Introduction

The world is hungry for energy, and climate change calls for lower emissions. Carbon neutrality will drive significant changes to energy producers.

Coming by 2030

- EU Climate Change Policy reduces CO_2 by 55%
- The UK plans to reduce offshore emissions by 70%
- Canada targets a 30% CO_2 reduction
- At least 46 countries will price carbon emissions
- Significant global investments in wind and solar

These changes may be challenging but can be navigated. Gas turbines can run more efficiently on fossil fuels today and prepare to run on carbon-neutral fuels tomorrow.

Renewables as Feedstock for Synthetic Fuels

Wind and solar generation will surge but remain volatile. Grid stability will continue to be serviced by fast-starting gas turbines fed by existing gas pipeline infrastructure.

Excess renewable energy will need to be stored and both hydrogen and methanol can be readily synthesized by excess electrical production and transported in existing downstream distribution systems.

Converting renewable electricity to green, synthetic fuels will extend the life of today's investments in infrastructure.

Efficiency Improvements

Simple cycle gas turbine efficiency can be improved today. Modifications to bleed valve scheduling, power turbine blade geometry, and use of HEPA air filtration can reduce CO_2 emissions by several percentage points or more.

Digital tools to predict emissions and optimise site operation are also available without hardware installation.

Carbon-neutral Methanol and Hydrogen

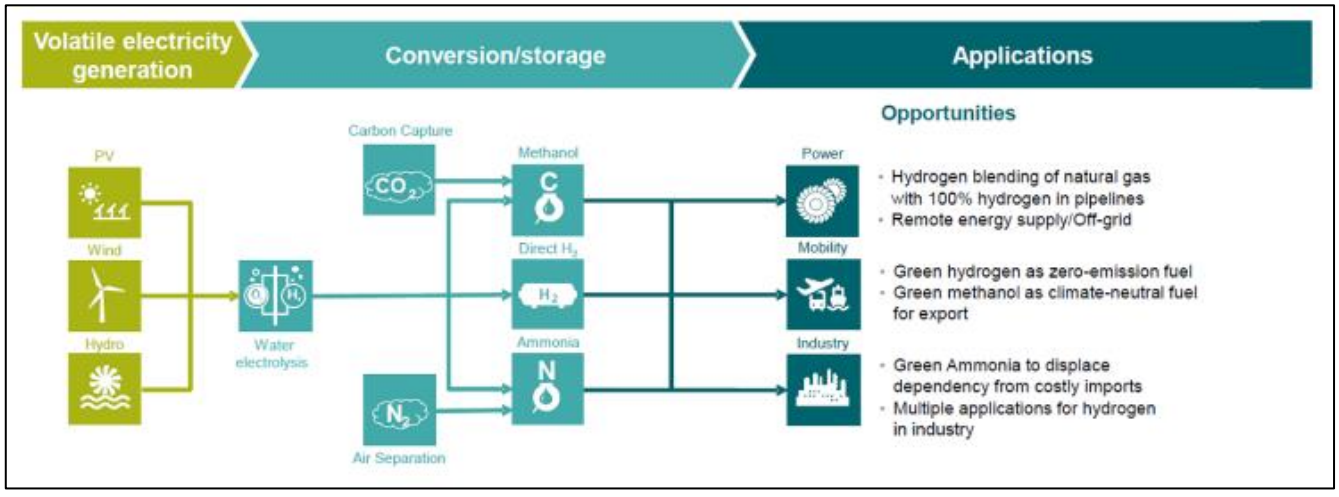
In the next decade, carbon-neutral fuels will take root. Methanol will likely come first, offering significant NO_x and CO_2 reductions as a replacement for diesel, followed by injection of hydrogen into natural gas distribution systems.

Both methanol and hydrogen are commonly produced by stripping carbon from fossil fuels today, but they will eventually be synthesized from water and sequestered CO_2 using excess renewable energy.

Synthetic fuels

- Methanol can replace diesel for sites with access to liquid fuel storage
- Hydrogen can be blended into existing natural gas lines or run as a standalone fuel

A suite of synthetic fuel modifications is prepared to support the energy transition



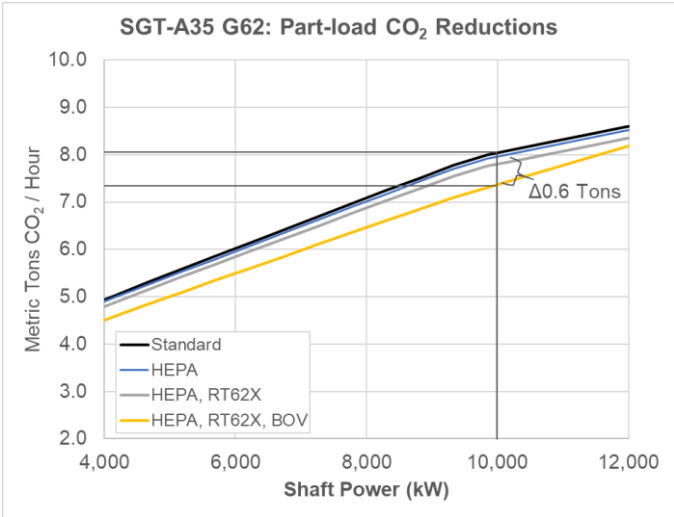
Efficiency Modifications

Bleed Valve Optimisation
At low load setpoints, the compressor bleed valves are rescheduled to close during stable operation.
This is accomplished by control system update.

RT62X Power Turbine
Nozzle guide vanes and turbine blades are upgraded to a more aerodynamic design and upgraded tip seals.

HEPA Air Filtration
High efficiency air filters significantly reduce the buildup of compressor fouling between overhauls, helping to maintain "new and clean" performance.

Waste Heat Recovery
Up to 7 MW may be added to the SGT-A35 through the addition of a supercritical CO_2 waste heat recovery module.

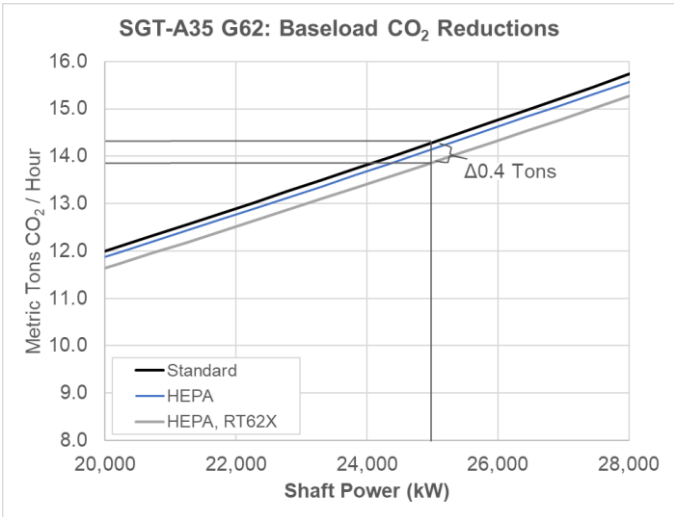


Benefits

The following hardware modifications on the A35 G62 could reduce CO_2 emissions by 0.4 metric tons of CO_2 per train per hour – roughly the same benefit as 20 vol% H_2.

Tabulated Benefits for the SGT-A35 G62

Mods	Hourly Reduction in CO_2
Bleed Valve Optimisation	Up to 0.35 tons CO_2 / hour
RT62X Power Turbine	Up to 0.2 ton CO_2 / hour
HEPA Air Filtration	Up to 0.1 ton CO_2 / hour



Example

Consider a site running 3x SGT-A35 G62 at 10 MW apiece:

	Site CO_2 Footprint
Starting Position	**24.13 tons CO_2 / hour**
Add HEPA Air Filtration	(0.23) tons CO_2 / hour
Add RT62X	(0.48) tons CO_2 / hour
Add Bleed Optimisation	(1.30) tons CO_2 / hour
Ending Position	**22.12 tons CO_2 / hour**

8% reduction in part-load CO_2 emissions is achievable by hardware modifications.

Further reductions are possible through optimising load sharing across assets

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Predictive Emissions

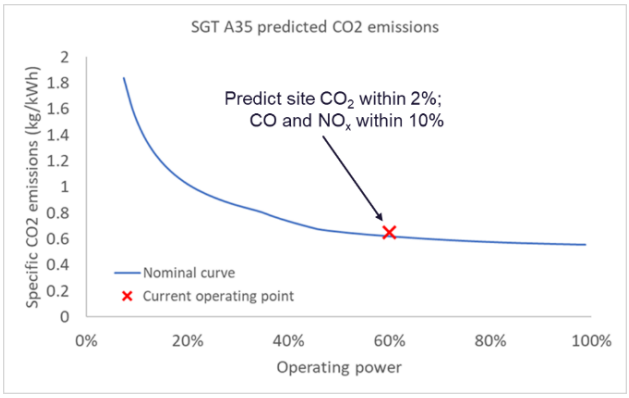
Applicability SGT-A35

Scope of Work
Control system update, or via remote diagnostics

Features and Benefits

- Predict real-time emissions performance
- Track historical emissions performance
- Predicts CO_2 emissions within 2%
- Predicts CO and NO_x emissions within 10%
- No new instrumentation required

Optimise site running profile to reduce carbon footprint; track year-over-year progress toward emissions goals



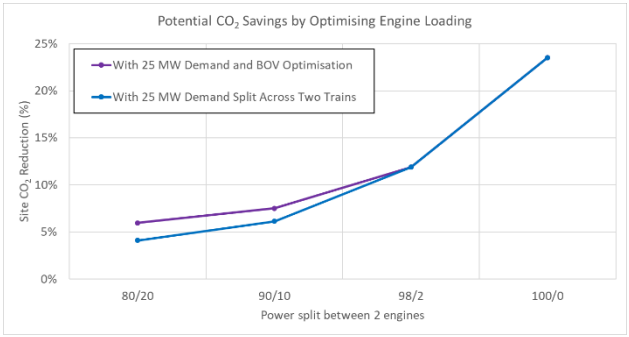
Load-share Optimisation

Applicability SGT-A20, SGT-A35

Scope of Work Software installation to control system or remote diagnostics

Features and Benefits

- Calculates the optimal load-sharing strategy for any operation,
  minimizing site emissions and fuel consumption
- CO_2 emissions may reduce by 10%+ versus an even power split
- Benefits stack with Predictive Emissions and Bleed Valve Optimisation
- No new instrumentation required



Up to 25,000 tons / year CO_2 reduction possible by optimising Load Share

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Methanol Conversions

Applicability

- SGT-A20 and SGT-A35
- Power Generation and Oil & Gas
- Onshore and Offshore, provided liquid fuel tanks

Scope of Work

- Higher capacity burners
- Liquid fuel capacity upgrade, pump change
- Assess package Fire & Gas, ventilation systems
- Control system update

Features and Benefits

- NOx reductions of up to 70% versus diesel
- No SO_2 emissions
- Biodegradable and easy to handle
- Flexibility in managing transition to carbon-neutral operation

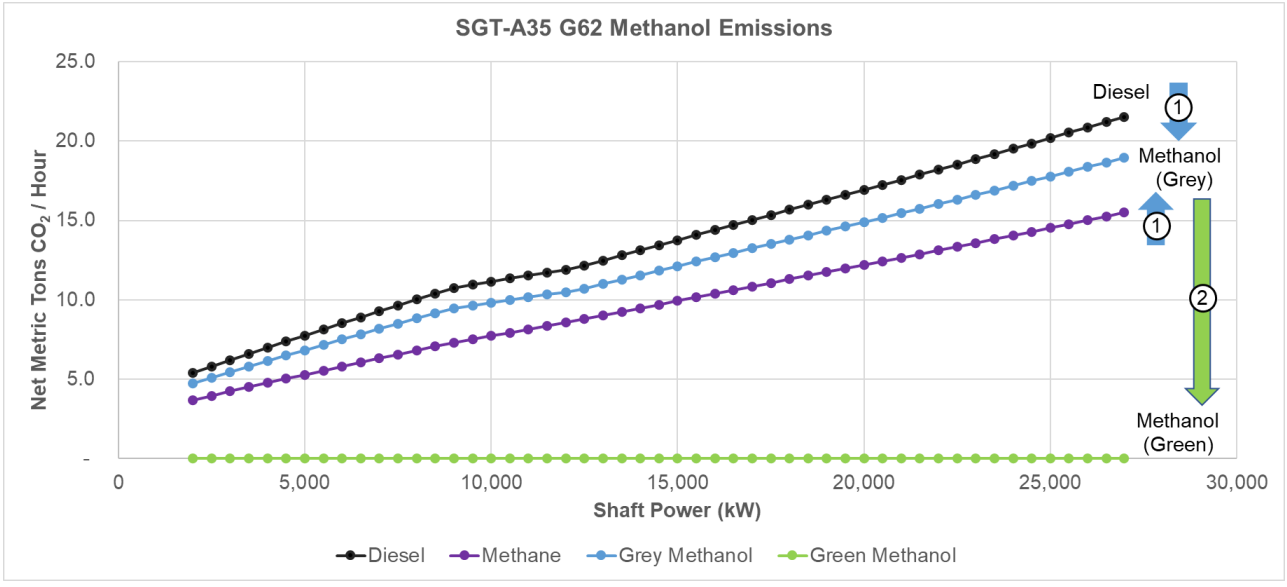
Converting from diesel to methanol can reduce CO_2 emissions by 2.5 tons / hour

Running carbon-neutral "green" methanol makes a site carbon-neutral

Diesel
809 kg CO_2 / MWh

"Grey" Methanol
732 kg CO_2 / MWh

"Green" Methanol
Carbon Neutral



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Hydrogen Conversions

Applicability

- SGT-A20, SGT-A35, SGT-A65
- Power Generation and Oil & Gas
- Emphasis on downstream and power generation

Scope of Work

- Sub-15% H_2: No changes
- 15 – 25% H_2: Site survey for pre-2006 builds
- 25 – 100% H_2: Package modifications required
  - Electrical certifications
  - Fuel capacity, materials compatibility
  - Nitrogen purge
  - Fire & Gas detection, ventilation systems
  - Controls upgrade

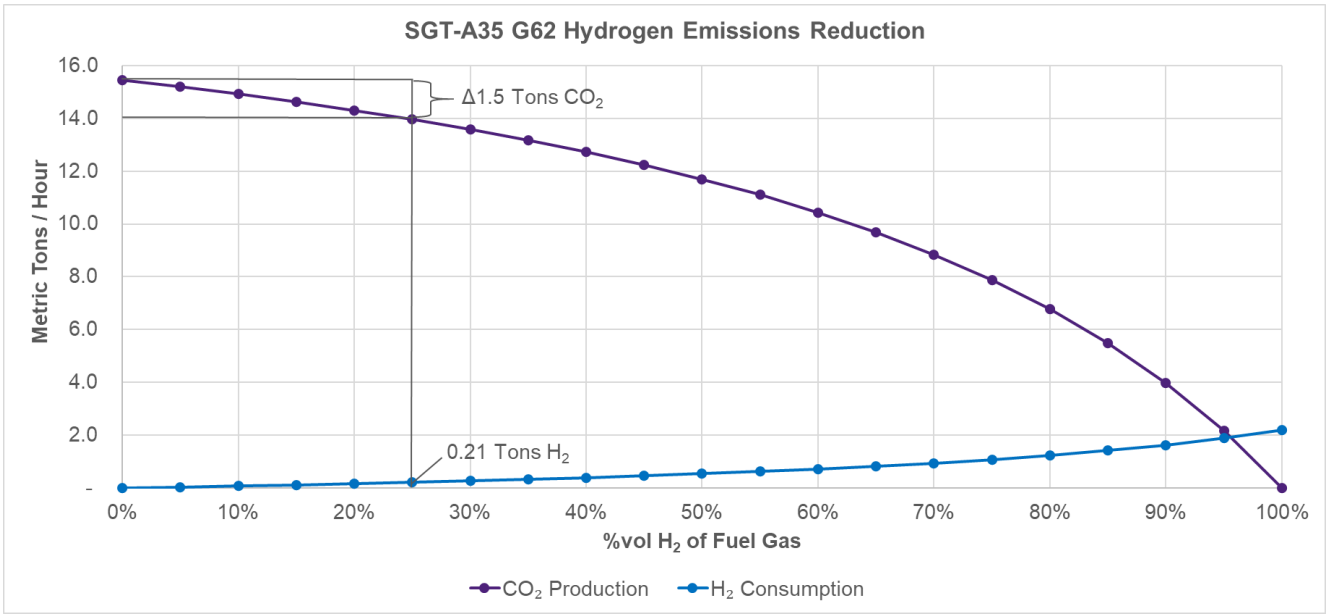
Features and Benefits

- Minimal hardware changes at lower H_2 blends
- Significant CO_2 reductions at higher H_2 blends
- Maintain full power all the way up to 100% H_2
- Both diffusion (WLE) and DLE combustion
- Upgraded H_2 burners can still run natural gas

No power reduction, even at 100% H_2

200,000+ hours of fleet operation on H_2

SGT-A20 began operating on H_2 in 1968



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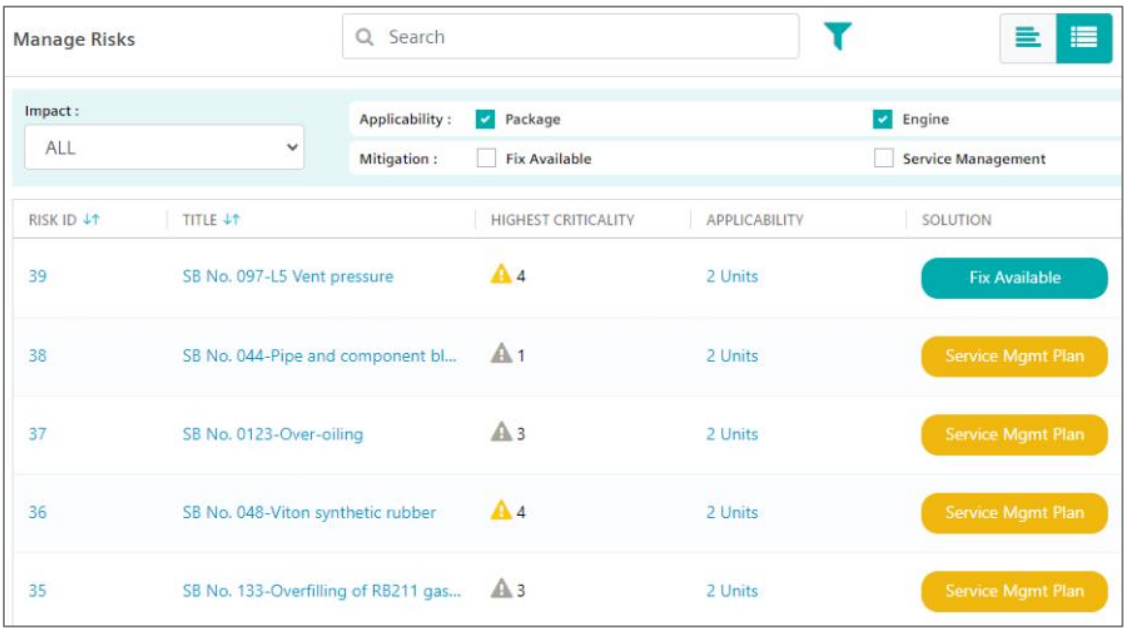
MyFleetRisk

Applicability SGT-A35

Scope of Work
Online platform; RDS not required

Features and Benefits

- Assess site reliability risks by comparing maintenance history to fleet average failure rates
- Highlight top reliability risks and ideal tasks for next outage
- Calculates the impact of delayed action, enabling an informed operations team
- Tracks applicability of Service Bulletins, including decarbonisation Service Bulletins
- Provides online engine log



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