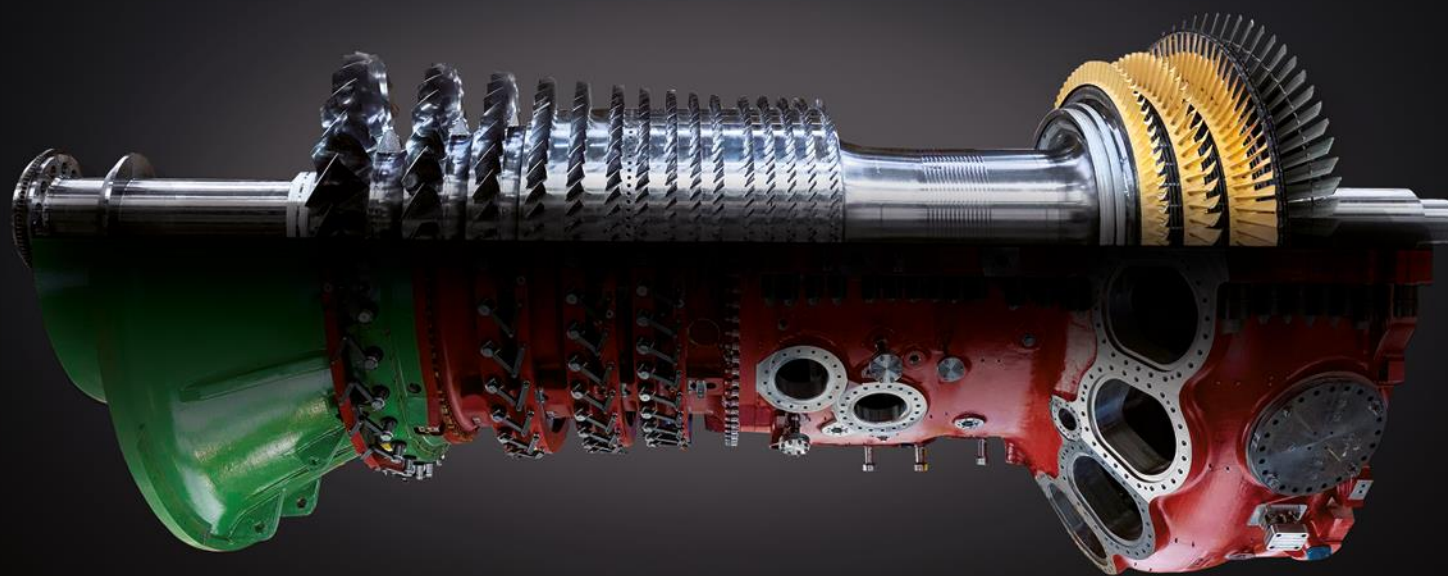


ITALIAN ENERGY

BRIGHTER FUTURE



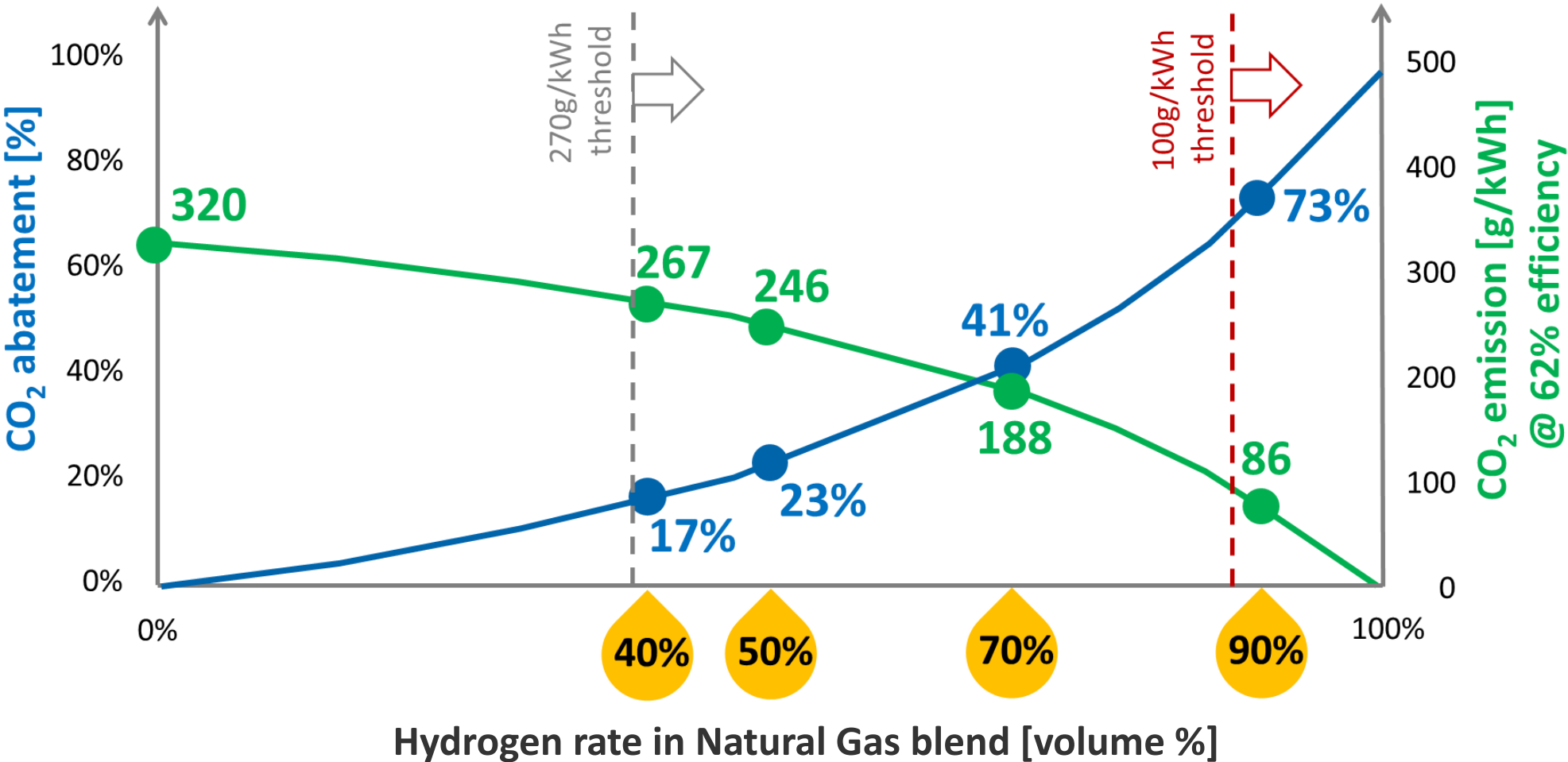
Prospettive della Combustione H2 nella Generazione Elettrica

June 8th , 2022 Hydrogen Expo

A.Silingardi, Product Development Program Director

**ANSALDO
ENERGIA**

Impact of H₂ volume on CO₂ savings



Operation with 90% H₂ in natural gas to achieve < 100g/kWh

Ansaldo Energia Current Portfolio for H₂ burning

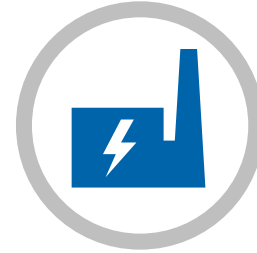
H₂ combustion technology portfolio on different GT classes for a wide array of applications



Gas Turbine



Current Capability* H₂



Application



Retrofit Solution

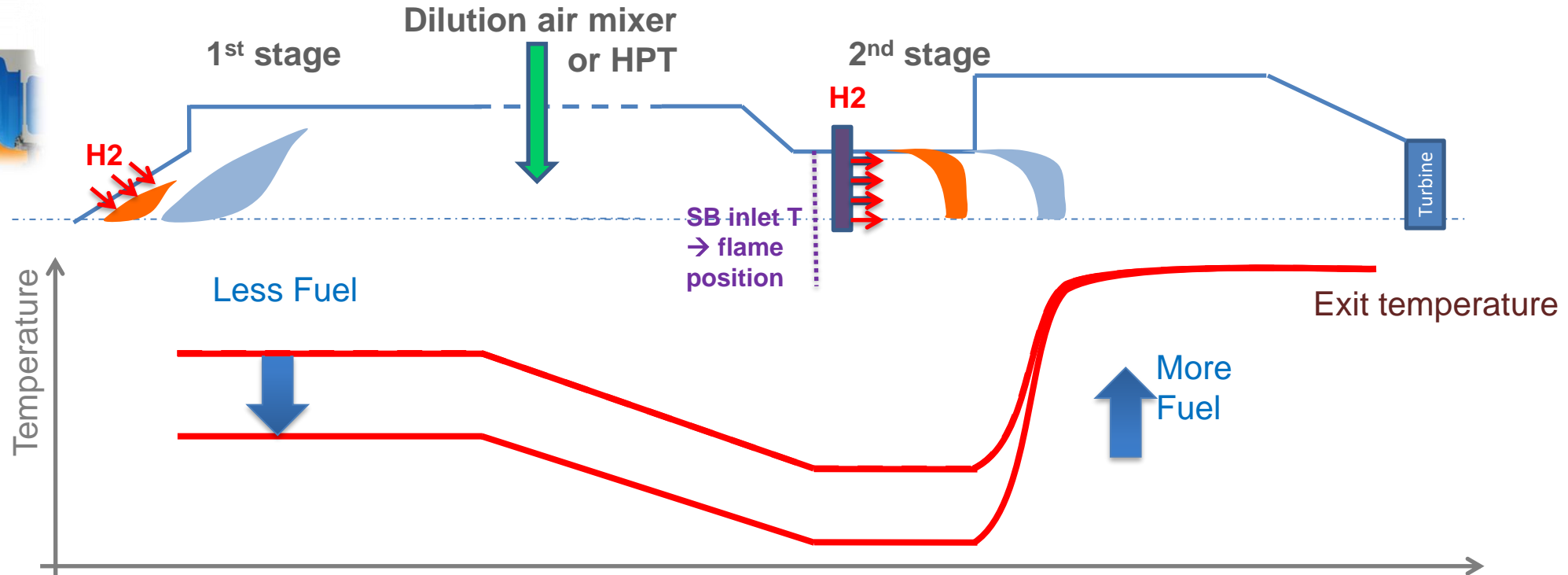
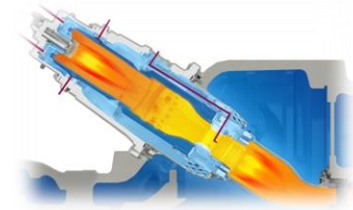
GT36	70% vol	Combined Cycle & Combined Heat and Power Plants	✓
GT26	45% vol		✓
AE94.3A	40% vol	Open Cycle, Combined Cycle & Combined Heat and Power Plants	✓
AE94.2	40% vol		✓
AE64.3A	40% vol		✓

*Dry premix combustion,
No dilution, **NG burner**

Standard hardware +
combustion tuning

H2 solutions available for new units and service engines

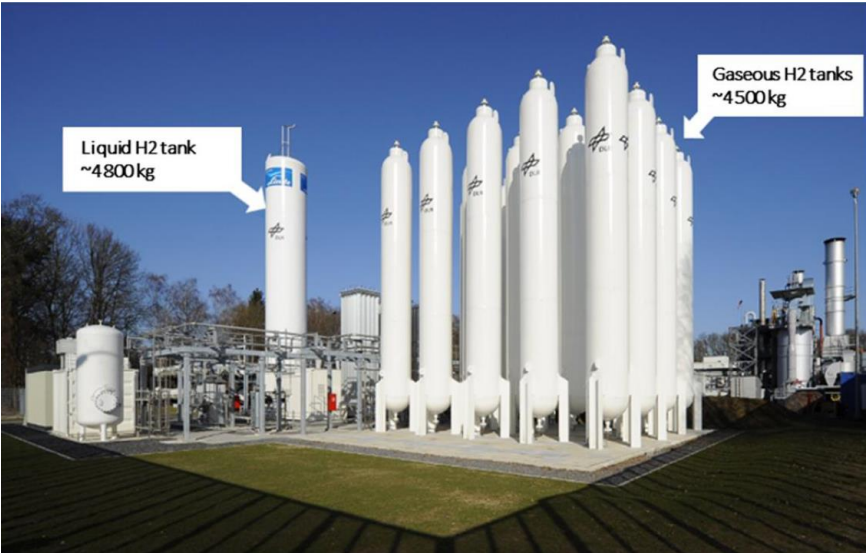
Reheat combustion advantage for highly reactive fuels



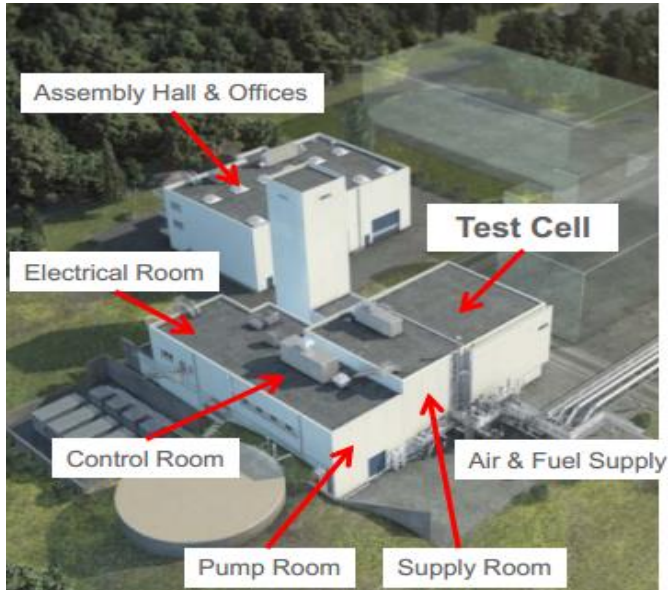
- Sequential combustion systems
 - Decrease of 2nd stage inlet temperature and not 2nd stage flame temperature
 - turbine inlet temperature not affected
 - 1st stage de-rating is compensated by shifting fuel to 2nd stage

Sequential combustor is an Ansaldo Energia key and unique feature in H class market

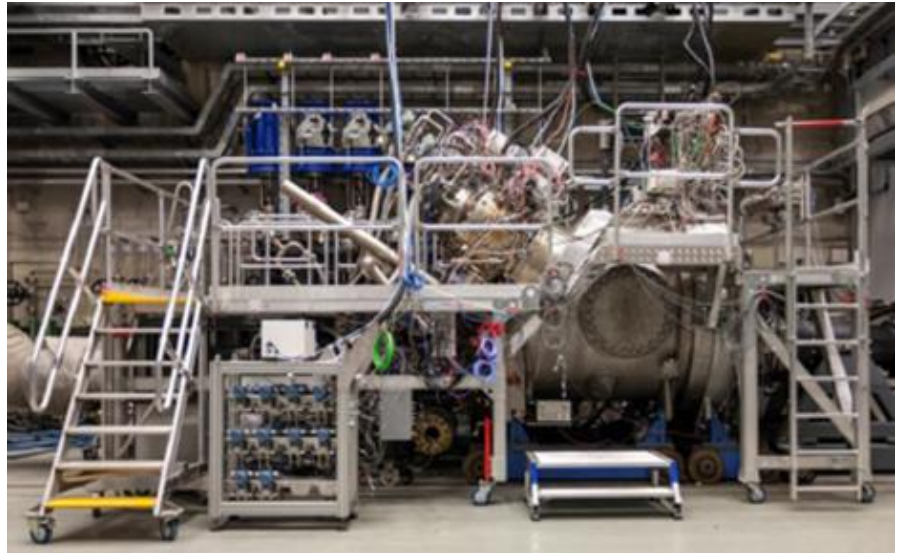
High Pressure Test Facility – DLR, Cologne



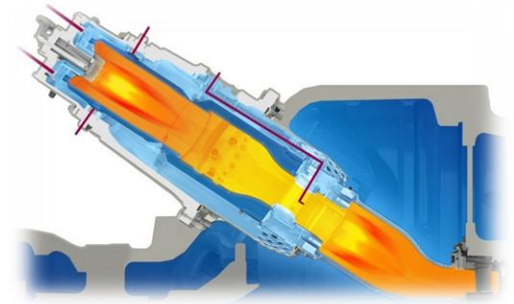
- Hydrogen handled: up to 4 tons / day
- Data acquisition with live monitoring of >1000 parameters
- Remote data transmission (Baden, Switzerland)



Main Parameters	
Air mass flow	70 kg/s
Pressure	40 bar
Preheat temperature	700°C
Hotgas temperature	2000K
Fuel types	Gaseous and liquid
Thermal power	125 MW

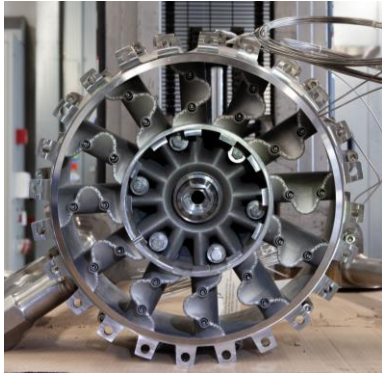
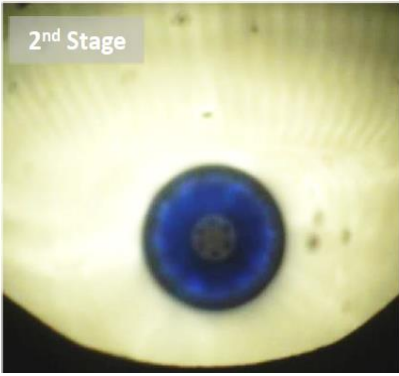
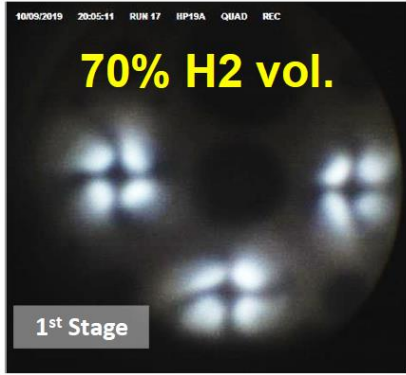
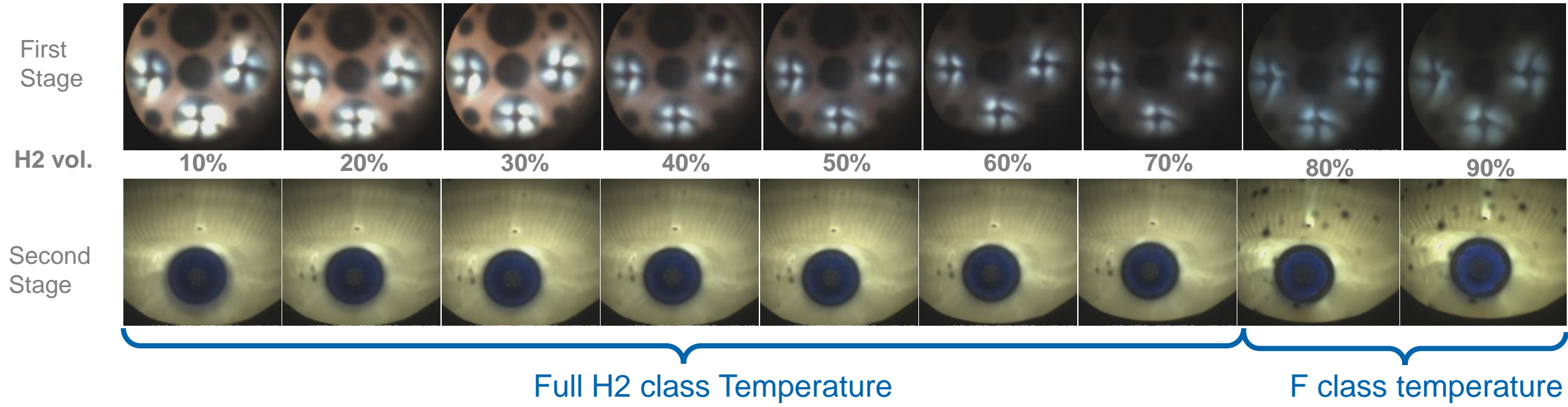


- Full scale single-can combustor test rig



Single can full scale engine conditions test rig demonstrated 100% meaningful of real engine

GT36 HP full scale and full pressure tests - Combustor with hydrogen



GT36 combustor already tested up to 90% H2 vol.



Experience with H₂ projects: AE94.3A

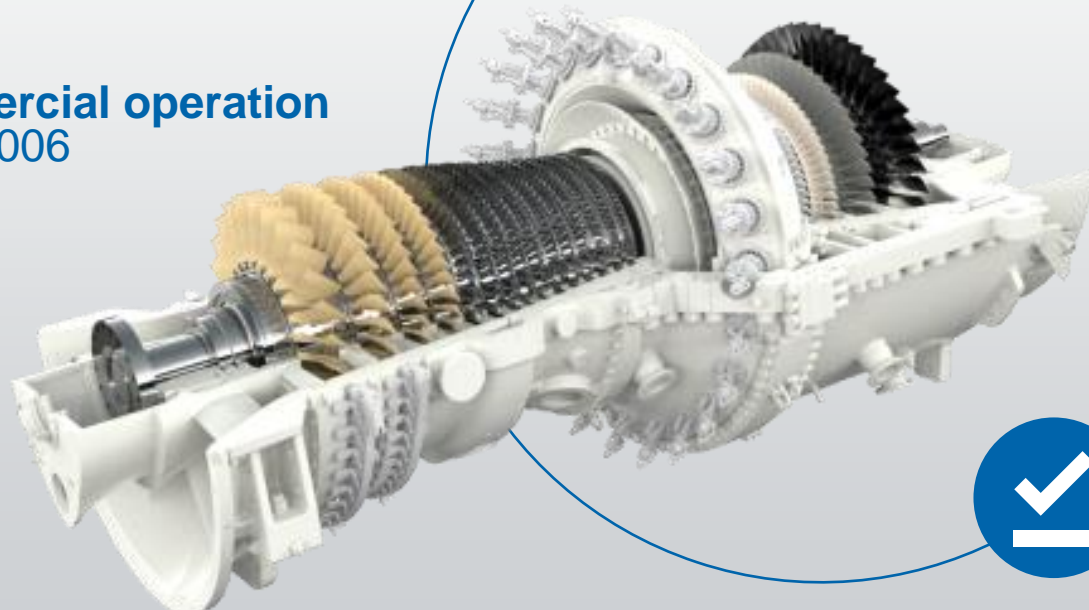


AE94.3A

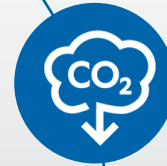
2 Units in CCPP

H₂ supplied by a Chemical Plant next to CCPP

Commercial operation since 2006



H₂ content in premixed mode validated up to **25% vol.**



CO₂ savings up to **40,000 tons/year**



260,000 EOH / 670 NS @ end 2021



Roadmap to: **test 40% H₂ capability**
On full burner / full range

**Annular combustor outstanding site experience in Brindisi
ENI and Ansaldo Energia led the way since 2006**

Conclusions and Outlook



- 70% H2 vol. available on sequential can combustor for H class GT
- 40% H2 vol. available on single annular combustor for F class GT
- 100% H2 vol. planned on mid term for both F and H class line up

- **GT36** Sequential combustion system tested up to 90%vol. H2 (100gCO2/kWh)
 - Previous need for de-rating recovered with water injection

- **AE94.3A** engines acquired substantial field experience with H2 up to 25% vol.
 - High pressure tests at full engine conditions demonstrated up to 40%H2vol. operation
 - NOx penalties fully recovered by fuel re-distribution within the burner (new rating burner)



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