



# Additive Manufacturing at MTU

1<sup>st</sup> Munich Technology Conference on Additive Manufacturing

10/11/2017 - Michael Schreyögg – Vorstand Programme MTU Aero Engines AG

# Business model of MTU Aero Engines AG

## Commercial Engine Business

- Balanced portfolio of products in all thrust categories
- Partnerships with OEMs going back decades



OEM

Sales	EBIT adj.
<b>2,9 bil. €*  </b>	<b>0,3 bil. €*  </b>

Share in sales ~50%

## Military Engine Business

- European and U.S. engine programs
- Lead industrial partner to the German Armed Forces



Share in sales ~10%

## Commercial Maintenance

- Access to high-growth segments
- Provider of services to airlines worldwide



MRO

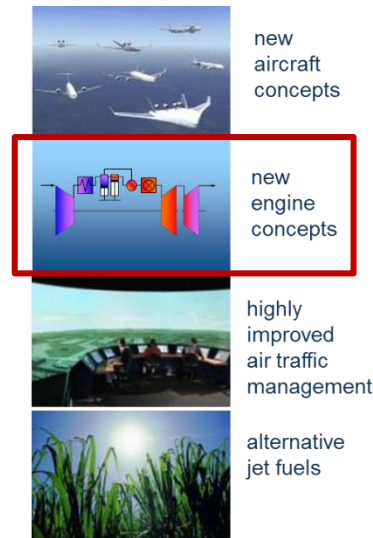
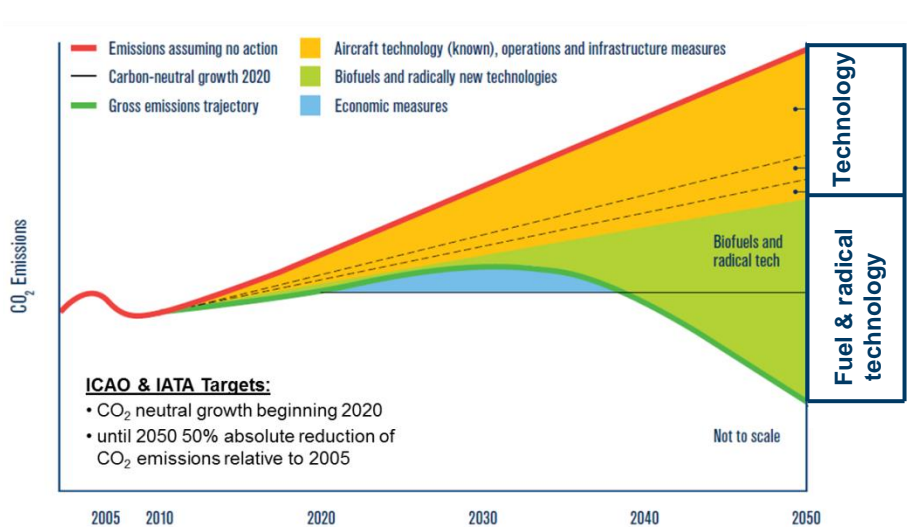
Sales	EBIT adj.
<b>1,9 bil. €*  </b>	<b>0,2 bil. €*  </b>

Share in sales ~40%

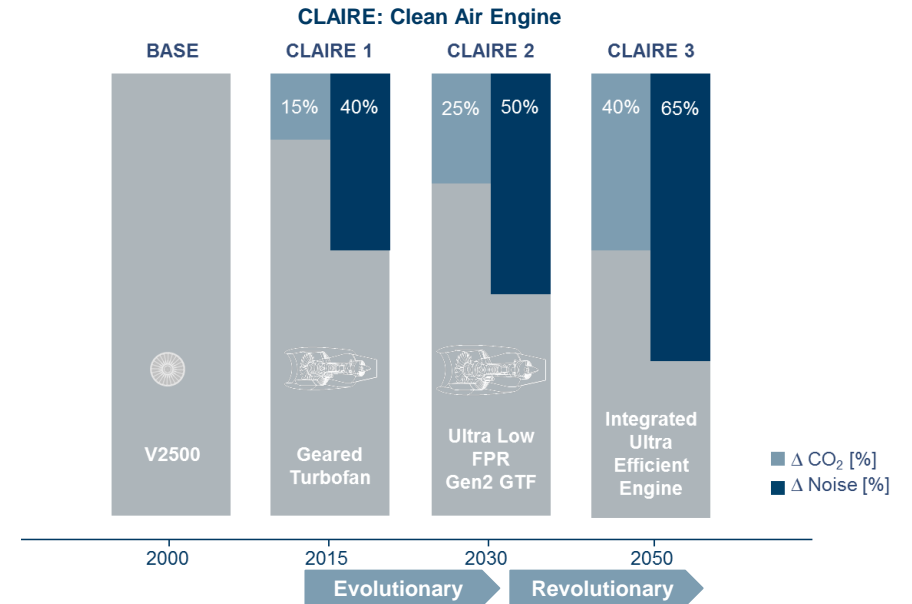
\*Fiscal Year 2016

# Demanding targets for civil aviation require a strong contribution on the engine side

## Flightpath 2050: carbon emission targets



## MTU-Roadmap supporting 2050 targets



- Long-term growth in aviation calls for efficiency, environment protection and noise reduction
- Evolutionary designs in support of 2030 targets: conventional engines with increased AM part share



# AM parts contribute to reduce fuel burn through bionic designs and functional improvements



**Fuel Burn** ~ **Weight** ×  $\frac{sfc}{L/D}$  × **Time**

$$\sim \frac{1}{\eta_{th} \eta_{prop}} \Rightarrow$$

- Thermal efficiency:**
- Increased overall efficiency
  - Lower demand for cooling air
  - Increased overall pressure ratio



- Propulsive efficiency:**
- Reduced Fan Pressure Ratio
  - Increased Bypass Ratio

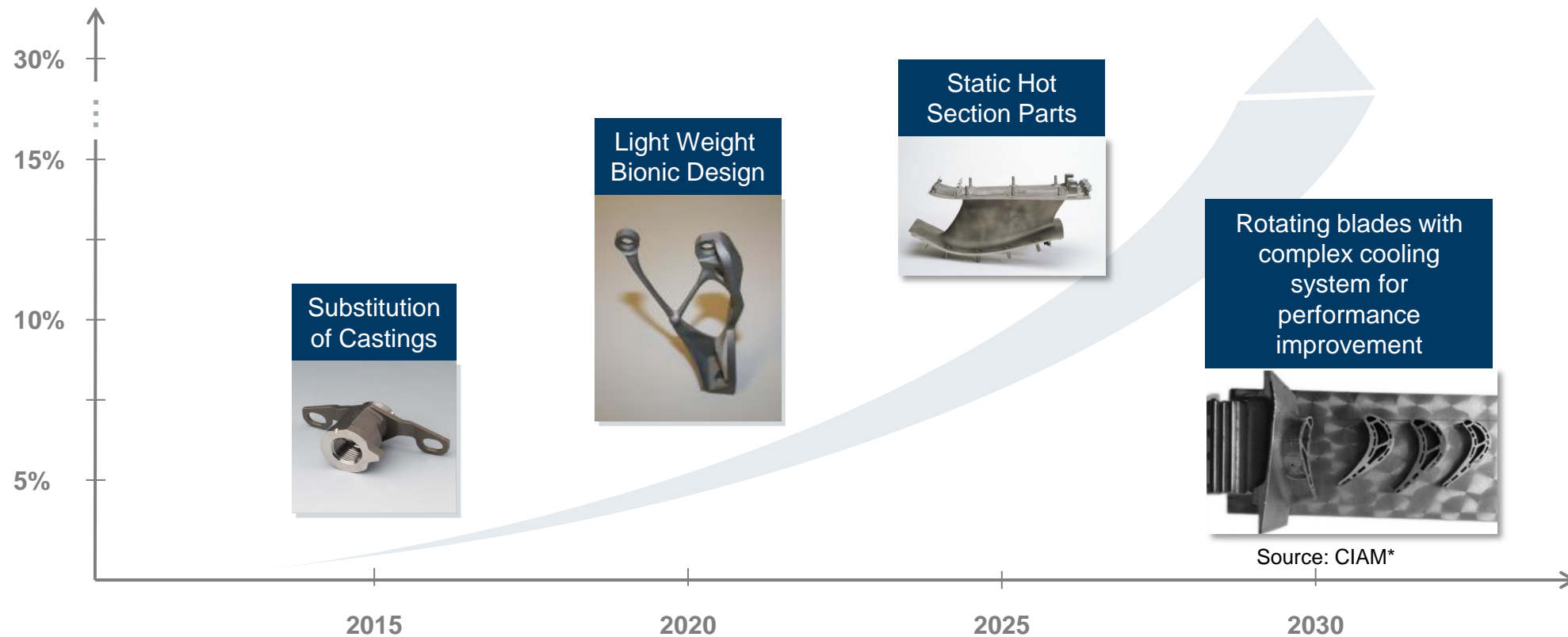
- Low weight structures**
- Bionic designs
  - Lightweight structure and materials



**High Lift/Drag**

➤ **Higher design complexity and more sophisticated manufacturing capabilities**

## Increase of complexity and share of AM parts in aero engines until 2030



- In 2030 a typical narrowbody engine will contain 15% of AM parts
- Expected weight reduction of 100kg per engine could lead to a reduction of fuel burn by 45 tons kerosene per aircraft and year

\*Central Institute of Aviation Motors, Moscow

## Challenges and Expectations

Criteria	Today	Needed	When
Cost of powder	100% (and US supplied)	Min. -40% (and non-US supplier)	2019
Establish design rules and competence	Substitution of castings	Bionic design and functional improvements	2020
Build-Up Rate	10 cm <sup>3</sup> / h	100 cm <sup>3</sup> / h	2021
Improved surface quality out of the machine	Ra 12 µm – 80 µm (depending on surface direction)	Ra 3 µm	2022
Further development of online process control	Lack of fusion	Hot cracks and porosity	2023

➤ **Further cost reductions and quality improvements required for extended economical production**

## Summary



- **Cost reduction** at relatively low batch sizes
- **New and innovative design** approaches to reduce weight and improve functionality
- **Competitiveness**

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