GEI ENERGY DECISIONS

ISSUE NUMBER 2

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Cogeneration: The Most Efficient Use of Energy.

High Court Ruling Reaffirms Government Support for Cogeneration.

The federal government's strong support for the development of cogeneration facilities was reaffirmed by a U.S. Supreme Court decision on May 17, 1983. The Court upheld a set of federal regulations which required utilities to interconnect with cogeneration facilities, and to purchase the excess electricity produced by those facilities at a rate equal to the utilities' cost to generate the power themselves.

This decision removed the last remaining uncertainty for many businesses seriously considering cogeneration. For several months, the publicity given this pending court decision had caused many potential cogenerators to hold off until they could be sure of the economics of their installations.

But now, with the court case resolved, cogeneration has become an economically attractive method for many companies to control rising energy costs and make more efficient use of their energy.

In addition, cogenerating facilities are assured of the availability of standby power when they need it, as well as the ability to sell their excess electricity at the utility's "full avoided cost" rate.

Extremely Efficient Technology

Although there is no universally accepted definition of the term "cogeneration," in most applications it is generally considered to be the production of both electricity and useful thermal energy from the same facility.

This technology is expected to remain economically attractive for many years to come for three reasons: (1) energy costs continue to rise; (2) cogeneration plants are extremely efficient compared to utility-supplied electricity; and (3) installation costs are fixed and not tied to the escalating costs of constructing new utility power plants.

The average efficiency of an on-site gas turbine cogeneration system is 70-80% vs. 30% for central power plants. Cogeneration systems also offer freedom from electric utility power interruptions. And cogeneration facilities are normally utilized to the fullest, while central power plants, even during peak periods, utilize only 70% of their capacity.

Cogeneration has been used in this country for nearly a hundred years; at the turn of the century, it accounted for 50% of the nation's electricity supply. But its use declined thereafter, due to the abundant availability of low-cost energy.

Then came the oil disruptions and severe inflation of the 1970's. The era of cheap energy and cheap power plants was over.

The chart below illustrates the increasing costs of building new utility power plants. At the 1983 construction cost of $1000 per kW (for a coal-fired plant), *the utility must charge its customers 4.4¢ per kWh just to pay for the plant itself.* On average, this fixed cost represents less than ⅓ of what customers pay for utility service. In addition to this, the utility's customers must also pay for fuel, plant operations (labor and maintenance), and power distribution costs.

And building a nuclear power plant at an initial cost of $3000/kW equates to 13.2¢/kWh for fixed costs alone!

Clearly the high cost of power plant construction is a major reason why cogeneration is once more an idea whose time has come.

How Cogeneration Works

With cogeneration, facility operators typically generate their own electricity on-site using a prime mover such as a gas turbine, steam turbine or diesel engine. Waste heat given off during the electricity-generation process is captured by a heat-recovery system and used to provide space heating, or process heating/cooling.

Because a cogeneration system uses heat that would normally have been wasted, heating and cooling are provided at no additional energy cost.

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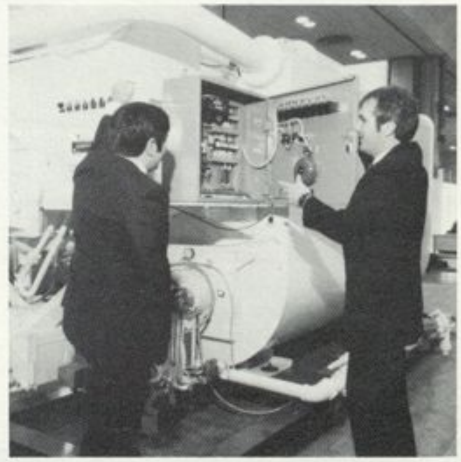
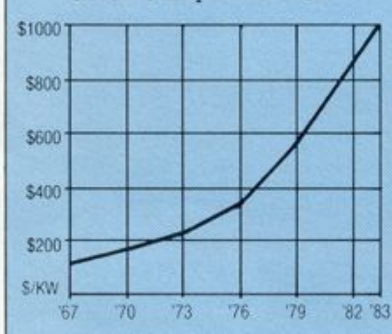


To dramatize the compact design *of the Hitachi PARAFLOW Chiller-Heater, Gas Energy Inc. displayed a 400-ton Direct Fired unit at the January 1983 ASHRAE Show at Atlantic City.*

An Important Factor in the Decision to Cogenerate

The Cost of Building a New Utility Power Plant



What Utility Customers Pay for Construction of a New Coal-Fired Power Plant

$$\frac{\$1000}{kW} \times \frac{1}{8760 \text{ hours}} \times \frac{1}{.65} \times .25 = 4.4¢ \text{ per KWh}$$

$1000/kW	1/8760 hours	1/.65	.25	= 4.4¢ per KWh
1983 cost of constructing a new coal-fired power plant	# of hours in one year	Portion of a year that the average plant operates	Fixed cost factor (depreciation, interest, stockholders earnings)	What customers pay for a new power plant

The cost of power plant construction has risen sharply since 1973. At 1983 estimated construction costs of $1000 per kW, a utility must charge its customers 4.4¢ per kWh just to pay for the plant. On top of this, the customers must pay for fuel, plant operations (labor and maintenance) and power distribution costs.

PARAFLOW: TODAY'S MOST COST-EFFIC

Converts Waste Heat Directly into Cooling/Heating

In 1980, Gas Energy Inc. added to its line of direct fired chiller-heaters a unique machine. The Hitachi PARAFLOW™ Heat Recovery Chiller-Heater is the only available chiller-heater which *directly* converts clean exhaust (above 550°F) into air conditioning and heating.

These highly efficient machines are now operating successfully in installations across the U.S. Many building owners are finding that the Hitachi PARAFLOW unit offers substantial savings on installation, maintenance and operating costs, compared to conventional heat recovery systems.

The unit's major savings are the result of Hitachi's use of the high-efficiency two stage absorption cooling cycle. It produces up to 40% more usable energy per unit of exhaust heat than any comparable system available today. And Hitachi's exclusive parallel flow system further enhances cycle efficiency while it delivers far greater reliability than the conventional series flow cycle.

The Hitachi PARAFLOW unit—we call it The Cogeneration "Chiller-Heater"*—is uniquely suited for a cogeneration facility. It is also highly practical for industrial applications where clean waste heat is available, such as ink-drying operations, paint-baking facilities, process ovens, heat-treating facilities and forges.

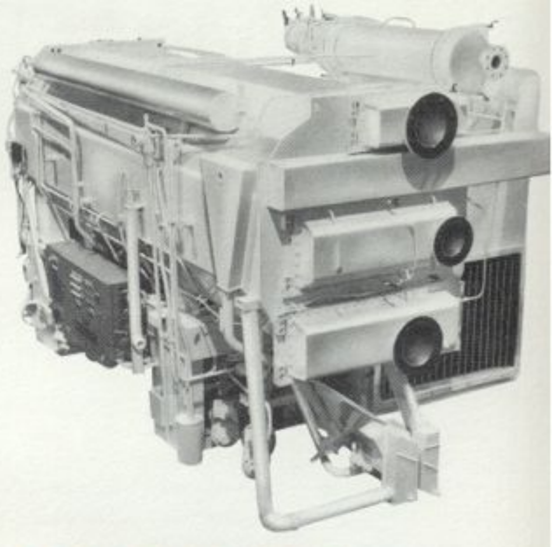
Today's Most Advanced Cooling/Heating Technology

This heat recovery unit is part of a growing family of Hitachi PARAFLOW Chiller-Heaters which together represent today's most advanced cooling and heating technology for commercial and industrial applications.

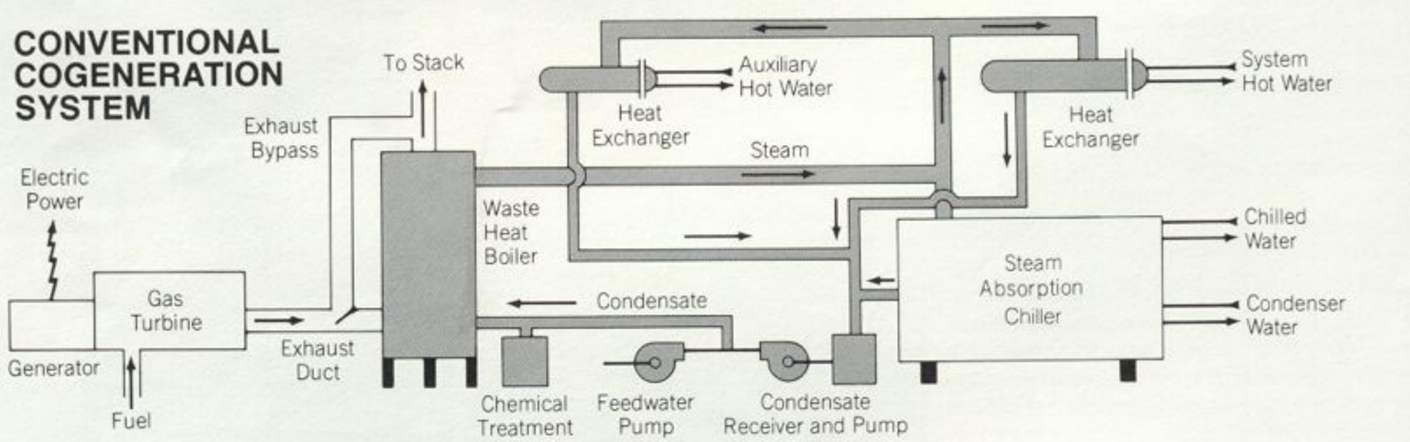
In 1979, Gas Energy Inc. introduced to the U.S. market the Hitachi PARAFLOW Direct Fired Chiller-Heater. Operating on gas, oil or propane, the Direct Fired unit provides up to 1500 tons of cooling.

At the beginning of 1983, GEI introduced the gas-fired PARAFLOW 100 Chiller-Heater, which is the most efficient unit available for cooling and heating facilities requiring 100 to 200 tons of air conditioning, such as office and residential buildings, nursing homes, schools and shopping malls.

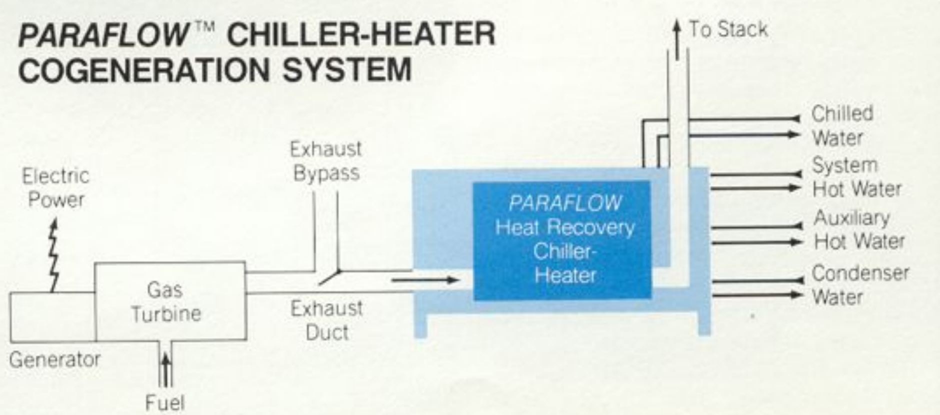
Thousands of Hitachi PARAFLOW Chiller-Heaters have been operating successfully in Japan for over 18 years. Now these remarkably efficient units are compiling a similarly impressive track record in the United States. ■



***The Hitachi PARAFLOW Heat Recovery Chiller-Heater** converts waste heat directly into 100 to 1500 tons of efficient cooling as well as heating.*



Hitachi PARAFLOW's dramatic savings are illustrated in these comparative diagrams. The Hitachi PARAFLOW (bottom) produces 40% more cooling than a conventional heat recovery system (top). Any power generator or industrial process which emits clean exhaust exceeding 550°F can utilize the Hitachi PARAFLOW to provide efficient and reliable air conditioning, heating and hot water at no energy cost. And there is no need to install and maintain the additional equipment required for conventional systems (gray-shaded portion at top).



ENT HEAT RECOVERY CHILLER-HEATER

Case History:

Computer Center, Home Federal Savings and Loan Association of San Diego

Home Federal Savings and Loan Computer Center

With more than 160 offices throughout California and $6 billion in assets, Home Federal is the nation's second largest savings and loan association.

To support the wide range of services it offers to its customers, Home Federal completed in September 1982 a 191,000 square foot Service Center, consisting of three buildings—computer center, central plant and distribution center—on a 29-acre site.

The computer center, especially, required a totally reliable source of energy for its electric and thermal requirements. For electric power, Home Federal decided to use three gas turbine generator sets, each capable of producing 800 kW, continuous duty, at standard conditions. Electricity from the utility company is the primary back-up, and two 10,000 gallon jet fuel storage tanks provide a standby source of fuel.

For air conditioning and heating, two 500-ton Hitachi PARAFLOW Heat Recovery Chiller-Heaters were selected. The Hitachi units use hot gases exhausted from the turbines to produce up to 1000 tons of cooling or 12,000 MBH of heating for the complex.

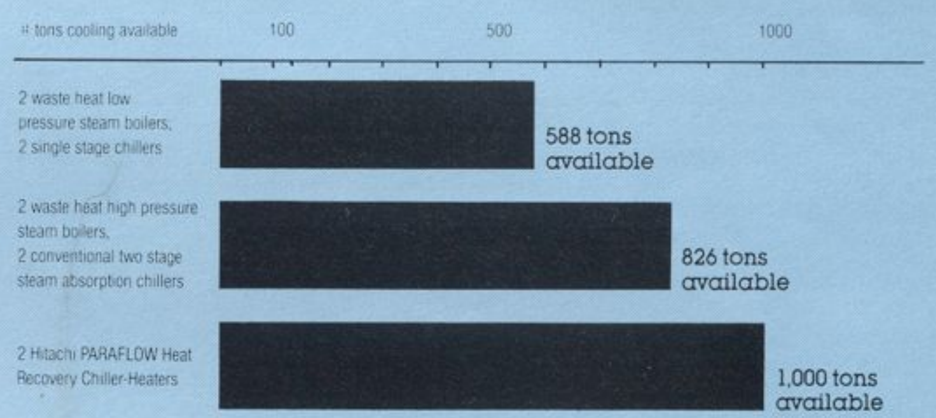
The Hitachi units were selected because they offered the most economical and efficient means of recovering heat from the gas turbines and converting that heat into the required amount of air conditioning and heating.

Other methods of using recovered heat for cooling and heating were found to be much more expensive to install and maintain, and could not match the Hitachi units' cooling output.

For example, using the combination of two heat recovery boilers and two single stage absorption chillers (see chart below), 588 tons of air conditioning could be produced. With two conventional two stage steam absorption chillers 826 tons of cooling would be available.

To equal the Hitachi units' 1000 tons of cooling output, the exhaust heat from additional prime movers would be needed. And this would make it necessary to "oversize" the electric-generating plant in order to satisfy the cooling requirement. ■

Hitachi PARAFLOW vs. Conventional Heat Recovery Systems



The Ideal Cogeneration Plant...

Cogeneration design basically attempts to balance the cogeneration system's electric and thermal output with the building's electric and thermal demand. Perfection would be producing just enough to meet the building's base electric and thermal needs. Ideally, the equipment would be used at full capacity twenty-four hours a day. When excess power is needed, it would be purchased from the utility.

In this ideal setup, the more hours the cogeneration plant is used, the faster would be the payback for its installation. Good examples of this are facilities which have twenty-four hour electric and thermal requirements such as apartment complexes, computer centers, hospitals, hotels, and multi-shift industrial facilities.

And the Less than Ideal...

In regions of the U.S. where the buy back rate is currently attractive, some cogeneration plants have been designed specifically to produce the maximum electric output. Such design takes advantage of the sell back clause in the PURPA guidelines and employs a low-efficiency heat recovery system.

Although this type of "oversized" plant maximizes revenues through the selling of electricity to the utility, it carries with it some significant drawbacks.

First, the larger the electric generator to be installed, the larger the first costs for the owner. Second, this is a risky strategy because buy back rates can vary over time.

Finally, this type of design runs counter to Congress' and FERC's intention to promote the most efficient use of the nation's energy. The sell back and interconnection clauses in PURPA recognize that the ideal design—with perfectly balanced thermal and electric loads—does not exist in the real world. Actual operating conditions sometimes require more and sometimes less electricity or thermal energy than is produced by the cogeneration plant. The guidelines were instituted to allow for this necessary margin. They were never intended to provide a new profit opportunity for cogenerators.

When designed properly, cogeneration benefits not only the installer of the equipment, but the electric utility as well. ■

Hitachi PARAFLOW
Applications Across the U.S.

Executive conference center

• The consulting engineer for a 300,000 square foot **executive conference center** in Westchester County, New York, specified two 430-ton Hitachi PARAFLOW Chiller-Heaters for cooling and heating. The engineer found the Hitachi unit to be a far more economical choice compared to systems using a boiler for heating and either a steam absorption unit or an electric centrifugal unit for cooling. The Hitachi equipment's capability to satisfy all cooling and heating requirements with the same unit, as well as its ability to operate on either gas or oil, were also important factors in the choice.

Religious organization headquarters

• Based on a GEI energy study, an international **religious organization** selected a 600-ton Hitachi PARAFLOW Direct Fired Chiller-Heater to provide air conditioning and heating for its Springfield, Missouri, headquarters. The study projected that replacing the building's single stage steam chiller and steam boiler with a Hitachi unit would achieve annual operating cost savings of $89,000.

Apartment complex

• In this 40-building Georgia **apartment complex** (550,000 sq. ft.), four Hitachi PARAFLOW Direct Fired Chiller-Heaters (ranging from 100 to 200 tons) replaced single-stage 25-ton gas absorption units which were distributed throughout the complex. The high efficiency of Hitachi's two-stage absorption technology and its compact design were two reasons the PARAFLOW Chiller-Heaters were selected to provide air conditioning and heating for the complex's 296 apartments.

Office building

• When the subsidiary of a northern Oregon gas distribution company built a 15-story **office building** (226,980 sq. ft.), it was only natural that they use gas to satisfy the building's thermal requirements. They selected a 500-ton Hitachi PARAFLOW Direct-Fired Chiller-Heater to provide all heating and cooling.

Cogeneration
(continued from page 1)

Though electric utility interconnection is vital for many facilities as a source of standby power, the utility's mandated requirement to purchase excess cogenerated power at the "full avoided cost" rate—the result of the May 17, 1983, Supreme Court decision—is only one factor in a company's decision to cogenerate.

The economics of cogeneration depend on a number of factors specific to the facility: these include electric and thermal loads, type of facility, location, and utility rates.

A number of electric utilities favor cogeneration because it helps them balance their load requirement during peak periods and reduces the need to build new power plants.

Duke Power Company, for example, encourages its large industrial customers to cogenerate. In anticipation of having its customers generate 350 mW by the mid-1990's Duke recently cancelled an order for a $3 billion nuclear power plant.

Southern California Edison plans to double the 156 mW of cogeneration in its territory. Today, cogeneration produces 1% of the power in its service area; the utility expects this percentage to increase to 5% by 1990.

Other utilities that actively support cogeneration include Virginia Electric Power Co., Niagara Mohawk, Pennsylvania Power & Light Co., Pacific Gas & Electric Co., Arkansas Power & Light Co., and San Diego Gas & Electric Co.

A Major Advance in Cogeneration Technology

One of the latest advances in cogeneration technology is the introduction to the U.S. market of the Hitachi PARAFLOW™ Heat Recovery Chiller-Heater. This compact, self-contained unit directly converts clean exhaust heat (above 550°F) from the engine or turbine to hot and chilled water for efficient heating, air conditioning, or process use.

The Hitachi unit is ideal for an on-site cogeneration operation because its unique PARAFLOW chilling cycle allows it to produce up to 40% more usable energy per unit of exhaust heat than is available in comparable cogeneration systems. Because the Hitachi unit uses exhaust heat directly, it does not require the installation of a heat recovery boiler. Nor is there any need for the boiler's ancillary equipment. As a result, the Hitachi unit is far less expensive to install and maintain. (See box on page 2.)

This high-efficiency heat recovery chiller-heater represents a major new step in the ongoing development of today's cogeneration technology. ■

THIS NEWSLETTER is for the architects, engineers, building owners and managers responsible for making energy decisions.

Today's rising energy costs call for more economical ways of cooling and heating mid- to large-sized buildings. *Energy Decisions* offers some important options for keeping these operating costs down. ■

FOR MORE INFORMATION: Write or Call Mark Fallek at Gas Energy Inc., 212/403-2602.

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