Steffen Haack

HOW TO BUILD BETTER MACHINES?

Bosch Rexroth: Our internal perspective

Our purpose

Our motivation

Technology as lever for a better, sustainable world

rexroth
A Bosch Company

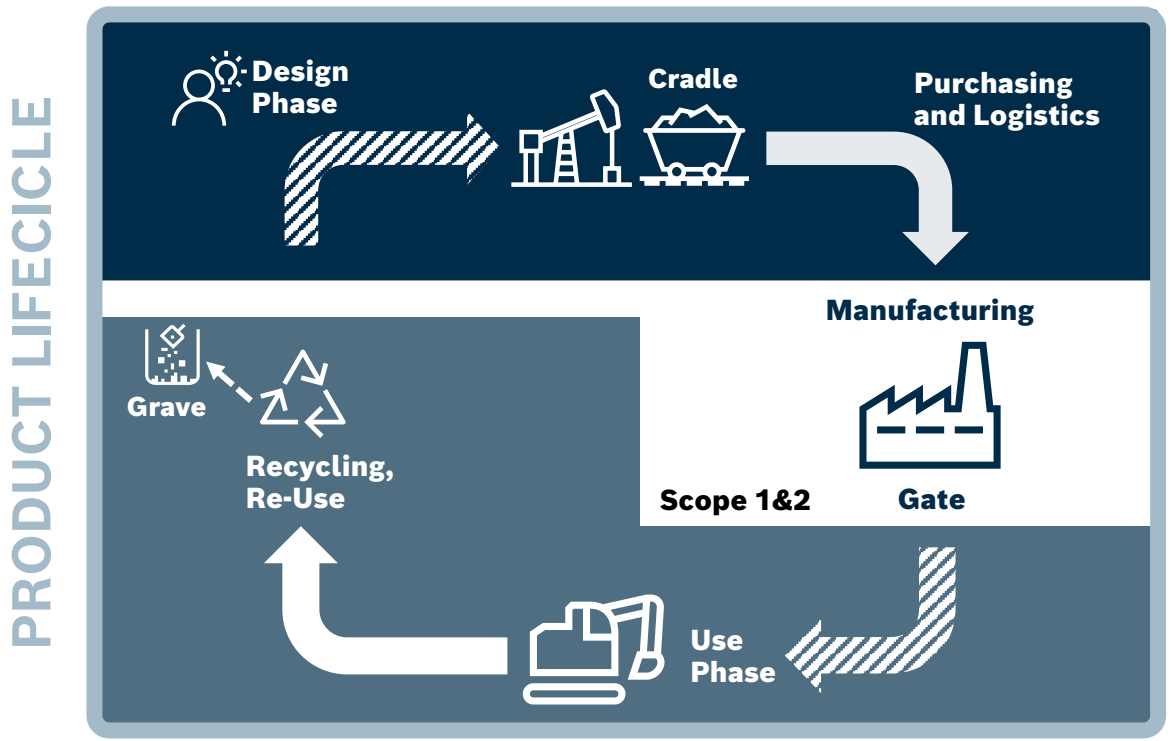
Sustainability – Carbon Footprint

SCOPE 1&2 CO_2 emissions:

- Bosch/ **Rexroth** is committed to the Paris Agreement's target
- Bosch/ **Rexroth** is carbon neutral since 2020* (Scope 1&2)

SCOPE 3 CO_2 emissions:

- CO_2 emissions in main categories of
  - "purchased goods",
  - "logistics" and
  - "use of sold products"
  to be reduced by **-15%** in absolute numbers until 2030 (base 2018)



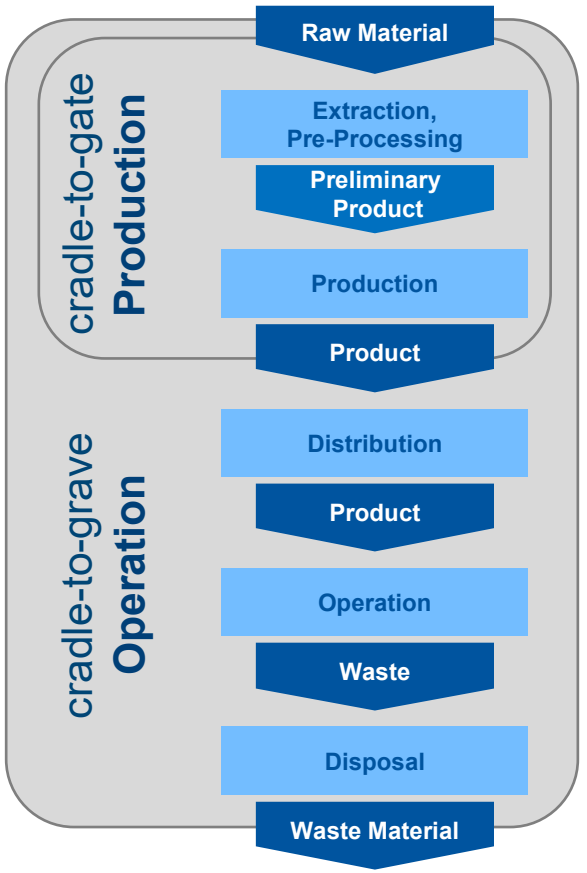
SCOPE 3 CO_2 emissions[2] to be reduced by 15% until 2030

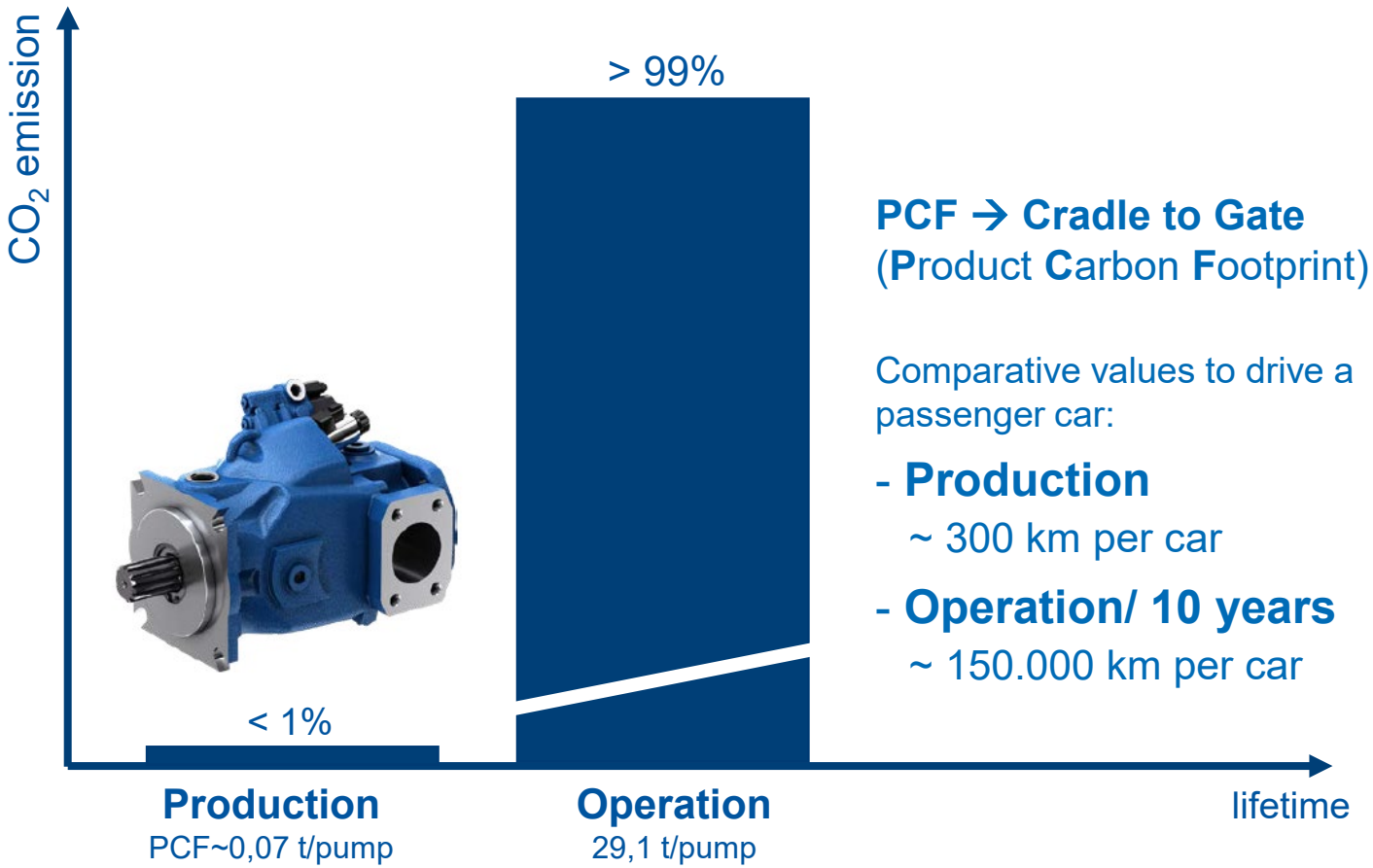
1 including carbon credits 2 purchased goods, logistics and use of sold products

Carbon footprint: Scope 3 for mobile and industrial applications

What can Rexroth bring to the table in terms of technology?

Carbon footprint: Scope 3 for an axial piston pump over lifetime





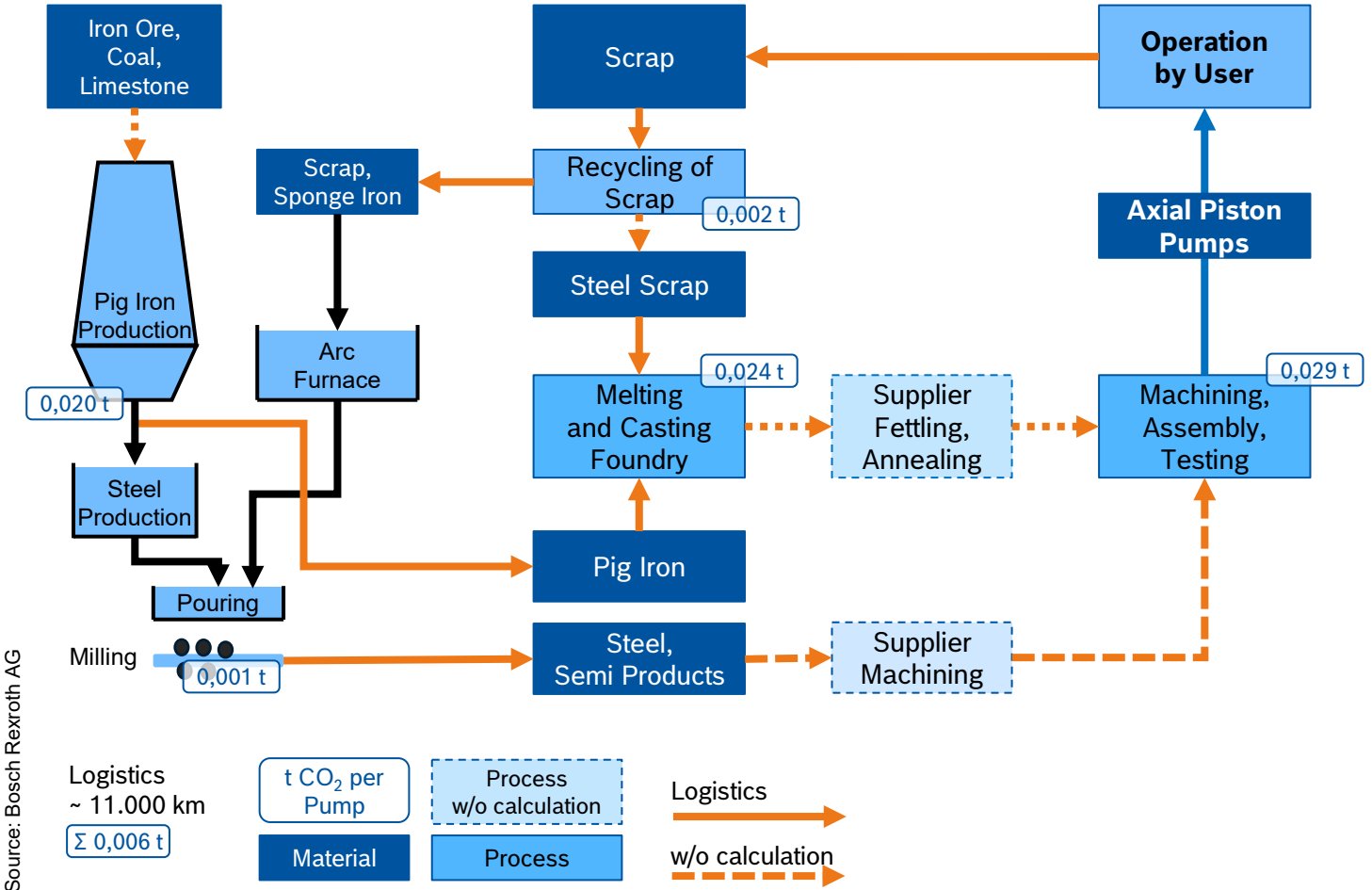
PCF → Cradle to Gate
(**P**roduct **C**arbon **F**ootprint)

Comparative values to drive a passenger car:

- **Production**
  ~ 300 km per car
- **Operation/ 10 years**
  ~ 150.000 km per car

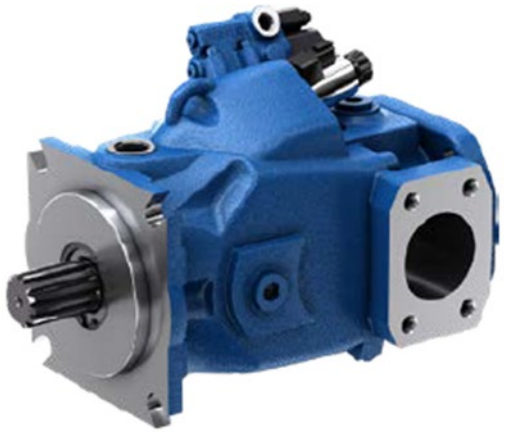
The PCF is important, but not the significant part of the overall story

Carbon footprint: PCF example axial piston pump



Source: Bosch Rexroth AG

PCF: ~0,07t CO_2/ pump



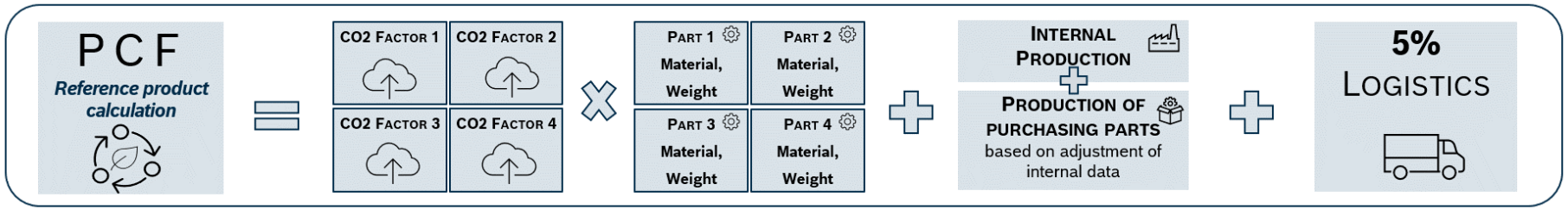
Premises

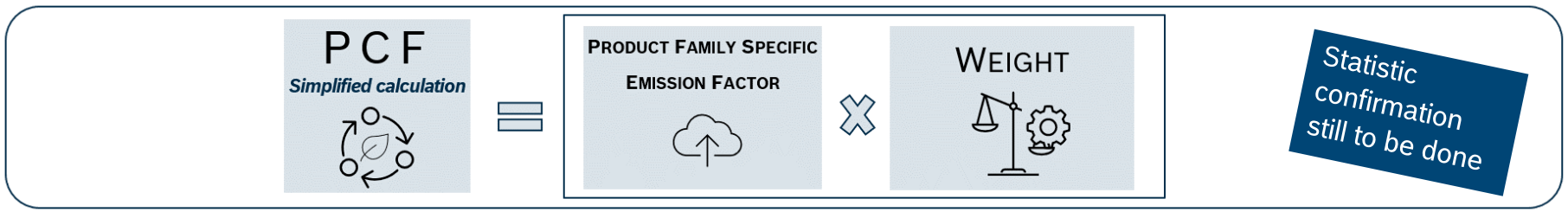
- Database 2019, before CO_2 neutrality
- KPI and calculation based on weights
- Average weight 50kg/pump
- Data sources:
  - ProBas database
  - Enablon database
- Following DIN EN ISO 14067

Pig iron production, foundry and machining are major levers to improve PCF

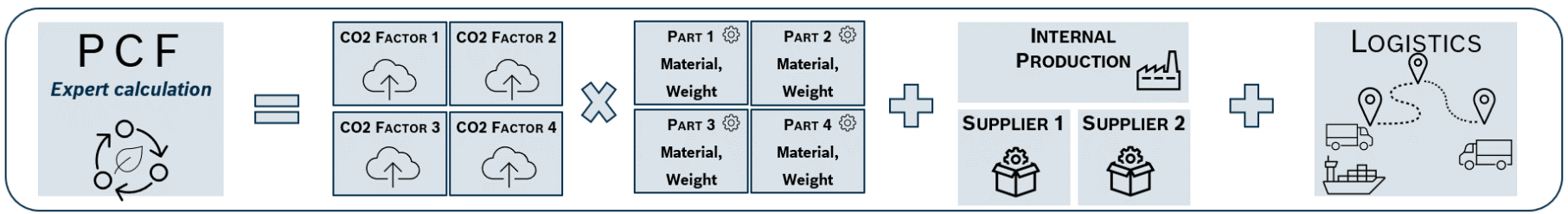
Carbon footprint: Method of PCF Calculation Cradle-to-Gate

PCF for reference products will enable automated simplified PCF calculation



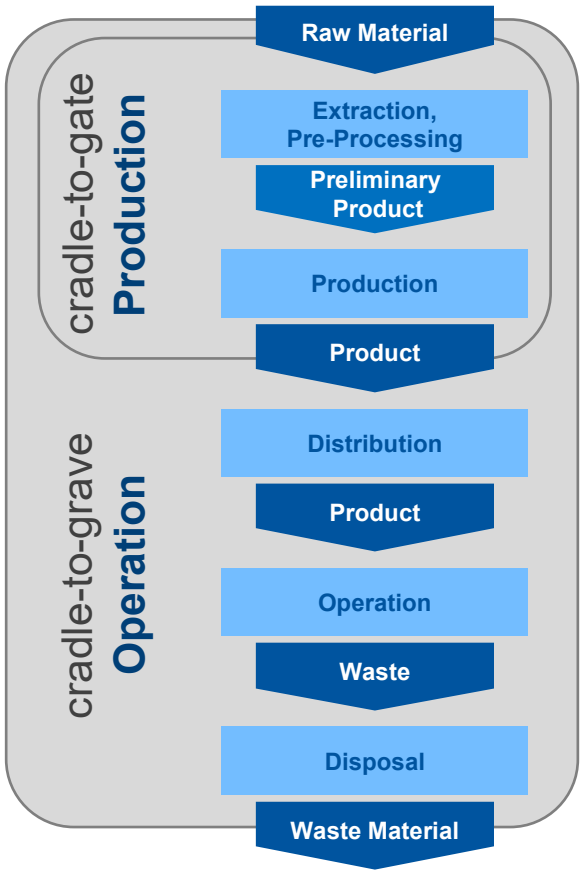


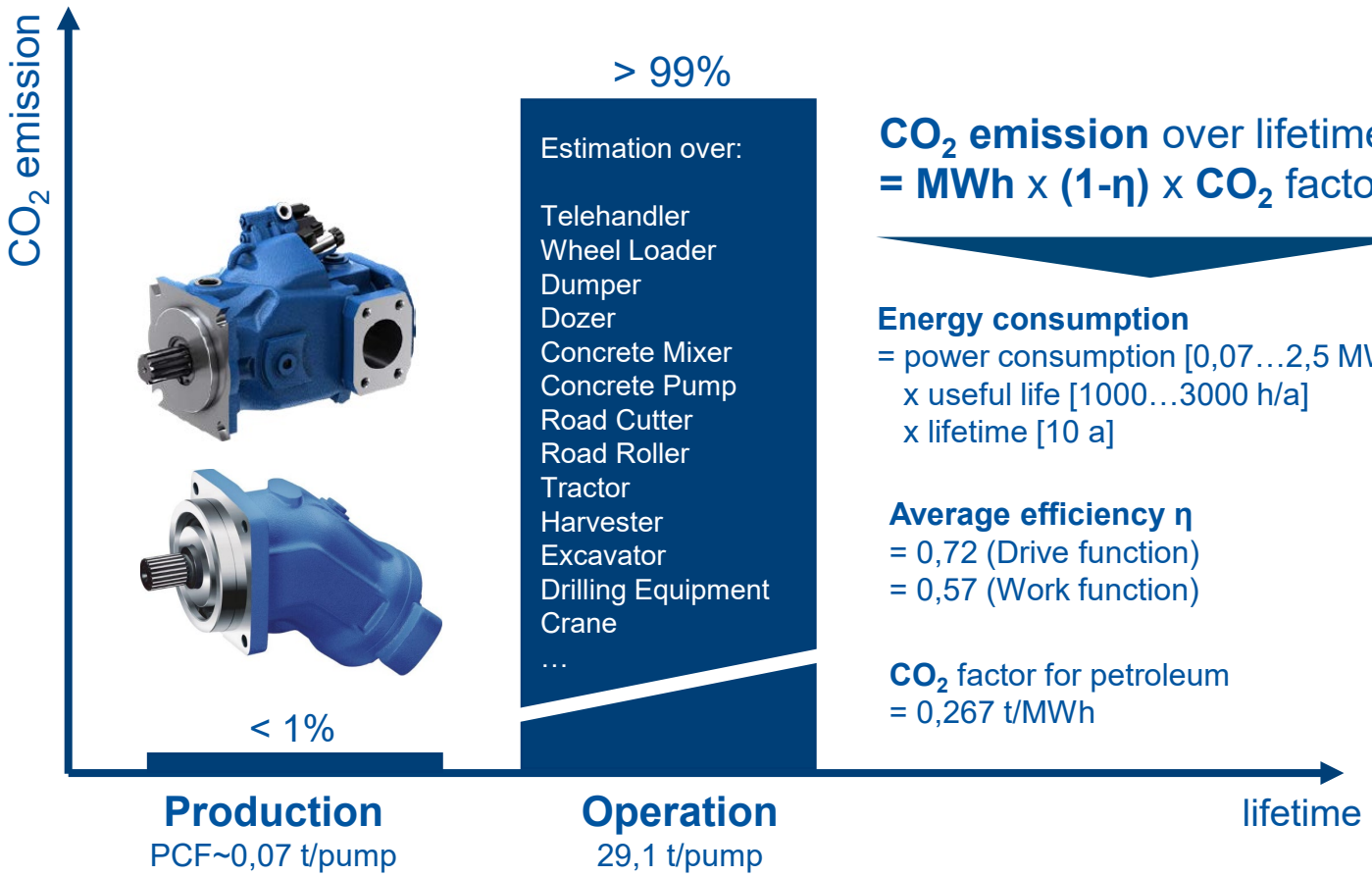
Expert calculation based on VDMA Guideline



> 1 million products require an automated mass PCF calculation

Carbon footprint: Scope 3 for an axial piston pump over lifetime





CO_2 emission over lifetime
= MWh x (1-η) x CO_2 factor

Energy consumption
= power consumption [0,07…2,5 MW]
x useful life [1000…3000 h/a]
x lifetime [10 a]

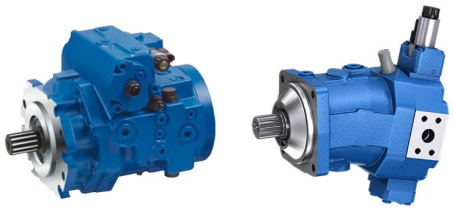
Average efficiency η
= 0,72 (Drive function)
= 0,57 (Work function)

CO_2 factor for petroleum
= 0,267 t/MWh

CO2 improvements driven by efficiency and consumption

Hydrostatic drive with 33% less weight and 8% higher efficiency

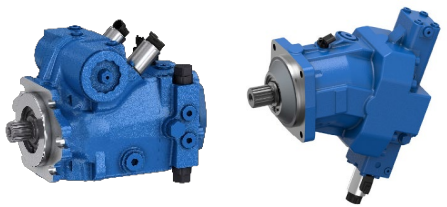
Last generation components:



A4VG 65 series 40: 500 bar, 58 kg, PCF 194 kg CO2
A6VM 160: 0-25°, 64 kg, PCF 228 kg CO2

High transmission ratio with oversized components

Next generation components:

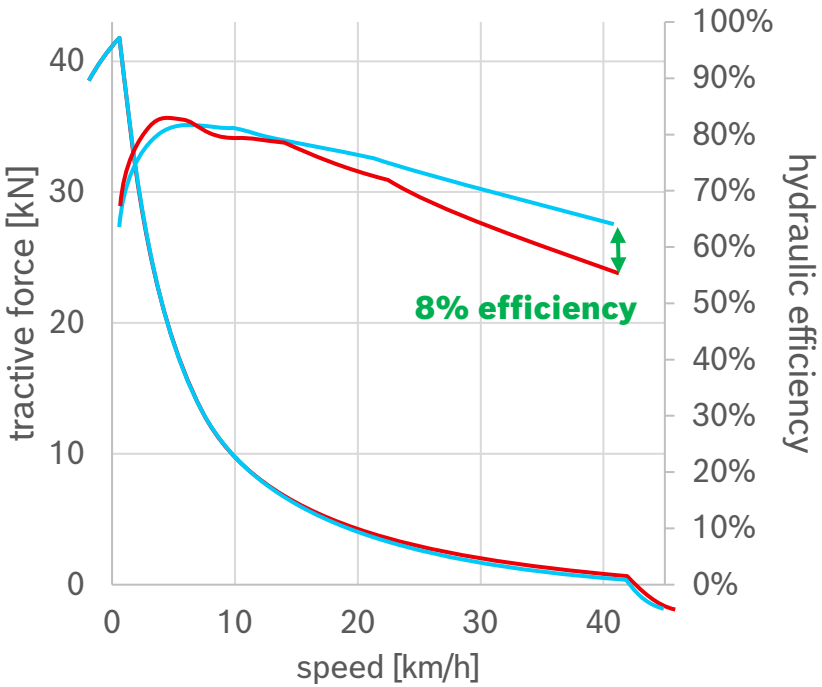


-29%

-37%

A4VG 56 series 35: 530 bar, 37 kg, PCF 138 kg CO2
A36VM 125: 5-38°, 44 kg, PCF 144 kg CO2

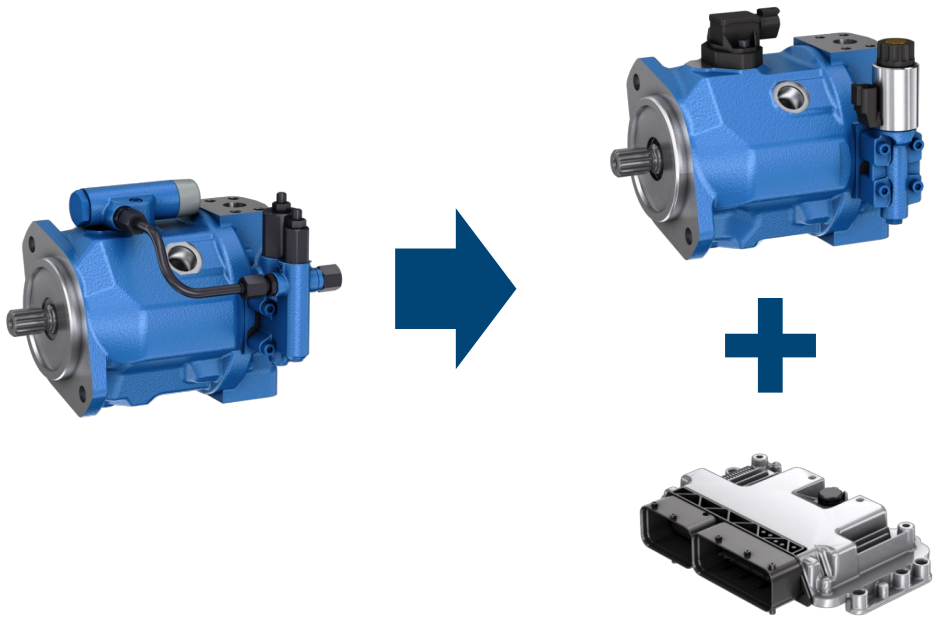
High transmission ratio with higher pressure range of pump and new design concept (swivel angle) of motor.

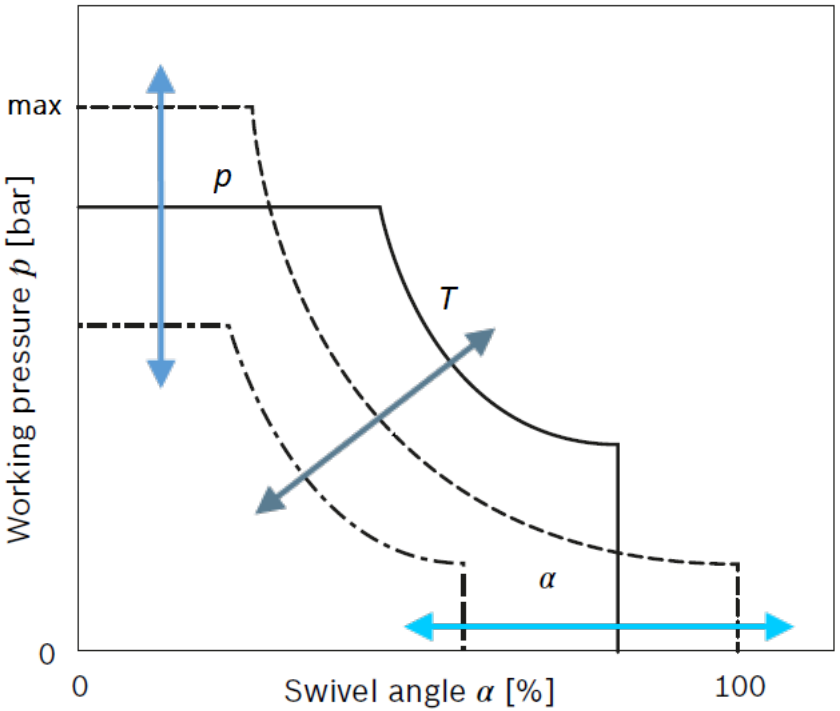


Wacker Neuson machinery: 20% CO2 reduction:
Dumper D24-D30, Wheel Loader RL50-RL70
Telehandler Kramer 418-32, Mobile Excavator E21

Next Gen products with significant CO2 savings in production and operations

Efficiency: Electronification of A10 implement pumps



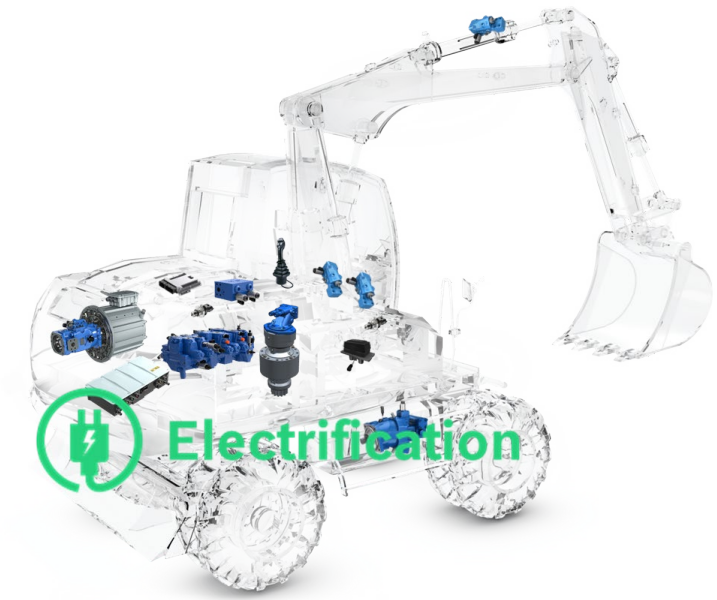


Efficiency increase

- 3.5% due to new control concept
- 7% due to new base pump design BR 60

Hydro-mechanical control functions transferred into software

Effiency: Optimizing is most effective on system level



-2%

optimized hydraulic components

Today's hydraulic components have efficiencies of around 90%, depending on operation.

Optimizing for higher efficiencies comes at usually high cost and requires robustness compromises.

-16%

assistance and automation

Experience of operators can have significant influence on the efficiency of machine operation.

Assistance functions can help leverage potential there.

-40%

optimized hydraulic systems

Hydraulics should always be optimized on a systems level.

The two biggest levers are: Not generating flow that needs to be metered away later on and recuperation of kinetic energy.

-60%

from diesel to electric

The biggest energy losses come directly from the combustion engine as prime mover.

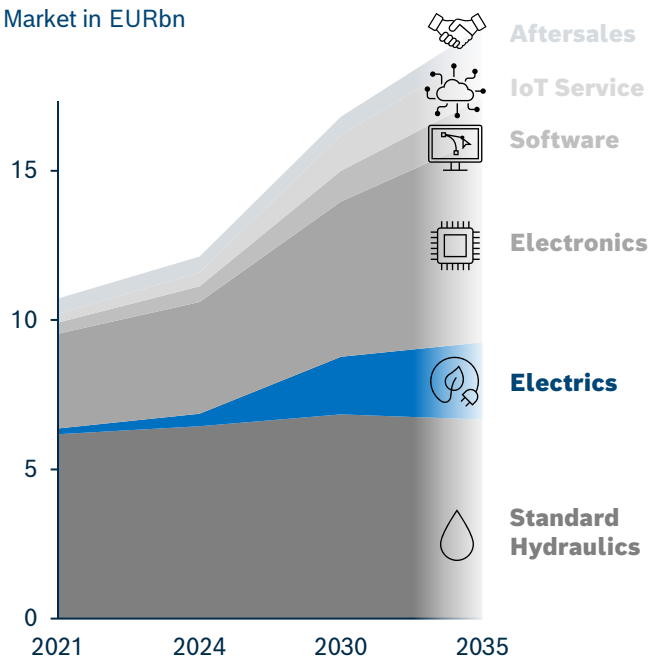
Electrification must be the top priority when optimizing for energy saving.

Energy savings on a 17t wheeled excavator (tank to wheel, own measurements)

Carbon Footprint: Mobile electrification for better efficiency

Why

Electrics emerges significantly



What

360° portfolio by providing OEMs a low-risk tech start

How

Strong partnerships and own R&D for fast ramp-up

Enpower 英搏尔

ZAPI GROUP

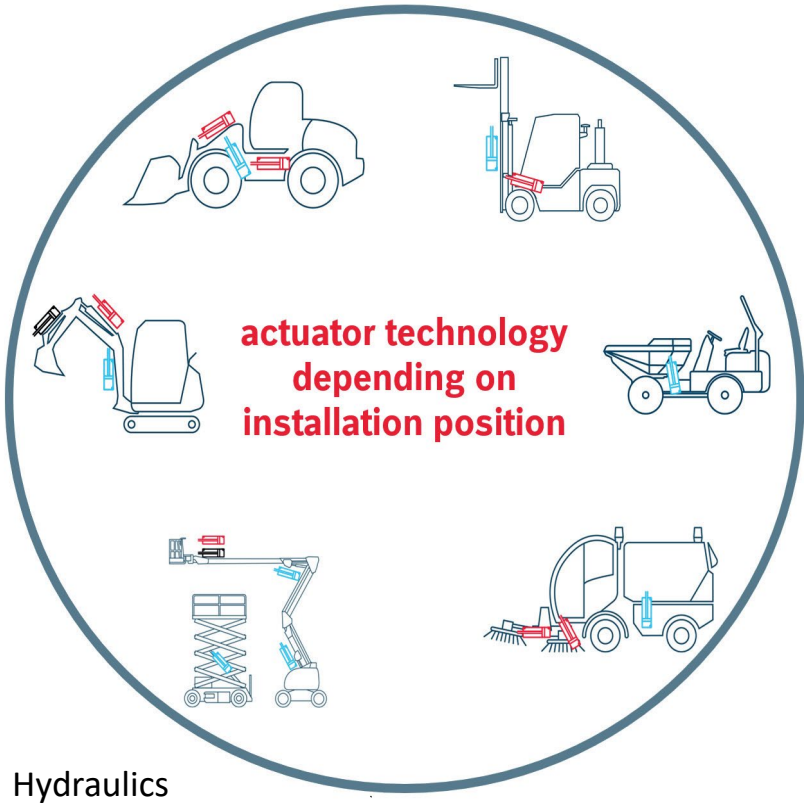
BRUSA HyPOWER

in-Tec DINTEC MorrellGroup

+ GTM via system integrators

For rotative motion is a complete product portfolio available

Carbon footprint: Mobile electrification of implement axis



Hydraulics
Electromechanics
Electromechanics with hydrostatic weight compensation

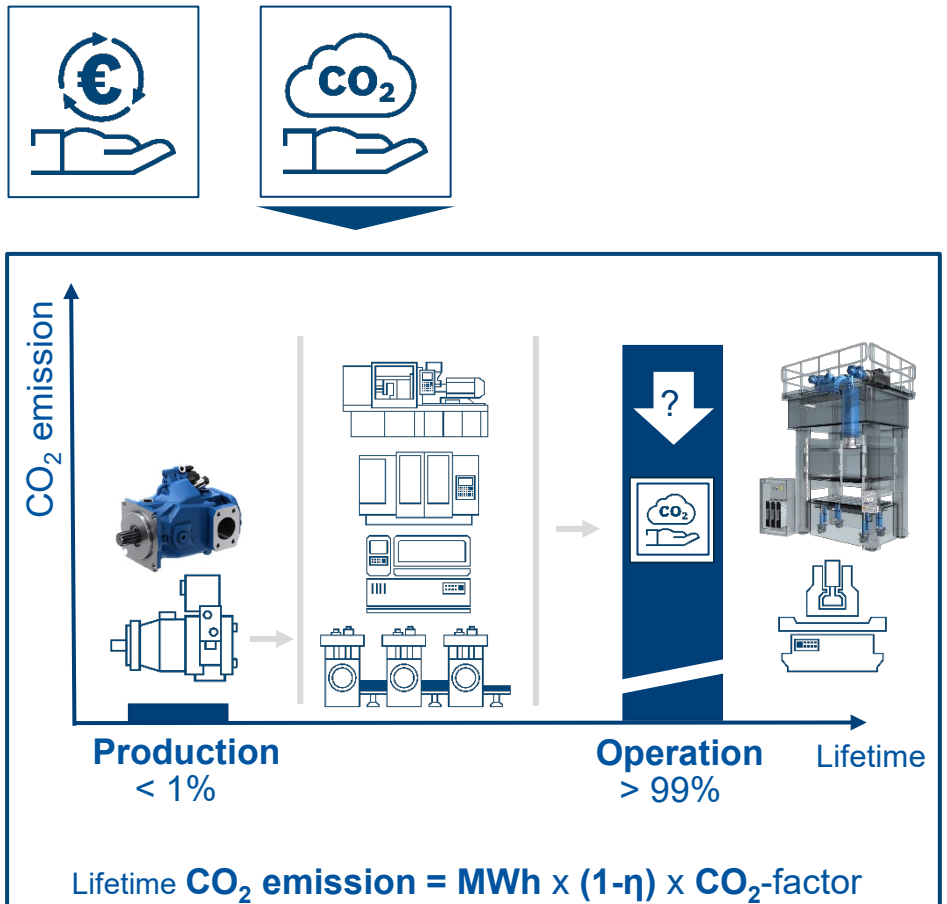
- Anti-twist
- Holding brake with safety *(option)*
- Damping for dynamic loads *(option)*
- Hydrostatic load compensation *(option)*
- Position determination *(option)*

After rotate motion also linear motion drives are expected to become more electric

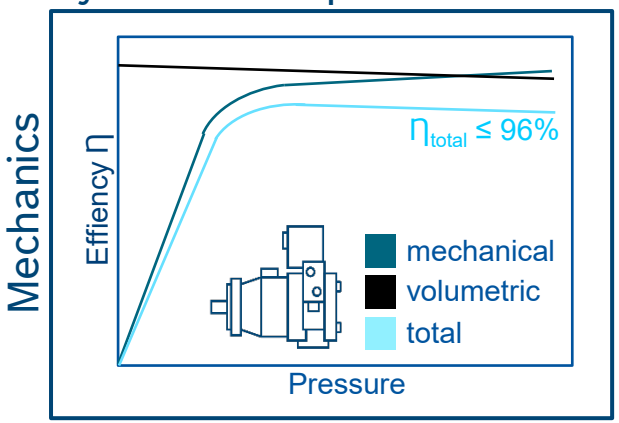
Carbon footprint: Scope 3 for mobile and industrial applications

What can Rexroth bring to the table in terms of technology?

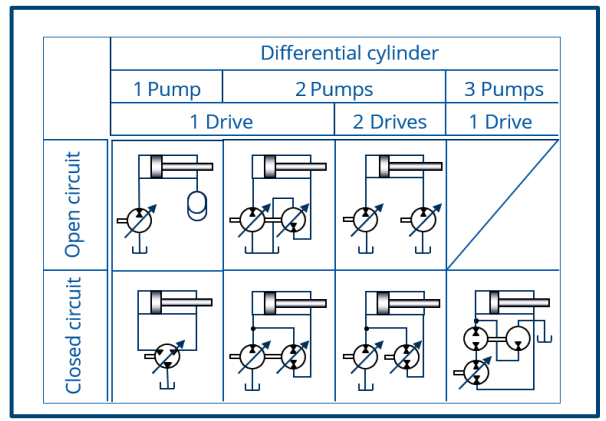
Efficiency: Software as main lever for improvements



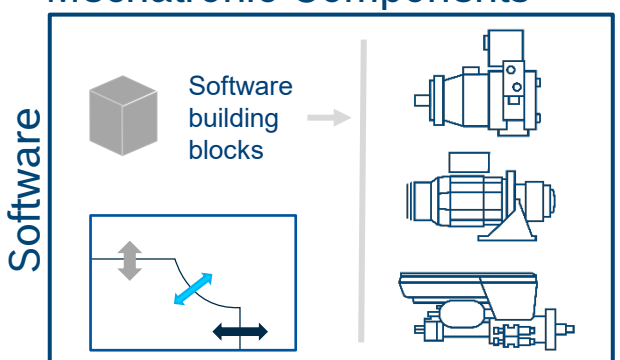
Hydraulic Components



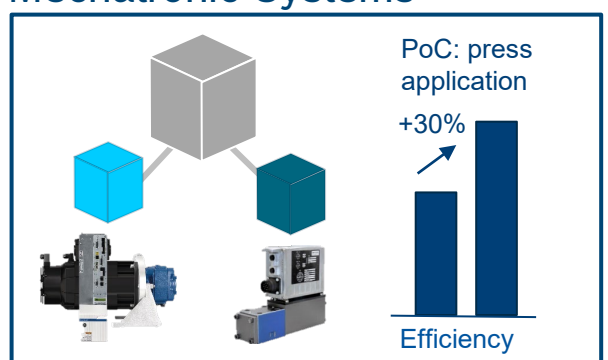
Hydraulic Systems



Mechatronic Components



Mechatronic Systems

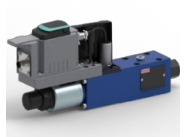


Effiency: Optimizing is most effective on system level

Efficiency: From hardware to software centric hydraulics

- Carbon footprint, scope 3

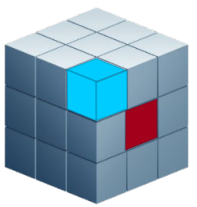
Hardware-centric solution



Complexity!

Complexity!

Software-centric solution

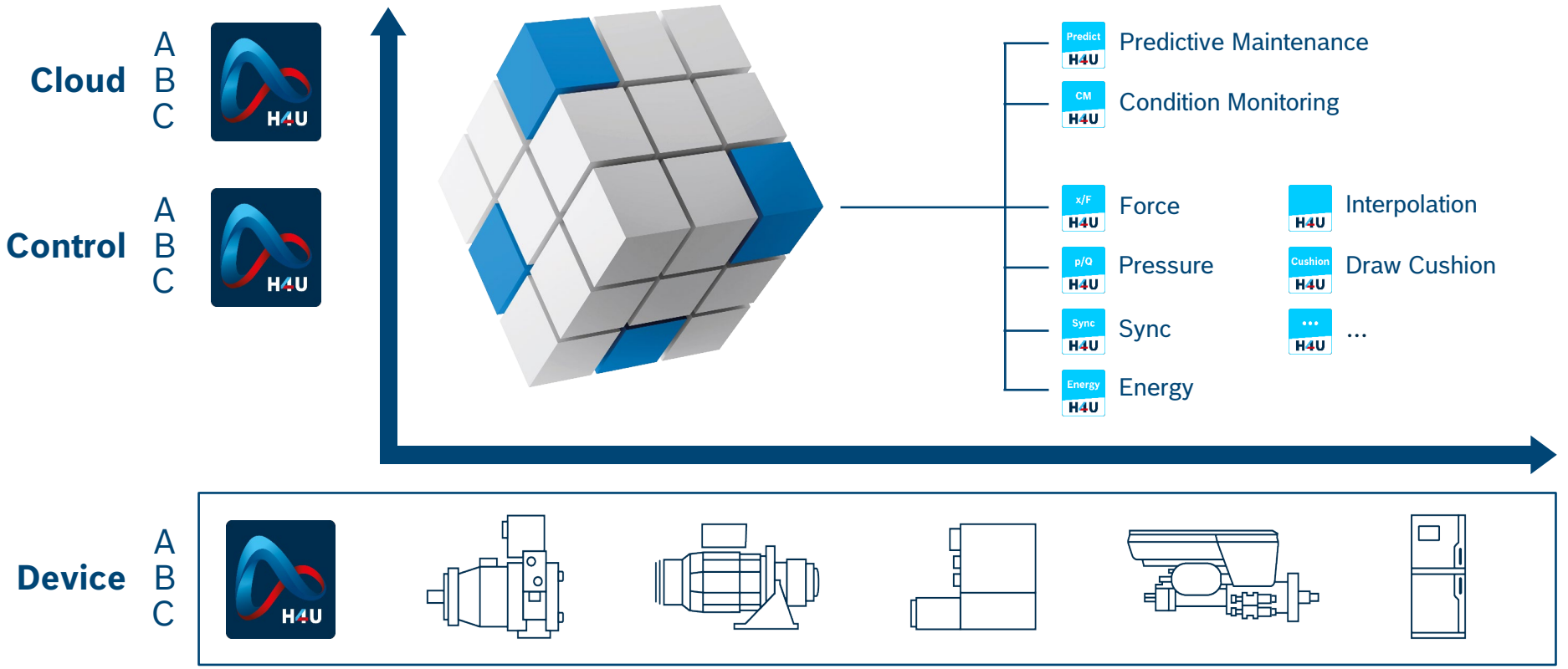


ONE modular software platform for all hydraulic products & solutions

...

Tesla thinking as role model for new electronified industrial hydraulics

Efficiency: Flexible software deployment

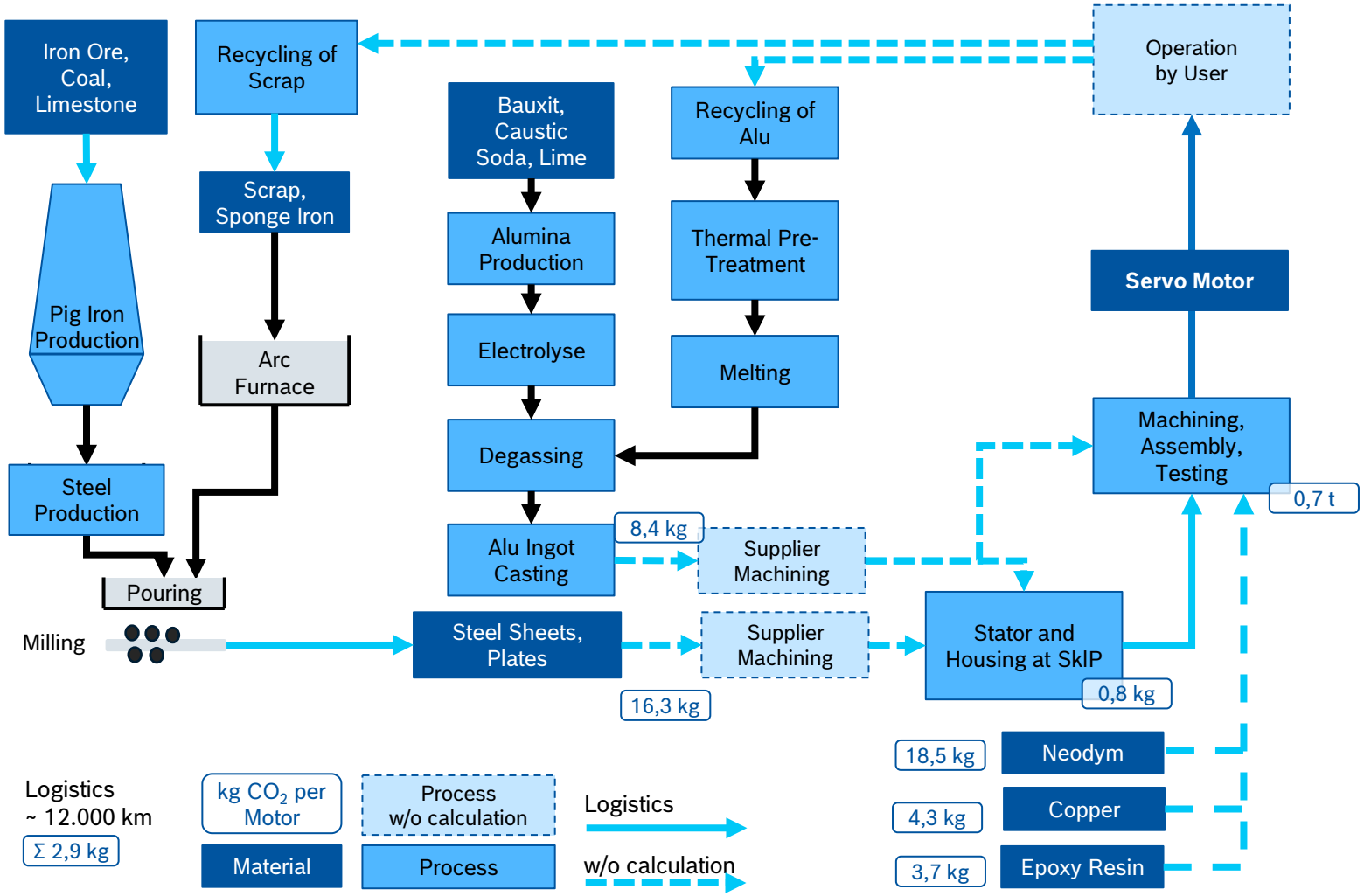


Software apps for energy improvements on different levels

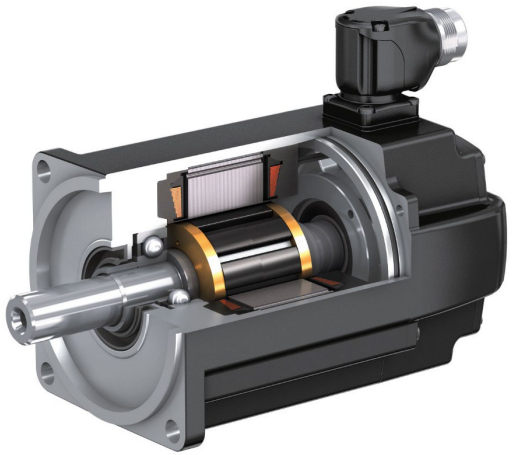
Carbon footprint: Scope 3 for mobile and industrial applications

What can Rexroth bring to the table in terms of technology?

Carbon footprint: PCF example servo motor



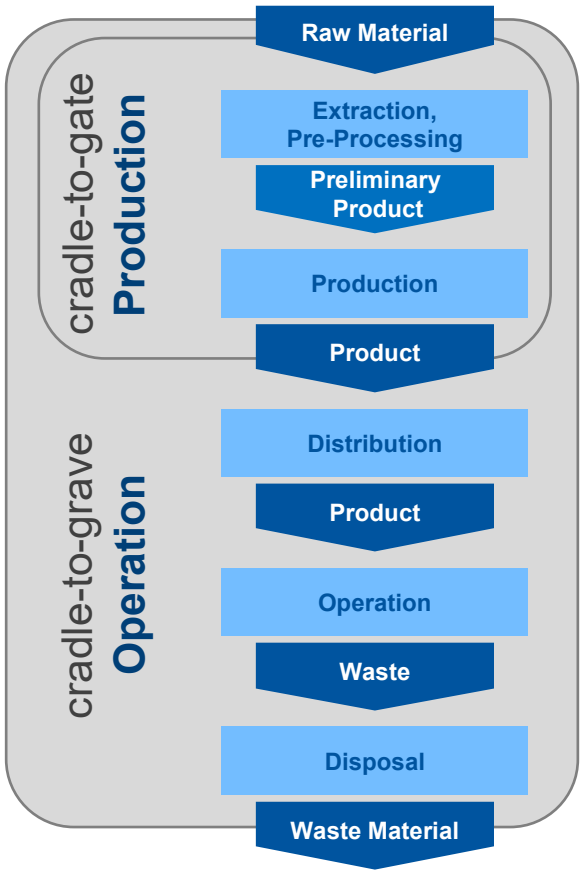
PCF: 0,06t CO_2/ motor

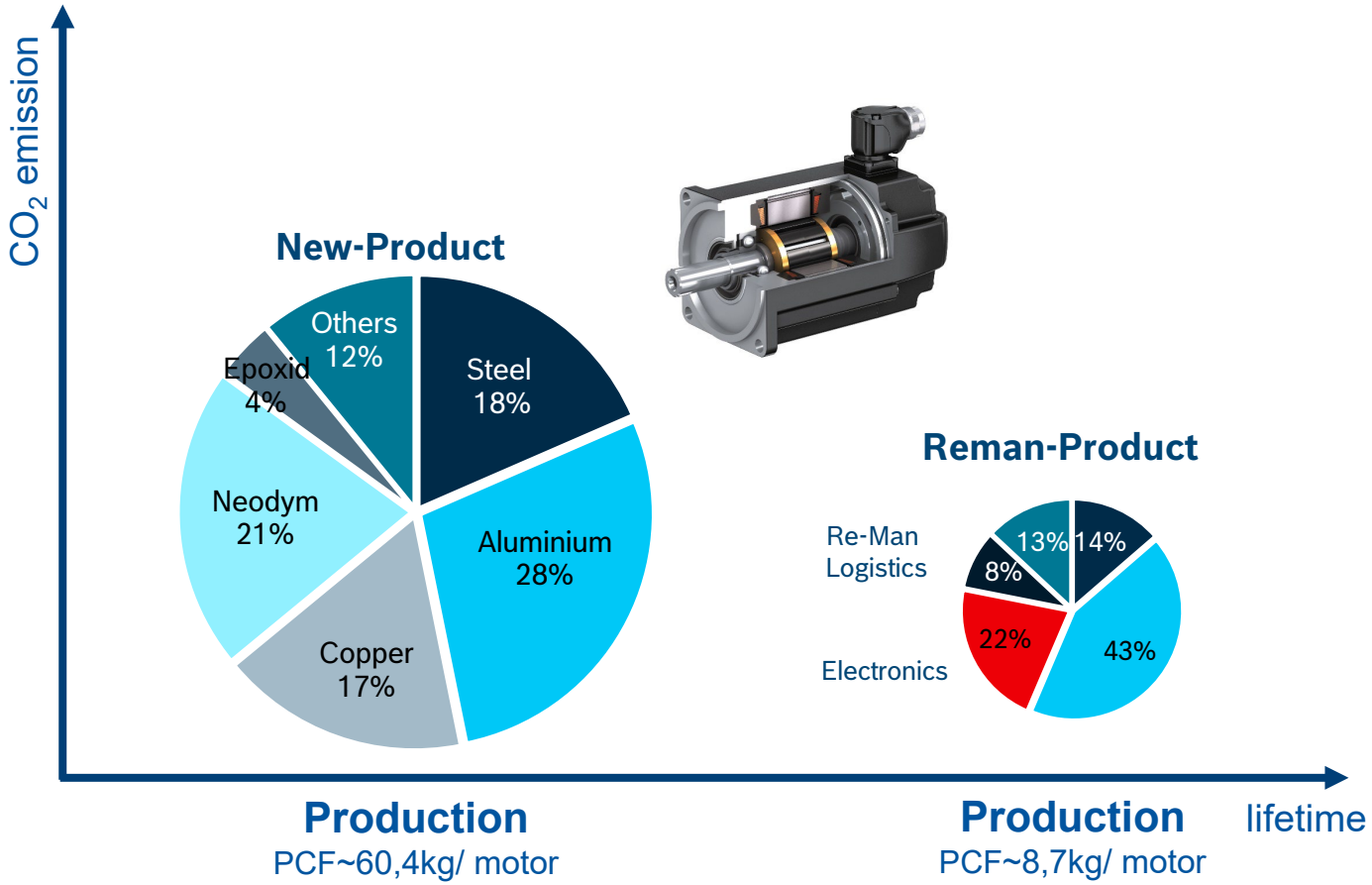


Premises

- Database 2021
- KPI and calculation based on weights
- Average weight: 17 kg/motor
- Data sources:
  - ProBas Datenbase
  - Enablon Database
  - Ecoinvent
  - Following DIN EN ISO 14067 and GHG Protocol

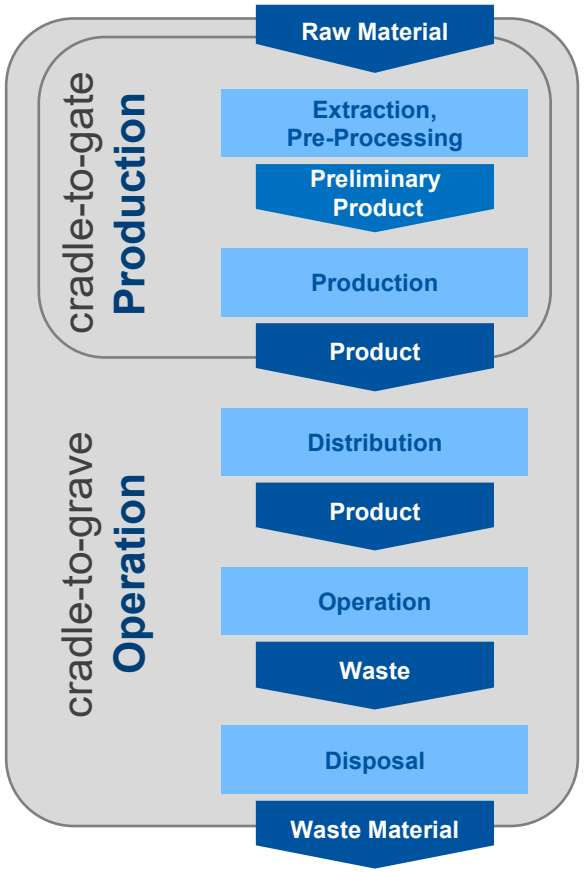
Carbon footprint: Re-manufacturing as opportunity

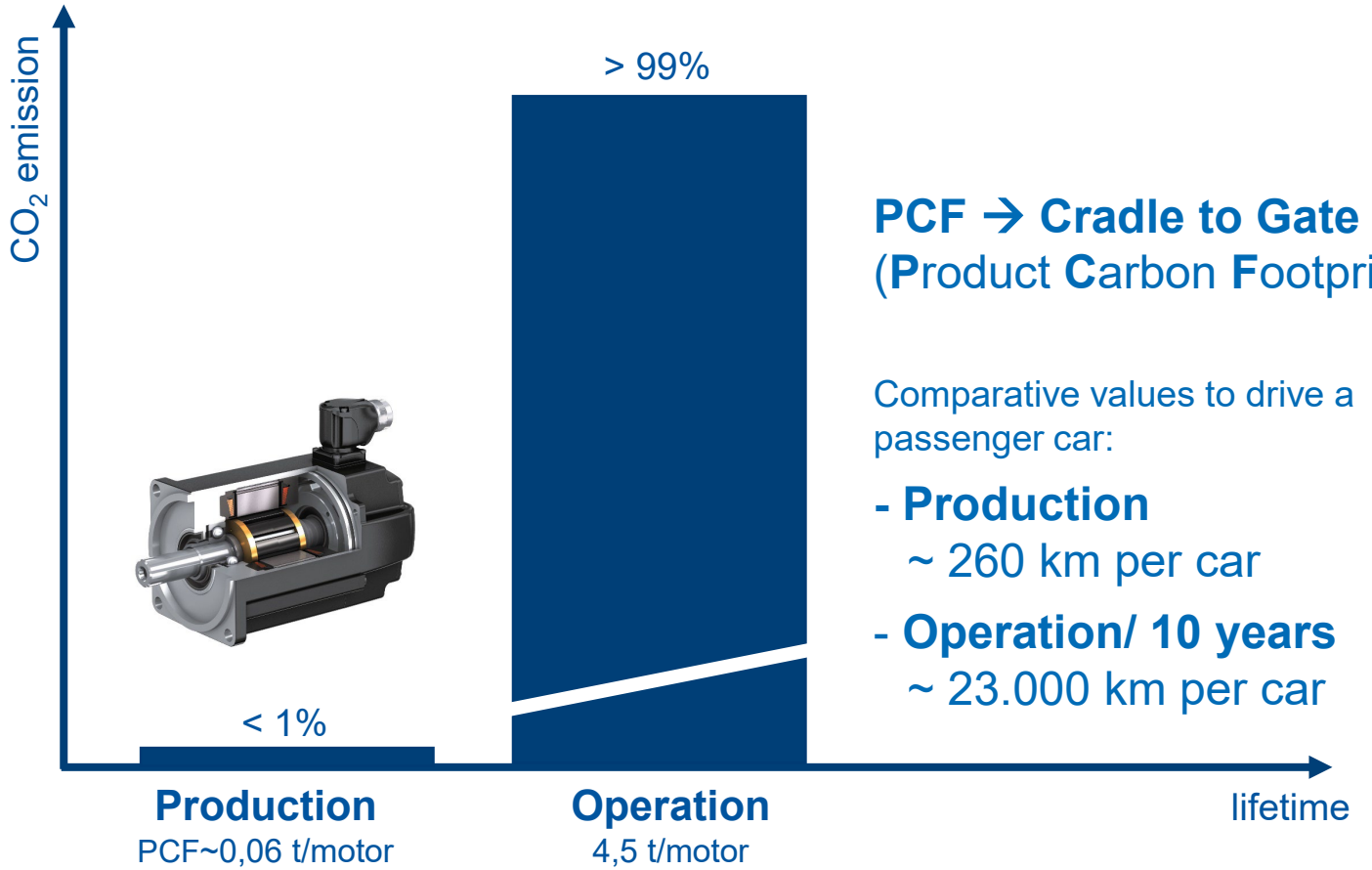




85% PCF reduction by re-manufacturing of electric motors

Carbon footprint: PCF example servo motor





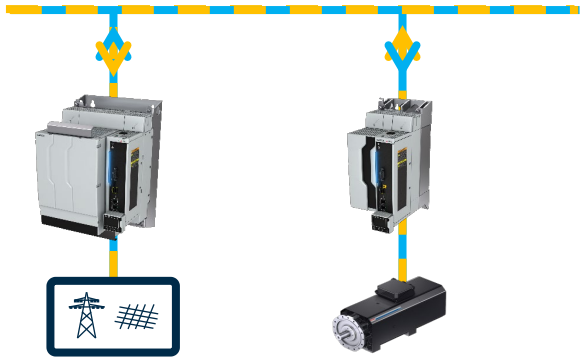
PCF → Cradle to Gate
(**P**roduct **C**arbon **F**ootprint)

Comparative values to drive a passenger car:

- **Production**
  ~ 260 km per car
- **Operation/ 10 years**
  ~ 23.000 km per car

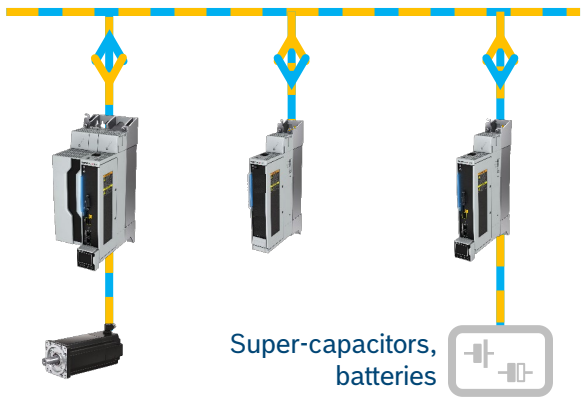
CO2 improvements driven by efficiency and consumption

Efficiency: Decrease of consumption and reduction of peak loads



Regenerative Mode

- Regenerating of excessive energy in the mains supply
- High mains supply quality with least harmonic distortion
- Decrease of energy consumption especially in case of long periods in regenerating mode

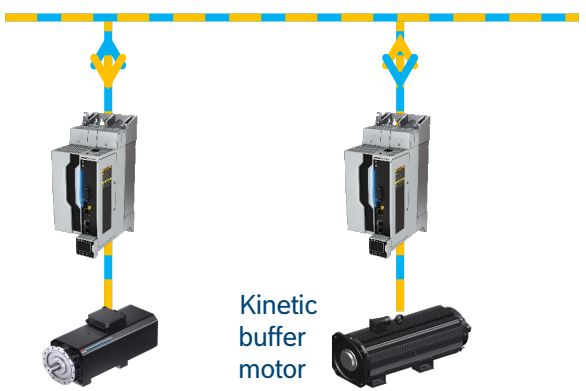


Electric Buffering

- Simple possibility for passive buffering of excessive energy
- Active buffering of excessive energy according the process
- Reduction of peak loads
- Smaller size of the mains connection components

DC- Coupling

- Energy exchange of drives which operates in generator and in motor mode
- Common use of central DC-bus components (power supply, capacities, brake resistor…)
- Smaller size of the mains connection components



Kinetic Buffering

- Active buffering of excessive energy according the process
- System solution with kinetic buffer motor
- Reduction of peak loads
- Smaller size of the mains connection components

There are many technical options for saving energy on the drive side

Efficiency: Software energy and power management

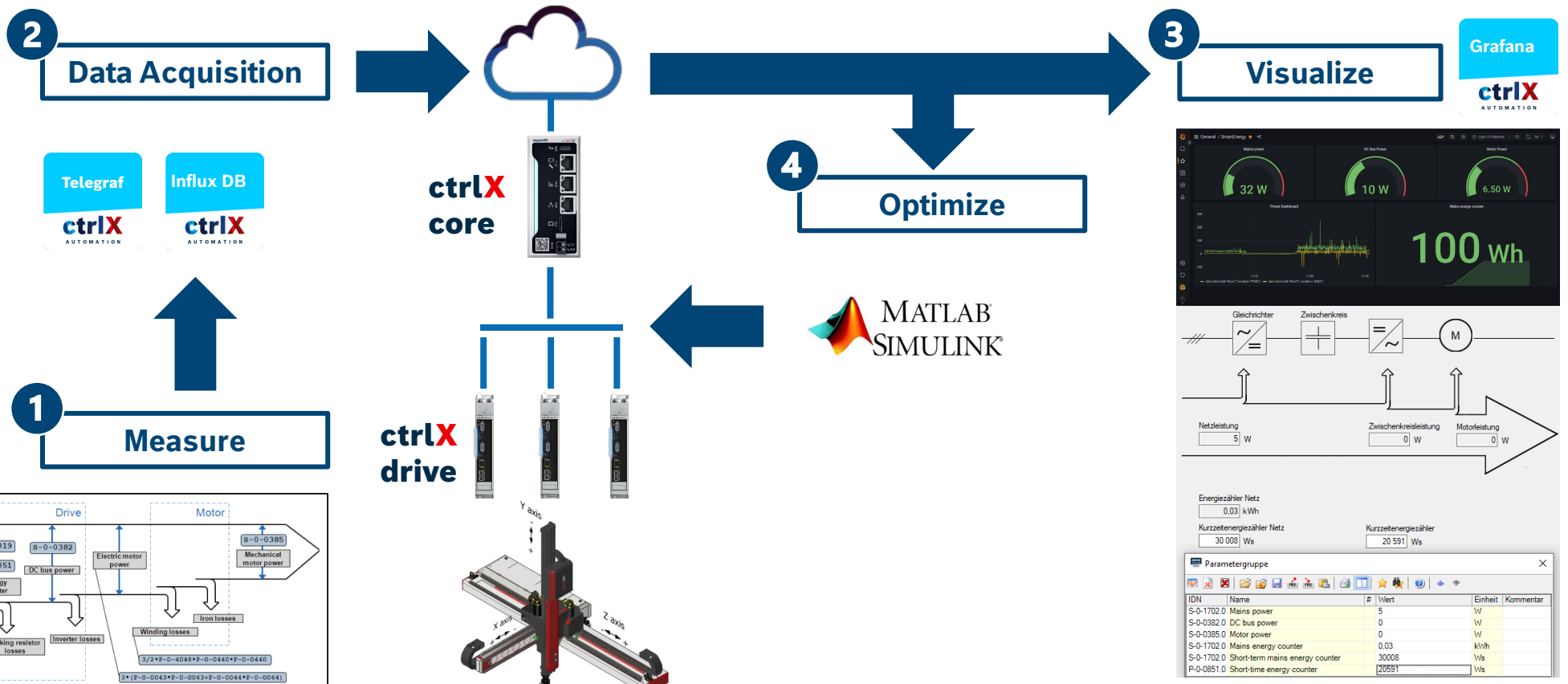


Fig. 11-55: Energy and power values of the IndraDrive system

Proven optimization tools can be used on the control side

Summary

- Rexroth = CO_2 neutral for scope 1, 2
- Rexroth with strong focus on scope 3
- Simplified PCF for Rexroth products available
- Software/ Digital as important lever for energy efficiency improvements on component and system level

What can Rexroth bring to the table in terms of technology?

THANK YOU!

Steffen Haack
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