Steam Turbine R&M Experience - OEM Perspective

Shekhar Thakur

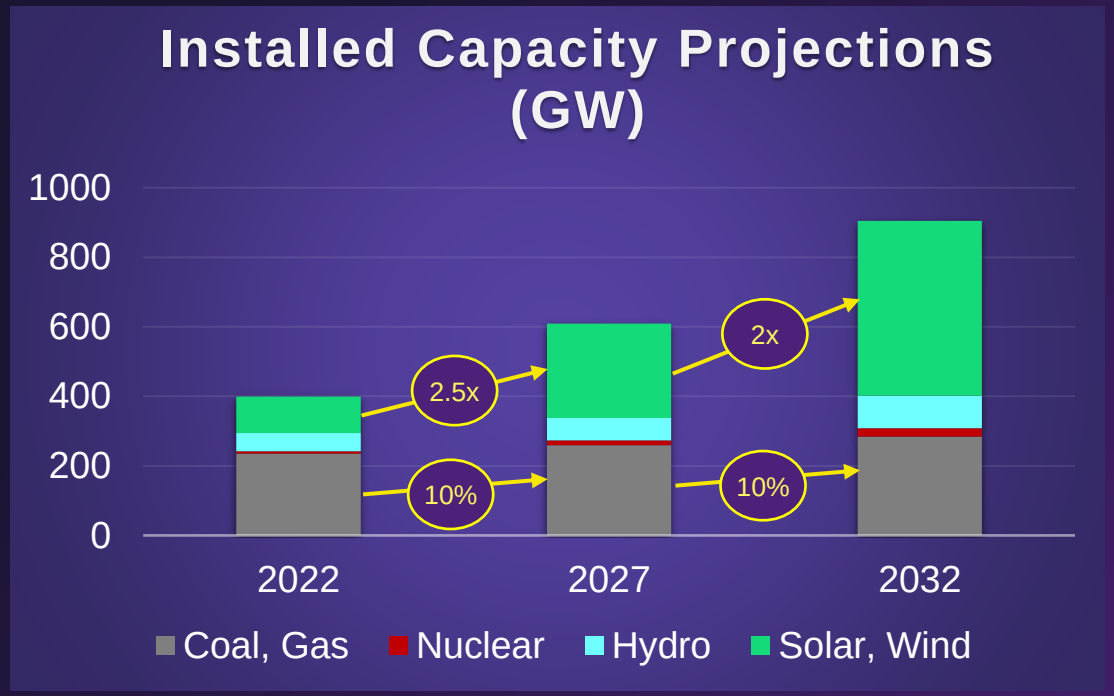
11th Sep 2024

Business Representation for Siemens Energy

SIEMENS

Power Plant Summit – 2024
September 10-11, 2024

R&M Market



- Total capacity increase by 50% every 5 years
- Renewables capacity >500GW by 2030-32
- New Thermal plants +80GW by 2032

Old Thermal plants to modernize for efficiency, life extension and flexibilization

Regulatory Guidelines:

- Not to retire any thermal units till 2030 and ensure availability of Units after R&M
- R&M guidelines released in 2023 with the list of potential Units (>20 years old)

	In Service	MW	No. of Units	Total GW	Avg. Years in Service	Ordered for R&M
Immediate	>25 Years	200/210MW	97	20.2	34	13
		250MW	5	1.3	26	0
		500MW	20	10	32	0
		Total:	**122**	**31.5**	**31**	**13**
Next 5-10 Years	**20-25 Years**	200/210MW	14	2.9	22	0
		250MW	3	0.8	21	0
		500MW	6	3	21	0
		Total:	**23**	**6.7**	**21**	**0**
	15-20 Years	200/210MW	8	1.7	16	0
		250/300MW	20	5.3	16	0
		500MW	13	6.5	17	0
		Total:	**41**	**13.5**	**16**	**0**

- 200/210MW are in focus for R&M, moving from LMZ make to Siemens/KWU make

Immediate R&M market of 100+ Units

R&M Technology Needs

…by continuous improvement of economic value

Efficiency

Better Performance
Less degradation

Flexibility

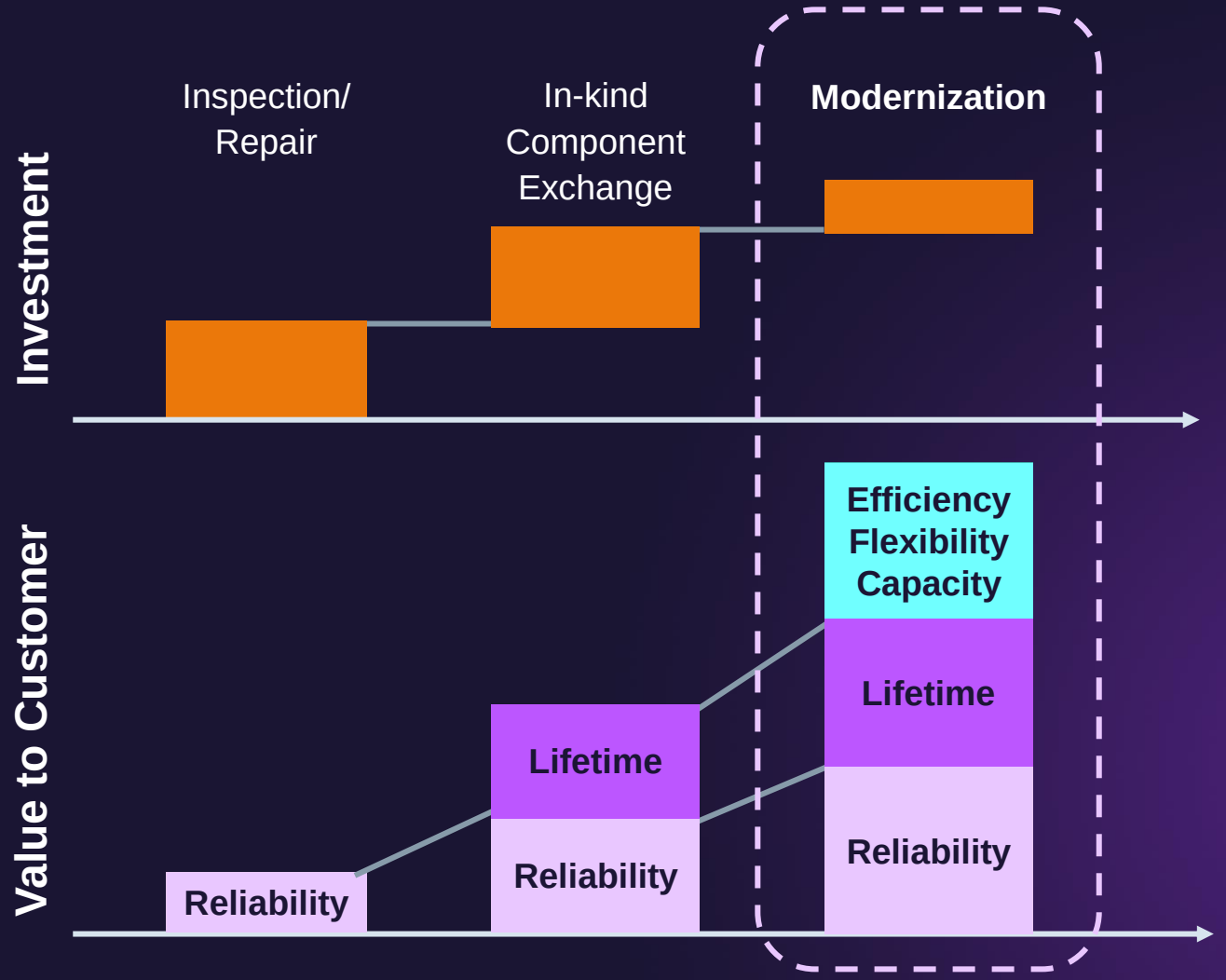
Less start-up time
Flexible start-up modes
Additional start-up features

Reliability

Less forced outage
Higher availability

Technology Partners

R&M Economic Justification



Investment in modernization is in general higher than a standard revision

But

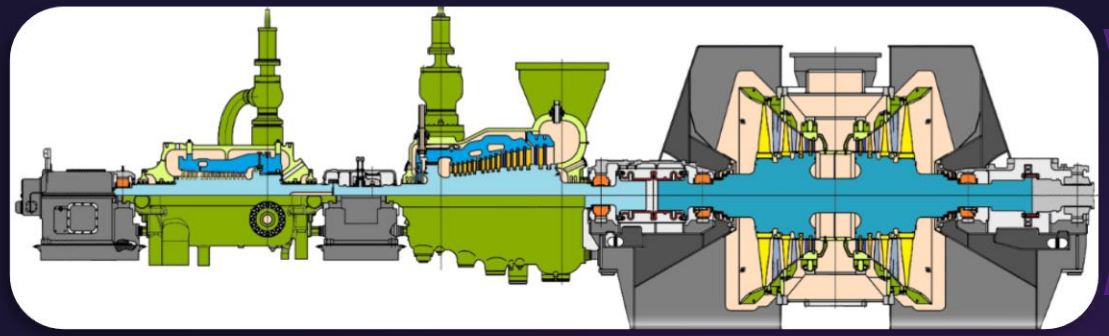
Modernization provides:
Efficiency increase
Flexibility Capabilities
Power increase
Lifetime extension
Minimized maintenance costs
Reduced spare part quantity
Latest level of technology

Therefore

Modernization provides **major financial benefit!**

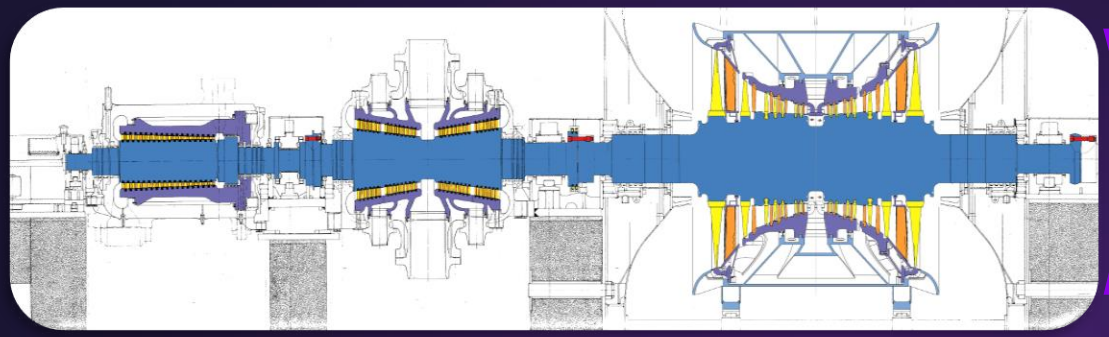
Steam Turbines R&M Categories
As per Scope of Work

Comprehensive R&M "Extended Scope"



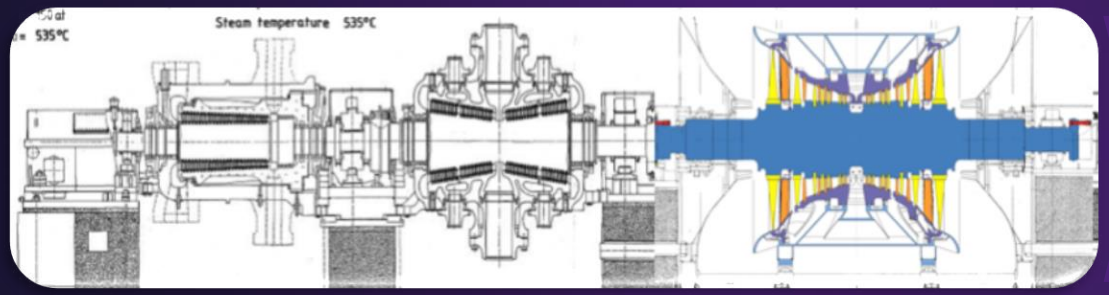
- Turbine Full-Module Replacements
- Modernization of Aux. Systems, C&I, etc.
- For LMZ Make Units

Comprehensive R&M "Shaft-line Upgrade"



- Turbine Inner-Module Replacements
- Retain Other Systems
- For KWU Make Units

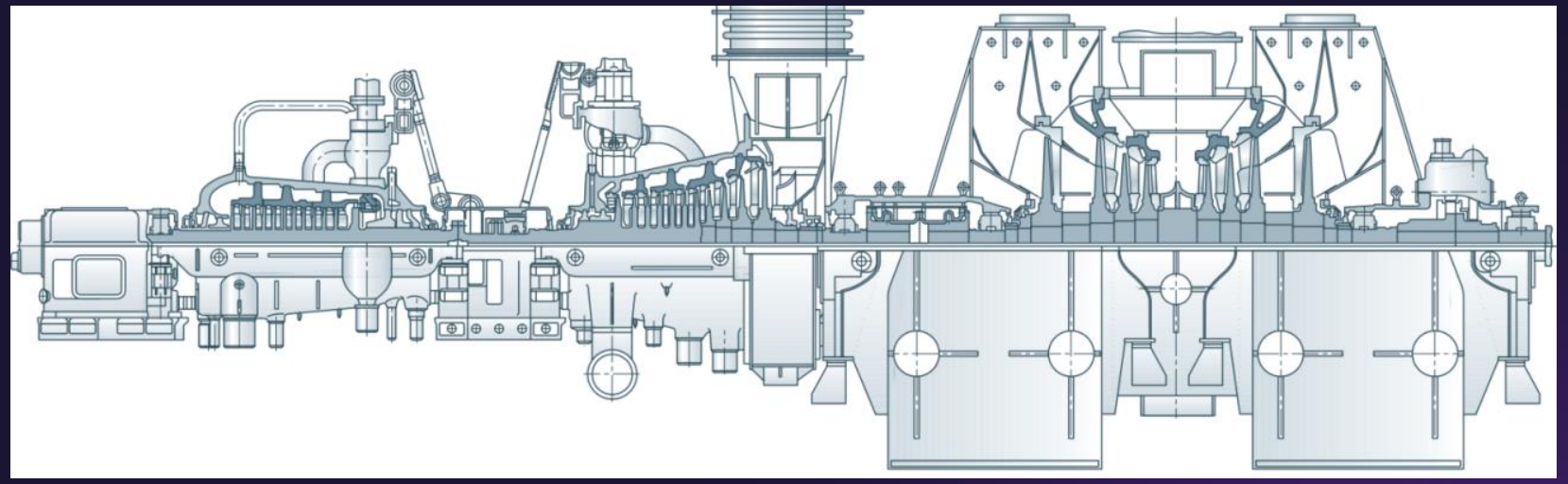
Need-basis R&M



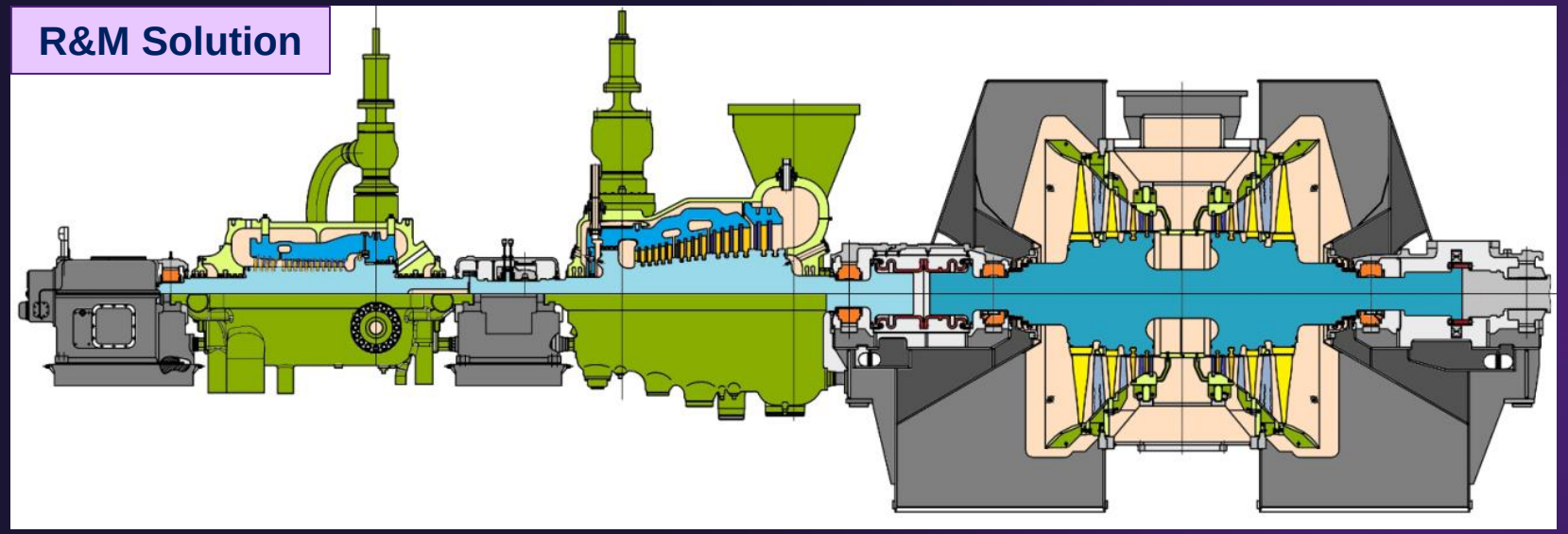
- Only selected turbine module modernization
- Retain Other Systems
- For KWU/CN Make Units

Customized R&M Solution specific for your Unit's Requirement

Comprehensive R&M “Extended Scope”
Applicable for LMZ 210MW Units



R&M Solution

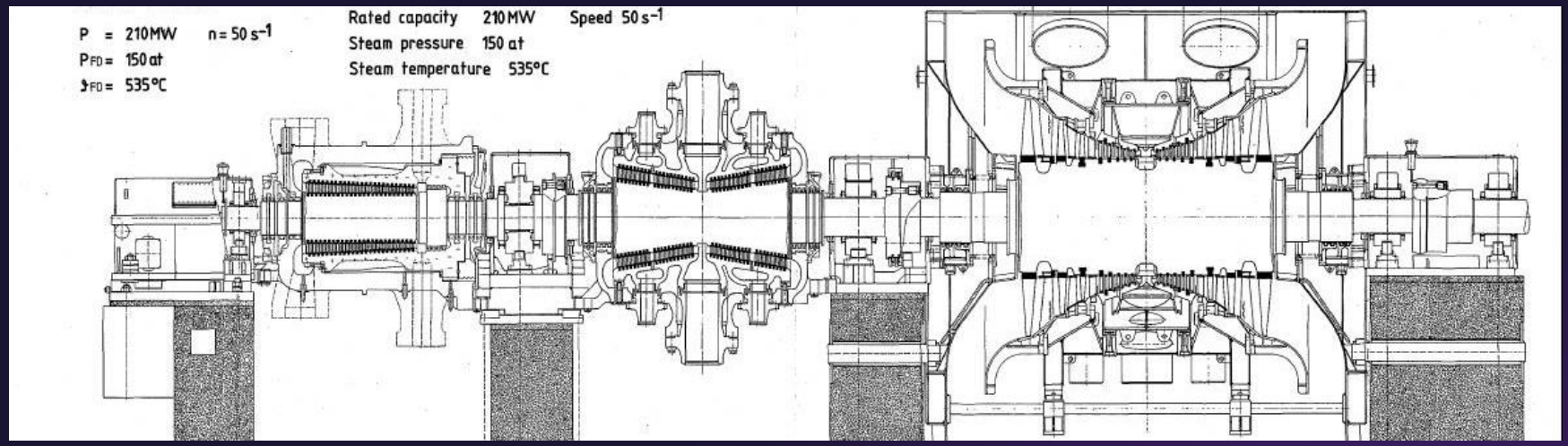


Scope of Work:

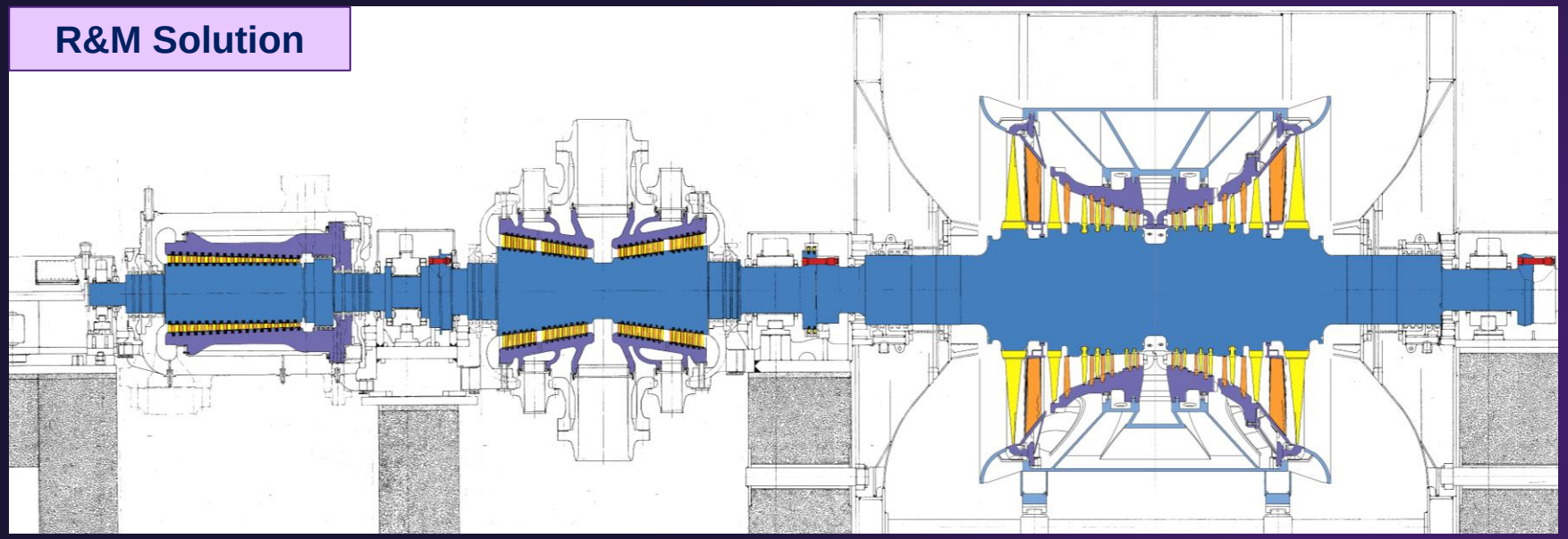
- HP, IP Full module and LP Inner module replacement
- HP, IP Valves, Bearings replacement
- Mechanical Auxiliary Systems Modernization
- MS, HRH, CRH Piping adaptations
- Aux. Systems Piping
- New Turbine Control system
- Electrical System Modernization

- Too many interfaces with existing system / equipment
- High price
- Unknown Risks
- Huge shutdown period, generation loss

Comprehensive R&M “Shaft-line Upgrade”
Applicable for SIEMENS-KWU 210/500MW Units



R&M Solution



Scope of Work:

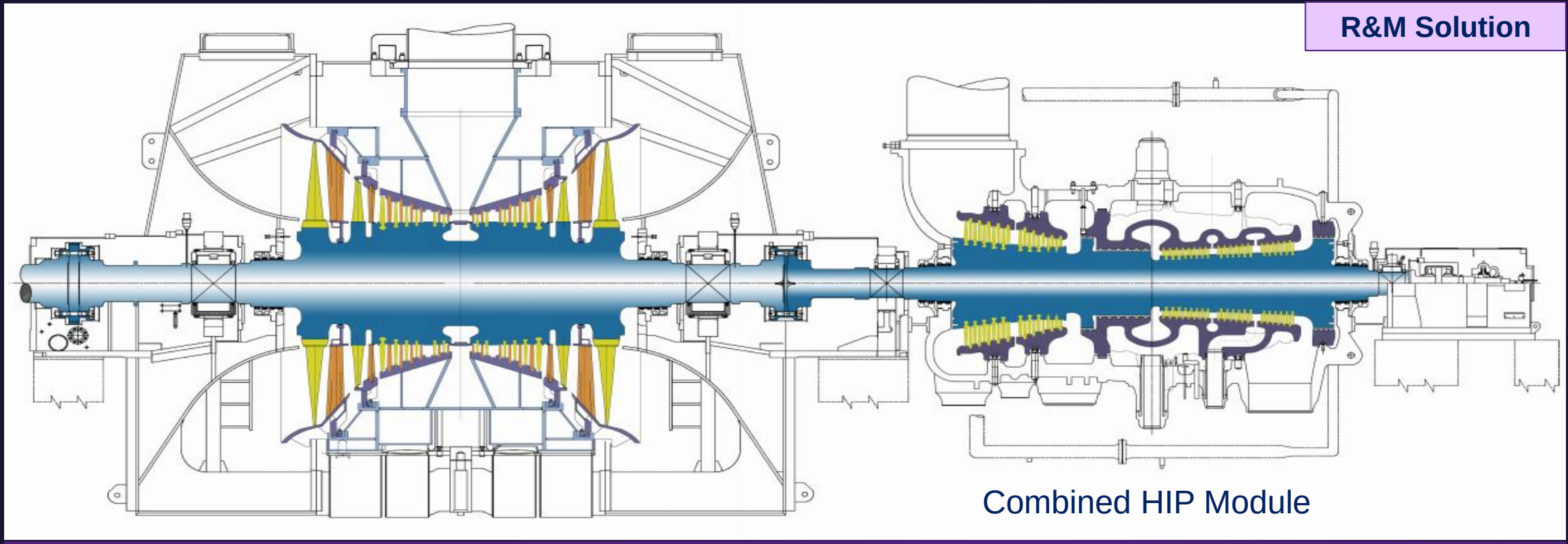
- HP, IP, LP Inner module replacement
- Retain HP, IP Valves, Bearings, Pedestals, etc.
- No mods & upgrades on Mechanical Auxiliary Systems
- No piping modification required
- Control system settings updates, if needed

- Limited interfaces with turbine components, controlled risks
- **~50% lesser cost & shutdown period**

Comprehensive R&M “Shaft-line Upgrade”
Applicable for Chinese OEM Make 135MW / 300MW

SIEMENS energy

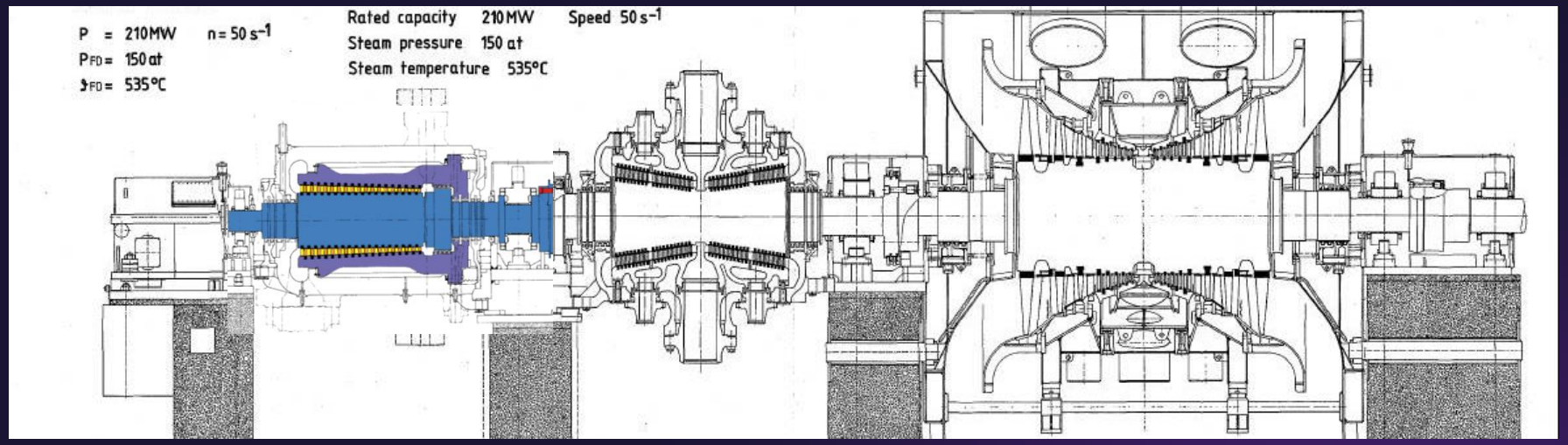
R&M Solution

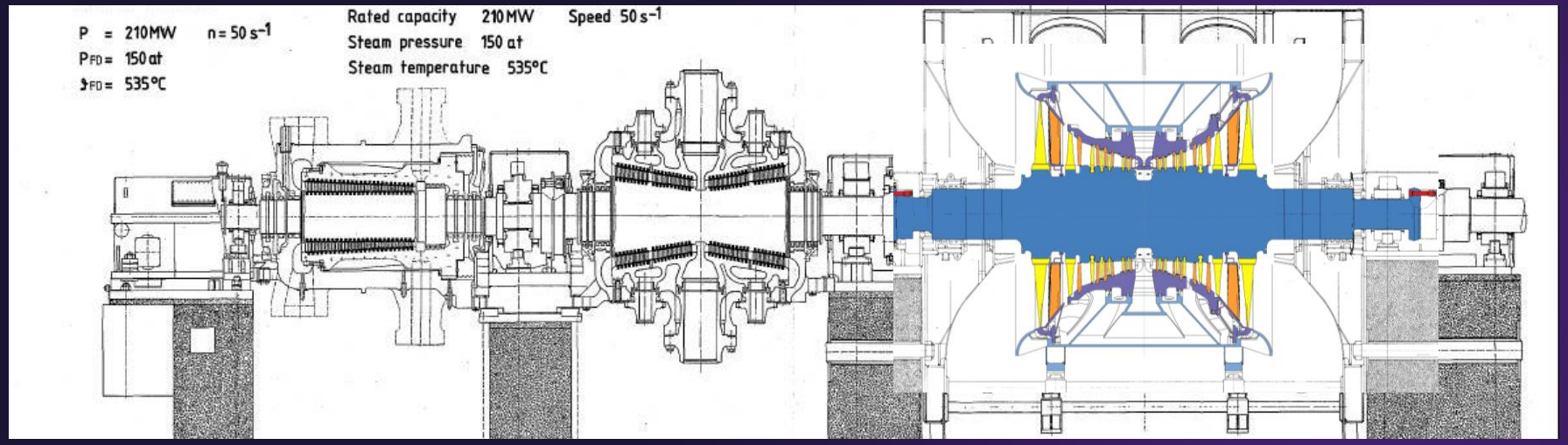


Combined HIP Module

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

Need-basis R&M
Module Level Upgrade / Modernization

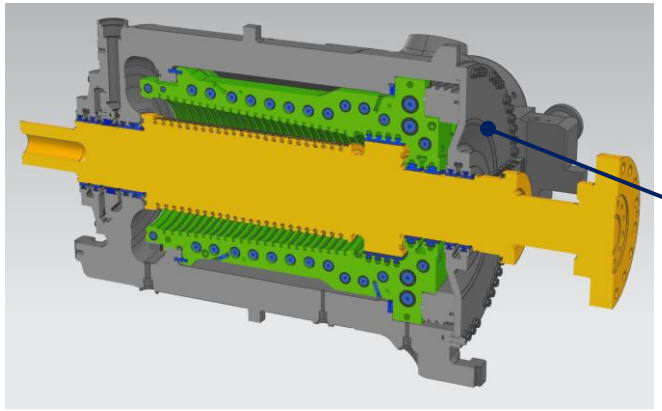




- Individual turbine modules upgrades for efficiency, life-time extension
- Less interfaces with existing components, so lesser risks
- Much shorter erection outage – reduced generation loss
- Quick turn-around of the projects – lesser tendering and execution time

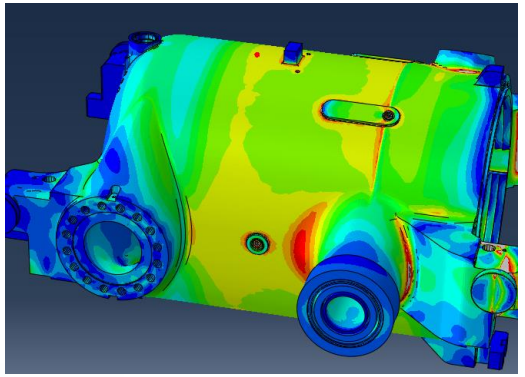
R&M Scope Optimization (KWU)
HP, IP Turbine Outer Casing

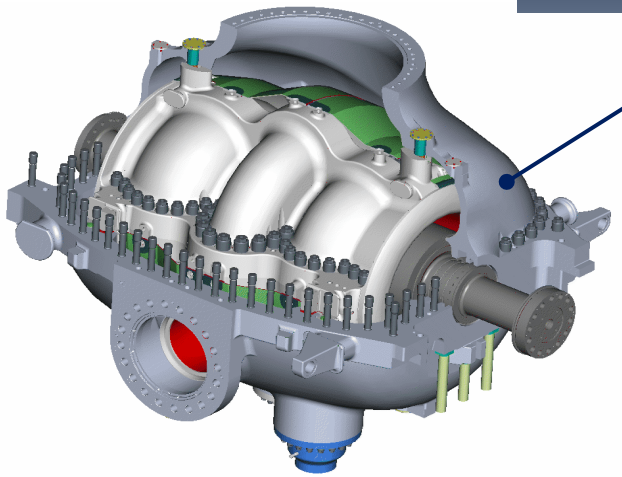
- **Ref ~30 years old Unit -** Assessment based on FE Analysis, previous references and RLA reports
- IP Outer casing is not exposed to creep temperature (~300 °C) and hence, no creep degradation.
- FE analysis using conservative operating regime and no. of start-ups
- As per RLA reports - No cracks and no microstructure damage
- **HP Outer casing estimated to have a residual design life of approx. 20 years**
- **IP Outer casing estimated to have a residual design life > 20 years**
- NDT assessment to be done after every 100,000 EOH



HP Outer Casing

Predicted damage shows residual life availability
Estimated Residual Life: ~20 Years

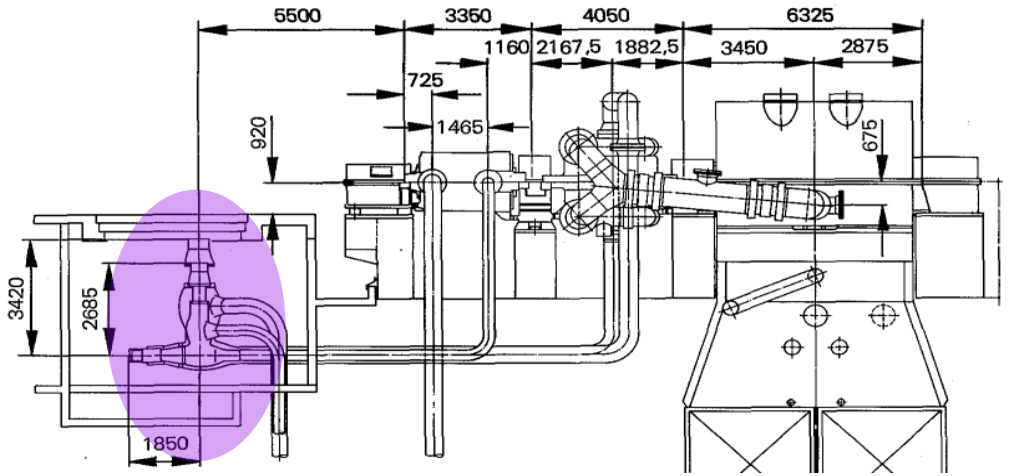


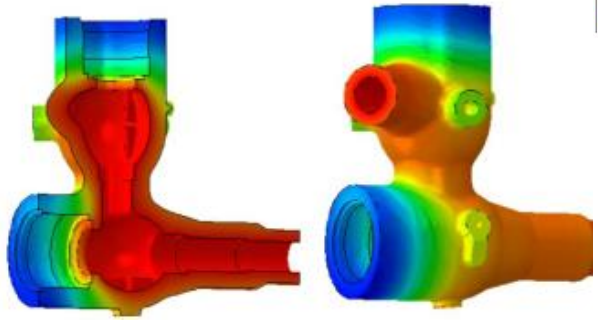


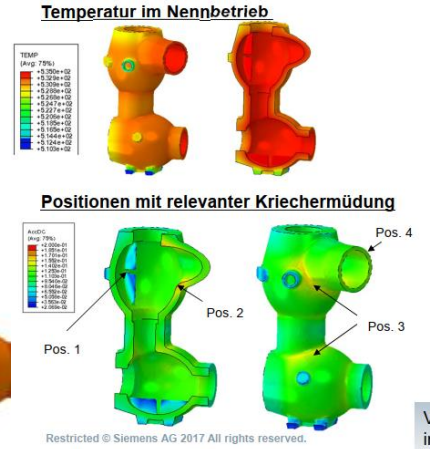
IP Outer Casing
Max. temp: ~300 °C

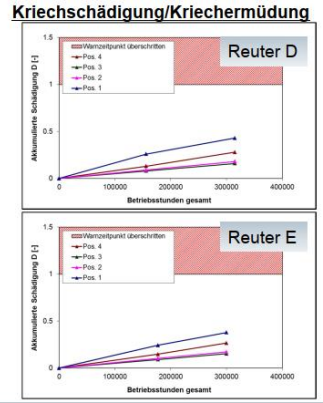
R&M Scope Optimization (KWU)
HP, IP Stop & Control Valve Casing

- Evaluation done on a reference project valve (similar size) shows design life of 320,000 EOH
- **HP Valve**
  - As per RLA reports – approx. 55% design life consumed
  - Remaining design life ~45%, equivalent to ~18 years of operation
- **IP Valve**
  - Utilization factor of 0.5 for 320,000 EOH
  - Expected remaining design life of >20 years
- Regular NDT every 50,000 EOH, with repairs if required, will increase design life further









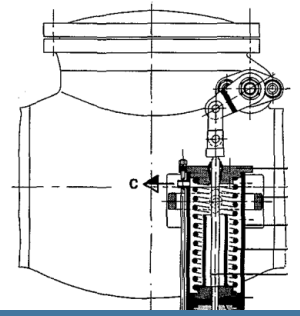
Vorhergesagte Kriechschädigung und Ermüdun
in relevanten Bereichen zulässig

Expected Design Life of HP Valve Casing ~18 Years & IP Valve Casing >20 Years

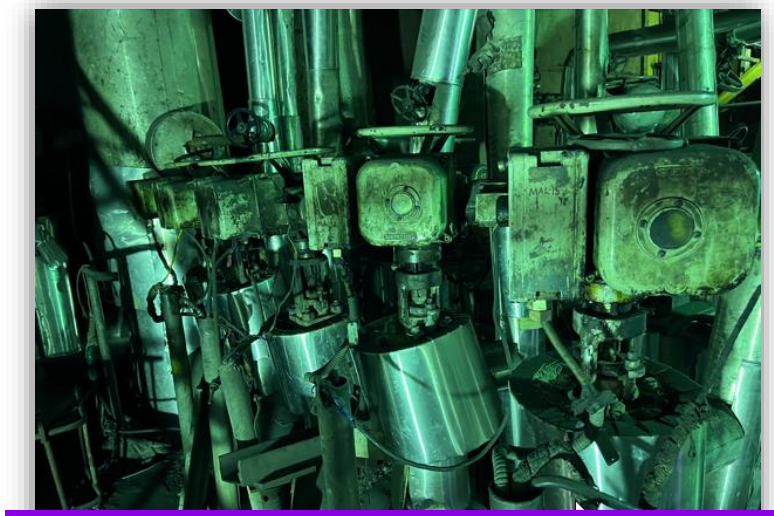
R&M Scope Optimization (KWU)
Turbine Auxiliary System

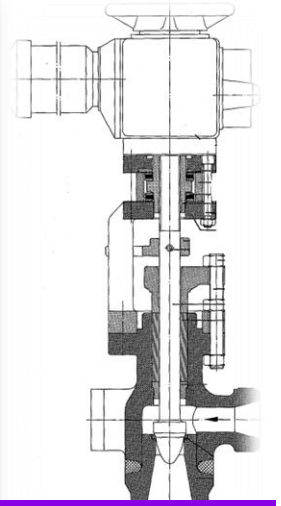
Retain: Lube Oil, Jacking Oil, Control Oil Systems

Retain: Gland Seal System and Piping



Retain: CRH & Extraction NRVs





Replace: Turbine Drain Valves

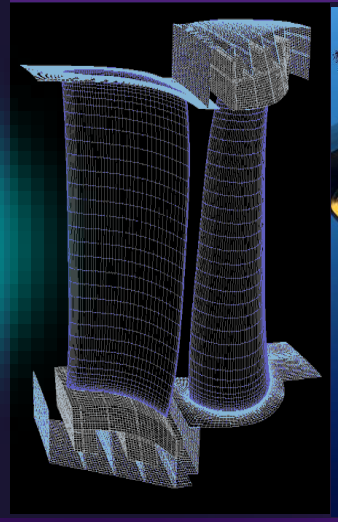
Advanced Technology Features

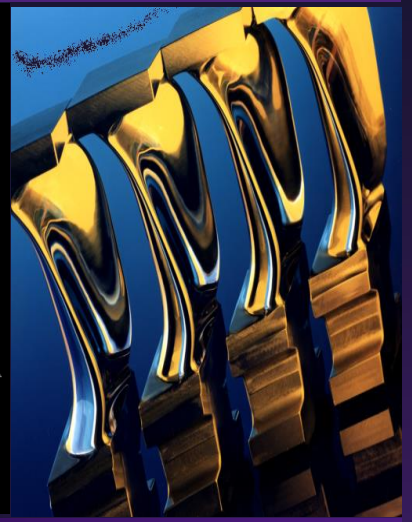
SIEMENS energy

T4-Blades

+ ~3%

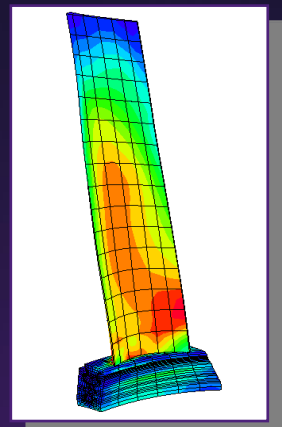
3DS™ Blades

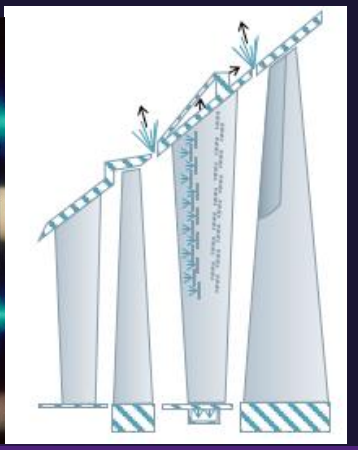




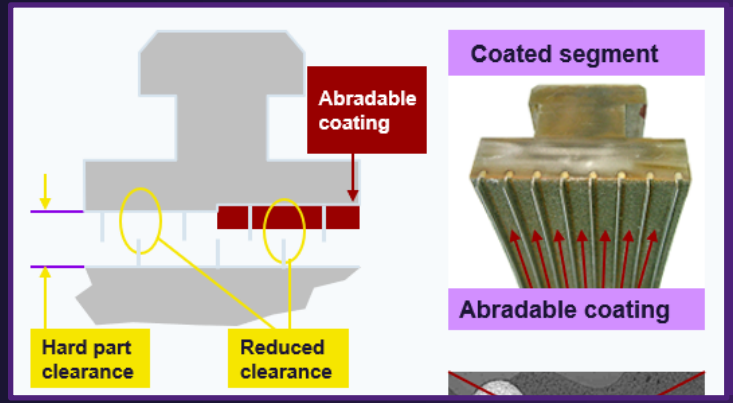
- Significant increase in efficiency
- Flexible solution offering a wide range
- Customized designs → highest performance

LP Last Stage Blade





- Optimized last stage blade size
- Optimized LP exhaust area
- Stage De-wetting, Hardening of La-0, Suction Slot in Le-0

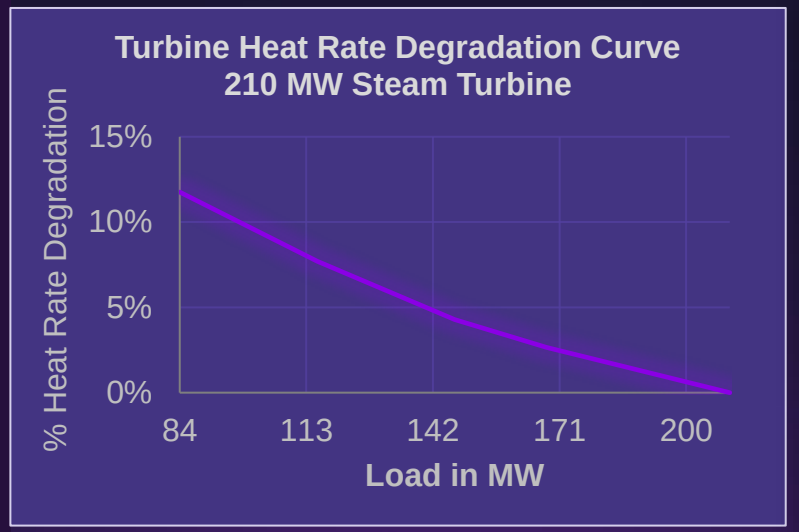


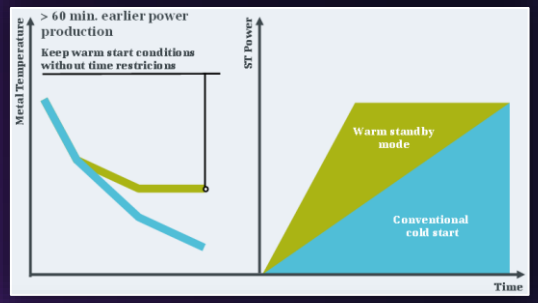
Abradable Seals

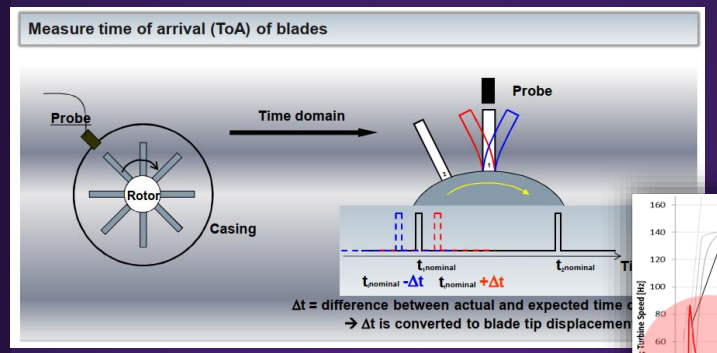
- Increased efficiency and power output(~0.3%)
- Increased operational safety
- Proven and sustainable design

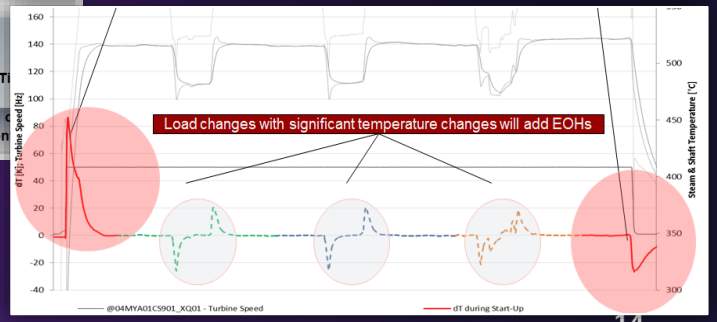
Advanced Technology Features
Optimized Performance with Flexible Operations

- **HP, IP Steam-path Optimization** for efficiency at part-loads (~0.4% improvement at ~70-80% load)
- **Optimized LP LSB** for low-load operations
- **Blade Vibrations Monitoring System (BVMS)** for safe low-load operations
- **Electrical Heating System** on turbine casings for fast start-up and high ramp rates
- **Lower Turbine Performance Degradation** with higher grade materials
- **Thermal Digital Twin** for long-term performance monitoring
- **EOH Counter** to monitor life consumption for start-up and load changes









Policy Interventions Needed

❖ Push from authorities required to develop more R&M opportunities

- More projects would lead to better learnings, that would lead to scope and performance optimization and with higher value addition

✓ Compensation package for utilities

❖ Evaluation Method

- Reverse Auction (e-RA) for selection of L1 bidder – Leads to imbalance between best technology vs. best price

✓ Loading due to additional evaluation parameters – Outage schedule, quality parameters, part-load performance, past experience

❖ Long-term Performance Guarantee

- Performance guarantee after 1, 3 and 5 years
- Higher value for customers

✓ Digital solutions could be implemented to monitor and control long-term performance

Thank You!

Shekhar Thakur
Chief Manager - Sales Consulting
Siemens India, Service and Digital
Phone: +91 9899696090
shekhar.thakur@siemens.com
siemens-energy.com