

## *Thermoelectric Generators: How Do They Work?*



Power where you need it.®

## THE WORLD'S LEADING MANUFACTURER

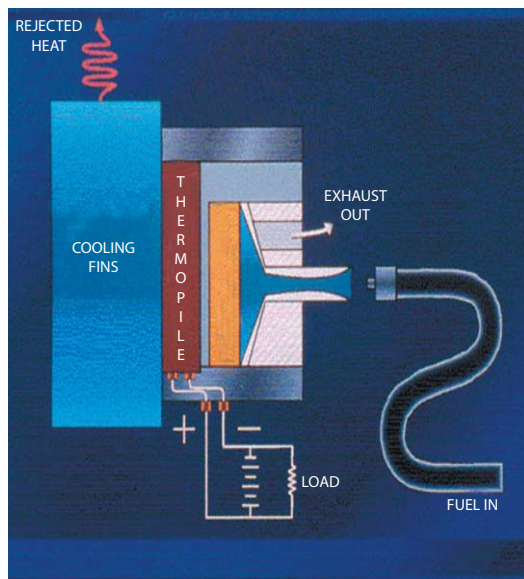
Global Thermolectric is the world's largest supplier of thermoelectric generators. A vertically integrated manufacturer with an ISO 9001:2000 registered QA program in place, Global has 30 years of experience in the engineering, manufacturing and installation of remote power systems.

The company established in 1975 to commercialize the unique lead telluride thermoelectric generator technology developed by the 3M Corporation in the 1960s for the Apollo space program. Based on this initial technology, Global has developed a product line of thermoelectric generators using high quality, field proven components which has resulted in the company's worldwide recognition for economic and reliable remote power solutions.

In 1998, 2001 and 2005 Global received the prestigious Canada Export Award in recognition of the company's success in and commitment to international markets.



**Pipeline:**  
220 watts and 550 watts  
cathodic protection and communications  
- Andes Mountains, Argentina



*The three main parts  
of Global's solid state generator:  
a burner, the thermopile and cooling fins*

## SIMPLE, INNOVATIVE TECHNOLOGY

A thermoelectric generator converts heat directly into electricity. As heat moves from a gas burner through a thermoelectric module, it causes an electrical current to flow.

The heart of a Global thermoelectric generator is a hermetically sealed thermoelectric module (thermopile) which contains an array of lead-tin-telluride semiconductor elements. This durable module provides a chemically stable environment for the thermoelectric materials which ensures a long service life. On one side of the thermopile, a gas burner is installed, while the opposite side is kept cool by aluminum cooling fins or a heat pipe assembly. An operating generator maintains a temperature of approximately 540°C on the hot side and 140°C on the cold side. The heat flow through the thermopile creates steady DC electricity with no moving parts.

## Reliability, Low Maintenance, Long Life



**Telecommunications:**  
75 watts, Ecology Wildlife Study  
- Wyoming, United States



**Offshore:**  
1000 watts  
- Gabon

### AT WORK AROUND THE WORLD

In more than 50 countries around the world, Global's thermoelectric generators are providing reliable, cost-effective power for critical operation located in remote areas.

Global's generators range in output size from 15 to 550 watts, and are ideal for numerous applications requiring power up to 5,000 watts. Applications include power for remote control and monitoring of oil or gas pipelines and production facilities, power for navigational aids, telecommunications systems and cathodic protection pipelines and well casings.

Producing power by the direct conversion of heat into electricity, Global's solid-state generators have no moving parts, which translates to many significant advantages in remote locations or whenever power supply is considered critical.

**HIGH RELIABILITY:** solid-state design ensures trouble-free operation and the most reliable power supply system available.

**LOW MAINTENANCE:** one to two hours a year is a pro-active maintenance schedule.

**COMPETITIVE PRICE:** extremely competitive capital and operating costs for systems up to 5,000 watts.

**LONG LIFE:** hermetically sealed thermopile has a 20-year design life.

**EASY INSTALLATION:** typically requires less than a day to install and commission.

**CONTINUOUS OPERATION:** field-proven, Global's systems operate unsheltered in all climates and weather conditions and are not affected by salt spray, bird droppings or airborne contaminants.



## Global Leadership



**Navigational aids:**  
100 watts system  
operating since 1985  
- Yukon, Canada



**Production:**  
200 watts for gas well automation and CP  
- Pakistan

### Systems Engineering

In addition to supplying thermoelectric generators, Global can provide complete turnkey power systems for both hazardous (Class 1, Division 2) and non-hazardous locations including:

- power conditioning for any DC or AC voltage output
- gas pressure reduction systems
- battery banks (NiCad, VRLAS, etc.)
- alarm monitoring and control
- peripheral equipment.

### Customer Support

Global takes pride in providing high levels of customer service and support. Knowledgeable sales staff, backed by Global's Integrated Systems Engineering group, are capable of providing full technical support in the selection and sizing of components for remote power supplies. As well, post-sales support is provided by Global's Customer Service representatives on a world-wide basis. This service includes telephone hotline support and field support for installation, commissioning and trouble shooting.

### Training

Scheduled training courses are conducted throughout the year at Global's facility in Calgary. These courses are a combination of hands-on maintenance procedures and classroom technical training. Global's training staff can also provide onsite customized training programs anywhere in the world.

#### WHEN TO SPECIFY GLOBAL

- ✓ Load requirements from 5 to 5,000 watts
- ✓ Critical application requiring highly reliable power
- ✓ Low maintenance is required
- ✓ Long life is important
- ✓ Extreme climatic conditions (hot, cold, wet, dry) exist
- ✓ Remote or unattended location
- ✓ Lowest life cycle cost

## The Preferred Remote Power Source



**Pipeline:**  
2000 watt TEG and Photovoltaic  
- Kazakhstan Pipeline

### FEATURES OF GLOBAL'S THERMOELECTRIC GENERATOR

- Operate on natural gas, propane or butane
- Hermetically sealed power unit with a 20-year design life
- Burner system constructed from high-temperature nickel alloys
- Stainless steel cabinets
- Automatic spark ignition
- Automatic safety shutoff

### OIL & GAS INDUSTRY

Global's thermoelectric generators are used for a variety of remote power applications in the oil and gas industry primarily because they have proven to be the most reliable power source available for the rugged demands of the industry.

### Cathodic Protection

*Use: to provide electrical current to prevent corrosion in pipelines and producing oil and gas wells.*

Global's thermoelectric generators are the perfect match for the unattended, continuous power requirements of impressed current cathodic protection systems in pipelines and well casings. With high reliability, low maintenance requirements and minimal gas consumption, Global generators have negligible operating costs.

### SCADA

*Use: for remote instrumentation, automation and communication.*

Pipeline operators and oil and gas producers are increasingly using Supervisory Control And Data Acquisition (SCADA) systems for monitoring, measuring and controlling equipment in the field. Global's thermoelectric generators are being used to power remote telemetry units, gas analyzers and metering equipment as well as for routine operating functions and emergency shutdown.

### Offshore Operations

*Use: to provide primary power for unmanned platforms and backup power on manned platforms for critical communications and emergency shutdown systems.*

For offshore oil and gas operators, the ultimate test of equipment operation is in the harsh and highly corrosive offshore environment. Global's generators pass this rigorous test - in terms of reliability, low maintenance and safety, including operating in hazardous (Class 1, Division 2) environments.



**Production:**  
220 watts  
gas production and cathodic protection  
- Argentina



**Pipeline:**  
1500 watts  
pipeline block valve station  
- Andes Mountains, Peru

## TELECOMMUNICATIONS INDUSTRY

Global generators are the obvious choice for an increasing variety of tasks in the rapidly growing telecommunications industry, including:

- VSAT terminals
- Point to point microwave links
- Point to multi-point systems
- Cellular and PCS
- Radio/television rebroadcasting systems
- Military communication systems
- Fiber optic links
- Mobile radio repeaters
- Emergency services communication.

As the telecom industry's reliability requirements approach 100%, Global's generators are becoming the reliable and cost-effective power supply solution of choice. Also, as many telecom applications involve remote sites, the proven performance of Global's generator technology is essential. The low maintenance requirements of Global's generators are a distinct advantage as site visits can be reduced to coincide with the annual preventive maintenance cycle of the telecom equipment.

## DIVERSE INDUSTRIAL USES

Global thermoelectric generators are also being used as the power source solution for many other remote applications, such as environmental monitoring, navigation aids, buoys, airstrip landing lights and lighthouses.



**Offshore:**  
200 watts  
communications and safety  
equipment, multiple systems  
- Thailand

## Operation & Maintenance

The key operational feature of Global thermoelectric generators is the minimal maintenance requirement associated with the products solid state design. Recommended maintenance of one to two hours per year is all that is required to check the power output and ensure a clean fuel supply by cleaning and/or changing the orifice and fuel filter. Consumables for recommended maintenance are typically less than one percent of the capital cost per year.

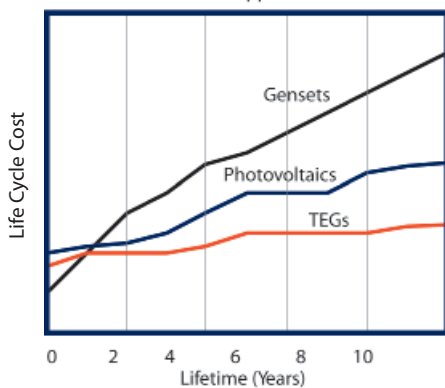
# How Thermoelectric Generators Stack Up



**Gas Distribution:**  
15 watts  
gas pipeline distribution metering  
station - Calgary, Canada

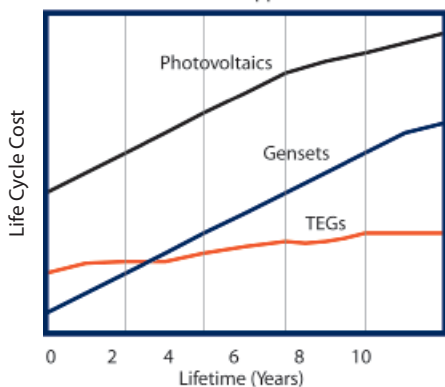
## LIFE CYCLE COST COMPARISON

80 Watts Application



## LIFE CYCLE COST COMPARISON

800 Watts Application



## COMPARED TO THE POWER GRID...

**RELIABILITY:** Power grid reliability can be a concern in many countries, particularly in developing countries where the reliability is often below the requirements of many applications. The installation of a Global thermoelectric generator is a common solution for customers requiring highly reliable power for automation, cathodic protection and telecom applications.

**COST:** Even in developed countries with a reliable grid infrastructure, the capital cost and service charges associated with running grid lines to a remote location can be prohibitive. In such cases, the installation for a thermoelectric generator to meet local power requirements is often a more cost effective solution.

## COMPARED TO GENSETS...

**MAINTENANCE, RELIABILITY:** While the capital cost of diesel or natural gas gensets is typically lower than that of a thermoelectric generator, the requirement to have a skilled technician perform regular maintenance on the gensets results in greatly increased operational costs, increased downtime and overall reduced reliability. When the complete life cycle costs, including all operational costs, are compared, the thermoelectric generator has lower operational costs and is more reliable.

## COMPARED TO PHOTOVOLTAICS...

**LIFE CYCLE COST AND PERFORMANCE:** Although properly sized photovoltaic systems have shown promise in providing low power solutions in areas with high solar insolation, solar users are increasingly turning to thermoelectric generators because of problems with reliability, short battery life and theft.

Global's thermoelectric generators have a 20-year design life and require minimal maintenance over the life of the system. An equivalent photovoltaic system would require 20-year life batteries - the cost of batteries alone can be as much as the thermoelectric generator. Studies have shown that when the capital cost of a photovoltaic system is based on medium life batteries (i.e. 10 years), the true life cycle cost of the solar system is much higher than that of a thermoelectric generator due to the high cost of battery replacement and higher maintenance costs. Theft and vandalism have not been a concern with Global systems, which are small and unobtrusive, and can be mounted inside security shelters if required.



*A history of innovation and performance in the commercialization of advanced technology.*

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Global Thermoelectric was established in 1975 to commercialize the thermoelectric generator technology originally developed for the Apollo Space Program. Today, Global is the world leader in the manufacturing and distribution of thermoelectric generators for use as remote power sources. The company produces a range of generators, from 5 to 550 watts, that use heat to directly produce electrical power for applications requiring up to 5,000 watts. The generator operates on natural gas, propane or LPG to provide highly reliable and cost effective remote power solutions for many applications including the telecommunications and oil and gas industries.

Global operates manufacturing, applications engineering and production engineering facilities in Bassano, Alberta. Its head office, engineering, and research and development facilities are located in Calgary, Alberta, Canada. Sales and marketing activities are conducted worldwide.



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