



# IDEA2022

## Building Connections

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INTERNATIONAL  
DISTRICT ENERGY  
ASSOCIATION

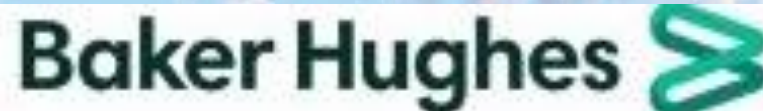
# Connecting Combustion Turbines, biofuel and Hydrogen to optimize District Energy and Distributed Generation

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# Manufacturing facility's challenges:

- Can I increase energy efficiency during partial load cycles?
- How to integrate low emission fuel into CHP operations?
- How to achieve CHP fuel flexibility?
- How can I define a roadmap to reduce CO<sub>2</sub> emissions for in CHP?



# Case Study 1 - Roadmap to zero CO2

- Leading Italian paper manufacturer **Lucart** upgraded two CHP facilities installed in the 80's and 90's
- Improved CHP efficiency and reduced emissions with new generation Gas Turbines (two facilities in 2019)

“We invested a lot in first cogeneration plants in the late '80s and early '90s,” says Tommaso De Luca, Corporate Communication Manager for Lucart. “Producing paper requires a lot of electricity, and also needs steam and heat, which means It is a big challenge for us to reach our commitment to net zero by 2050.”



# Case Study 1 - Roadmap to zero CO2

- Decimo's facility achieved US\$3,000,000 in savings per year
- Ready to use the Fuels of the future
- Hydrogen ready Gas Turbines ensure a roadmap to zero CO2 emissions



# Case Study 1 – Lucart @ Diecimo's facility

- Emissions reduction:
  - CO2 by 11%
  - NOx by 40%
- CO2 reduction equivalent:
  - 2,500 tons of CO2 per year
  - Equivalent to 500 cars off the road
- Ready to use hydrogen 10% blend while keeping low NOx emissions (Dry Low Emissions)



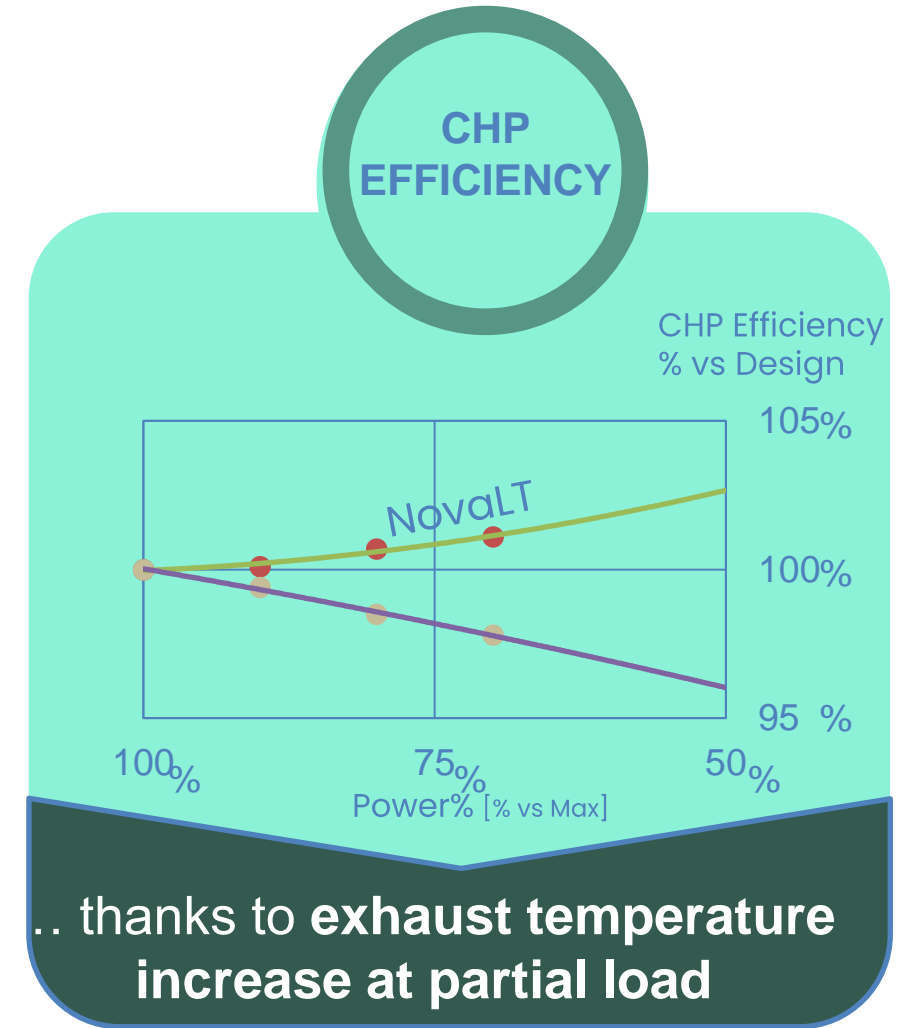
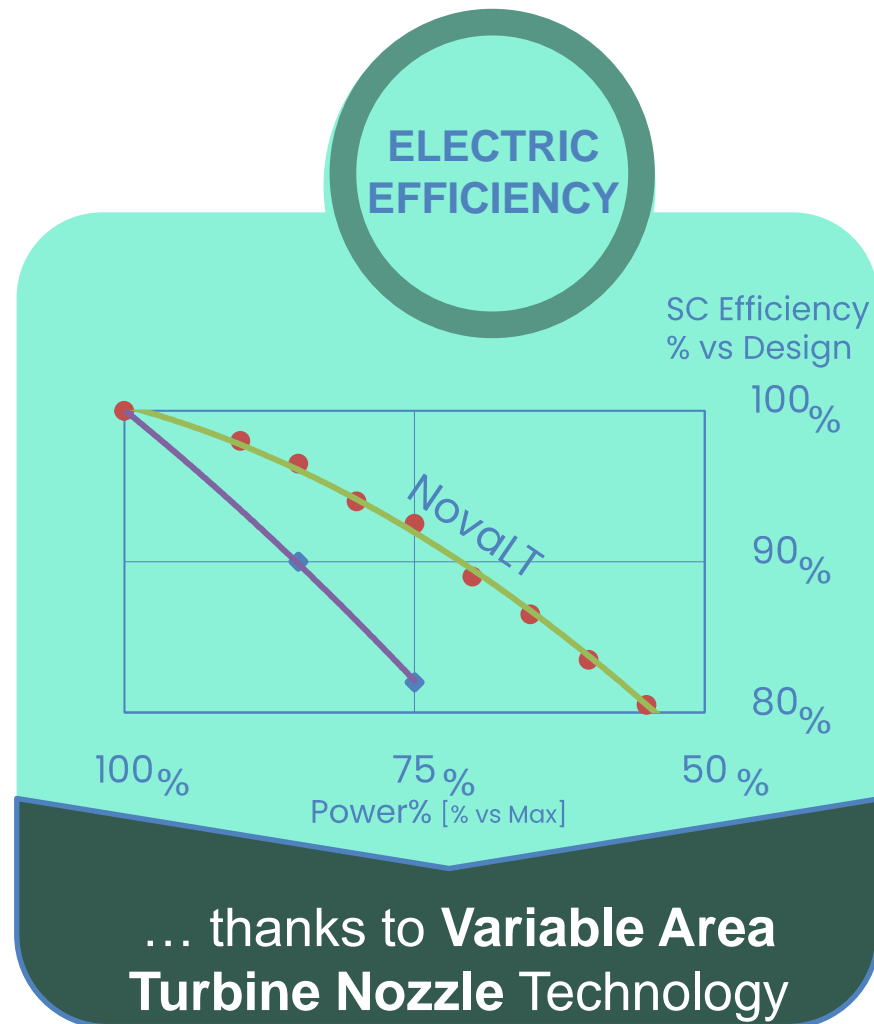


# Case Study 1 – Efficient CHP & Hydrogen roadmap

- **High efficiency Gas Turbine at partial load**
- Low maintenance cost
- Extended time between overhaul (35,000 hours)
- One inspection per year
- **Hydrogen ready Gas Turbine Generator**



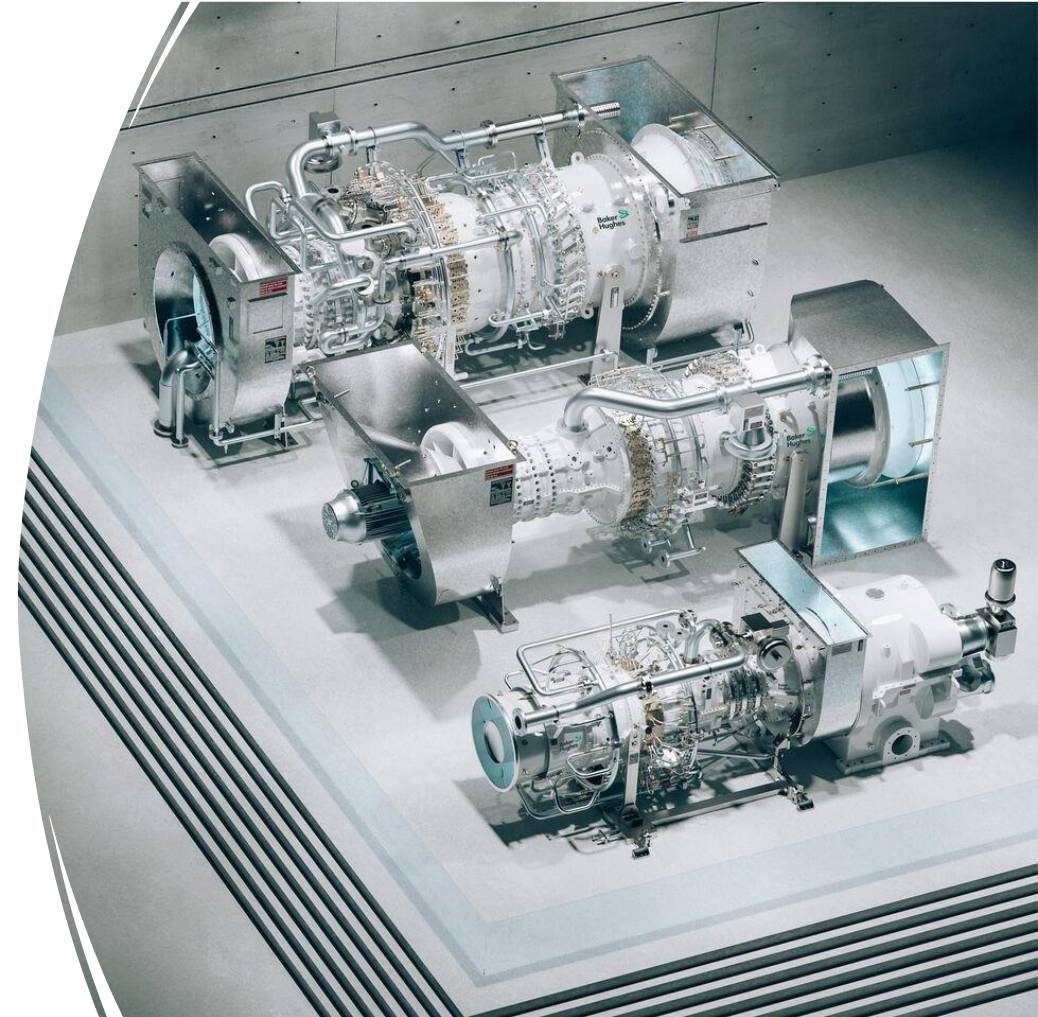
# High efficiency CHP and Hydrogen roadmap





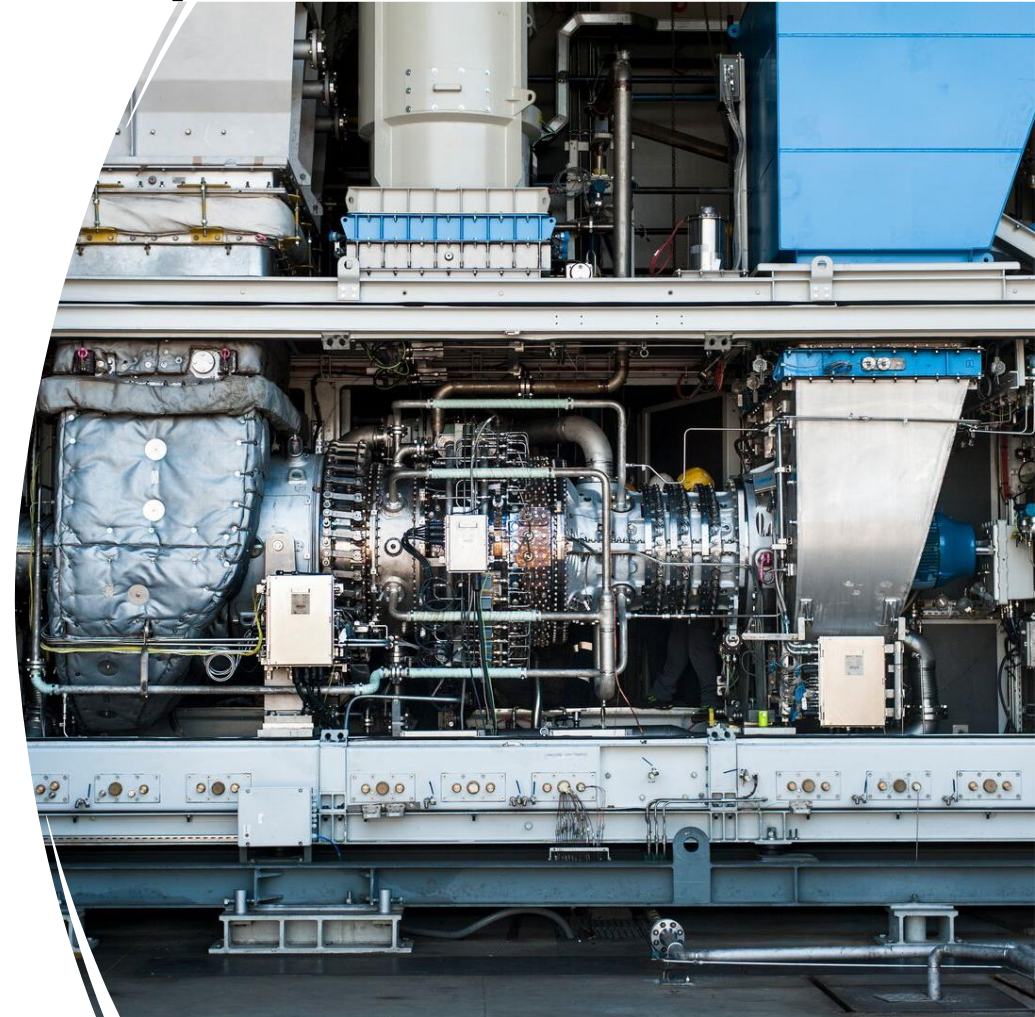
# Hydrogen Roadmap

- **NovaLT** Gas Turbines inherently designed for Hydrogen
- 5% to 100% Hydrogen blend capability
- Hydrogen blend % change during Gas Turbine operation
- Hydrogen blend up to 100% with Dry Low Emission system (future)



# Solution: Hydrogen Roadmap

- Baker Hughes & Snam test first “hybrid” Hydrogen GT (NovaLT12)
- Snam tested compression, pipeline and fuel gas blend
- Test completed successfully in July 2020





# Hydrogen Roadmap (steps completed)

- Test process & facilities:
  - Virtual Lab test (CFD) for thermo fluid-dynamics
  - SingleCup atmospheric and pressurized testing
  - Full scale annular rig and multican rig test
  - Full engine testing





# NovaLT Gas Turbine ready for Hydrogen Utilization

## Combustion

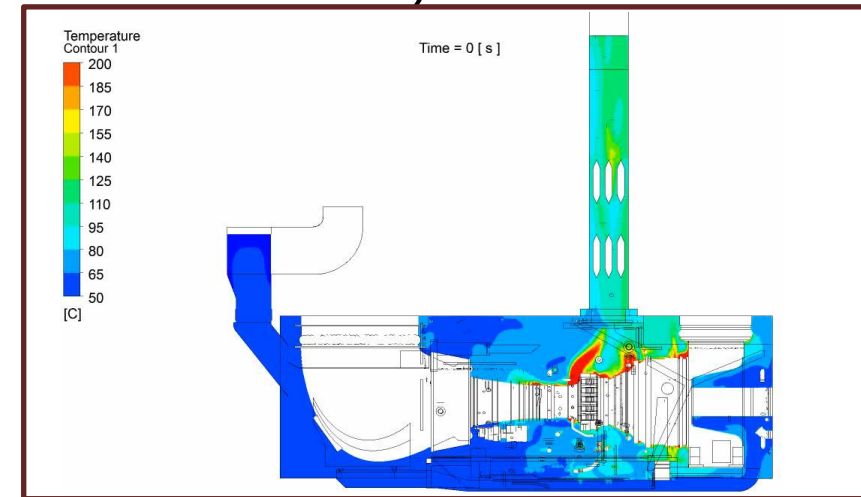
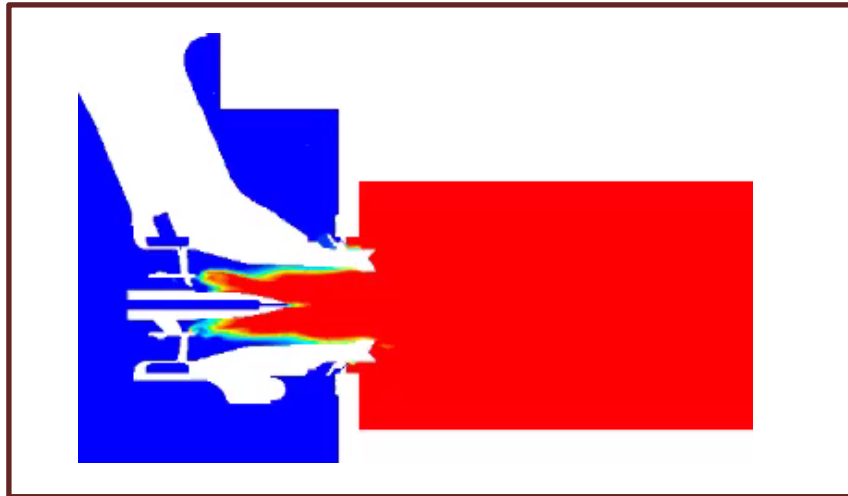
- ❑ High flame speeds
- ❑ Wide flammability limits
- ❑ High flame temperatures
- ❑ Flashback
- ❑ Combustion dynamics

## Delivery & Package

- ❑ Storage
- ❑ Sealing
- ❑ Material compatibility
- ❑ Equipment validation & ATEX certification

## Operation

- ❑ Start-up and shut-down procedures
- ❑ Fuel system/engine/package purge requirements
- ❑ Flame & gas detection
- ❑ Performance/durability (high % H<sub>2</sub>)



# Solution: Hydrogen Roadmap

- Test results:
  - Full unit NovaLT-12 tested (standard configuration)
  - Up to 10% Hydrogen blend
  - Dry Low Emissions (DLE)  $\text{NO}_x \leq 15 \text{ ppm}$
  - Power, load and efficiency not affected
  - Combustor tested 100% Hydrogen (WLE)



# Hydrogen Roadmap



## Today – 100% H<sub>2</sub> Wet Combustion

- Start up & burn gas blends up to 100% H<sub>2</sub>
- Auto-switch from NG to gas blends up to 100% H<sub>2</sub> *while operating*

## 2020 H<sub>2</sub> NG Blend DLN Combustion

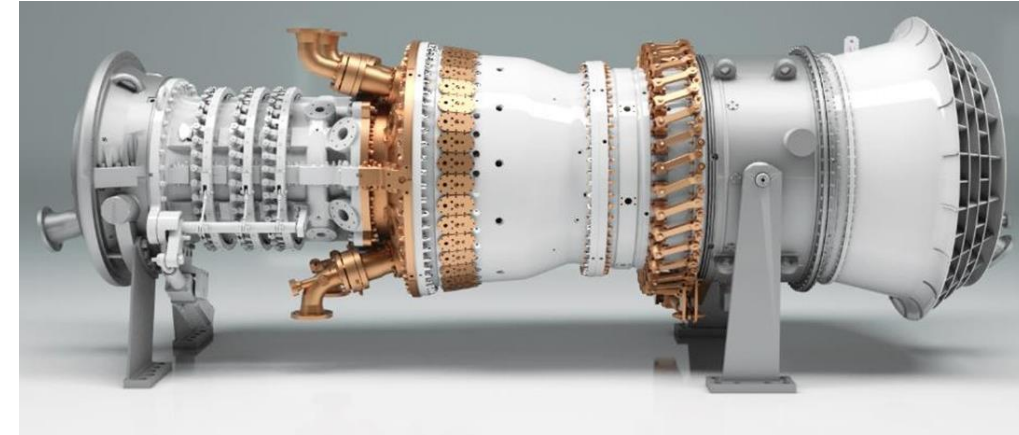
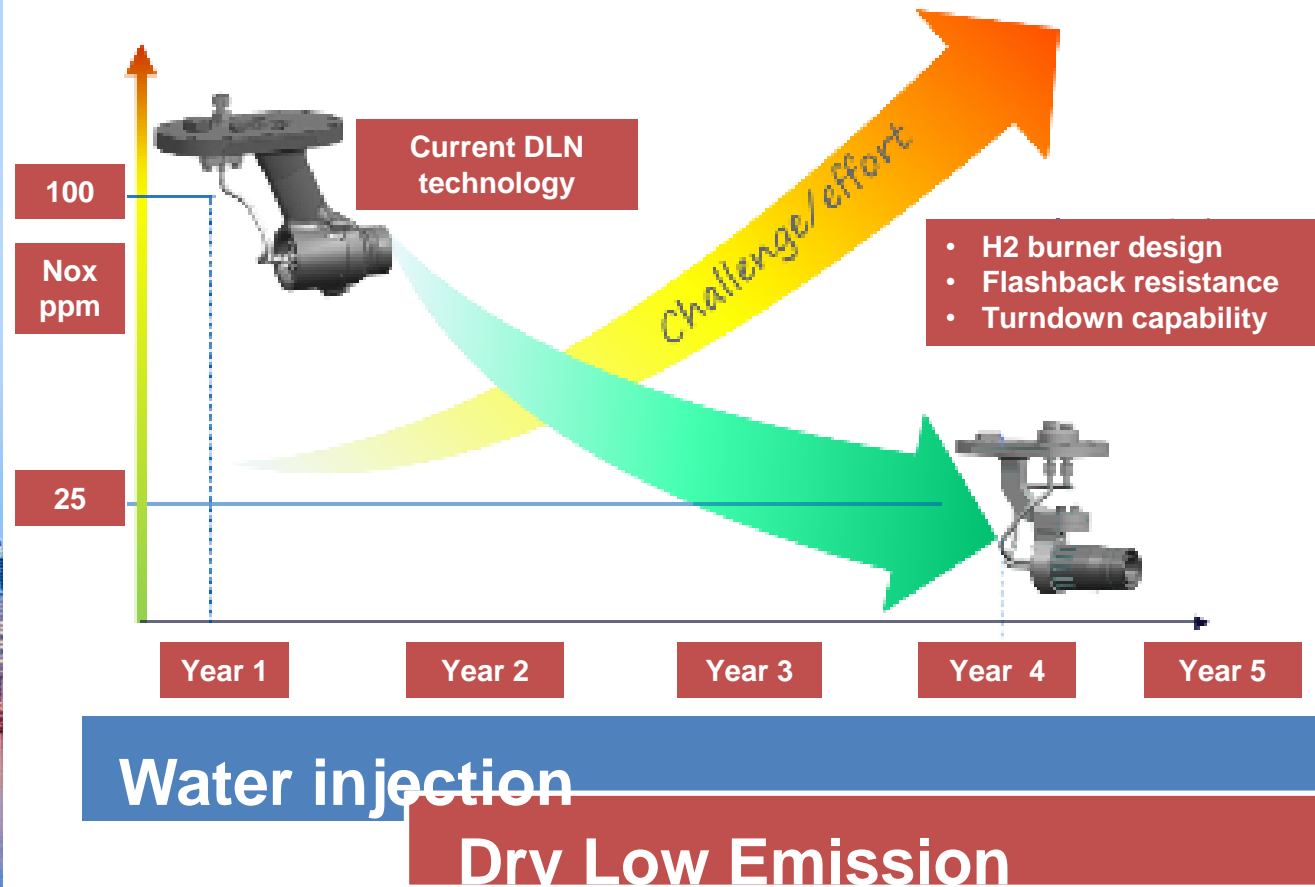
- NOx emission reduction strategy based on multi-fuel burner
- Preliminary tests for DLN combustion system

## Next – 100% H<sub>2</sub> DLN Combustion

- Full annular rig verification
- Engine test verification



# Nova LT™ Family - H2



## NovaLT™ Current Capabilities

- Start up & burn gas blends up to 100% H2
- Switch from NG to gas blends up to 100% H2 on the fly

## Single digit NOx w/ 100% H2

- Dedicated burner design and verification for NOx abatement
- 100% hydrogen Dry Low NOx (DLN) combustion with full annular rig and engine test verification

# Strategic Hydrogen collaborations – Case Studies

## H2/NG blending testing

Istrana, Italy



Baker Hughes and Snam successfully completed testing the world's first "hybrid" hydrogen turbine designed for a gas/H2 network

## Green H2

NEOM, Saudi Arabia



Providing advance hydrogen compression technology to Air Products H2 production plant

## Blue H2 Power Gen

Edmonton, Canada



Providing 100% hydrogen fueled NovalLT-16 gas turbine generator to Air Products

# Q&A





# Thank You!

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