

CONNECTING AN ALL-ELECTRIC WORLD

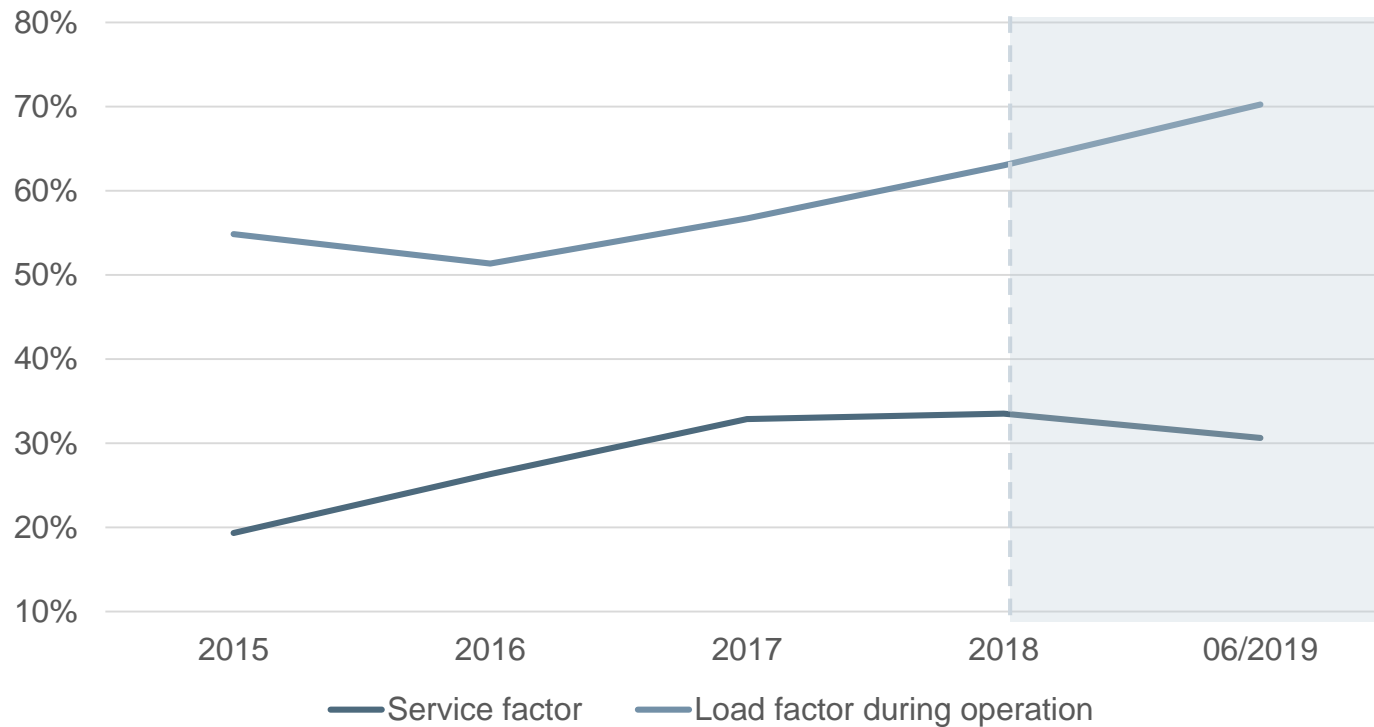
Flexibility Solutions and Upgrades for CCPP

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Flexible Solutions

Market Development for Combined Cycle Power Plants



What can make your Power Plant more successful?



Service factor: Operating hours/period hours – Load factor: actual power / installed power
Data source: Siemens WinTS Data from Power plants in AT; HU; SK; CZ

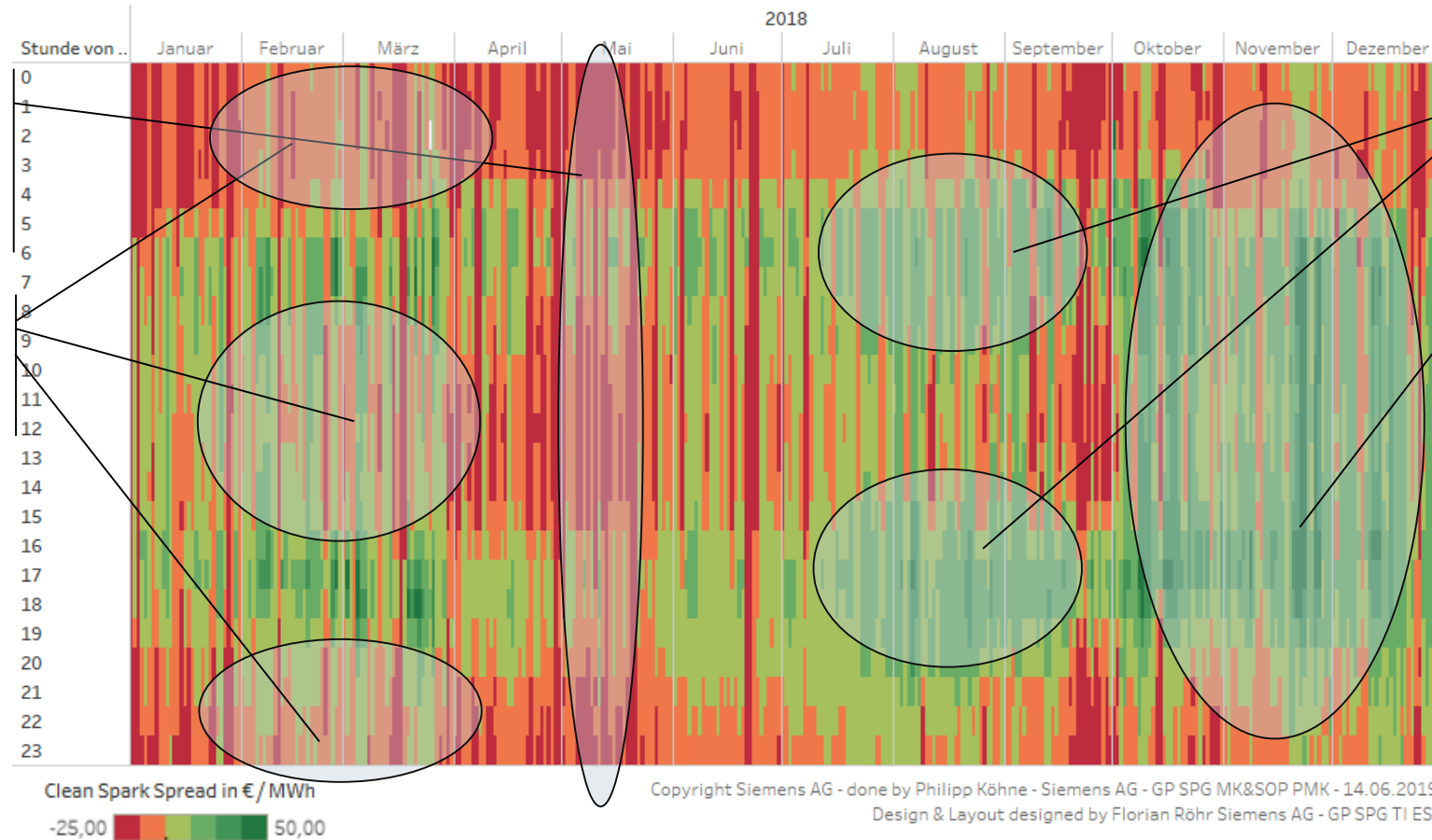
Clean Spark Spread - Identify Potential for optimization

**Scheduled
Maintenance**

**Minimum Load/
Fast Start**

**Power
Augmentation**

**Maximum Power
Output**



Formula: $CSS = \text{hourly electricity price (DAM price AT from Entso-e)} - [\text{daily gas price (DN1 prices NCG-hub from EEX)} / \text{plant efficiency (assumed 55\%)} + \text{carbon allowances (daily prices from EEX)} * \text{emission intensity of 0,21t/electrical MWh (source: Chamarro)} + \text{O\&M costs of 1,6€/MWh (Source: Bode, Groscurth)}]$

Example of CSS Overview based on own calculations sourced on ENTSO-E & EEX data

Power Generation Service – Your Partner for Flex Solutions



Our Target:

Be your Partner for innovative solutions and attractive service programs.

Maintenance

- Optimize **maintenance intervals**: Minor & Major inspections
- **Increase outage flexibility**
- Fast outage: Innovative **Field Service** methods & tools
- Turbine exchange (BEX)

Performance

- **Service Packages** / Upgrades & Modernization
- **Plant Assessment** / Plant Optimization

- Further increase engine **efficiency – New Turbine Generation**
- **Hydrogen Application**
- **Low NOx-Emission Solutions**

Environment

- **Increased Load Gradients, Fast Start, Turn Up**
- Optimize part load capabilities

Flexible Operation

Digital Solutions towards Intelligent Gas Turbine & Smarter Service

Upgrades for Flexible operation

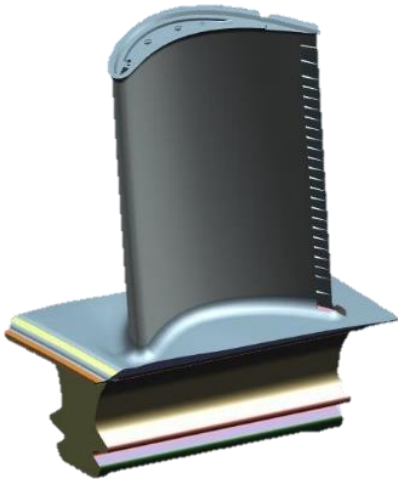
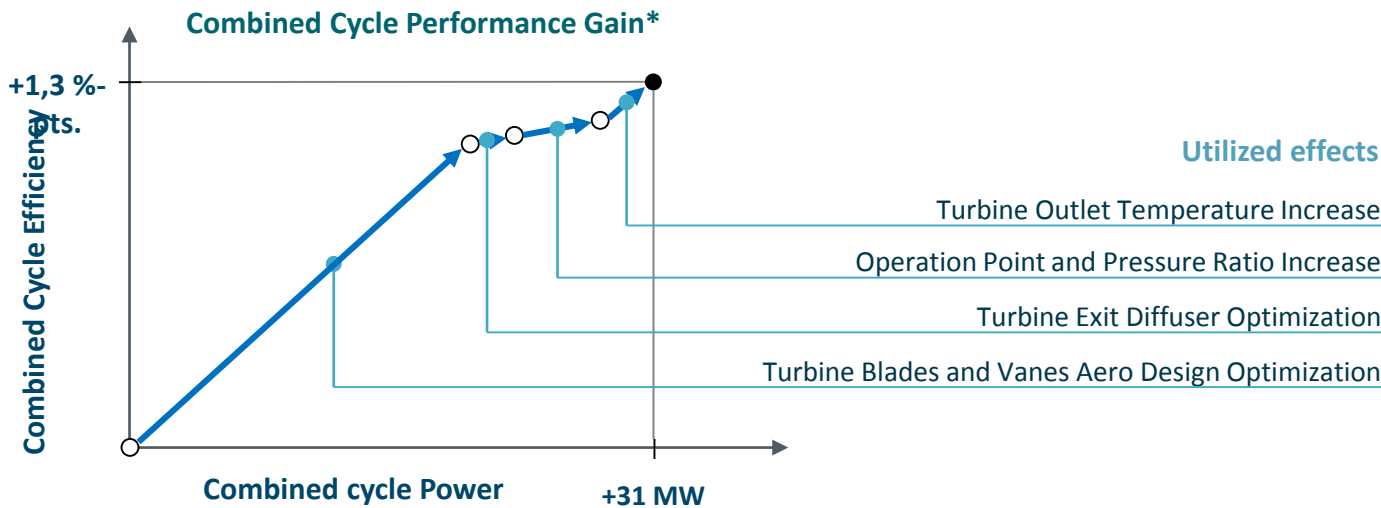
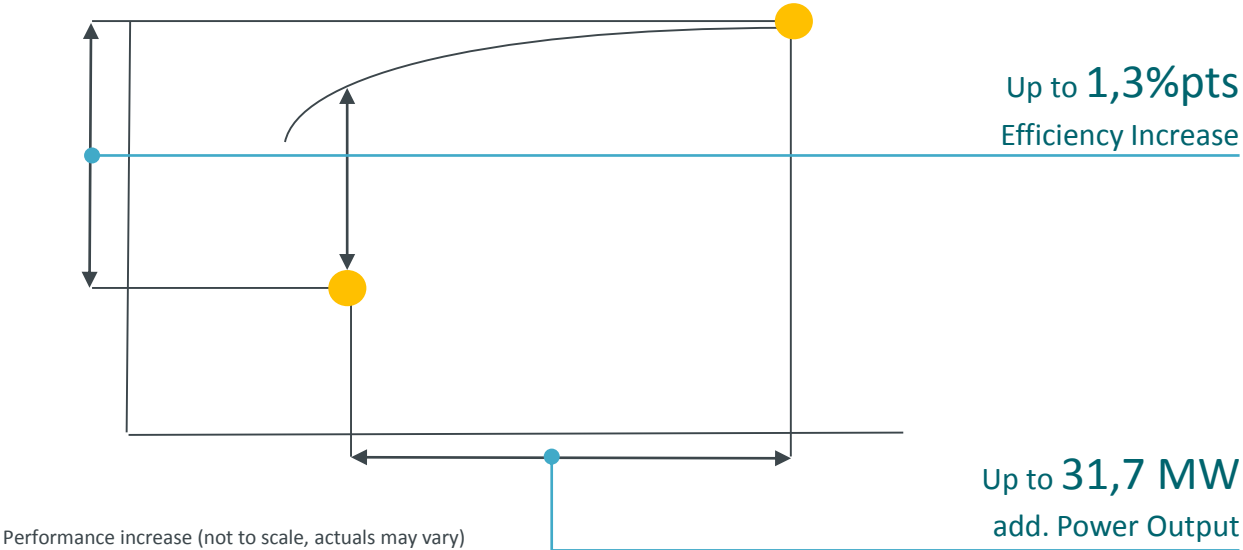
Flexibility in modernized power plants: What is it worth and can we afford to ignore it?



- 1 Advanced Turbine Efficiency Package
- 2 Turn Down – Part Load Options
- 3 Hot Start on the Fly – Shut Down on the Fly
- 4 H2

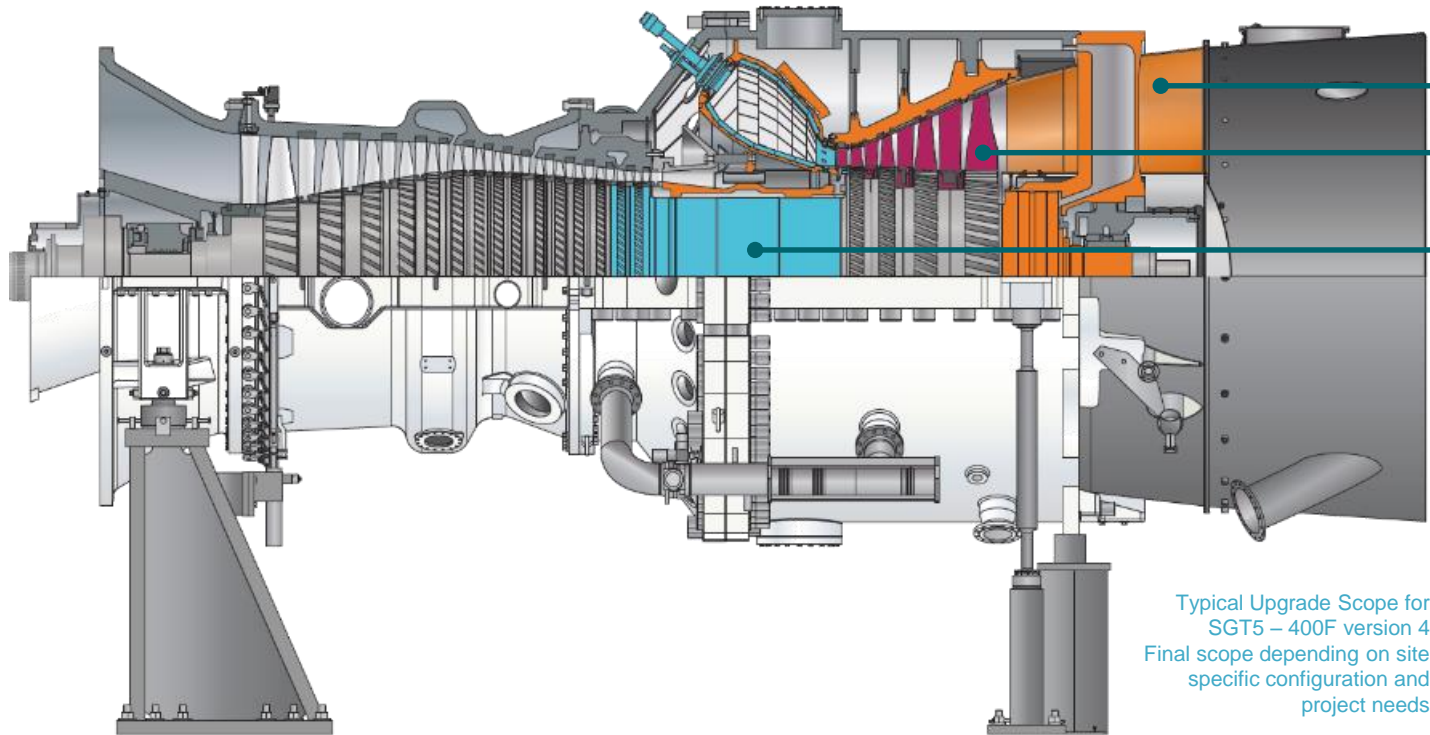
Advanced Turbine Efficiency Package (ATEP)

Are you ready for the future?



Advanced Turbine Efficiency Package (ATEP)

Are you ready for the future?



Typical Upgrade Scope for
SGT5 – 400F version 4
Final scope depending on site
specific configuration and
project needs

New Designed Parts

Turbine Blades and Vanes 1-4

Modification of parts in place

Turbine Exhaust Casing

Turbine Vane Carrier

Rear Hollow Shaft

Combustor Cooling Air Adaptions

Shaft Cover Modification

Exchange parts with existing designs (depending on site specific configuration)

Burner Upgrade

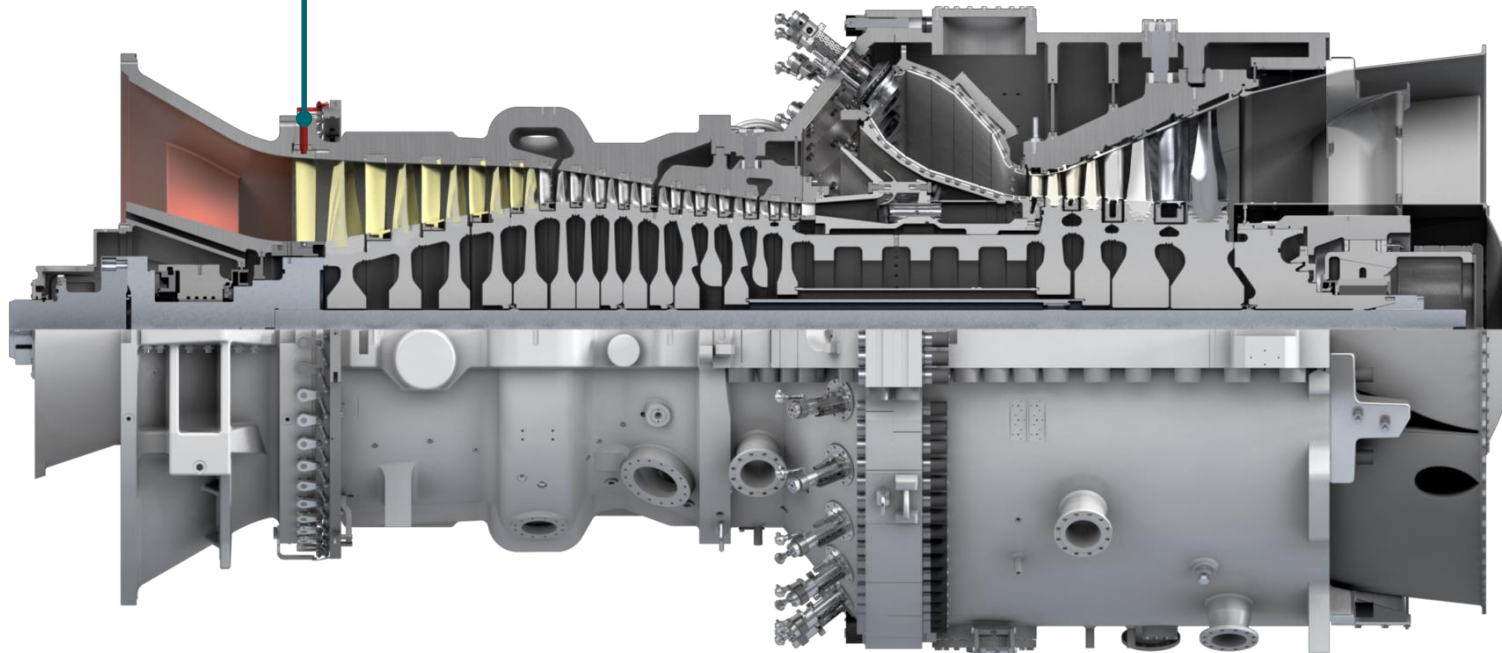
Torque Discs 1-3

Compressor Discs 14 & 15

Turn Down – Part Load Options

Hardware Modification

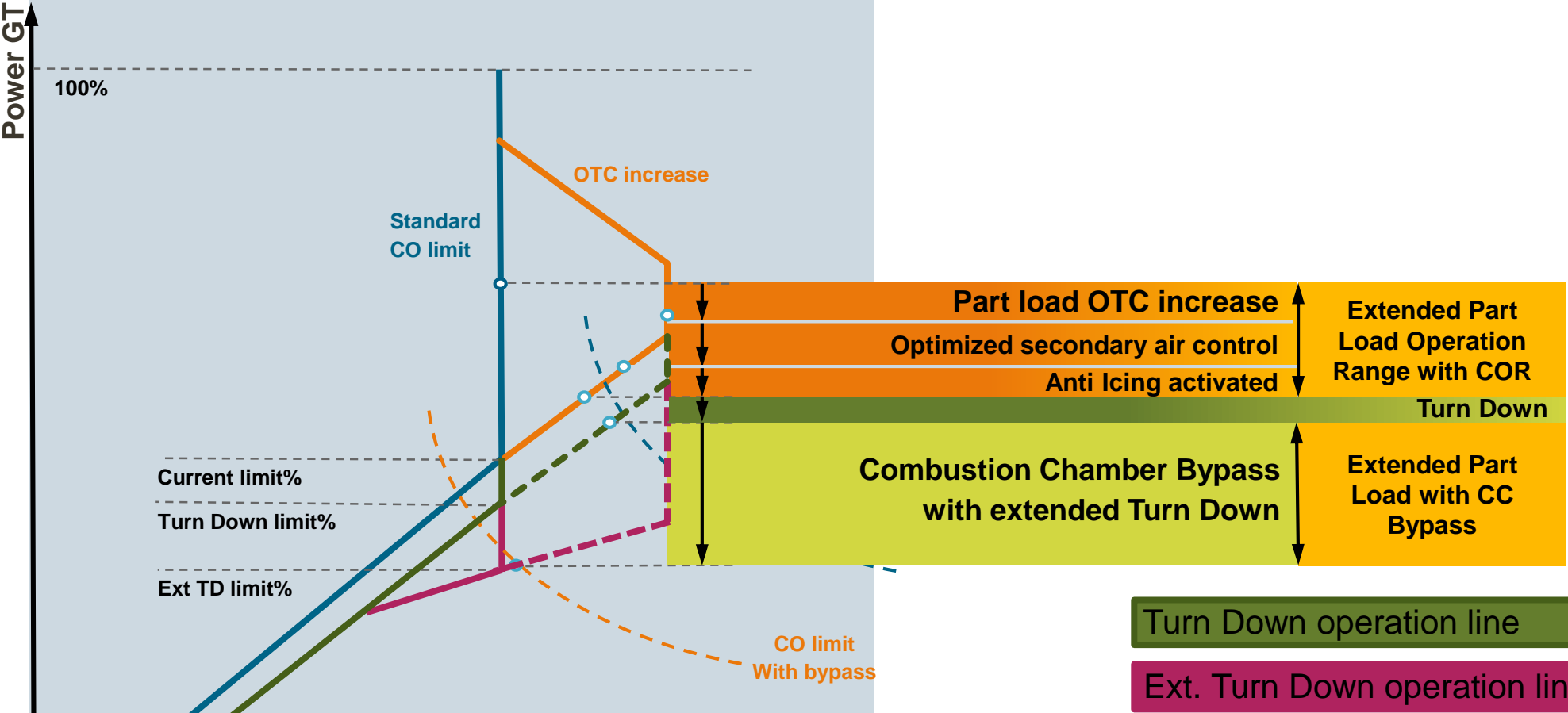
- New linearization unit for Inlet Guide Vane
- New Inlet Guide Vane position sensor with extended operating range
- Modification of Inlet Guide Vane ring (including new scale and new bolts for bearing blocks)



Further Scope

- I&C modifications (icing controller & Cooling air monitoring)
- TVC/TEC liner sealing & CVC groove 7-9 grinding recommended
- Detailed engineering and implementation of instrumentation and controls modifications related to the gas turbine

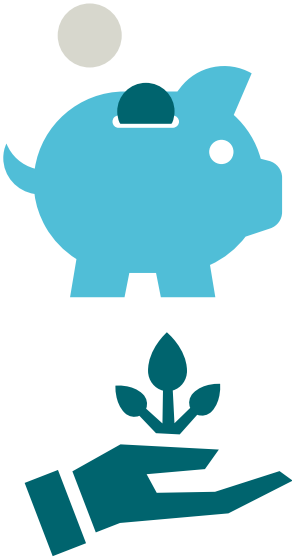
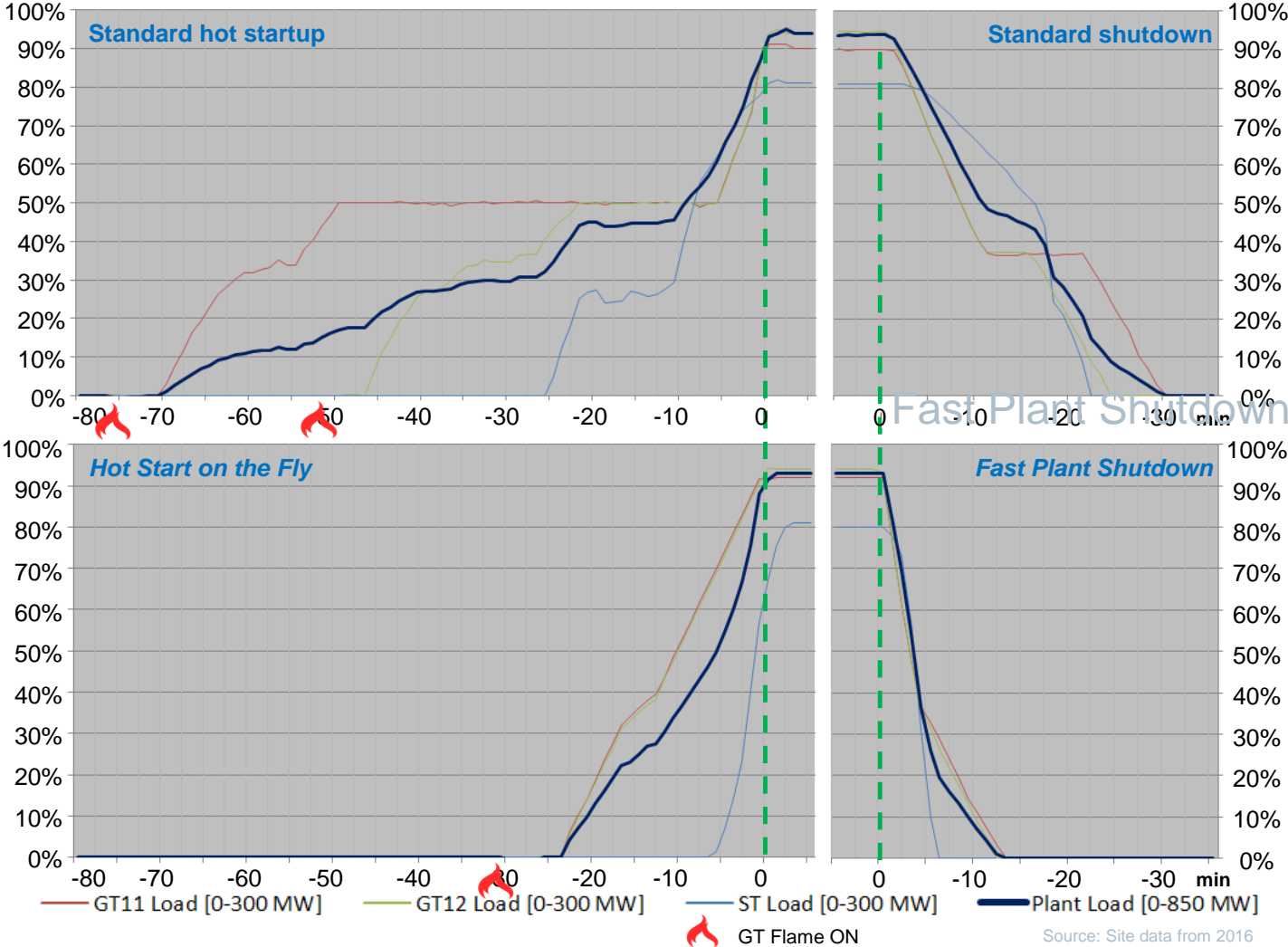
Turn Down – Part Load Options



OTC Schematic illustration for explanation of principles, actual values have to be calculated plant specific with individual emission parameter.

Improving startup and shut down

Cycling operation with/without startup & shutdown improvements



Start

60%

Up to 46 min reduced start up time

Stop

56%

Up to 17 min reduced plant shut down time

Gas

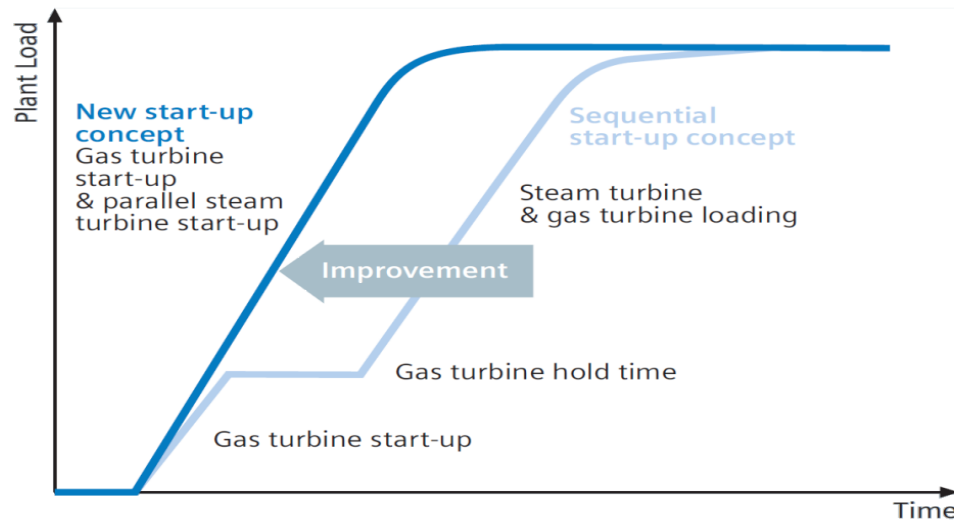
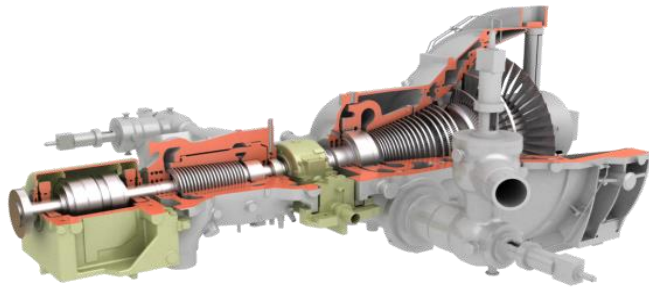
57%

Up to 50 kNm³ reduced gas consumption

* depend on the specific plant configuration

Hot Start On The Fly

Hot Start Optimization



Benefit

- Hot start-up time reduction
- Efficient operation due to less fuel consumption
- Reduced gas turbine CO emissions during start-up

Scope

- Mechanical evaluation of steam turbine
- Revised start-up logics of UMC/BoP/ST
- I&C implementation & testing on site
- Operator training and documentation

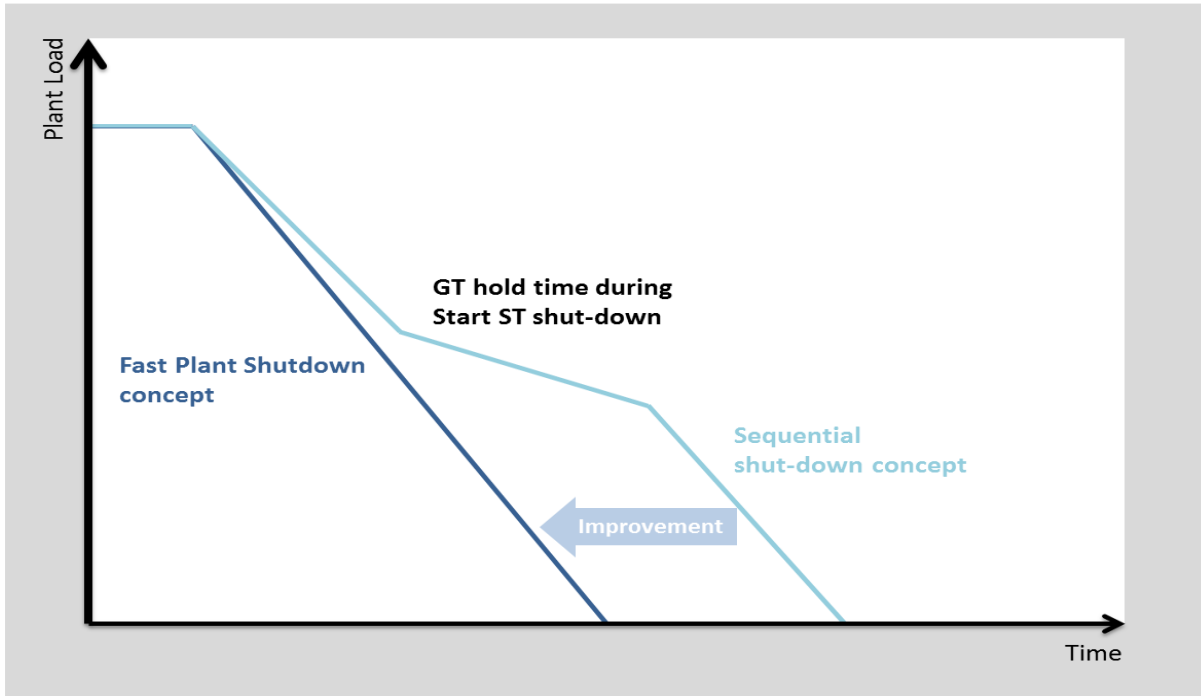
Applicability

- Siemens reheat steam turbines



**The perfect extension for the GT
Start Gradient Optimization !**

Fast Plant Shutdown



Benefit

- Shutdown time reduction
- Efficient operation due to less fuel consumption
- Reduced gas turbine CO emissions during shutdown

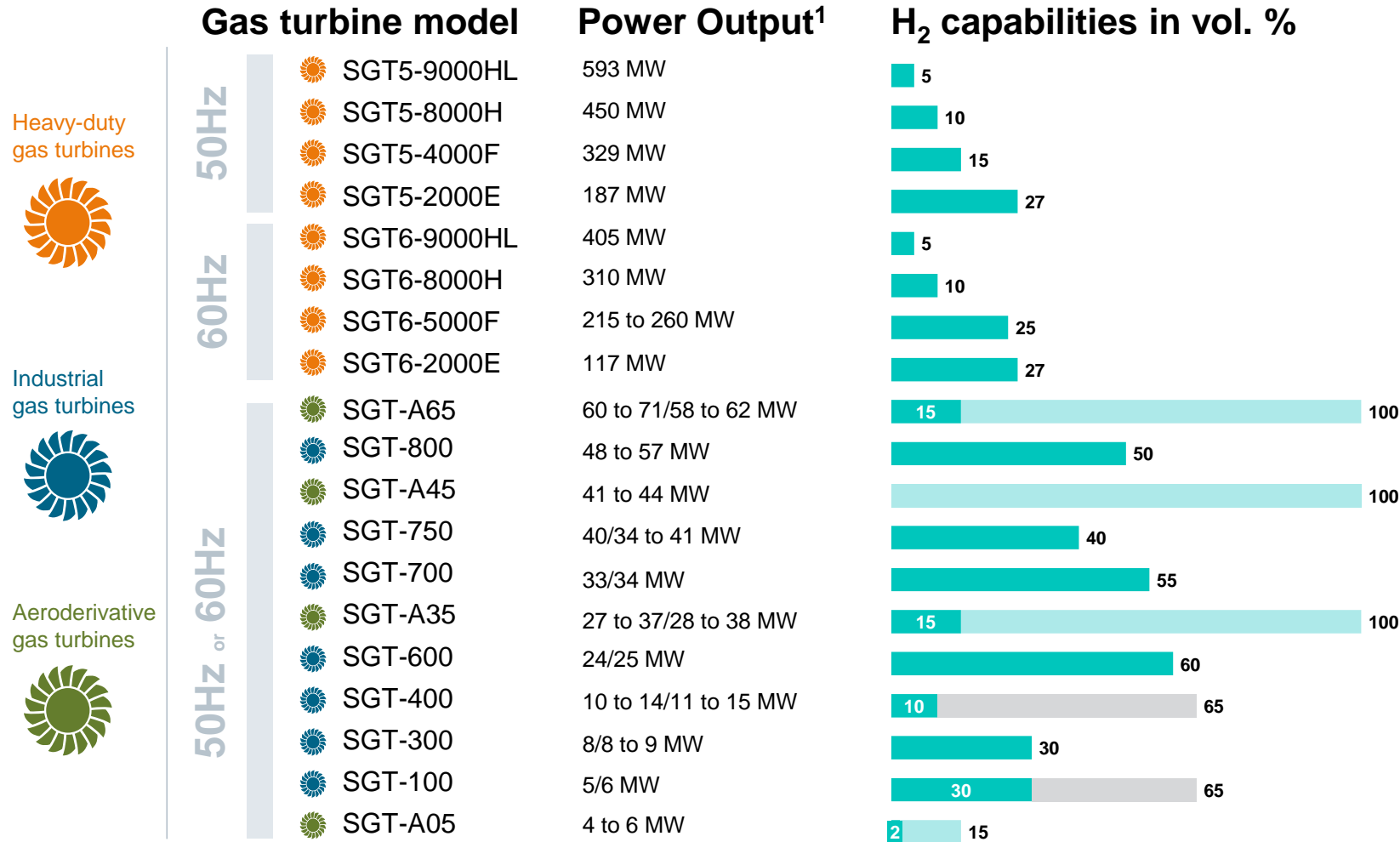
Scope

- Revised shutdown logics of UMC/BoP/ST
- I&C implementation & testing on site
- Operator training and documentation

Applicability

- Siemens CCGT with UMC

Siemens Hydrogen Gas Turbines for our sustainable future – The mission is to burn 100% hydrogen



Values shown are indicative for new unit applications and depend on local conditions and requirements. Some operating restrictions/special hardware and package modifications may apply. Any project >25% requires dedicated engineering for package certification.

Higher H₂ contents to be discussed on a project specific basis



¹ ISO, Base Load, Natural Gas
Version 2.0, March 2019

DLE burner WLE burner Diffusion burner with unabated NOx emissions

Hydrogen Combustion in Siemens Large Gas Turbines

H₂DeCarb¹⁾ SGT5-2000E & SGT5-4000F Status

SIEMENS
Ingenuity for life

SGT5-2000E

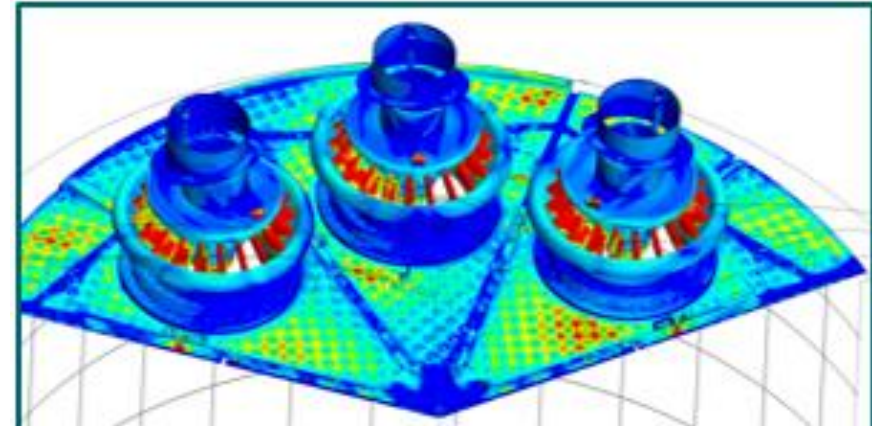
- **Burner modified** based on latest fleet improvements and optimized for H₂ combustion
- **Successfully tested** in High Pressure Combustion Test Rig
- Operational influence (emission & combustion behavior) revealed and related **control measures** defined

Capability: 27 vol% H₂

SGT5-4000F

- SGT5-2000E **design derived for SGT5-4000F**
- Functional changes & control measures defined

**Capability: 15 vol% H₂
and with further potential as soon as requested**



1) Upgrade working title

Contact



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