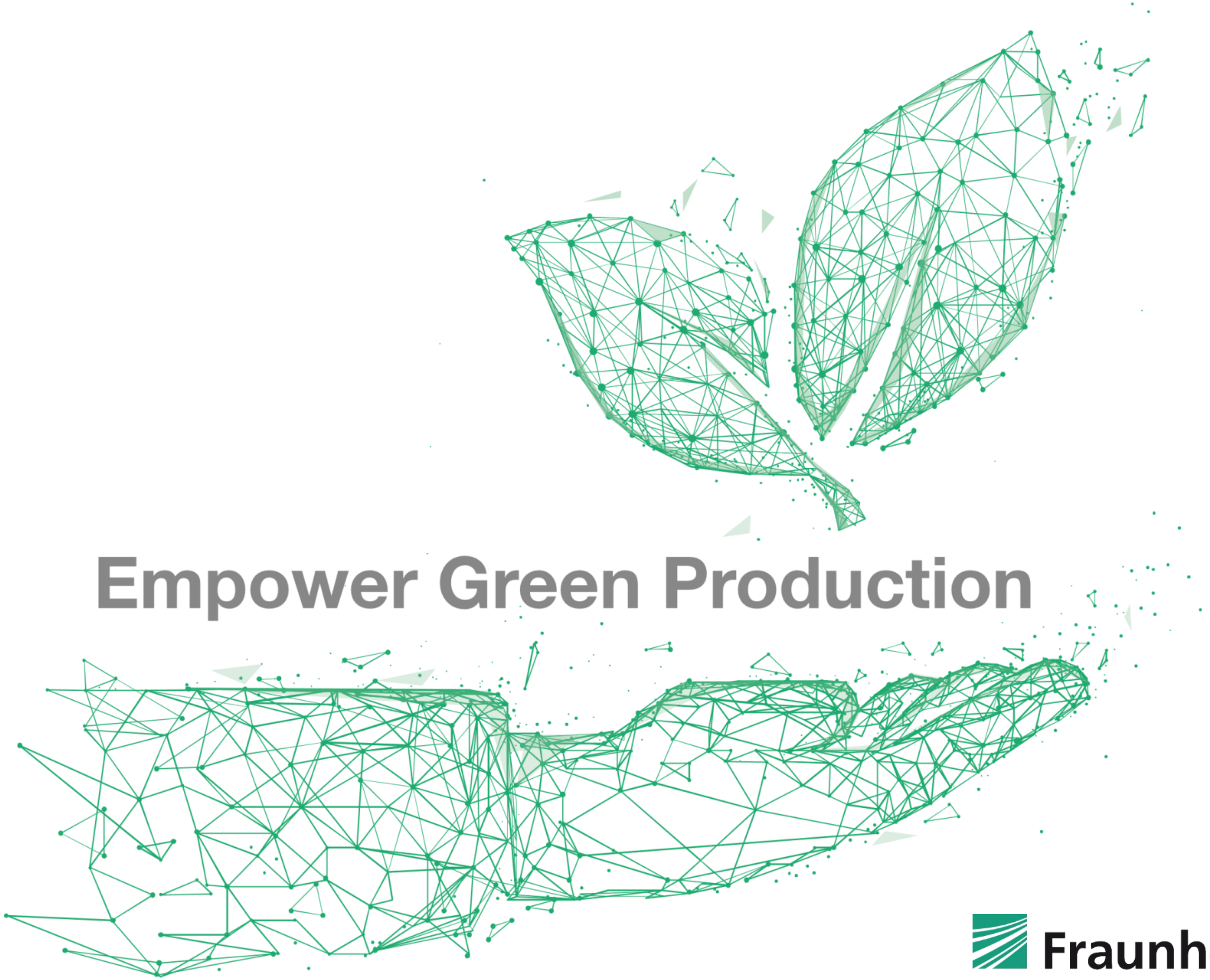
AWK'23

WWW.AWK-AACHEN.DE 11th/12th of MAY 2023

Energy and Resource Efficiency in Manufacturing



Empower Green Production

Expert presentation – Session 2
Dr. Christoph Zeppenfeld

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Companies have to provide evidence of their sustainability
The pressure from politics and customers is growing

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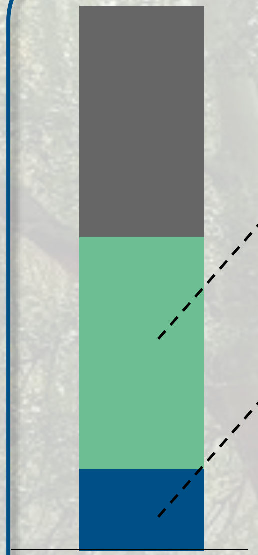
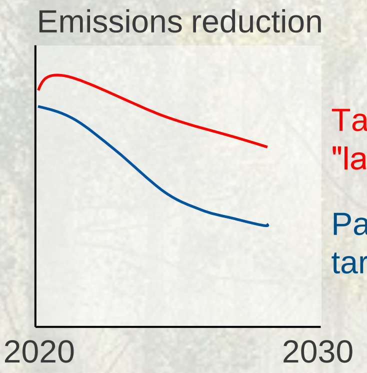


approx. **50 %** of the largest companies have concrete decarbonization goals

approx. **15 %** of which have target values for 50 % emission reduction until 2030

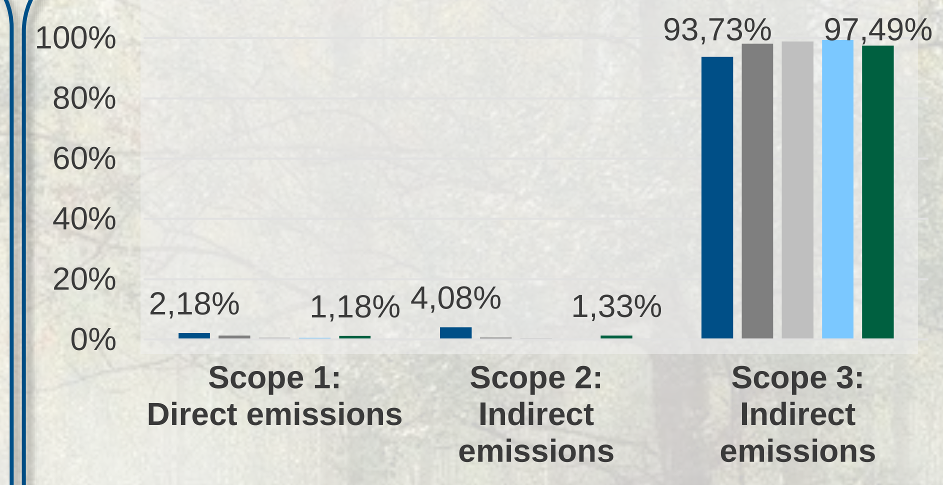
A large proportion of companies have no concrete plans to achieve the required CO_2 savings [1]



Target for reference group "largest companies“

Paris Climate Agreement target

Sum of Target values for 2030		Target Paris Climate Agreement
□ **20 %** [1]	◀▶	□ **43 %**



More than 90% of the emissions of automobile manufacturers are in Scope 3 [2].

Current challenge: Limited willingness of customers to pay extra cost for sustainability
↔ Future: A change will come, preparation is necessary despite advance performance and payback risk

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Companies must take action now to remain competitive
What measures need to be taken?

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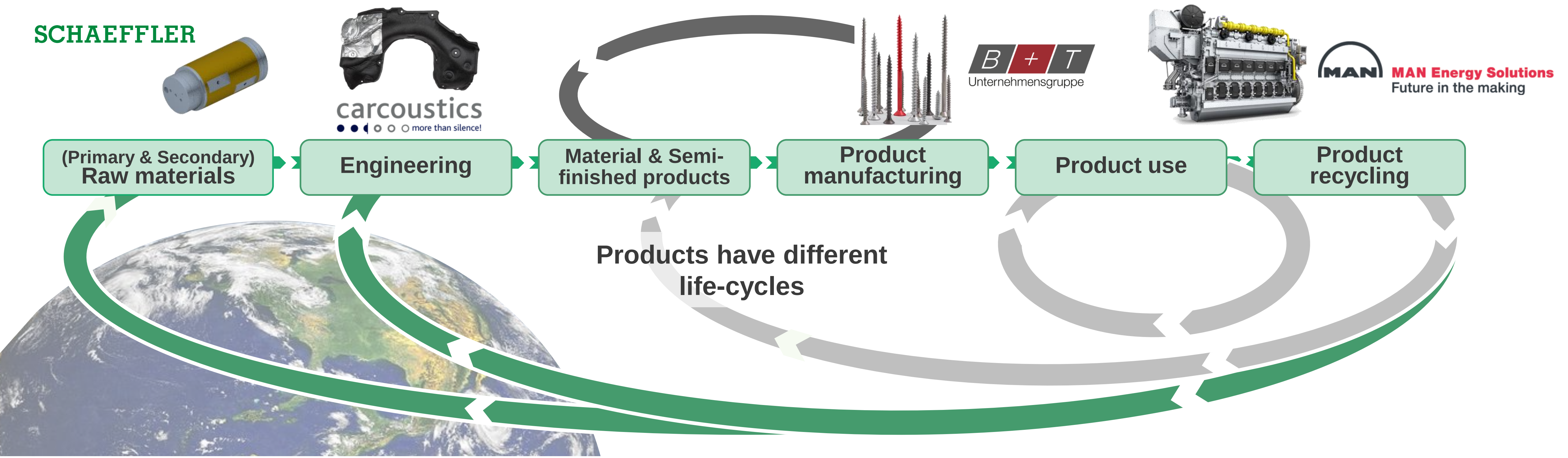
Short-term in manufacturing — time limit — *Long-term in life phase*



Consumption through production — Material and consumption flows — *Consumption in use phase*

For the earth, it is the overall balance that counts – which is product-specific

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4 steps on the way to more sustainable manufacturing: Target definition, measurability, measures IN and WITH manufacturing

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Target

Strategic alignment

Clear target definition with holistic consideration of the **value chain** and **product life cycle**!

Measurability

Evaluability

"You can't manage, what you don't measure!" (P. Drucker)

What needs to be **measured**?

How can **sustainability** be **evaluated?**

IN manufacturing

Short-term measures

WITH manufacturing

Life cycle assessment

Maximum sustainability when considering the **entire product life cycle/ -cycles**

- **Short-term measures to conserve resources and energy often located directly IN production**
- **Great potential for long-term action to improve product sustainability WITH manufacturing**

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Transparency of consumptions in production are the basis for identifying levers to increase efficiency (I/II)

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Create transparency — *Visualize* — *Improve*

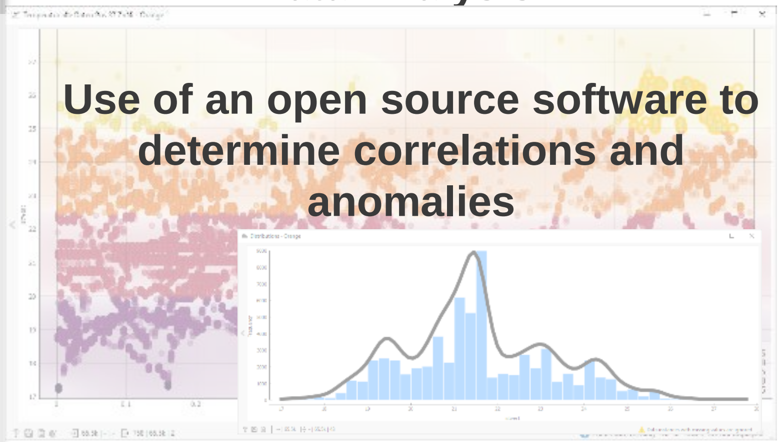
Dashboard

B + T Unternehmensgruppe

Monitoring of energy peaks

Energy consumption — Coated surface

Data Analysis



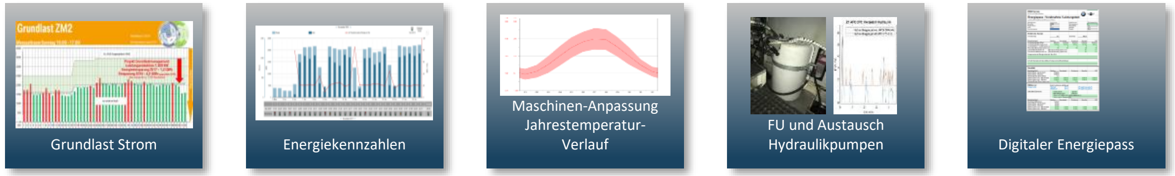
Use of an open source software to determine correlations and anomalies

- Reduction of peak loads
- Lower grid connection power required
- Higher supply security
- Alarm in the event of limit values being exceeded

Analysis of the causes of deviations → Levers for increasing efficiency

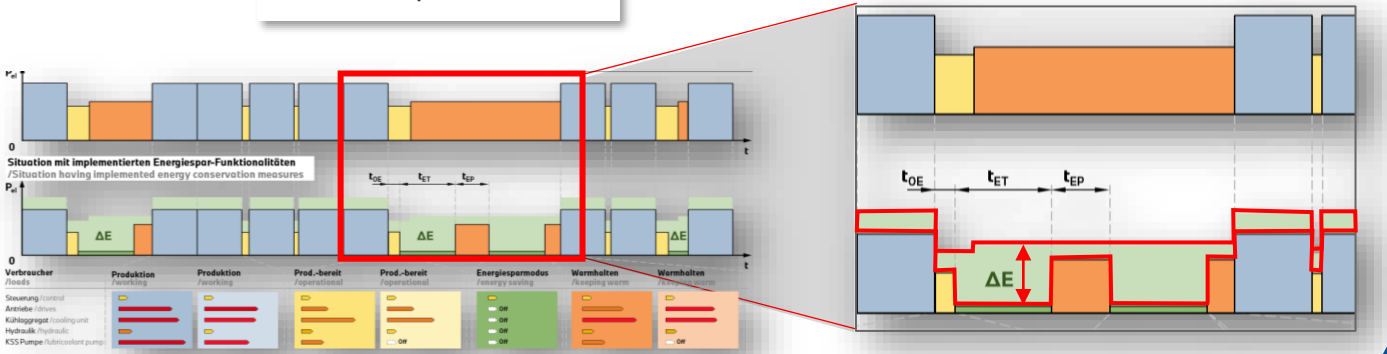
Transparency of consumptions in production are the basis for identifying levers to increase efficiency (II/II)

Create transparency → *Visualize* → *Improve*



- Production
- Ready for production
- Energy saving mode
- Start up

Annual energy savings of 28.7 GWh



Digital energy passport for machines and plants

Lever of energy efficiency in machinery and equipment:
Expected 20 % savings in production through the digital energy passport

Energy efficiency at machine level
Design to meet requirements enables efficient operation

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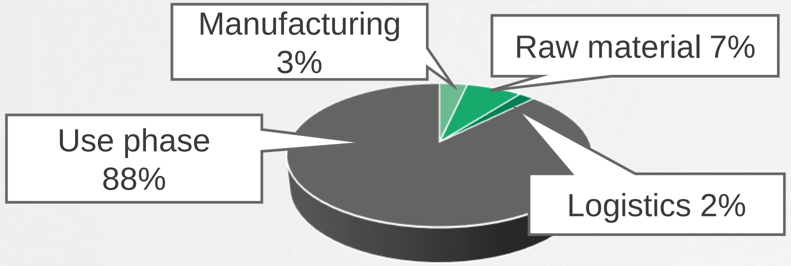
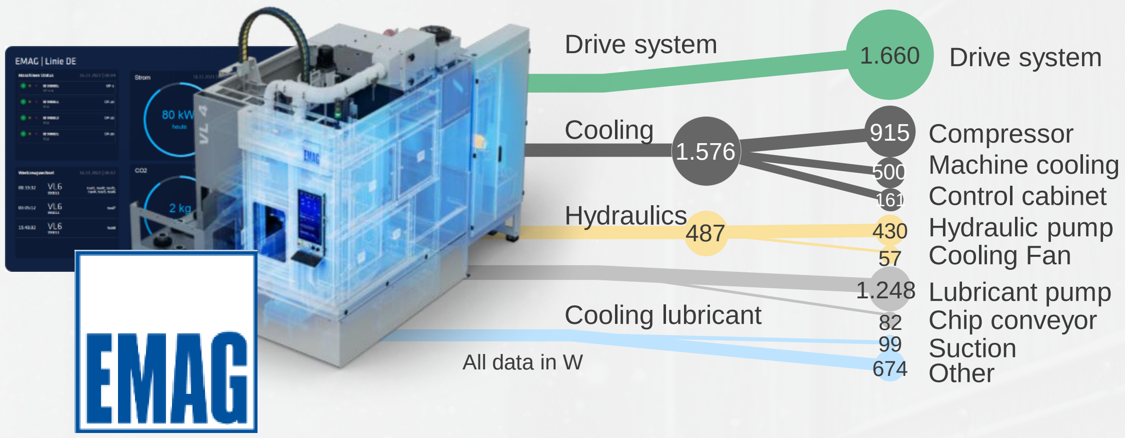
WITH the production of the machine ***manufacturer***



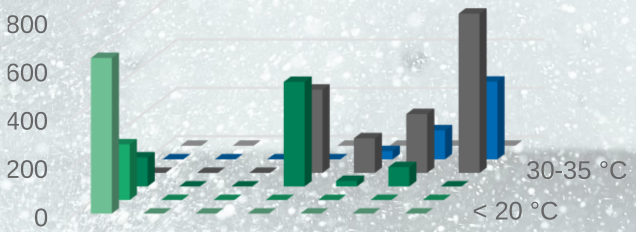
+GF+

The majority of CO_2-emissions from a machine tool occur during the use phase!

IN the production at the machine ***user***

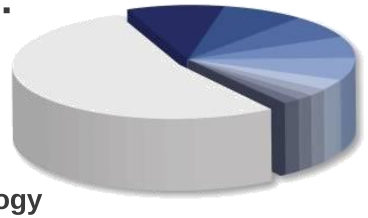


GMN



Load-optimized design [3]

Savings potential of new machines:
46.9 % vs. previous machines



- **9.6 % - Optimization refrigeration equipment**
- **8.0 % - Hydraulics (e.g.: DvP units)**
- **6.9 % - Drive cooling with push-through technology**
- **6.6 % - Reduction of sealing air, system pressure pneumatics**
- **6.6 % - Stand-by-mode**
- **3.2 % - IE3 motors**

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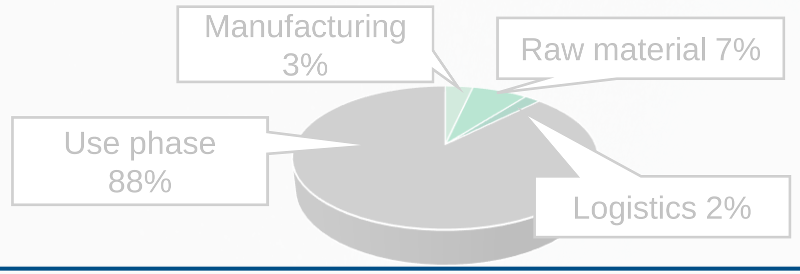
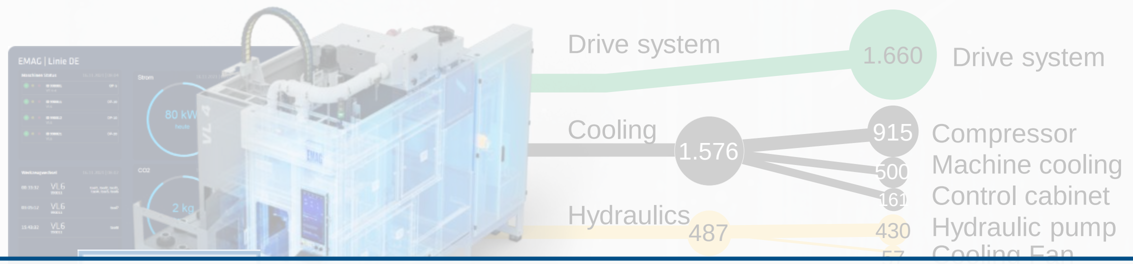
Energy efficiency at machine level
Design to meet requirements enables efficient operation

WITH** the production of the machine **manufacturer

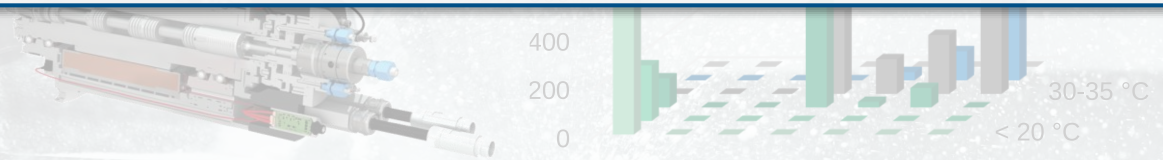
IN** the production of the machine **user





Potentials IN the product application (manufacturing of the machine user) are...

- **Often higher, but longer term**
- **Frequently "recurring effects“**
- **Tend to increase with rising costs (e.g. energy)**



Load-optimized design [3]

- 8.0 % - Hydraulics (e.g.: DvP units)
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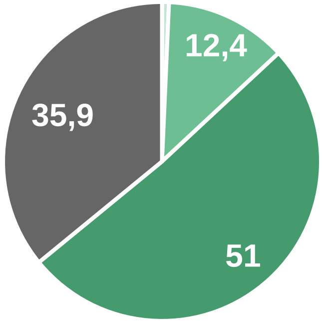
Energy efficiency at machine level
Optimization of the periphery: Lubricant supply system

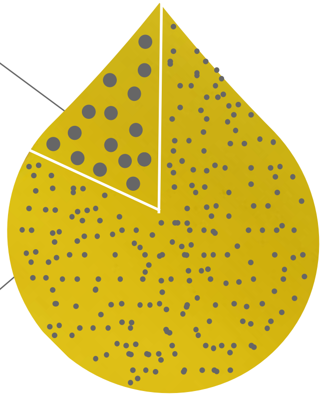
System monitoring [4]

Energy consumption during rough grinding



Oil Reconditioning [18]

20% micro
particles > 1 µm



80% nano
particles < 1 µm

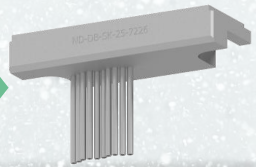
Nanoparticles are not separated by filters

Track grinding

A_{Nozzle} = 35 mm² □ A_{Nozzle} = 18 mm²

~50 % saving

External cylindrical grinding



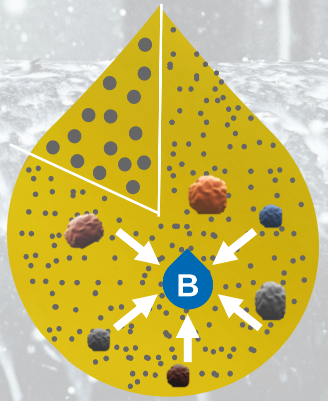
A_{Nozzle} = 100 mm² □ A_{Nozzle} = 32 mm²

~ 62 % saving

grindaix
A QUAKER HOUGHTON COMPANY

RecondOil®

The RecondOil booster binds nanoparticles to form microparticles



CO_2 emissions ↓ 96 %
Scrap ↓ 1.3 %
OEE ↑ 1.6 %

Functional optimization through adaptation of manufacturing processes
Example: Sealing mating surfaces in the electric drive train

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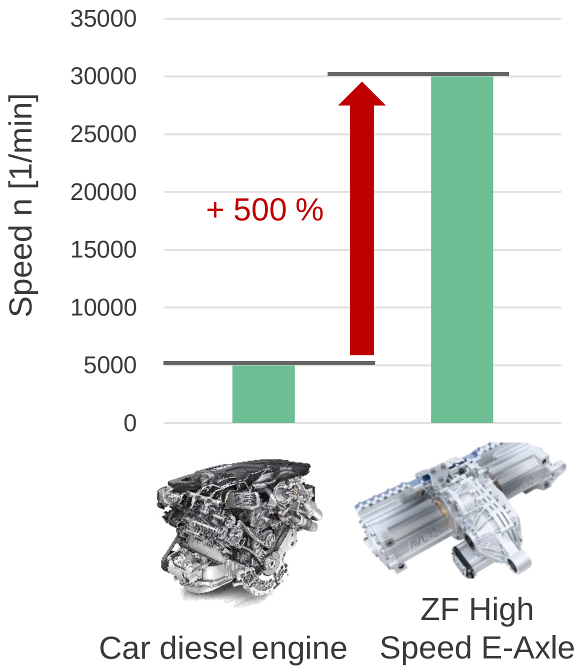
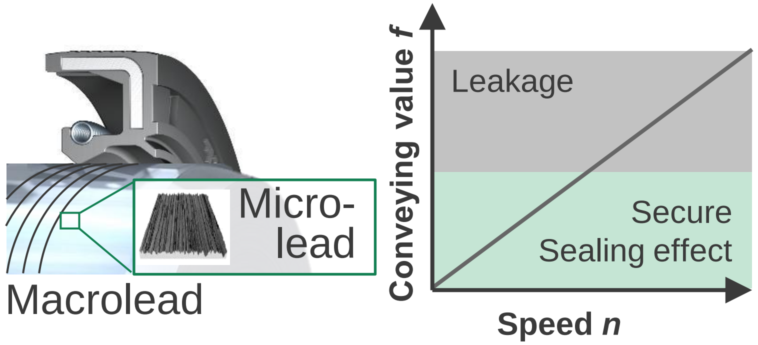
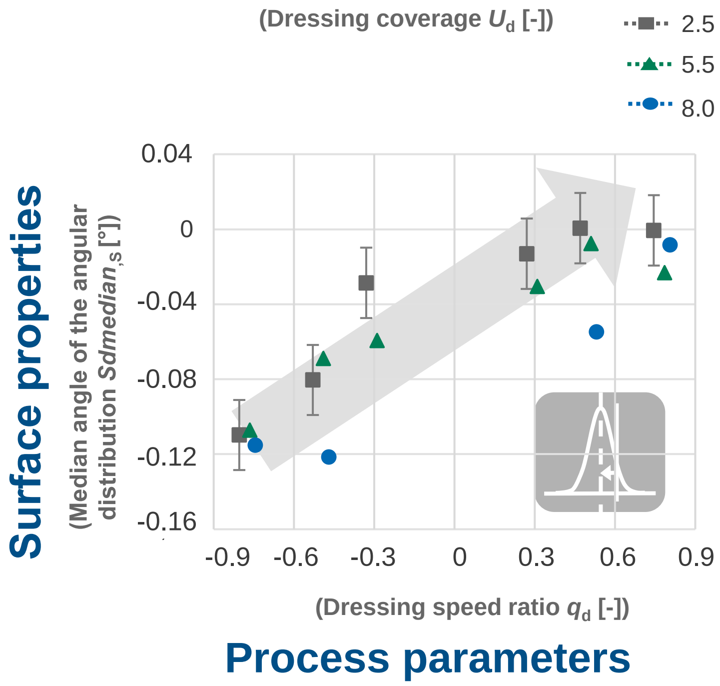
New challenges due to new technologies and product functionalities





Conventional manufacturing processes lead to leakage on electric motors at high speeds



Fulfillment of the increased product requirements for e-mobility through adaptation of the production technology (grinding of the seal mating surfaces) [6].

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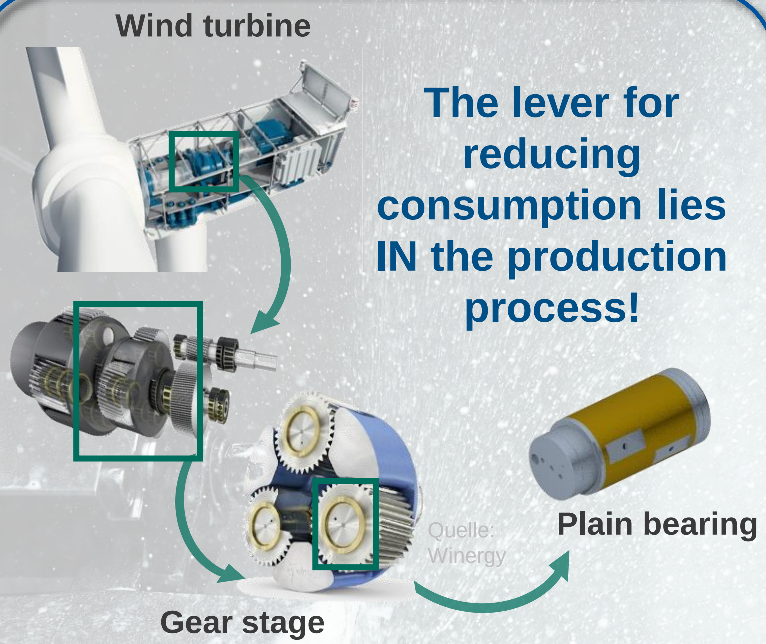
Material efficiency through technology substitution
Example: Plain bearings in wind turbines



The lever for reducing consumption lies IN the production process!

SCHAEFFLER

Cast sleeve

Wall thickness bush
» **15 mm**

Material consumption
» **30.6 kg**

CO -eq$_2$
» **152.69 kg /part**

Process steps
» **21**

Process chain: Machining → Fine Machining → … → Melting → Centrif. Casting → Pre-Turning → Stress Relief Ann. → Fine Turning → Joining on Pin → Final Machining

Laser Cladding

Coating thickness
» **1 mm**

Material consumption
» **2.9 kg**

CO -eq$_2$
» **14.67 kg /part**

Process steps
» **14**

Process chain: Machining → … → Cladding → … → Final Machining

In order to leverage potentials IN manufacturing, a change in the technologies can lead to success

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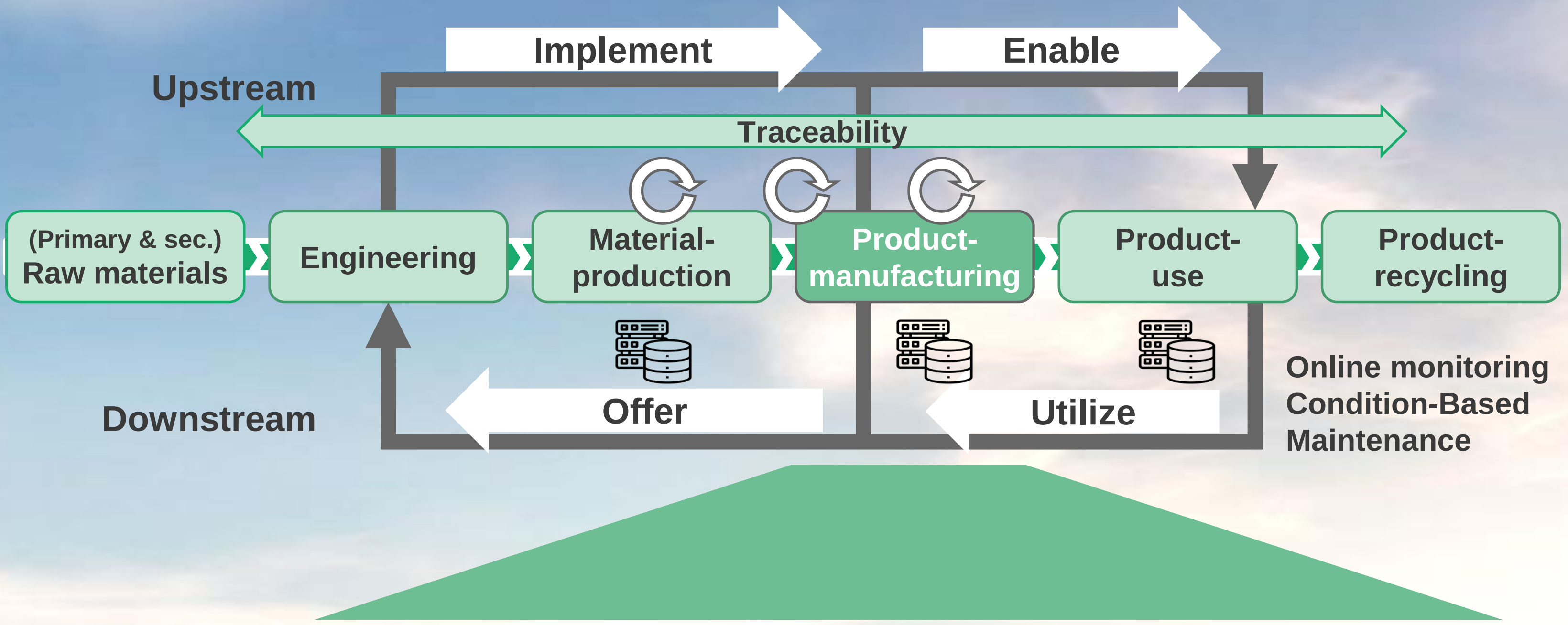
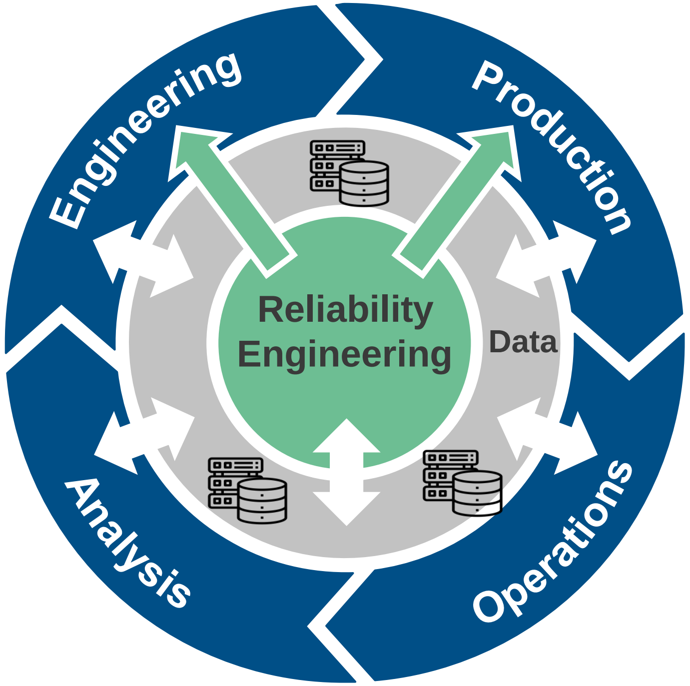
The special position of manufacturing: In the middle of the chain



1) Emission reduction, resource reduction, cost reduction
2) Production Footprint (not everything is on the drawing)
    - Formation of peripheral zone
    - Surface structure
    - Tolerances ...

Close the loop for reliability engineering



Internal optimization cycles

The levers are located at different points in the product life cycle, depending on the environmental impacts

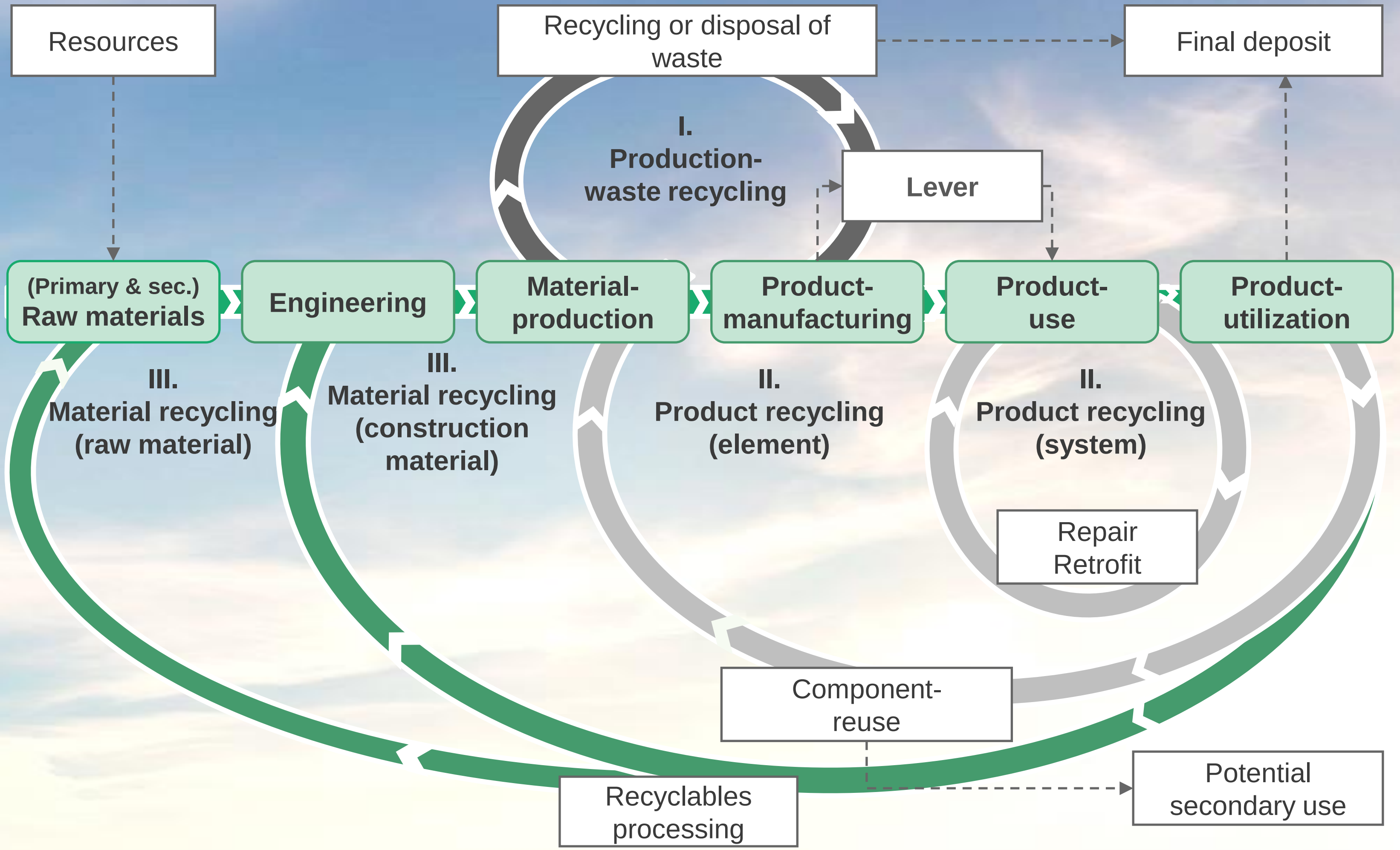


Figure i. A. a [7]

The potential lies in...

- The material flows
- The life cycles
- Their dependencies

IN manufacturing → *WITH manufacturing*

Levers for improving sustainability in the product life cycle
Example: Acoustic absorber

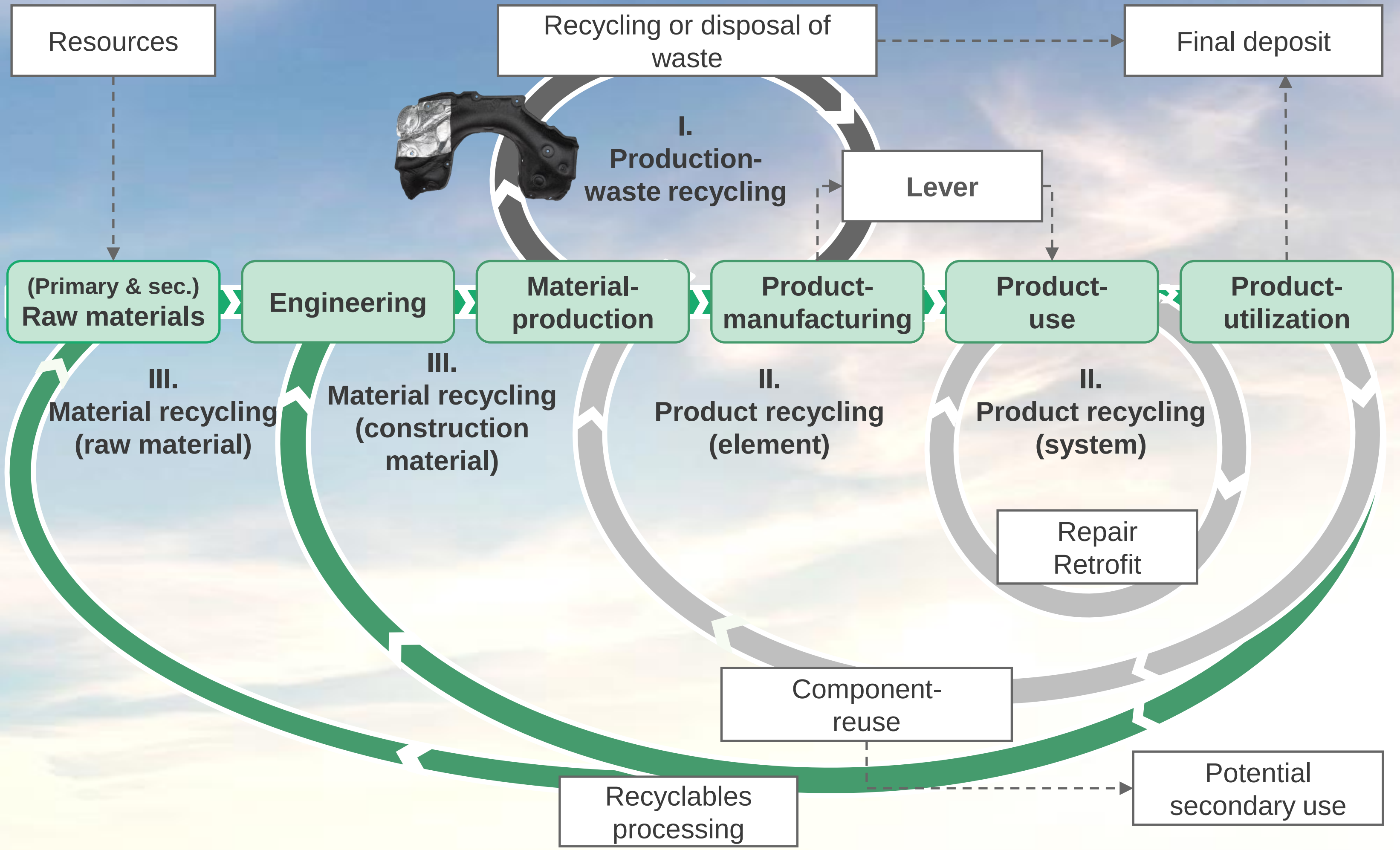


Figure i. A. a [7]

- Shredding of production waste & use as filling material
- **Improvement of** the acoustic properties and thus the component **functionality**

Levers for improving sustainability in the product life cycle
Example: Coated screws

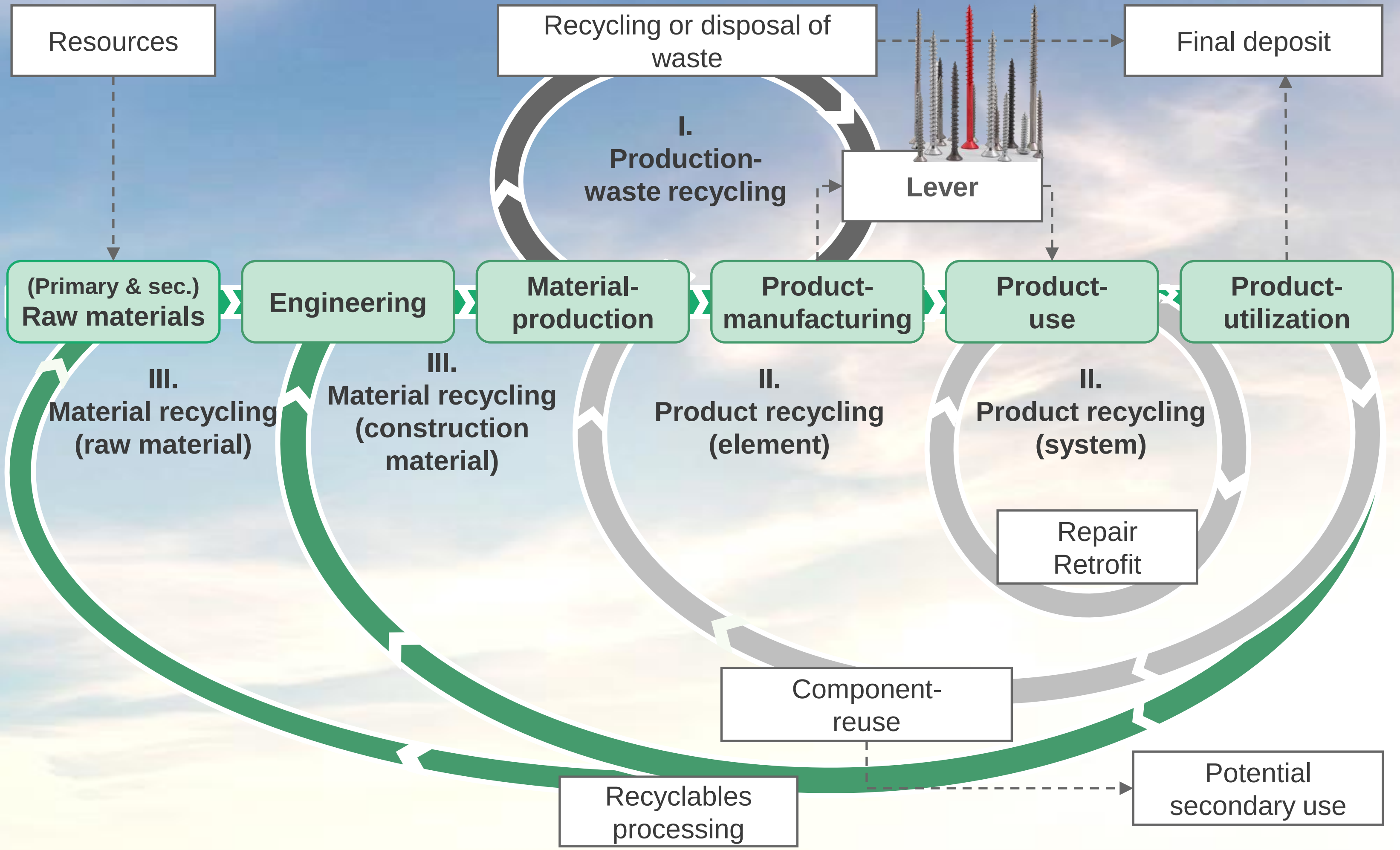


Figure i. A. a [7]

- Coating of the screws for longer life
- Emissions in production but savings due to longer shelf life

IN manufacturing → *WITH manufacturing*

Levers for improving sustainability in the product life cycle
Example: marine engine

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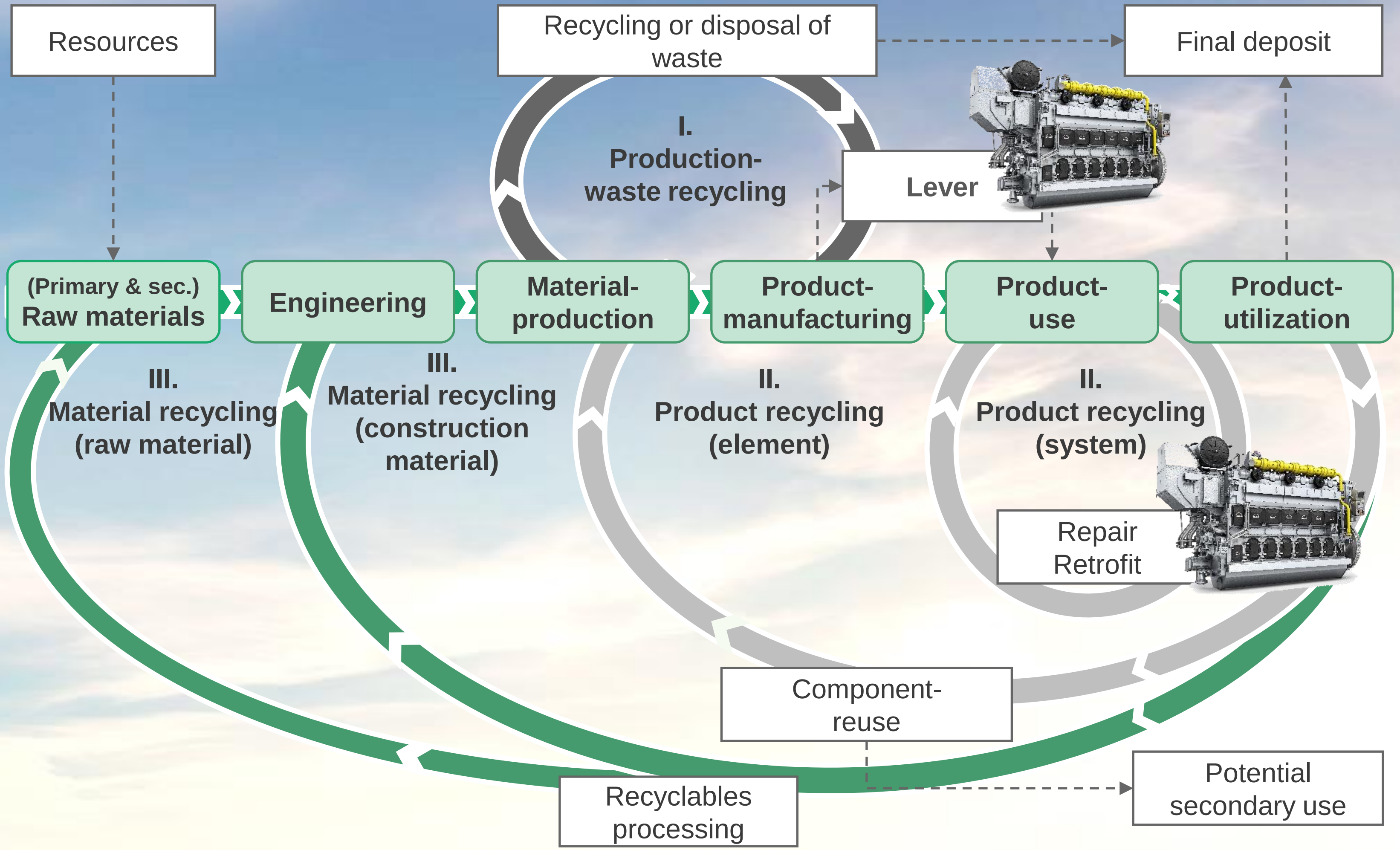
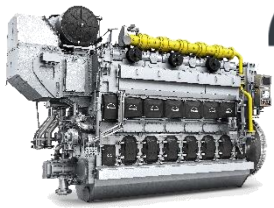


Figure i. A. a [7]



MAN Energy Solutions
Future in the making

- CO_2 emissions in own manufacturing approx. 120 t / engine
- CO_2 emissions during operation: 70,000 t / year (18V4X), 30-year service life
- Great leverage for efficiency increases through functionally appropriate components

IN manufacturing → *WITH manufacturing*

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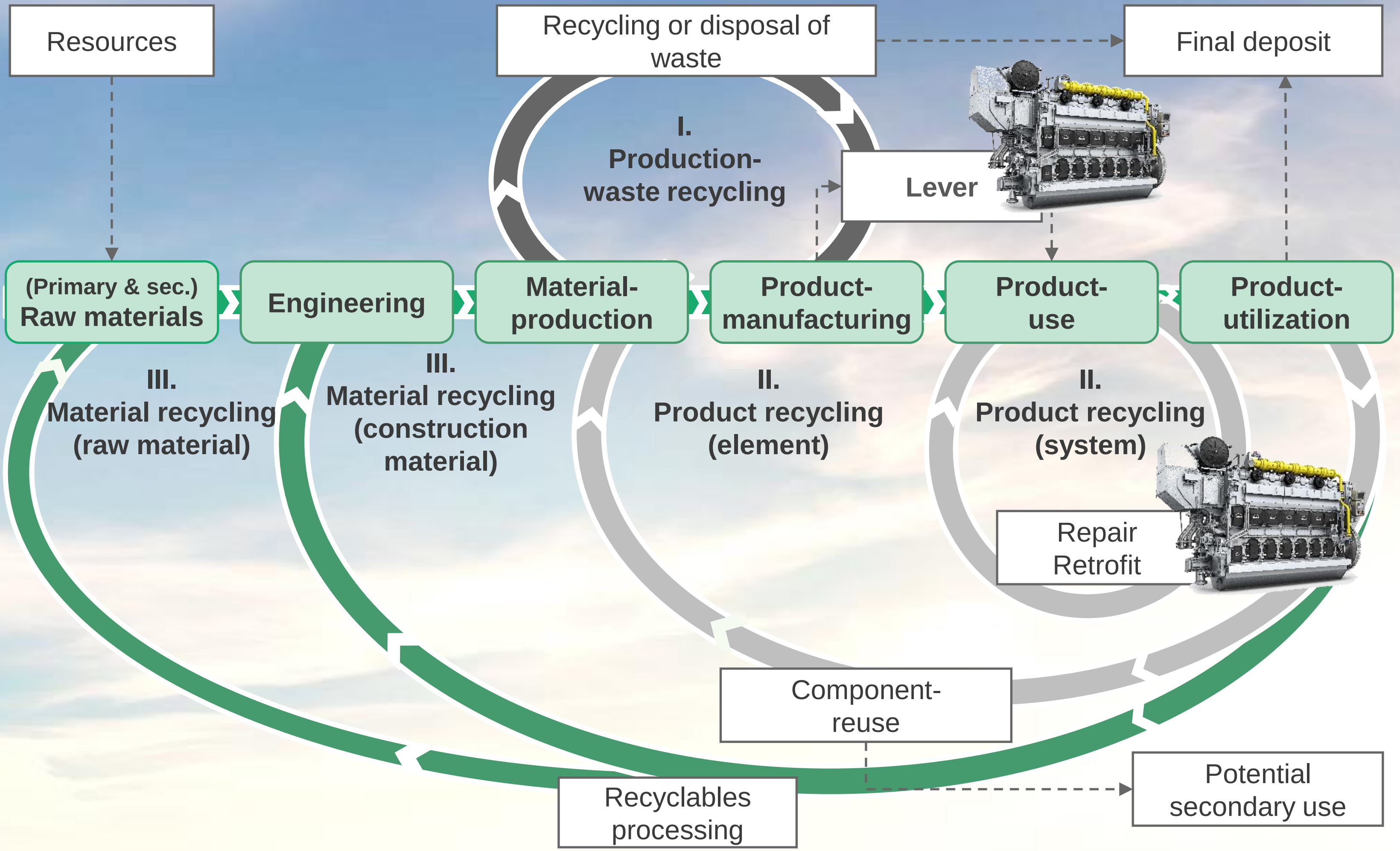
Levers for improving sustainability in the product life cycle
Example: marine engine



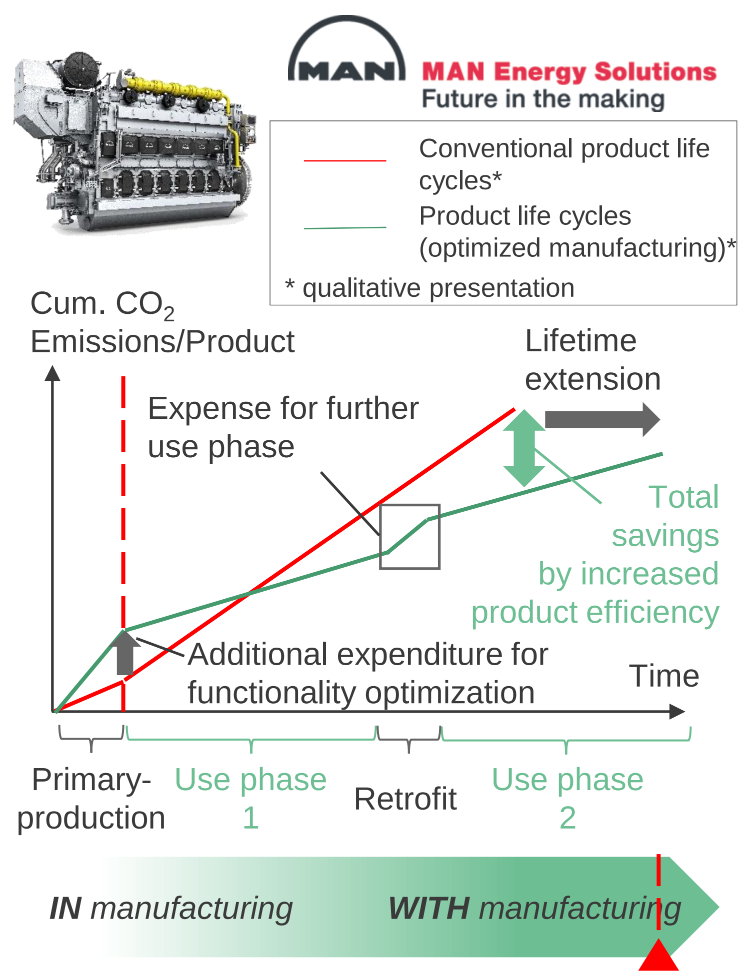


Figure i. A. a [7]

Conclusion

Demands towards companies to improve their **sustainability** are increasing rapidly

The levers are product-specific: **"One size does not fit all"**

Levers are located both **"IN"** and **"WITH"** manufacturing

The potentials are in the **bottom-line** (cost reduction) **AND top-line** (USPs for customer)

The Trade-off between today's effort & costs and future payback
 Investment in **long-term competitive advantage**

References

[1] D. Frans, J. Rabe, Y. Ruf and D. Koroleva. "Six areas where companies can reduce their emissions. can reduce rapidly." https://www.rolandberger.com/de/Insights/Publications/Mehr-Tempo-bei-der-Decarbonization.html (accessed on: February 28, 2023).

[2] G. Grünert, "CO2 balancing for grinding technology - challenges and opportunities".

[3] J. Falker, "Spindle technology and digitization as enablers for more efficiency and sustainability in grinding".

[4] R. Stabauer, "Minimizing the use of cooling lubricant in grinding".

[5] D. Wilke, "Resource Saving and Quality Improvement through Innovative Oil Reconditioning".

[6] T. Bergs, "Function-optimized grinding machining of drive components".

[7] J. Lienig and H. Brümmer, "Recyclinggerechtes Entwickeln und Konstruieren," in Elektronische Gerätetechnik: fundamentals for developing electronic assemblies and devices, J. Lienig and H. Brümmer, eds, Berlin: Springer Berlin, 2014, pp. 193-218.

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Thank you very much for your attention!