



JOIN THE JOURNEY TO NET ZERO

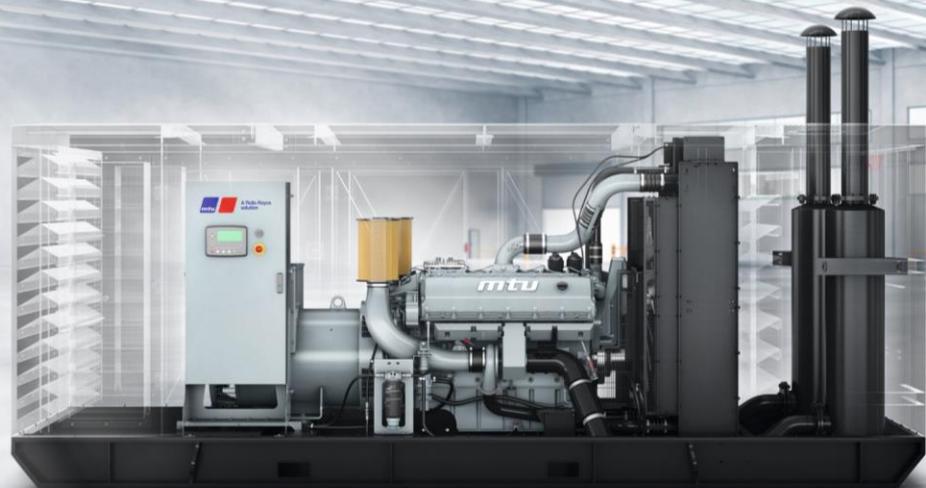
Power Generation Symposium | Europe



A Rolls-Royce
solution



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Next generation backup power

The new *mtu* Series 1600 generator sets

Jonas Knoll, Product Management

29th June 2022



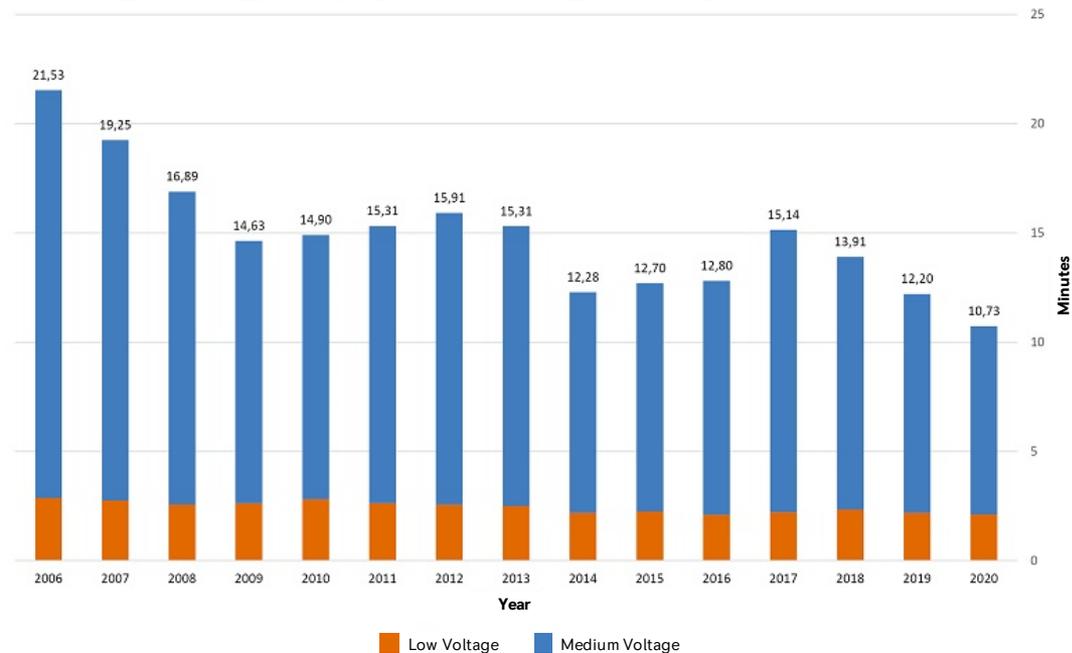
Have YOU
experienced a
blackout during
the last year?





SAIDI - the “average blackout”?

SAIDI – System Average Interruption Duration Index for Germany [min]



Source: Bundesnetzagentur

SAIDI vs. reality



Local industry & infrastructure:



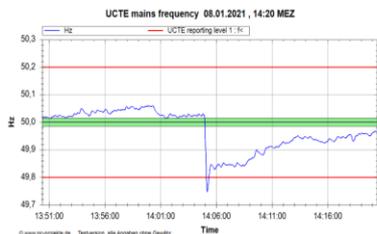
Two blackouts in front of our door within 3 months in 2021...



Source: Schwäbische Zeitung & Wochenblatt



Almost area wide blackout in Europe



08.01.2021

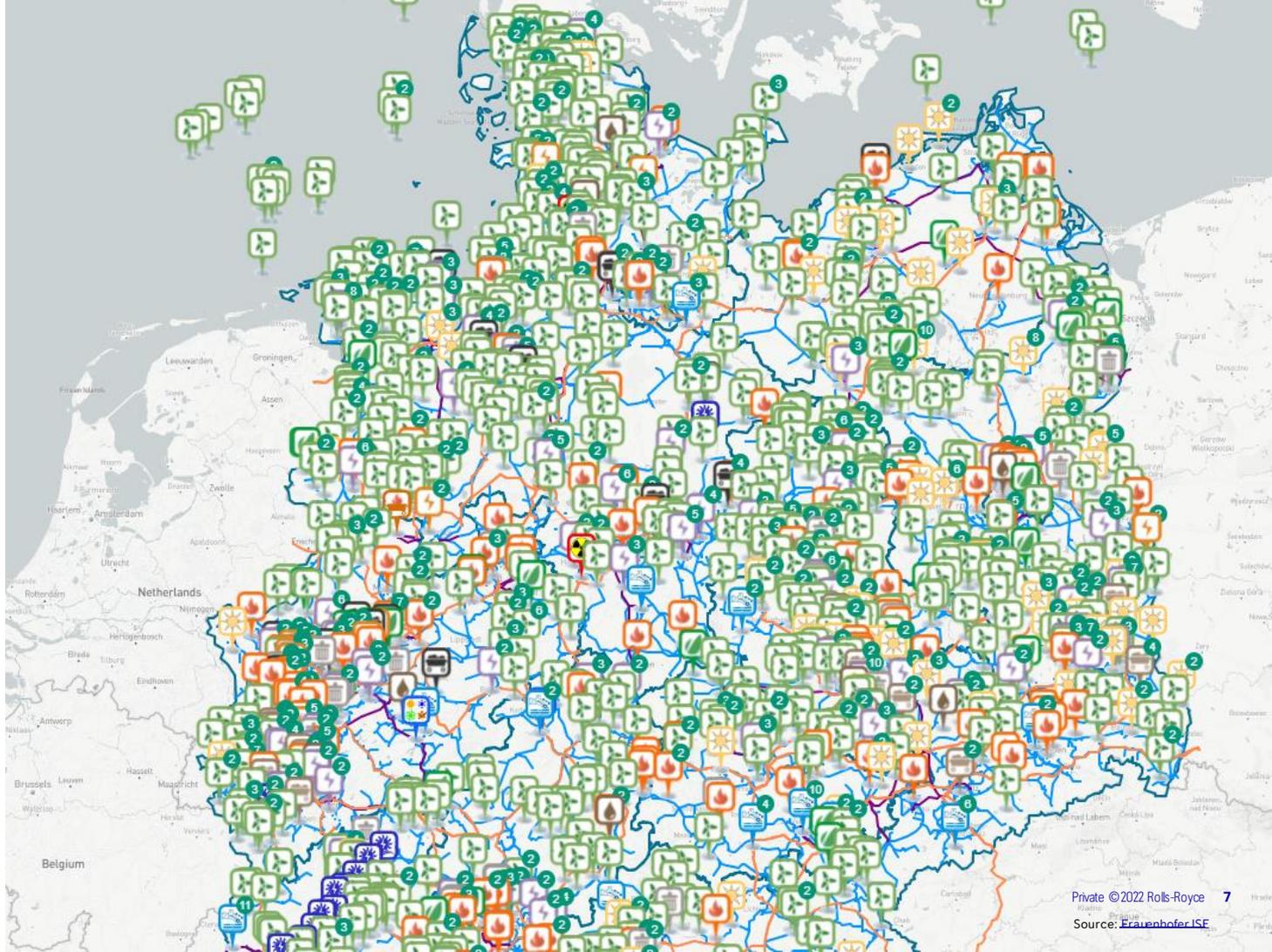
- Most severe frequency disturbance in the European transmission system since 2006.
- Trigger substation Ernestinovo was not rated as system-critical.



Blackouts – a real threat?

“A large electric power system is **the most complex existing man-made machine**. Although the common expectation [...] is that the electric supply should never be interrupted, **there is, unfortunately, no collapse-free power system.**”

– **ENTSO-E**, conclusion statement in the final report on the large scale blackout in Turkey on 31st March 2015





01

The new *mtu* Series 1600 generator sets

450 – 715 kVA (50Hz)



New Series 1600 generator sets 450 – 715 kVA

Standard and optional scope of supply

Open Power Unit (OPU)

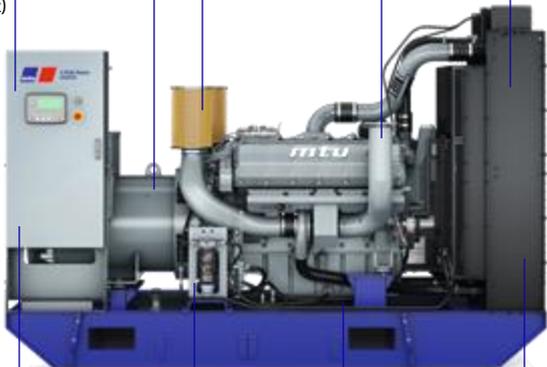
Controller cabinet A-side or B-side with integrated 4-pole circuit breaker (optional without)

Premium low voltage Leroy Somer alternators, digital voltage regulation

Heavy-duty air filters (optional)

Exhaust elbows, bellows, silencers (optional)

50°C aluminium radiators



VDE AR-4110 grid code compliance

Fuel pre-filter (heavy-duty optional)

Lube oil extraction hand pump (optional)

Duct flange, fuel cooler (optional)

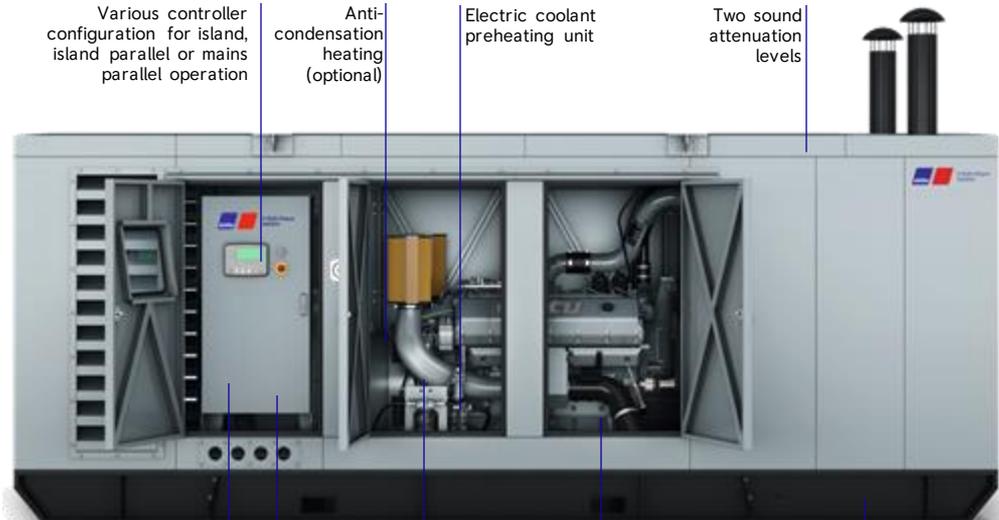
Enclosed Power Unit (EPU)

Various controller configuration for island, island parallel or mains parallel operation

Anti-condensation heating (optional)

Electric coolant preheating unit

Two sound attenuation levels



Modbus RTU-TCP Gateway/Ethernet or bus system (optional)

Electric battery charger

1x24V electric starters

2x24V redundant electric starters (optional)

Starting batteries with battery rack, disconnect and cabling (optional)

Base frame integrated fuel tank and oil pan

→ Please visit our booth for detailed technical information about the scope of supply





Requirements and design highlights



Highest Performance



High power density



Industry-leading load factors



Superior load acceptance & power quality



Full Flexibility



Available in all ISO power ratings



Highly robust against derating



VDE-AR-N 4110 grid code certification



Ecological Footprint



GHG & emission reduction with alternative fuels



Suitable for hybrid applications (low load)



Fuel consumption & emission optimized calibrations



Low Life Cycle Costs



mtu Series 1600 Overhaul Solution



Extended maintenance schedules



ValueCare Agreements & Extended Coverage

Today's focus



Full Flexibility

- Full rating flexibility in accordance with ISO 8528.
- All major ISO 8528-1 ratings are covered by S1600 (ESP, PRP, DCP) for each type of application

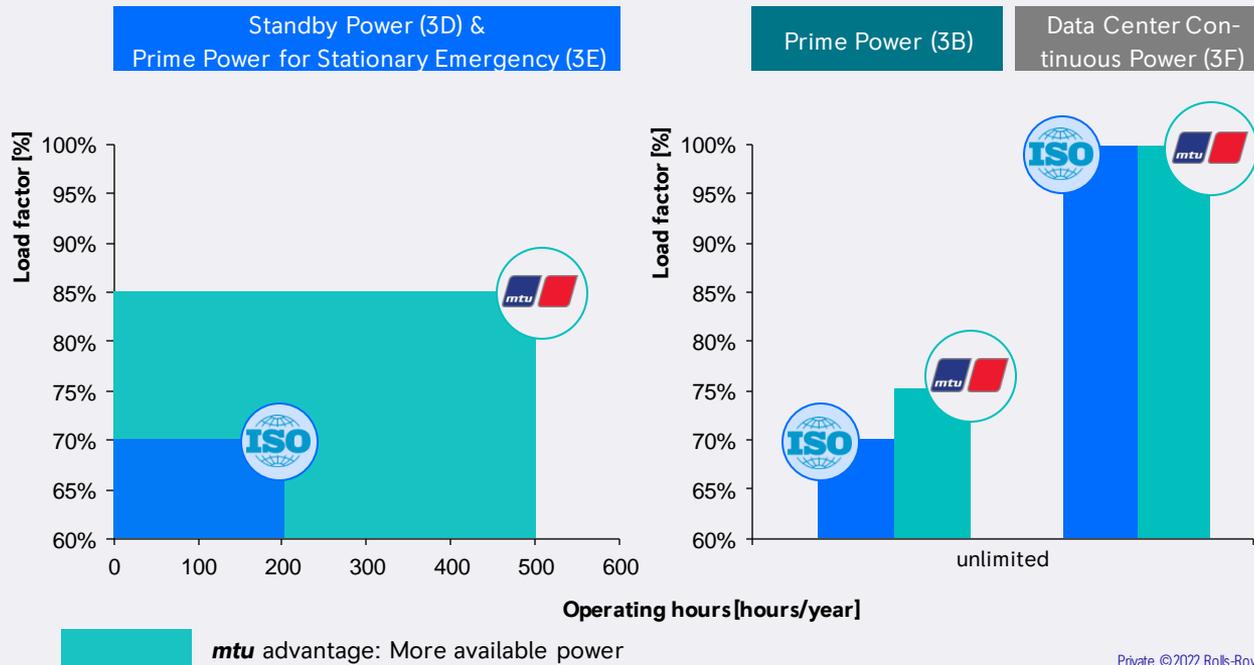
	Continuous / Prime / Grid Stability	Standby & Mission Critical		
Application				
ISO	ISO 8528-1 PRP Prime Power	ISO 8528-1 ESP Emergency Standby Power		ISO 8528-1 DCP Data Center Power
mtu ratings	3B	3D	3E	3F
	Prime Power	Standby Power	Prime Power for Stationary Emergency	Data Center Continuous Power
			<i>new</i>	<i>new</i>



Highest Performance

- Higher load factors and more operating hours offer more *available power* than ISO rated engines with the same nominal engine output.
- Available power = rated power x load factor

Industry-leading load factors



Highest Performance

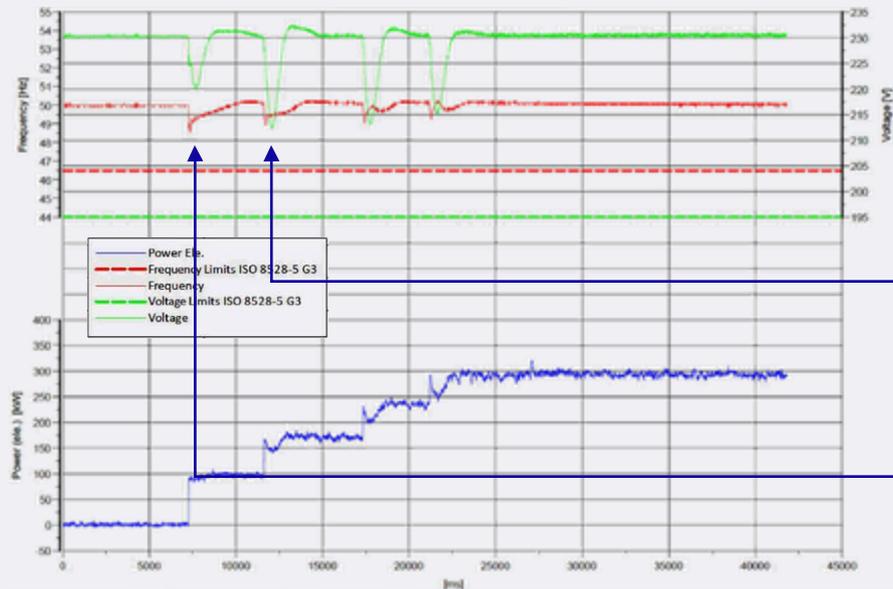
Exceeding limit values for recovery time, voltage and frequency of highest ISO 8528 performance class G3

- Protection for sensitive electrical loads and IT equipment
- Simplification for electrical infrastructure and power conditioning equipment

Source: Prototype test report. Performance depending on system configuration

Superior power quality (→ transient frequency and voltage)

mtu 10V1600 DS500 ramp-up curve
(Load steps acc. to ISO 8528-5, $P_{me} = 22,54\text{bar}$)



Max voltage drop
mtu: -7,8%
ISO G3: max. -15%

Max. frequency drop
mtu: -3%
ISO G3: max. -7%

Highest Performance

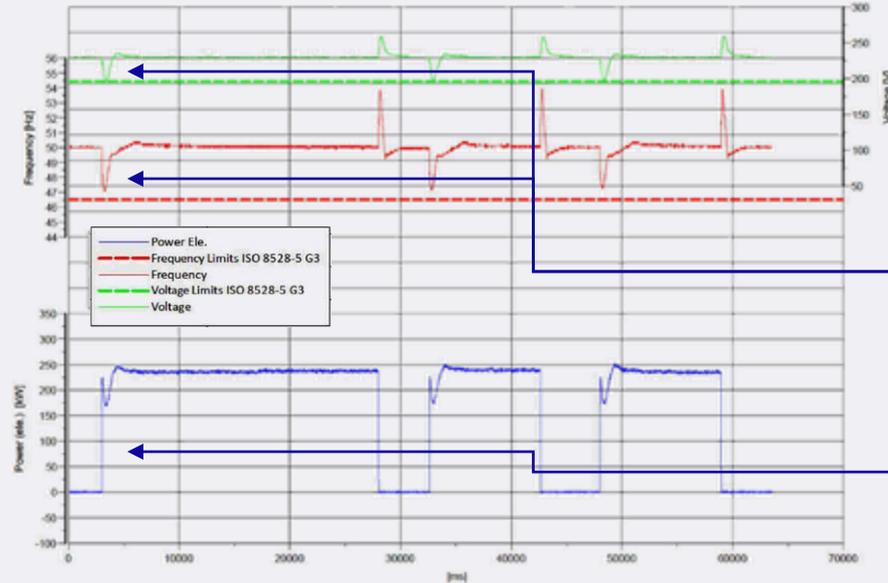
First load step up to 57% possible while keeping ISO 8528 performance class G3

- Faster ramp up
- Smaller genset sizing for large loads
- Less investments in gensets, UPS-systems and switchgear

Source: Prototype test report. Performance depending on system configuration

Superior load acceptance (→ max. 1st load step)

mtu 10V1600 DS500 ramp-up curve
(Max. 1st load step under to ISO 8528-5 performance class G3 limits)



1st load step
Keeping limits of ISO
performance class G3

1st load step
mtu: 57%
ISO reference: 35%

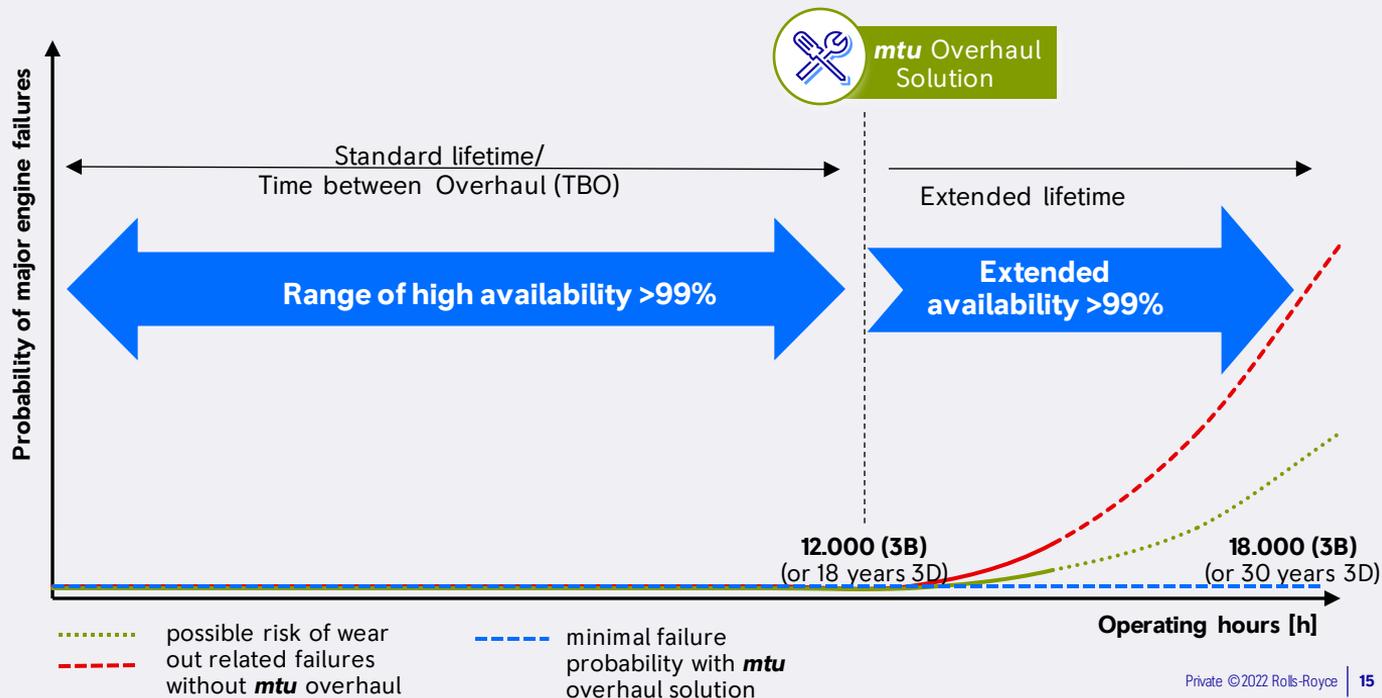


Low Life Cycle Costs

- Scheduled overhaul provides the same peace of mind as a traditional overhaul at a fraction of the cost
- It ensures minimal failure probability for additional 6,000+ operating hours or 12 years.
- Short downtime: removal and reinstallation of the engine is not required, only exchange of specific engine components
- Economic and environmentally friendly solution compared to new engine purchase.
- Available for all Series 1600 Gx0 engines



mtu Series 1600 Overhaul Solution





Approved for
renewable fuels

Best-in-class low load
operation



Grid code
certification

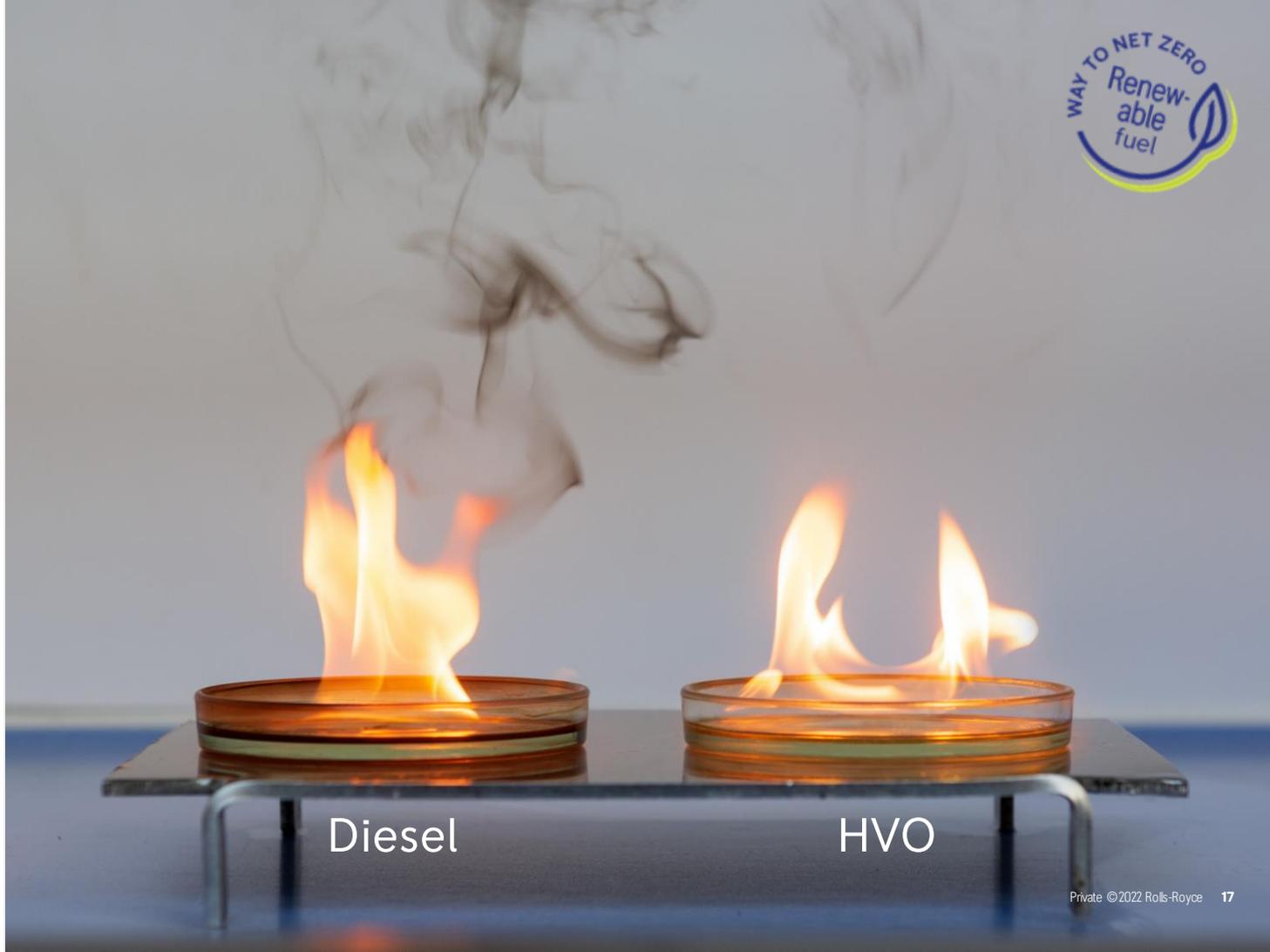


A Rolls-Royce
solution



Approved for renewable and synthetic fuels

- Approval includes fuels such as HVO, GtL, BtL, PtL,... fuels according to EN15940
- no 1st generation bio diesel (FAME)
- Up to 90% CO₂ reduction with HVO



Diesel

HVO



HVO advantages: Besides reduction of harmful pollutants & up to 90% CO2 footprint, HVO owns properties which especially meet PowerGen customer requirements



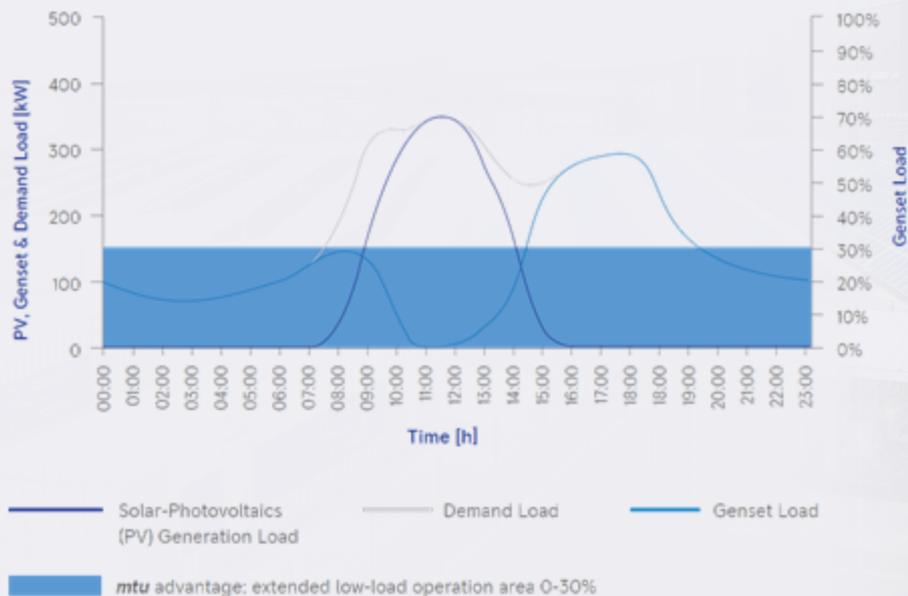


Best-in-class low load operation

- Series 1600 with **outstanding low load operation**
- Low-load operation commonly defined at $P < 30\%$ → limitation of renewable energy share
- S1600 engines can be operated even in engine idle mode for **up to 12h**
- Grid stability through synchronous alternator

Seamless microgrid and hybrid integration

Illustrative load profiles of a Diesel-PV hybrid system



Lower fuel costs



Lower CO₂ emissions



Increased grid stability

VDE-AR-N 4110 grid code certification



Reduced site certification cost



Grid parallel test runs



Stability in hybrid or microgrid installations



Additional revenue with grid services

- Increasing share of renewable power generation & “prosumers”
- Grid stability is becoming more complex for the grid operators
- **Grid codes** define requirements for power generation assets
- VDE-AR-N 4110 German grid code based on European NC-RfG

Generator set advantages: inertia of rotating mass, static & dynamic grid support, power factor adjustment, reactive power provision & absorption



Off-grid, hybrid
microgrid, Diesel-
PV



Commercial &
public buildings,
airports



Target applications



Data centers



Microgrids

Healthcare



Construction &
Mining



Rental



Power stations



The main drivers behind edge computing

Low latency, high bandwidth, data privacy & security, distributed resilience



Internet of Things (IoT)

- Digitally connected machines, devices, automation systems
- Artificial intelligence to increase productivity & efficiency

Smart cities

- Urbanization of population
- Smart traffic and waste management, smart street lighting & buildings, security infrastructure
- Sector coupling to meet sustainability goals

Autonomous driving

- 4.000GB of data/day for autonomous operation
- >8GB of data upload to enhance road safety, traffic efficiency, environmental issues & energy costs
- Vehicle-to-Vehicle communication

Cloud gaming

- Gaming-on-demand
- Augmented and virtual reality gaming
- Up to 90GB data traffic per hour

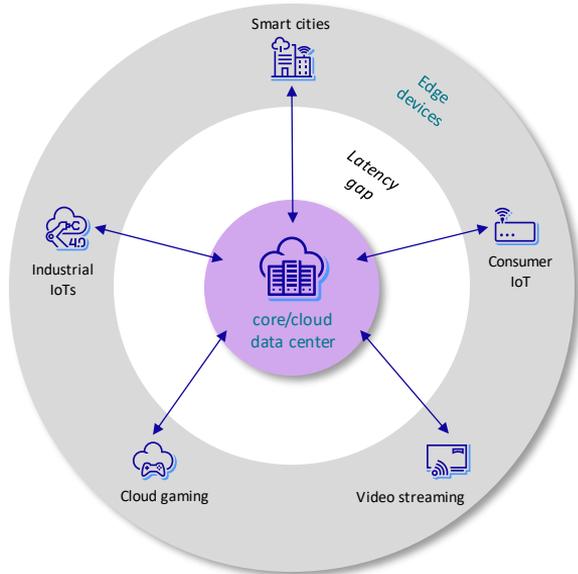
Video streaming

- ~60% of internet traffic and increasing
- High user sensitivity to delays during media consumption

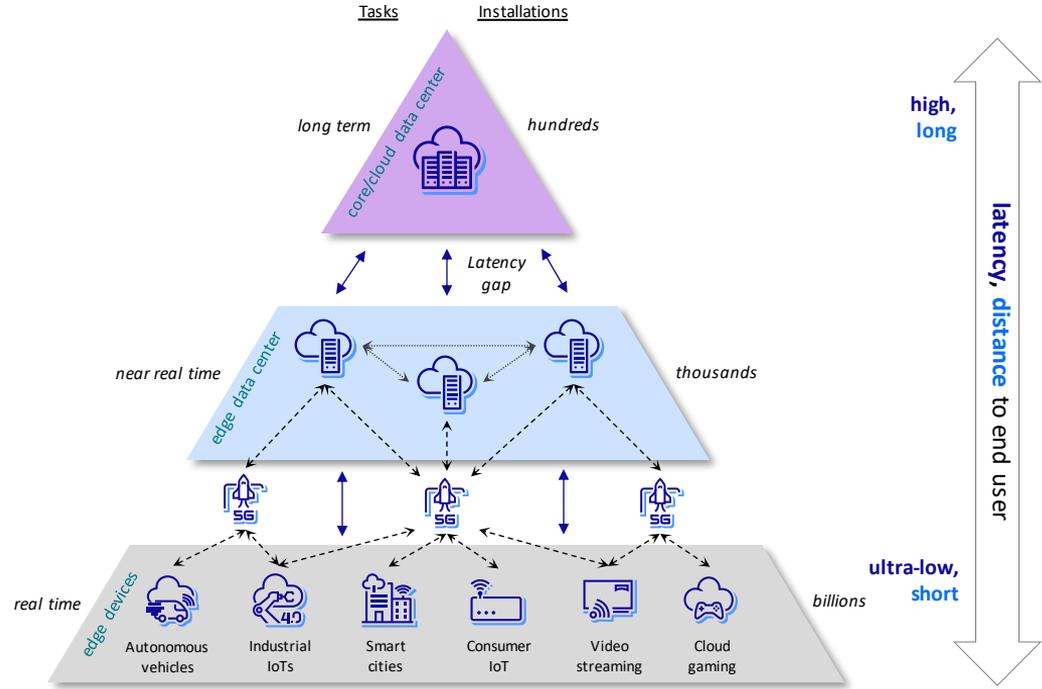
The decentralization into a new data center ecosystem

Decentralization similar to the energy transition – 5G as the key enabler

Centralized data center infrastructure



Decentralized data center ecosystem



↔ data transmission via cable or fibre

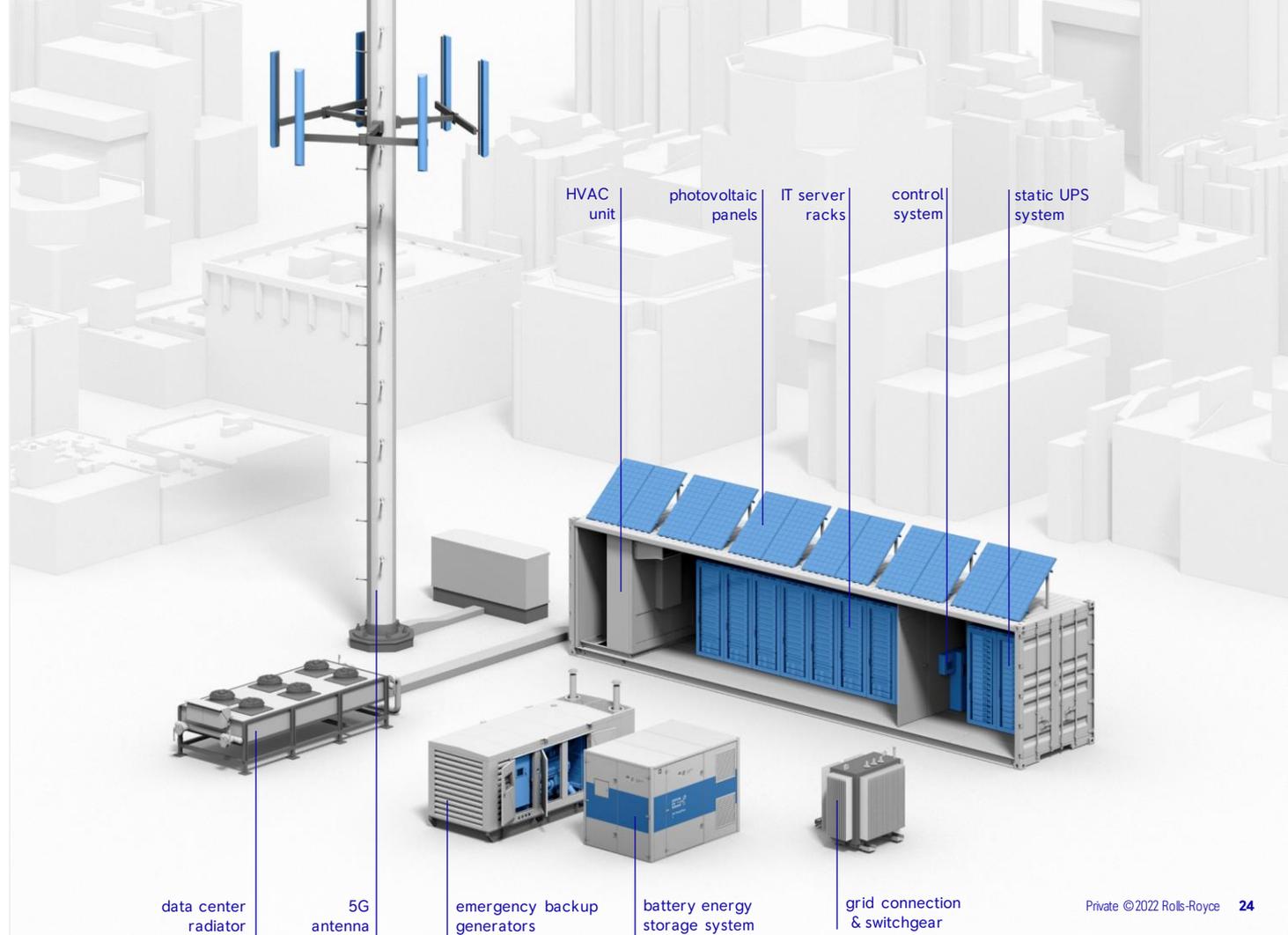
--- Wireless data transmission (e.g. 5G)

⋯ Load balancing between edge data centers



Typical edge data center configuration

- Prefabricated, modular systems (PFMs)
- Pre-certified 
- Factory-tested
- Plug & play installation & commissioning
- Remote operation





S1600 for edge data centers



All-in-one, factory-tested, scalable, plug & play solution



Best in class power density



Approved for renewable fuels: reduced GHG (CO₂) emissions



Superior low-load capability for hybrid generation



Uptime Tier I-IV & ISO-8528 DCP compliant



Sound- and weather-proof, installation and transport-friendly enclosure

Premium high-efficiency Leroy Somer alternators

Integrated radiator for up to 50°C ambient temperature



Base frame-integrated fuel tank for full autonomy

Integrated genset controller and circuit breaker

High efficient and robust **mtu** S1600 engine

Integrated exhaust silencers



02

Power density redefined

Outlook: Up to 40% more power for S1600 (50Hz)



Up to 40% more power for Series 1600 (50Hz)



Series 4000

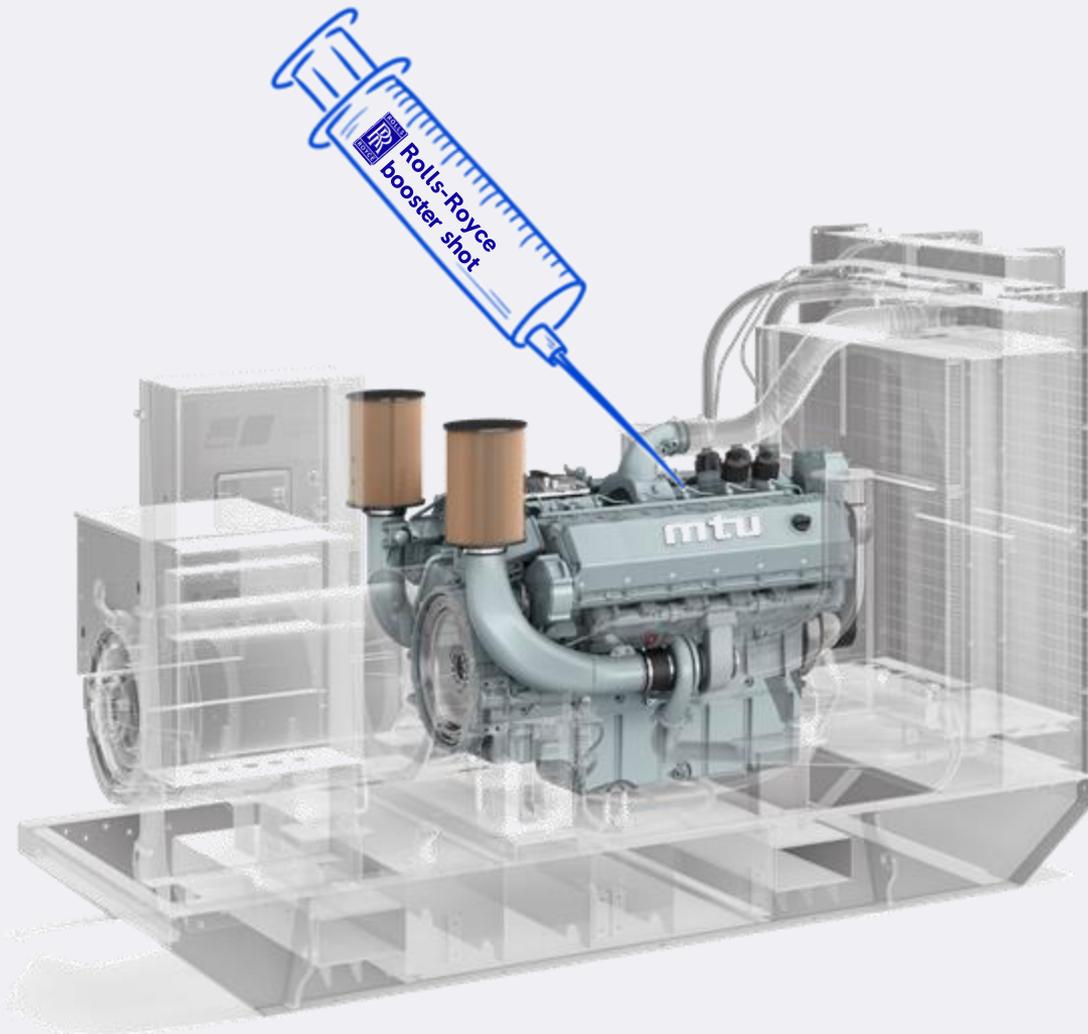


Series 2000





How to realize 40% power increase?

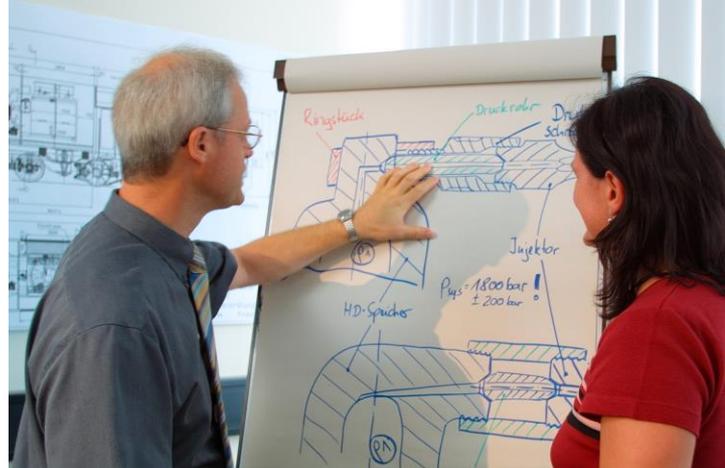




Our heritage and core competencies



More than 100 years of experience...



...in research & development...



...in prototype testing & validation...

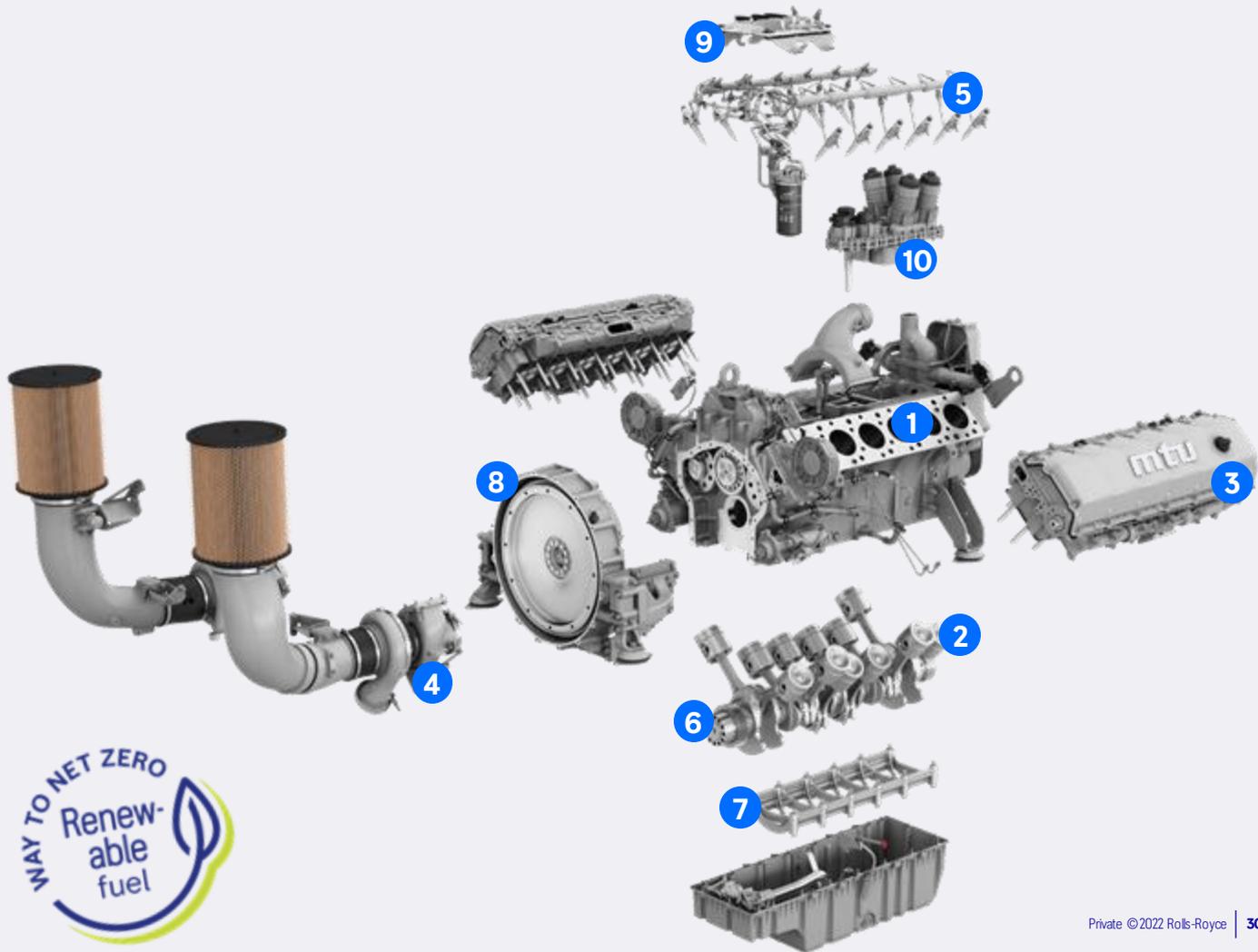


...and production of heavy duty engines.



How to realize 40% power increase!

- 1 More displacement (+7%)
- 2 Improved pistons
- 3 Redesigned cylinder head
- 4 New turbocharging system
- 5 Optimized injection system
- 6 Heavy-duty crankshaft
- 7 Reinforced crankcase
- 8 Reinforced flywheel housing
- 9 Upgraded Engine Control Unit
- 10 New crankcase ventilation





Thank you for your attention!

