

# R&M of Steam Turbines Improvements in Efficiency, Flexibility and Reliability

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Business  
Representation  
for Siemens  
Energy

**SIEMENS**

# Technology Needs

...by continuous improvement of economic value



Efficiency

Better Performance  
Less degradation



Flexibility

Less start-up time  
Flexible start-up modes  
Additional start-up features



Reliability

Less forced outage  
Higher availability

Technology Partners

# Drivers for R&M

## Improved Power Plant Profitability

- Improved Heat Rate “**Greener Energy: Less Coal**”
- Higher **efficiency**
- Reduction of **fuel costs**
- Enhanced dispatch factor

## Lifetime Extension & Lower CO<sub>2</sub> Emissions

- **Safe operation** for next 15-20 years
- Reduced **maintenance costs**
- Improvement of **availability and reliability**

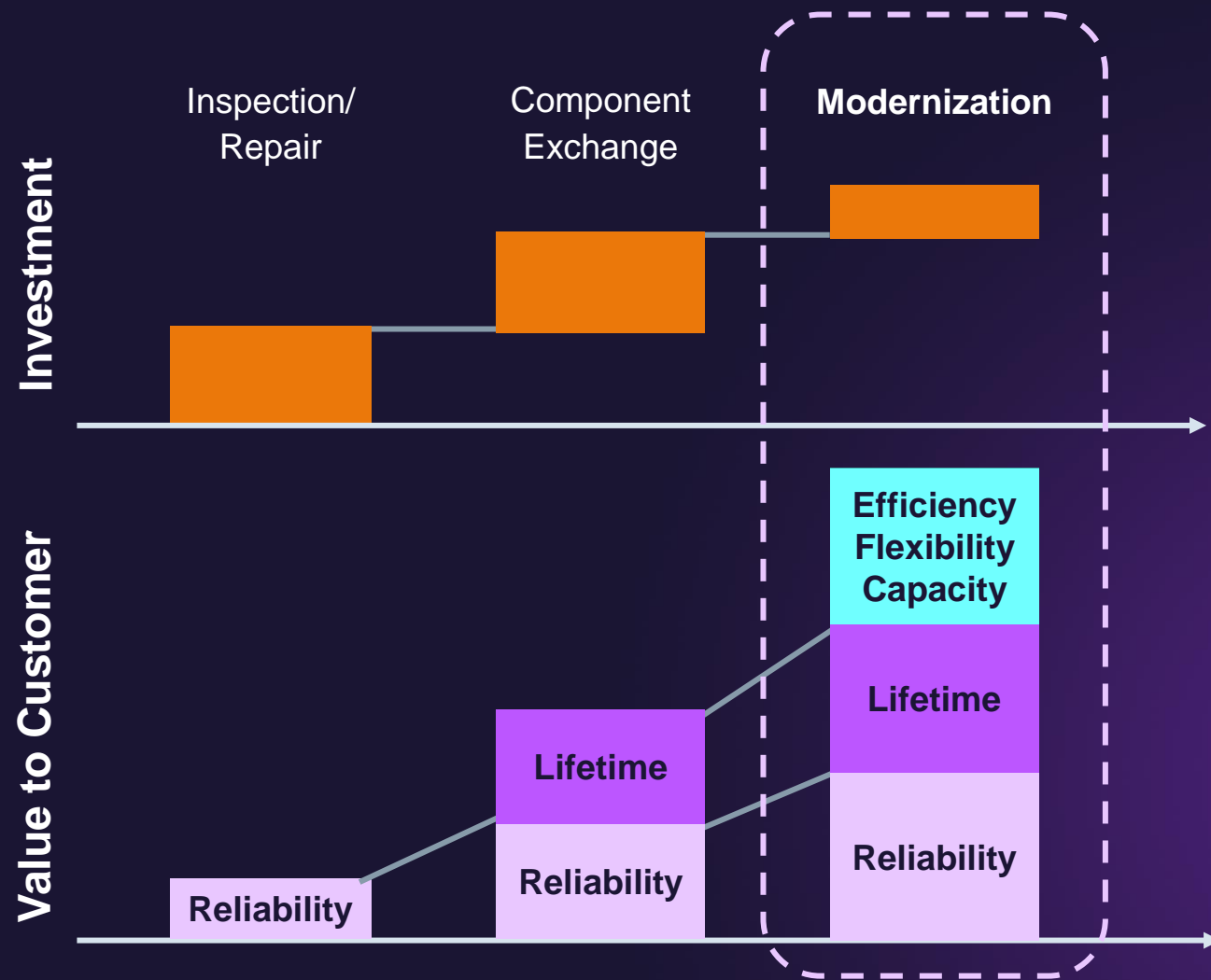
## Outage Optimization

- Advanced **outage planning** and **on-site machining** capabilities
- **Outage Schedule** Optimization



**Modernization makes a significant contribution to economic value**

# Steam Turbine Modernization Economic Justification



**Investment** in modernization is in general higher than a standard revision

**But**

**Modernization provides:**

- Efficiency increase
- Flexibility Capabilities
- Power increase
- Lifetime extension
- Minimized maintenance costs
- Reduced spare part quantity
- Latest level of technology

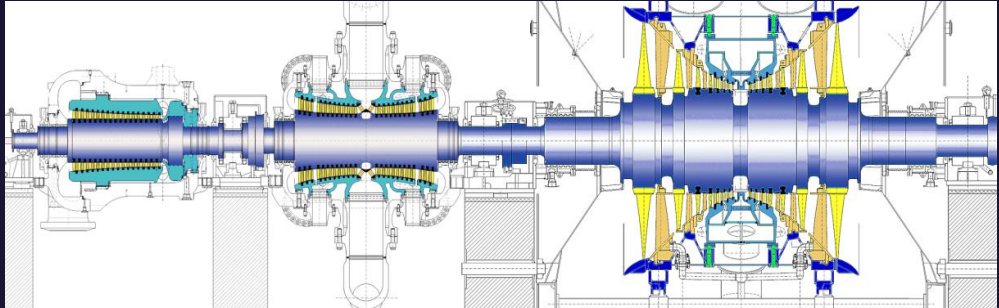
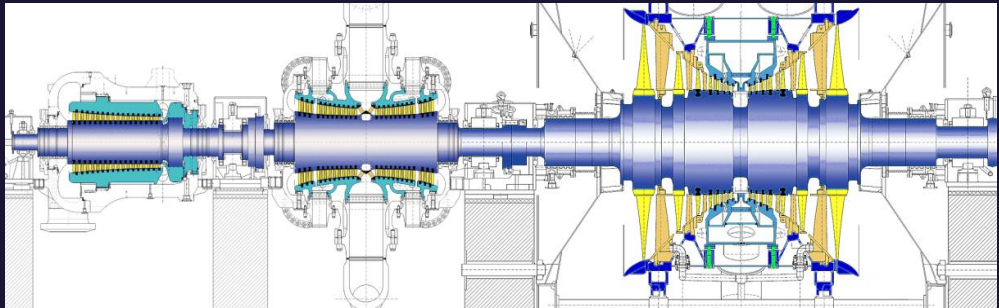
**Therefore**

**Modernization provides major financial benefit!**



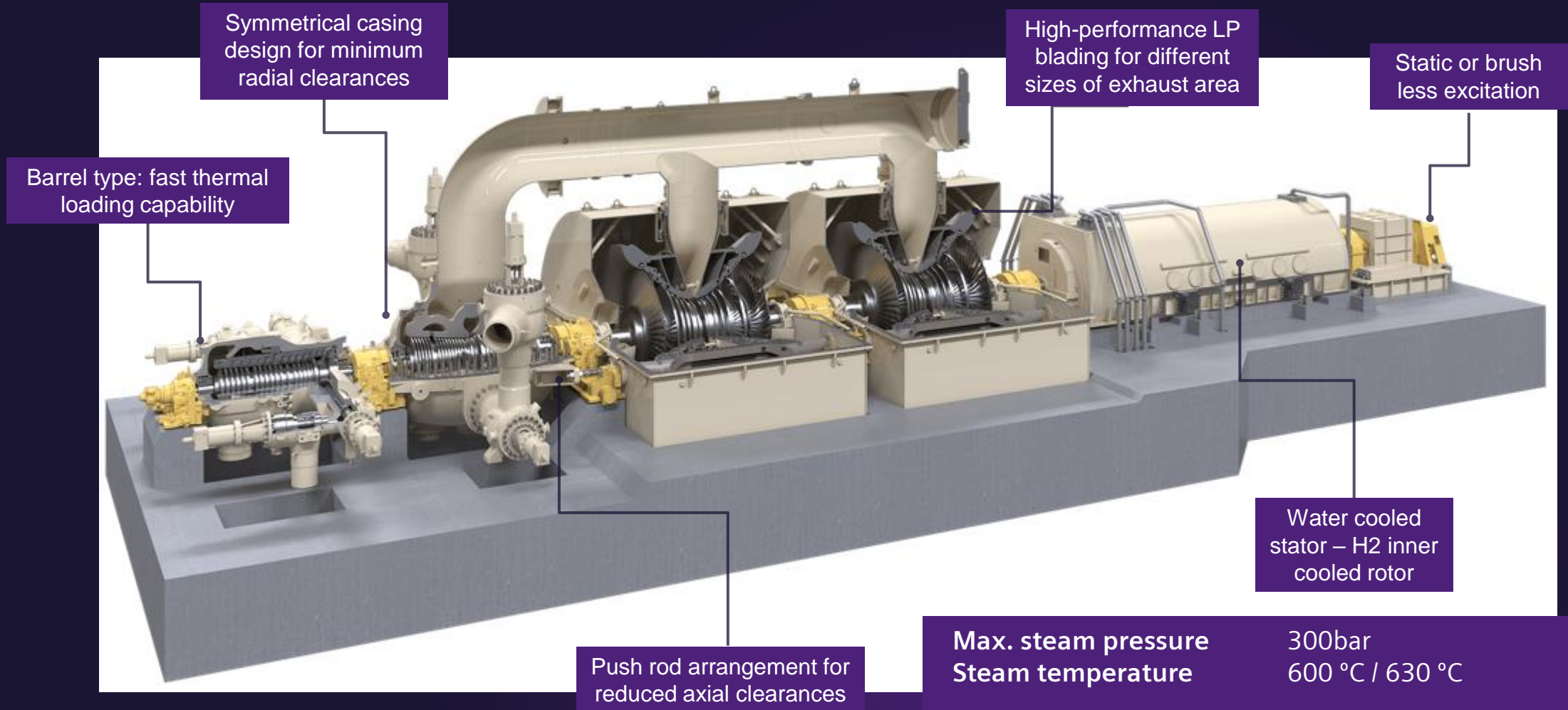
# Indian Fleet – Siemens Design

More than 2/3<sup>rd</sup> of fleet operating in India is based on Siemens Design  
Includes Siemens – KWU, Siemens – BHEL, SEC and Harbin

Frame	Turbine		
KWU 200 / 210 MW	HP	H30-25	<p><b>Fleet Size – 98 Units</b></p> 
	IP	M30-20	
	LP	N30-2x5m <sup>2</sup>	
KWU 500 MW	HP	H30-63	<p><b>Fleet Size – 40 Units</b></p> 
	HP	H30-100	
	IP	M30-50	
		M30-63	
	LP	N30-2x10m <sup>2</sup>	

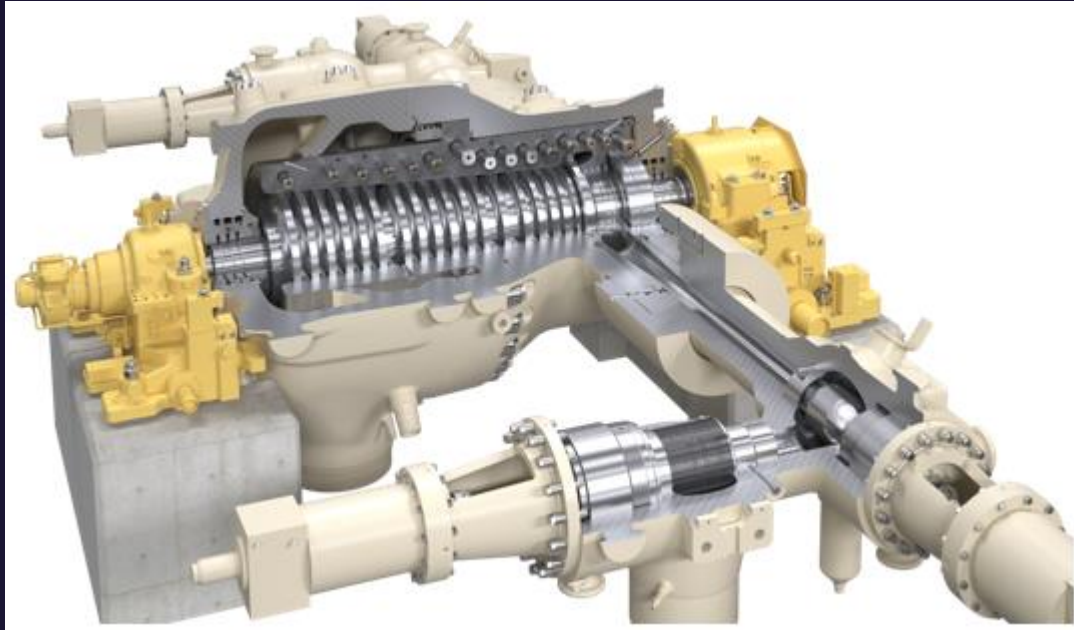
# SST-6000 Series (300 – 1200 MW)

## Design features for efficient and flexible application

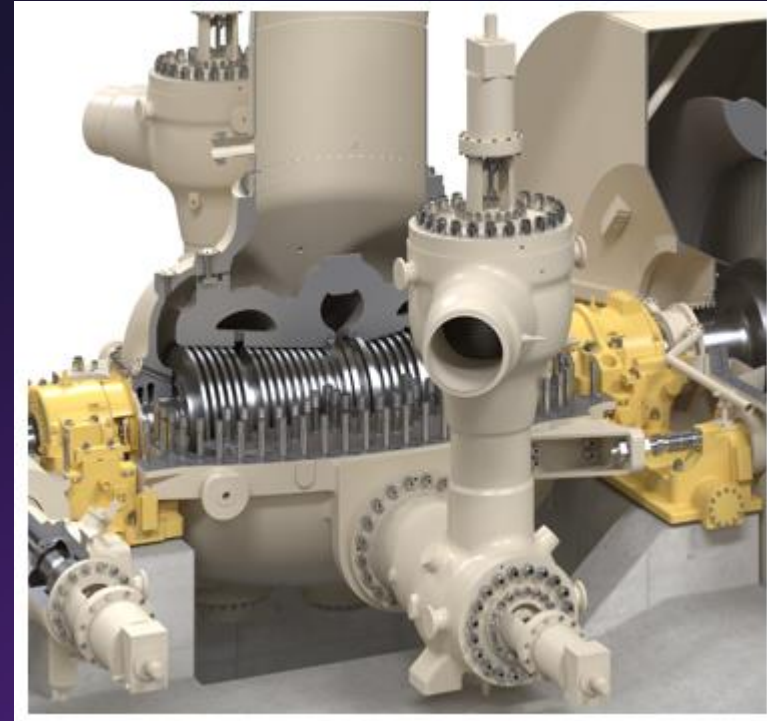


# HP & IP Turbine

## High / Intermediate pressure turbine design features



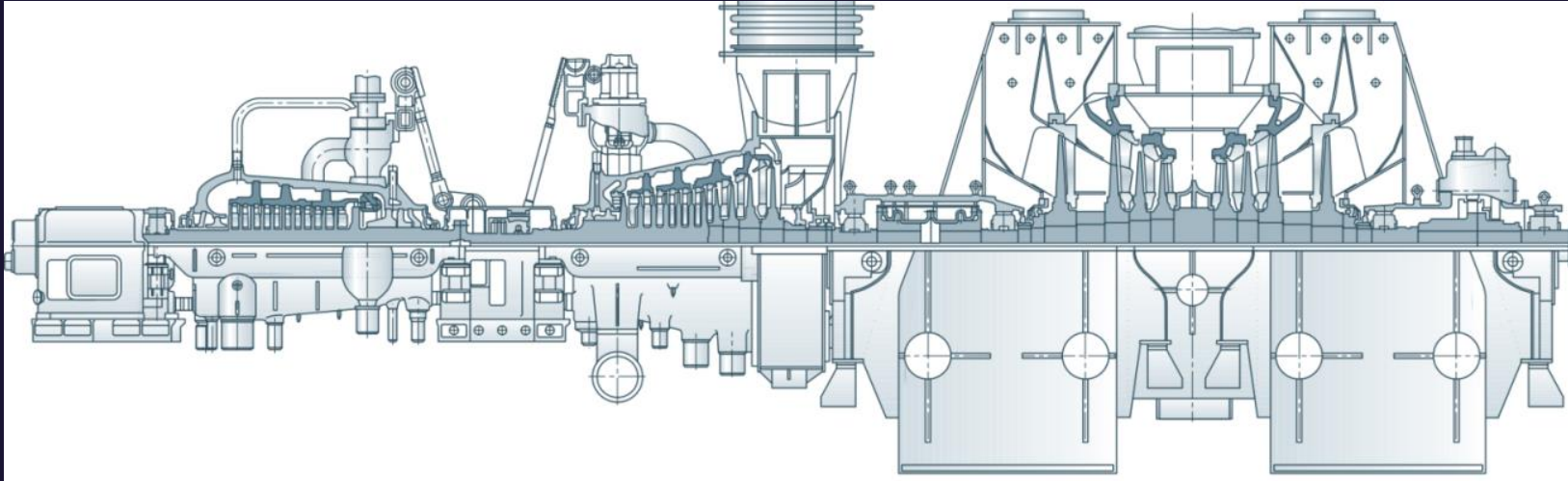
No inner casing leakages due to Barrel-type design at super critical conditions  
Optimum thermal loading  
Short start-up times due to circular inner and outer casing  
High efficiency and robustness



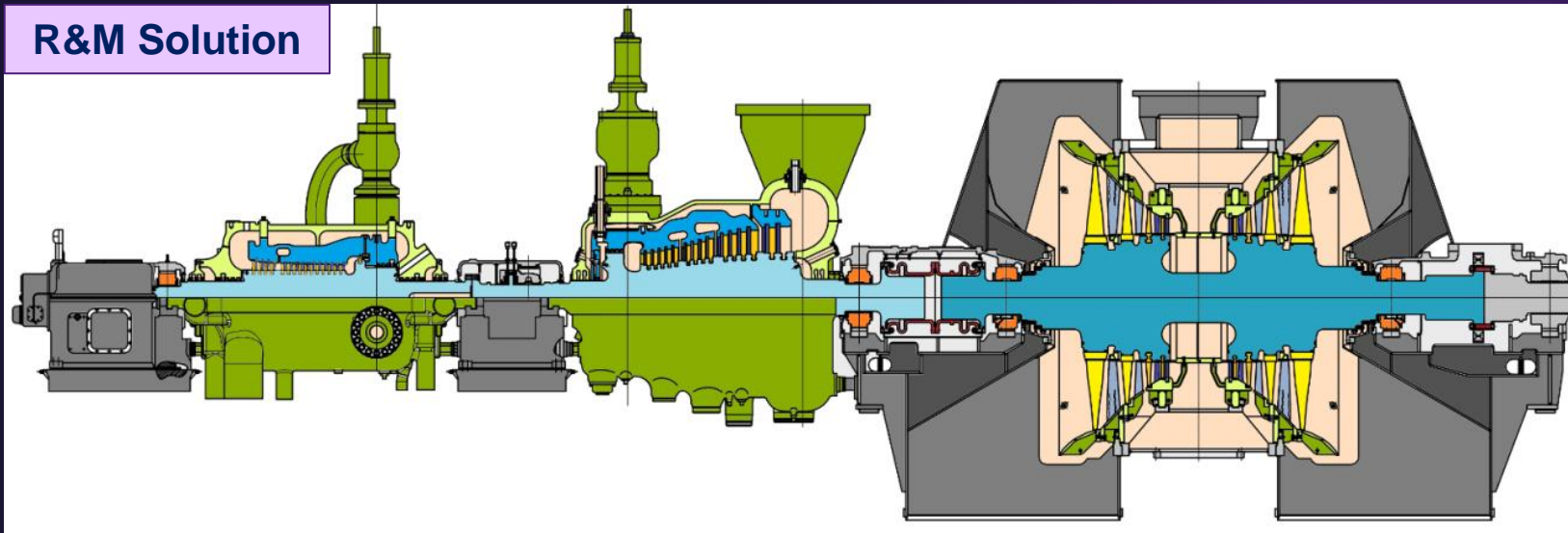
Double casing design, horizontal split  
Short start-up times due to circular inner and outer casings  
Optimized casing contours and wall thickness  
High efficiency and robustness



# R&M– Scope of Work LMZ 210MW Units



## R&M Solution



### Scope of Work:

- HP, IP Full module and LP Inner module replacement
- HP, IP Valves, Bearings replacement
- Mechanical Auxiliary Systems Modernization
- MS, HRH, CRH Piping adaptations
- Aux. Systems Piping
- New Turbine Control system
- Electrical System Modernization

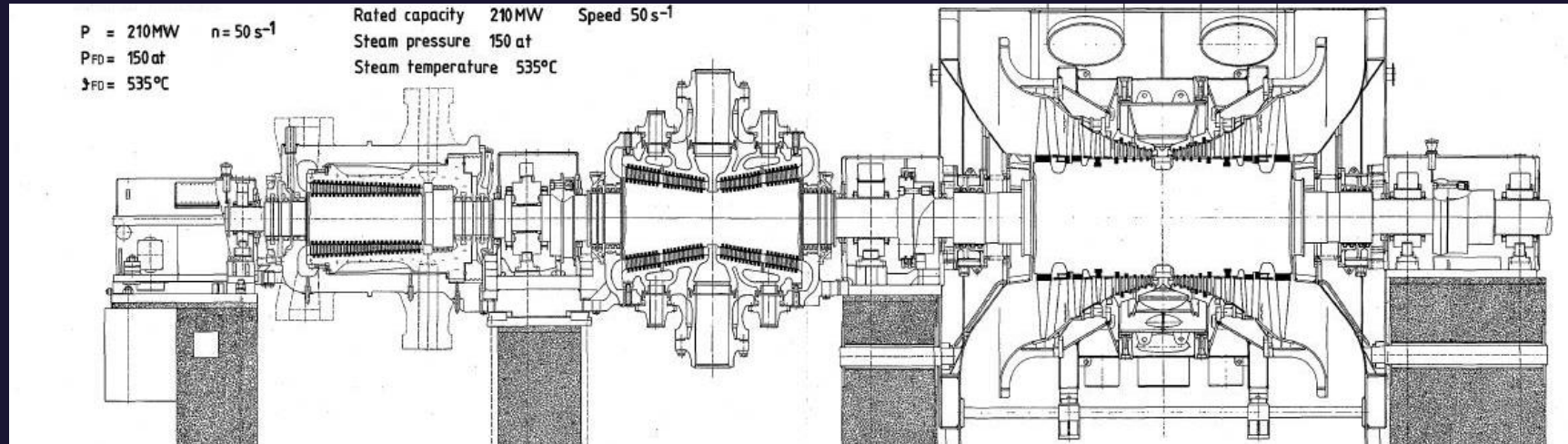
**Implemented on:**  
GSECL Ukai U4 & Wanakbori U3

**Under Execution:**  
GSECL Ukai U3&5

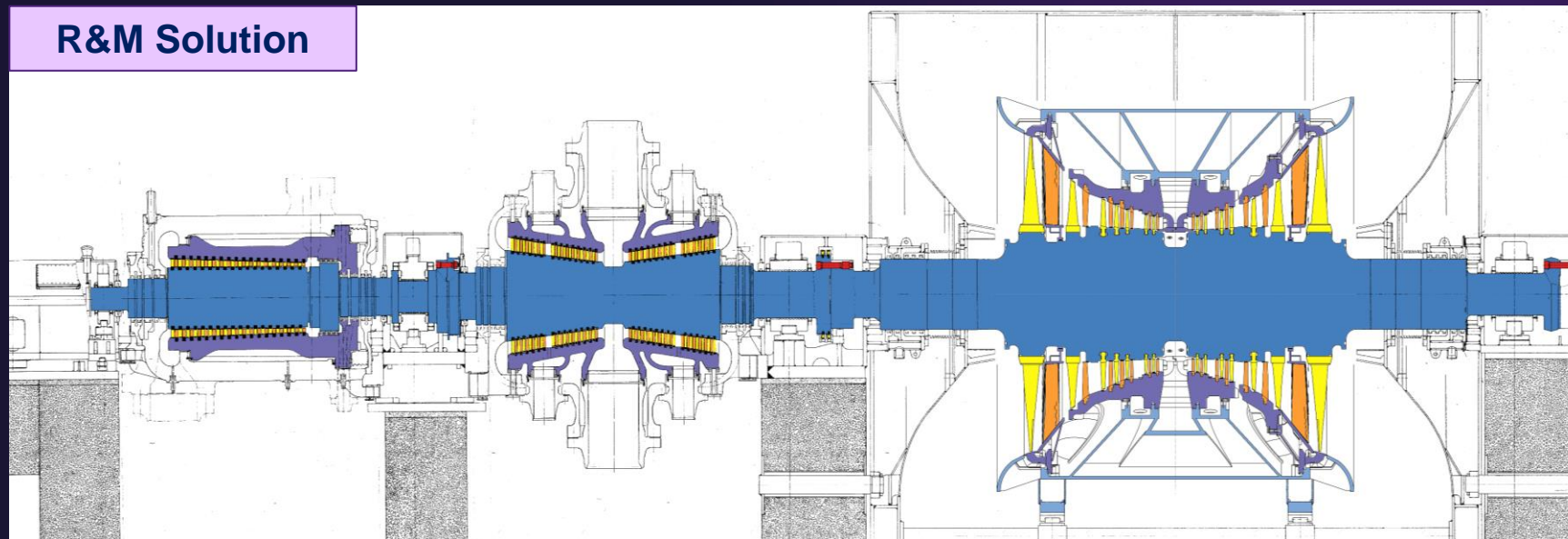
**On-going tenders:**  
NTPC Vindhyachal U1-3  
GSECL Wanakbori U1&2



# R&M – Scope of Work SIEMENS-KWU 210MW / 500MW Units



## R&M Solution

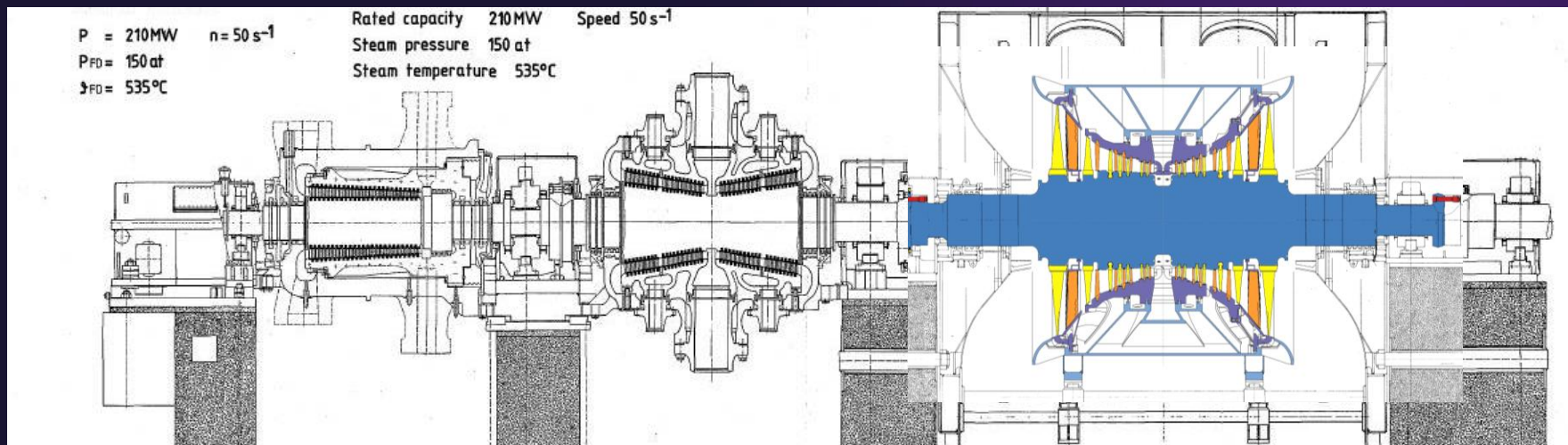
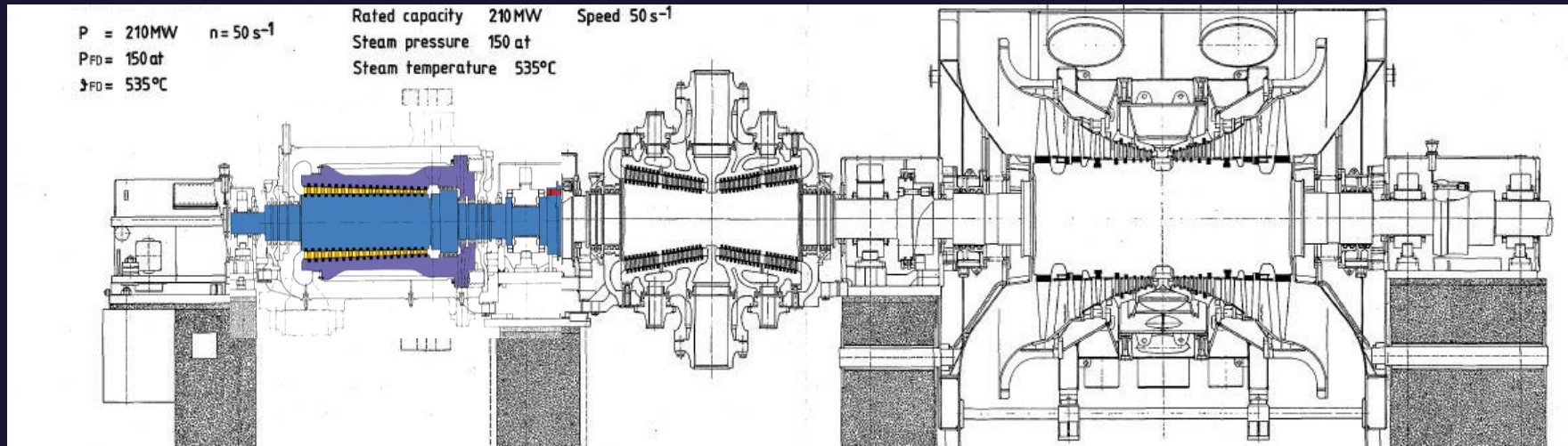


## Scope of Work:

- HP, IP, LP Inner module replacement
- Retain HP, IP Valves, Bearings, Pedestals, etc.
- No mods & upgrades on Mechanical Auxiliary Systems
- No piping modification required
- Control system settings updates, if needed

**Under Execution:**  
KPCL Raichur U3

# R&M – Scope of Work Module Level Upgrade - Option

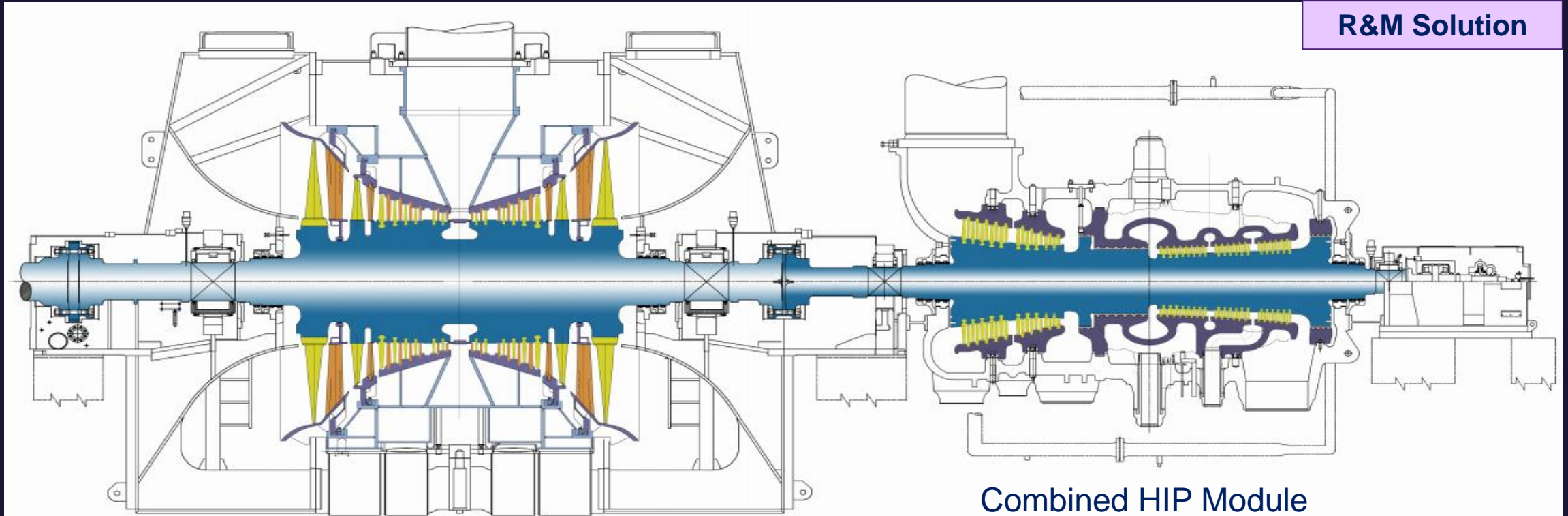


- Individual turbine modules upgrades for efficiency, life-time extension
- Less interfaces with existing components, so lesser risks
- Much shorter erection outage – reduced generation loss
- Quick turn-around of the projects – lesser tendering and execution time



# M&U – Scope of Work

## Chinese OEM Make 135MW / 300MW



- HIP, LP Inner module replacement
- No scope related to HP, IP valves, bearings, pedestals, etc.
- Life extension and reliability improvement

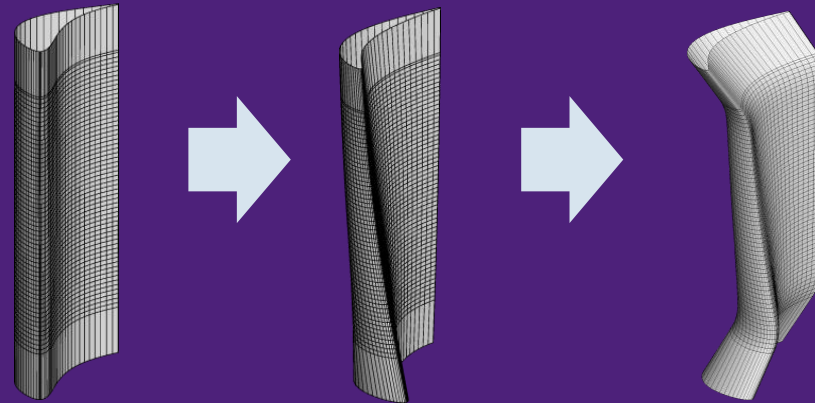
# HP/IP Blading Technology

## State-of-the-art 3DSTM Drum Stage Blading

### Aerodynamic



### Airfoil Design



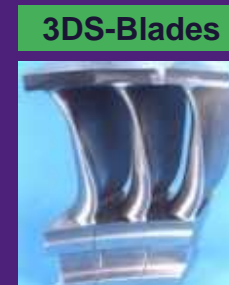
### Customer Benefits

- World-class performance
- Wide range of application
- Specific design for each application within short delivery times
- Long life & high reliability

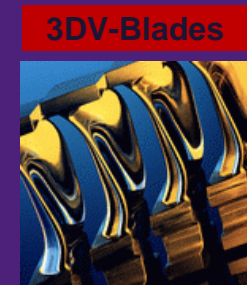
### Benefits



+ 2%



+ 1%





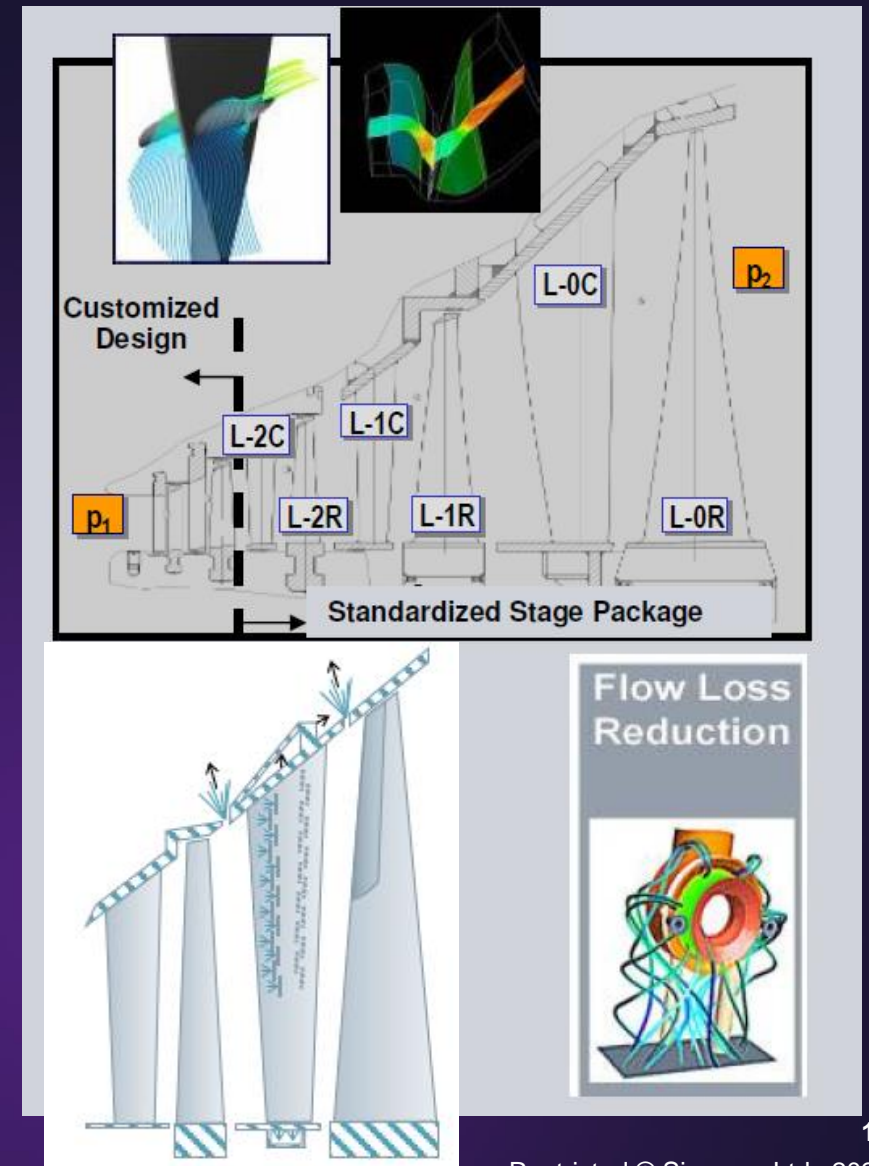
# LP Blading Technology

## LP Blading Design Features

- State-of-the-art fully 3D design
- Optimized last stage blade size
- Optimized LP exhaust area
- New shrouded/free-standing Last Stage Blade with Trans- and Supersonic Tip Sections, 3D-Flow Design
- Stage De-wetting, Hardening of La-0, Suction Slot in Le-0

## Customer benefits

- Improved blade efficiency by advanced 3D blade design
- Increased efficiency by shrouded rotating blades
- Reduced exhaust losses



# Sealing Features & Technologies

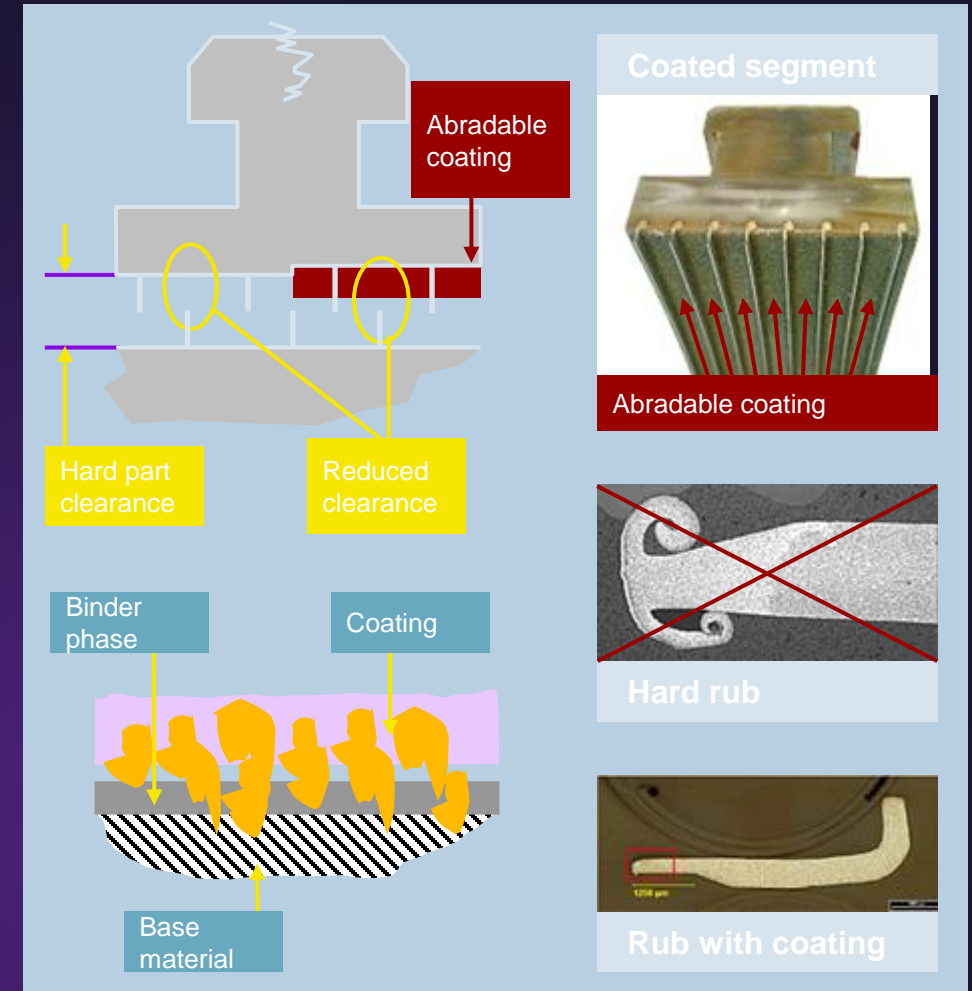
## Abradable coating sealing

### Design features

- Coating applied to standard seal segments (thickness ~0.6 mm)
- Reduced leakage flow due to reduced clearances (about 20% less)
- Fin cuts groove into coating without damage to fin or significant heating
- Suitable for large pressure drops
- Increased clearance between hard parts for additional operating safety

### Customer benefits

- Increased efficiency and power output
- Increased operational safety
- Proven design



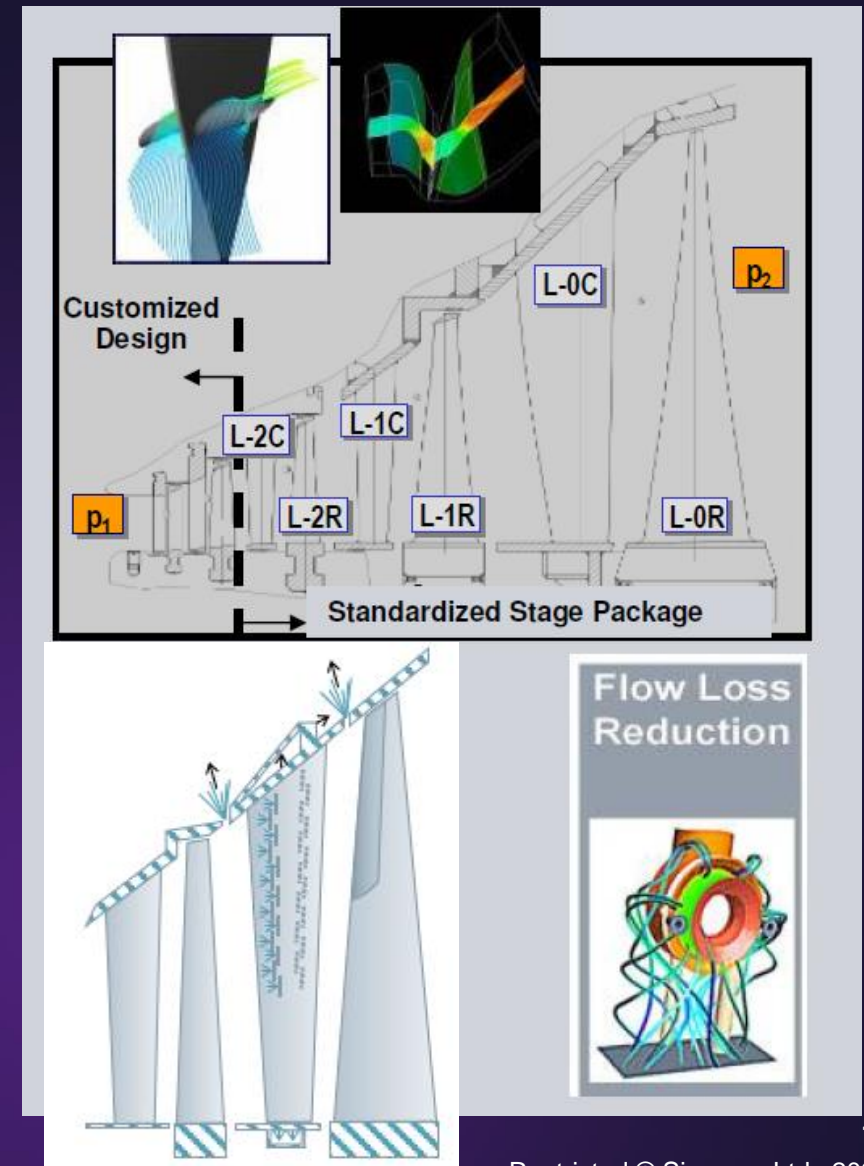
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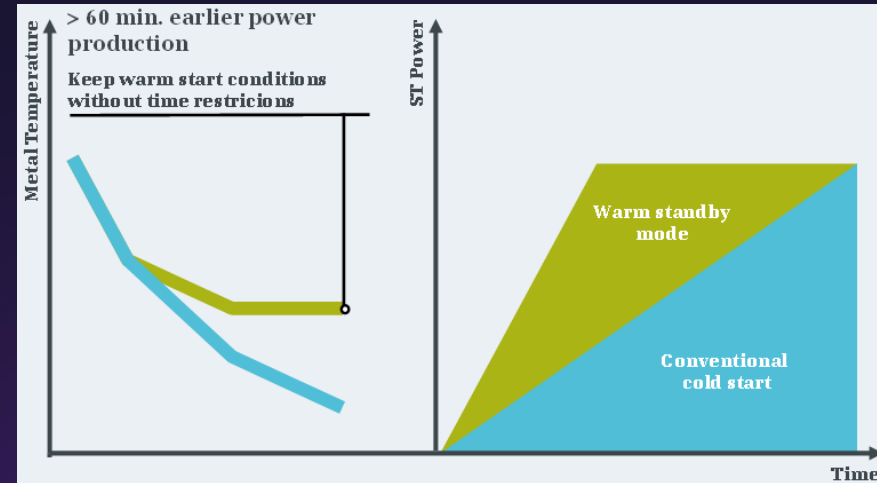


# Reduced Startup-times: Heating blankets

## ST Warm Standby Operation to prepare for fast start-up

### Technology

- Electrical heating system for ST in turning gear
- Maintains rotor shaft temperature at warm startup conditions



### Benefit

- Significant reduction of startup time... > 60 min.
- Reduction of EOH consumption per start
- Significant oil savings in startup and cost
- Less energy is bypassed to condenser
  - Reduced costs per start up



Electric heating coils to keep HP/ IP Turbine casing and shaft in warm start conditions



# Part Load Efficiency: Turbine hardware upgrade

## HP + LP Turbine

### Replacement of HP module

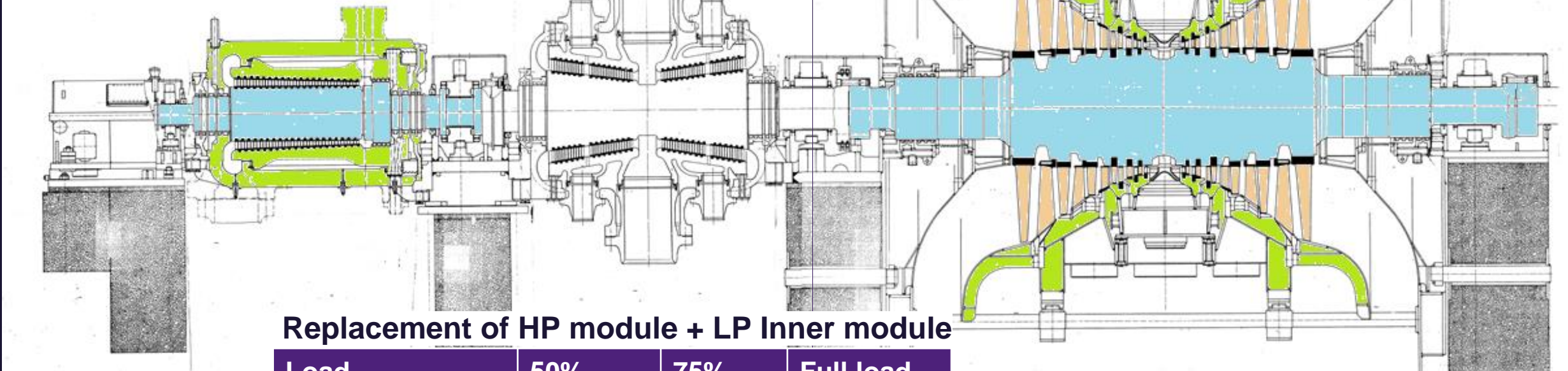
Load	50%	75%	Full load
Savings (coal) *	≈ 0.6%	≈ 0.6%	≈ 0.7%
Savings (coal) **	≈ 1.3%	≈ 1.3%	≈ 1.5%

### New 3D Blades



### Replacement of LP Inner module

Load	50%	75%	Full load
Savings (coal) *	≈ 1.0%	≈ 1.0%	≈ 1.1 %
Savings (coal) **	≈ 1.2%	≈ 1.2%	≈ 1.3%



### Replacement of HP module + LP Inner module

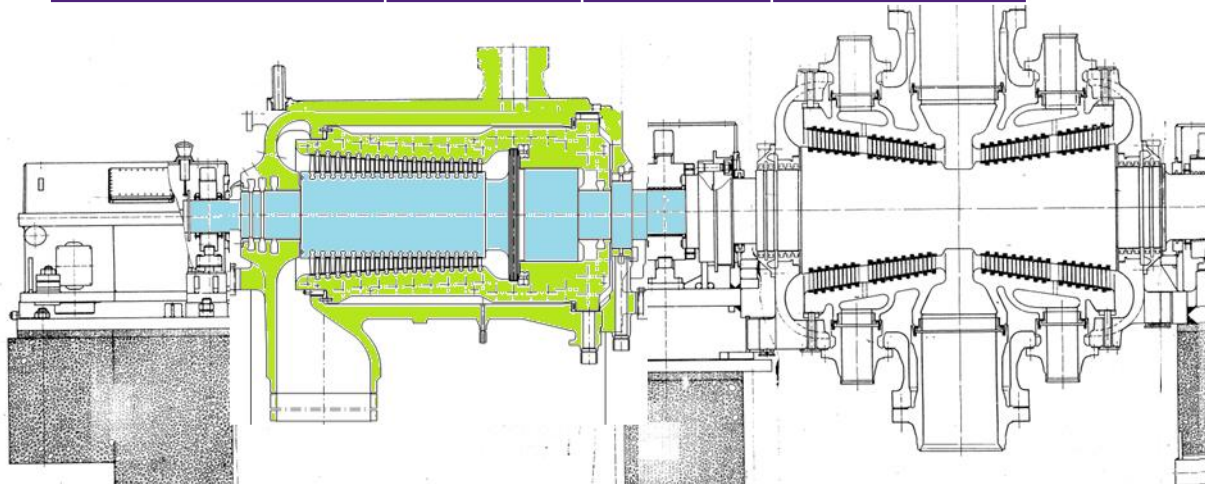
Load	50%	75%	Full load
Savings (coal) *	≈ 1.5%	≈ 1.6%	≈ 1.8 %
Savings (coal) **	≈ 2.7%	≈ 2.7%	≈ 2.9%

\* Relative to new & clean conditions  
 \*\* Relative to aged condition  
 (both in fixed pressure operation)

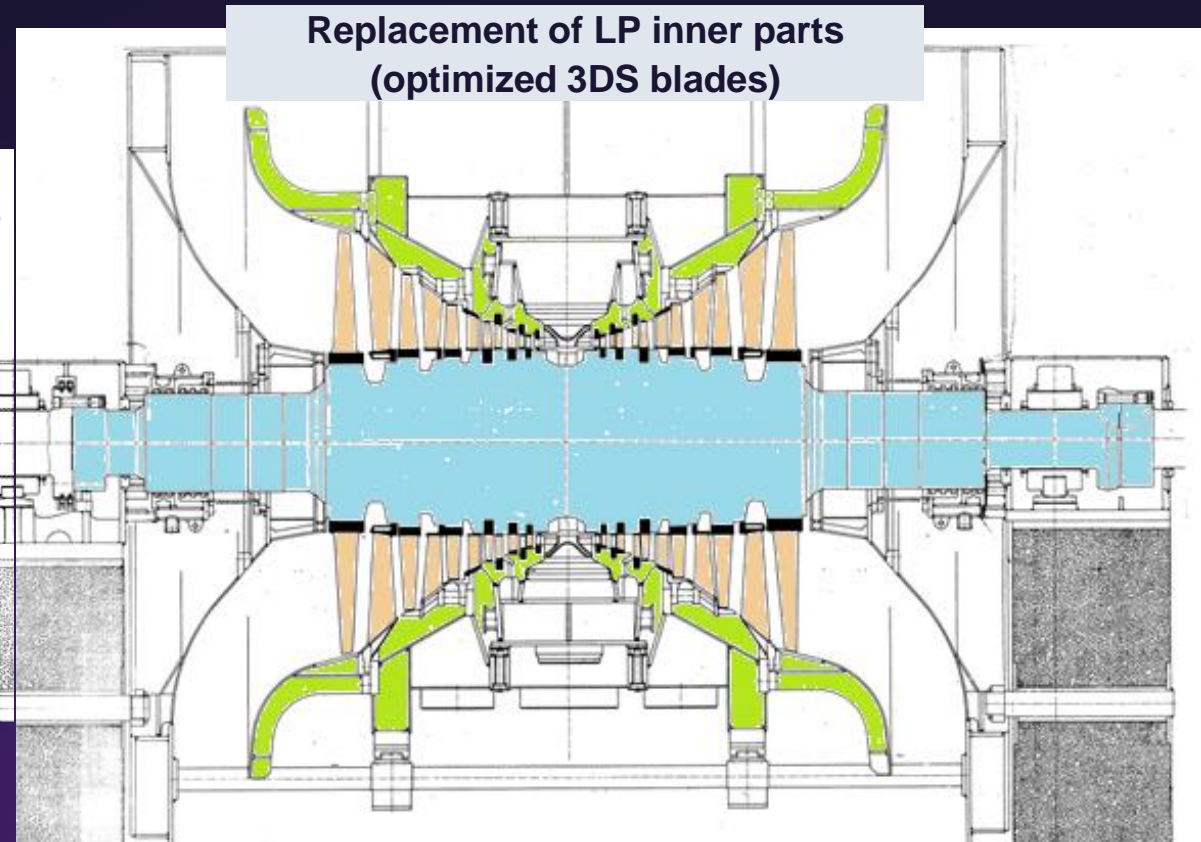
# Part Load Efficiency: Turbine hardware upgrade

## HP Turbine with control stage + LP Turbine

HP Module Upgrade			
Load	50%	75%	Full load
Savings (coal) *	≈ 2.7%	≈ 2.1%	≈ 0.2%
Savings (coal) **	≈ 3.5%	≈ 2.9%	≈ 1.0%



**Replacement of HP module  
(Control stage & optimized 3DS blades)**



HP and LP Module Upgrade			
Load	50%	75%	Full load
Savings (coal) *	≈ 2.7%	≈ 3.2%	≈ 1.3%
Savings (coal) **	≈ 4.7%	≈ 4.1%	≈ 2.2%

\* *Relative to new&clean conditions*  
 \*\* *Relative to aged condition*  
*(both in fixed pressure operation)*

# Thank You!

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