

Tecogen

InVerde[®]

INV-100 e+



New Product Overview

CHP Basics

All of our Combined Heat and Power (CHP) systems use cutting edge technology to generate electrical power, along with thermal power recovered from the natural gas engine. Though a valuable source of energy, thermal power is usually lost in electrical production in the form of waste heat. However, captured and recycled thermal power can be used for very energy demanding heating processes, such as heating spaces and water. Customers benefit from a dramatic reduction in their energy costs while also cutting their building's carbon footprint. With CHP efficiency typically twice that of conventional utility produced power, carbon emissions are inversely proportional, i.e., reduced by 50% or more. CHP is recommended by many notable groups, including the U.S. EPA,

Department of Energy, Sierra Club, and the American Council for Energy Efficient Economy as a preferred resource option for the future. To encourage the installation of CHP, many Tecogen customers qualify for investment tax credits, accelerated depreciation benefits, clean energy incentives and demand response subsidies.

With the addition of our patented Ultera emission control system, Tecogen's **InVerde e+** improves upon CHP technology leaving an even smaller ecological footprint by nearly eliminating emissions of harmful criteria pollutants.



Figure 1. Tecogen InVerde *Ultera* 100e+ Module

Renewable & Battery Input

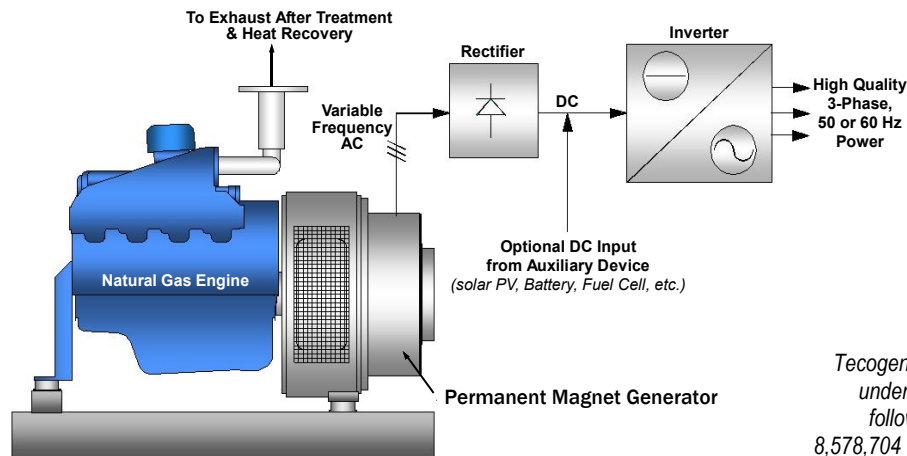
Featuring a DC input option, the **InVerde e+** allows seamless integration with battery back up or renewable power arrays. The battery input capability enables uninterrupted transfer during an outage via microgrid capability. Along with battery connectivity, solar PV arrays may directly connect to the unit, providing power conditioning for the array and eliminating the need for an additional solar inverter. With Tecogen's proprietary integrated microgrid, the **InVerde e+** can function as a true building energy management system; transferring loads as demand requires.

Rapid Black-Start

The **InVerde e+** meets the rapid 10 second black-start requirement for NFPA Type 10 Emergency Power Supply Systems. The only inverter-based engine-driven CHP product on the market to meet this strict criteria, the **InVerde e+** ensures facilities will never be left in the dark and mission-critical applications will continue seamlessly, boosting a building's resiliency. Controlled by proprietary microgrid technology and powered by reliable natural gas, the equipment offers a hassle free solution for continuous operation.

Ultera-Low Emissions

Ultera system, the **InVerde e+** is among the only natural gas engine-driven CHP systems able to operate with extremely low levels of pollutants that comply with the strictest emission regulations in the country for distributed generation, set by California's SCAQMD (South Coast Air Quality Management District). Delivering near-zero levels of harmful criteria pollutants (NO_x, CO and hydrocarbons) on par with those of fuel-cells, the *Ultera* ultra-low emission control system ensures equipment will remain compliant for years to come.



Tecogen products are covered under one or more of the following U.S. patents: 8,578,704 7,239,034 7,243,017 and other patents pending

Figure 2. The InVerde *Ultra* e+ Advanced Power Generation Technology

Cutting Edge CHP Technology

The **InVerde e+** utilizes a totally unique power generation technology made possible from recent advances and cost breakthroughs in power electronics (variable speed drives) and magnetic motor/generator materials (hybrid vehicle drive systems). The product was developed under a major grant from the California Energy Commission's Public Interest Energy Research (PIER) program and Sempra Utilities (Southern California Gas/ San Diego Gas & Electric).

The **InVerde e+** shown in Figure 2, is a natural gas fueled CHP module rated at 100 kW continuous electrical output while simultaneously producing 6.1 therms per hour of hot water (230°F). When all the recoverable heat is used¹, the overall efficiency reaches an impressive 92%.

The **InVerde e+** module features a low-emissions natural gas engine, which drives a water-cooled permanent magnetic generator (PMG). This module is conceptually depicted in Figure 2. The engine is operated over a wide speed range, depending on the load requirement, while the power electronics convert the variable frequency output from the PMG to high quality 60-Hertz power. Variable speed operation in grid-tie mode maximizes fuel efficiency under part load conditions, while also allowing operation in a "peaking" mode of 125 kW for up to two thousand hours per year to offset especially high "on-peak" utility demand tariffs and energy charges or to obtain extra savings from utility demand reduction programs.

This is the first engine-driven product to carry full UL 1741 Certification for "utility-safe" interconnection, while also providing seamless power transfer to stand-alone operation in the event of a power outage. The product features the proprietary control software, incorporated under exclusive license from the Wisconsin Alumni Research Foundation² and demonstrated at the AEP Dolan Laboratory³, enabling multiple machines to load-share on an isolated bus, without any interconnecting or supervisory controls.

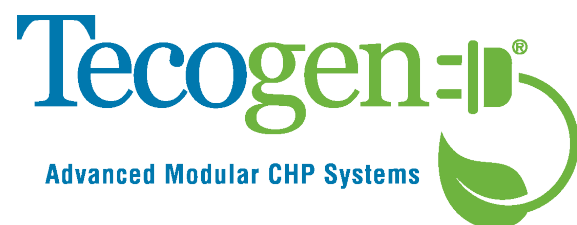
This highly innovative control method solves the difficult problem of applying clusters of small-scale prepackaged CHP modules that can operate both in grid-tie mode and during power outages, without complex and expensive controls. The single **InVerde e+** Module, equipped with this control architecture, can be applied in a building block fashion to many types and sizes of facilities, and provide power outage security, in addition to their CHP benefits.

Other Premier InVerde e+ Features Include:

- Best in class 33% electrical efficiency
- 4" wc gas pressure requirement, no costly booster
- Cloud based real-time performance monitoring
- Inverter-based standard utility connection
- Modular units for ease of installation and scalability
- 25% power boost for demand-side response

Typical Applications

The most common applications for the product are facilities that have concurrent and consistent electric and heating loads and ownership that values the standby power feature. Typical applications are schools, hospitals, recreation facilities, and multi-unit housing of almost any category (e.g., elder housing, condominiums, nursing care homes, dormitories, etc.).



Obtaining More Information

For more information about the **InVerde INV-100e+ Ultra** Premium Power Module contact:

Bill Martini, West Coast Sales Manager at 503.641.1768
Jeffery Glick, East Coast Sales Manager at 781.466.6481

Detailed specifications are available at www.tecogen.com.

1. Based on the lower heating value (LHV) of natural gas (905 BTU/ft³)
2. The Wisconsin Alumni Research Foundation is the University of Wisconsin's technology licensing affiliate.
3. AEP is American Electric Power, the 11-state Midwest Electric Utility.