Research & Technology, New Propulsion Systems (TR-S)

New propulsion systems for non-road applications and the impact on combustion engine operation

London, 14th March 2014, Benjamin Oszfolk

Power. Passion. Partnership.

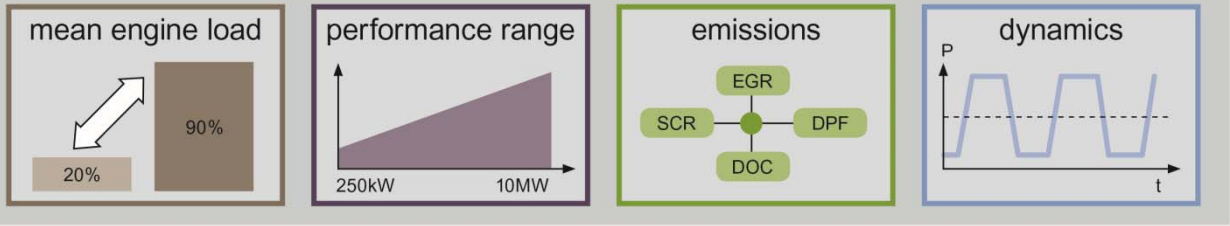
Content

Incentive

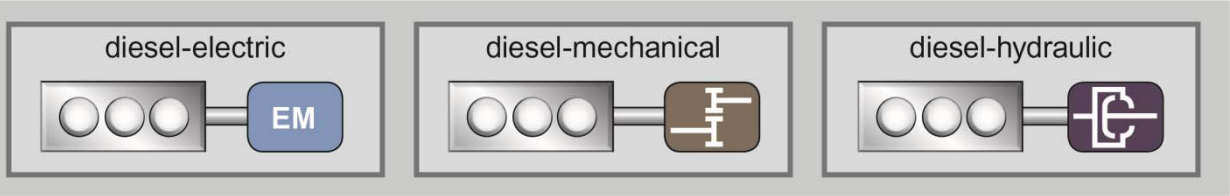
01 Incentive
Non-road applications / MTU products

MTU applications

requirements

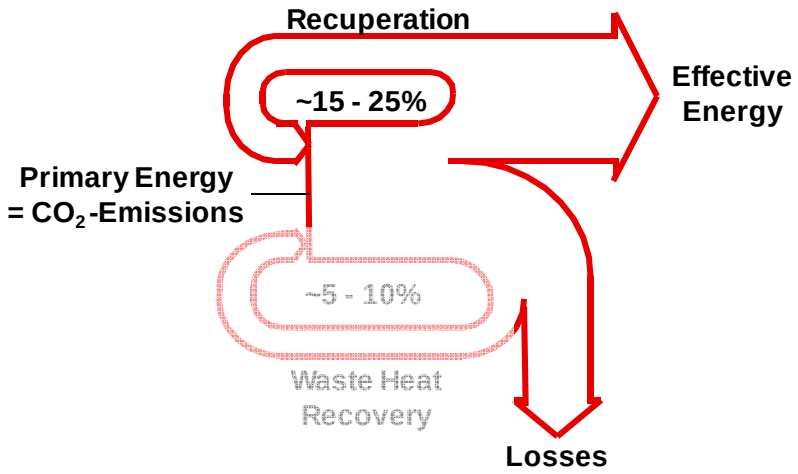


drive trains



01 Incentive
Trend of reducing CO_2 emissions

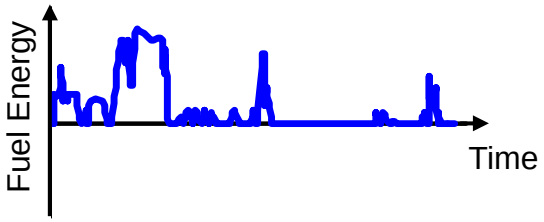
A significant step towards future CO_2-targets and reduction in life cycle cost will be achieved only by optimising both, internal combustion Engine and propulsion system

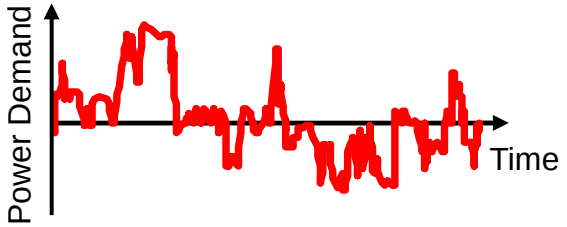


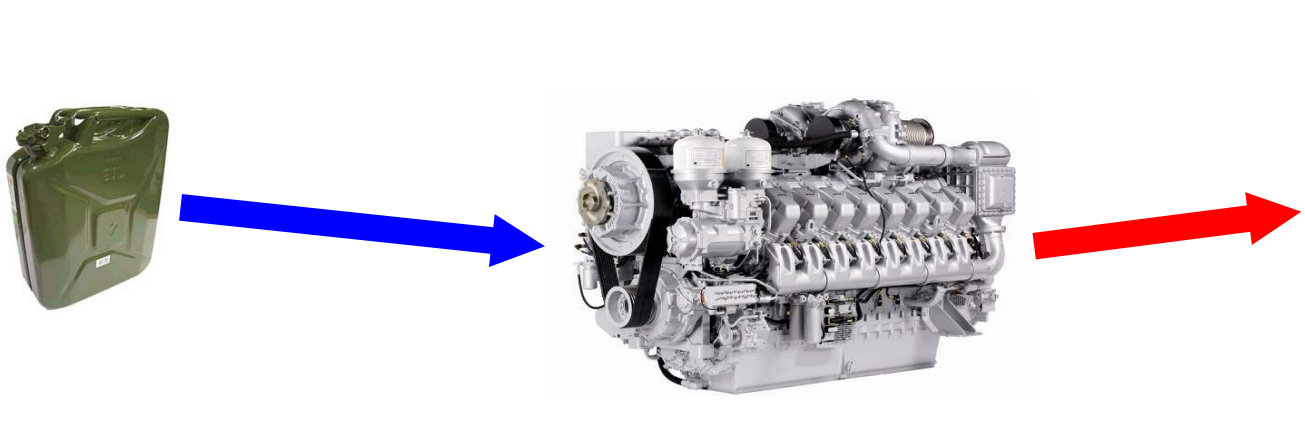
Benefits of new propulsion systems:

- Optimised engine operation → reduction of real life exhaust gas emissions (NO_x, PM, HC)
- Functional enhancement (e.g. boost capability, temporary silent operation, strong on-board electrical grid)

01 Incentive
Trend of reducing CO_2 emissions

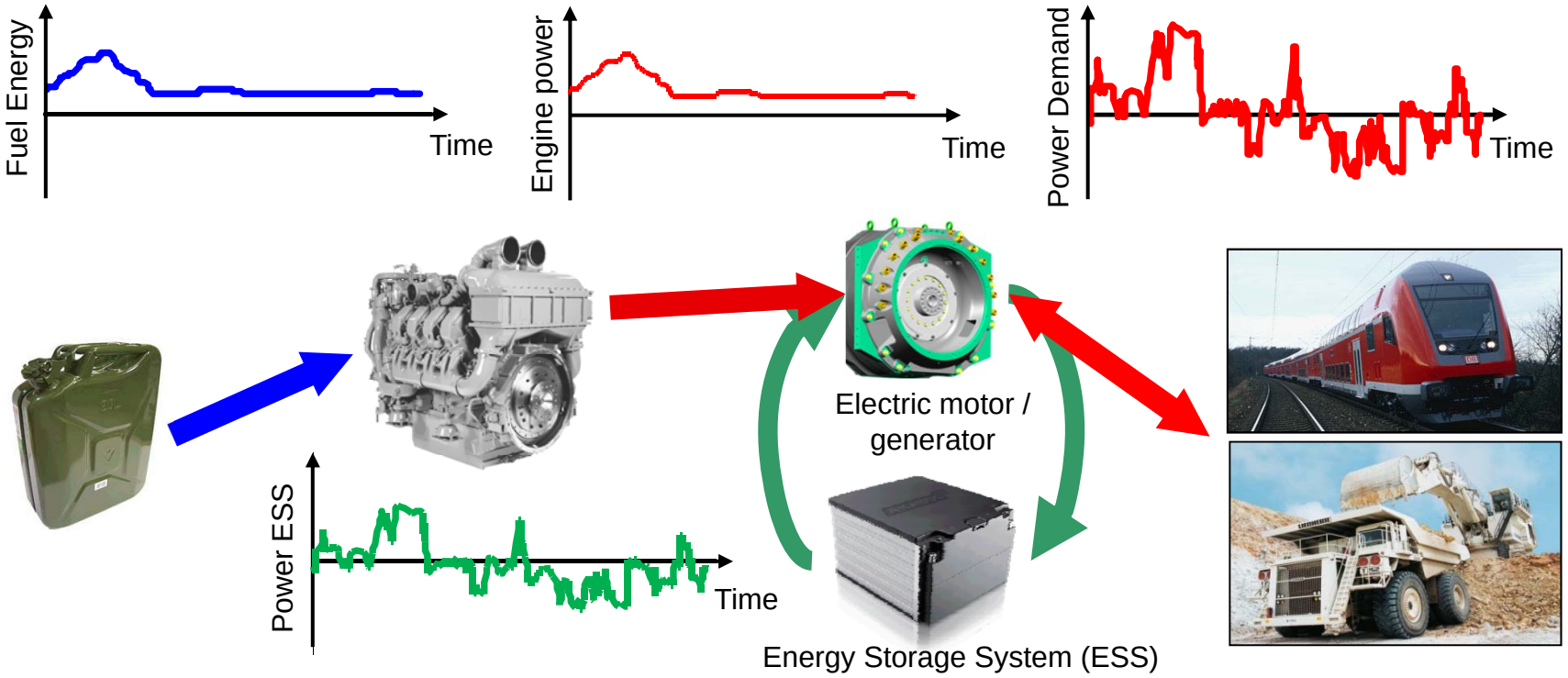






The IC engine is able to deliver maximum power at any time and at short notice
→ power-oriented rating and dynamics-optimised operating strategy

01 Incentive
Technological challenges of ICE & propulsion system

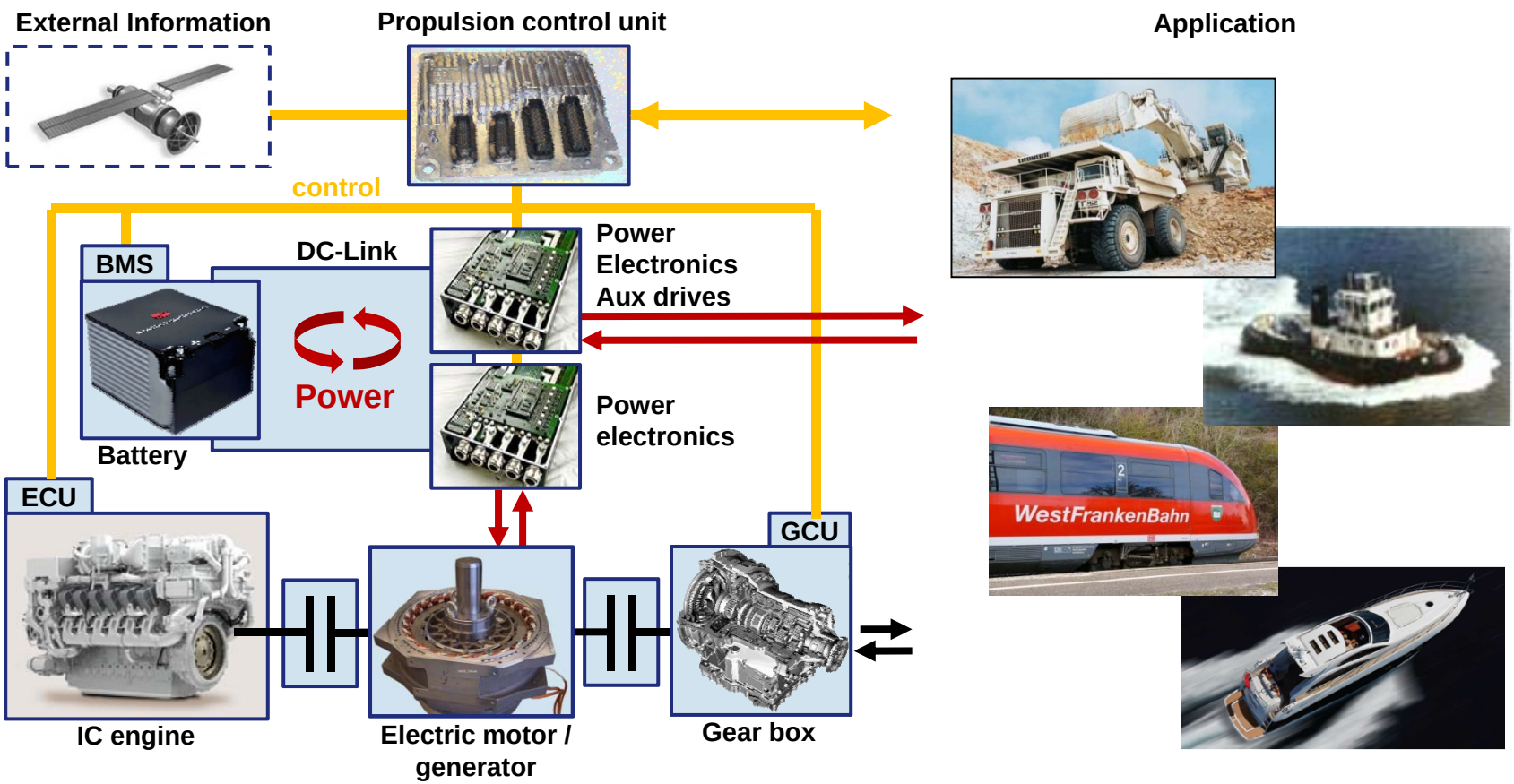


Future IC engine delivers the energy for a specified mission within a mean power range
→ energy-oriented rating with efficiency-optimised operating strategy

02

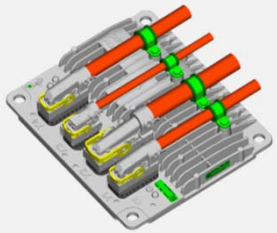
Electrical enhanced propulsion systems

02 Electrical enhanced propulsion systems
E-Drive system



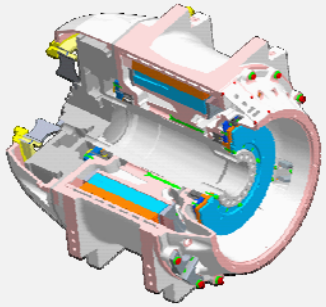
02 Electrical enhanced propulsion systems
E-Drive components

Controls



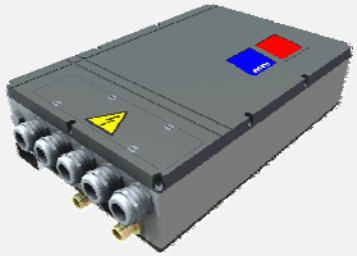
- Power and Energy Management
- Interface to the Application
- Safety Functionality

E-Machine



- Electric motor for propulsion
- Generator
- E-Motor for Auxilliaries

Power Electronics



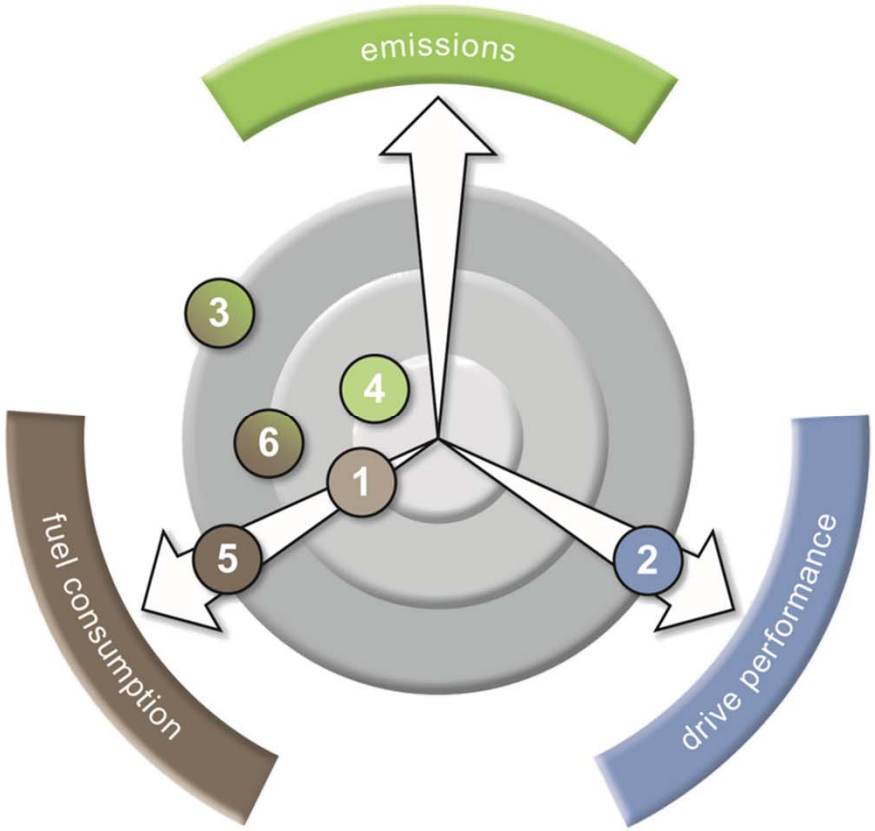
- Traction Converter
- Geno Rectifier
- Filter element in the DC- or AC-Bus
- Auxiliary Supply / Battery Charger

Battery System

Source & Sink:

- Energy Storage
- Power Buffer

02 Electrical enhanced propulsion systems
Functional benefits



1. engine operation point shifting
2. boosting
3. electric drive
4. start-stop
5. recuperation
6. cross-over-mode

Railcar E-Drive propulsion system

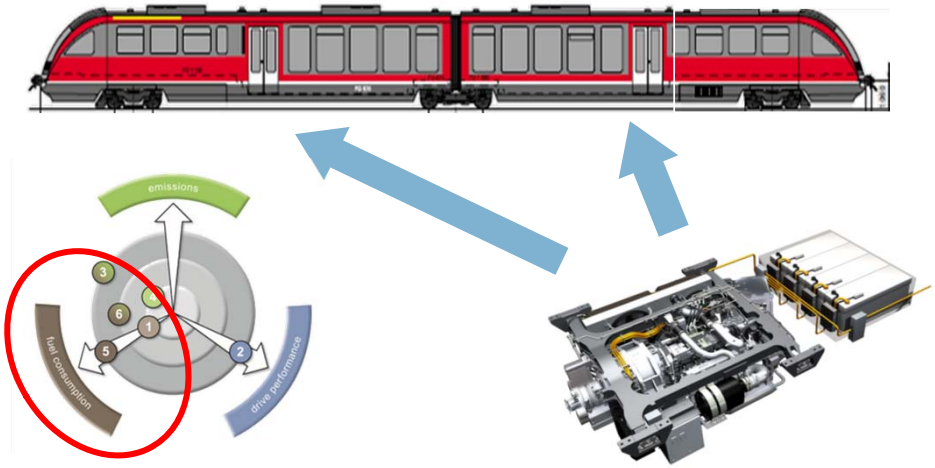
03 Railcar E-Drive propulsion system Application

Drive cycle:

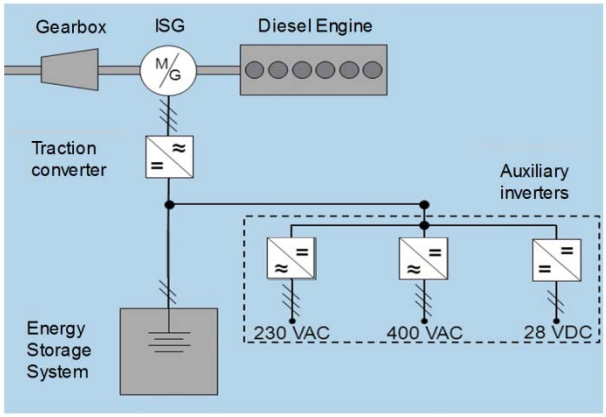
- Distance 37 km
- 13 Stops
- 43min
- speed limit 120kph

Vehicle:

- Mass: 78t
- 2 x MTU 6H1800R75 (2 x 315kW)
- Electric motors: 2 x 400kW peak
- Li-Ion-Battery
- Diesel-mechanical / parallel hybrid



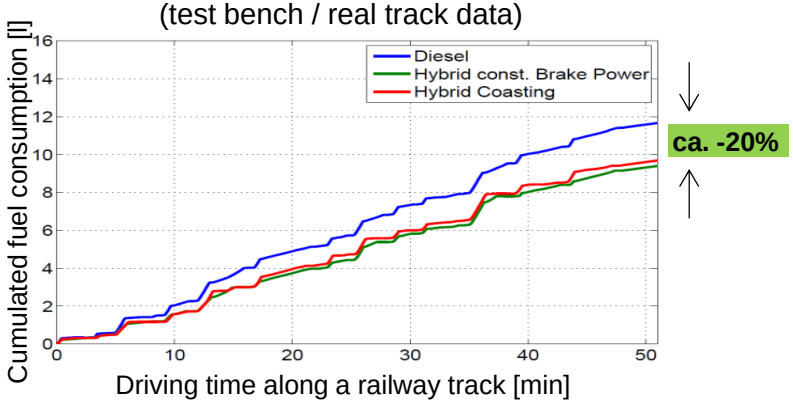
03 Railcar E-Drive propulsion system
System layout & fuel savings



Implemented features:

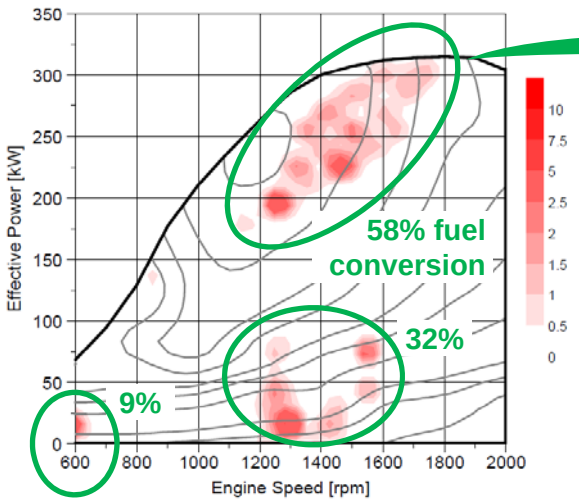
- Regenerative braking
- Load point shifting
- Partially electrified auxiliary drives
- Fuel consumption optimized drive strategy

Measured fuel savings over time
(test bench / real track data)



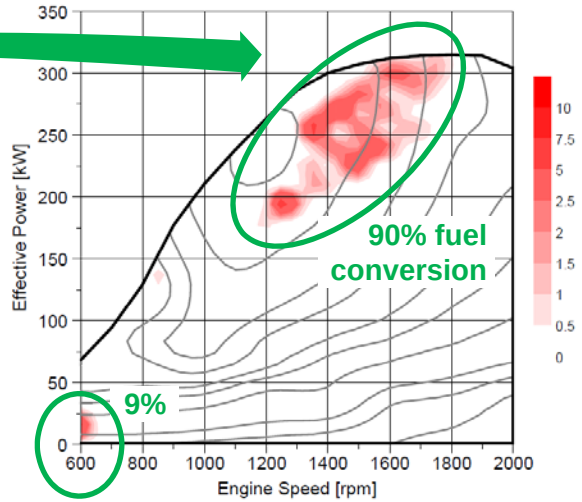
03 Railcar E-Drive propulsion system
Impact on internal combustion engine operation

Diesel only
consumption optimized drive strategy



+55%

E-Drive
consumption optimized drive strategy



Impact on combustion engine:

→ Increase of 55% of fuel conversion at high engine loads

→ Still 9% fuel converted at idle speed

Further potential:

- Decoupling auxiliary drives from combustion engine
- Engine shutdown during idling

04

Summary

04 Summary

New propulsion systems for non-road applications:

- New propulsion system concepts are capable of significant fuel savings heavily dependent on the application
- Fuel savings result from optimized operation of internal combustion engine and auxiliary drives
- Fuel savings result from energy recovery

Impact of future propulsion system design on internal combustion engine:

- Increased fuel conversion at high engine loads → mechanical / thermal fatigue?
- Increased frequency of engine starts → main bearings, starter lifetime?
- Engine shutdown during vehicle operation → effect on main bearings?
  → effect on exhaust aftertreatment?

Thank you very much for your attention.

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