

AUTONOMOUS TUNING FOR AERODERIVATIVE TURBINES

Closed-loop AI/ML software engineered to reduce emissions

Explore now 

MEET EMISSION REQUIREMENTS. EVEN DURING PEAK SEASON.

Benefits

0.5% - 1%
reduction in fuel consumption

Up to **14%**
reduction in CO emissions

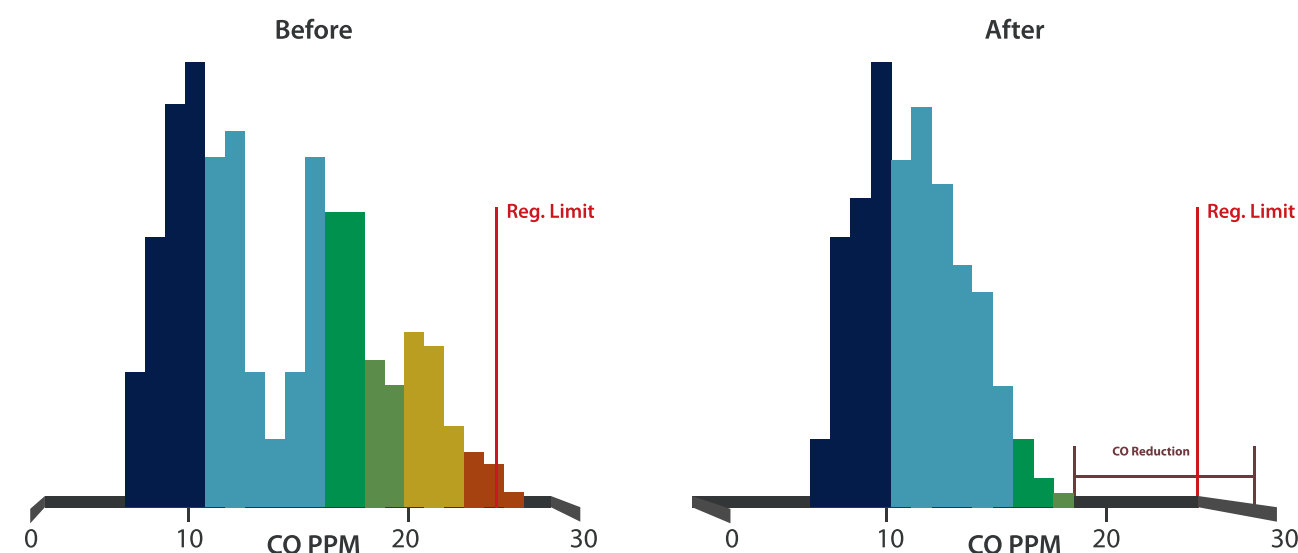
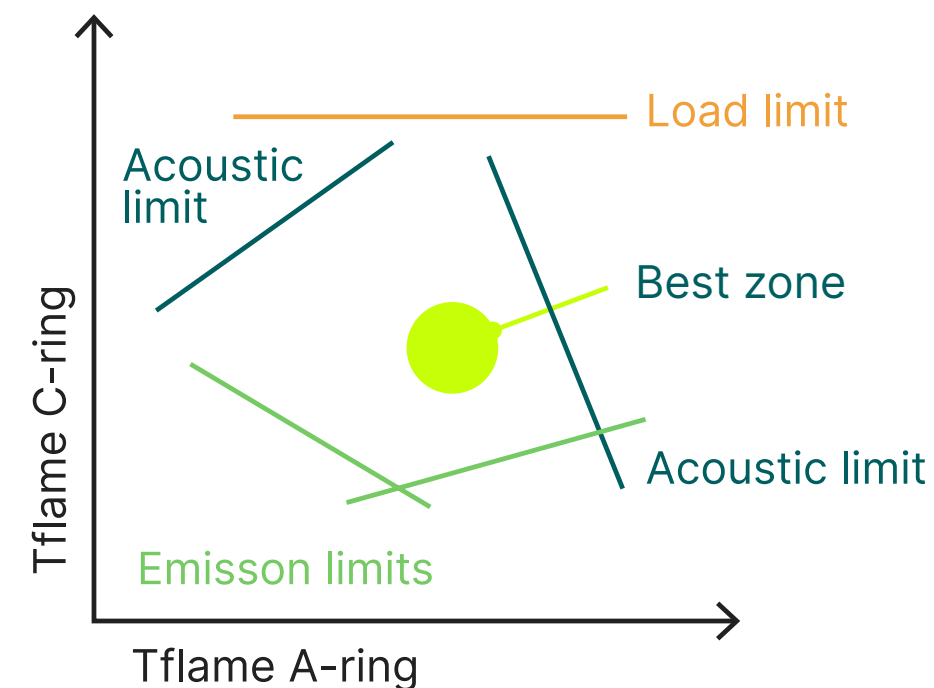
Up to **12%**
reduction in NOx emissions

0 Manual tuning
or associated downtime

The AI/ML behind the software automatically explores the operational space of gas turbines, then builds updated models. The models continuously find the optimal fuel splits to minimize emissions and acoustics **every 2 seconds**.

Frame Applications

- LM2500 Base, Plus, +G4, +G5
- LM6000 PD
- LM6000 PF/PF+
- Any OEM (control system agnostic)



STANDARD SCOPE

The key components of the on-premise software and hardware solution include the following:

L1 Turbine Control

L1 Turbine Control Integration Level 1 (L1) Primary Control Package Software, will be connected to the L2 ProcessLink Edge Control Server and a new Autonomous Tuning HMI screen will be added to the user interface.

This architecture enables upgrades to either legacy systems (already installed) or new systems (installed in parallel).

L2 Digital Twin Model & Supervisory Control

Level 2 (L2) provides supervisory combustion control utilizing Autonomous Tuning turbine-specific models and ProcessLink software. For L2 and gas turbine controller (L1) communications EGD protocol is preferred, however, AT will work with any off the shelf protocol (i.e. OPC).

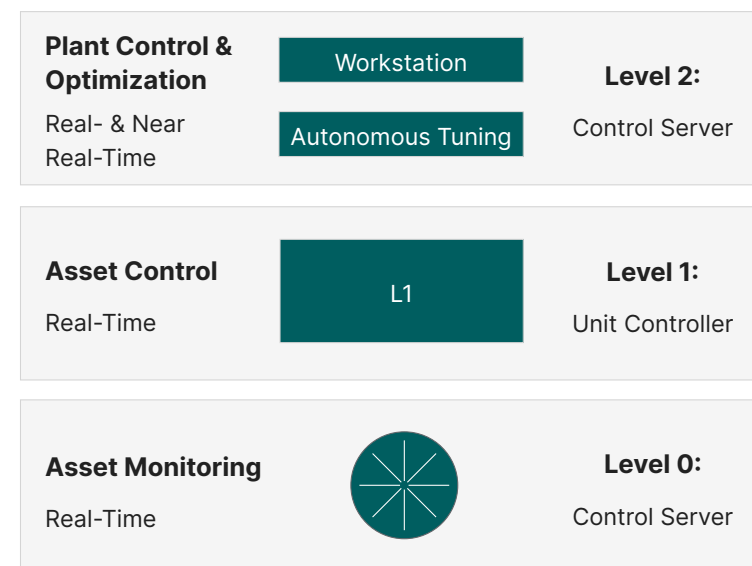
Communication speed does not have a “minimum speed” requirement; typical speed is 100 ms. Software solves a nonlinear optimization problem to find optimal adjustments every 2 seconds subjected to constraints in manipulated variables.

Manipulated Variables (MVs): Inner Ring Flame Temperature, Outer Ring Flame Temperature, Bulk Flame Temperature, Pilot Split, ELBO

Controlled Variables (CVs): PX36 Acoustics, NOX Emissions, CO Emissions; priorities can be adjusted to meet customer requirements. (e.g. European customers are more interested in emissions)

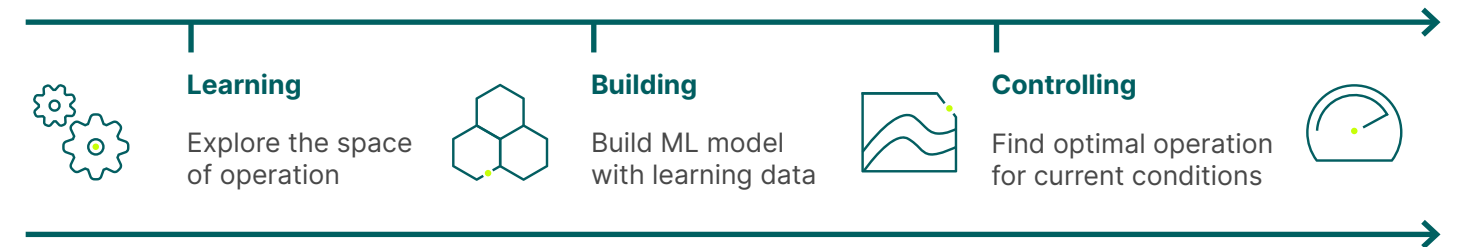
- **Level 2 control:** Autonomous Tuning acts only on biases
- Biases ramp back to base schedule when deactivated
- Deactivated by manual operator action or automatically in case of unsafe conditions (e.g., loss of communication, high dynamics, fluctuations)
- Remote access for supervision
- **ProcessLink Edge Control Server:** See Appendix A for hardware specification

Priority	Variable
1	Acoustics
2	T48Error
2	N25HError
3	CO
3	NOX



MODES OF OPERATION

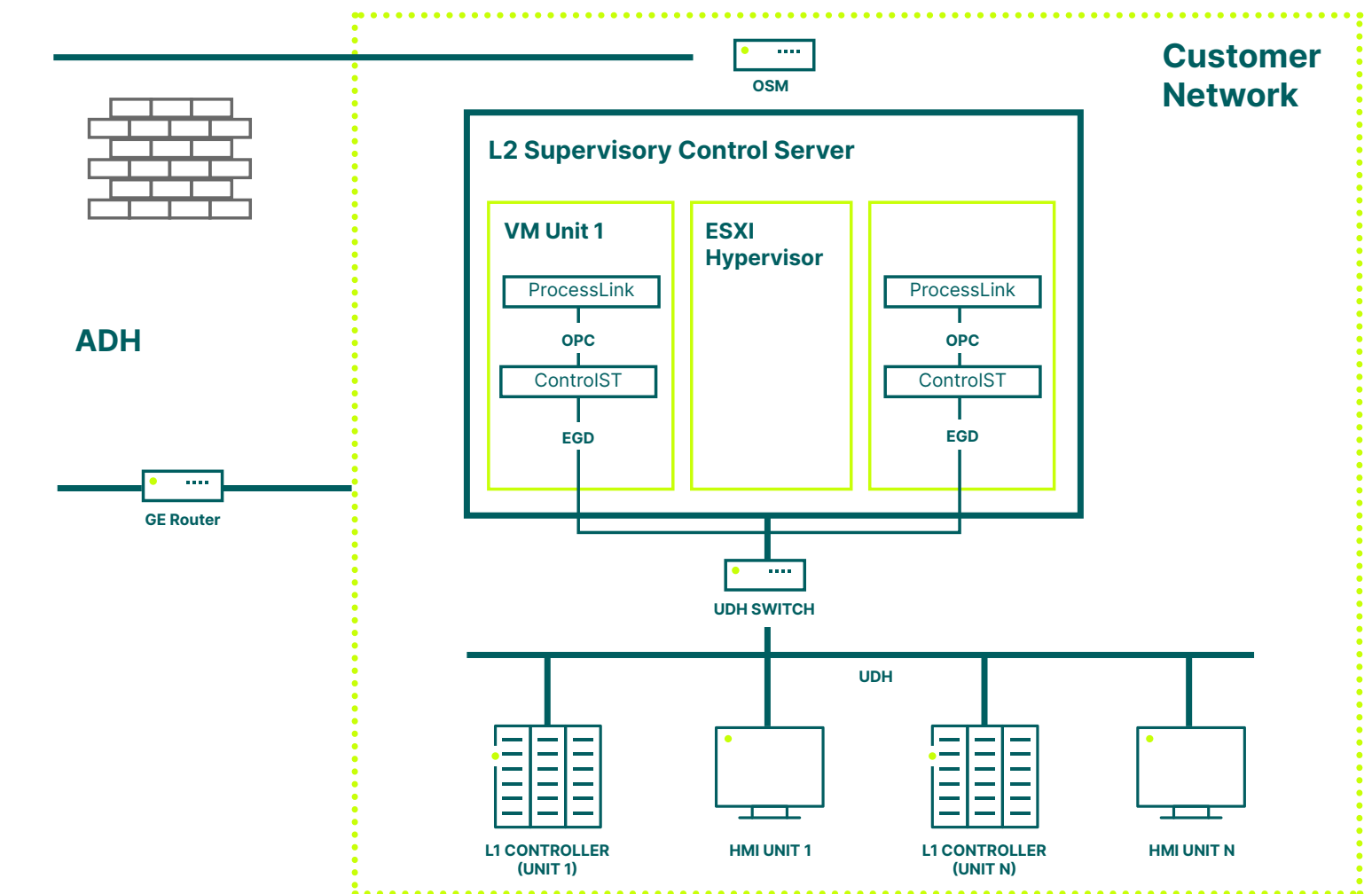
Autonomous Tuning has two automated modes of operation – Learning Mode and Control Mode – that are linked by a supervised model building step.



Autonomous Tuning modes of operation are sequential. Learning Mode must be executed first to map the space of operation of the turbine. Data collected in Learning Mode is subsequently used to build a neural network model of the turbine’s behavior. Once the models have passed quality checks, they are used in closed loop to adjust the turbine’s flame temperatures to ensure optimal behavior.

The software is allowed to operate (in Learning or Control Mode) if the following conditions are true:

- No safety critical conditions are present
- Shutdown must not be in progress
- Software must have been enabled on the operator’s HMI



PREREQUISITES

Remote access is required for implementation and support on an as-needed basis. There are two options available.

- Required: Minimum of one NOx emissions sensors located in engine exhaust upstream of any duct burners, CO catalysts or NOx reduction SCRs with ammonia injection. Must be connected to turbine control system with Autonomous Tuning
- Required: Minimum of one O2 sensor for emissions corrections to 15% O2
- Optional: CO sensor in engine exhaust upstream of any duct burners, CO catalysts or NOx reduction SCRs with ammonia injection if to be part of Autonomous Tuning limits imposed. Not part of Base Autonomous Tuning offering, but must be connected to turbine control system with Autonomous Tuning under such conditions
- Optional: Ambient Pressure (Pamb) and Ambient Temperature (Tamb) outside of the turbine inlet of one package or site measurement available to turbine control system with Autonomous Tuning
- Optional: Humidity Sensor located downstream of inlet conditioning inside inlet filter house connected to turbine control system. Site measurement acceptable if no inlet conditioning present and humidity input is available to turbine control system with Autonomous Tuning

For sites that may not have the required sensors or wish to include optional sensors these can be sold and implemented by GE Vernova Gas Power. Emissions measurements (CO, NOx, O2) must be routed (analog wiring) to the unit controller and made available as tags, hence, it is required to have field services personnel at site to perform standard communication and connection checks, other activities are performed remotely by the GE Vernova team.

CONNECTIVITY CYBER OPTIONS

Standard – Lock Box:

- Lockbox is part of the Electronic Security Perimeter
- The Lockbox allows the customer to control GE Vernova Wan access to PDH via an On/Off Air Gap Switch

Access is enabled by the customer to the GE Vernova Services Team only during set and mutually agreed upon periods of time

Premium - Remote Connection Broker:

- Zero-trust security backbone t-less browser (HTML5), virtual, safe access
- Multi-factor authentication
- Centralized User Management
- Custom permitting (unit, application, time-frame customization)
- User monitoring & recording (Forensics)

IMPLEMENTATION SERVICES

Project implementation, starting after receipt of order, typically consists of:

- Project Initiation (1 week)
GE Vernova & GE Gas Power
 1. R3 Handover
 2. Pre-kick off preparation
 3. Kick-off meeting with customer
- Server/Hardware Prep and Installation* (6 weeks)
GE Vernova Services via Supplier
 1. Configuration
 2. Shipment
 3. Installation
- L1/L2 Updates (2 weeks)
GE Vernova Services - L2, Gas Power - L1
 1. Configure Software
 2. Deploy Software
 3. Validate Software
- Unit Start, Manual Mapping & Communication checks (1 week)
Gas Power leads with GE Vernova Services support
- Learning Mode & model training (1 week) GE Vernova Services
- Control Mode validation and UAT (1 week) GE Vernova Services

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Support (Acceleration Plans)

GE Vernova provides an option for Acceleration Plan support services. If included, GE Vernova will provide on-going support during the term of the agreement to implement software updates, bug fixes, (collectively "Updates") and engineering support to ensure proper functionality.

The following describes GE Vernova's processes and approach to working with our Customers on technical support issues and inquiries for the solution.

Software Updates

Periodically, GE Vernova will remotely review the models and perform updates to the software solution as need to maintain functionality, in accordance to your product license entitlement.

Proactive Software Monitoring

GE Vernova Support Services continuously monitors your software solutions to ensure that they are running reliably and that issues are identified and resolved quickly.

Case Management and product assistance

GE Vernova offers multiple channels to contact your support agent, report any problems with your GE Vernova Software products, and find answers to your questions about our software products.

Web Self-Service: available 24/7

Support ticket creation and management can be performed on our Customer Center Support Portal at digitalsupport.ge.com.

Customers have access to our knowledge base and search for answers to questions about our software products. We are constantly updating and improving our knowledge base to provide the most up to date and comprehensive information.

Phone Support for Critical "System Unavailable" issues: available 24/7

US 1-800-433-2682

Europe, Middle-East, & Africa

+ 800-1-433-2682 /
+ 420 239015850

Asia, India, Indonesia, & Pakistan

+ 86-400-820-8208 /
+ 86-21-3877-7006

HARDWARE*

Hardware for 1 to 4 Unit(s) Quantity

GE Vernova ProcessLink Server

Low to Medium Capacity Applications

Provides:

16-Cores/32-Threads

128 GB memory

1.92 TB Unformatted disk space (RAID 1+0).

Features:

- Dell R440 19" Rackmount Server System - (Including the Following Items) (1)
- Intel® Xeon® Silver 4216 2.1 GHz 16-Core (32-Thread) Processor - 22 MB Cache (1)
- 32 GB DDR4-2666 Dual Rank ECC Registered DIMM - (128 GB Total System Memory) (4)
- Dell PERC H730P PCI-Express 12 Gb/s SAS Hardware RAID Controller - 2GB NV Cache (1)
- Dell 240 GB 2.5" Hot-Pluggable 6 Gb/s SATA Intel S4610 Mixed Use Solid State Drive (1)
- Dell 960 GB 2.5" Hot-Pluggable 6 Gb/s SATA Intel S4610 Mixed Use Solid State Drive (4)
- Dell IDSDM and Combo Card Reader (1)
- Dell 16GB microSDHC/SDXC Card (2)
- Dell Slim-Line SATA DVD-ROM Drive (1)
- Broadcom 5720 LOM 10BaseT/100BaseTX/1000BaseT Dual Port Gigabit Ethernet Adapter - (Dual RJ-45 Interfaces) (1)
- Broadcom 5720 Mezzanine Card 10BaseT/100BaseTX/1000BaseT Dual Port Gigabit Ethernet Adapter - (Dual RJ-45 Interfaces) (1)
- Dell Trusted Platform Module 2.0 (1)
- Dell iDRAC 9 Embedded Systems Management - Basic with Factory Generated Password Configuration (1)
- Dell 550 Watt High-Efficiency 1+1 Hot-Pluggable AC Power Supply Module (2)
- Dell 1U ReadyRails Tool-Less Slide Rail Kit (1)
- Dell 1U Cable Management Arm (1)
- Dell 1U Locking Front Security Bezel (1)
- Dell ProSupport 39-Month Hardware Warranty & Support with NBD On-Site Service (1)
- DB-9 Serial Port Blocker (Black) (1)
- USB Micro B Port Blocker (Black) (1)
- USB Type A Port Blocker (Black) (3)
- RJ-45 Network Port Blocker (Black) (5)
- 14' CAT6 Ethernet Cable - Gray with Sentinel Clear Connectors (5)
- 10' Standard U.S. Power Cable - NEMA 5-15P to IEC-60320-C13 - (Black) (2)
- 10' International Power Jumper Cable - IEC-60320-C13 to IEC-60320-C14 - (Black) (2)
- VMware vSphere Standard 6.x - Per Processor - Perpetual License - (Includes 1-Year Software Maintenance) (1)
- Microsoft Windows Server 2019 Standard - 16 Core - (OEM Edition) - Base License - Includes Downgrade Rights to Server 2016 / 2012 R2 (1)
- Microsoft SQL Server 2014 Standard - Perpetual Embedded Server License - Includes 5 Client (1)
- Intel® Xeon® Silver 4216 2.1 GHz 16 - Core Processor - 2 MB Cache (2)

HARDWARE*

Hardware for 4+ Units Quantity

GE Vernova ProcessLink Server

Medium to High-Capacity Applications

Provides:

32-Cores/64-Threads

256 GB memory

1.92 TB Unformatted disk space (RAID 1+0).

In addition to previously listed features:

- 32 GB DDR4-2666 Dual Rank ECC Registered DIMM - (256 GB Total System Memory) (8)
- Microsoft SQL Server Device Client Access License - Includes 5 Client Access Licenses (1)
- Microsoft Office Professional Plus 2016 - Perpetual ISV License (1)
- AVG Antivirus Business Edition - 1 User - 3 Years (1)
- Intel® Xeon® Silver 4216 2.1 GHz 16 - Core Processor - 22 MB Cache (2)

The models and versions are representative. Computing technology, operating systems and software versions have a relatively short life cycle making it difficult to guarantee specific models/versions. Any deviations from these specs will be discussed in detail during the kickoff meeting. The capacity of the server is determined by the number of units and the size of the models required for the optimization solution at GE Vernova's discretion.

GET IN TOUCH TODAY.

Find out how much Autonomous Tuning can cut your emissions and improve your fuel efficiency.

[Request a quote](#)

[Learn more](#)