)	●		●						●	●	●		●		●	
process-related	15	Manufacturing process selection and optimisation		●		●	●		●			●					●	
	16	Equipment dimensioning		●		●						●						●
	17	Minimisation of machining volume		●	●	●	●		●			●					●	

Source: VDI 4800 Part 1 Resource efficiency - Methodological principles and strategies (2016)

AGENDA

- Introduction into development of improvements
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- Process-related strategies and measures
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- Resource efficiency through Digitisation & Industry 4.0

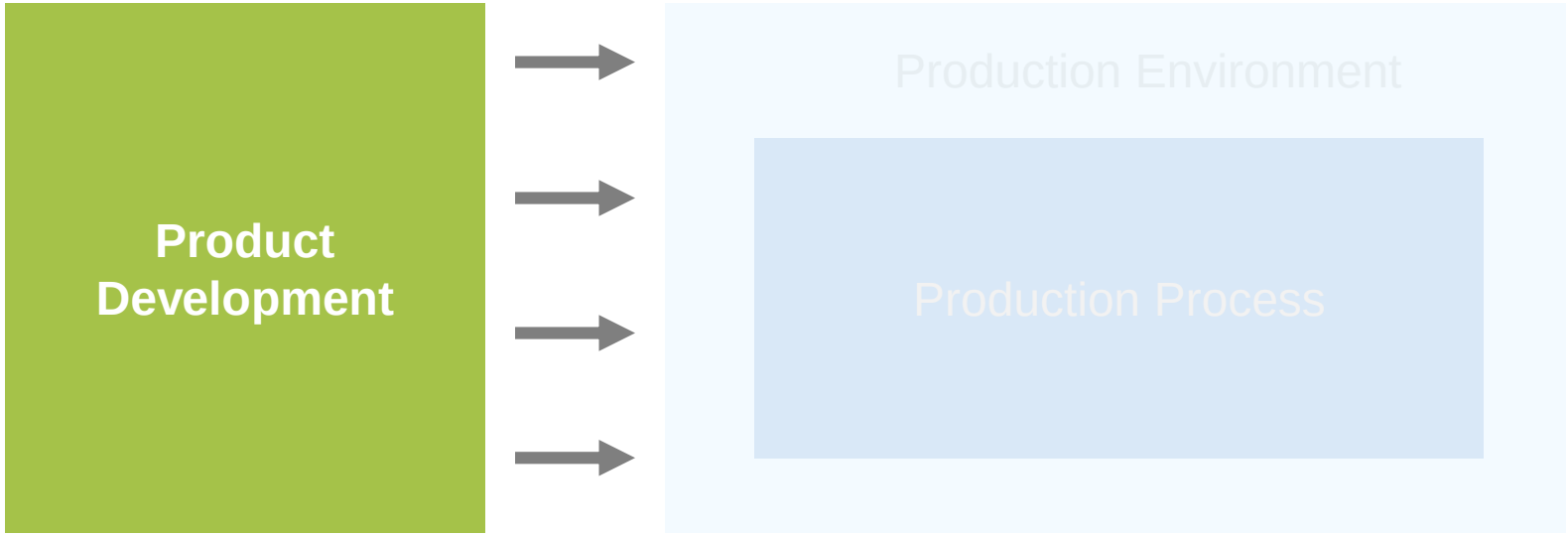
Product-related strategies and measures

What product-related measures and strategies exist?

How high are the energy and material savings of Good-practice-examples?

Resource efficiency approaches for companies

- Where are savings potentials for **material**, **energy** and **water** in the company?

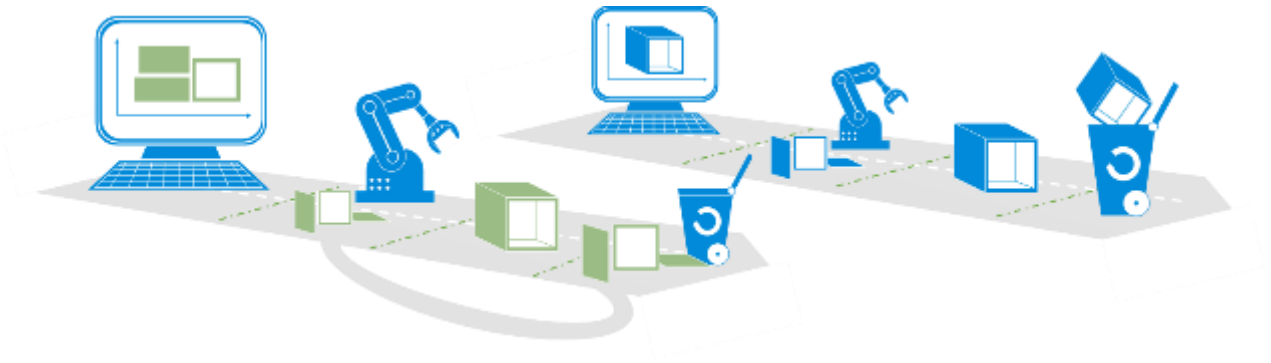


Product-related solutions

Product development determines the majority of resource consumption over the entire life cycle

→ **High impact on resource efficiency**

Product-related strategies and measures	
■ Product Service Systems ■ Production-oriented product design ■ **Recirculation-oriented product design** ■ Lightweight design	■ Optimised choice of material ■ Resource efficient product usage ■ Extension of product service life ■ Extension of technical life time



Recirculation-oriented product design

Recirculation-oriented product design - Advantages for RE

- When substances and components are extracted from a product and reprocessed for use in a new product, extra resource costs for the extraction and initial production of the material and components are avoidable.
- In addition, there is a reduction in waste that would otherwise have to be sent to landfill.

Strategy features	
Related to	Product
Influential parties in the company	Product development
Life phases with relevant effects	Raw material production, Recycling/ disposal
Life cycle analysis	required

Example I: Innovative LEDs

Initial Situation

- LED lamps usually consist of a variety of materials that are difficult to separate

Problem

- Higher material consumption and environmental impact due to aluminium heat sinks manufactured by casting
- LED lamps are poorly recyclable

Cut open socket of an LED lamp

Source: VDI ZRE WebVideoMagazine: Material efficient LED production

Example I: Innovative LEDs

Solution: Recycling-friendly product design

- reduction to seven components
- assembled by means of plug connections
- use of only two materials
- deep drawing instead of casting of the heat sinks
- automated manufacturing process

Source: VDI ZRE WebVideoMagazine; Titel: Material efficient LED production

Example I: Innovative LEDs

RE-potential

- 90 % reduction in raw material costs
- Energy savings of 50%

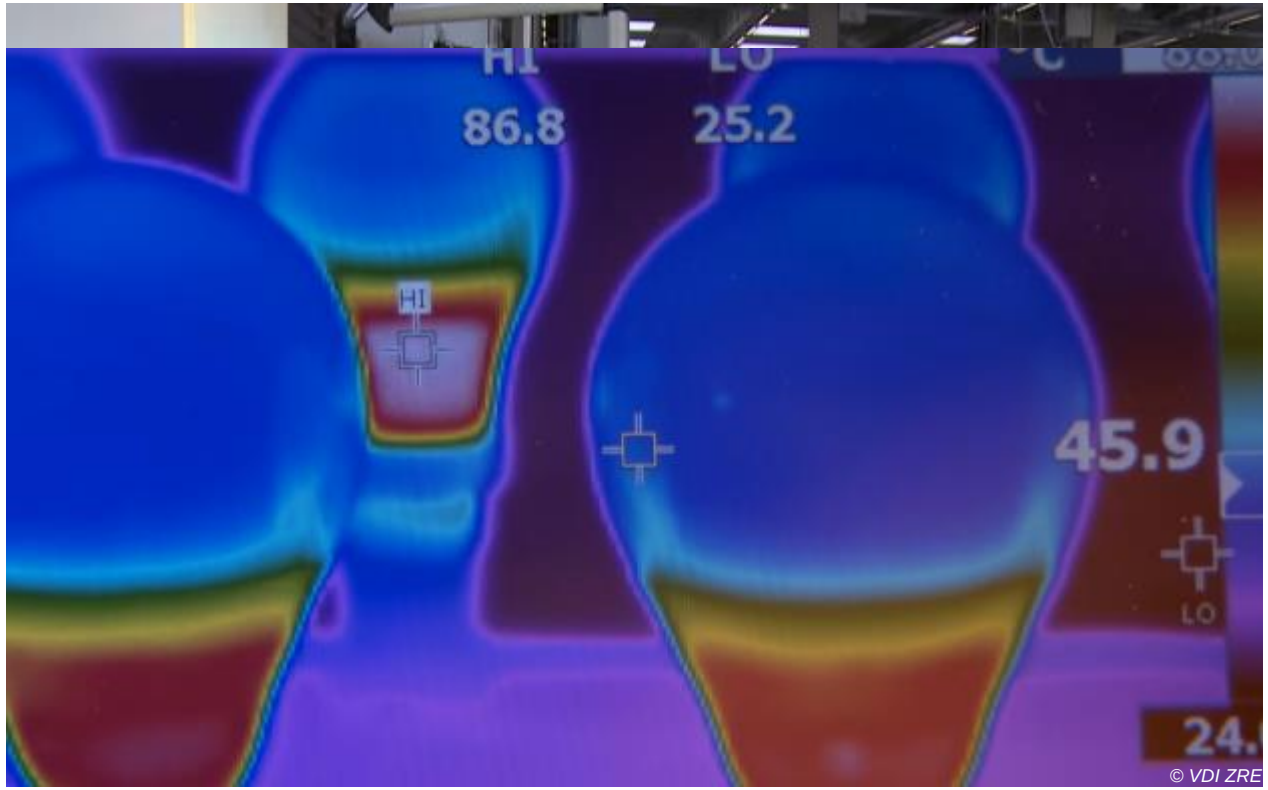
Additional Value

- Production close to customers → Shortening of transport routes
- increased service life due to dimming function in the case of overheating

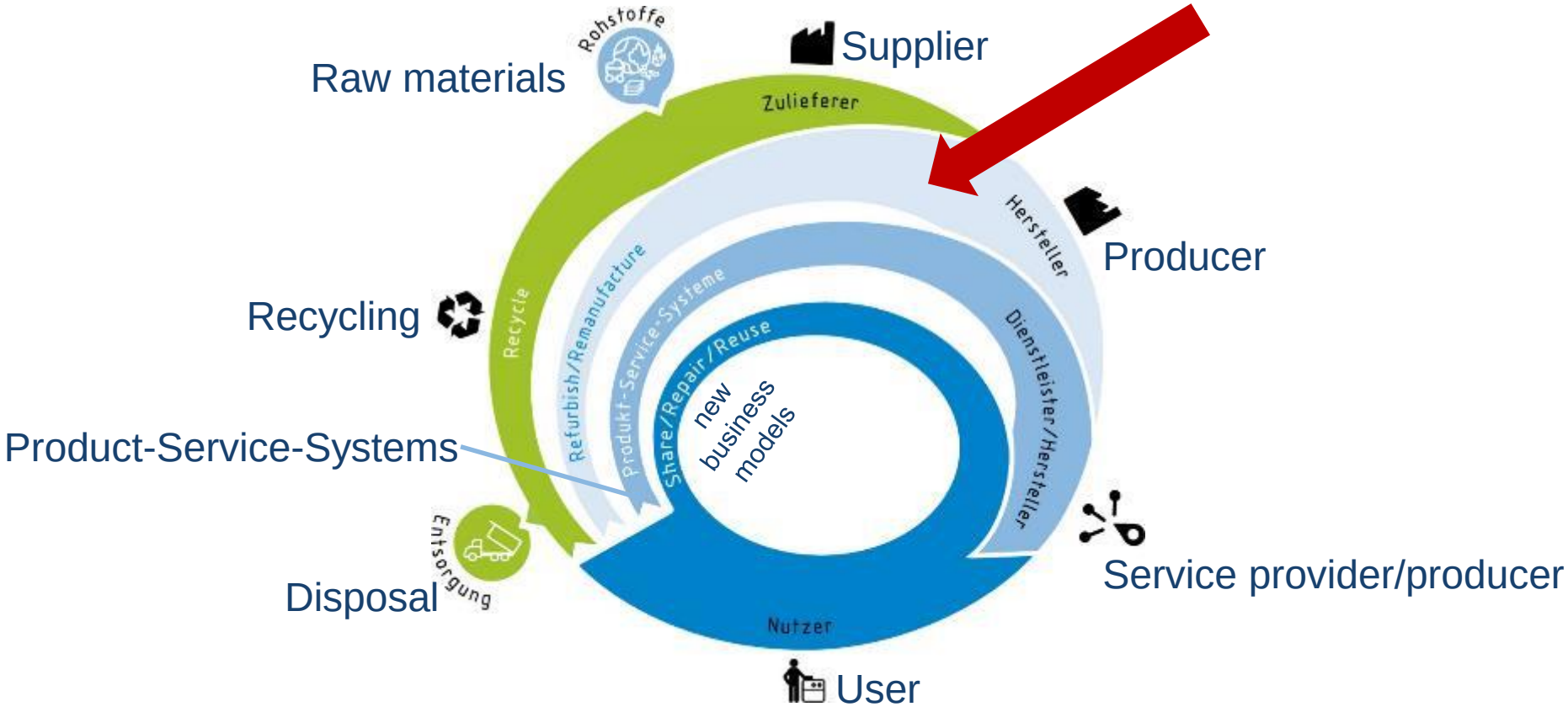
Source: VDI ZRE WebVideoMagazine; Titel: Material efficient LED production

Example I: Best Practice

Movie: Material efficient LED production in Germany



Example II: Remanufacturing



Example II: Remanufacturing

Definition

(1) Remanufacturing is an **industrial rebuilding process used on** cores.

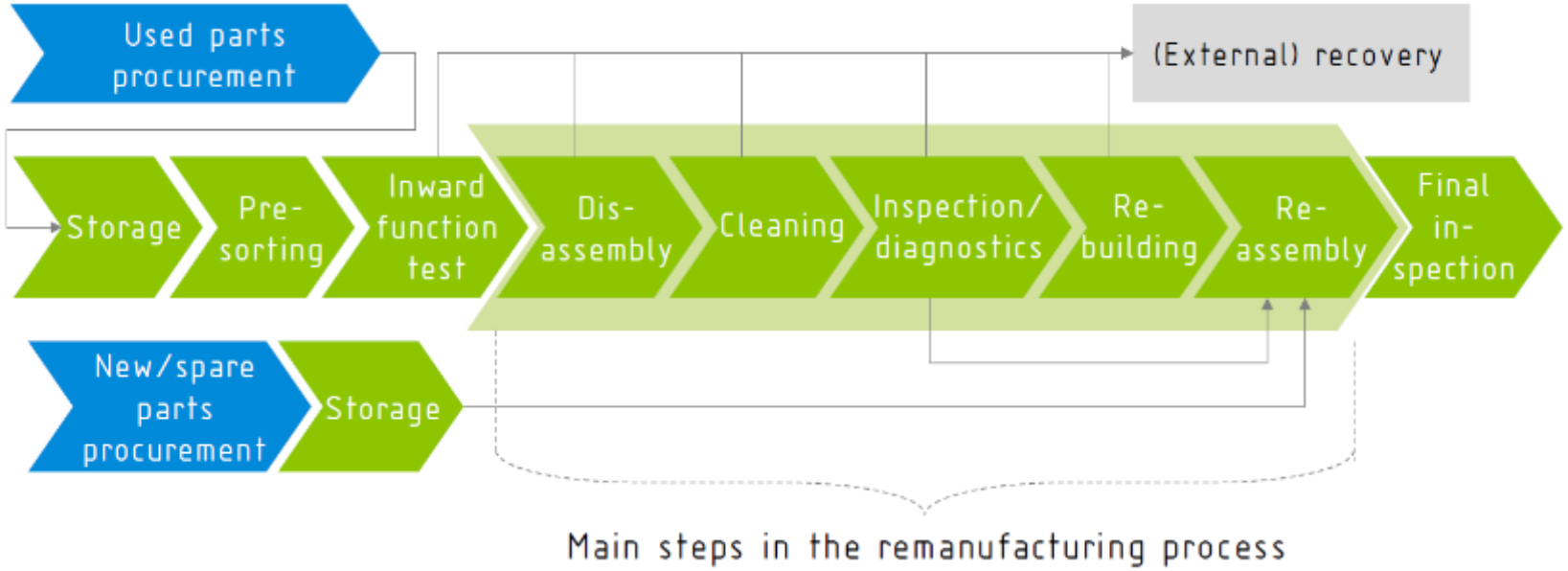
(2) A core is subjected to **standardised process steps** to rebuild it and restore its original function.

(3) The product performance given back to the core **is at the same level as or a higher level** than that of an equivalent new part.

(4) By means of the same **quality assurance measures** as for new parts production and a **warranty** it is ensured that the refabricated product or the refabricated product unit[7] has the quality of a new product or product unit.

Example II: Remanufacturing

Process chain



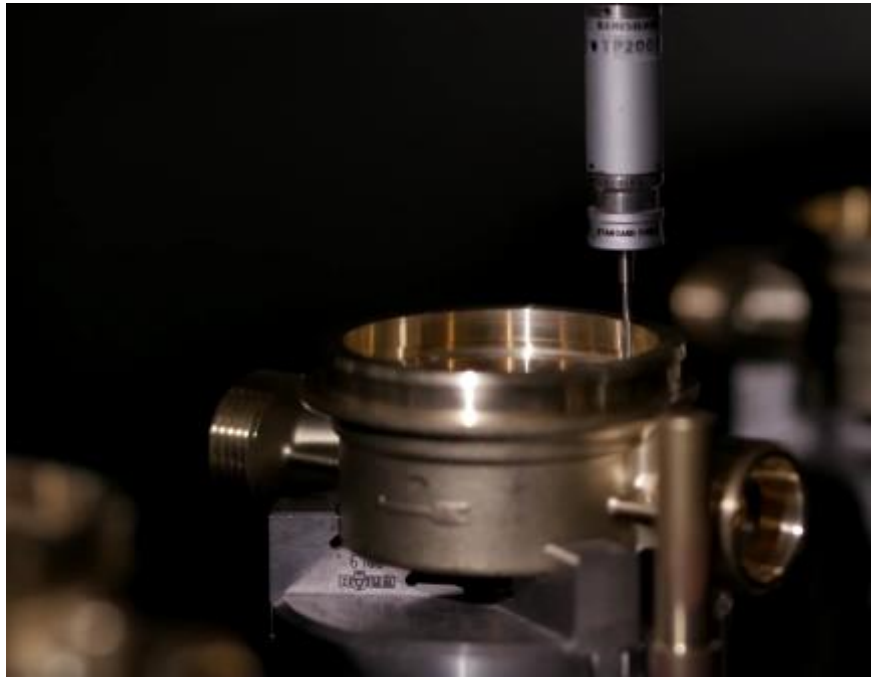
Example II: Remanufacturing

Initial Situation

- According to law, water meters must be replaced every 5 to 6 years.

Problem

- Disposal of still working products



Measurement of the water meter housing

Source: VDI ZRE WebVideoMagazine; New from old – resource efficiency through remanufacturing

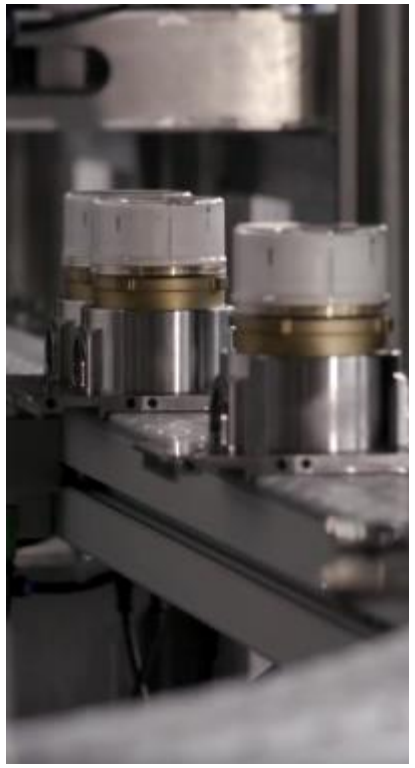
Example II: Remanufacturing

Solution:

Recyclable product design/repairability

- Remanufacturing of used products and reuse

- New product line
  → Consideration of "Design for Remanufacturing":
  - Production of products easily to disassemble
  - Software update of remanufactured products
  - Simplified calibration



Water meters

Source: VDI ZRE WebVideoMagazine; New from old – resource efficiency through remanufacturing

Example II: Remanufacturing

RE-potential

- Material savings of up to 80% of brass and electronic parts
- Energy savings of up to 80%

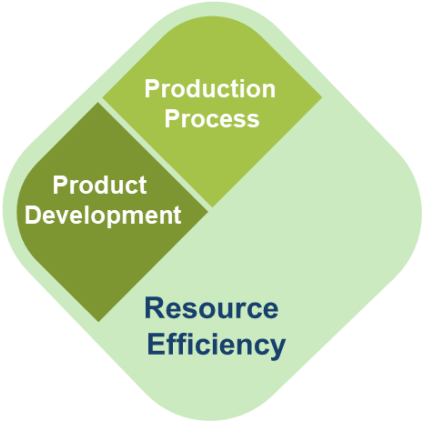
Additional value

- Cost advantage for customers

Source: VDI ZRE WebVideoMagazine; New from old – resource efficiency through remanufacturing

Example II: Best Practice

Movie: New from old – resource efficiency through remanufacturing



AGENDA

- Introduction into development of improvements
- Product-related strategies and measures
- Process-related strategies and measures
- Product- and process-independent strategies and measures
- Resource efficiency through Digitisation & Industry 4.0

Process-related strategies and measures

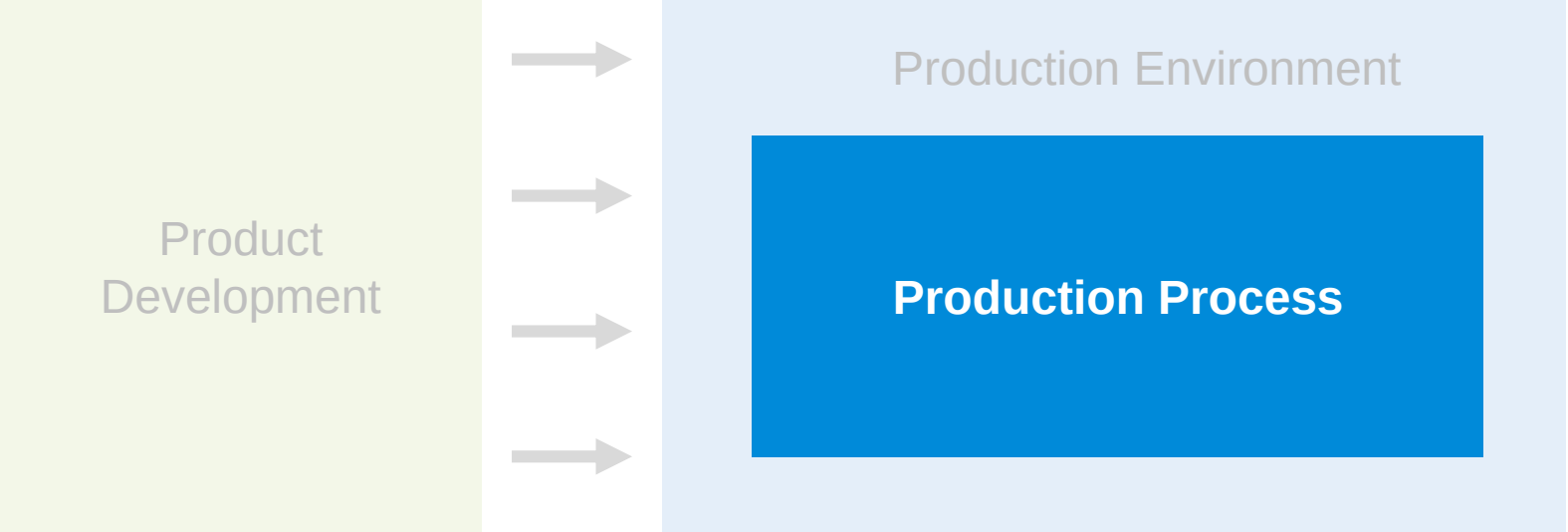
Which different process-related strategies are known?

What are examples for implementation?

What effort is to be expected during the implementation?

Resource efficiency approaches for companies

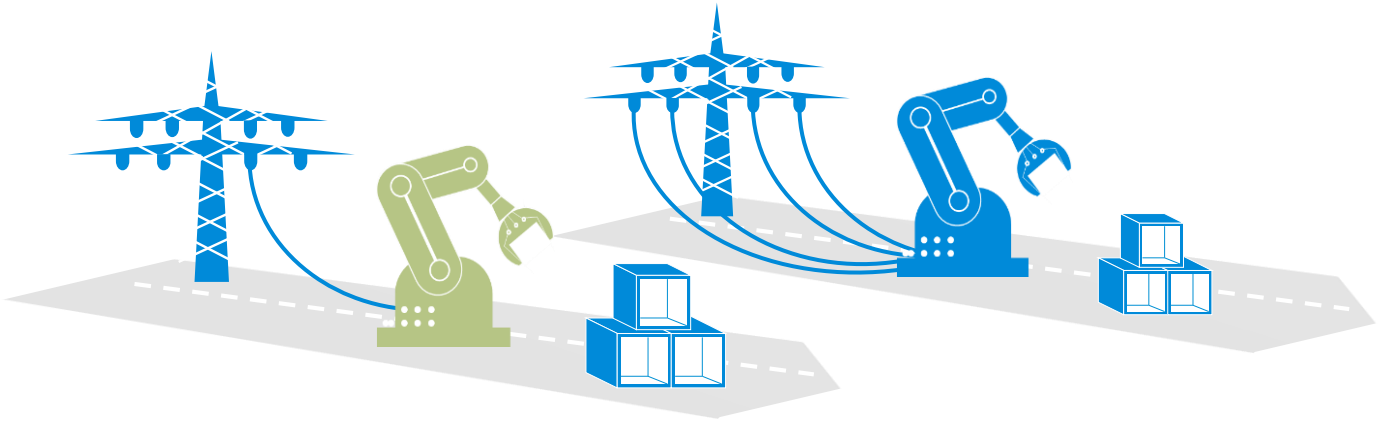
- Where are savings potentials for **material**, **energy** and **water** in the company?



Process-related solutions

Process-related solutions for increasing resource efficiency play an important role, especially since they can influence the manufacturing processes within their own plant boundaries themselves.

Process-related strategies and measures	
■ Manufacturing process optimisation ■ **Recirculation of products and components** ■ Recirculation of raw materials, auxiliary materials and operating supplies ■ Minimisation of machining volume	■ Minimisation of planned scrap ■ **Minimisation of planned loss** ■ Minimisation of storage loss ■ **Reduction of energy consumption** ■ Cascading use of auxiliary materials and operating supplies ■ Substitution of auxiliary materials and operating supplies



Reduction of energy consumption

Reduction of energy consumption

- By using energy in production, considerable amounts of finite resources in the form of energy sources are sometimes used.
- From a geopolitical point of view, until there is a complete switch over to renewable energies, there are risks due to dependencies on nations that produce oil and natural gas.
- In addition, the energy consumption of production processes contributes greatly to greenhouse gas emissions, which are damaging to the environment.

Strategy features	
Related to	Production
Influential parties in the company	Factory planning, operations planning, production
Life phases with relevant effects	Product manufacturing
Life cycle analysis	Conditionally required

Heat recovery in plastic pipe production

Initial situation

- Production of HDPE pipes with grooved barrel extruder

Source of loss

- Energy-intensive heating and cooling during the production process

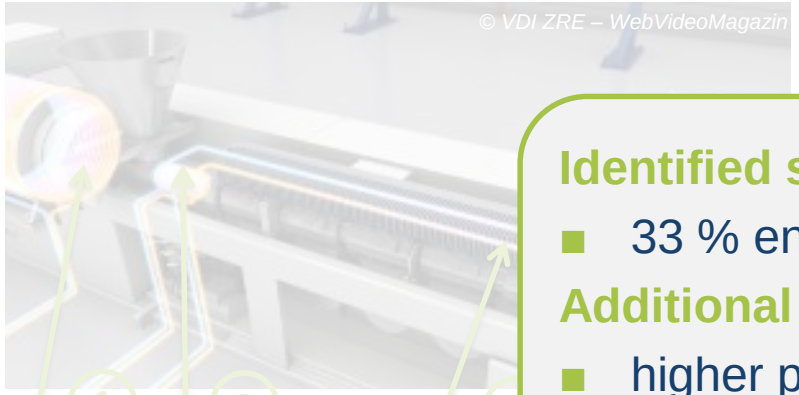
Solution

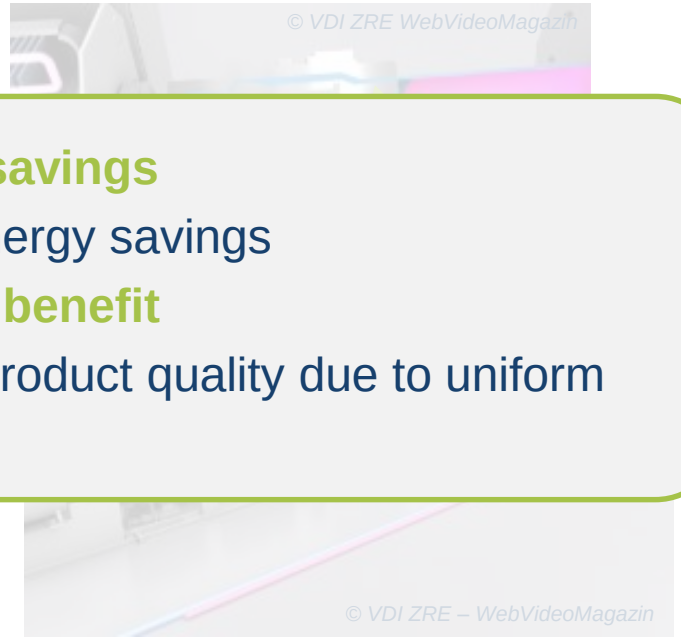
Use of process and waste heat

- Utilization of 4 waste heat flows
- Granulate preheater: heating of the granulate with waste heat from the manufacturing process

Heat recovery in plastic pipe production

- Utilization of 4 heat flows





cooling section (cascade cooling)

Identified savings

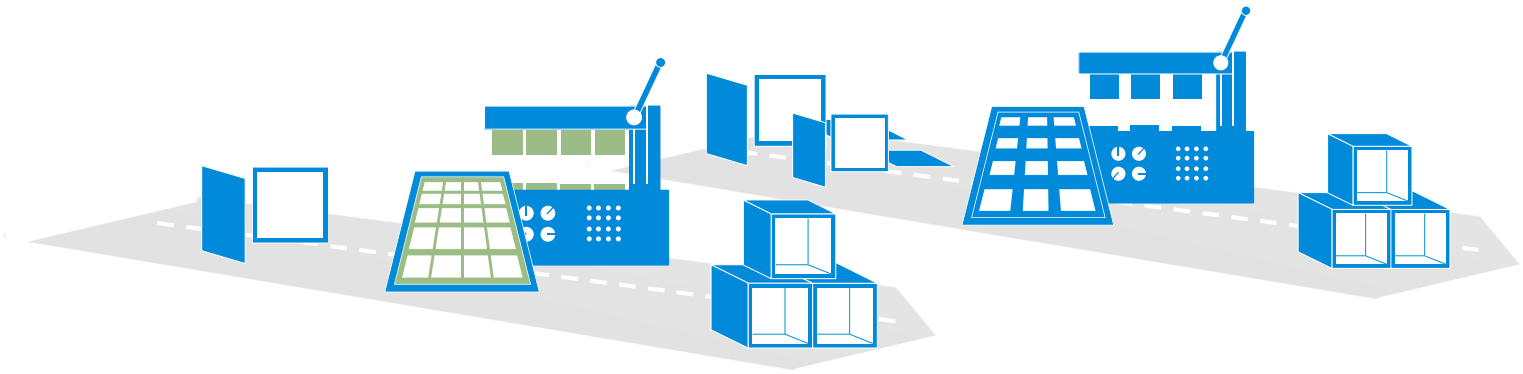
- 33 % energy savings

Additional benefit

- higher product quality due to uniform cooling

granules preheater

Source: VDI ZRE WebVideoMagazine: Plastic: less material, more quality



Minimisation of planned loss

Minimisation of planned loss

- The reduction of the planned loss leads to improved utilisation of (raw) materials
  - → With the same material input, production can achieve a higher production volume or reduce the material input whilst keeping the production volume the same. The material efficiency can thus be increased directly. The higher material utilisation also results in an indirect increase in resource efficiency, as less waste is generated, which then needs to be disposed of or recycled.

Strategy features	
Related to	Production
Influential parties in the company	Production development, operations planning, production
Life phases with relevant effects	Raw material processing, product manufacturing
Life cycle analysis	Not required

Punching of sheet metal components

Initial situation

- Stamping of components from sheet metal

Source of loss

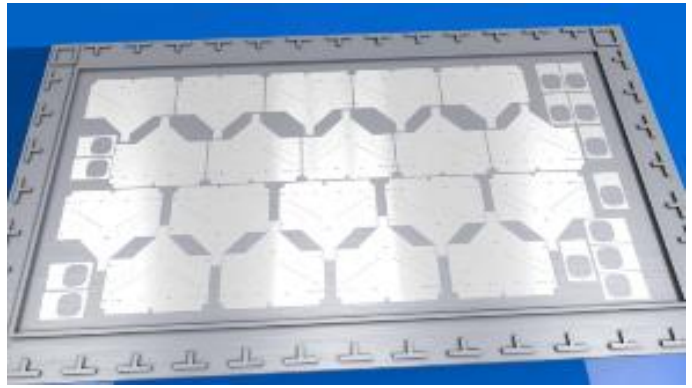
- Material loss due to large waste stamping grid

Solution

Optimal use of the punching grid area

- Implementation of a new punching and nibbling machine
- Optimising of the punching process with special software
- Punching out of the gaps: reduction of residual grid

Punching head © VDI ZRE



Setting of punched parts © VDI ZRE

Punching of sheet metal components

Initial situation

- Stamping of components from sheet metal

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- Punching out of the gaps: reduction of residual grid

Identified savings

- 10 % material saving
- Energy savings due to reduced non-productive set-up times

Additional benefit

- Higher product quality (avoided scratches)
- Punching of various shapes from one sheet metal

Punching head

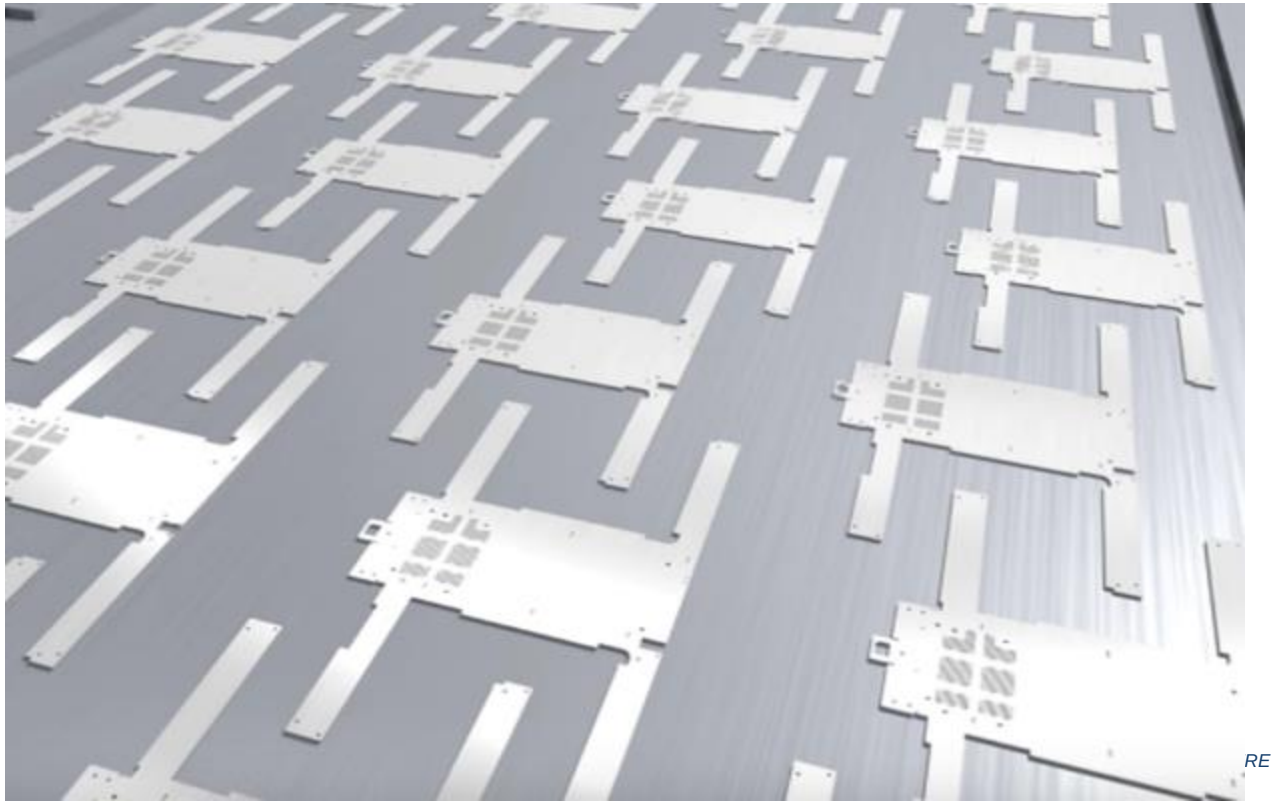
© VDI ZRE

Setting of punched parts

© VDI ZRE

Best Practice

Movie: More efficient punching and rolling



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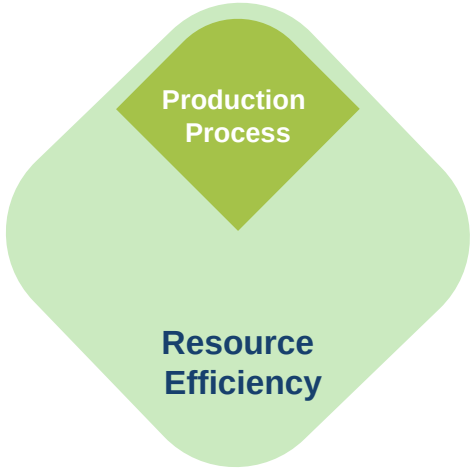
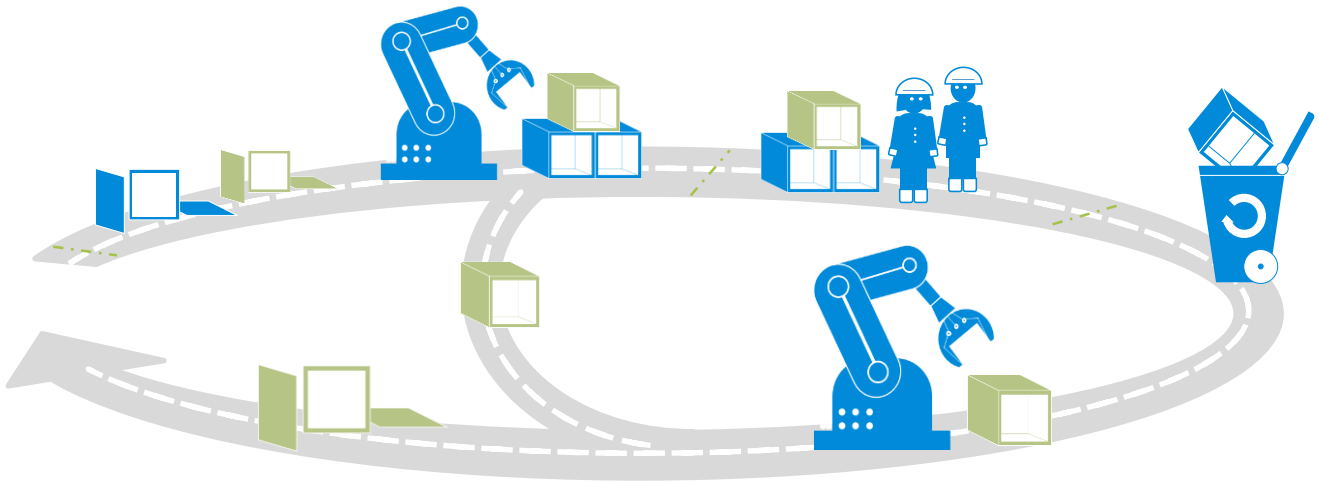




Recirculation of products and components

Recirculation of products and components

- By reusing parts, repetitive resource costs can be avoided for production input.
- Reduction of the waste that would otherwise be subject to thermal utilisation.
- Reuse is favoured over recycling and other use mechanisms in the waste hierarchy as it eliminates additional material and energy costs for re-manufacturing components

Strategy features	
Related to	Production
Influential parties in the company	Management, factory planning, production
Life phases with relevant effects	Raw material processing, product manufacturing, transport
Life cycle analysis	Conditionally required

Internal plastics recycling

Initial situation

- Production of plastic basket

Source of loss

- Process-related scrap

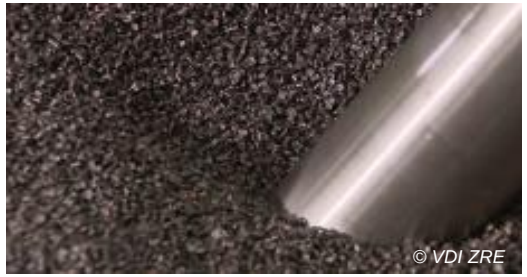
Solution

Recirculation of scrap material

- Use of scrap material
- Adaptive process control of the extruder by measuring the viscosity

Separation

Milled material



Re-Granulate

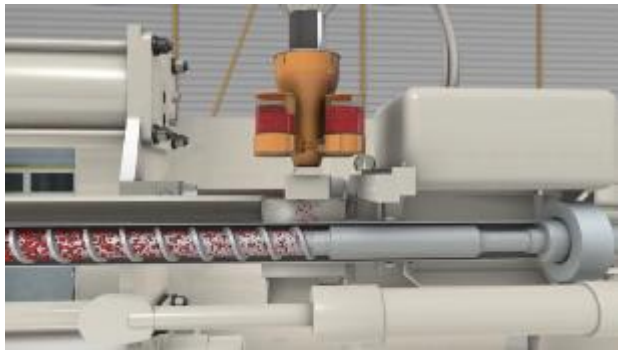
Internal plastics recycling

Identified savings

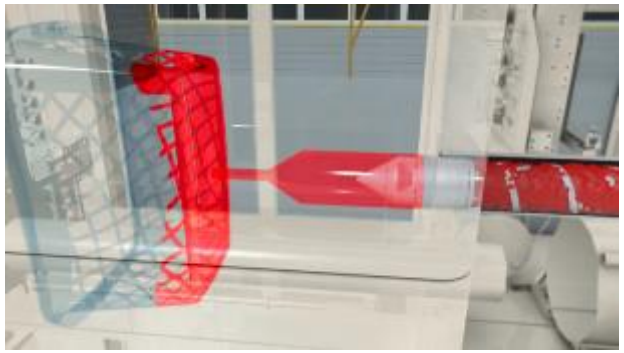
- saving of raw materials
- cost reduction

Additional benefit

- achieving the same product properties with recycled material
- optimised use of self-produced recycled material



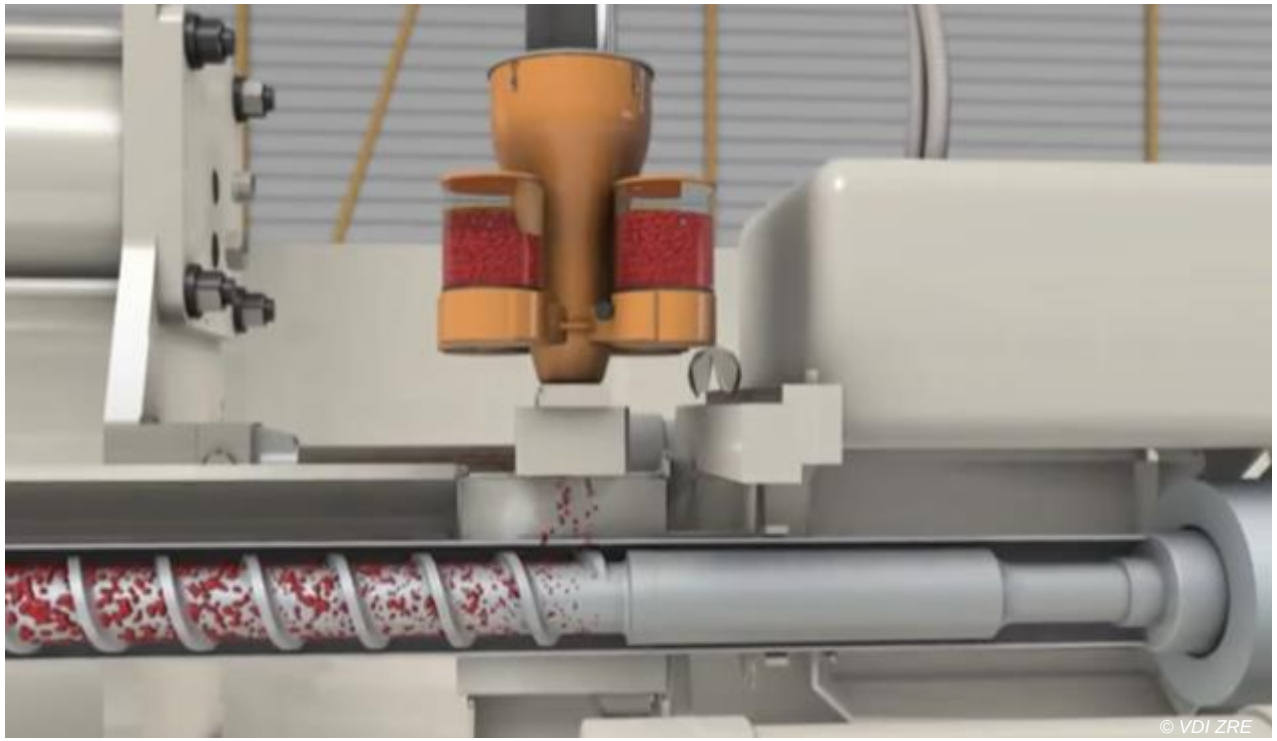
Coloured granulate fed to extruder © VDI ZRE

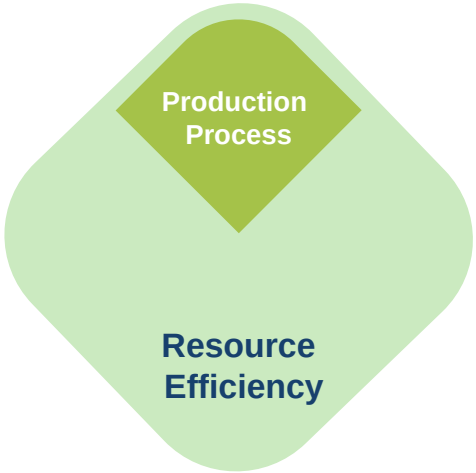


Plastic is pressed into the mould © VDI ZRE

Best Practice

Movie: Plastic: less material, more quality





AGENDA

- Introduction into development of improvements
- Product-related strategies and measures
- Process-related strategies and measures
- Product- and process-independent strategies and measures
- Resource efficiency through Digitisation & Industry 4.0

Product- and process independent strategies and measures

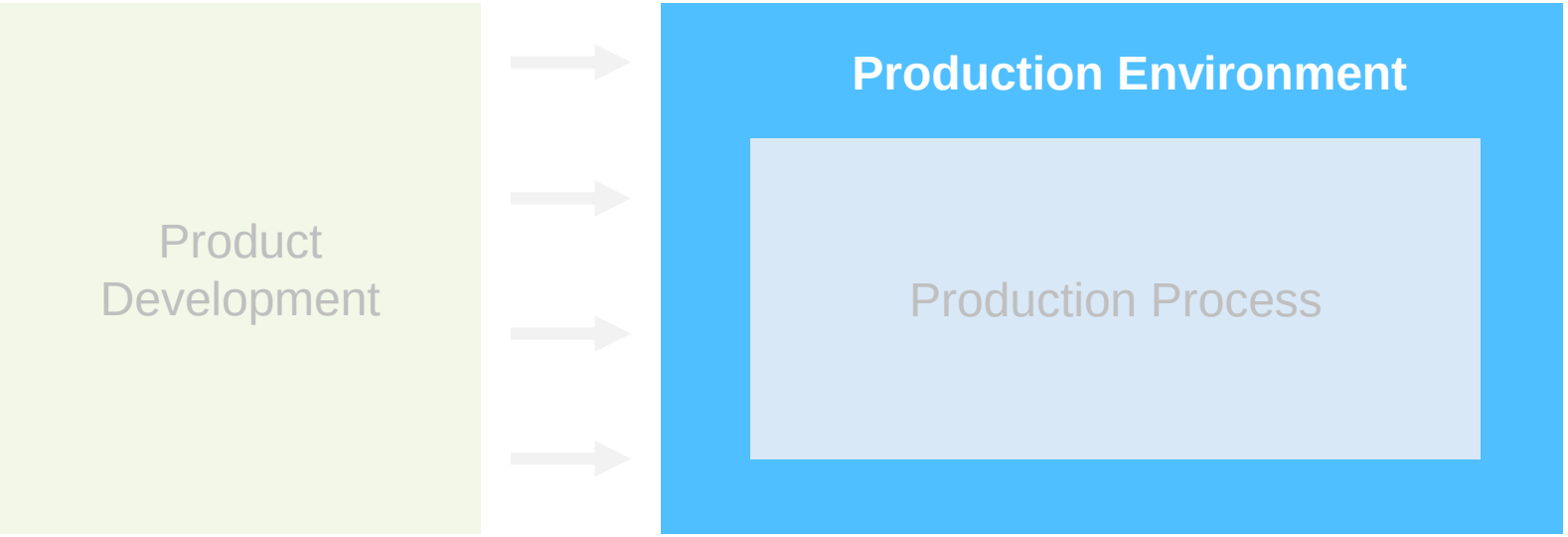
Which different product- and process-independent strategies are known?

What are examples for implementation?

What effort is to be expected during the implementation?

Resource efficiency approaches for companies

- Where are savings potentials for **material**, **energy** and **water** in the company?



Product- and process-independent solutions

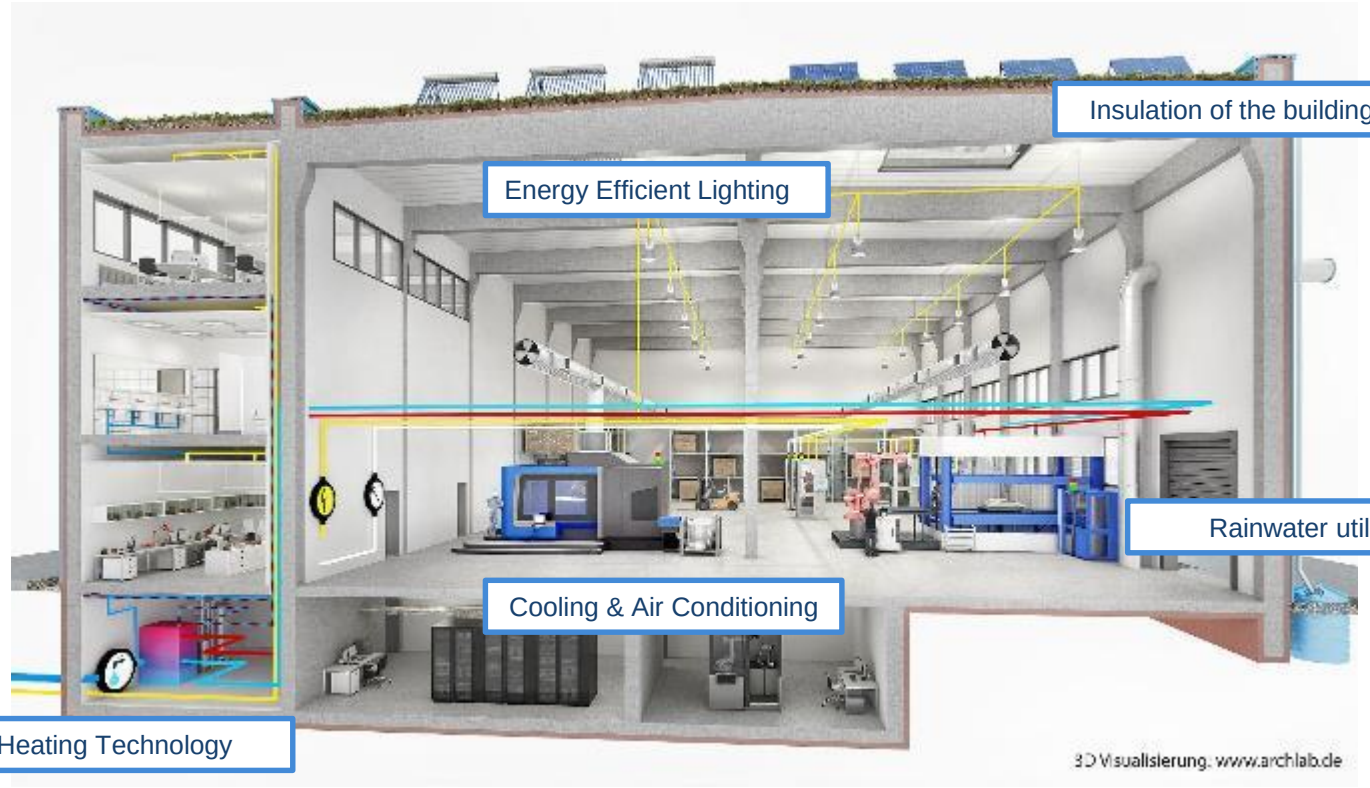
Product- and process-independent solution approaches include measures that affect the production infrastructure, such as technical building equipment, on the one hand, and work organizational measures, such as procurement or logistics, on the other.

Product- and process-independent strategies and measures	
■ **Efficient building infrastructure** ■ **Efficient energy supply** ■ Efficient company organisation	■ Efficient logistics ■ Efficient procurement

Efficient building infrastructure

Efficient building infrastructure & Efficient energy supply

Main topics



Efficient building infrastructure

- An efficient building envelope can minimise the energy losses of a building and optimise the energy gain through the passive use of renewable energies.
- In conjunction with an efficient building infrastructure or technical building equipment the interior space requirements can be met efficiently during the usage phase and with energy demand that is as low as possible.
- In addition to energy, the water efficiency in parts of the technical building equipment plays a role in the utilisation phase. The resource expenditure for the production of the components/construction technology and/or building technology should be considered in addition to the energy and water requirements in the use phase.

Strategy features	
Related to	Product- and process-independent
Influential parties in the company	Factory planning, production
Life phases with relevant effects	Product manufacturing
Life cycle analysis	Conditionally required

Lighting in industrial buildings

Initial situation

- Lighting in industrial halls with energy inefficient HQL luminaires

Sources of loss

- Up to 20 % of the electricity costs in companies for lighting
- Short technical service life of the HQL-lamps
- High-maintenance

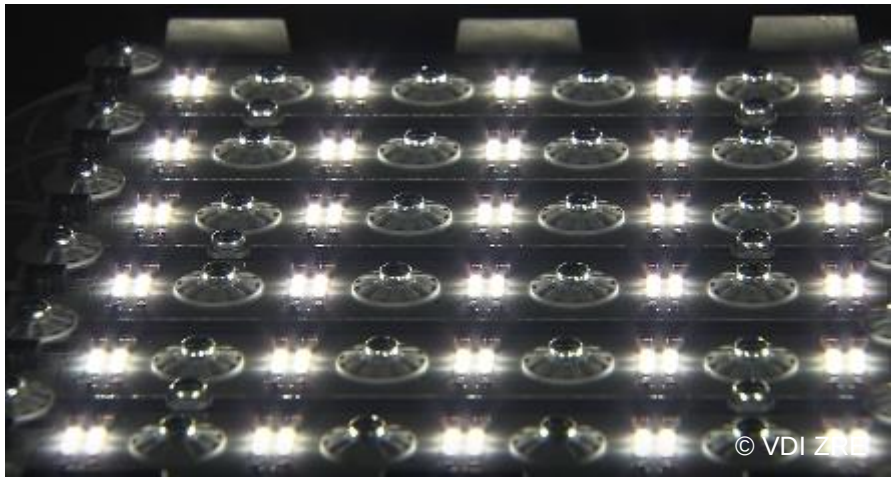
Conventional light bulbs

Lighting in industrial buildings

Solution

Use of LED luminaires in industrial buildings

- Use of LED light sources and intelligent lighting system (motion sensor, daylight control)



LED panel

Identified savings

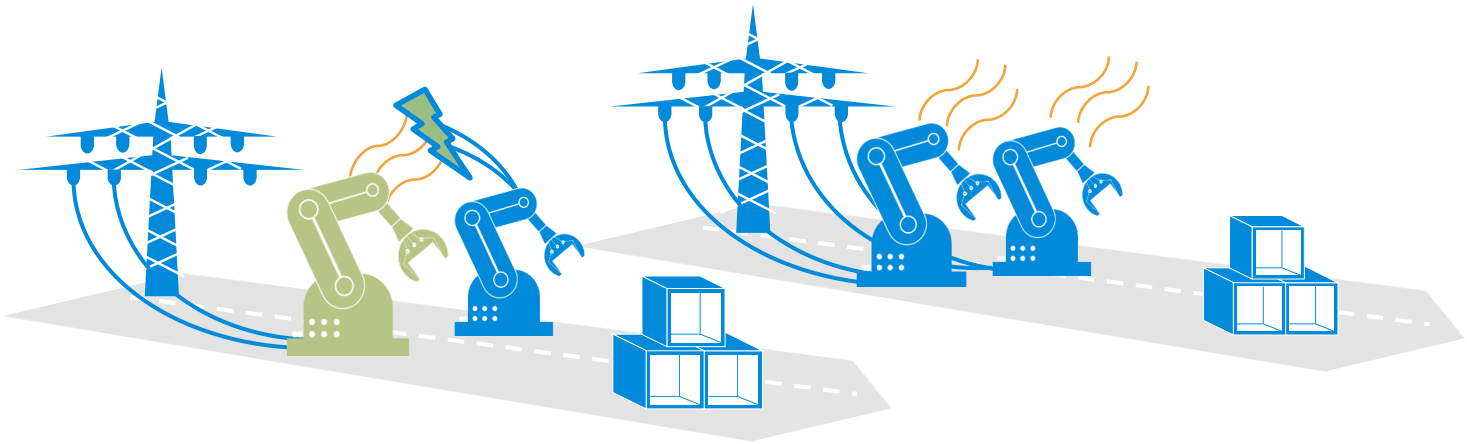
- Reduced energy consumption
- Savings of 90 % of electricity costs
- lower maintenance costs

Addes value

- more pleasant light (dimmability)
- insensitive to frequent switching on/off and vibrations

Best Practice

Movie: LED luminaires save energy



Efficient energy supply

Efficient energy supply

- If energy is provided more efficiently, the consumption of primary energy sources decreases. As a result, savings can be made on energy costs.
- In addition, manufacturing companies can use load management to help stabilise the electricity grid, thereby promoting the transformation to renewable energy. This results in additional business models for the companies (e.g. by providing control energy).

Strategy features	
Related to	Product- and process-independent
Influential parties in the company	Factory planning
Life phases with relevant effects	Product manufacturing
Life cycle analysis	Conditionally required

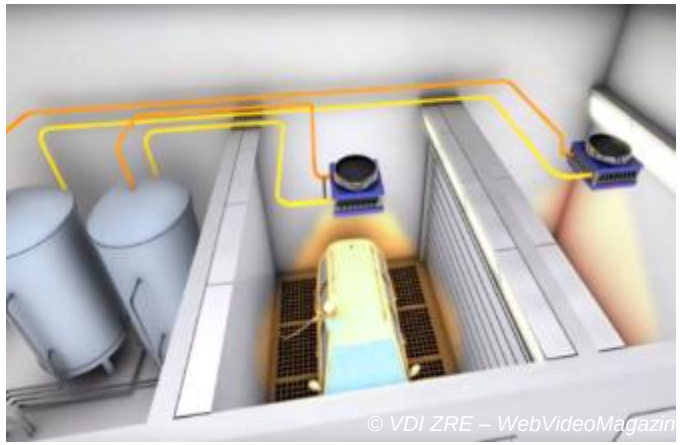
Use of solar energy in coating processes

Initial situation

- In coating and drying chamber a constant and warm air flow is needed (27 °C and 70 °C)

Source of loss

- High energy consumption for air flow heating in the coating and the drying section



Use of solar energy in coating processes

Solution

Use of solar energy

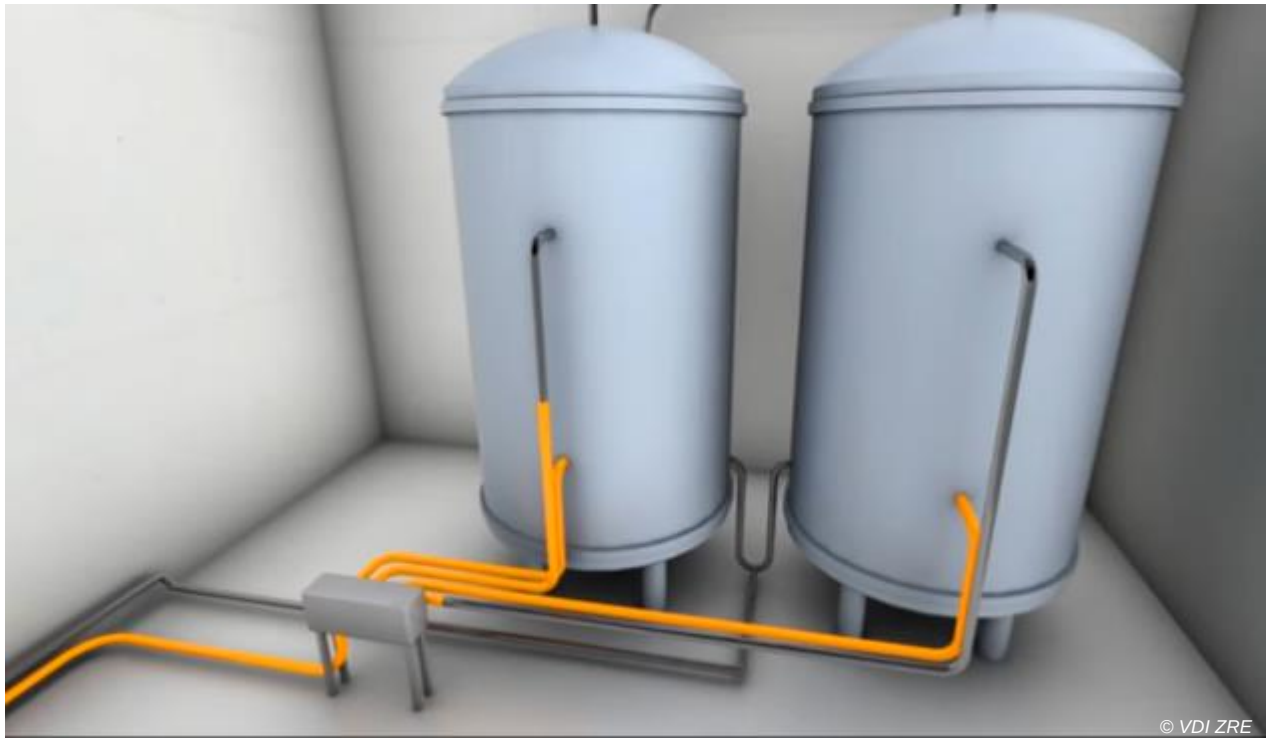
- Solar energy generation using vacuum tube collectors
- Intelligent heat distributor regulates the efficient distribution to two storage tanks
- Heating of the air for coating and drying processes by means of a water-air heat exchanger
- Obtaining additional heat from exhaust air by rotary heat exchangers (heat recovery)

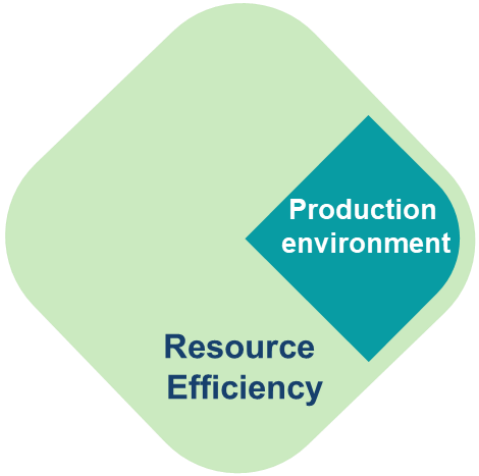
Identified savings

- 32 % savings due to solar thermal system
- 20 % savings due to heat recovery

Best Practice

Movie: Producing with sunlight – process heat



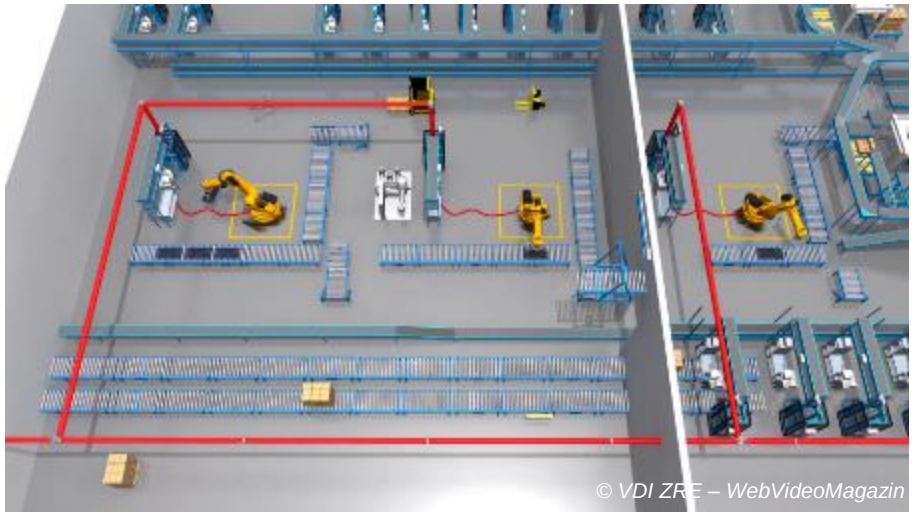


Efficient use and supply of compressed air

Sources of loss

High energy losses when compressed air is provided:

- Inefficient compressed air generation
- Waste heat
- Leakages



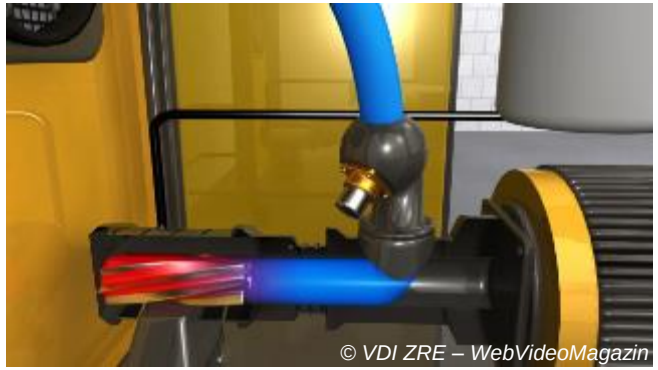
Efficient use and supply of compressed air

Compressed air system

Solution

System optimisation

- Use of waste heat for heating other processes with low heat requirement
- Use of speed-controlled drive system
- Decrease of pressure level in the piping system
- Disconnecting parts of compressed air system which are not used (using valves) → reduction of possible leaks



Identified savings
Use of 70% of the electrical energy (previously 3%)

Source: VDI ZRE WebVideoMagazine: Compressed air made easy

Efficient use and supply of compressed air

Leakages

Solution

Efficient data management

- Systematical monitoring of the piping system with ultrasonic measuring device
- Precise detection of smallest pin holes
- Collection, analysis and provision of leakage data using an app

→ efficient repair and maintenance planning

Leckagemessungen

Datenauswertung

Identified savings

- 35.000 € savings in energy costs
- Amortization time: a few weeks

Source: VDI ZRE WebVideoMagazine: Industry 4.0 - It´s Easy! Apps help save material and energy

Questions? …

Wissen
Qualifizierung
KMU
MATERIAL
Ressourcenchecks
WebVideomagazin
VDI ZRE
TECHNOLOGIE
RESSOURCEN
EFFIZIENZ
Einsparpotenziale
STUDIEN
Netzwerk
Klima
UMWELT
Innovationsradar
ENERGIE
Nachhaltigkeit

AGENDA

- Introduction into development of improvements
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Resource efficiency through Digitisation & Industry 4.0

Interactive session

Which strategies and measures might be **especially effective** on the path to increasing resource efficiency?

How can the digitisation and technologies of **“Industry 4.0”** can support the **implementation of resource efficiency** in companies?

Please share **your experience** with us…

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Study: Resource efficiency and Industry 4.0

- Title: „ Resource Efficiency through Industry 4.0 – Potential for SMEs in Manufacturing“
- Clients:
  - VDI Centre for Resource Efficiency
  - Ministry of the Environment Bavaria, Baden-Wuerttemberg und Rhineland-Palatinate
  - Ministry of Economics Hesse
- Research consortium:
  - TU Darmstadt (IWAR, PTW, DiK)
  - Fraunhofer Institute for Manufacturing Engineering and Automation
  - German Research Centre for Artificial Intelligence GmbH

Measures of digital transformation

- 11 generic measures of digital transformation that bring savings in operational resources
- Individual practical applications can be implemented when the measures are combined

M1	Networking of sensors and actuators
M2	Use of Digital Object Memory
M3	Decentralised controlling
M4	Factory support and assistance
M5	Dynamically cooperating systems and modularisation
M6	Use of positioning and localisation systems
M7	Condition monitoring
M8	Predictive maintenance
M9	Consistent data integration
M10	Virtual product development
M11	Cloud Computing

Effects of Resource Savings through Digitisation in SMEs

- Effects of resource savings estimated by SMEs: up to 25 % (Interviews and questionnaires)

- Identification resource savings
  - Reduction of used material
  - Savings of electric energy
  - Reduction of the error ratio
  - Avoidance of waste
  - Savings of transports
  - Savings of storage room

Praxis-anwendungen	Einspareffekte					
	Abfall	Fehlerrate	Lagerraum	Material	Strom	Transport
Optimierte Geschäftsprozesse			n. r.	n. r.	n. r.	
Druckluft-Leckage-App	n. r.	n. r.	n. r.	?		n. r.
One Piece Flow			?	n. r.	n. r.	
Warehouse Management System	n. r.	n. r.	?	?	n. r.	?
Data on a Stick			n. r.			n. r.
Virtuelle Produktsimulation	n. r.	?	n. r.			n. r.
Business Warehouse System	n. r.	n. r.	?			n. r.
Virtuelle Produktfertigung im Prototypenbau	n. r.	n. r.	?		?	n. r.
Cloud-basierte Fertigung	?	n. r.	n. r.	?	?	n. r.
FoamCreator	n. r.	n. r.	n. r.		n. r.	

n. r.: Die Maßnahme ist nicht relevant für den jeweiligen Einspareffekt

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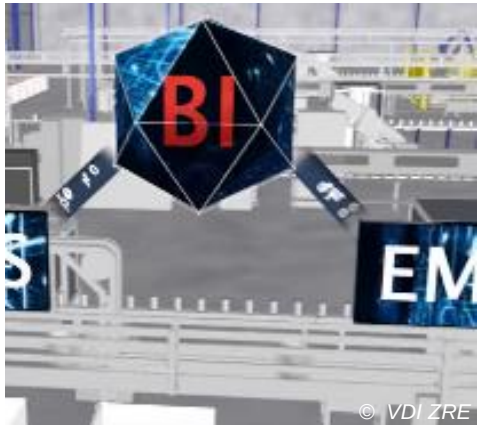
Example – Digitisation of production

The company processes about 20,000 tons of tinplate per year into several million cans, canisters and buckets.

- **Initial situation:**
  - Energy-intensive production
  - Downtimes due to repair of defective components
  - No digital interconnectivity applied in the production process
- **Solution approach:**
  - Several management systems are used to digitalise production
  - A Business intelligence system is deployed to connect these systems and coordinate and control the production.



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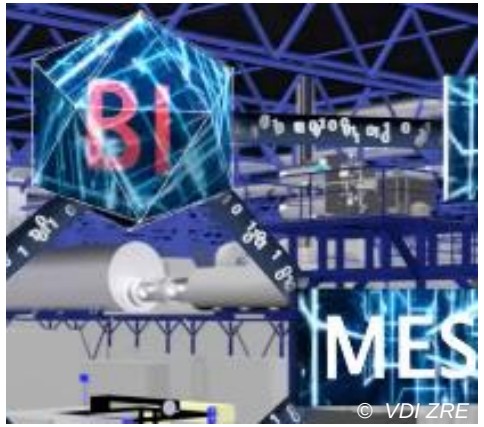

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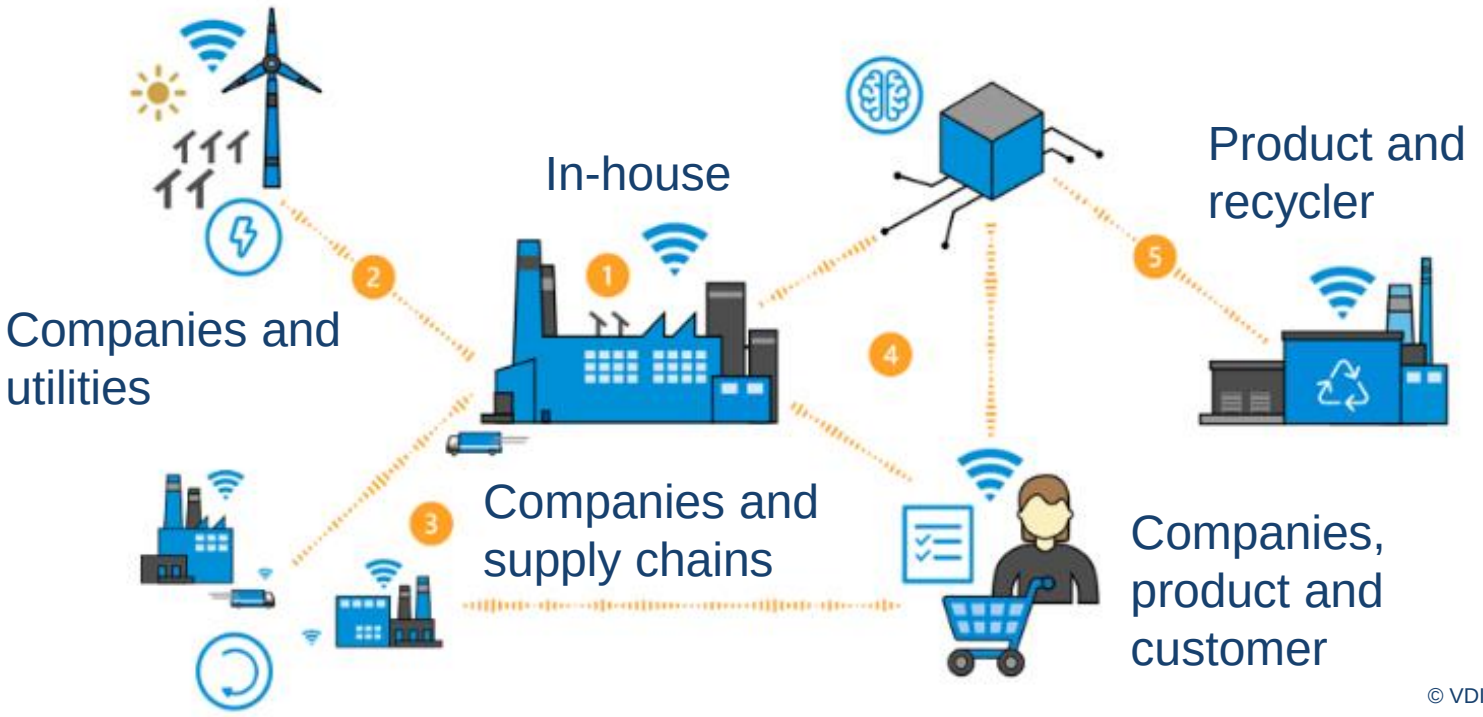
Example – Digitisation of production

Estimated Savings of

- ✓ 500 thousand Euros in material and energy costs per year
- ✓ Total of 2,600 tons of CO_{2eq} per year

Supporting tool – Digitisation in production

Stakeholders in the product life cycle and their IT networking



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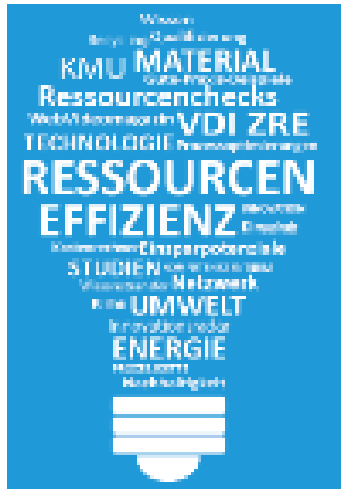
Supporting tool (only available in German):
www.ressource-deutschland.de/instrumente/prozessketten/digitalisierung

Thank you very much for your attention and your contributions to the discussion!

This presentation is available at:
ggkp.org/ResourceEfficiencyTraining