TC1: Low-carbon GT technologies - *"Expanding the solutions portfolio of new energy systems"*

16 March 2021

Chairs: Marco Ruggiero, David Sanchez

Summary:

- Great interest in this TC, 226 online registrations
- 4 topics presented
  - **Low Carbon Resource Initiative**: Jeffery Preece, Electric Power Research Institute (EPRI)
  - **Pressure gain combustion**: Fabio Ciccateri, Finno Exergy and Donald Ferguson, National Energy Technology Laboratory (NETL)
  - **New solutions to reduce the total cost of ownership of combined cycle gas turbines in a low-capacity factor scenario,** Ambra Giovannelli, University of Roma 3 and Markus Lesemann, Gas Turbine Institute (GTI)
  - **Carbon capture, utilisation and storage (CCUS) projects and global cooperation**, Juho Lipponen, Clean Energy Ministerial CCUS Initiative (CEM CCUS)

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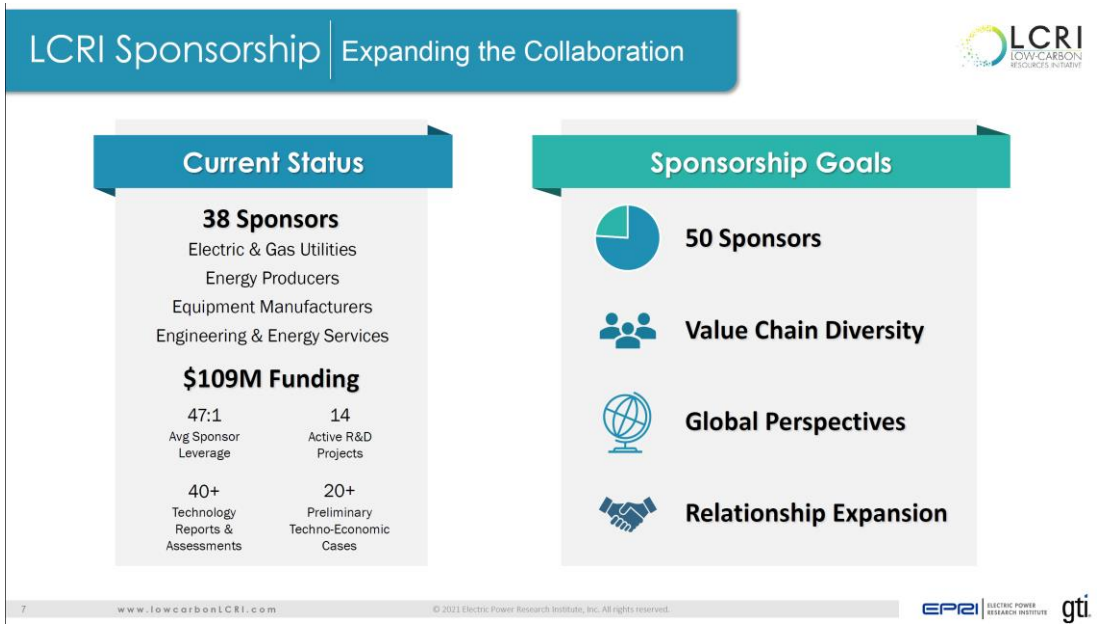

- Integrated energy system approach to decarbonisation
- Looking at the whole low carbon value chain (production-delivery/storage-end use)
- International network, open to collaboration

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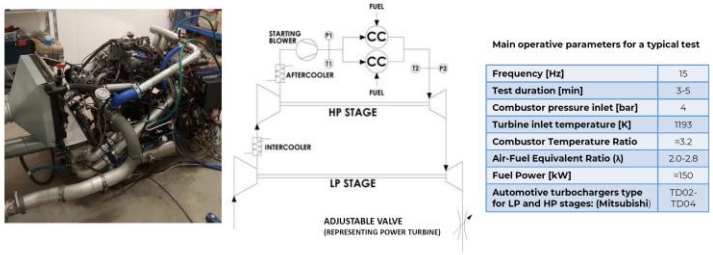
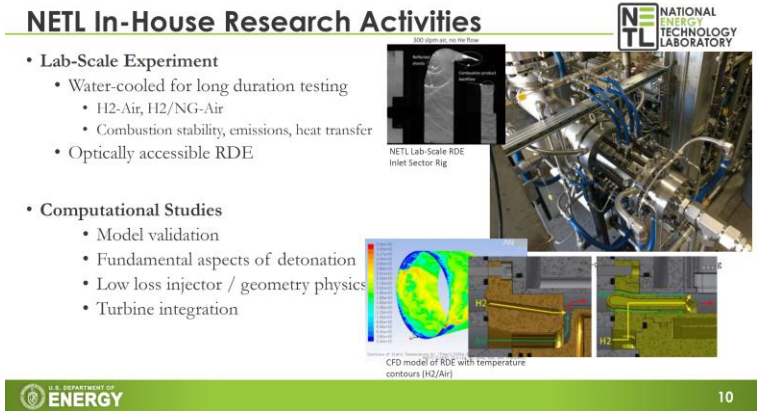
TEST UNIT: EXPERIMENTAL FACILITY DESCRIPTION



Main operative parameters for a typical test

Frequency [Hz]	15
Test duration [min]	3-5
Combustor pressure inlet [bar]	4
Turbine inlet temperature [K]	1193
Combustor Temperature Ratio	≈3.2
Air-Fuel Equivalent Ratio (λ)	2.0-2.8
Fuel Power [kW]	≈150
Automotive turbochargers type for LP and HP stages: (Mitsubishi)	TD02-TD04

FINNO EXERGY



- Laboratory testing of technology in GT conditions ongoing
- Multiple fuels envisioned
- Promising results in terms of NOx emissions

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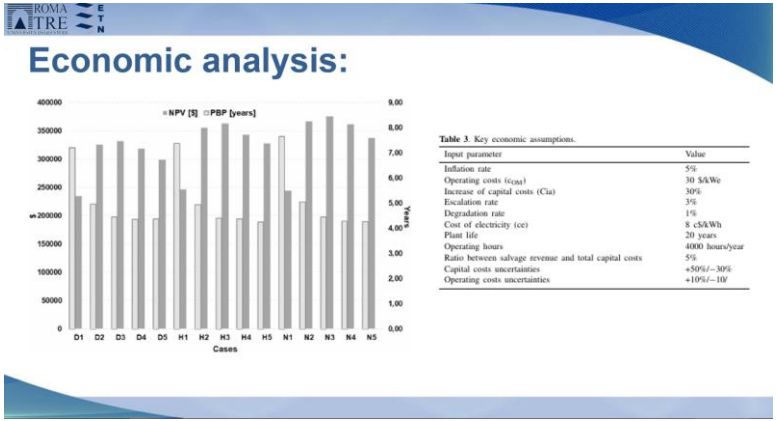

- Several demonstrators at various stage of development
- Multiple applications
- Studying conditions for economic viability
- Expanding the technology and collaboration network

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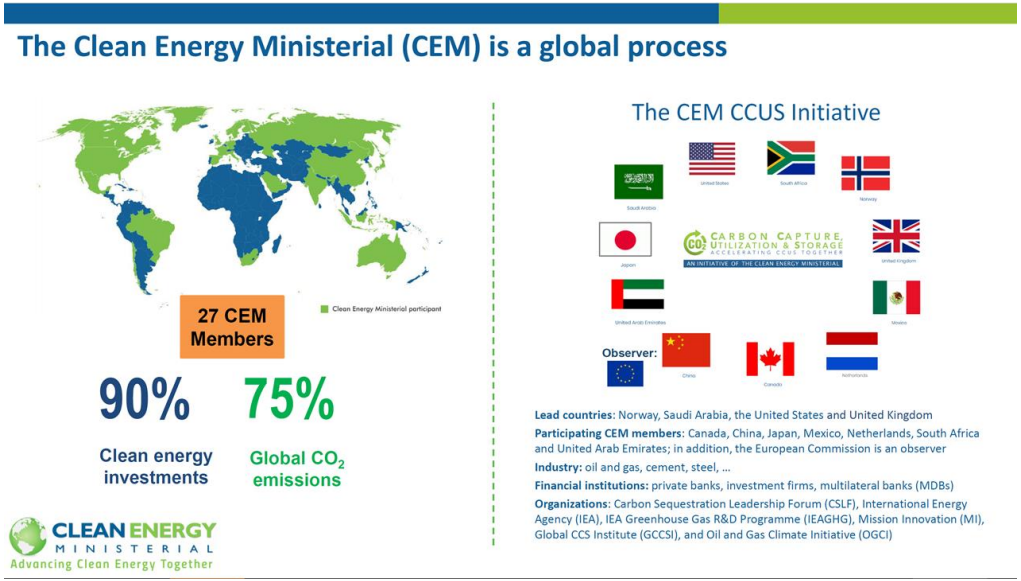

- Resetting the strategic narrative – from burden to opportunity
- Collaboration is critical

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Follow-up:

- Explore opportunities for collaboration between LCRI and ETN
- Evaluate inclusion of PGC technology in one of ETN WGs
- Create info exchange connection between sCO2 WG and STEP consortium
- Evaluate ETN webinar on CCUS

TC2: Operational and fuel flexibility - *“Analysing new technological solutions in respect of market opportunities”*

17 March 2021

Chair: Peter Kutne, DLR

Summary:

- *Focus of the session was on economic aspects of different technologies*
- *Hydrogen is still the topic with the highest interest and the actual status on hydrogen combustion as well as the economic feasibility was discussed*
- *The use of ammonia as energy storage was evaluated from an economic point of view, but no direct comparison was drawn so far*
- *The integration of gas turbines into industrial processes or with renewable energy sources can open up new application fields for gas turbine technology. The combination with other technologies (e.g. heat pumps) can help to increase the overall flexibility of the system*

Follow-up:

- Benchmark of hydrogen and ammonia pathways would be helpful
- Further evaluation of process integration and new GT cycles could help to identify new opportunities for the technology

TC3: Materials degradation, repair technologies & manufacturing – *"Expected materials impacts and new technology opportunities to overcome challenges in the energy transition"*

18 March 2021

Chair: John Oakey, Cranfield University

Summary:

- The workshop addressed the materials-related challenges and opportunities arising from the use of low-carbon fuels (H2, Biogas, etc), advanced cycles (sCO2) and application of Additive Manufacturing for Gas Turbine Energy Systems

- The use of H2 was not foreseen as giving any problems within the hot gas path but there were challenges in the feed systems. Further work was required for handling variable CH4:H2 mixtures.

- The materials challenges for the implementation of exhaust gas sCO2 cycles needed attention re erosion, durability and manufacturing

- Additive Manufacturing is well established and provides many opportunities, but designing with AM in mind is required. Close cooperation with the sector and further projects to consider the best ways to implement the technology and how to control/assess component quality are required.

TC4: Condition monitoring and asset management - *"Implications of introducing 5% to 30% hydrogen into the grid"*

19 March 2021

Chair: Chris Dagnall, DNV

Summary: Topic - Implications of introducing 5% to 30% hydrogen into the grid

Three presentations followed by 50 minute panel discussion;

- Hydrogen operation assessment, Tom Kavanagh - Uniper
- Hydrogen Usage in Gas Turbines – Impact on Enclosure Safety, Irfan Siddiqui – Frazer Nash
- Technology aspect, Marc Vignal – Solar Turbines

Some key points;

- ATEX Gas Grouping Changes when above 25% hydrogen content
- No enclosure and ventilation standard for hydrogen
- Higher % would need new seals
- Flange management – new maintenance procedures required

Follow-up:

- Consider developing an enclosure standard for hydrogen
- Produce a document of what H2 readiness would look like
- Consider an H2 user group