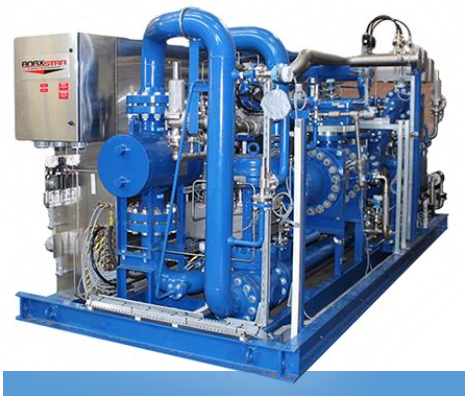
500kW Anax Turboexpander (ATE)

Reducing Natural Gas Pressure: Wasted Energy, Wasted Opportunity!

Natural Gas Pressure Regulating Stations maintain acceptable operating pressure in hundreds of thousands of miles of pipelines across the U.S. These stations make up an integral part of the country's natural gas infrastructure, but are inefficient and **waste easily accessible, lucrative energy**.

Gas Letdown Generators (GLGs) generate renewable energy from the flow of natural gas through pressure regulating stations. By employing an inline turboexpander, these systems generate electricity by expanding natural gas to an appropriate outlet pressure and temperature. Despite the benefits, **this technology has yet to achieve widespread adoption** due to high cost, safety risks, and an inability to handle fluctuating inlet pressures.



By harnessing wasted energy in pressure regulating stations, the ATE improves overall efficiency in the natural gas supply chain. The renewable electricity from the ATE can be fed directly into the power grid or can be used to offset the captive load of large natural gas and electricity customers, **making it an integral part of corporate sustainability goals.**

The ATE can unlock new business models that boost profitability through cost savings and increased revenue. By converting the flow of natural gas to electricity, gas companies, pipeline operators, and end-users of natural gas can maximize the return on their natural gas assets, without increasing risk. ATE systems can **increase a company's bottom line by anywhere from $100k to +$1M per year** by generating 400kW to 5+ MW of electricity. Possible arrangements to achieve this benefit include power purchase agreements, revenue sharing, electricity cost savings, renewable energy credits, and other financial models. Furthermore, GLGs qualify for lucrative state and federal tax credits, infrastructure grants, renewable energy credits, and other renewability incentives that improve the system's ROI.

Since the ATE generates electricity from the flow of natural gas, pressure reduction, and waste heat recovery, rather than combustion, **the system reduces overall natural gas emissions.** ATE benefits include:

- Zero carbon emissions with system efficiency of over 80%
- $0 in variable operating costs, $30/kw-year in fixed operating costs
- Improved natural gas efficiency and added safety redundancy
- Distributed generation that creates a more resilient energy grid
- Provides reliable backup to other clean-energy resources such as wind and solar

Safety & Performance

The ATE is installed in-parallel with the existing regulating station and works in-tandem with the pressure regulating station to maximize safety. **Parallel installations ensure redundancy and reliability for both the pipeline and the end user of natural gas.**

A 250kW Anax-Star prototype Turboexpander (ASTE) was field evaluated by GTI at the DNV GL Flow Centre in the UK, and was found to overcome obstacles that have prevented widespread adoption of GLGs.

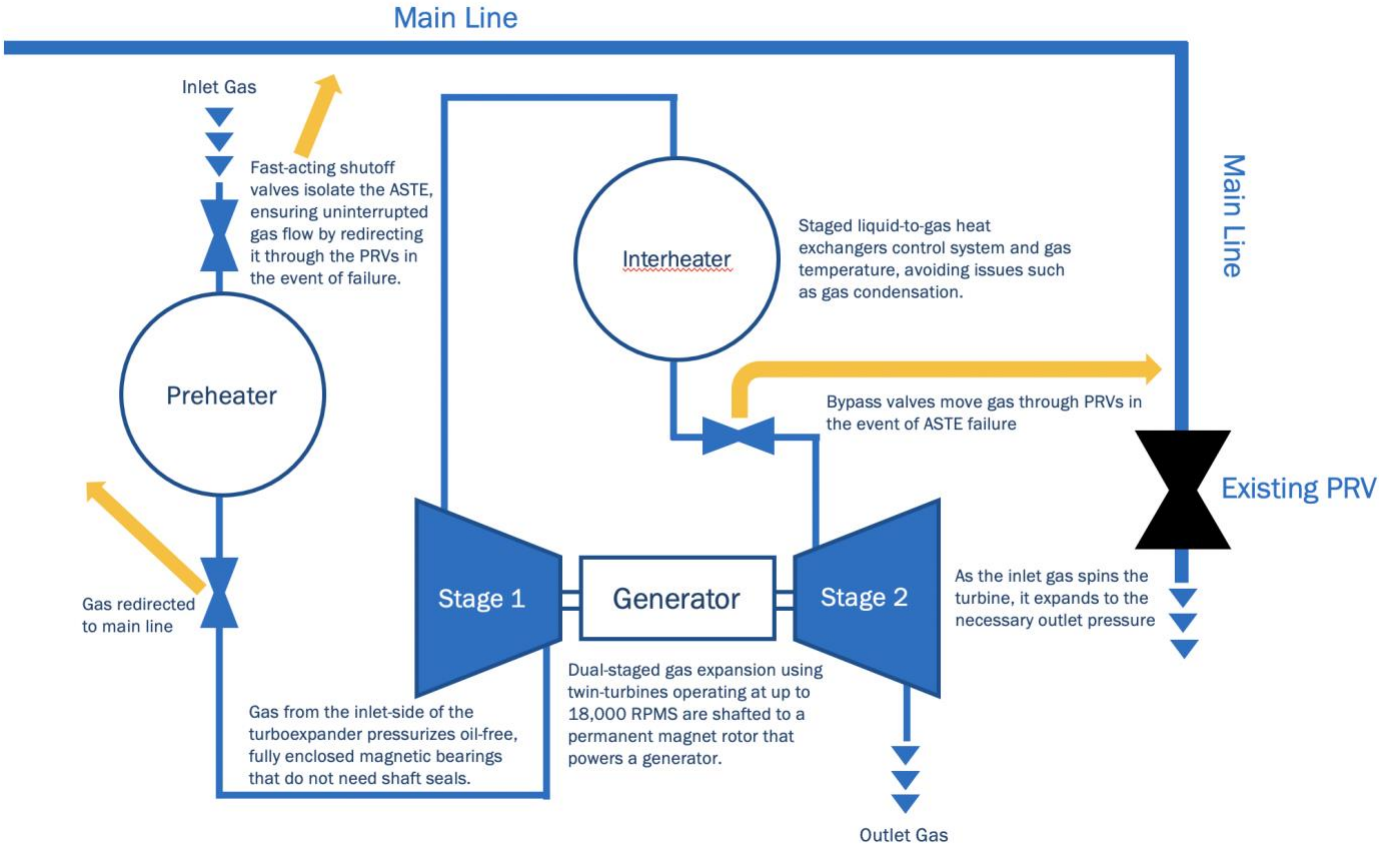
In its field performance evaluations, GTI verified the machine's ability to generate over 250kW while maintaining pressures, and handling controlled and fast stop scenarios such as shaft overspeed/imbalance, loss of utility grid power, loss of external heat, loss of bearing pressure, loss of instrument air, and other safe operating scenarios.

For more information regarding GTI's testing, contact Tim Kingston at 847-768-0936 or tim.kingston@gastechnology.org

Safety measures on the ATE include pressure control valves, bypass valves, and fast-acting shutoff valves that regulate gas inlet pressure and isolate the ATE by redirecting flow through the existing pressure regulating station if something goes wrong. The machine's ability to generate power while maintaining pressures, and handle controlled and fast stop

scenarios such as shaft overspeed/imbalance, loss of utility grid power, loss of external heat, loss of bearing pressure, loss of instrument air, and other safe operating scenarios was verified in field performance evaluations by GTI.

These safety valves protect the machine and ensure reliable gas delivery no matter what happens on the gas or electrical side. In addition to safety, these valves also **maximize the efficiency and maintain stable gas outlet pressure.** Finally, the ATE has full remote control and remote monitoring of critical operational metrics.



Gas Requirements

The ATE is designed for inlet pressures from 600 to 1,200 psig, with pressure ratios from about 1.4:1 to 4:1. In order to achieve 500kW power output at those pressure ratios, gas flow must be greater than 10,000 scfm. This unit also uses low-grade waste heat to ensure appropriate gas outlet temperature.

The ATE includes several features that differentiate it from other GLGs, including:

- **Active magnetic bearings** enable the ATE to handle fluctuating inlet pressures without losing stability, unlike GLGs in the past. Additionally, these bearings contain no oil lubrication and eliminate the risk of cross-contamination with the gas, which diminished the reliability and efficiency of other GLGs.
- **Dual-stage heating** maximizes the ATE's efficiency by increasing the amount of energy that can be generated from natural gas pressure-reduction. Other GLGs use single-stage heating that limits the total power output.
- **Increased power output** minimizes the machine's cost per kW and provides the best ROI of any GLG on the market.
- **25-30 year lifespan** ensures a long-term, value-generating asset, with minimal maintenance.
- **Zero downtime** ensures the ATE will generate electricity 24/7, provided that gas is flowing.
- **Modular, plug-and-play** unit minimizes engineering costs and enables the ATE to provide an industry-leading ROI. Other GLGs require costly custom engineering and design for each installation.

Michael Longo
mlongo@anaxpower.com
201-401-8603
www.anaxpower.com

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