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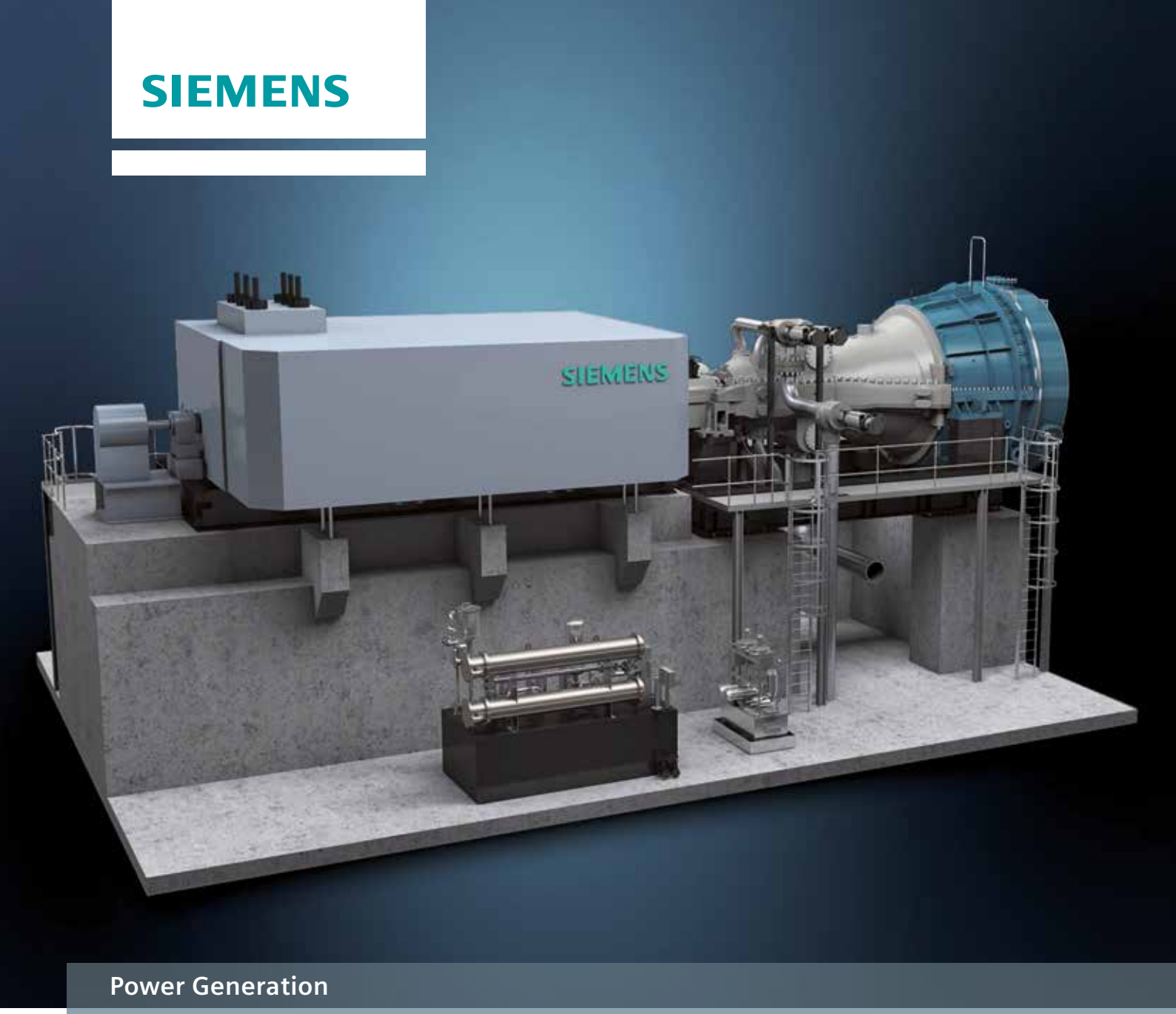

Power Generation

The Enhanced Platform

The Next Generation of Industrial Steam Turbines

www.siemens.com/energy/steamturbines

Advanced Steam Turbine Design

The Enhanced Platform steam turbine design sets the course for the next generation of Siemens industrial steam turbines. As an innovative technology basis it represents the development of a steam turbine family with a flexible casing concept applied for upgrading several well-known Siemens product lines, such as the SST-300, SST-400, SST-500, SST-600 and SST-800.

Harmonization of Product Lines

The Enhanced Platform steam turbine design combines the advantages of all the established Siemens industrial steam turbine product lines. Furthermore, it integrates the latest technological developments which form the basis for the modified versions of existing product lines. The Enhanced Platform design combines various turbine model designs to establish a common basis that helps to significantly reduce the maintenance and upgrade efforts required for various steam turbine models. Moreover, the integration of new features and upgrades can be realised quickly. This modular design concept ensures that these features are available simultaneously for all relevant applications – providing a significant reduction of time-to-market and enhanced availability.

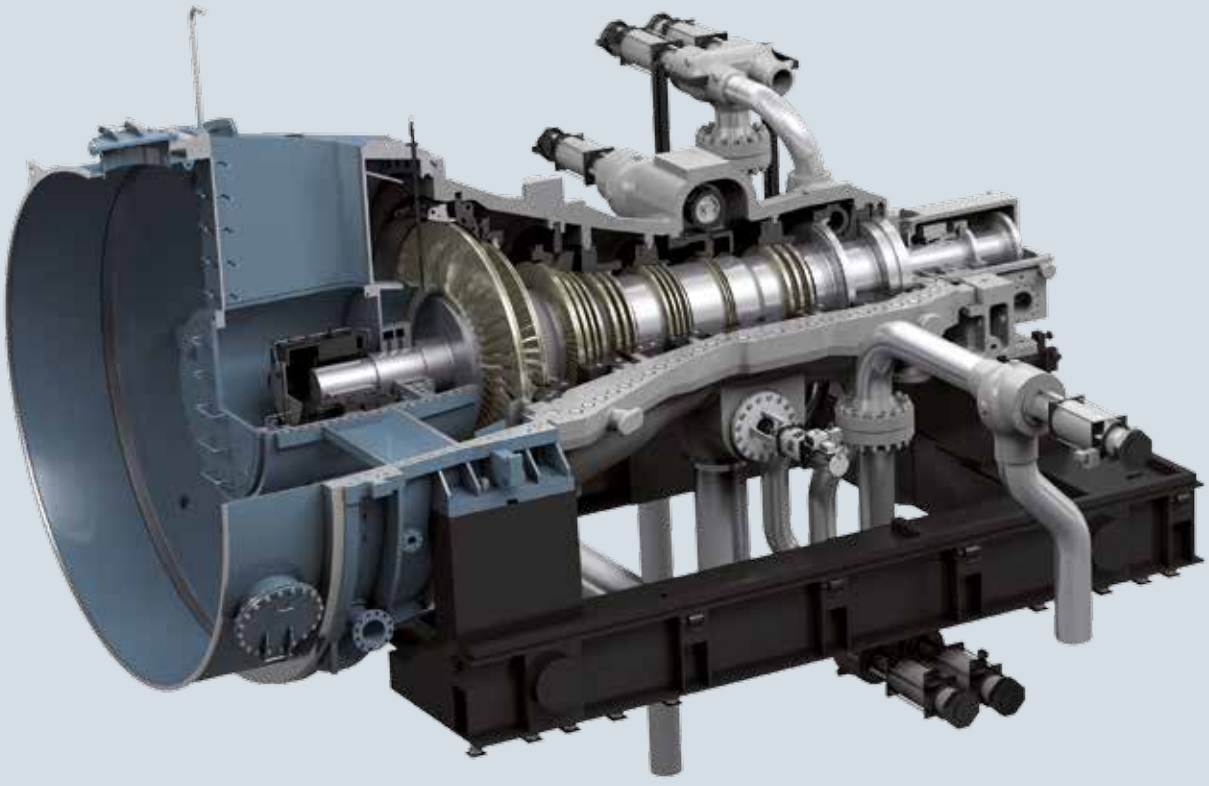

Figure 1:
Enhanced Platform Design

Enhanced Platform Means Innovation

The Enhanced Platform is Siemens' answer to our customers' need for extended operating capabilities and improved economical solutions. It brings the entire Siemens industrial steam turbine product range under one common umbrella and incorporates new state-of-the-art features.

The very best features of the Siemens steam turbine portfolio have been incorporated in a new series of standardized modular components that can be assembled to meet virtually any customer need. Accordingly, customer solutions benefit from many innovative features, such as improved blading and sealing design, an optimized casing and, last but not least, improved steam paths.

Modularization for Maximum Flexibility

The Enhanced Platform is a technoloy platform allowing the realization of different product lines such as customized and standardized turbine configurations as single and multi-casing solutions.

It uses predefined components to cover different turbine solutions and applications. This concept allows a maximum flexibility due to standardization at the sub-part level.

Enhanced Efficiency

Compared to previous steam turbine designs, Enhanced Platform steam turbines provide a more efficient operation. Due to the improved blade and seal concept, turbines operate with up to 2 % higher efficiency. An additional contribution to higher efficiency is the revised steam path realized by specialized steam inlets which ensure high temperatures (up to 565 °C) with short heat-up times, along with competitive solutions for lower parameters.

Better Operational Flexibility

Moreover, the optimized homogenous geometrical casing design guarantees a reduced start-up time of up to 50 %. Faster load changes and unlimited load changes over the entire life time for small and medium size turbines allow for virtually any load regime.

Improved CO_2 Footprint

A CO_2 emission reduction up to 15 % will be achieved over the entire life time applying the benefits provided by the Enhanced Platform. A reduction of CO_2 emissions produced based on key influential factors such as material, manufacturing, packaging, service and transport can be achieved thanks to the following points:

- Long-term experiences in material behavior lead to efficient material inventory for all components and result in a total turbine weight reduction.
- Applying pre-standardized components leads to reductions in both engineering and manufacturing effort.
- Less total weight leads to benefits for both packaging and logistics.

The carefully designed Enhanced Platform building block system enables Siemens to combine customized design solutions for maximum efficiency and performance with standardization and repeated use for proven high reliability and availability.

Higher Reliability and Availability

The persistent and long term material behavior ensures a long life cycle of 200,000 operating hours. The application of a proven design, e. g., high and intermediate pressure blades with tried-and-tested root clamping designs, or maintenance-free bolts up to 50,000 operating hours results in a high level of availability.

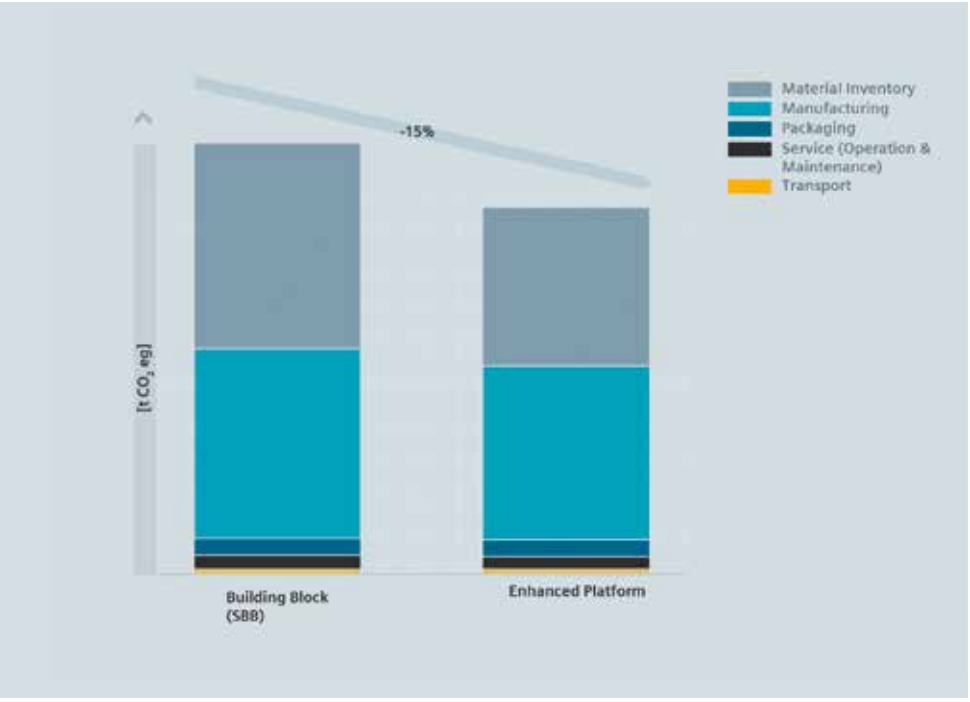

Figure 2:
A benchmark of the Enhanced Platform against the existing Siemens Building Block (SBB) solution showed environmental benefits. The produced CO_2 emissions were calculated on turbine examples for both designs.

Technical Specifications

Outer Casing

Reduced start-up times due to optimized turbine casing

The symmetrical design of the upper and lower halves avoids material concentrations and ensures improved thermal behavior and improved start-up time. The optimized split joint flanges also avoid thermally-induced stress and, furthermore, supports of internal parts allow thermal expansion. The scaled and homogeneous geometrical casing design over the complete range simplifies the engineering. The design of guide blade carriers is flexible enough to allow optimum usage of space and material.

Figure 3:
Comparison of admission section of conventional Siemens building block design (upper) and the improved Enhanced Platform design (lower).

Steam Guide

Ideal steam path for a highly efficient steam turbine

The inner casing is designed to realize both front and center steam admission. Front steam admission is an efficient solution here, as it guarantees a short radial bearing distance. Center steam admission leads to increased bearing distance but allows the realization of more efficient turbine solutions because of reduced leakage flow and mechanical losses. Furthermore, center steam admission allows for more applicable sizes. Highly efficient turbine solutions can now be realized even for high live steam parameters and for smaller sizes. Also, the standard inner casing allows a three step elongation according to required blade path length.

Figure 4:
Examples for the pre-defined valve-piping-arrangement.

Steam Inlets

High temperatures with short heat-up times

The Enhanced Platform technology employs a valve piping arrangement for control of live steam. To ensure short turbine design processes a dedicated number of pre-designed arrangements were created covering most applications.

Depending on the live steam conditions (pressure, temperature, mass flow), the application and turbine operation, the valve piping arrangement is implemented with one to four control valves in combination with one or two emergency stop valves.

Diffuser valves are used for high parameters:

- Up to four control valves with one or two emergency stop valves
- Poppet or bell valve design
- No material concentrations, allowing short heat-up times
- HP (High Pressure) and LP (Low Pressure) hydraulics possible

Internal butterfly valves are used for low parameters:

- One or two main control valves with one emergency stop valves each, hydraulically operated
- Up to three internal butterfly valves, electrically or hydraulically operated

Blades and Vanes

Highest efficiency with improved blade profiles and material know-how

The improved cylindrical high pressure blades and conical (twisted) intermediate pressure blades allow longer airfoils and, therefore, contribute to the overall high efficiency. The improved sealing system allows more sealing strips per blade row at both moving and stationary blades. All sub-components are predefined and ensure simple processes in sales, engineering, and production.

Optimized seal concept minimizes leakages

An improved sealing system allows more sealing strips per blade row for both moving and stationary. The improved sealing concept combined with the improved profiles leads to less profile losses and secondary losses. This results in an increase of efficiency and better performance.

Low Pressure Blades

Optimized blade design

Depending on the application, standard stages are available for variable and fix speed, direct drive and geared applications, and normal and high condensing pressure conditions (water and air cooled condenser).
The maximum continuous operating speed is 18,000 rpm. The maximum condensing pressure is limited to 0.5 bara for continuous operation. In total, five different standard stage groups are available. Two types of standard stages are available for each variable speed and geared application and one standard stage type for direct drive 50 and 60 Hz.

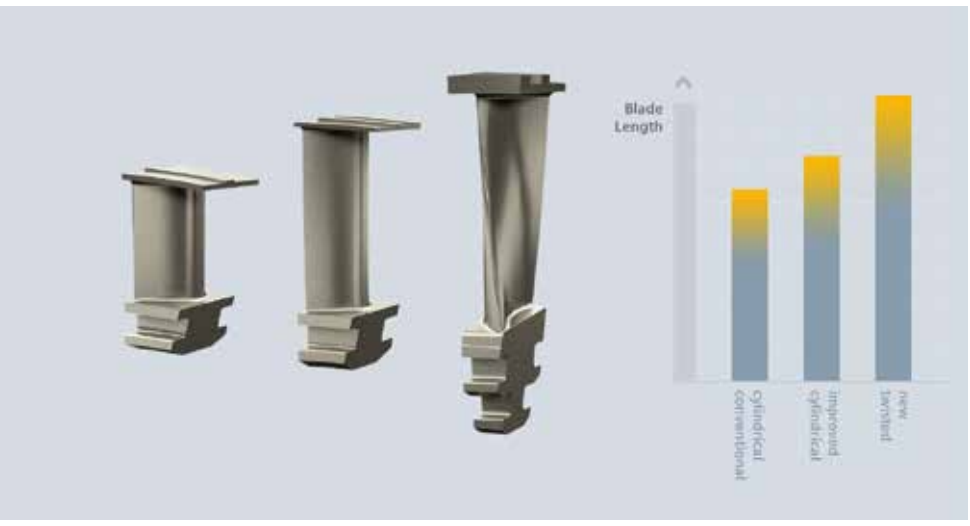

Figure 5:
Improved cylindrical high pressure blades and conical (twisted) intermediate pressure blades allow longer airfoils.

Extraction Points

Additional options for thermal cycles

With the Enhanced Platform all well-known and proven extraction systems will now be provided under one common umbrella. Available are:

- External control valves, applicable for very high steam extraction conditions
- Internal control valves in combination with and without nozzle group
- Both profiled and un-profiled grid valves

Depending on customer process and application demands, several solutions are possible. This inlcudes up to seven extraction planes for one casing, including up to two controlled solutions. The choice is primarily driven by thermodynamic requirements, but also takes performance and cost into consideration. Our experts will help you to find the optimum balance between highest efficiency and lowest cost.

Bearings and Thrust

Smaller bearings and lower oil consumption by optimized thrust and bearing system

The possibility of applying up to three balancing pistons minimizes thrust and allows smaller axial bearings. Thanks to improved radial bearings less oil and thus a smaller oil tank are needed. Furthermore two bearing housing types that are based on well proven technology cover the full range of applications.

Exhaust Casings

Larger condensing stages and higher backpressures

Axial and radial exhaust solutions ease installation in our customers' environment. Typically both solutions are fabricated of sheet metal, radial exhausts up to 0.6 m² are available as casted solution. Radial as well as axial exhaust casings up to 8.7 m² allow for both air and water cooled condensation.

Figure 6:
Extraction solution available within the Enhanced Platform technology: external valve (1), internal valve with/without nozzle group (2), profiled grid valve (3) and un-profiled grid valve (4).
Exhaust casings in different sizes. (right)


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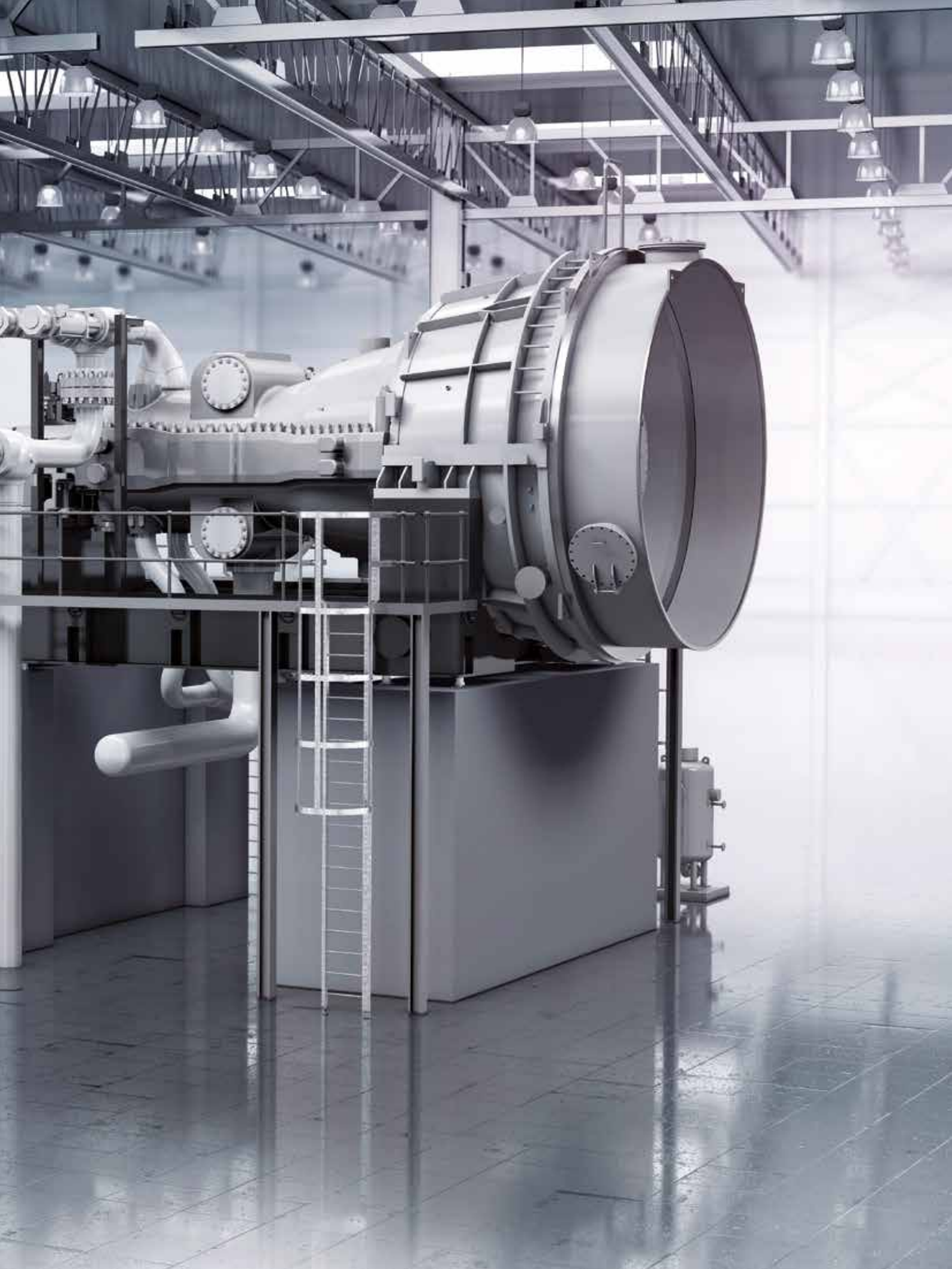


Customized Solution

Siemens Enhanced Platform: Extensively Tested

The Enhanced Platform is an ideal steam turbine technology platform for realizing turbine solutions for power generation, steam conditioning and mechanical drive applications for industry, utilities and the oil & gas market. High performance, outstanding reliability and an improved efficiency ensured by the improved blading, sealing and the optimized steam flow path have been verified and approved in extensive tests using a full-scale steam turbine. The symmetrical homogeneous outer casing and the flexible valve piping arrangement combined with unique Siemens know-how for steam path and blading result in shorter start-up times, faster load changes and an increased availability. The new design allows simplified installation and extended maintenance intervals.

The Enhanced Platform design

1 **Steam Admission**
Both front and center steam admission applying nozzle casing or inner casing

2 **Control Stage**
Improved flow guidance within the nozzle (meridian profiling) and sealing

3 **Vanes / Blades**
- High pressure blading with improved profiles and sealing
- Intermediate pressure blading with improved profile and sealing, use of twisted blades for both vanes and blades
- Low pressure blading, several proven technical solutions for fix, geared, and variable speed
- Grid valve, adaptive stage, A-wheel

4 **Bolts**
50,000 operating hours maintenance free (formerly 30,000)

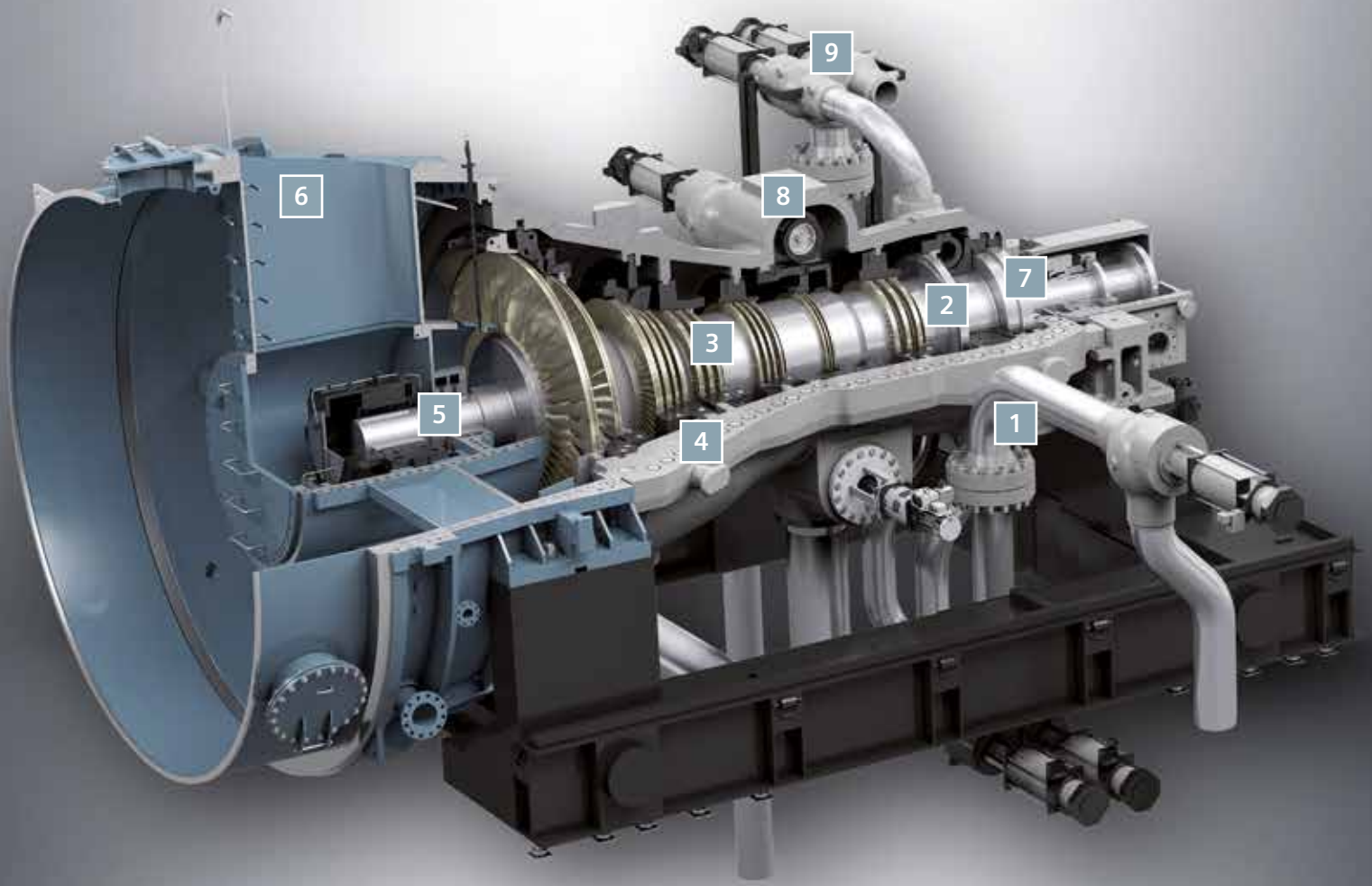
5 **Bearings**
The improved bearings have a lower oil consumption allowing a smaller oil system to be used.

6 **Exhaust Casing**
Special solution for backpressure, condensing and district heating

7 **Balancing Piston**
Stepped piston to reach optimal axial thrust compensation

8 **Extraction**
- Controlled and uncontrolled extraction – up to 7 levels covered in one casing
- Several technical solutions available depending on steam pressure / temperature

9 **Valve**
Optimized customer solutions according to requirements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Test Turbine Vision One

For the final validation and calibration of the turbine design calculation tool for customer orders an actual turbine equipped with an improved flow path was designed, engineered, manufactured and operated. The turbine was tested as a backpressure extraction steam turbine with 19 stages in total, with cylindrical as well as twisted blade configurations beeing installed. The output power was 9 to 10 MW and the maximum continuous operational speed was 9000 rpm. The turbine was operating with live steam of 70 bara / 476 °C in maximum. Load control was achieved using a water friction brake.

The complete turbine was equipped with extensive measurement techniques for pressure and temperature measurements to obtain a feedback on the thermodynamic expansion through the turbine. In addition, two stages were equipped with strain gauges for blade vibration measurement to ensure the unchanged reliability for the blade row coupling during different operational speeds and loads.

Figure 8:
Full size test turbine.

Key Parameters

Topic	Parameter	
Power Output	5–250 MW	
Speed	3,000–18,000 rpm	
Live Steam	Inlet pressure	≤ 165 bar / ≤ 2393 psi
	Inlet temperature	≤ 565 °C / ≤ 1049 °F
Controlled Extractions (up to 2)	Pressure, ext. valve	≤ 72 bar / 1044 psi
	Pressure, int. valve	≤ 55 bar / 798 psi
	Temperature	≤ 480 °C / 895 °F
Uncontrolled Extractions (up to 6)		≤ 85 bar / 1233 psi
Exhaust Conditions	Backpressure	≤ 80 bar / 1160 psi
	Condensing	≤ 1.0 bar / 15 psi
	District heating	≤ 3.0 bar / 43 psi

Figure 9:
First Enhanced Platform steam turbine in manufacturing.

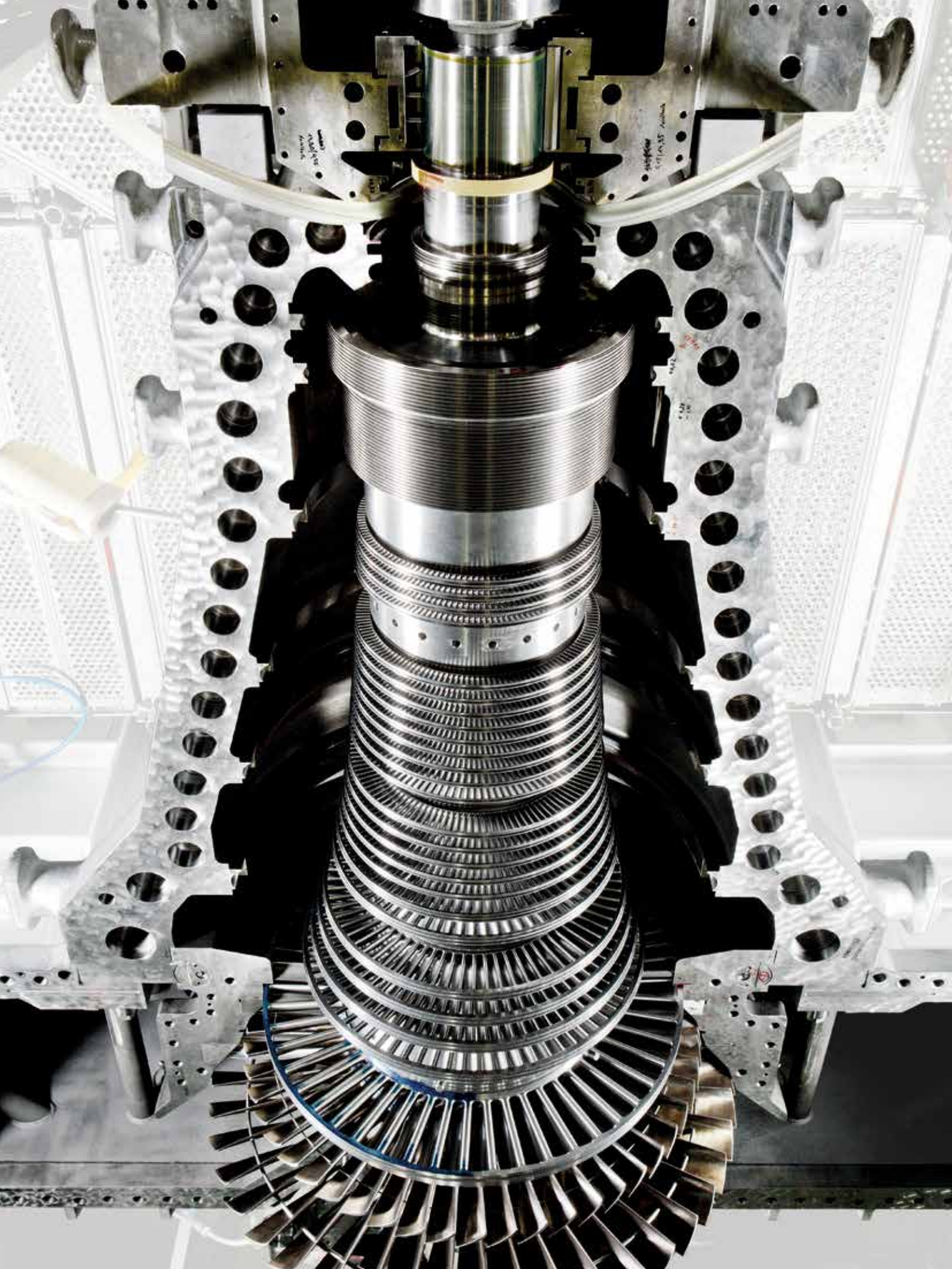
Summary

The Enhanced Platform: Combination of Innovation, Efficiency and Reliability

High quality and customized solutions are guaranteed for every Siemens steam turbine. Based on that philosophy, Siemens took the very best features of individual turbine designs and applied them across the entire product range resulting in the Enhanced Platform. This innovative technology basis is the best solution for every application where steam turbines are deployed.

Optimized Performance

- Higher steam parameters
  165 bar, 565 °C (formerly 140 bar, 540 °C)
- High reliability
  Bolts are maintenance-free for 50,000 h
  (formerly 30,000 h)
- Reduced start-up time
  Up to 50 % less for turbines of small and medium size
- Faster load changes
  For turbines of small and medium size < 63 no limits of load changes
- Improved CO_2 footprint
  15 % reduction of CO_2 emissions
- Improved efficiency
  Up to 2 %
- Long life cycle – increased life time
  200,000 h (formerly 100,000 h)
- Extensively tested and verified initial turbine
  Full load test in Duisburg Megatest Center



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