PSM
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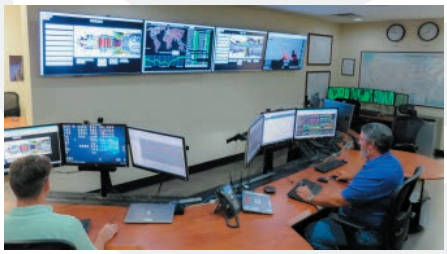
Digital Products



Helping our gas turbine power plant customers achieve their business and profitability objectives is why PSM & Thomassen Energy exists. This is achieved by delivering service service solutions that enhance the reliability and operational flexibility of their assets.

Maximizing Plant Performance

Before, during or after large equipment upgrades our Digital Technology Portfolio maximizes the potential performance of your plant. Very often combining several engineered systems together, there are some layers of overlapping redundancy, which if fully understood provides significant optimization potential. Over the last decade, we have been combining our domain expertise in GT technology, combustion system design, engine upgrades, engine operation from our M&D Center, as well as controls logic experience, together with balance of plant operations and advanced controls methods, to create innovative optimization tools. Using propriety and patented controls blocks we can offer multiple optimization features offered to suit your individual needs.

FlexSuite and AutoTune

A portfolio of applications for your existing controller FlexSuite provides Digital Optimization for your power plant operations. No matter if you are looking for **operational reliability** improvements or increases **operational flexibility** there are multiple optimization features offered to suit your individual needs.

FlexSuite Building Blocks

+ Combustion Optimization
+ Start-up / Shut-down Optimization
+ Enlarged Load Range
+ Efficiency and Lifetime
+ Fuel Flexibility
+ Grid Support
+ Service Flexibility

Virtual FlameScanner – DLN1.0 & DLN2.6 System Reliability

Feedback on the presence of flame in the combustor is critical to engine reliability, our Virtual FlameScanner eliminates common issues with B/E and F Class optical flame detectors. By replacing the standard optical flame scanners with data from the exhaust temperature sensors, it is possible to reduce maintenance efforts and improve overall system reliability.

DLN2.6 Mode 3E Start-Up Logic Package

Combining PSM's combustor system design knowledge with the operational challenges todays plant operators face, we have been able to alter the OEM start-up combustion modes to remove hold points. Often installed during a turbine outage, the additional controls logic block can remove visible plume at the exhaust stack and demonstrating a ~3x reduction of start-up stack NOx emissions.

FlexSuite

Multiple Controller Platforms

With our Multi-Platform approach, PSM is uniquely positioned to develop solutions for one platform and then apply across multiple GT platforms. For example, taking technology implemented on Fr7F units and applying to SW501F units and Fr7EA Units as well as developing new solutions for all platforms.

FlexSuite Applications can also be implemented on any control platform, no matter if you are using original OEM GT controls or alternative Emerson Ovation or ABB controls and plant DCS. Allowing you to achieve significant advanced features without the need for costly full system upgrades, even on decades old controllers.

Operational Reliability

Ensure your plant starts and performs with greater predictability with Flex Apps like Startup Automation, Start-up Emissions. Additional reliability can be gained with Virtual FlameScanner. These digital applications can augment the current plant capabilities, adding an extra layer system wide of optimization.

AutoTune

Intelligent GT combustion optimization for emissions and combustion dynamics, while maximizing operational range and fuel variation. Utilize in conjunction with FlexSuite, FlameSheet™ and GTOP™ to maximize the optimization potential.

System Features

AutoTune is an expert advisory system that provides extra level of intelligent protection to your existing controller

+ External to control system
+ HMI screen seamlessly integrated

Patented learning algorithms eliminate the need for seasonal tunes and provide significant system enhancement:

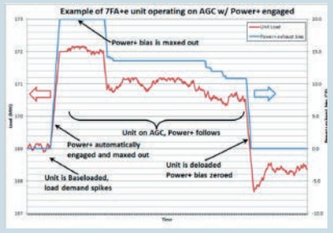
Tuning Optimization

+ Dynamics - providing improved hardware life and Lean Blow Out mitigation
+ Emissions – avoiding excursions, providing consistent emissions even with atmospheric/ climate/seasonal changes, at varying load points
+ Learning – intelligent learning of known operational points allows for less tuning and therefore less chance for error
+ Transient tuning - adapts to cycling of units and provides response to dynamics changes
+ Trip Avoidance: provides ultra-fast reaction if combustor is flaming out to prevent a trip

Power+ on AGC

Power+ automatically increases power output once AutoTune detects the engine is baseloaded.

When AGC requests higher target load Power+ will quickly and safely reach maximum power automatically



Operational Flexibility

With PSM's patented algorithms, it is possible to maximize the GT output according to the climate conditions and actual system performance, for example do you want to maximize season peak power potential? AutoTune continuously seeking to maximize load range while maintaining emissions and dynamics, three optional modes are available:

+ Power+ at current firing temperature range with no impact to hardware life
+ Peak+ at option for increase peak firing mode to achieve greater improvements, with some hardware lifetime debit
+ Turndown - minimizing low load point by maintaining output just above premix transfer

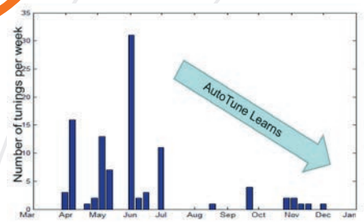
While running on Automated Generation Control (AGC) or remote dispatch: Peak+, Power+, Turndown & Transient Tuning are all active and do not require stable load conditions before optimizing.

AutoTune

AutoTune Learns

Patented learning algorithm captures information from successful and unsuccessful tuning events.

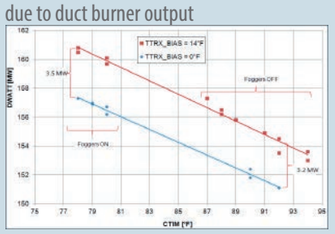
Overtime, AutoTune learns and the need for tuning reduces drastically whenever the same operating conditions are experienced.



Power+

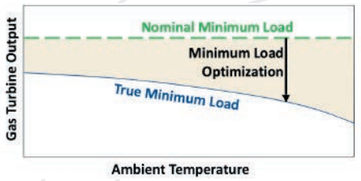
ERCOT Site generated sufficient additional MWh with Power+ to re-coup investment in 9 months

Another site reported 4 MW increase per unit, increasing plant capacity by ~10 MW and mitigated concerns for emissions excursions due to duct burner output



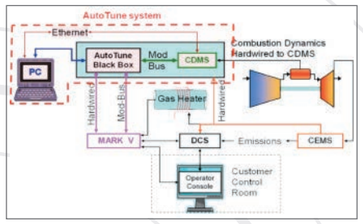
Extended Turndown

+ Dynamic optimization of unit minimum load
+ AutoTune monitors emissions and combustion dynamics to safely meet load target or hold at lowest safe point of operation
+ Integrated with both manual load control or AGC drive load targets
+ Learns over time by saving ambient condition profiles to allows for quicker load ramp when revisiting safe operating points

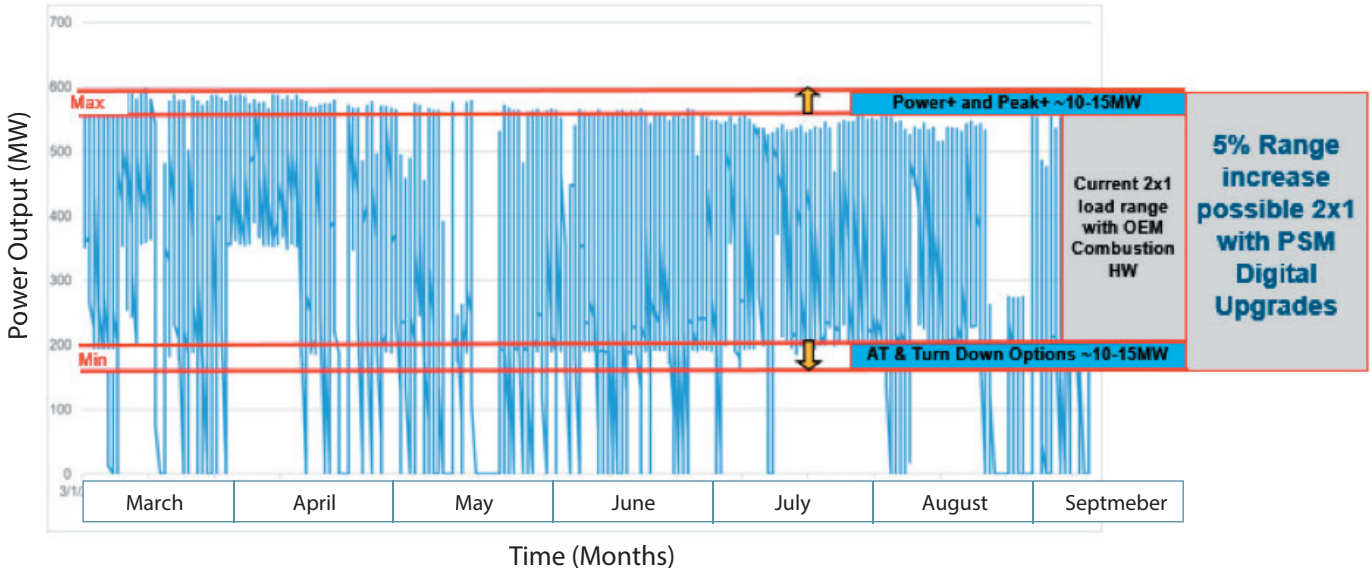


Fuel Flexibility

Three levels of fuel flex technology are available offering +/- 2% MWI range improvement, does not require fuel gas chromatograph or any kind of combustion system modification. These optional modules allow multiple fuel supplies to be switched with the GT online, keeping



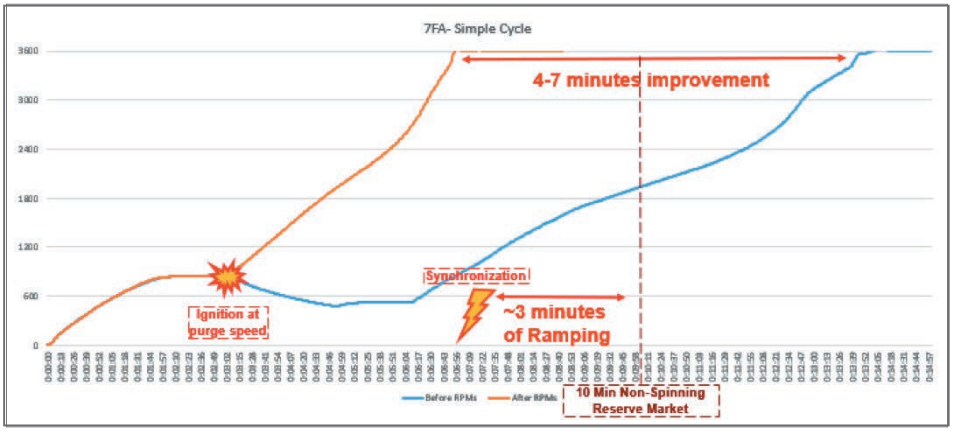
+ FGT (Fuel Gas temperature): reduces Fuel Gas temperature to minimize hot tone dynamics
+ FPP (Fuel Property Parameter) table to enable extra dimension of tuning intelligence if distinct variations in fuel are detected (eg multiple sources of Fuel Gas)
+ FTO (Fuel Temperature Optimization) utilizes a high performance fuel gas heater to actively manage the wobbe range of the fuel



Example CCGT Plant, by combining FlexSuite and AutoTune optimization a 5% increase in load range is possible, using OEM combustor and no other hardware changes.

Start-Up Optimization

FlexStart & FlexRamp: **increase reliability** and **availability** through control logic improvements and adaptations that allow your GT's to better meet your performance needs. No matter if you are in a 10 minute start-up market or auxiliary services, being able to start faster and subsequently ramp fast both before and after heat soak can provide significant monetary value.



Example 7F rotor RPM with FlexStart controls logic optimization, gets SCGT to grid synchronization 7 minutes faster than originally commissioned allowing plant to operate in 10 minute spinning reserve market.

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Thomassen Energy BV
Havelandseweg 8D
6991 GS Rheden, The Netherlands
Phone: +31 (026) 497 5800
E-mail: info@thomassen.psm.com

www.psm.com / https://thomassen.energy

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