

GPPS Forum23

Reducing Emissions on Industrial Gas Turbines through Additive Manufacturing

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How AM can contribute to Decarbonized World and Energy Transition ?



GT's sustainable value & flexibility generated by AM technology

Business Value Improvement



Generated value:

- **Efficiency improvement** to reduce Emissions and OpEx
- **Longer Life** of GT-components to **reduce Lifecycle cost**
- Operation **flexibility enhancement**
- **Increased** Power Plant **Profitability**

Lead Time Reduction



Speed:

- **Rapid development**, prototyping, validation and manufact.
- Spare Parts **on Demand**
- **Quick response** to Customer demands

Environmental Contribution



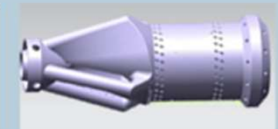
Sustainable value:

- **30% less carbon footprint** due to less waste materials and transportation
- **Fuel Flexibility** (e.g. , **biofuel**, **H2**, towards zero CO2)
- **Energy efficiency** enhancement (more Power for less fuel)
- **Opportunity** for AM components **re-cycling**

Fuel flexibility enabled by AM



AM burners enabling H₂



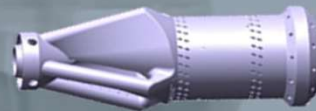
- 2x SGT-600 DLE Sold to Braskem – Brazil
- In operation beginning of 2022
- **60% H₂** content in natural gas



AM burner design and manufacturing for fuel flexibility, emission reduction and lifetime extension

Approach

- Redesign of existing burners for SGT-600 / 700 / 800 to utilize the design freedom offered by AM
- Long-term validation in real engine condition



Conventional

- 13 parts / 18 welds
- TBC on front

AM burner

- 1 integrated part
- No TBC
- Fuel flexibility
- H2 capability



Additive Manufacturing as a Key Enabler

GT efficiency enhancement by Additive Manufacturing

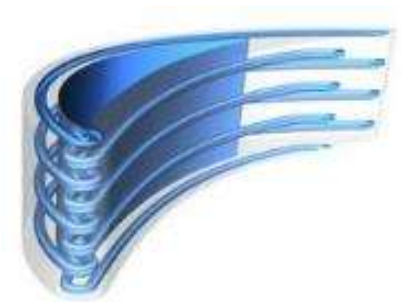
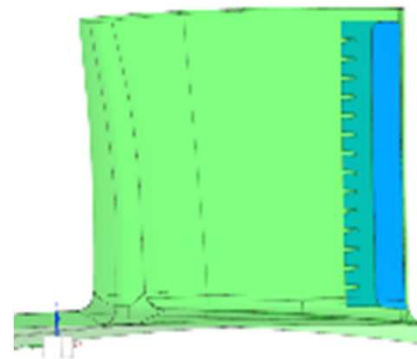
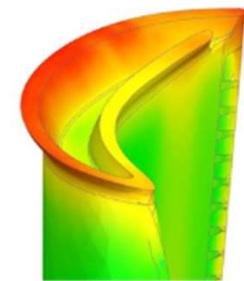
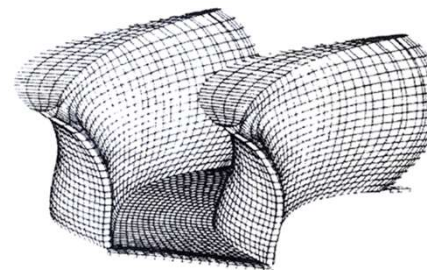
Key approaches for GT efficiency improvement:

- **Turbine blades and vanes aerodynamic enhancement**

- 3D airfoils profiling w/o any geometry limitation (compared to casting)
- Thin trailing edge
- Cooled light-weight shrouds / winglets

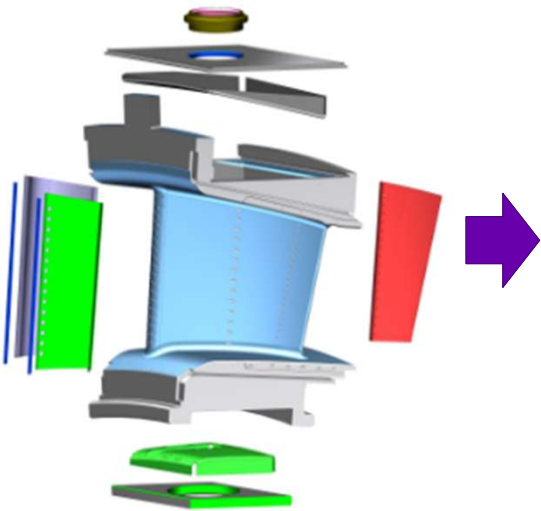
- **Blades & Vanes Cooling air saving**

- Less cooling air for blades and vanes to improve turbine efficiency

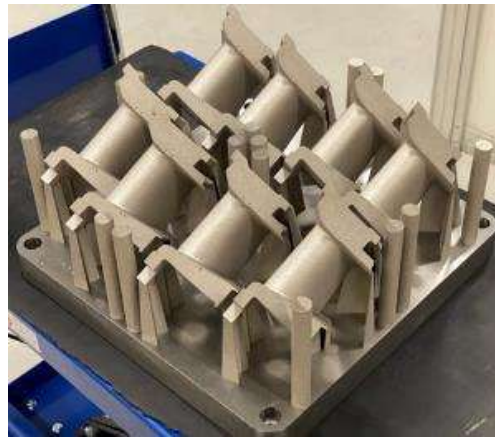


GV1 AM Design and Manufacturing

Conventional casted vane



8x Vanes printed



Printed vane machined



Printed vane coated



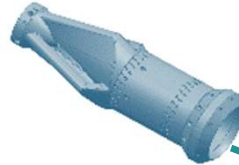
- 12 -> 1 Part
- Reduced cooling -30%
- Leadtime - 6 months
- Performance improvement

SGT-700 – Additively manufactured for higher efficiency and fuel flexibility Components Validation



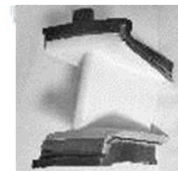
Burners:

- Fuel flexibility
- H2 capability



GV1:

- Performance improvement or life extension



HS1:

- Performance improvement or life extension
- Reduced perform. degradation

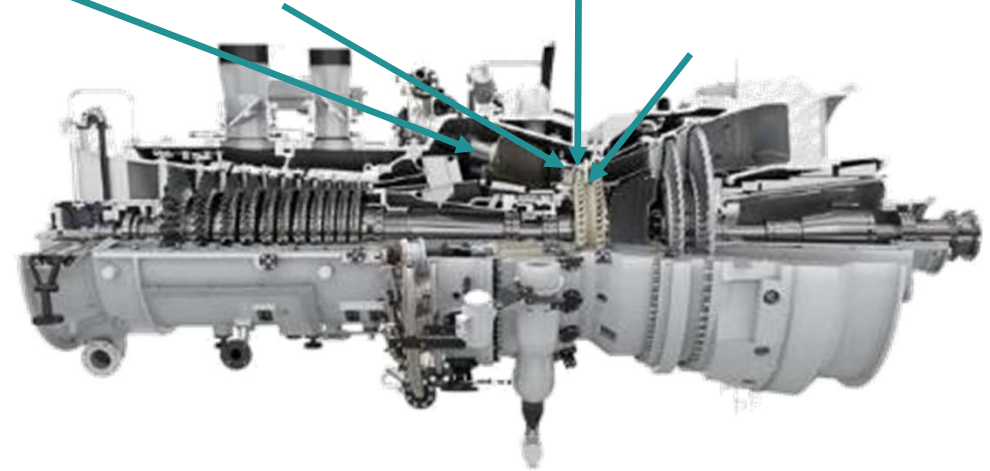
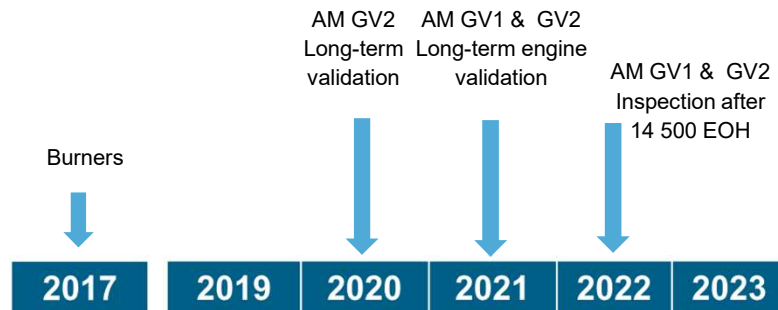


GV2:

- Performance improvement or life extension



AM Component field Validation



AM Components Test & Validation

Materials and design long-term validation in real engine condition



- **AM Materials long-term Validation:**

- SGT-1000 (V64.3) engine (68MW) Conventional robust turbine vanes 1 design, but additively manufactured from In939 (with similar coatings) were installed in customer engine for long-term material validation:

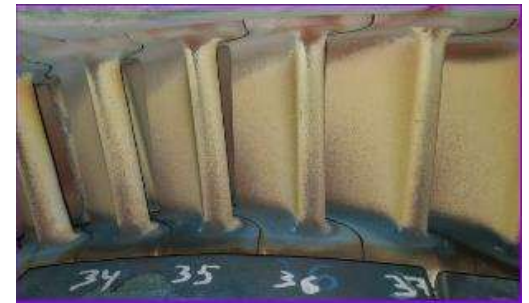
- Inspection after 24 000 EOH shows that vanes are in a good condition

- **AM Vanes design long-term validation:**

- SGT-700 GV1 and GV2 Long-term validation in a customer engine

- Inspection after 14 500 EOH shows that vanes are in a good condition

SGT-1000 AM GV1



SGT-700 AM GV1



GV2

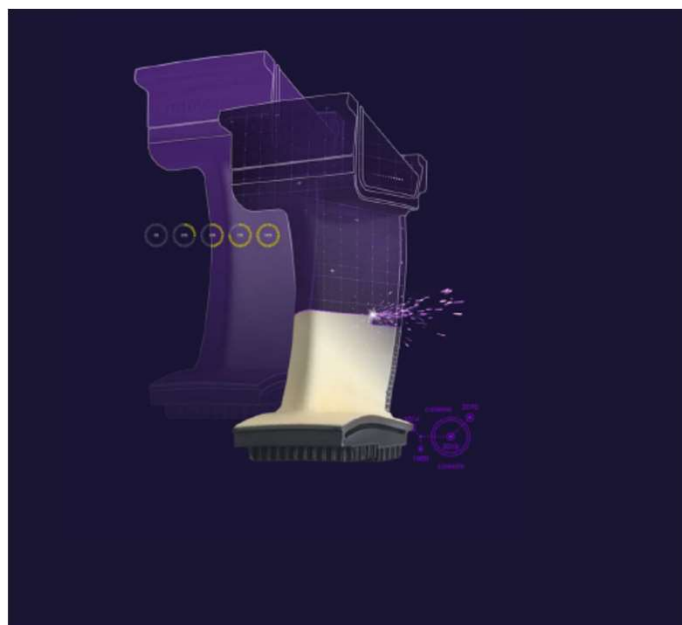


Summary



- Gas turbines will play a very important role in the **future energy market** and therefore high efficiency and low emissions GTs will be needed
- **Demand for higher contents of H2 and green fuels will be increased**
- **Additive manufacturing accelerate** GT performance & fuel capability enhancement and installed **fleet decarbonisation**
- An open and trustful OEM & Operator **cooperation** is crucial to accelerate innovation infusion into the installed fleet

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