

A nighttime photograph of a city skyline, featuring a prominent skyscraper with a glowing spire and illuminated facade. The sky is dark blue with some clouds. The skyscraper has a distinctive triangular top section and a long, thin spire that is brightly lit. The building's facade is dark, but several vertical columns of light are visible. Other buildings in the background are also lit up, creating a vibrant city scene.

CRITICAL MATERIALS FOR

# THE NEW MILLENNIUM

**AMG**

AMG Advanced Metallurgical Group N.V.  
Annual General Meeting 2017  
AMG Engineering – Aerospace Developments

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# AMG PRODUCTS – MAKING AIR TRAFFIC MORE EFFICIENT

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Increasing air traffic around the world generates an impact on the global environment



Major influencing factors are:

- Emission of CO<sub>2</sub>
- Emission of noise

AMG is at the forefront developing solutions for these negative effects and is largely involved in new developments in this matter.

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# AMG PRODUCTS – MAKING AIR TRAFFIC MORE EFFICIENT

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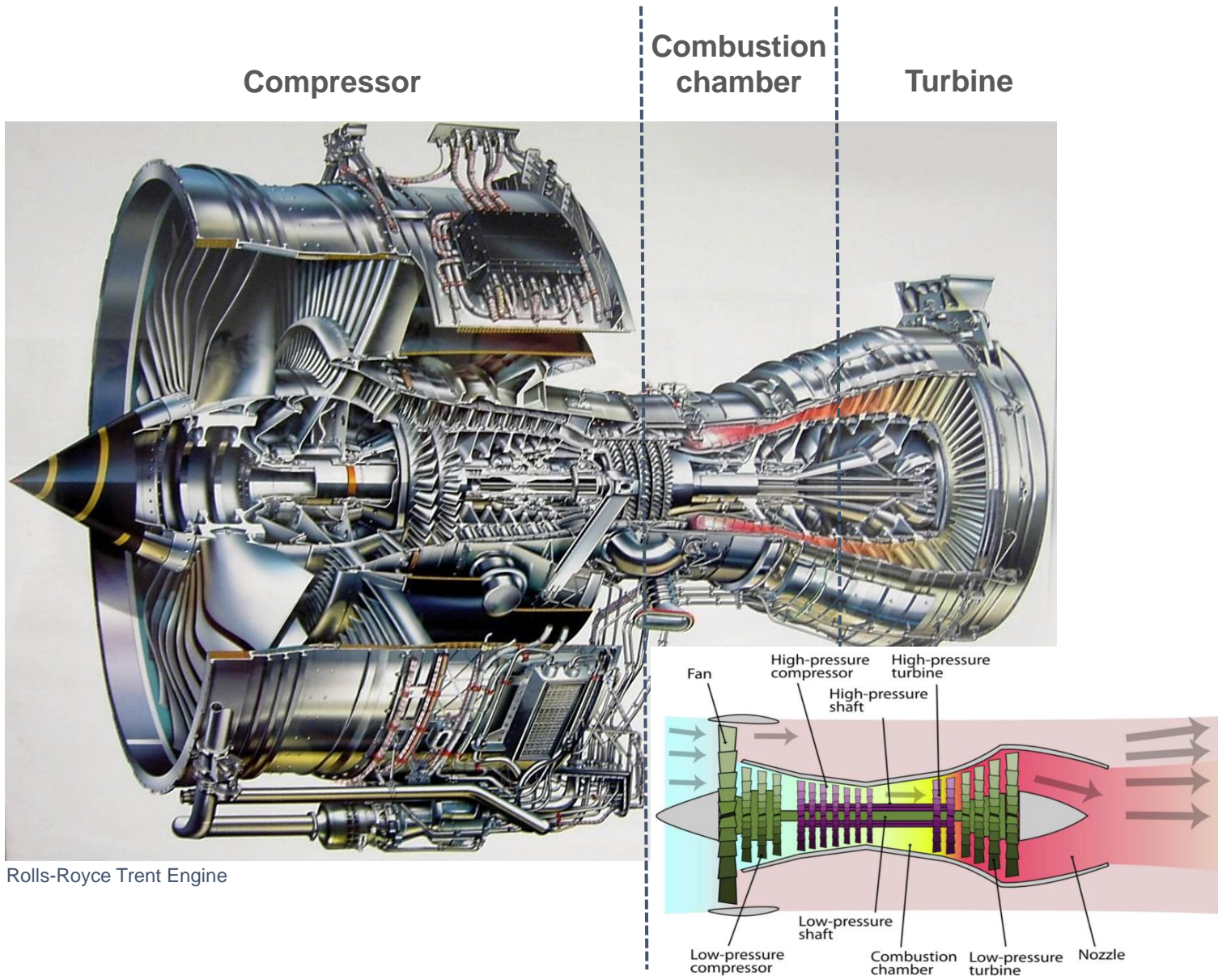
## Environmental Objectives of Global Aviation Traffic

*compared with the year 2000*

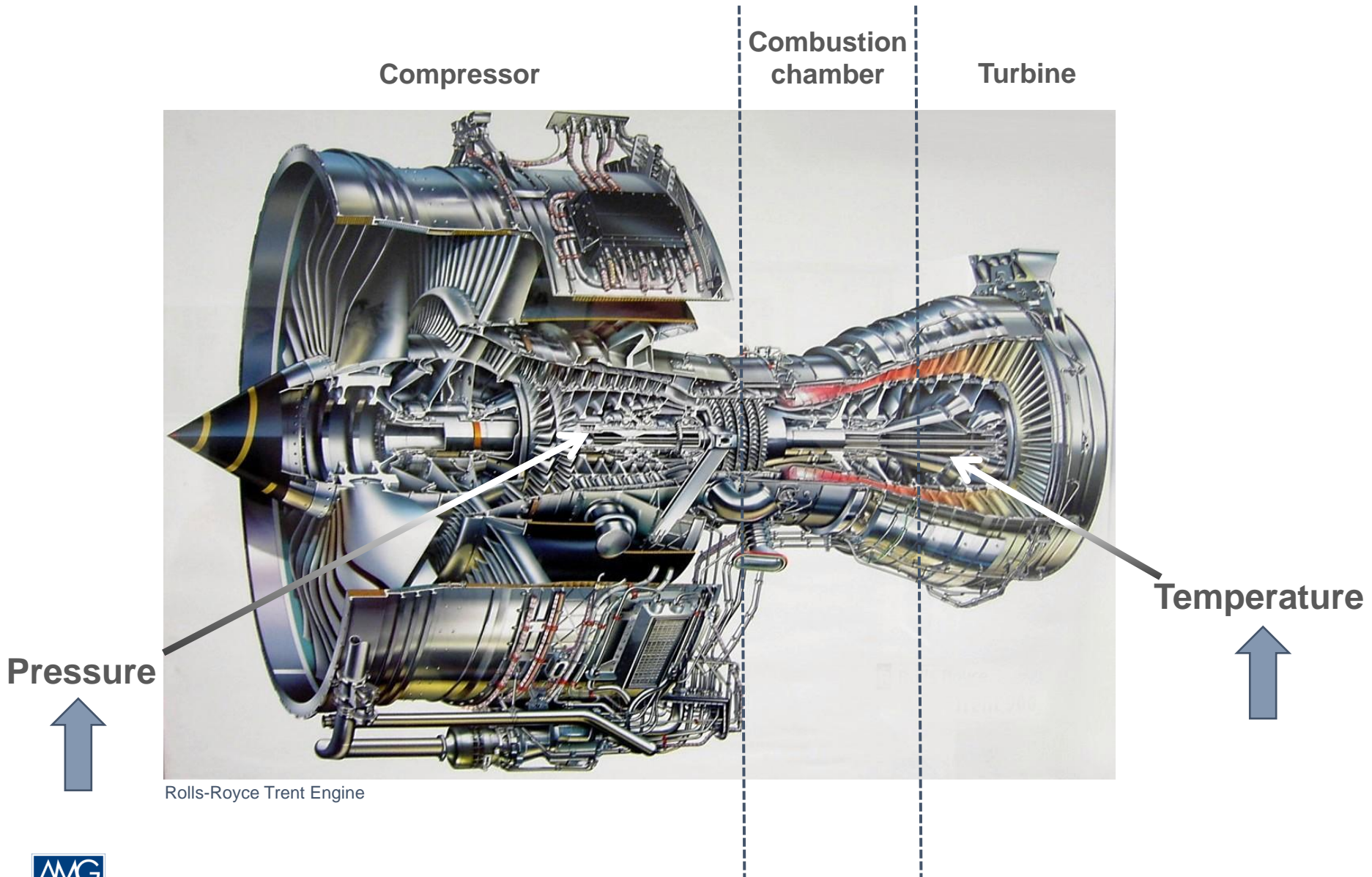
Strategic Research and Innovation Agenda (SRIA) of the European Forum for Aviation Research ACARE (Advisory Council for Aviation Research and Innovation in Europe)

	SRIA 2035 Targets
CO <sub>2</sub> Emissions and Fuel Consumption (per pkm)	- 60%
NO <sub>x</sub> Emissions (per pkm)	- 84%
Noise Emission/aircraft (Decibel)	- 55% (-11dB)

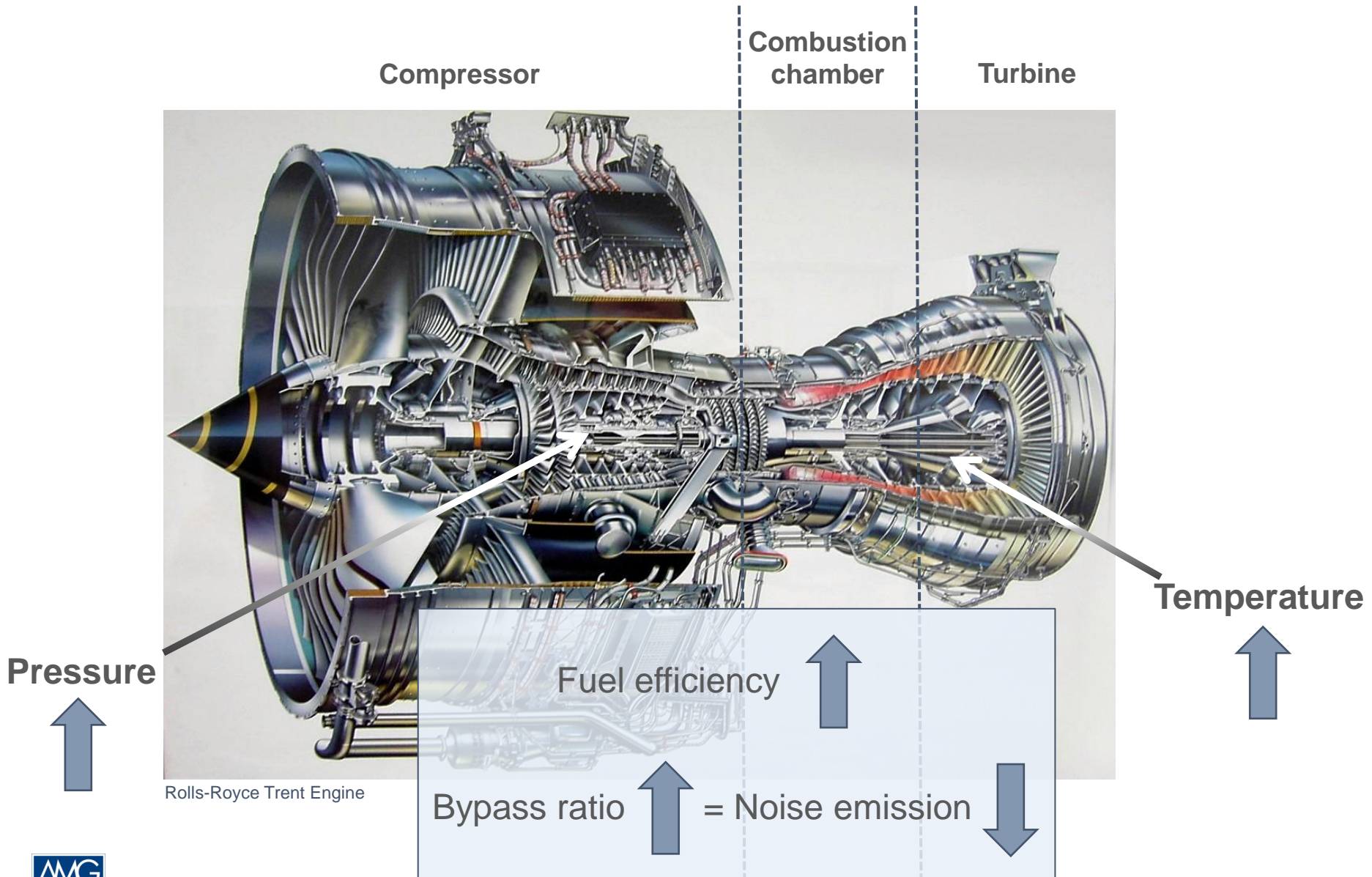
# AMG PRODUCTS – THE THERMODYNAMICS OF A JET ENGINE



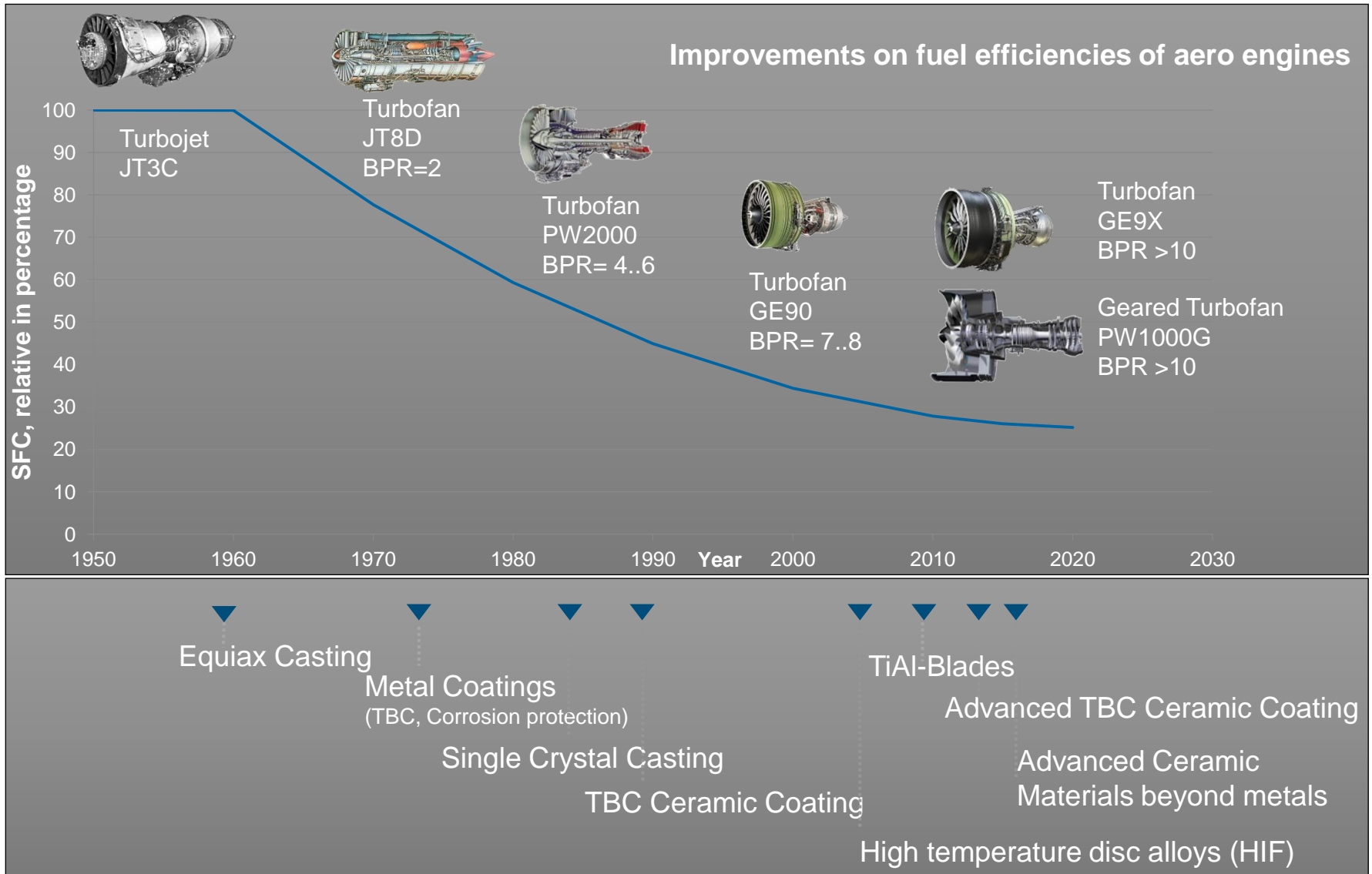
# AMG PRODUCTS – MAKING A JET ENGINE MORE EFFICIENT



# AMG PRODUCTS – MAKING A JET ENGINE MORE EFFICIENT

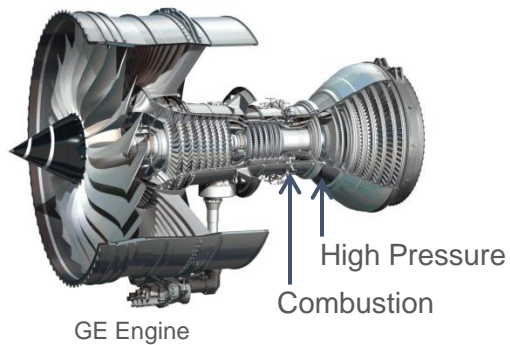


# AMG ENGINEERING'S INNOVATIONS FOR THE ENGINE INDUSTRY



SFC: specific fuel consumption    BPR: bypass ratio  
 TBC: Thermal Barrier Coatings    HIF: Hot Isothermal Forging

# AMG PRODUCTS – MAKING A JET ENGINE MORE EFFICIENT



## THERMAL BARRIER COATING (TBC)

Allow turbines to operate above the melting point of the construction alloy

Estimated fuel saving is 1%<sup>1</sup>

In 2013, 3.1 billion passengers travelled by air and aircraft emitted  
705 million mt of CO<sub>2</sub>

**Enables ~ 800,000 mt CO<sub>2</sub> Savings per Year<sup>1</sup>**



# AMG PRODUCTS – WHERE WE ARE IN A JET ENGINE

## Compressor

### AMG TAC

- Vanadium-containing Master Alloys (e.g. Vanadium Aluminum)
- Molybdenum-containing Master Alloys (e.g. Molybdenum Aluminum)
- Multinary Master Alloys (e.g. AlNbSiTi)

### AMG Aluminum

- Aluminum Master Alloys (Fan Blades)

### AMG Engineering

- Titanium alloy melting equipment

## Combustion chamber

### AMG Superalloys UK

- Chrome Metal

### AMG Engineering

- Nickel alloy melting equipment

## Turbine

### AMG TAC

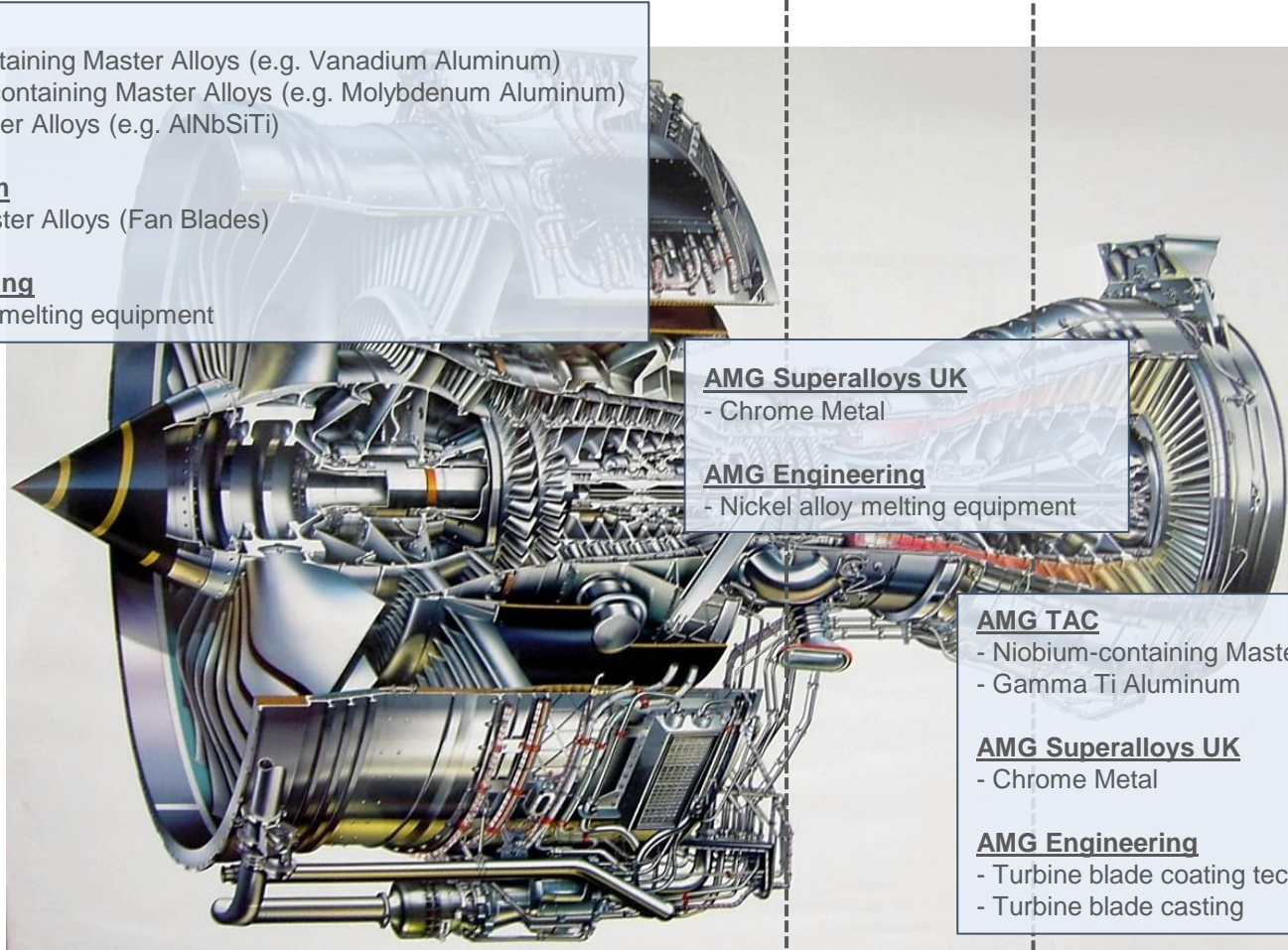
- Niobium-containing Master Alloys (e.g. Nickel Niobium)
- Gamma Ti Aluminum

### AMG Superalloys UK

- Chrome Metal

### AMG Engineering

- Turbine blade coating technology
- Turbine blade casting



Rolls-Royce Trent Engine

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# AMG – ENGINEERED SOLUTIONS FOR HIGH PERFORMANCE MATERIALS

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Plasma Arc Melting Technology for recycling of Titanium Alloy revert material.  
Saves approx. 90% of energy against the use of virgin material.