

Rexroth eLION

High Voltage Solution Portfolio



MAIL

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Off-highway

General view



Off-highway market view

Trends and drivers

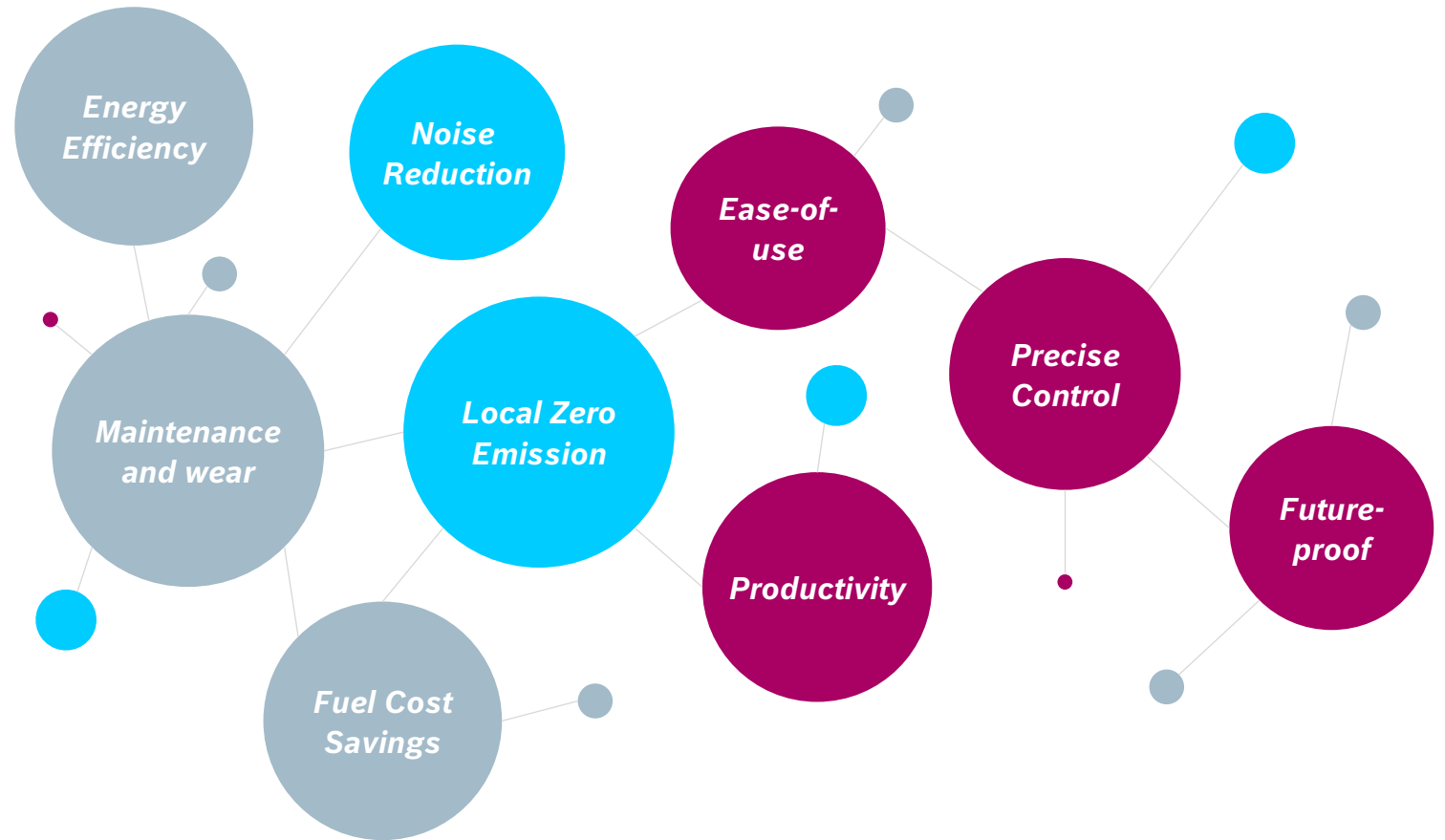
WORLDWIDE LEGISLATION



Emission Reduction



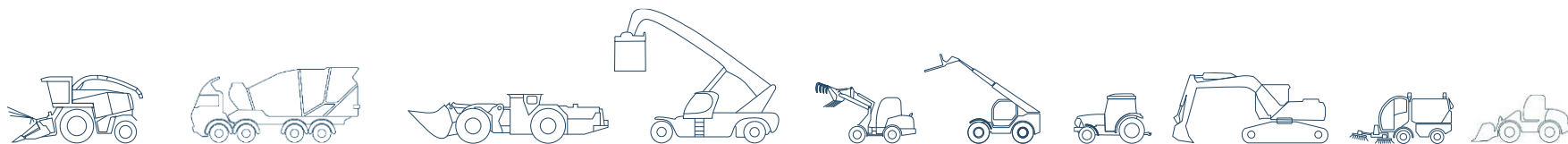
*Zero Emission
Zones*



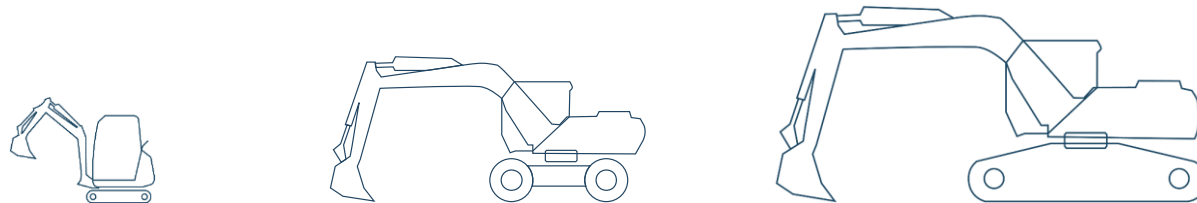
Off-highway market view

Market view | Applications

Various Applications



Various Application Segments

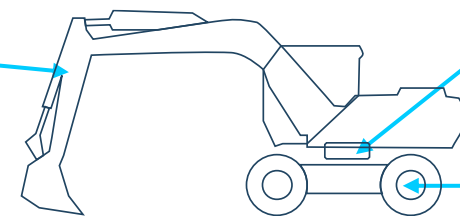


Various Functions

Implement

Swing

Drive



Diverse market environment with many different requirements on electrification

Off-highway market view

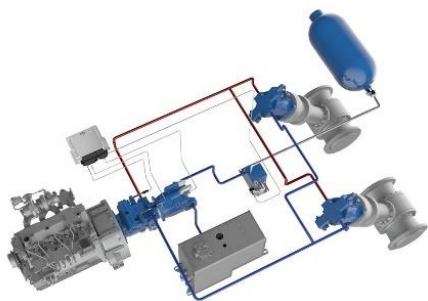
Rexroth market positioning

Bosch Rexroth

Solution Provider for Hydraulics & Electrics

Bosch Rexroth Hydraulic Solutions

01



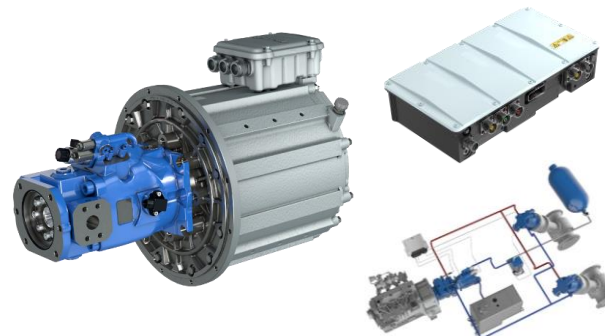
Bosch Rexroth Electric & Mechanical Solutions

02



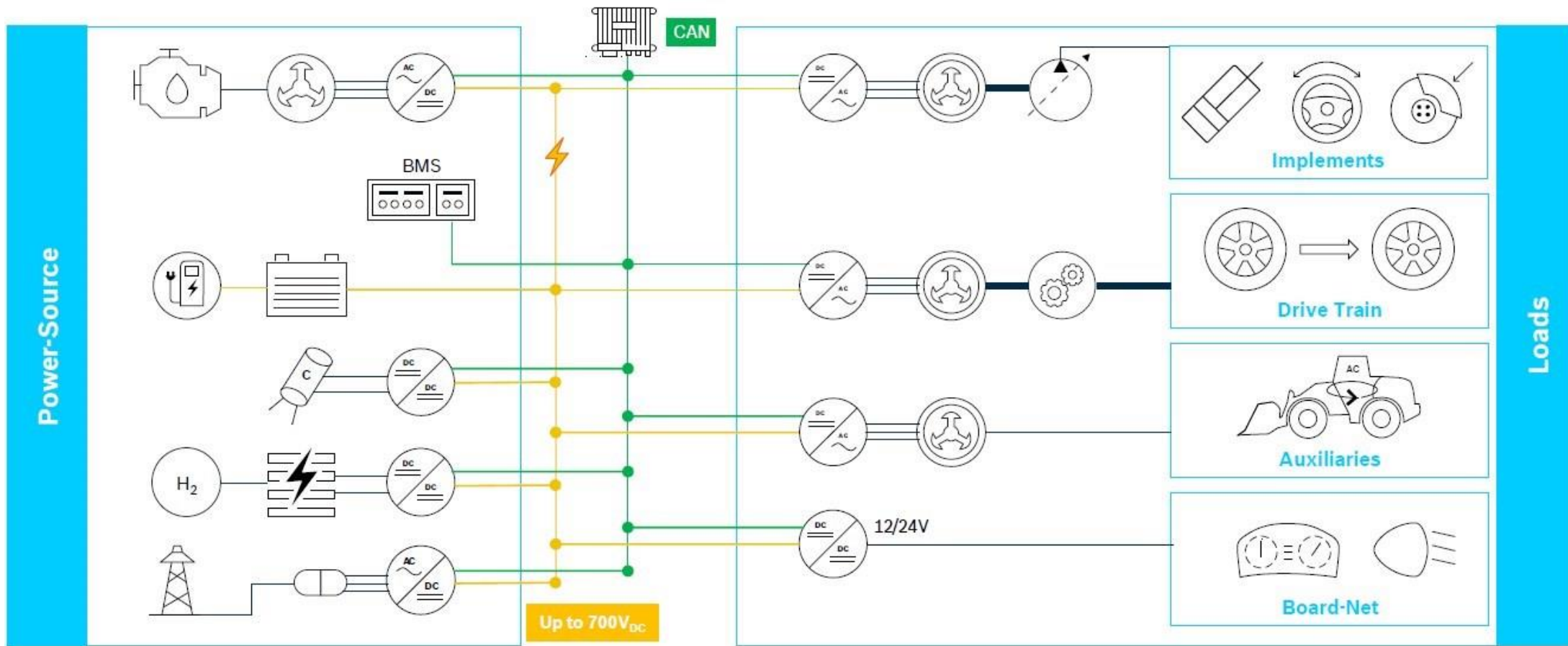
Bosch Rexroth Electric-Hydraulic Solutions

03



Off-highway market view

Electrification topologies



Rexroth **eLION** solution portfolio

High-voltage portfolio for off-highway machines

Gear Boxes for High Speeds
1 & 2 gear for central & wheel drives

Motors up to 229 kW nominal
Traction – Implement – Generator

Energy-efficient Hydraulics

HV Cables

DC-DC Converter
HV → 12V & 24V

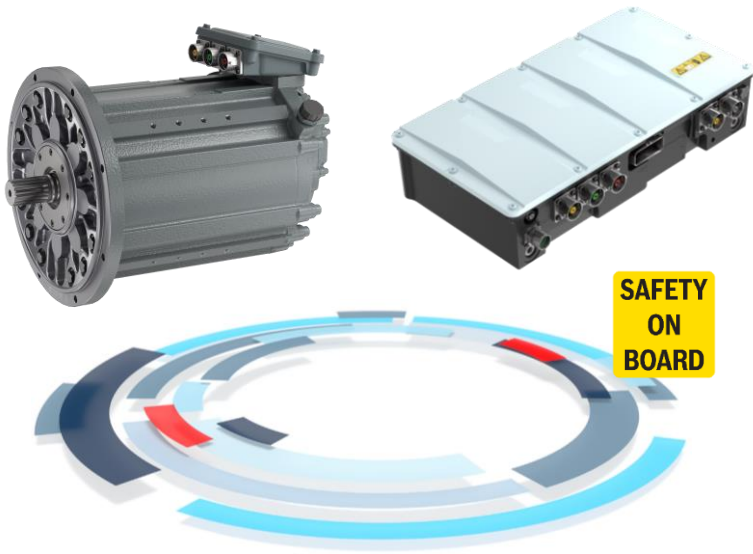
Onboard Charger
20 kW EU & US

3 Inverter Power Classes up to 200 kW
Functional Safety ISO 13849, 25119 and 19014



Rexroth **eLION** solution portfolio

Portfolio characteristics



High-voltage Electrification Portfolio

- ✓ **Nominal power up to 200 kW**
- ✓ **Efficiency up to 98 %**
- ✓ **Designed for off-highway machines**
 - ▶ Liquid cooling, ambient temperature: -40 / +100 °C
 - ▶ Mechanical resistance: Shock 50 g, Vibration 10 g
 - ▶ Ingress protection: up to IP6K7 & IP6K9K
 - ▶ CAN communication
- ✓ **Modular vehicle software:** Safety functions acc. ISO 13849, 25119, & 19014 up to PL d

✓ **Compact and modular for scaling in power and torque**

Permanent Magnet Synchronous Motor Portfolio

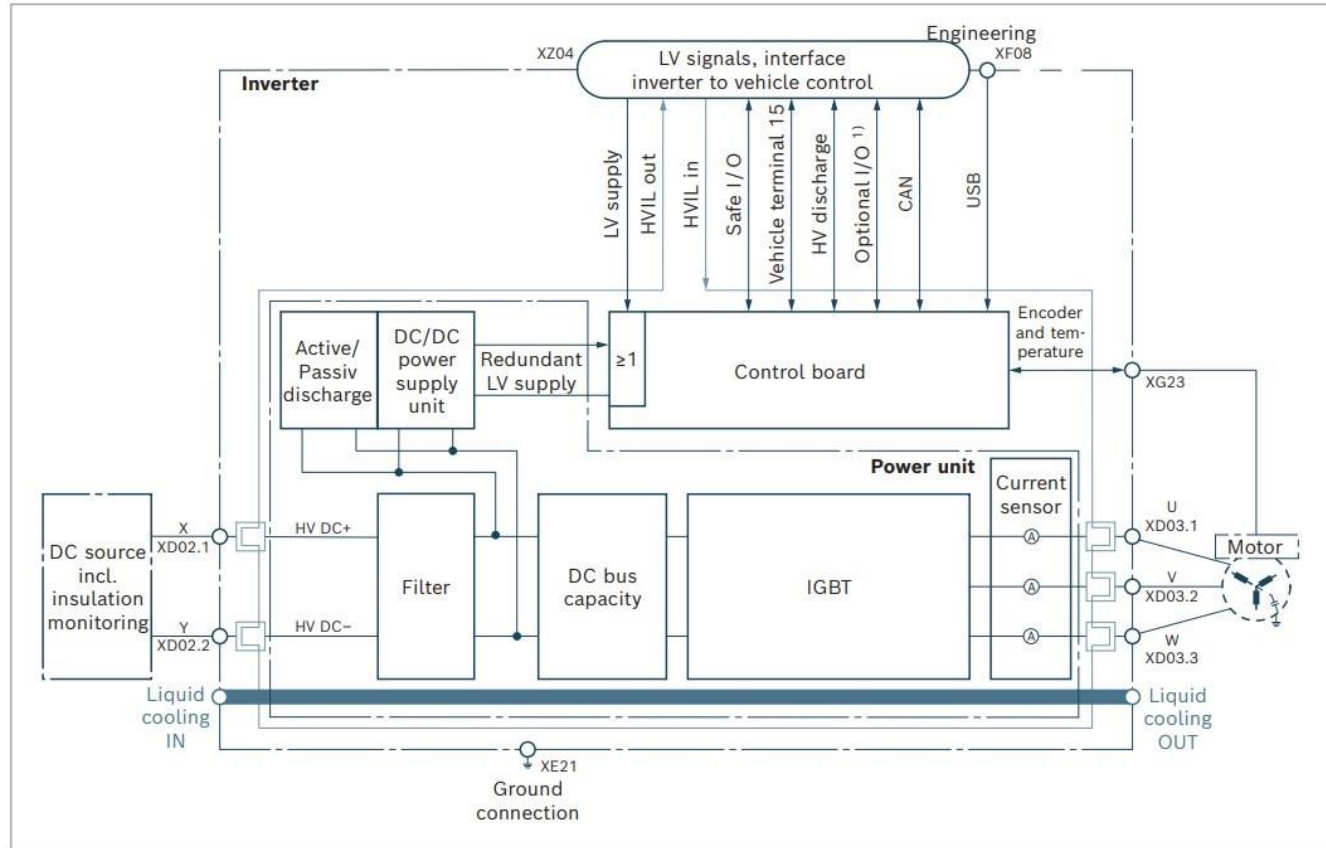
- ▶ 4 diameters, each configurable in length and windings
- ▶ Available in low & high-speed versions

Inverter Portfolio

- ▶ 2 housing sizes and 3 power classes

Rexroth **eLION** solution portfolio

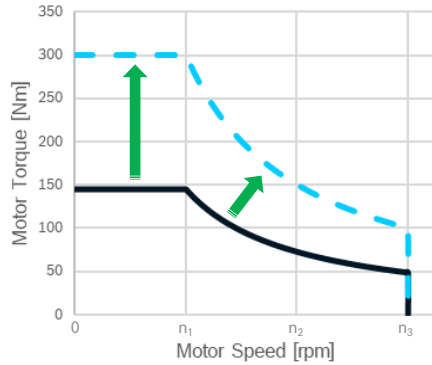
Inverter/Motor EMS1 series



Rexroth **eLION** solution portfolio

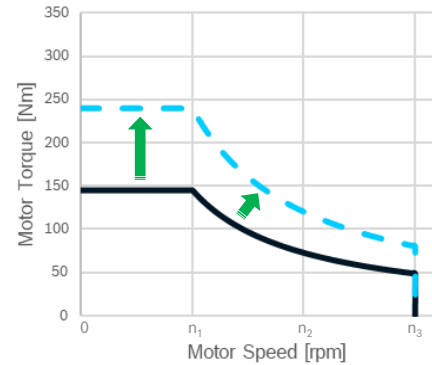
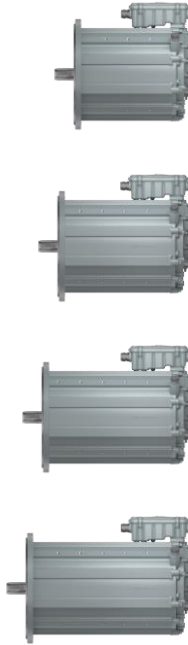
Electric motor scalability

Motor Diameter



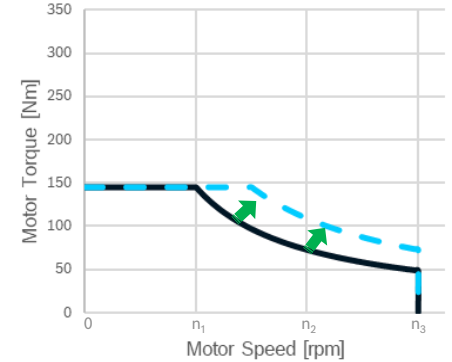
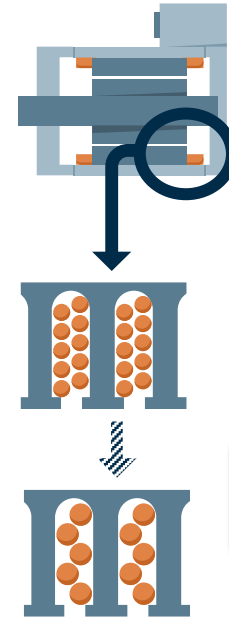
↑ **DIAMETER** = ↑ **Torque** = ↑ **Power**

Motor Length



↑ **LENGTH** = ↑ **Torque** = ↑ **Power**

Motor Winding

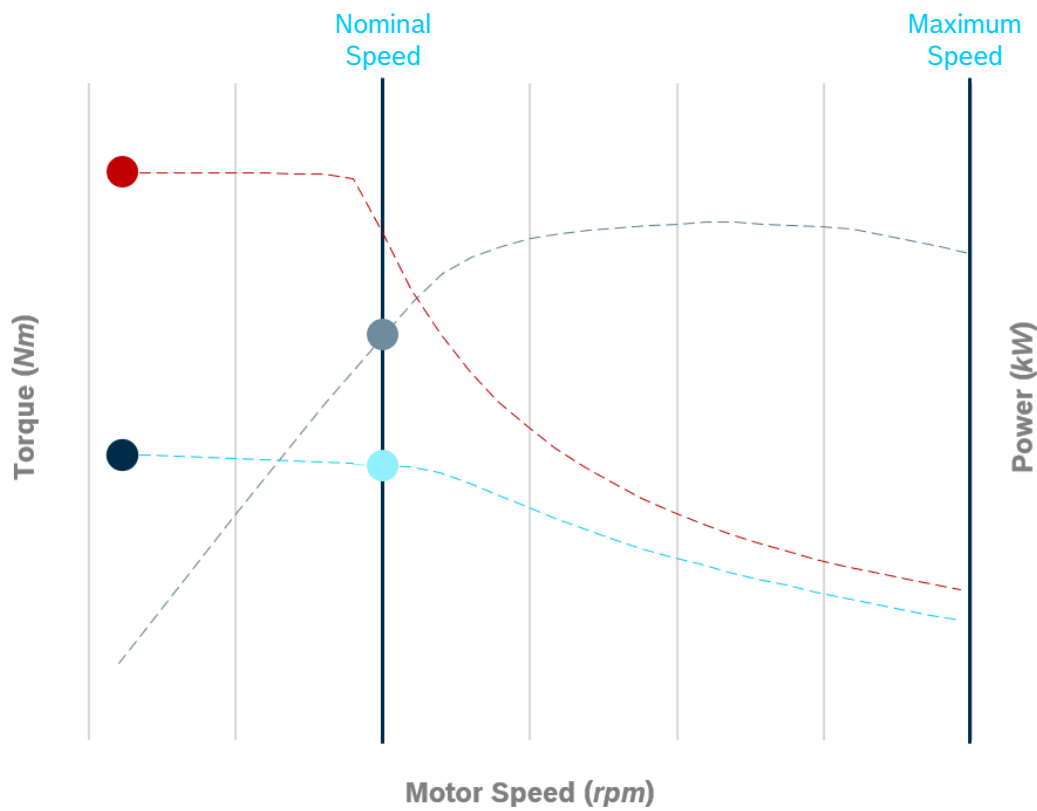


↓ **# TURNS / SLOTT** = ↑ **Power**

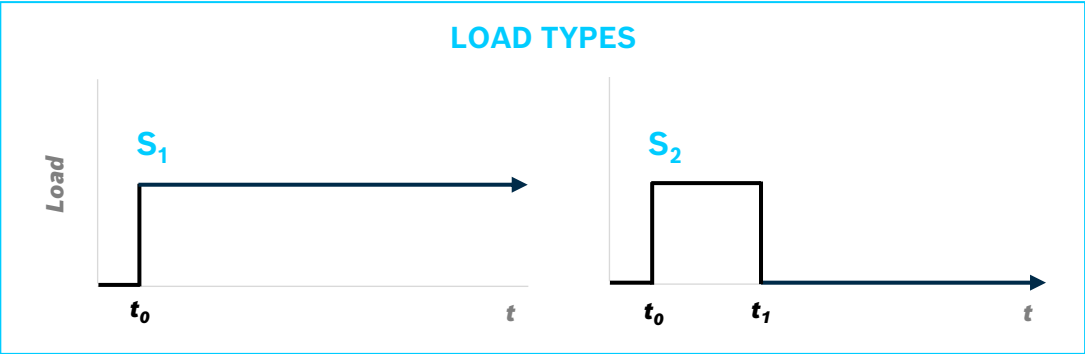
Several motor sizes & winding configurations → Portfolio with over 80 variants

Rexroth eLION solution portfolio

Description of motor curves

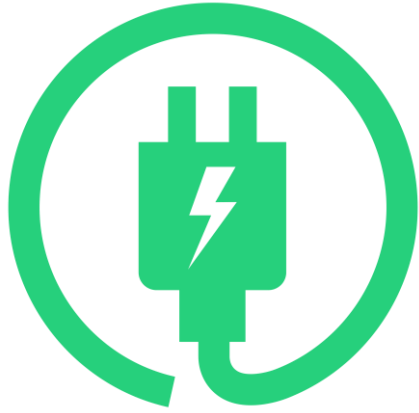


| LEGEND | | | | |
|--------|---------------|------|------------------------|-----------------|
| | Symbol | Unit | Description | Speed |
| ● | M_0 | (Nm) | Low speed motor torque | 200 rpm |
| ● | $M_{S2\ 60s}$ | (Nm) | S2 60s torque | 200 rpm |
| ● | M_{S1} | (Nm) | Continuous torque | Nominal speed |
| ● | P_{S1} | (kW) | Continuous power | Nominal speed |
| - - - | $M_{S2\ 60s}$ | (Nm) | S2 60s torque | Operating range |
| - - - | M_{S1} | (Nm) | Continuous torque | Operating range |
| - - - | P_{S1} | (kW) | Continuous power | Operating range |

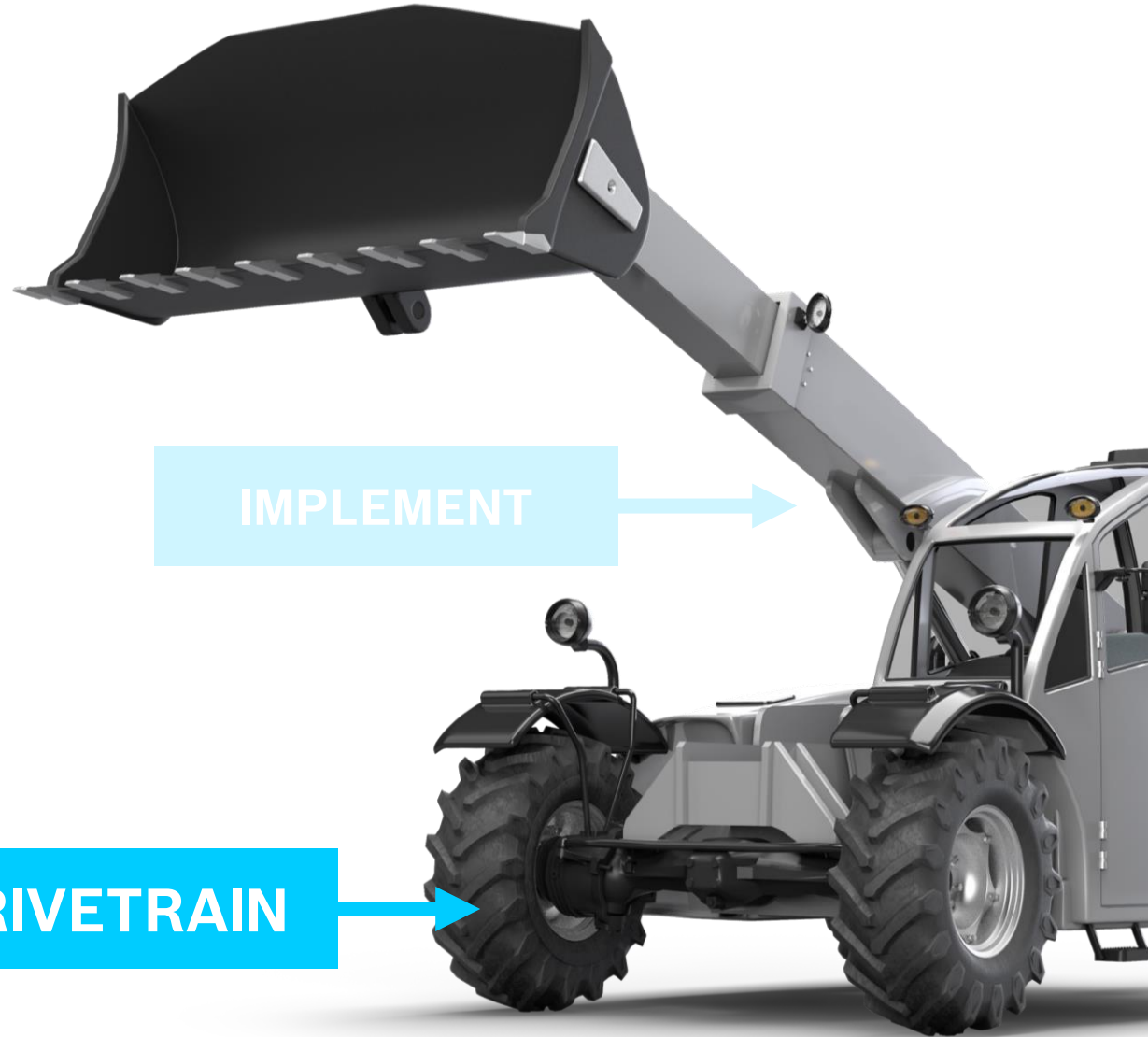


Rexroth **eLION** solution portfolio

Electrifying mobile machines

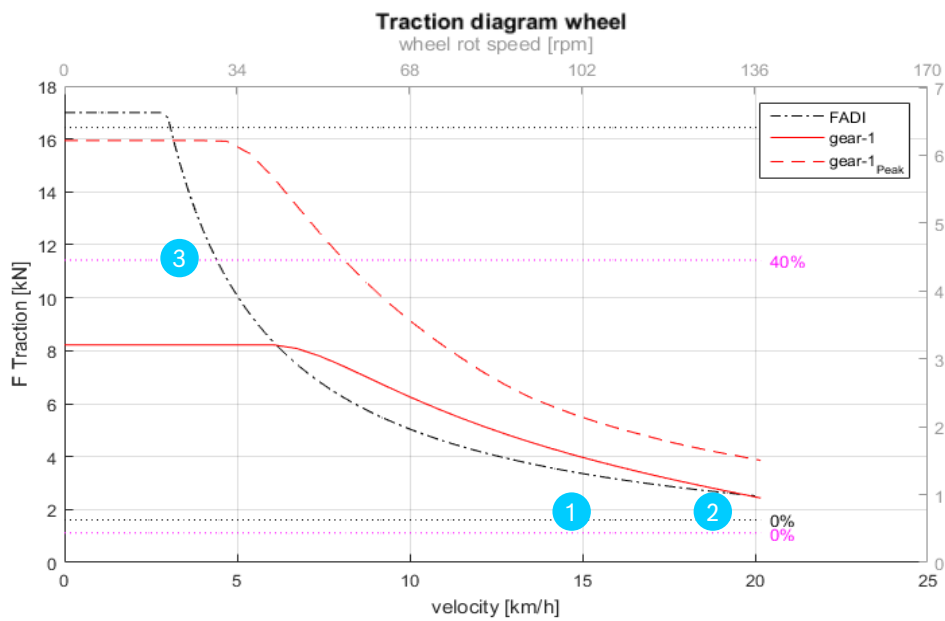


**Optimization of
drivetrain function**



Rexroth eLION solution portfolio

eFADI (Design Tool): Electric Traction System



INPUT VEHICLE DATA

| | | | |
|----------------------------------|---------|--------------------------------------|----------|
| Machine mass (unloaded, w/ tool) | 2850 kg | Topology | Central |
| Load capacity | 1250 kg | Low Rotation Dropbox max input speed | 6000 rpm |
| Wheel radius (loaded) | 0.39 m | Dropbox (1+0) Ratio 3 | 3 |
| Average Rolling resistance | 0.04 | Axle ratio | 14 |

INPUT TECHNICAL REQUIREMENTS

| | | |
|--|---------|---|
| Mandatory continuous top speed (loaded, flat road) | 15 km/h | 1 |
| Top speed (unloaded) | 20 km/h | 2 |
| Max slope (loaded @3km/h) | 40 % | 3 |

RESULTING PERFORMANCE

| | |
|--|-------|
| Traction FZ (slope 40%, loaded @3km/h) | 17 kN |
| (slope 40%, loaded @3km/h) | 14 kW |
| .. | ... |

Selected E-Motor: EMS1-XX YZZ

| | | | | | |
|------------|---|-------------|---|------------|---|
| T nom [Nm] | X | n nom [rpm] | X | P nom [kW] | X |
| T max [Nm] | X | n max [rpm] | X | P max [kW] | X |

Inverter: EDS1-L0XXX

| | |
|--|--|
| | |
| | |

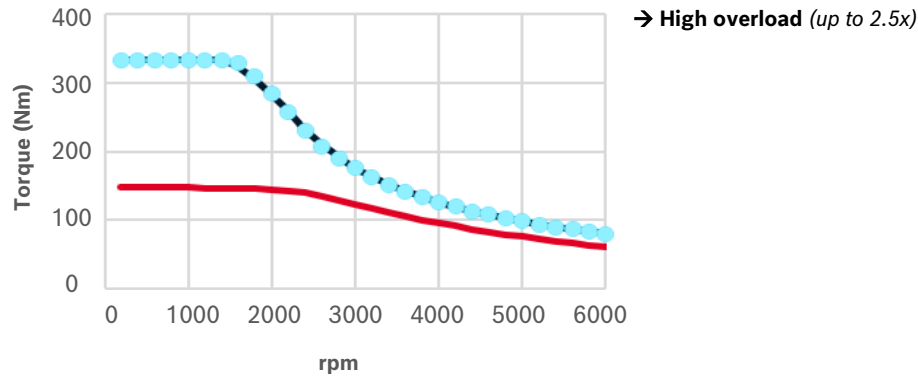
REQUIREMENTS

| | S2 [s] | Sx [s] | X [mm] | Y [mm] | Z [mm] | Volume[dm3] | Weight [kg] |
|------|--------|--------|--------|--------|--------|-------------|-------------|
| Req. | | | | | | | |

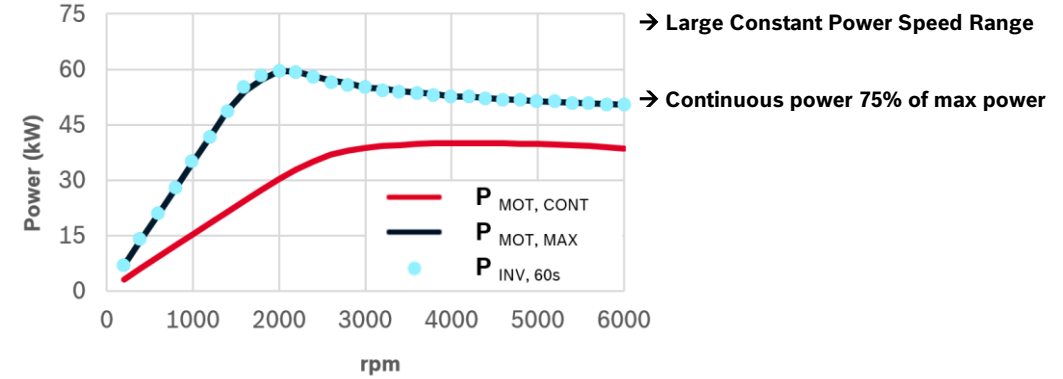
Rexroth **eLION** solution portfolio

Design considerations for electric off-highway drivetrains

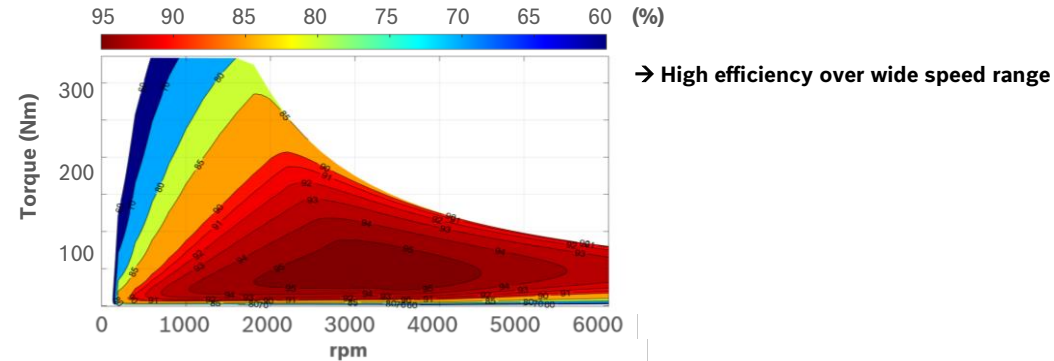
Torque



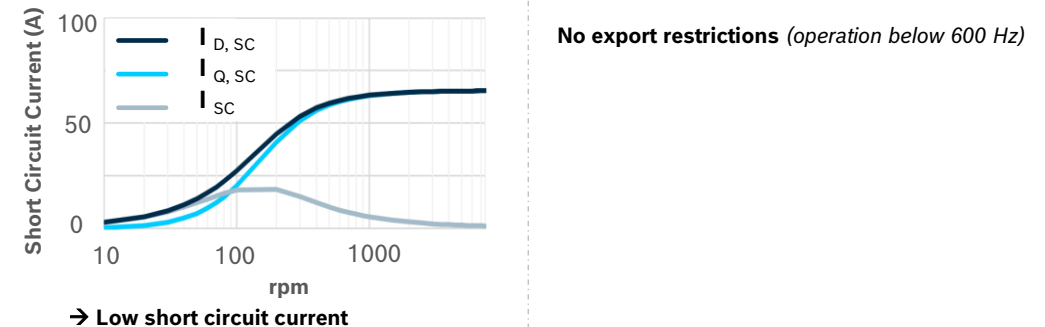
Power



Efficiency

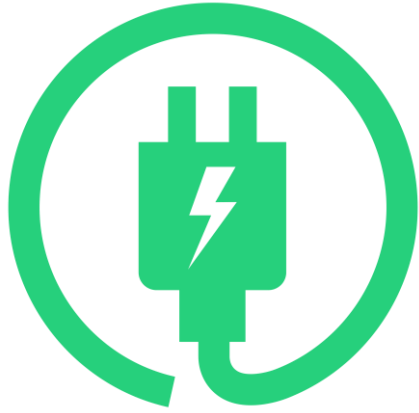


Additional Requirements

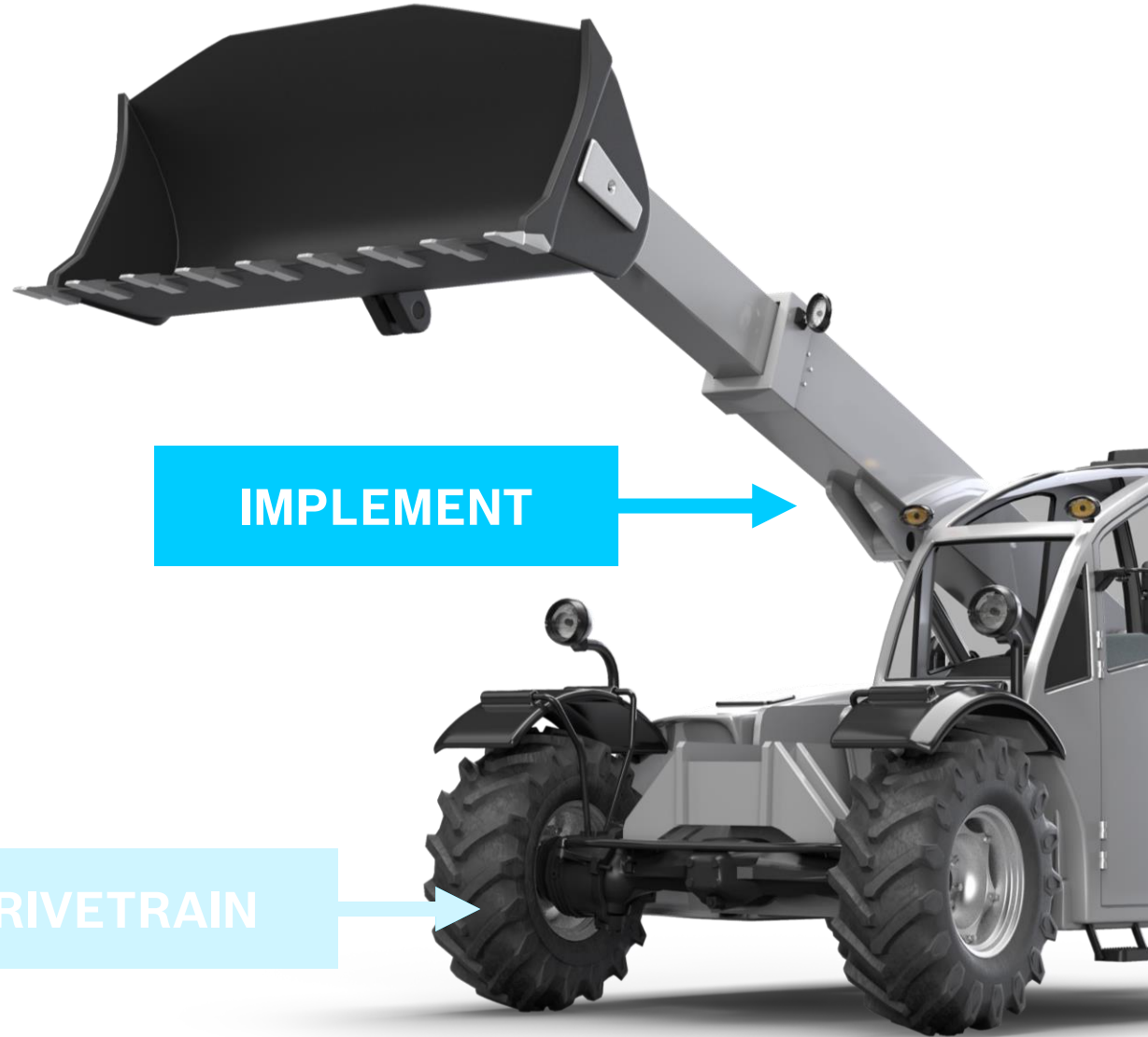


Rexroth **eLION** solution portfolio

Electrifying mobile machines

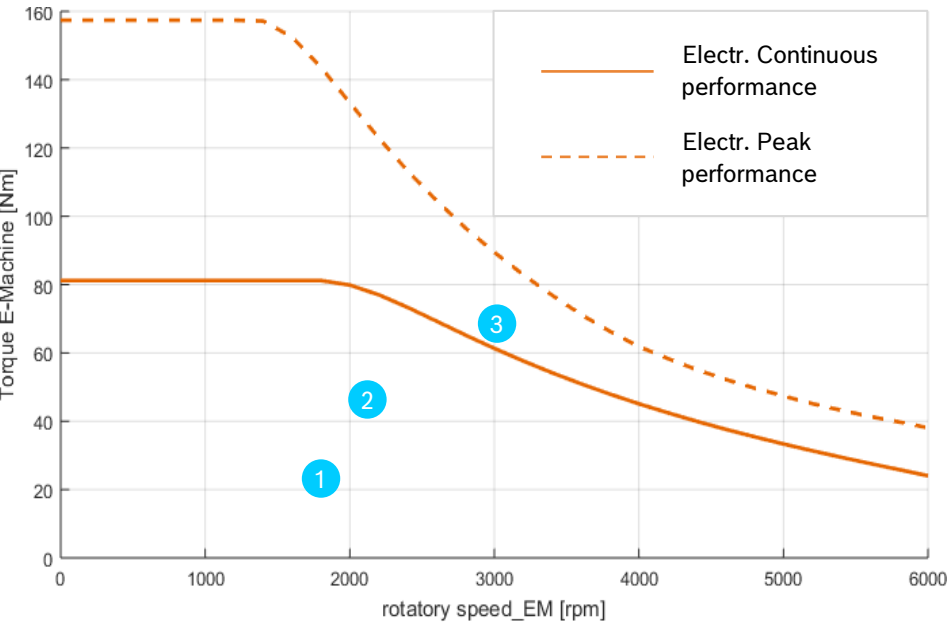


**Optimization of
implement function**



Rexroth eLION solution portfolio

eFADI (Design Tool): Electric Hydraulic System



| Input data | | |
|----------------------|---------------------------|---|
| Continuous operation | 4.5 kW / 1800 rpm / 24 Nm | 1 |
| Maximum operation | 11 kW / 2100 rpm / 45 Nm | 2 |
| Max. Hydraulic Power | 21 kW / 2960 rpm / 66 Nm | 3 |
| Estimated Pump Size | 16 cc | |

Selected E-Motor: EMS1-XX YZZ

Inverter: EDS1-L0XXX

REQUIREMENTS

| | | | | | |
|------------|---|-------------|---|------------|---|
| T nom [Nm] | X | n nom [rpm] | X | P nom [kW] | X |
| T max [Nm] | X | n max [rpm] | X | P max [kW] | X |

| | | | | | | | |
|------|--------|--------|--------|--------|--------|-------------|-------------|
| | S2 [s] | Sx [s] | X [mm] | Y [mm] | Z [mm] | Volume[dm3] | Weight [kg] |
| Req. | | | | | | | |



eLION

Pilot Activities

Rexroth eLION pilot activities

Bosch Rexroth: Battery-electric Telehandler

CHARACTERISTICS

Project Scope:

- Electrification of traction
- Electric-hydraulic implements and auxiliaries

Rexroth Contribution:

- eLION Motors, Inverters, Gearbox, Onboard charger & Pumps
- Electrical & Functional Safety
- System Software

System Topology:

- Battery-electric



Rexroth **eLION** pilot activities

Sennebogen: Diesel-electric Material Handler

CHARACTERISTICS

World Premier:

- First electrified Sennebogen material handler

Project Scope:

- Electrification of traction

Rexroth Contribution:

- eLION Motors, Generators, Inverters, Cables & PDU
- Electrical & Functional Safety
- Drivetrain Software (incl. Generator)

System Topology:

- Diesel-electric

Efficiency increase up to
30%



Rexroth **eLION** pilot activities

Kalmar: Battery-electric Reach Stacker

CHARACTERISTICS

Project Scope:

- Electrification of traction
- Electric-hydraulic implements and auxiliaries

Rexroth Contribution:

- eLION Motors, Inverters, Gearbox & Cables
- Electrical & Functional Safety

System Topology:

- Battery-electric



Rexroth **eLION** pilot activities

Krone: Autonomous Diesel-electric Tractor

CHARACTERISTICS

Project Scope:

- Electrification of traction
- Electric power take-off (ePTO)

Rexroth Contribution:

- eLION Motors, Inverters, Gearbox, PDU & Cables
- DC-Bus Software for Generator
- Electrical & Functional Safety

System Topology:

- Diesel-electric



Rexroth **eLION** pilot activities

Cifa: Battery-electric concrete mixer

CHARACTERISTICS

Project Scope:

- Electrification of drum drive

Rexroth Contribution:

- eLION Motors, Inverters, & Cables
- Electrical & Functional Safety

System Topology:

- Battery-electric



Rexroth **eLION** pilot activities

Cifa: Hybrid concrete pump

CHARACTERISTICS

Project Scope:

- Electrification of concrete pump and auxiliaries

Rexroth Contribution:

- eLION Motors, Inverters, & Cables
- Electrical & Functional Safety

System Topology:

- Hybrid



Rexroth **eLION** pilot activities

Broderon: Battery-electric carry deck

CHARACTERISTICS

Project Scope:

- Electrification of traction
- Electrification of implements and auxiliaries

Rexroth Contribution:

- eLION motors, inverters, & axial piston units
- Electrical & Functional Safety

System Topology:

- Battery-electric



Transforming Mobile Machines

Now. Next. Beyond



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