



GTEN 2021 Virtual Symposium

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**Reducing the carbon footprint of supplying Canada's energy with Aero-derivative Gas Turbines
through efficiency and emissions enhancements and conversion to use low carbon fuels**

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Siemens Energy Aeroderivative Gas Turbines

- Grid emergency and peak duty, synchronous compensation
- start up and accept full load rapidly preventing shutdown of grid
- Remote oil & gas production facilities
- Transportation of energy through pipelines to consumers



(Image: Ontario Power Generation)



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(Image: Atlantic Packaging)



SGT-A65



SGT-A35



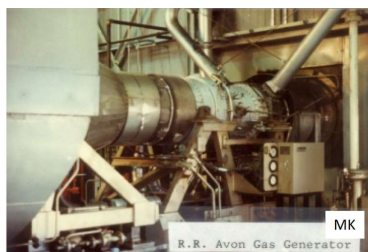
SGT-A20



SGT-A05

Canadian History & Milestones- Siemens Energy Aeroderivatives

59	SGT-20 (Industrial Avon) 50 Pipeline, 9 Peak	1964	1 st SGT-A20 pipeline Saskatchewan
31	SGT-05 (Industrial 501) 19 Pipeline, 12 Power generation	1968	
89	SGT-A35 (Industrial RB211) 82 Pipeline, 7 Offshore/Process Power	2019	1 st SGT-A05 KB7HE Mobile Package
7	Industrial Olympus Peak + grid stability	1973	1 st SGT-A35 Saskatchewan
9	Industrial Spey Pipeline	2002	1 st SGT-A35GT Alberta
2	SGT-A65 (Industrial Trent) Co-Generation	1975	
		1976	1 st Industrial Spey Winnipeg
		1997	1 st SGT-A65 Ontario

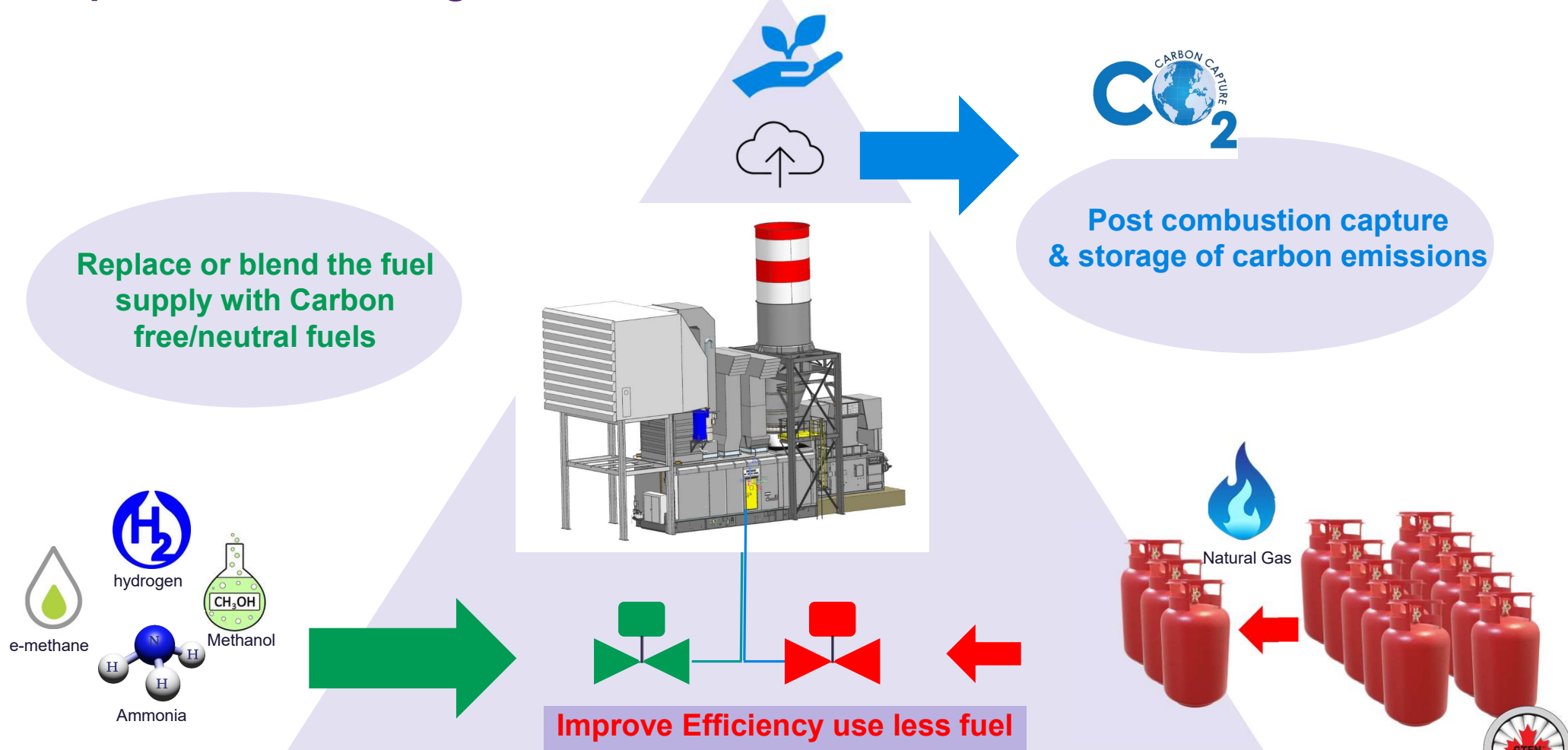


(Photo M Klein)



(Image: Atlantic Packaging)

Options for Reducing Carbon Emissions



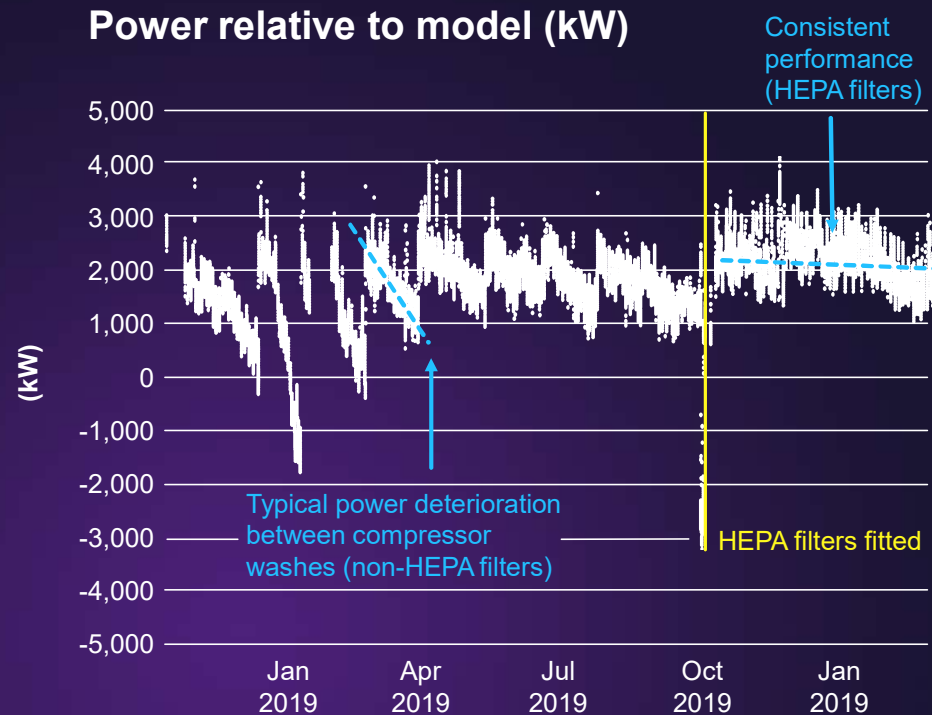
Intake filter upgrade – case study

SGT A35 upgrade to E12

- Average 2% reduction in CO₂ emissions
- Reduction in methane emissions
- Maintain engine condition

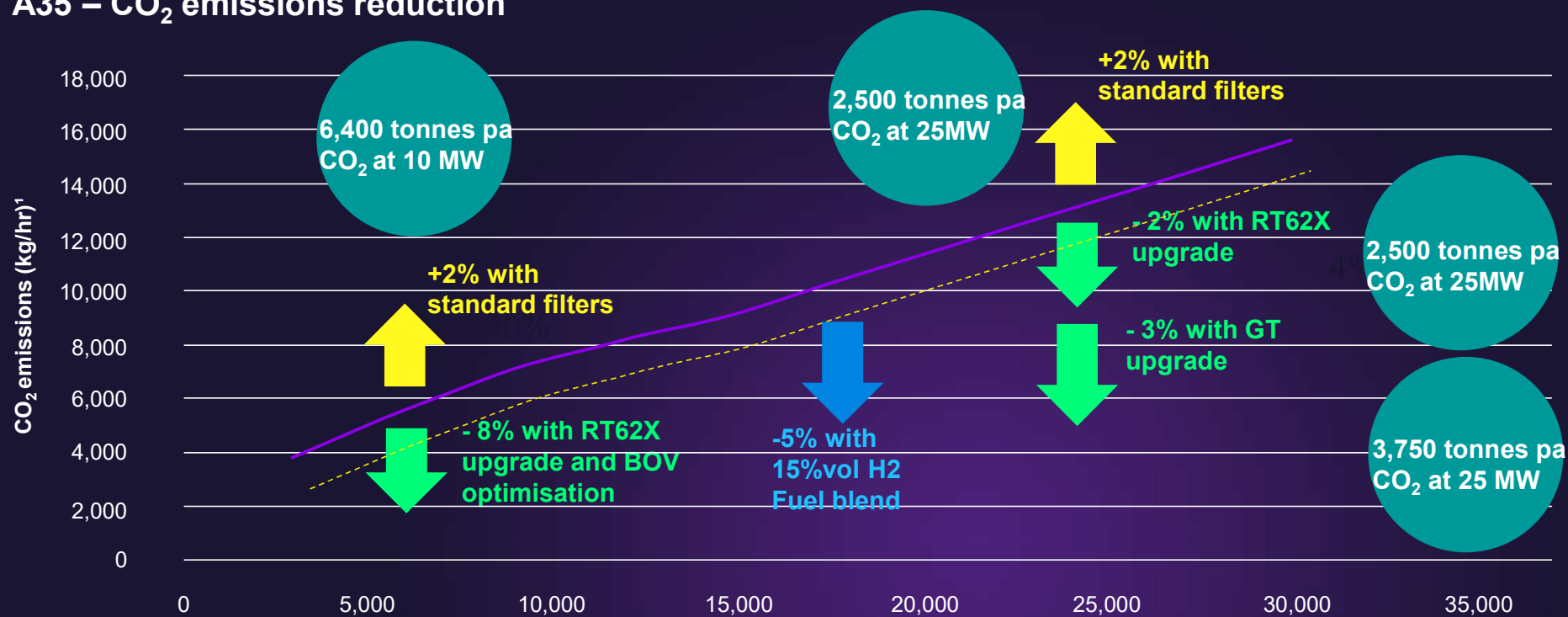


Power relative to model (kW)



Product Efficiency Modifications

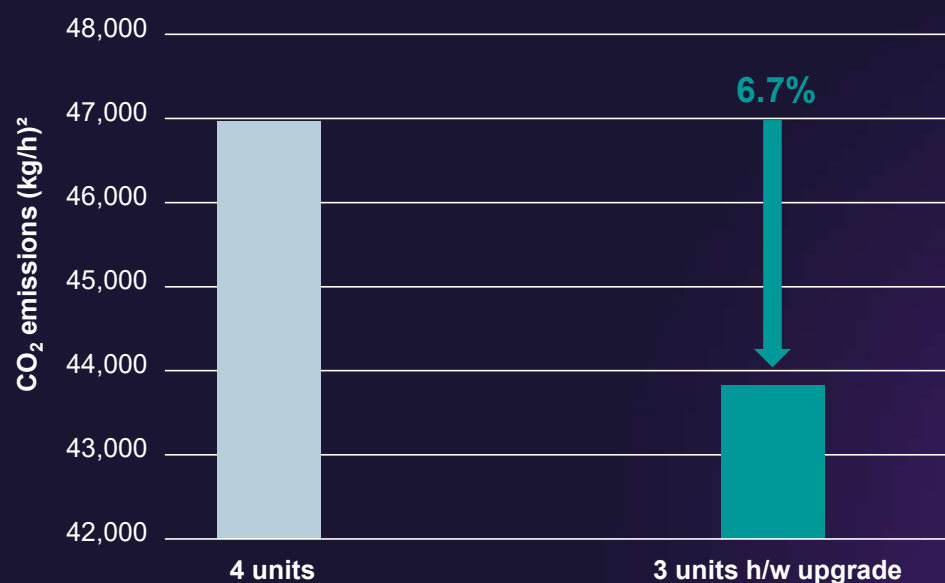
SGT A35 – CO₂ emissions reduction



¹Methane natural gas

Spinning reserve case study

CO₂ reduction from h/w optimisation

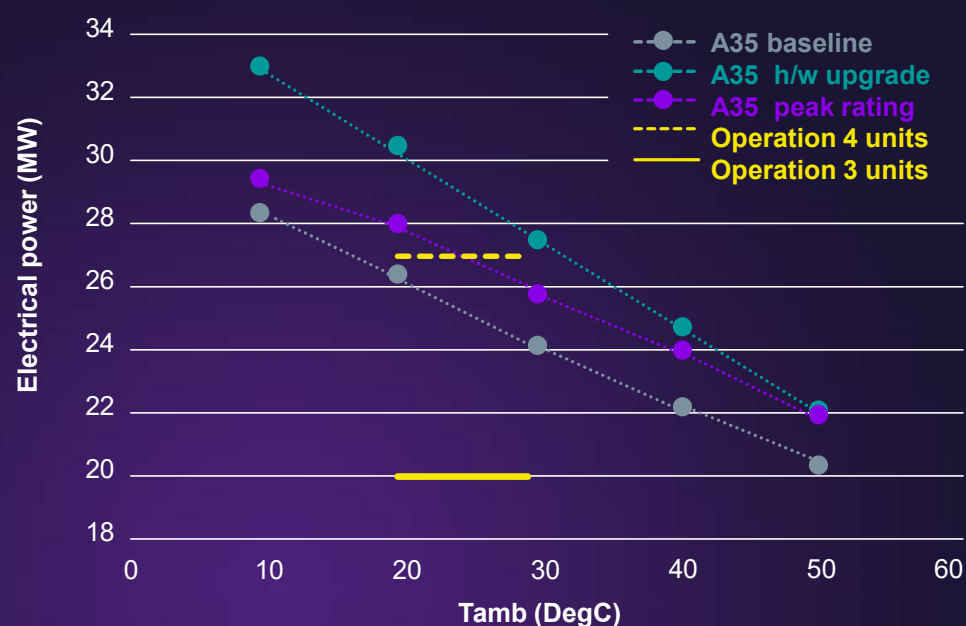


Combined hardware upgrade (within current package) and optimising operation
6.7% less fuel + CO₂ emissions (25,000 tonnes pa / €750k reduction in CO₂)

¹CO₂ tax at €30 per tonne

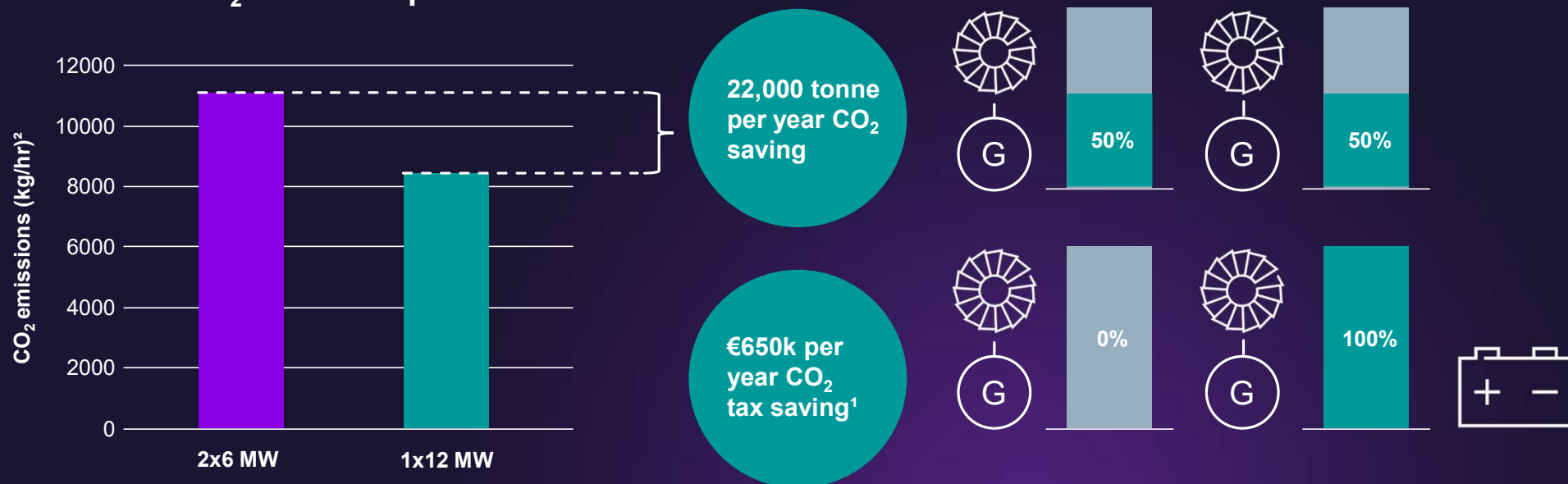
²Methane natural gas

SGT A35 case study – optimising operation



Case study – battery backup

SGT A35 – CO₂ reduction potential



6 MWh battery with a C2 rating gives 12 MW power for 30 minutes
Minimise footprint size and investment cost (pay per MWh)

¹CO₂ tax at €30 per tonne

²Methane natural gas

Waste Heat Recovery

Ultra Light Bottoming Unit
Compression & Oil separation modules



Compact WHRU
<500 tons
16MW additional power 2+1 GT (SGT-A35)
80,000 tonne pa CO2 saving

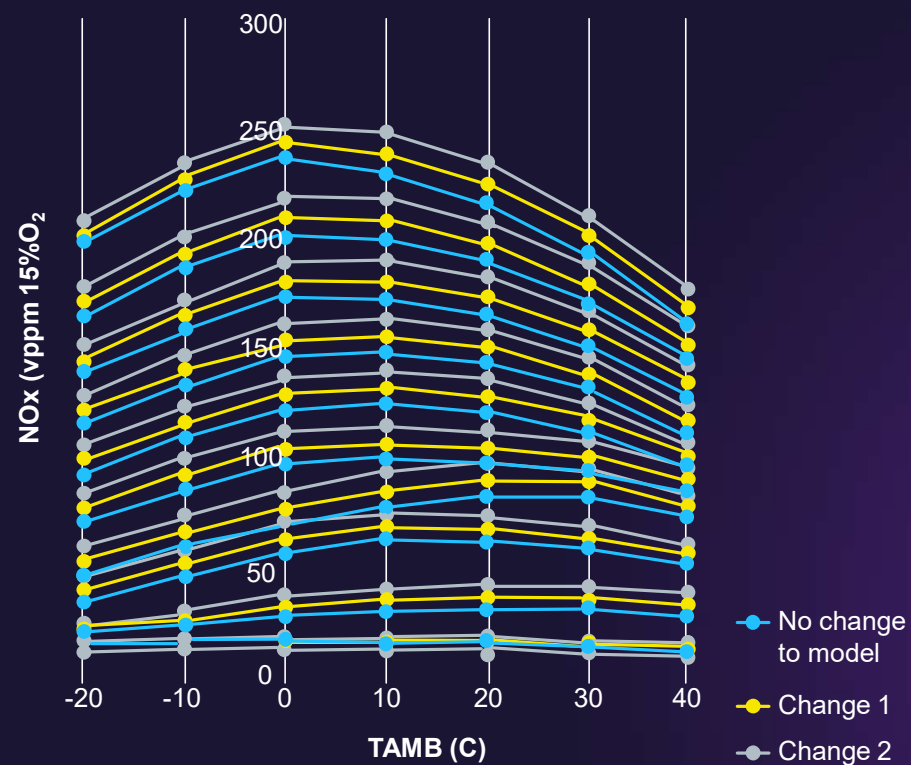
Supercritical CO₂ Heat Recovery Engine



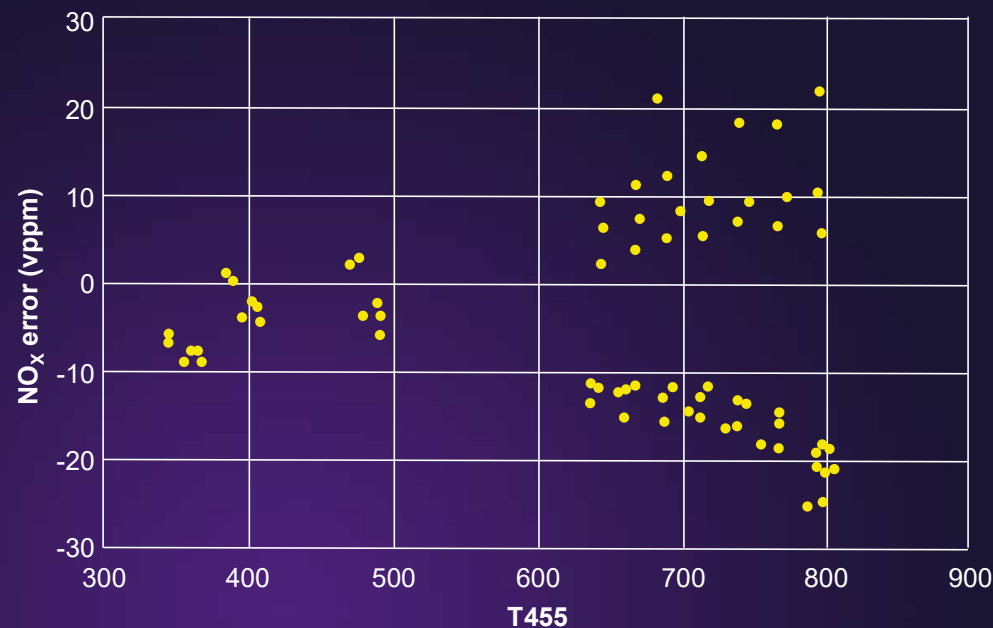
Compact WHRU Heat engine
9 MW additional power 1 GT (SGT-A35)
44,000 tonnes CO2 saving
➤ CO₂ for working fluid
➤ No water needed

Predictive Emissions Monitoring - data driven model reporting

Dataset available



NO_x error



NO_x, CO and CH₄ < 8% error
CO₂ < 1.5% error

Siemens Energy Aeroderivative Gas Turbines

Hydrogen Capability



Gas turbine	Power Output ¹	Hydrogen Capability (vol%)
SGT-A65	60 to 71/58 to 62 MW	15
SGT-A45	41 to 44 MW	100
SGT-A35	27 to 37/28 to 38 MW	15
SGT-A20	12 to 17 MW	100
SGT-A05	4 to 6 MW	15

DLE
 Aero
 Diffusion burner with unabated NOx emissions

¹ISO, Base Load, Natural Gas

Values shown are indicative for new unit applications and depend on local conditions and requirements. Some operating restrictions and special hardware and package modifications may apply.

Aero Diffusion Combustion Systems

- Capable of Co-firing with natural gas up to 100% H₂
- Same power rating on 100% H₂ as high-methane natural gas
- NO_x < 25 vppm with water injection



Dry Low Emissions Combustion Systems

For 15 vol% hydrogen, no change for new units to:

- Emissions capability
- Component life and overhaul interval
- Power rating



SGT-A65 WLE



SGT-A35 WLE



SGT-A20



SGT-A05

Siemens Aeroderivative Gas Turbines Hydrogen Experience and Roadmap

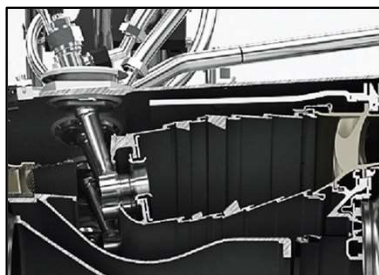


SGT-A20

+230K hours of recorded operation on hydrogen fuels (up to **80 vol%**) since 1968

Aero Annular combustor(SAC)

100% hydrogen atmospheric rig testing



SGT-A20



SGT-A65 WLE



SGT-A35



SGT-A05

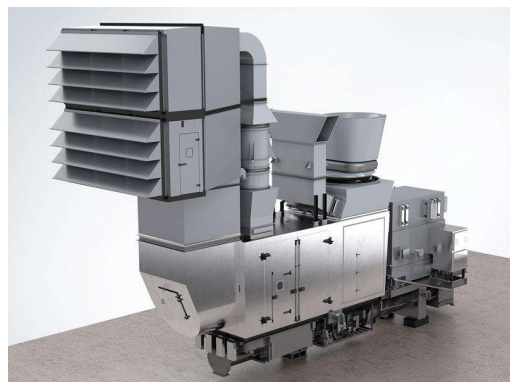


Hydrogen Upgrade Process

Customer requirements



- Fuel hydrogen content
- Operational requirements
- Local regulatory requirements



Site survey



- Specifications of installed equipment
- Combustion system
- Fuel gas system
- Other auxiliary systems

Agree modifications



- Define scope based on customer requirements
- Plan upgrade project
- Proposal on required modifications
- Negotiation and decision on modifications (pricing, timeline)
- Contract award

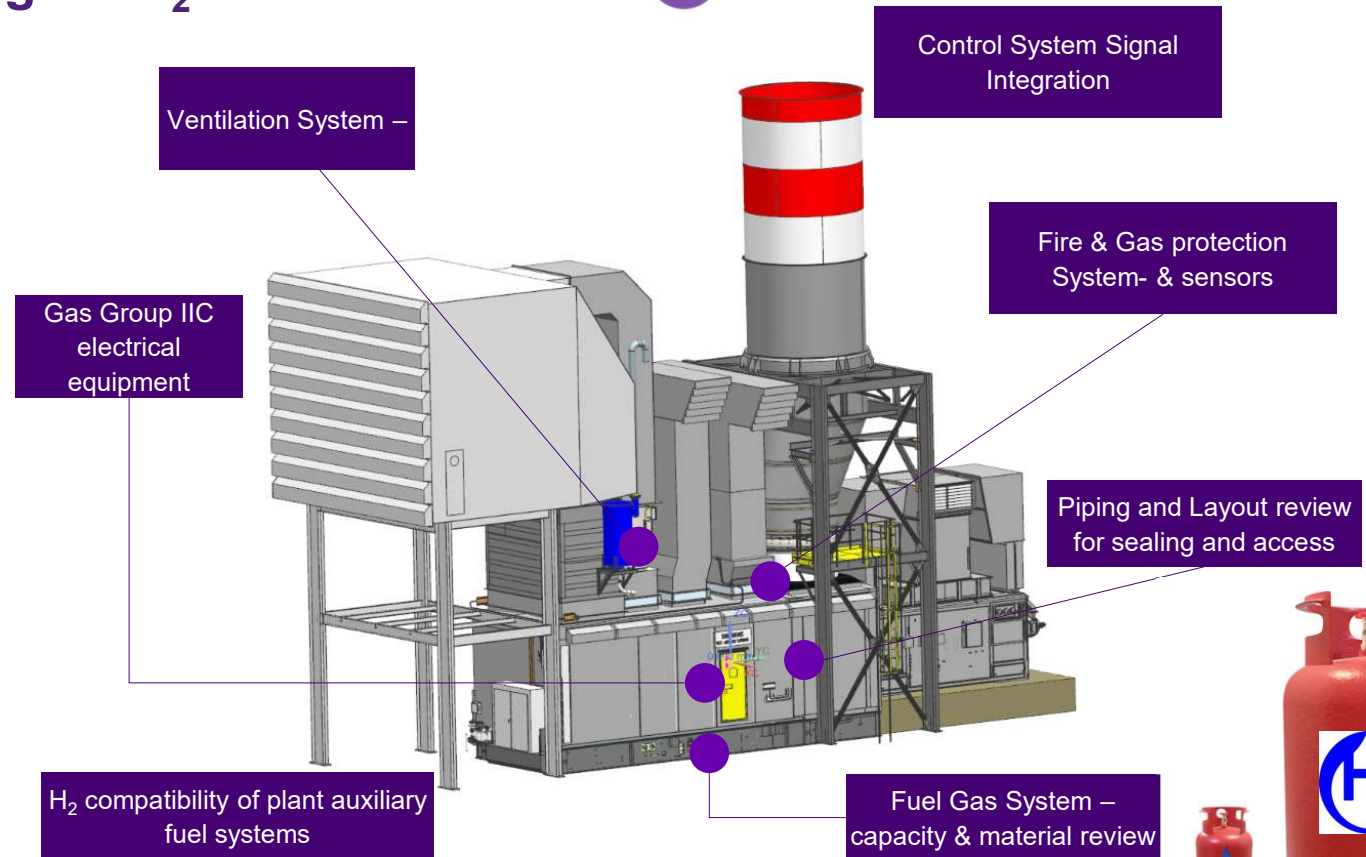
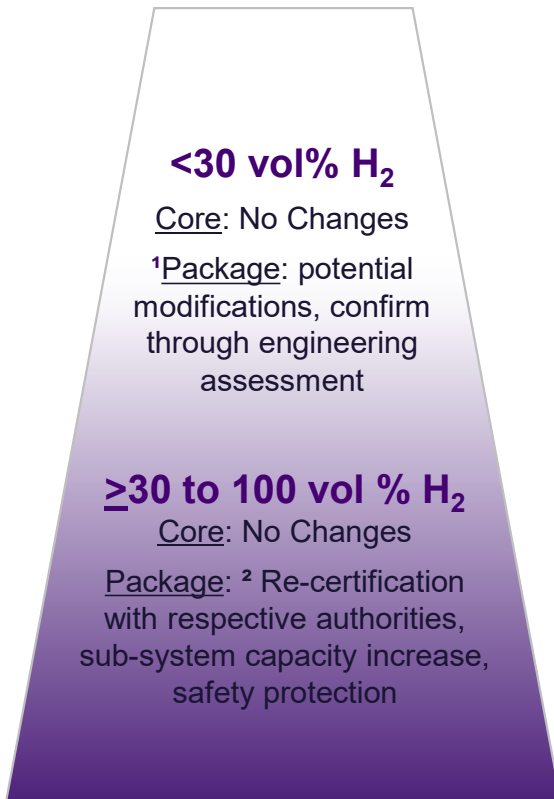
Implementation, testing, and certification



- Joint HAZOP
- Certification/certification amendments as required
- Installation
- Commissioning
- Validation of upgraded plant
- Performance and acceptance tests



Primary Systems Requiring Modification When Blending to Higher H₂ Content



¹ Site survey recommended to assess older equipment, ² IEC 60079-10-1 H₂ hazardous area classification



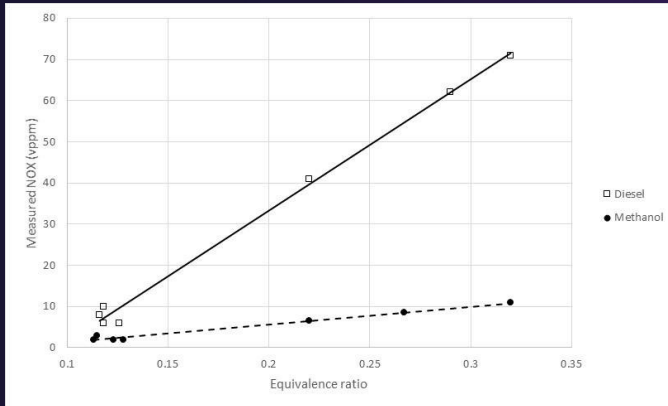
eMethanol - sustainable liquid fuel whenever there is no gas supply

- Carbon Neutral sustainable fuel manufactured from **waste**
- Environmentally friendly – **Biodegradable**
- Lower combustion temperature – **70% reduced NOx emissions**
- No SO2 emissions – **no sulphur**
- **No visible exhaust** plume
- Alternative fuel for managing the Energy Transition

Ideal substitute for Aero Gas Turbines to replace Diesel

SGT-A20 Gas Turbine Demonstration planned Fall 2021

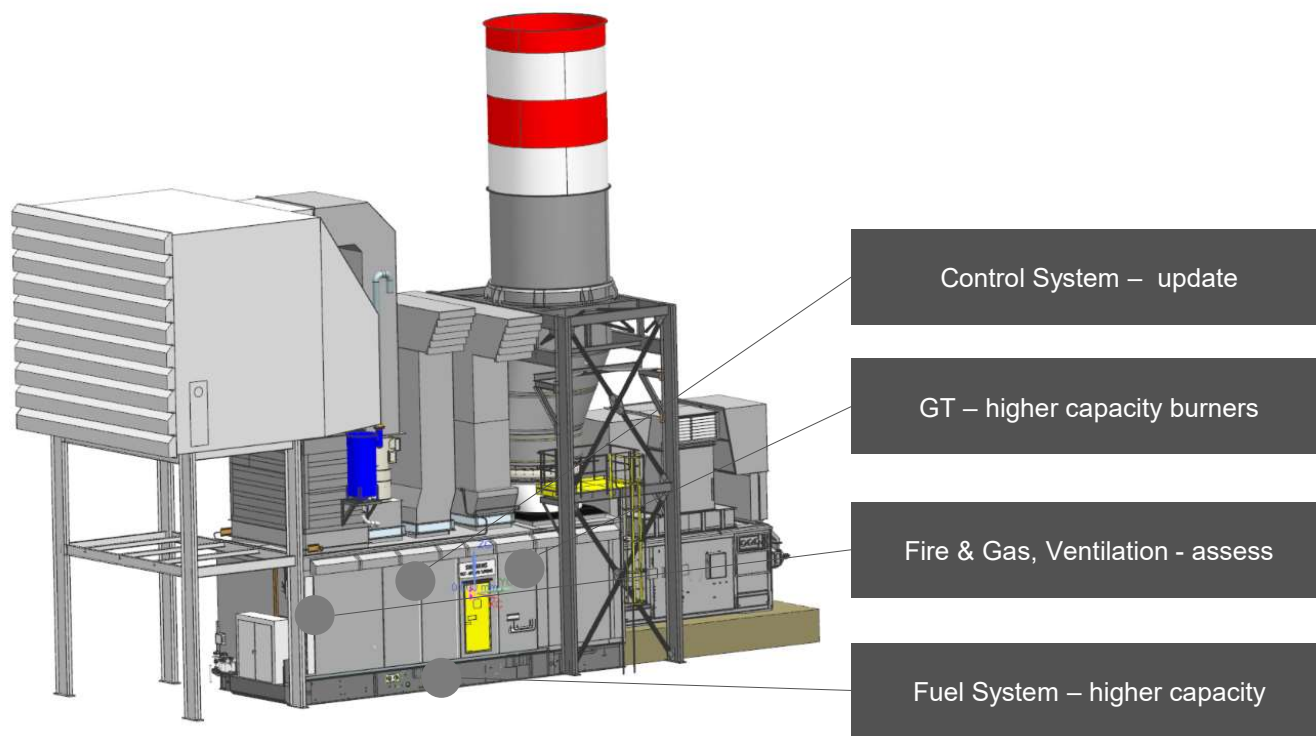
270 million litres of Methanol produced from 360,000 tonnes of municipal waste saving 300,000 tonnes of CO2



Rig tests of Industrial Olympus produced greater than 70% less NOx

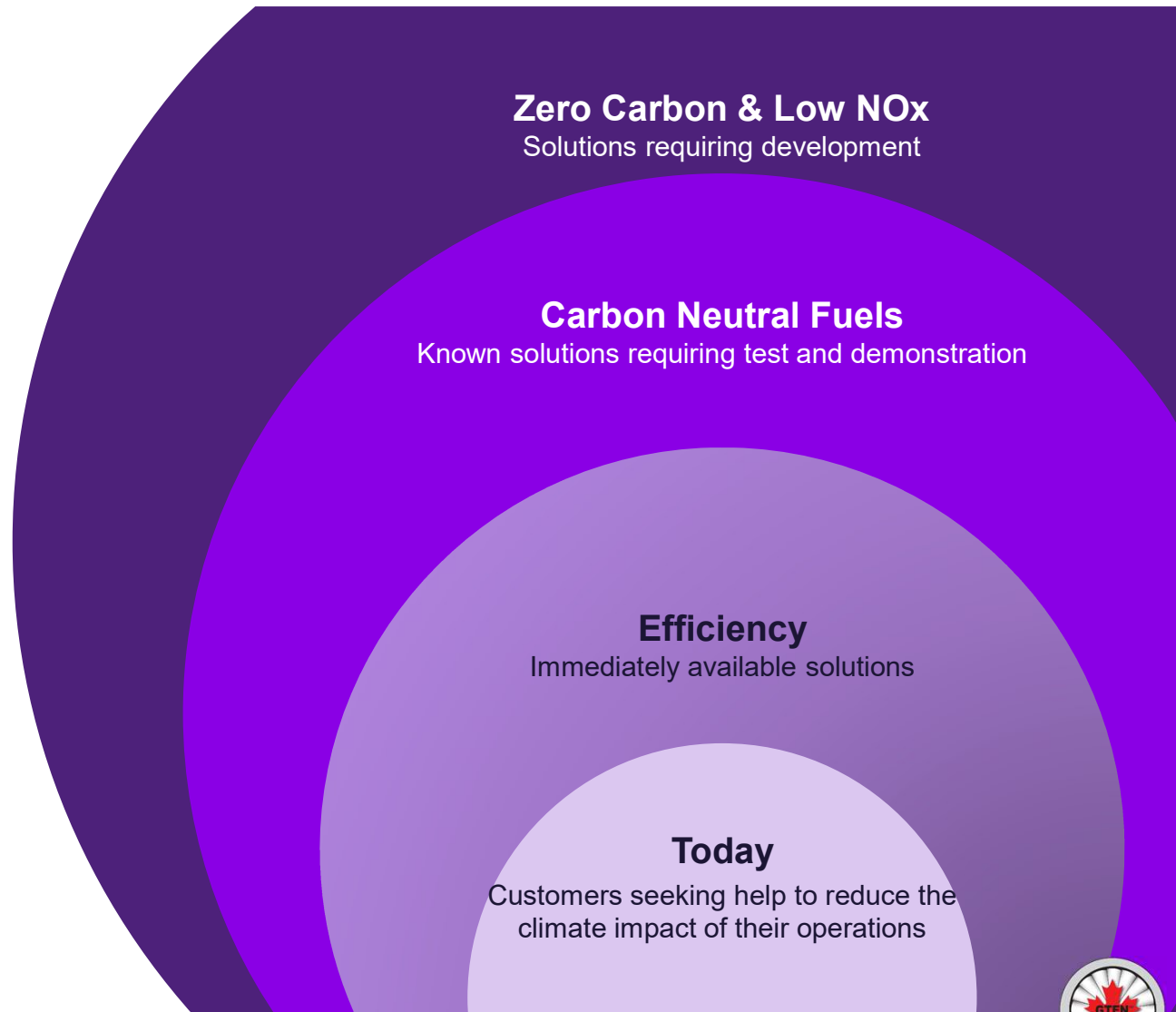


Package Modifications - eMethanol



Aeroderivative Gas Turbine Decarbonization Solutions

- Proven fuel flexibility experience
- Capable of Co-firing with natural gas up to 100% H₂ (DLE 15%vol H₂)
- Planned engine test using Methanol
- Optimize efficiency with Digital & product solutions
- Low risk for managing the Energy Transition



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