

# Small Gas Turbine (1-15MW) Decarbonization

Our world is changing, and so should we.

[siemens-energy.com](https://www.siemens-energy.com)



Discover the  
Decarbonization  
Portfolio

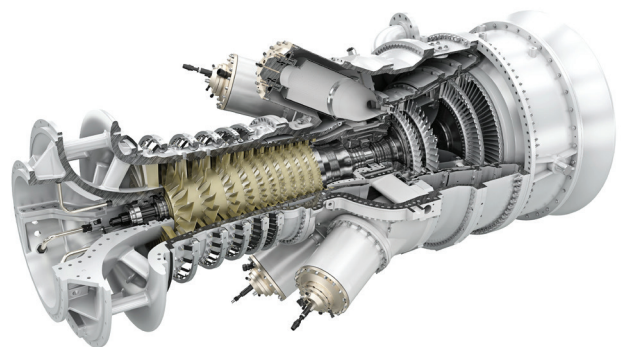
## Introduction

The implication of climate change paired with the increase in energy demand result in major challenges for our planet and our businesses. We need to generate enough energy to satisfy growing worldwide demand with the global priority of reducing carbon dioxide emissions.

Government policy makers are already enacting rules and legislation that support a move to a carbon free future with future standards determining your funding options as investors seek shelter in investments seen as climate friendly. Your local regulations, carbon pricing, the availability of renewables and more may impact your carbon reduction ambitions.

By partnering with us to prioritize the most cost-effective interventions, you can reduce your carbon footprint, promote the least expensive abatement options while increasing the value of your existing assets.

**Today we can offer range of products and solutions both for new units and installed fleet. We can partner you to reduce your carbon footprint and increase your efficiency therefore reducing your costs and making carbon reduction pay for itself.**



## Efficiency Improvements

At Siemens Energy we share your decarbonization goals and understand that deep decarbonization takes time and improving the efficiency of existing assets may be an important first step. This step alone may not enable you to meet your decarbonization targets and often once you start your journey you will deliver initiatives which cover efficiency improvements, modernizations and upgrades and a transition away from conventional fuels in parallel.

Efficiency is critical for decarbonization, less fuel burn, means less CO<sub>2</sub> emitted and in most cases can have an immediate impact. Efficiency improvements can be achieved through multiple solutions. From data driven digital tools to enable us to optimize operations to modifying and upgrading your assets.

Siemens Energy has proven history in achieving step changes in the efficiency of our products, for example, we have improved the efficiency of the SGT-400 11MW by nearly 3% across 10-15MW power range. The equivalent CO<sub>2</sub> saving is similar to operating current SGT-400 with 10% H<sub>2</sub>.

In this section, let's explore our SGT efficiency solutions in a bit more detail.

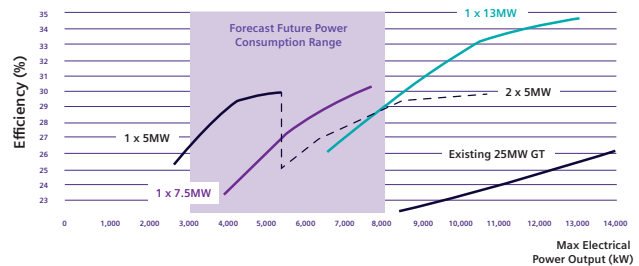
**With the introduction of SGT-400 11MW, SGT have improved the efficiency of the product by 3% across 10-15MW power range portfolio**

## Brown Field Exchange (BEx)

Siemens Energy will tailor solutions to your specific needs and focus on right sizing to optimize operations.

BEx is a concept that replaces your existing gas turbine with a more appropriate solution. BEx is a solution customized to your needs with the goal of enhancing performance and is a perfect resolution for aging and obsolete assets. A more appropriately specified rated unit can provide an attractive business case, given the higher overall efficiency leading to a reduction in fuel burn and subsequent carbon emissions. This is especially beneficial if you are no longer operating at the gas turbine design point and may be able to dramatically improve efficiency through correct sizing.

The chart below provides an example where an existing 25MW gas turbine has seen a change in load requirements over time, to the point where it is operating at a much lower load than originally specified. Operating a gas turbine at low-load and away from the design point can have a significant impact on the operational efficiency. Through exchanging this with a latest technology, more appropriately sized unit(s) for the power duty, you can achieve significant improvements in efficiency and subsequent reduction in CO<sub>2</sub> emissions, providing a sustainable and attractive economic solution for your energy needs.

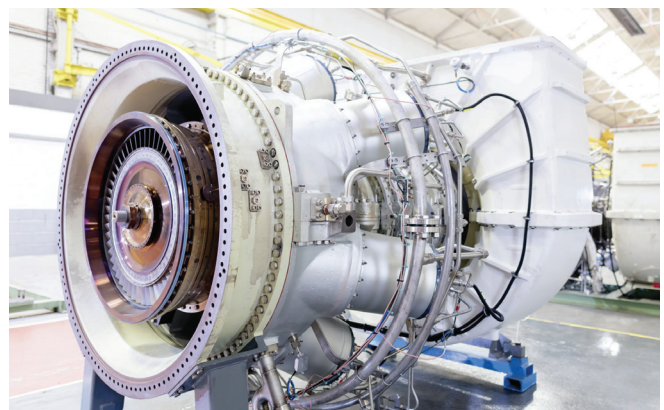


The key concept will focus on making the installation as simple as possible to minimize downtime, whilst trying to retain appropriate infrastructure. The SGT team will work to find that optimum and most beneficial solution to your future energy needs.

### What are the benefits?

The key benefits associated with this new service are:

- Improved efficiency
- Right sizing to optimize operations
- Significant savings on fuel cost
- Reduction of CO<sub>2</sub> footprint
- Reduced emissions
- Quick start and cyclic capability
- Fuel flexibility with DLE technology and high focus on renewable fuels



## SGT-400 Power Upgrade

The 15 MW gas turbine can be retrofitted into existing 13 MW package as it retains common interfaces.

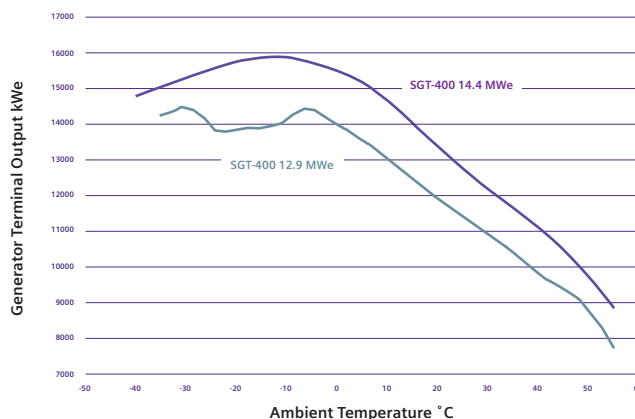
Since its introduction in 2000, the SGT-400 13MW has accumulated extensive operating experience, contributing to the design of the 15MW with a subsequent new product release in 2011. The 15MW rated unit can be retrofitted into existing 13MW assets given it retains common interfaces, making it a natural upgrade meeting your operational energy needs.

This upgrade can be most valuable for an operation that has seen its power generation requirement increase since the original installation, or an operation wishing to become more efficient by reducing the number of (N+1) units operating at one time. The increased capacity can be useful during summer months when the higher ambient temperature makes it difficult to achieve the required loads.

The power increase is generated by changes in the compressor section to create higher mass flow through the core engine.

### What are the benefits?

- Increased power output (MWe), pre-studies revealed scenarios of between 0.6MW(e) and 1.5MW(e) based on ISO conditions (limited by the capability of the driven unit).
- An upgrade can provide the opportunity to reduce the number of units operating at any one time.



#### Datum Conditions

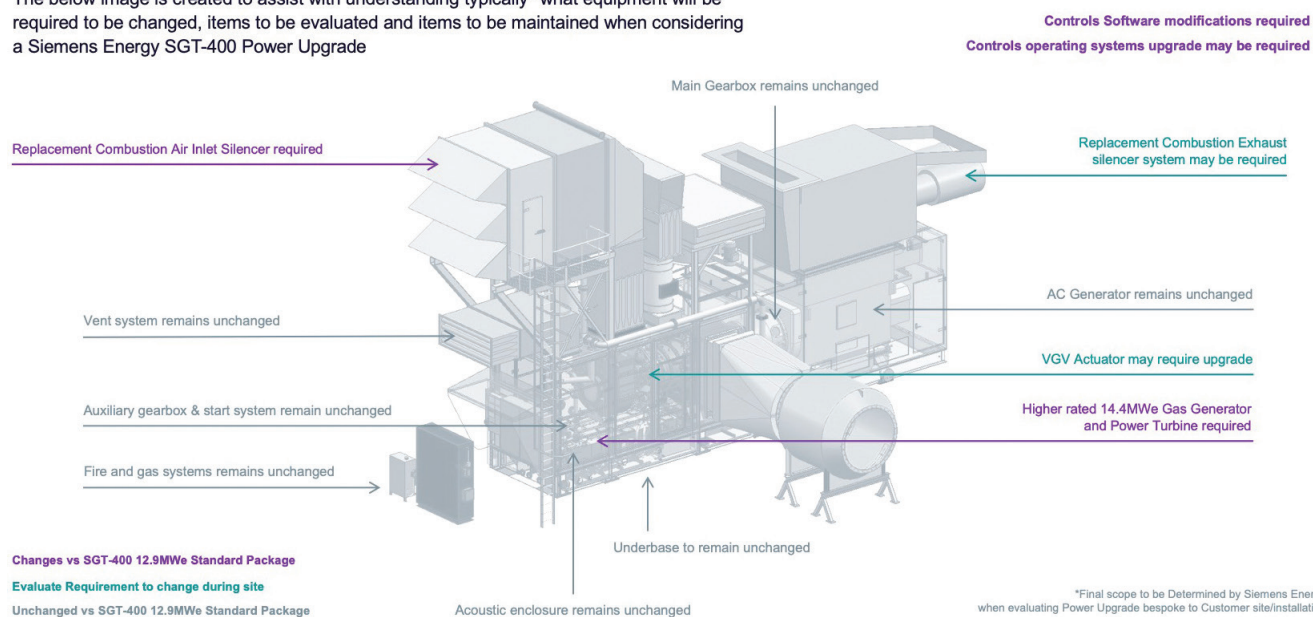
Altitude	0 m	Power Turbine Speed	9500 rev/min
Relative Humidity	60%	Gas Fuel File	stdgas.fug
Inlet Ducting Loss	100 mmH <sub>2</sub> O	DLE Combustion Only	
Exhaust Ducting Loss	75 mmH <sub>2</sub> O	Expected data for a new and clean engine	

Generator output against ambient temperature

Where SGT-400 13 MW units are operated in an N+1 configuration, where typically two units are operating at part-load, there is potential that only one SGT-400 15 MW can be used and therefore meet the energy requirements whilst achieving much higher efficiencies.

- In a multiple unit scenario, the SGT-400 power upgrade can deliver the efficiency increases identified above, but also key sustainability benefits, with a reduction in CO<sub>2</sub>, emissions and assisting customers with overall decarbonization of their processes.
- Potential reduction in the need to import extra power during periods of higher power demand, typically when operating for long periods at high ambient conditions.

The below image is created to assist with understanding typically\* what equipment will be required to be changed, items to be evaluated and items to be maintained when considering a Siemens Energy SGT-400 Power Upgrade



Applicable retrofit to an existing 13MW SGT-400

## Dry Low Emissions (DLE)

First introduced in 1993, more than 500 units are sold now with more than accumulating 30 million running hours.

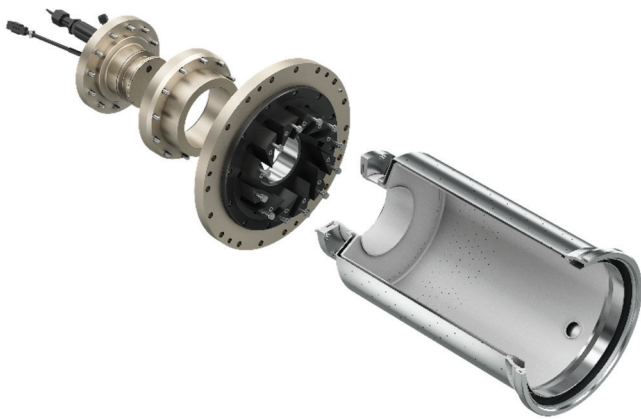
Dry Low Emissions (DLE) is a method of reducing emissions of Oxides of Nitrogen (NO<sub>x</sub>) and Carbon Monoxide (CO) from the gas turbine without utilizing steam or water injection.

Upgrading to the gas and liquid fuel DLE combustion system not only drastically reduces the emissions, it also provides greater control over the engine combustion which results in a more reliable starting philosophy and generally improved operational capabilities.

### What are the benefits?

- Reduced NO<sub>x</sub>, CO emissions\*
- Reduced unburned hydrocarbon (UHC) emissions\*
- Low smoke emissions, < Bacharach 1 (no visible plume)
- Improved starting
- Improved response and controllability

\*Relative to 15% O<sub>2</sub>, engine type and rating



**Enhanced DLE:** Although the SGT team has proven DLE technology to meet the needs of the market, they are in the final process of releasing a new technology to target <9ppmvd NO<sub>x</sub> over a greater load range.



## Exhaust Emission Treatment / Reduction

**With ever increasing stringent emissions requirements, Siemens Energy Gas Turbine packages can be retrofitted to include SCR (Selective Catalytic Reduction) technology to further reduce both CO and NO<sub>x</sub> in the exhaust constituents.**

SCR options can be used in conjunction with a range of fuel types including Dry Low Emission technology and both Predictive and Continuous Emission monitoring.

Siemens Energy has access to the supply of unique patented Ammonia injection grid technology and tempering air systems. By means of flow testing and physical modelling (cfD) exact individual customer requirements can be met. Field site assembly costs are reduced through modular designs and with little to no maintenance this means maintenance costs are minimal.

### Benefits:

- CO & NO<sub>x</sub> reduction to single digit ppm (typically 2ppm CO and 4ppm NO<sub>x</sub>).
- Scaled cfD modelling & physical test to suit exact site and equipment requirements.

### Considerations:

- Available space around the balance of plant of the installation including location of the Ammonia skid and availability of Ammonia (Which is also a potential future green fuel) as well as air systems and the SCR catalyst.
- Pulse, static or anti-icing requirements for tempering air filtration.

In summary SCRs can be tailored to suit existing package layouts and individual customer emissions reduction requirements.



## Remote Customer Witness Test

The customer witness test is a key stage in the testing and acceptance of new or overhauled gas generators or power turbines. The remote customer witness test gives the flexibility for the witness test to be viewed from multiple locations around the world while maintaining the interaction and benefits of attending the test in person.

With the advanced communication equipment in our pool of testing bays, you can view the running of your unit for the first time with the ability to access live camera feeds, trending, controls mimics and data analytics. With the hybrid option, attendees can still attend the test in person and include key individuals from anywhere in the world leading to even greater flexibility and functionality.

**SGT have successfully conducted over 100 remote tests, helping customers to reduce travel and carbon impact.**

### What are the Benefits?

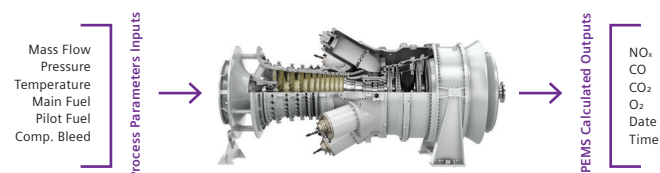
- Flexibility: View the testing of your equipment from the comfort of a location that works for you.
- Cost savings: With this additional functionality, there's no need to spend valuable time away from your site/ operations. This, along with the reduction or eradication of travel costs, means considerable savings.
- Can be achieved by opting for the remote customer witness test.
- Decarbonization: With the reduction or eradication of travel, we can reduce the effects on the environment.

## Predictive Emission Monitoring System (PEMS)

PEMS represents a significant cost saving over Continuous Emissions Monitoring System (CEMS) and gives you the opportunity to manage your emissions output.

A digital solution which provides emissions data to your fingertips and has the capability to calculate NO<sub>x</sub>, CO and CO<sub>2</sub>.

Siemens Energy PEMS uses unique knowledge of the product with thermodynamic and chemical kinetics modeling, which can predict the exhaust emissions. This PEMS development will provide you with a lower life-cycle cost, due to the reduced capital investment and lower maintenance costs, compared with a dedicated CEMS.

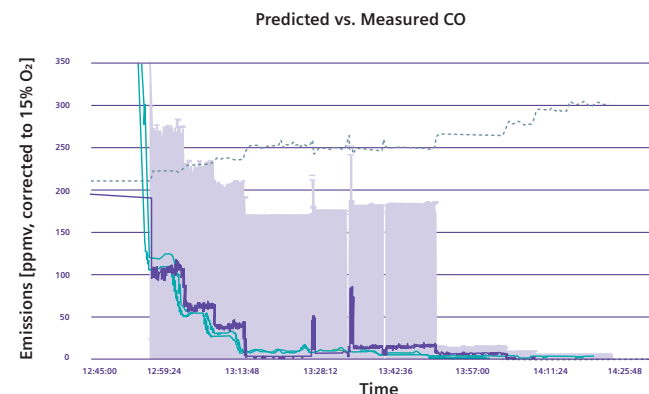


Accurate emissions monitoring without the requirement for significant capital investment and regular maintenance.

PEMS can integrate with your current systems and support providing emissions data to local authorities whilst being widely accepted globally.

### What are the benefits?

- PEMS is a suitable means for evaluating emissions under MPC directives (possible to CEN/TS 17198 certify).
- No requirement for additional instrumentation, as PEMS uses sensors already installed within the engine.
- PEMS can be accessed via STA-RMS remote monitoring platform or be fully embedded within your control system.
- Can be installed as Software-as-a-Service or independent software platform.

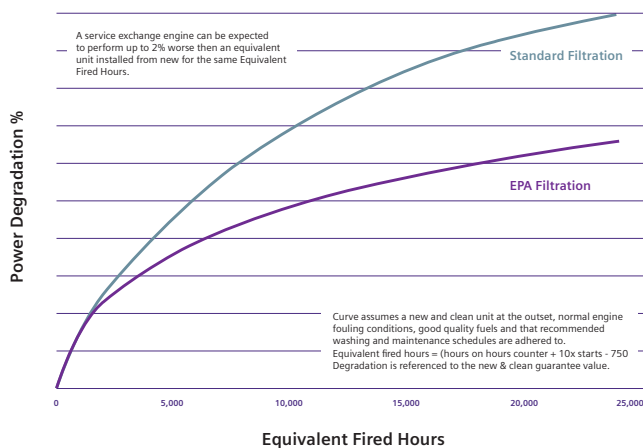


Predicted vs. Measured CO Data Example

## Efficiency Particulate Air Filter (EPA, previously known as HEPA)

A high efficiency particulate air filter that intercepts, impacts and diffuses particles that can have a detrimental effect on your asset.

By reducing the contaminants being drawn into the engine you will limit degradation in compressor performance. This will maintain a higher efficiency and subsequent reduction in fuel burn over conventional filtration.

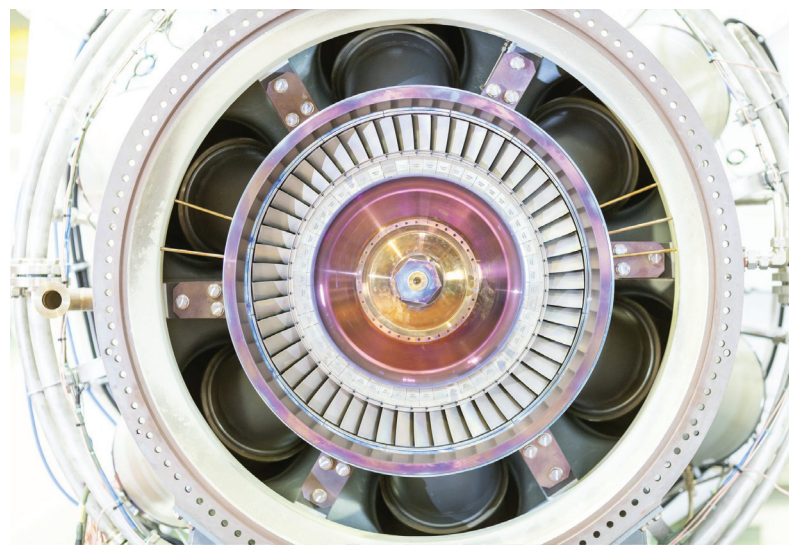


### What are the benefits?

Retrofitting EPA filtration represents a win/win situation. You will achieve:

- Increased gas turbine availability of typically 2% due to a reduction in water washing.
- Increase in power generation (MW-h per annum) of typically 1% due to the increase in availability and reduction in power degradation.
- Reduced fuel burn (based on life cycle costing) of typically up to 5% due to the reduction in power degradation.

**Up to 365 tonnes less CO<sub>2</sub> per year can be achieved, based on replacing a F9 with E12 HEPA filtration on an SGT-400 13MW**



## Fuel Flexibility



Whatever your business challenges may be, our small gas turbines are precisely designed to master the dynamic energy market environment. Low life cycle costs, low CO<sub>2</sub> footprint and an excellent return on investment right from the start are just three of the major benefits that our gas turbine portfolio offers.

Fuel flexibility helps address these three major benefits, making use of the lowest cost available fuel and sometimes running on gases which are otherwise considered wastes, even in DLE combustors. From natural gas to LPG, Renewable Natural Gas (biomethane) to Biogas, our turbines offer significant CO<sub>2</sub> reductions in CHP and Distributed Power plants compared to coal and fuel oils, while industry can make use of process off-gases such as Refinery Fuel Gas or Coke Oven Gas to reduce flaring and fossil fuel consumption.

We can meet stringent emissions standards while running loads as low as 30% and in most instances have seamless, true dual-fuel (gas/liquid) capability with no pilot fuel. We continue to improve that on this fuel flexibility with developments to operate on net zero carbon fuels such as 100% hydrogen from 'blue' or 'green' sources, e-methanol, ammonia and more, while still striving to achieve as low combustion emissions as possible.

Many view Hydrogen as the fuel of the future. Since the 1960s, more than 55 Siemens Energy gas turbines, built for a range of industries around the world, have combusted fuels with varying hydrogen content, amassing more than 2.5 million operating hours. Demonstrating our proven history in continuously innovating our products on hydrogen capability, SGT has successfully increased the percentage of hydrogen (H<sub>2</sub>) in the fuel mix over this time. Currently we have proven technology with a mix of up to 80% H<sub>2</sub> dependent on the product type.

The ultimate goal however, and our commitment as Siemens Energy is to be capable to operate our gas turbines on 100% H<sub>2</sub> by 2030 – and thanks to the EU-funded HyflexPower project, we are on track to achieve this well before 2030 on some gas turbine models.

This development project will allow operation on 100% H<sub>2</sub>, 100% natural gas, or any blend of H<sub>2</sub> and natural gas in between, helping you decarbonize gradually and flexibly by allowing low carbon hydrogen to be blended into the fuel mix to meet the environmental and regulatory needs of the market. Ultimately our SGTs can pave the way to a more sustainable energy future.

## We have over 2.5 million operating hours currently running on alternative fuels

### What are the benefits?

- Significant CO<sub>2</sub> reductions at higher H<sub>2</sub> blends
- Maintain full power all the way up to 100% H<sub>2</sub>
- H<sub>2</sub> operation is possible with both DLE and non-DLE combustion technology
- Upgraded H<sub>2</sub> burners can still run 100% natural gas
- Minimal hardware upgrade

Let Siemens Energy help you reach your decarbonization targets. To calculate your CO<sub>2</sub> reduction benefit and cost savings potential by operating your gas turbines on a H<sub>2</sub>/NG blend or pure H<sub>2</sub>, please find the link below:

<https://www.siemens-energy.com/global/en/offerings/power-generation/gas-turbines/hydrogen-decarb-calculator.html>

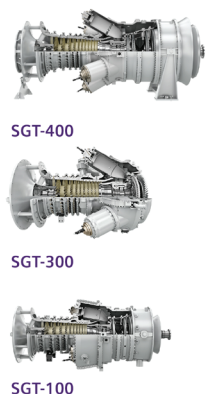
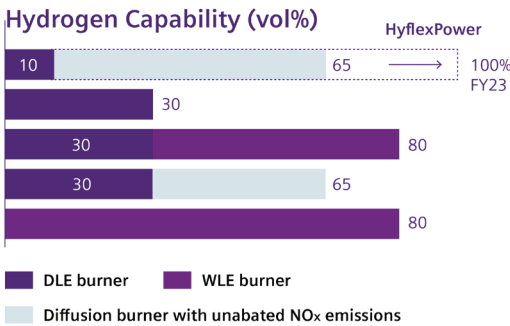
## SGT Hydrogen Gas Turbines for our Sustainable Future: Well on track to burn 100% Hydrogen

- ✓ Carbon-free power generation
- ✓ Proven Fuel Flexibility
- ✓ Fast, efficient and reliable



Gas Turbine	Power Output <sup>1</sup>
SGT-400	10 to 15 MW
SGT-300	8/9 MW
SGT-200	6/7 MW
SGT-100	5/6 MW
TB <sup>2</sup>	4/5 MW

<sup>1</sup> ISO Base Load, Natural Gas    <sup>2</sup> Only available in NON-DLE Combustion  
 Values shown are indicative for new unit applications and depend on local conditions & requirements. Some operating restrictions and special hardware and package modifications may apply.



## Our Journey

HYFLEXPOWER develops the world's first industrial-scale power-to-X-to-power demonstrator (EU funded project in France) using the Siemens Energy advanced hydrogen SGT-400 DLE Gas Turbine. With high flex power we provide CO<sub>2</sub> free power generation for the future!

### Solutions

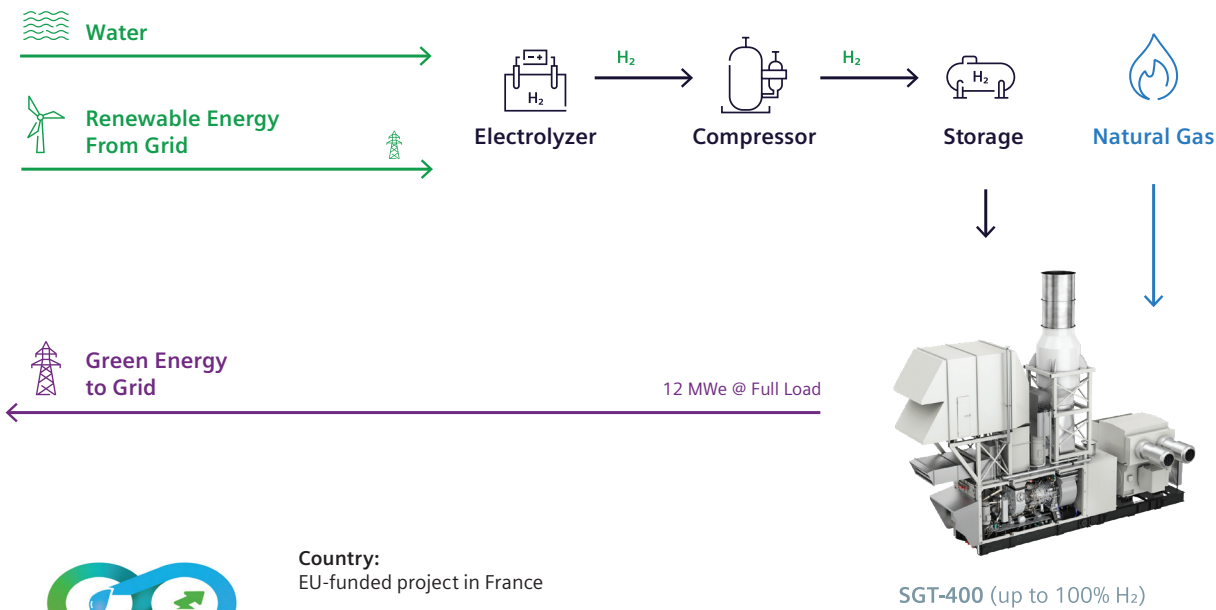
- CO<sub>2</sub> free power-to-power path using Low NO<sub>x</sub> DLE technology
- Today SGT-400 DLE with 10% Hydrogen capability
- SGT-400 DLE Hydrogen pilot, demonstrating 30% H<sub>2</sub> capability by 2022 and 100% H<sub>2</sub> capability by 2023 using technology that is transferable to other SGT frames
- Fuel flexibility to meet decarbonisation and emissions targets, not only H<sub>2</sub> focused, but fuels such as Ammonia are being evaluated

### Benefits

- No carbon taxation due to CO<sub>2</sub> free emissions
- Continues to target low NO<sub>x</sub> output whilst being H<sub>2</sub> capable
- Turnkey solution for H<sub>2</sub> production, storage and fuel delivery

We have developed decarbonisation solutions beyond our products to help us jointly achieve our carbon neutral targets. Creating digital solutions from "Remote Customer Witness Tests" to innovating in what we do in our own site and factories to reduce carbon footprint in-house and externally.

We are going on a similar journey to you of continuously introducing new efficiency measures to delivering longer term transformational change on how we generate our energy. All while ensuring we implement economically sustainable business models to support these activities.



**Country:**  
EU-funded project in France

- Scope of Supply:**
- Exchange of H<sub>2</sub> ready GT + Ancillaries Upgrades
  - Integrated H<sub>2</sub> producing Electrolyser and storage

SGT-400 (up to 100% H<sub>2</sub>)

Joint Venture Project by:



## Conclusion

The 17 Sustainable Development Goals (SDGs) set out in the United Nations 2030 Agenda guide us in our plans and actions. Whilst Siemens Energy contributes to achieving all 17 SDGs, we are focusing on the five where we can have the greatest impact, for example: SDG 7 “Affordable and Clean Energy”.

We actively endorse the Paris Agreement on climate change and support ambitious political programs such as the EU Green Deal and the EU hydrogen strategy.

We offer products, services, and solutions across the entire energy value chain. The transition to a net zero future is a journey with many steps. It will take time and require a range of both mature and emerging technologies. With our operational optimization, fuel flexibility and digital solutions, Small Gas Turbines (1-15MW) are at the forefront of the decarbonization strategy and are uniquely qualified to partner you in navigating this dynamic journey. But decarbonization takes time. It’s not an overnight shift. We are pragmatic and thorough.

SGT continue to innovate in this field with future research and development focused on optimization of various areas such as, engine bleed, power turbine speed, multi engine (load share) and VGV modulation.

We also continue to invest in our journey to 100% hydrogen with a vision of reaching this target by demonstrating our capability by 2023. Our alternative fuel strategy remains open to exploring other renewable sources.



We will continue to work in partnership with you in defining sustainable, affordable, and reliable decarbonization roadmaps for your assets. Together we will adapt to new realities and seize emerging opportunities taking a holistic and step by step approach.

This is how SGT will continue to lead the way to a deeply decarbonized world, supporting you and our governments, utilities, and industry to a transformed system of energy.

We are continuously developing our decarbonization offerings, to find more information and keep up to date with our progress, please access MyAdvisor via the link below:

<https://siemens-energy.secure.force.com/myAdvisor/>



Source: United Nations 2021. [www.un.org](http://www.un.org)

Published by  
Siemens Energy Global GmbH & Co.KG

Siemens Energy Industrial Turbomachinery Ltd.  
Teal Park Road  
Lincoln LN6 3AD, United Kingdom

[support.energy@siemens-energy.com](mailto:support.energy@siemens-energy.com)

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