BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In re: Comprehensive review of revenue requirements and rate stabilization plan of SOUTHERN BELL.	DOCKET NO. 920260-TL
In re: Investigation into the integrity of SOUTHERN BELL'S repair service activities and reports.	DOCKET NO. 910163-TL
In re: Investigation into SOUTHERN BELL'S compliance with Rule 25-4.110(2), F.A.C., Rebates.	DOCKET NO. 910727-TL
In re: Show cause proceeding against SOUTHERN BELL for misbilling customers.	DOCKET NO. 900960-TL
In re: Request by Broward Board of County Commissioners for extended area service between Ft. Lauderdale, Hollywood, North Dade and Miami.	DOCKET NO. 911034-TL DATED: 10/13/93

CERTIFICATE OF SERVICE (DOCKET NO. 900960-TL)

I HEREBY CERTIFY that the original of Staff's Eighth Request for Production has been furnished to Harris R. Anthony, J. Phillip Carver and R. Douglas Lackey, c/o Marshall M. Criser, III, 150 South Monroe Street, Suite 400, Tallahassee, Florida 32301, on behalf of BellSouth Telecommunications, Inc. d/b/a Southern Bell Telephone and Telegraph Company, and that true and correct copies thereof have been furnished by U.S. Mail, this 13th day of October, 1993, to the following:

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CITY GAS COMPANY OF FLORIDA

SCANNED

An NUI Company

Ms. Mary Ann Helton
Legal Services Division
101 E. Gains Street
Tallahassee, FL 32399

October 7, 1993

OCT 13 1993
FPSC-RECORDS/REPORTING

SUBJECT: CITY GAS COMPANY'S RESPONSE TO REQUEST FOR INFORMATION ON NATURAL GAS TECHNOLOGIES

Dear Ms. Helton:

The enclosed information is City Gas Company's response to the PSC Staff's request for information on natural gas technologies that should be included in the electric utilities' conservation programs. City Gas Company's response consists of:

1. My letter to Mr. Joe Jenkins dated September 3, 1993 which provides information on gas engine chillers, gas engine heat pumps, desiccant dehumidification and gas water heating;
2. My letter to Mr. Edward Mills dated September 16, 1993 which provides detailed calculation methods used to compare gas engine chillers, gas water heating and gas engine heat pumps with the electric alternatives; and
3. My letter to Mr. Joe Jenkins dated October 7, 1993 which provides information on cogeneration plants now operating in Florida and detailed calculation methods used to compare cogeneration systems and desiccant dehumidification systems with the electric alternatives.

Please contact me if I can provide any additional information.

Sincerely,

Richard C. Furman

Richard C. Furman
Consulting Engineer
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cc: Vernon Krutsinger
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CITY GAS COMPANY OF FLORIDA

An NUI Company

Mr. Joseph D. Jenkins
Director-Div. of Electric & Gas
Florida Public Service Commission
101 East Gaines Street
Tallahassee, FL 32301

Oct. 7, 1993

RE: ADDITIONAL INFORMATION ON COGENERATION AND DESICCANT DEHUMIDIFICATION SYSTEMS

Dear Mr. Jenkins:

As part of City Gas Company's response to provide information to the electric utilities on gas technologies I have enclosed the following additional information on cogeneration and desiccant dehumidification systems. My letter to you dated September 3, 1993 provided information on gas engine chillers, gas engine heat pumps, desiccant dehumidification and gas water heating. My letter to Mr. Edward Mills on September 16, 1993 provided detailed calculation methods used to compare gas engine chillers, gas water heating and gas engine heat pumps with the electric alternatives. This additional information will provide an overview of cogeneration plants now operating in Florida and provide detailed calculation methods to compare cogeneration systems and desiccant dehumidification systems with the electric alternatives.

Enclosed for your information is a recent Energy User News (Feb. 1993) article entitled "Cogeneration Benefits Environment, Ratepayers, As Well As Users" which discusses why electric utilities should include cogeneration as part of their DSM programs.

Please note that your present summary table of gas technologies does not include the energy savings by making use of the recovered heat from the gas engine technologies. The primary advantage of on-site gas engine technologies is the ability to recover the heat from the engine and to use it on-site. During conventional electric power production, the thermal energy is released into the environment. In a gas engine chiller, a gas heat pump and a cogeneration system this thermal energy is recovered and used to displace thermal energy requirements on-site. This recovering of thermal energy increases the overall efficiency from approximately 33% in conventional electric production to greater than 70% in these gas technologies. Therefore your summary table should include the annual thermal energy savings and its associated annual cost savings for gas engine chillers, gas engine heat pumps, gas engine A/C systems and cogeneration systems.

Please also note that your present list of gas technologies only includes cogeneration systems up to 2000 KW in capacity. Many gas turbine cogeneration systems and a few reciprocating engine cogeneration systems are already operating in Florida with capacities of greater than 2000 KW. Therefore the upper limit may need to be 200 MW or greater. The annual operating hours can also vary greatly for different cogeneration applications. The case study that follows shows a base loaded cogeneration system that operates 8322 hours/yr with acceptable economic feasibility. It may also be possible to operate some cogeneration systems only 2000 hours/yr to reduce peak demands and also show acceptable economic feasibility. Therefore a wide range of possible operating

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TREASURE COAST DIVISION: 1323 NW ST LUCIE WEST BOULEVARD • PORT ST LUCIE, FL 34986 • 407-871-2551 • FAX 407-871-2044

hours is needed for any of these gas technologies.

My letter of September 3, 1993 contains a description of desiccant dehumidification systems, a list of some operating systems in Florida and results of actual testing and economic evaluations. The enclosed table shows a detailed comparison of a desiccant dehumidification system for a new supermarket in Tallahassee versus a new conventional A/C system to control humidity. A computer analysis is required to conduct this comparison due to the need to input variable inside load conditions, variable outside weather conditions and the need to control both temperature and humidity of the conditioned space. This analysis shows that the desiccant dehumidification system will have a slightly lower capital cost and a lower operating cost while providing a healthier store environment.

Please contact me if I can provide any additional information.

Sincerely,

Richard C. Furman

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ENERGY USER NEWS

TECHNOLOGY REPORT

"Every business that uses electricity and hot water together could reduce energy consumption by switching to cogeneration."

"Widespread use of cogeneration would decrease the number of transmission lines needed."

On-Site Power

Cogeneration Benefits Environment, Ratepayers, As Well As Users

By DAVID E. NEWMAN

David Newman is the founder of Physics Solutions, a consulting firm here. This article was first published in DSM Quarterly.

ENCINITAS, Calif.—Cogeneration is the most promising demand-side energy management tool to be introduced in many years. It benefits users, utilities, and ratepayers alike by offsetting the need for new central power plants, and it benefits the environment through lowered pollution and the virtual elimination of resource waste.

Everyone wants to conserve energy today, but most ways to save energy involve some unpleasant compromises. We can save plenty of gasoline if we are willing to sacrifice performance, convenience, and safety in cars. We can save plenty of heating oil; it all depends on just how cold you want to be.

Cogeneration is different. Unlike energy conservation measures that nobody really wants, cogeneration saves energy while benefiting the user and the environment. There is no "Catch-22" with cogeneration.

The amount of energy saved with cogeneration is equal to the amount of energy formerly used to heat water, or produce other process heat. The fuel consumed by the on-site cogeneration plant to generate electricity is roughly the same as that consumed by a large central generating station to produce the same amount of electricity, but with cogeneration the hot water costs no additional energy. Cogeneration enables the heat from the on-site generating plant to be used, thus eliminating the need to burn fuel for that heat. In contrast, the central utility typically wastes the heat byproduct when it generates electricity.

Every business that uses electricity and hot water together could reduce energy consumption by switching to cogeneration. Schools, restaurants, laundromats, health care facilities, athletic clubs, motels, apartments, and many other potential users should consider this important energy saving measure.

For example, suppose there are 10,000 cogeneration units in operation, with each unit producing 20 kilowatts (kw) of electricity and .2 million Btu (MMBtu) of heat energy per hour with an overall efficiency of 89 percent. The net energy saved, because of the extremely high overall efficiency of cogeneration, would be 20 million MMBtu per year. This energy is simply wasted today when electricity and process heat are produced separately.

With cogeneration, you automatically conserve energy because you no longer need to burn fuel to heat your water.

On-site packaged cogeneration units can use natural gas for fuel, whereas utilities sometimes burn coal to generate electricity. Natural gas produces much less sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter than coal.

Concern for the environment is a strong argument for switching to cogeneration. Coal, being mostly carbon, produces more CO_2 per Btu than any other common fuel. Natural gas is mainly methane, a molecule composed of one carbon atom and four hydrogen atoms. Methane has the lowest carbon-to-hydrogen ratio of any common fuel, and produces far less CO_2 per Btu than coal or oil. Cogeneration plants using natural gas for fuel produce only one fifth as much carbon dioxide as a typical utility plant with the same electrical output. Furthermore, the CO_2 that would otherwise have been produced in burning fuel to heat water, is no longer produced in the cogeneration process. This represents an additional savings in greenhouse gas emissions.

For cogeneration users, the lights never go out. The combination of on-site generators and utility backup constitutes a virtually uninterruptible power source. During cogeneration maintenance periods, or in the event of a malfunction in the cogeneration unit, the site is instantly and automatically shifted over to utility grid power. Similarly, the user is impervious to utility power outages, since the cogeneration system provides electricity during utility problems.

The reliability of cogeneration also relieves utilities of a significant amount of generating responsibility. For example, suppose that there are 10,000 cogeneration units and that each one has at the least 90 percent availability. On the average, 9,000 units are producing, and the utility is picking up the load for only 1,000. This is a reduction in the utility energy demand by 9,000 units equivalent.

It is natural to ask what the variation is in this number. Statistically, the large number of units in the pool results in extremely high reliability, assuming that the unavailability of each individual unit is uncorrelated. It can be shown that the likelihood of having 1,200 or more unavailable on any given day is not likely to occur once in a million years. Therefore the utility can plan on covering a load of at most 1,200 units with virtually complete certainty.

Electromagnetic fields emitted by power lines are suspected of causing negative health effects. Several large epidemiological studies have confirmed this, and laboratory experiments have demonstrated cellular effects that could explain our apparent sensitivity to electromagnetic radiation. High power transmission lines are an unavoidable feature of central station electricity generation. Cogeneration, however, needs no transmission lines since the power is used on-site. Widespread use of cogeneration would decrease the number of transmission lines needed, and would decrease the strength of the fields they emit since they would carry less power. This is good news for anyone living near a power line.

People decide to install a cogeneration system for a variety of reasons, but the main reason is to save money. The cost of heating water is simply pocketed. This is a substantial sum in many cases, and is the central motivating factor for many businesses to switch to cogeneration.

Whenever a utility decides to build another large generating plant, everyone who buys electricity from that utility pays for it. Electricity demand is increasing in the U.S. This could cost ratepayers billions of dollars.

However, utilities can defer construction if more businesses switch to cogeneration. This will be reflected in lower utility bills in the near term, since utility capital will not be pumped into more large plants. If the use of cogeneration can be expanded rapidly enough to absorb the increases in demand, then it is likely that new utility plant construction can be delayed indefinitely. Each time a cogeneration unit is installed, every ratepayer in the grid benefits.

How often do you find a chance to win without making someone else lose? Not often in today's competitive social jungle. The user wins because he saves money, and gets greater flexibility and reliability in his energy supply. The utilities win because they do not need to spend precious capital for new plants. The ratepayers win because they do not have to pay for major new facilities as long as cogeneration picks up the load. People living near power lines win because their exposure to electromagnetic fields would be lessened. The public wins because cogeneration produces less atmospheric pollution and fewer greenhouse gases.

A hundred years from now, it is likely that each independent energy user will have a complete energy management system on-site, including cogeneration of electricity and heat. Cogeneration may then be recognized as one of the healthiest ideas ever created for society.

Circle No. 111

Regulators Should Consider Adding Cogen to Utils.' DSM Options

By SCOTT SPIEWAK

Scott Spiewak is president of Cogeneration & Small Power Consulting & Information Services in Great Falls, Va. His firm publishes a number of publications on cogeneration and demand-side management issues.

GREAT FALLS, Va.—Ironically, investment in power generation equipment has become one of the least attractive alternatives for utility capital allocations. If such investment goes well, it is subjected to a regulated rate of return. If it goes poorly, the losses have often been transferred to the utility's shareholders.

Similarly, utilities have little reason to obtain generating resources from cogenerators. If all goes well, the costs incurred in such purchases are simply passed through to the ratepayer. If something goes wrong, there is the possibility that regulators will require utility shareholders to absorb the associated costs, just as they have done with costs incurred in utility power plant construction programs.

The bottom line is that new power plants are needed, but the electric utilities traditionally charged with the responsibility for constructing them are neither doing so, nor are they purchasing adequate supplies from cogenerators. The nation is thus facing electric generating capacity shortages in the near future.

One way of ameliorating this shortage is through load displacement cogeneration, in which the electric output is provided directly to the user, rather than being sold to an electric utility. From the utility's perspective, the electric load served by the cogenerator has been "displaced."

While utilities with surplus capacity have in the past opposed load displacement cogeneration, in the face of shortages, load displacement cogeneration should face little opposition. In fact, electric utilities should be actively encouraging such cogeneration. Encouragement is necessary to garner the substantial benefits available from these true cogenerators, for several reasons.

First, utilities that most need new sources of generation often have very low retail rates, making cogeneration appear uneconomic. Second, the owners of these sites do not see electric power generation as being their business. It is often perceived as a mere distraction, even if potentially profitable.

Finally, unlike the large cogeneration facilities which were designed to sell power to electric utilities, load displacement cogeneration plants must be designed and operated primarily to serve the host site, and not the power system. This is a more complicated and expensive undertaking at every stage, including the critical early stages when the feasibility of a cogeneration project is being studied.

Load displacement cogeneration benefits not only the customer employing the plant, but also the utility's other ratepayers, the employees of the customer, and society at large. Other ratepayers are benefitted by avoiding the construction of new plants, and eliminating the risk of "stranded investment" in that new plant should a large customer suddenly close down or move. Employees are benefitted because the owners of the plant will be less likely to close or move it because of the added investment in the cogeneration facility that would have to be written off.

Society would benefit because of the environmental benefits of cogeneration. These include improved efficiency that results from the simultaneous production of electrical and thermal energy; higher reliability, as the increased number of plants reduces the likelihood that all plants will be down simultaneously; and reduced need for new transmission facilities. Placing plants closer to the load also helps mitigate current shortages in transmission capacity.

Regulatory commissions should provide the same incentives for load-displacement co-

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Consultant: Include Cogen in DSM

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generation programs as they currently do for demand-side management programs. Regulators throughout the U.S. have encouraged billions of dollars of expenditures by utilities for the support of demand-side management programs. These mechanisms fall into three general categories: recovery of costs incurred in implementing DSM programs; compensation for revenues lost when load is reduced as a result of the success of those programs; and extraordinary compensation, beyond ordinarily allowable rates of return, granted to encourage utilities to act.

But in order for load-displacement cogeneration to reach its potential, utilities must similarly be assured that funds expended to support cogeneration will be recovered, revenues lost from reduced sales will be compensated, and innovative programs that successfully encourage load displacement programs will be rewarded.

The creation of similar mechanisms for compensating utilities that establish load-displacement programs would likely have an immediate effect on their attitudes toward cogeneration. Effective, efficient load-displacement cogeneration needs and deserves the same support provided to demand-side management programs.

Rebate Assists HVAC, Lighting That Saves 1.1 MMKwh, Yields

Continued from Page 19

energy use another 419,390 kwh a year. The lighting strategies earned a $5,563 rebate.

The delamping included installation of 1,100 32-watt T-8 Octron lamps from Sylvania Lighting Services, Danvers, Mass., Miskus said. Throughout most of the site, the fixture's new two-lamp T-8 configuration replaced a three-lamp T-12 arrangement. Adequate light levels were preserved by installing 450 Silverlux reflectors from 3M Construction Markets, St. Paul, Minn. Finally, 450 Model B-2321277 electronic ballasts from MagneTek, Los Angeles, were ir stalled. Old lamps and ballast were recycled, said Miskus.

The lighting project was rounded out with Model W500A W1000A, and W2000A infrare and ultrasonic occupancy senso supplied by The Watt Stoppe Inc., Santa Clara, Calif. A total o 120 devices were installed, fo which the user received a rebat of $1,544. The occupancy sensors which eliminated the need for separate time-of-day lighting cor troller, are positioned in all of th facility's individual offices, hal ways, and other areas.

COGENERATION

Cogeneration is the simultaneous production of electricity and thermal energy. During conventional electric power production, the thermal energy is released into the environment. In a cogeneration plant, this thermal energy is recovered and used to displace thermal energy requirements at the site. This recovering of thermal energy increases the overall efficiency from approximately 33% in conventional electric production to greater than 70% in a cogeneration system. This concept of cogeneration can be used in the right applications to substantially reduce energy costs by using a highly efficient on-site cogeneration system. A recent EPRI Journal cover story entitled "Distributed Generation" (EPRI Journal, April/May 1993) provides a case study of a 1.1 MW natural gas engine cogeneration system versus new central station power generation to show the benefits to electric utilities. This case study shows that the benefits from deferral of transmission and distribution upgrades, reduced emissions, fuel diversity and customer use of waste heat can significantly reduce the higher initial cost of this cogeneration system.

The concept of cogeneration was introduced in the early 1900's. Today, private power and cogeneration plants provide more than 11% of the Nation's electric requirements and will provide more than 20% of the new power generation tomorrow. Cogeneration is fulfilling the growing electrical needs of the nation with improved reliability and efficiency. Table 1 provides a partial list of some of the existing cogeneration plants in Florida. These plants are designed to provide all or part of the electric requirements for their facilities with little or no excess electricity being sold to the electric utilities. The thermal energy is recovered to provide hot water, steam and/or air conditioning on-site. Table 1 indicates that hospitals are good applications for cogeneration systems. This is due to their relatively constant need for electricity and thermal energy. By having an efficient on-site cogeneration system operate in parallel with the electric utility, a site can also improve the quality and dependability of the electric service. This can be extremely important for hospitals in Florida due to the occurences of hurricanes and other causes of electric interruptions. Table 2 is a partial list of the non-utility generators in Florida. These plants are designed to make use of the thermal energy on-site and provide electricity to the electric utilities in Florida. Tables 1 and 2 show that there are many industries and fuel sources that are good applications for cogeneration in Florida.

The following information includes the technical and economic feasibility of cogeneration using natural gas for a typical hospital application in Florida. Most of the existing hospital cogeneration systems in Florida use natural gas turbine generators to provide electricity and the thermal energy is used for hospital steam or in an absorption chiller to provide air conditioning. The typical hospital application presented here uses a 1500 KW gas turbine generator with the waste heat being used in a 1000 ton direct fired, absorption chiller. Table 3 shows the input design data, energy savings, operating costs, and installed capital cost for this system versus operation without the cogeneration system. The design data include a total electric cost of $0.065/KWH and a total gas cost of $0.35/therm. Due to the large quantity of gas used by the cogeneration system, the user will probably contract for the purchase of their own gas and use the transportation rates available from Florida Gas Transmission and City Gas Company. Therefore the gas cost is the sum of the contract price for gas plus the transportation rates. Conventional cogeneration plants of this type have a 94% to 96% capacity factor. Hours out-of-service are normally due to scheduled and preventive maintenance. A cost of $0.007/KWH is included for preventive maintenance and an equipment escrow to replace equipment at the end of its normal life. The electric centrifugal chillers used in most hospitals are being required to convert to a non-CFC refrigerant. The electric chiller efficiency of 0.69 KW/ton is typical of most centrifugal chiller efficiencies after conversion. The heat rate for this gas trubine is 14,200 BTU/KWH

The energy savings that are obtained by the hospital include the 1500 KW of electricity that is avoided and the cost of 1000 tons of air conditioning that would have been supplied by the hospital's electric chillers. The added operating costs for using the cogeneration plant include the cost for the natural gas and the cost for maintaining and replacing the cogeneration equipment. When the annual energy savings of $1,184,637/yr are reduced by the operating costs of $707,786/hr the net savings of $476,851/yr is available to the hospital. The installed capital cost for this cogeneration system is $2.8 million. Therefore the simple payback is 5.9 years. The addition of the proposed cogeneration plant to the hospital would: (1) improve the quality and reliability of electric service at the hospital; (2) reduce the hospital's cost of energy; and (3) enable the hospital to provide essential services during periods of electric power interruptions like hurricanes.

Presently 1500 KW is probably the smallest size gas turbine generator with acceptable economic feasibility in Florida. Due to economies of scale, the economics will improve for larger cogeneration systems. Applications needing less than 1500 KW should probably consider using reciprocating engine cogeneration systems or gas engine chillers with heat recovery.

Hospitals are only one possible application for cogeneration systems. Other large users of both electricity and thermal energy (steam or hot water) or air conditioning are other applications. Industrial sites, hotels, universities, health care facilities, apartment buildings, schools, restaurants, laundries and many others are possible sites for cogeneration systems in Florida.

TABLE 1

SOME COGENERATION PLANTS IN FLORIDA

PROJECT	PLANT OUTPUTS ELECTRIC/ STEAM /A.C.	PLANT DESIGN ENGINE/HEAT RECOVERY	OPERATIONAL STATUS
Baptist Medical Center of Jacksonville	12 MW /80,000#/hr /3000 tons	4 Gas Turbines 4 Heat Recovery Boilers 3 Absorption Chillers	1978
St. Vincent's Hospital (Jacksonville)	1.4 MW/10,200#/hr /1060 tons	1 Gas Turbine 1 Heat Recovery Boiler 1 Absorption Chiller	1990
St. Joseph's Hospital (Tampa)	1.7 MW/Hot Water /403 tons	1 Reciprocating Engine 1 Heat Recovery Boiler 1 Absorption Chiller	1993
North Shore Medical Center (Miami)	1.5 MW/ - /850 Tons	1 Gas Turbine 1 Absorption Chiller (Direct Fired)	1993
Merritt Square Mall (Merritt Island)	4.9 MW/ - /2200 Tons	7 Reciprocating Engines 7 Heat Recovery Boilers 2 Absorption Chillers 2 Electric Chillers	1969
Citrus World (Lake Wales)	4.0 MW/110,000#/hr/ -	1 Gas Turbine 1 Heat Recovery Boiler	1987
Tropicana (Bradenton)	33 MW to 45 MW 125,000 #/hr to 45,000 #/hr STIG Cycle	1 Gas Turbine (STIG) 1 Heat Recovery Boiler	1989

TABLE 2

NON-UTILITY GENERATORS IN FLORIDA

DEVELOPER(s)	PROJECT/LOCATION	SIZE	UTILITY	STATUS	FUEL
AES	Cedar Bay, Jacksonville	250 MW	FP&L	construction	coal
Air Prod. & Chemicals	Orlando	110 MW	FP—72 MW Reedy Creek —38 MW	construction	gas
Ark Energy 50% CSW Energy 50%	Pahokee	250 MW	FP&L	planned	coal
	Mulberry Energy, Polk Co.	72 MW	FP	planned	gas
Babcock & Wilcox	W. Palm Beach	60 MW/ 2,000 tpd	FP&L	operating	MSW
CFR Bio-Gen Corp.	unnamed	74 MW	FP	planned	gas
Community Energy Alternatives 23% Dade County 77%	Montenay-Dade Dade Co.	43 MW	FP&L	operating	MSW
Conserv	Polk Co.	2.7 MW	NA	operating	waste heat
Decker Energy 50% Wheelabrator 50%	Ridge Generating Sta., Polk Co.	40 MW	FP	planned	wood, tires
Destec Energy 50% EcoPeat 50%	Lake Placid	156 MW	FP	planned	peat
	W. Palm Beach	52 MW	FP&L	planned	peat
Flo Sun	Okeelanta	70 MW	FP&L	planned	sugar cane
	Osceola Farms	42 MW	FP&L	planned	sugar cane
Mulberry Phosphates	Manatee Co.	28 MW	FP	planned	waste heat
	Polk Co.	3 MW	TECO	operating	waste heat
North Canadian Power	Lake Cogen Ltd., Umatilla	102 MW	FP	planned	gas
NRG Energy 50% Black & Veatch 50%	Cypress Energy Partners, Okeechobee	832 MW	FP&L	planned	coal
Ogden Projects	Hillsborough Co.	29 MW/ 1,200 tpd	TECO	operating	MSW
	Lake Co.	13.5 MW/ 528 tpd	FP	operating	MSW
	Pasco Co.	31MW/ 1,050 tpd	FP	operating	MSW
	Lee Co.	37.5 MW/ 1,200 tpd	FP&L	planned	MSW
Panda	Lakeland	74.9 MW	FP	planned	gas
Peoples Cogen 50% North Canadian Power 50%	Pasco Cogen Ltd., Dade City	102 MW	FP	planned	gas
Thermo Energy Systems 50% Rolls Royce 50%	Miami	27.5 MW	FP&L	operating	gas
Tosco	Seminole Fertilizer, Polk Co.	15 MW	FP	planned	waste heat
U.S. Generating	Indiantown Cogeneration, Palm Beach Co.	300 MW	FP&L	planned	coal
Waste Management	CDSL, Pompano Beach	16 MW	FP&L	operating	methane
Wheelabrator	Broward Co. South	70 MW/ 2,250 tpd	FP&L	operating	MSW
	Broward Co. North	70 MW/ 2,250 tpd	FP&L	operating	MSW
	Pinellas Co.	70 MW/ 3,150 tpd	FP	operating	MSW
Westinghouse	Bay Co.	11 MW/ 600 tpd	FP	operating	MSW, wood

TABLE 3

NATURAL GAS COGENERATION ANALYSIS

GAS TURBINE GENERATOR WITH ABSORPTION CHILLER

DESIGN DATA:

- 1500 KW Gas Turbine Generator
- 1000 Ton Absorption Chiller
- $0.065/KWH Electric Cost
- $0.35/therm Gas Cost (Gas Contract + Transportation Rates)
- 95% Capacity Factor
- $.007/KWH Maintenance Cost
- .69 KW/Ton Electric Chiller Efficiency
- 14,200 BTU/KWH Gas Turbine Efficiency

ENERGY SAVINGS:

Electric : 1500 KW X $\frac{\$.065}{KWH}$ X $\frac{8760\ HR}{YR}$ X .95 capacity factor = $811,395/yr

A/C: 1000 tons X $\frac{.69\ KW}{Ton}$ X $\frac{\$.065}{KWH}$ X $\frac{8760\ HR}{YR}$ X .95 = $373,242/yr

TOTAL ENERGY SAVINGS $1,184,637/yr

OPERATING COSTS:

Natural Gas: 1500 KW X $\frac{14,200BTU}{KWH}$ X $\frac{\$.35}{10^5 BTU}$ X $\frac{8760\ HR}{YR}$ X .95 = $620,405/yr

Maintenance: 1500 KW X $\frac{\$.007}{KWH}$ X $\frac{8760\ HR}{YR}$ X .95 = $ 87,381/yr

TOTAL OPERATING COSTS $ 707,786/yr

NET SAVINGS: $476,851/yr

CAPTIAL COSTS:

Gas Turbine Generator	= $1,250,000
Absorption Chiller	= $ 600,000
Installation, Overhead, Fees	= $ 950,000
TOTAL CAPITAL COST	= $2,800,000

SIMPLE PAYBACK: 5.9 Years

TABLE 1

NATURAL GAS DESICCANT DEHUMIDIFIER ANALYSIS

DESICCANT DEHUMIDIFIER VERSUS ELECTRIC HUMIDITY CONTROL

DESIGN DATA:

APPLICATION	- New Supermarket (34,433 sq. ft.) Tallahassee, FL
DESICCANT SYSTEM	- 17,200 CFM Desiccant Dehumidifier with Gas Regeneration Plus 45 tons of Conventional Electric A/C to Maintain Conditioned Space @ 75°F and 35% R.H.
ELECTRIC SYSTEM	- 70 Tons of Electric A/C with Subcool And Reheat System for Humidity Control Using Hot Gas For Reheat to Maintain Conditioned Space @ 75°F and 50% R.H.
ENERGY COSTS	- Electric - $ 0.65/KWH Natural Gas - $ 0.45/therm

CALCULATIONS: Computer Analysis Based Upon Hourly Internal Load Conditions For New Supermarket and Ambient Weather Conditions for Tallahassee

RESULTS:

	DESICCANT DEHUMIDIFIER	CONVENTIONAL A/C
ENERGY CONSUMPTION		
HVAC SYSTEM		
Electric	221,887 KWH/yr	400,680 KWH/yr
Gas	20,943 therm/yr	-0-
REFRIGERATION CASES		
Electric	920,431 KWH/yr	1,127,519 KWH/yr
PEAK DEMAND	207 KW	263 KW
TOTAL ENERGY USE		
Electric	1,142,318 KWH/yr	1,528,199 KWH/yr
Gas	20,943 therm/yr	-0-
ENERGY COSTS		
Electric	$ 74,250/yr	$ 99,333/yr
Gas	$ 9,424/yr	-0-
Total	$ 83,674/yr	$ 99,333/yr
NET SAVINGS	$ 15,659/yr	-
CAPITAL COSTS	$ 76,500	$ 77,000

CITY GAS COMPANY OF FLORIDA

An NUI Company

Mr. C. Edward Mills
Bureau of Gas Regulation
Florida Public Service Commission
101 East Gaines Street
Tallahassee, FL 32399-0868

Sept. 16, 1993

RE: REQUEST FOR INFORMATION ON GAS TECHNOLOGIES

Dear Mr. Mills:

Enclosed please find the information that you requested on Gas Engine Chillers, Gas Water Heating, and Gas Engine Heat Pumps. It is important that the electric utilities know what the input design criteria, system characteristics and utility rates are that were used for these comparisons. The calculation sheets will show the electric utilities how to determine the energy consumption and operating costs for these gas technologies. Since the gas engine chillers and gas engine heat pumps produce both A/C and hot water it was necessary to include the costs for providing hot water with the electric A/C systems also. Please ask Joe Jenkins if it is possible to provide the electric utilities with all of the following information so that they have the complete picture of these gas technologies and our evaluation.

Please contact me if I can provide any additional information.

Sincerely,

Richard C. Furman

Richard C. Furman
Consulting Engineer
City Gas Company of Florida
10404 SW 128 Terrace
Miami, FL 33176
(305) 232-4074
fax: 232-4074

enclosures (5)
cc: Henry Block
Jack Langer
John Stark
bcc: Vern Krutsinger
Joe Jenkins
Mary Ann Helton

GAS DRIVEN CHILLERS - TECOCHILL 150 TONS

INPUT DATA

APPLICATIONS: HOTELS, NURSING HOMES, HOSPITALS, CONDOMINIUMS

NEW A/C UNIT CAPACITY - 150 TONS

A/C LOAD FACTOR - 6000 EQUIVALENT FULL LOAD HOURS PER YEAR (EFLH)

NEW GAS HOT WATER BOILER - 75% EFFICIENCY

SYSTEM CHARACTERISTICS: TECOCHILL CH - 150

EFFICIENCY - 1.7 C.O.P. = $\frac{\text{1.7 BTU OF COOLING}}{\text{1.0 BTU OF FUEL}}$ (INTEGRATED PART LOAD VALUE)

AUXILIARY ELEC. - 3 KW

ENGINE MAINT. + REPLACEMENT COSTS - $0.01/TON·HR

HOT WATER PRODUCTION - 700,000 BTU/HR @ FULL LOAD

SYSTEM CHARACTERISTICS: NEW ELECTRIC CHILLER - 150 TONS

EFFICIENCY - 0.65 KW/TON = $\frac{\text{6.5 KW OF ELEC}}{\text{1.0 TON OF COOLING}}$ (INTEGRATED PART LOAD VALUE)

ENERGY COSTS :

NATURAL GAS - $ 0.45 /THERM CITY GAS CO. COMMERCIAL RATE (8/93) (excluding customer charge and taxes)

ELECTRICITY - $ 0.065 /KWH FLORIDA POWER & LIGHT CO. (8/93) (excluding customer charge and taxes)

CALCULATIONS

SEE FOLLOWING TABLE 2.0 - CALCULATIONS

RESULTS

	GAS ENGINE CHILLER TECOCHILL CH-150	NEW ELECTRIC CHILLER AND GAS BOILERS
ANNUAL ENERGY CONSUMPTION		
GAS	63,529 THERMS/YR	42,000 THERMS/YR
ELECTRIC	25,500 KWH/YR	585,000 KWH/YR
ANNUAL OPERATING COSTS		
GAS	$28,588/YR	$ 25,200/YR
ELEC.	$ 1,658/YR	$ 38,025/YR
MAINTENANCE	$ 9,000/YR	-
CAPITAL COSTS (CHILLER ONLY)		
EQUIPMENT	$ 66,500 (including City Gas rebate)	$55,000
INSTALLATION	SAME	SAME

TABLE 2.0 - CALCULATIONS

-TECOCHILL CALCULATIONS-

GAS COST : $\frac{12{,}000\ BTU_c}{Hr \cdot Ton}$ X A/C Capacity 150 Tons X Gas Rate $\frac{\$\ 4.50}{10^6\ BTU_f}$ X Eq. Full Load Hours per Yr. 6000 $\frac{EFLH}{Yr}$ / C.O.P. 1.7 $\frac{BTU_c}{BTU_f}$ = # 28,588 /YR

ELEC. COST: Tecochill KW Load 3.0 KW X $/KWH ($\frac{\$\ 0.065}{KWH}$ X Run Hrs/Yr 8500 $\frac{Hr}{Yr}$ = # 1,658 /YR

ENGINE MAINT. + REPLACEMENT : $ 0.01 /Ton·Hr. X 150 Tons X 6000 $\frac{Hours}{Yr}$ = # 9,000 /YR

TECOCHILL ANNUAL OPERATING COST = # 39,246 /YR

-NEW ELECTRIC CHILLER & GAS BOILER CALCULATIONS-

ELEC. COST: (Capacity 150 Tons X $/KWH $\frac{\$0.065}{KWH}$ X EFLH 6000 $\frac{Hr}{Yr}$ X IPLV KW/Ton $\frac{0.65\ KW}{Ton}$) = # 38,025 /YR

HOT WATER COST : MMBTU/HR $0.7 \times 10^6\ \frac{BTU}{Hr}$ X Gas Rate $\frac{\$\ 4.50}{10^6\ BTU}$ X EFLH 6000 $\frac{Hr}{Yr}$ / Boiler Eff. 75 % = # 25,200 /YR

NEW ELECTRIC CHILLER & GAS BOILER ANNUAL OPERATING COSTS = # 63,225 /YR

-SAVINGS-

NEW ELECTRIC	-	TECOCHILL	=	ANNUAL SAVINGS
# 63,225 /YR	-	# 38,025 /YR	=	# 25,200 /YR.

RESIDENTIAL WATER HEATERS IN FLORIDA

	TYPICAL ELECTRIC WATER HEATER	TYPICAL GAS WATER HEATER	SEAHORSE GAS WATER HEATER
ANNUAL ENERGY USE	4195 KWH/YR	216 THERMS/Yr	216 THERMS/YR
ENERGY COST	$0.078/KWH	$0.67 /THERM	$0.67 /THERM
ANNUAL HOT WATER COST	$ 327/YR	$ 145/YR	$ 145/YR
ANNUAL HOT WATER SAVINGS		$ 182/YR (56%)	$ 182/YR (56%)
ANNUAL FUEL USE	47.7 $\frac{MMBTU}{YR}$	21.6 $\frac{MMBTU}{YR}$	21.6 $\frac{MMBTU}{YR}$
ANNUAL FUEL SAVINGS		26.1 $\frac{MMBTU}{YR}$ (55%)	26.1 $\frac{MMBTU}{YR}$ (55%)
CAPITAL COSTS (New Home)			
WATER HEATER	$100	$140	$455
INSTALLATION	$200	$225	$253
CITY GAS BUILDER INCENTIVE	$ 0	-$225	-$225
TOTAL COST	$300	$140	$483

GAS ENGINE HEAT PUMP - YORK 3 TON

INPUT DATA

APPLICATIONS: RESICENTIAL AND SMALL COMMERCIAL

NEW A/C UNIT CAPACITY - 3 TONS

A/C LOAD FACTOR - 3000 EQUIVALENT FULL LOAD HOURS PER YEAR (EFLH)

SYSTEM CHARACTERISTICS: YORK GHP WITH GAS WATER HEATER

EFFICIENCY - 1.2 C.O.P. = $\frac{\text{1.2 BTU COOLING}}{\text{1.0 BTU FUEL}}$ (SEASONAL C.O.P.)

AUXILIARY ELEC. - 0.35 KW

HOT WATER PRODUCTION - YORK GHP - 17,500 BTU/HR @ FULL LOAD
(TOTAL HOT WATER FOR RESIDENCE FOR 9 MONTHS)
(GAS WATER HEATER FOR RESIDENCE FOR 3 MONTHS)

SYSTEM CHARACTERISTICS: NEW ELECTRIC A/C SYSTEM WITH ELECTRIC WATER HEATER

EFFICIENCY - 1.2 $\frac{\text{KW}}{\text{TONS}}$ (10.0 SEER)

HOT WATER PRODUCTION - ELECTRIC WATER HEATER - 4195 $\frac{\text{KWH}}{\text{YR}}$

ENERGY COSTS:

NATURAL GAS - $0.67/THERM — CITY GAS CO. RESIDENTIAL RATE (8/93) (excluding customer charge and taxes)

ELECTRICITY - $0.078/KWH — FLORIDA POWER & LIGHT CO. (8/93) (excluding customer charge and taxes)

CALCULATIONS

SEE FOLLOWING TABLE 6.0 - CALCULATIONS

RESULTS

	YORK GHP WITH GAS WATER HEATER	NEW ELEC. A/C WITH ELECTRIC HOT WATER
ANNUAL ENERGY CONSUMPTION		
GAS	954 THERMS/YR	-
ELECTRIC	1575 KWH/YR	14,995 KWH/YR
ANNUAL OPERATING COSTS		
GAS	$ 639/YR	-
ELECTRIC	$ 123/YR	$1169/YR
MAINTENANCE	$ 50/YR	-
CAPITAL COST - INSTALLED (without water heater)	$6800	$3000

TABLE 6.0 – CALCULATIONS

YORK GHP WITH GAS WATER HEATER

GAS COSTS :

York GHP: $3 \text{ Tons} \times 3000 \frac{Hr}{Yr} \times 12000 \frac{BTU_c}{Ton} \times \frac{1.0\ BTU_f}{1.2\ BTU_c} \times \frac{therm}{10^5\ BTU_f} \times \frac{\$.67}{therm}$ = \$ 603/yr

Hot Water: $216 \frac{therms}{Yr} \times \frac{3\ months}{12\ months} \times \frac{\$.67}{therm}$ = \$ 36/yr

ELEC. COST: $0.35\ KW \times 4500 \frac{operating\ hours}{Yr} \times \frac{\$.078}{KWH}$ = \$ 123/yr

ENGINE MAINTENANCE: \$50/yr = \$ 50/yr

ANNUAL YORK GHP WITH GAS WATER HEATER = \$812/yr

NEW ELECTRIC A/C WITH ELECTRIC WATER HEATER

ELEC. COSTS:

A/C : $3 \text{ Tons} \times 3000 \frac{Hr}{Yr} \times 1.2 \frac{KW}{Ton} \times \frac{\$.078}{KWH}$ = \$ 842/yr

Hot Water: $4195 \frac{KWH}{Yr} \times \frac{\$.078}{KWH}$ = \$ 327/yr

ANNUAL ELECTRIC OPERATING COST = \$1,169/yr

-SAVINGS-

NEW ELEC. A/C WITH ELECTRIC HOT WATER	–	YORK GHP WITH GAS HOT WATER	=	ANNUAL SAVINGS
\$1,169/YR	–	\$ 812/YR	=	\$ 357/YR

CITY GAS COMPANY OF FLORIDA

An NUI Company

Mr. Joseph D. Jenkins
Director-Div. of Electric & Gas
Florida Public Service Commission
101 East Gaines Street
Tallahassee, FL 32301

Sept. 3, 1993

RE: CITY GAS COMPANY'S RESPONSE TO INTERROGATORIES ON ELECTRIC UTILITIES ADOPTION OF CONSERVATION GOALS

Dear Mr. Jenkins:

Enclosed please find City Gas Company's Response to Tampa Electric's First Set of Interrogatories that was requested by September 6, 1993. We understand that City Gas Company's response to this set of Interrogatories from Tampa Electric is not required since the original Interrogatories from the Staff to the Electric Utilities is being rescinded. We also understand that a new set of Interrogatories from the Staff to the Electric Utilities will be issued after collecting additional information on the commercially available gas technologies from the gas utilities. Please review the enclosed information and let me know if this is the information that is needed by the PSC Staff.

Please indicate which of the following commercially available gas technologies should be included:

Gas Cogeneration
Gas Engine Chillers
Gas Engine Heat Pumps
Gas Engine A/C Systems
Desiccant Dehumidification
Gas Hot Water
Gas Space Heating

Please let me know if you would like copies of any of the video presentations, publications, studies, and equipment specifications that are discussed in the following text. I would be glad to meet with your staff to make any presentations, answer questions and provide any additional information on new gas technologies.

Thank you for your assistance.

Sincerely,
Richard C. Furman
Richard C. Furman
Consulting Engineer, City Gas Co. of FL
10404 SW 128 Terrace
Miami, FL 33176
(305) 232-4074

enclosures
cc: Langer, J.
Stark, J.
bcc: Vern Krutsinger
Mary Ann Helton ✓

DRAFT-FOR YOUR COMMENTS

CITY GAS COMPANY'S RESPONSE TO FIRST SET OF INTERROGATORIES FROM TAMPA ELECTRIC COMPANY

BACKGROUND

City Gas Company believes that the proper application of natural gas cooling technologies will have positive benefits for electric and gas utilities while providing cost savings for the end user, more efficient use of our natural resources and less emissions to the environment. City Gas Company would like to work together with other electric and gas utilities to offer coordinated conservation programs for the more widespread use of these new technologies. In other areas of the country gas and electric utilities are working together, like Con Edison and Brooklyn Union Gas, to offer rebate programs for gas cooling equipment. This demand side management program reduces the need to construct new electric generating capacity while making better use of the existing natural gas distribution system. The enclosed brochure from Con Edison entitled "Con Edison Enlightened Energy Rebate Program - High Efficiency Gas Air Conditioning" and the enclosed brochure from Brooklyn Union Gas entitled "Gas Cools. Gas Saves" describes how electric and gas utilities can work together.

The availability of a new generation of more efficient and reliable gas cooling products from a number of manufacturers is one reason for renewed interest in gas cooling. A good source of information on the gas cooling equipment that is currently available from various manufacturers is a publication by the American Gas Cooling Center (AGCC), 1515 Wilson Blvd., Arlington, VA 22209 entitled "Natural Gas Cooling Equipment Guide" dated October 1992. The AGCC also has an installation data base consisting of installed gas cooling equipment throughout the U.S. consisting of descriptions of the applications, equipment and economics. The AGCC also has installation summaries and economic analysis software based upon Trane Company's "Trace" building analysis program.

Other recent developments contributing to the momentum toward natural gas cooling include;

- desires to cut energy costs and eliminate electric peak demand charges
- low natural gas prices
- financial incentives from the gas industry
- need for improved indoor air quality
- responsiveness to environmental calls for a switch to cleaner, CFC-free technologies

Today, high-efficiency gas-fired cooling equipment is readily available for commercial facilities-including hotels, hospitals, nursing homes, office buildings, warehouses, supermarkets, and retail outlets and industrial facilities. Some equipment on the market is also appropriate for residential use. In addition, several promising systems being developed and demonstrated today are expected to reach the market place within the next few years.

There are three basic types of gas cooling systems available today - absorption, engine-driven, and desiccant. Each type is readily available from multiple vendors in standard packaged systems that have proven reliable in a variety of applications. Most manufacturers will also provide larger units or special custom configurations tailored to meet the needs of virtually any application. Absorption and desiccant systems are particularly amenable to being packaged with cogeneration systems, which provide the heat needed to power their chillers. The American Gas Association has a video tape entitled "Natural Gas Cooling - Today's Solution to Tomorrow's Problems" which is an excellent introduction to these three basic types of gas cooling and shows various applications. The proper application of each of these technologies is the key to reducing energy costs.

The first set of interrogatories to City Gas Company only lists some of the new gas cooling equipment available from some of the manufacturers. Therefore our response will be as specific as possible for these individual pieces of equipment but also include our assessment of the overall technical and economic feasibility of gas cooling technologies in Florida.

1.0 "SUPERAIRE" DESICCANT DEHUMIDIFICATION

Commercial dehumidification systems have historically been developed to correct specific high humidity problems that could not be resolved with other technologies. In these applications the service interruptions, product loss, etc. easily justified the high capital cost of the equipment.

More recently, manufacturers have refined the technology so that the equipment is available at lower cost for a wider variety of applications. At the same time standards for indoor air quality are becoming stricter, requiring much more outside air to be processed through a building's air conditioning system. In Florida the amount of moisture that must be removed in such a system is significant all year long.

The primary functions of a commercial air conditioning system are normally to reduce the humidity of an air stream ("latent" cooling) and to lower temperature ("sensible" cooling). Most air conditioners perform latent and sensible cooling simultaneously by cooling the air stream until sufficient moisture condenses out. Where low humidity levels are required, the air is sub-cooled and then reheated to a comfortable level before it can be reintroduced to the conditioned space.

Desiccant systems, in contrast, directly remove moisture from the air without cooling it. Combining a desiccant system with a separate chiller enables the user to control humidity and temperature independently. This capability provides several potential benefits:

* Eliminates condensation on cooling coils and in drip pans and reduces humidity levels in ducts, which virtually eliminates the growth of mold, mildew, and bacteria. This reduces costly maintenance and helps avoid indoor air quality problems.

* Lowers humidity levels in occupied space and provides equivalent comfort levels at higher temperatures, which allows set points on chillers to be raised to save energy and reduce operating costs.

* Permits the downsizing of chillers and ducts in new construction, which can yield significant cost savings-in many cases, making the first cost equal to or lower than that of conventional electric cooling systems.

* Stretches the capacity of existing chillers-where loads increase to make existing chillers insufficient, adding a desiccant system may eliminate the need to replace a functioning chiller with a larger unit.

In general, desiccant systems are suitable for any facility where a low dew point is required or the ratio of latent to sensible cooling loads is high. A few examples of attractive applications for desiccants are:

* Supermarkets-eliminating frost build up on foods and freezer case coils; reducing sweat on refrigerated cases; greatly reducing electricity use; and maintaining a more comfortable environment.

* Offices and retail stores-helping to eliminate "sick building syndrome;" stretching the capacity of existing chillers.

* Hotels-eliminating mold and mildew problems, along with musty odors.

* Industrial applications-eliminating problems in manufacturing moisture-sensitive products.

* Other appropriate applications are SCHOOLS, HOSPITALS, NURSING HOMES, MUSEUMS & LIBRARIES, and ICE RINKS.

The central component of desiccant systems is the desiccant material itself. Two basic types are used: (1) a solid crystalline material, such as lithium chloride or silica gel impregnated into the flutes of a rotating honeycomb wheel; or (2) a liquid that is sprayed into the air stream. The desiccant captures moisture as the air passes through its rotating wheel or liquid spray.

The removal of moisture from the air results in a release of heat (the heat of sorption), which raises the temperature of the air. This heat can then be transferred to the air used to regenerate the desiccant by using a heat pipe or heat wheel. Figure 1.1 shows a typical desiccant dehumidifier consisting of a desiccant wheel, a heat exchanger and a heat source for regeneration. In most commercial applications this heat source is most economically fueled by natural gas.

The *SuperAire* system referenced by Staff Interrogatory #1 is typical of the latest commercially available air conditioning systems which employ a desiccant impregnated rotating wheel as the key component in the process. *SuperAire* is representative of a larger product line produced by Munter's CargoCaire and its affiliates, which also includes custom-built and retrofit equipment. Other manufacturers produce similar equipment employing certain proprietary variations to the design[1]. *SuperAire* in particular is designed for new installations or total replacement of existing conventional air conditioning installations.

Since the basic operating principle of a desiccant system differs dramatically from that of a conventional cooling system, desiccants cannot simply be substituted for electric cooling systems (or absorption or engine-driven systems) on a ton-for-ton basis. Conventional systems designed to produce low-humidity conditions typically contain considerable excess capacity that is required for sub-cooling. In one case, for example, it was possible to substitute a 77-ton electric chiller combined with a 53-ton desiccant unit (a total of 130 tons) for a 160-ton electric chiller. Lowering humidity levels with a desiccant system may also make it possible to raise the operating temperature of the supplemental gas or electric chiller, which can yield significant efficiency improvement.

In a report published recently in the ASHRAE TRANSACTIONS N.J. Banks describes in considerable detail a fully instrumented 1 year test of a typical application at the Marriott Courtyard Hotel in West Palm Beach, FL. The results showed that the desiccant based system maintained lower humidity levels and used less energy than an appropriately sized cool/reheat system. Figure 1.2 is borrowed from that report[2].

Tests are now being conducted on a larger, more advanced unit at the Swan Hotel at Disney World near Orlando.

An earlier study of a SuperAire supermarket installation in San Antonio, Texas showed excellent energy saving performance, as shown in Figure 1.3[3].

It is possible to use computer modeling techniques to predict energy consumption characteristics for gas-fired desiccant systems compared to a properly sized cool/reheat system using electric resistance heating elements. In a recent study of a high-rise hotel in Fort Lauderdale substantial energy savings were forecast for a desiccant system when compared to proper operation of the existing system and using historical weather data. The results are summarized in Figure 1.4.

A partial list of desiccant systems installed in Florida and other states with similar climatic characteristics is shown in Figure 1.5.

RECOMMENDATIONS

Gas-fired desiccant dehumidification systems offer an alternative to conventional vapor compression cycle air conditioning systems which can defer new power plant construction, reduce consumption of natural resources, and reduce the use of CFC's, HCFC's and other refrigerants. Electric and Gas utilities should cooperate in encouraging the use of this equipment by offering incentives to customers and publicizing the opportunities to use this technology.

At this time in Florida only Gas utilities offer first cost assistance to prospective purchasers. This is usually based on the tons of electric-powered equipment displaced and electric strip heating eliminated.

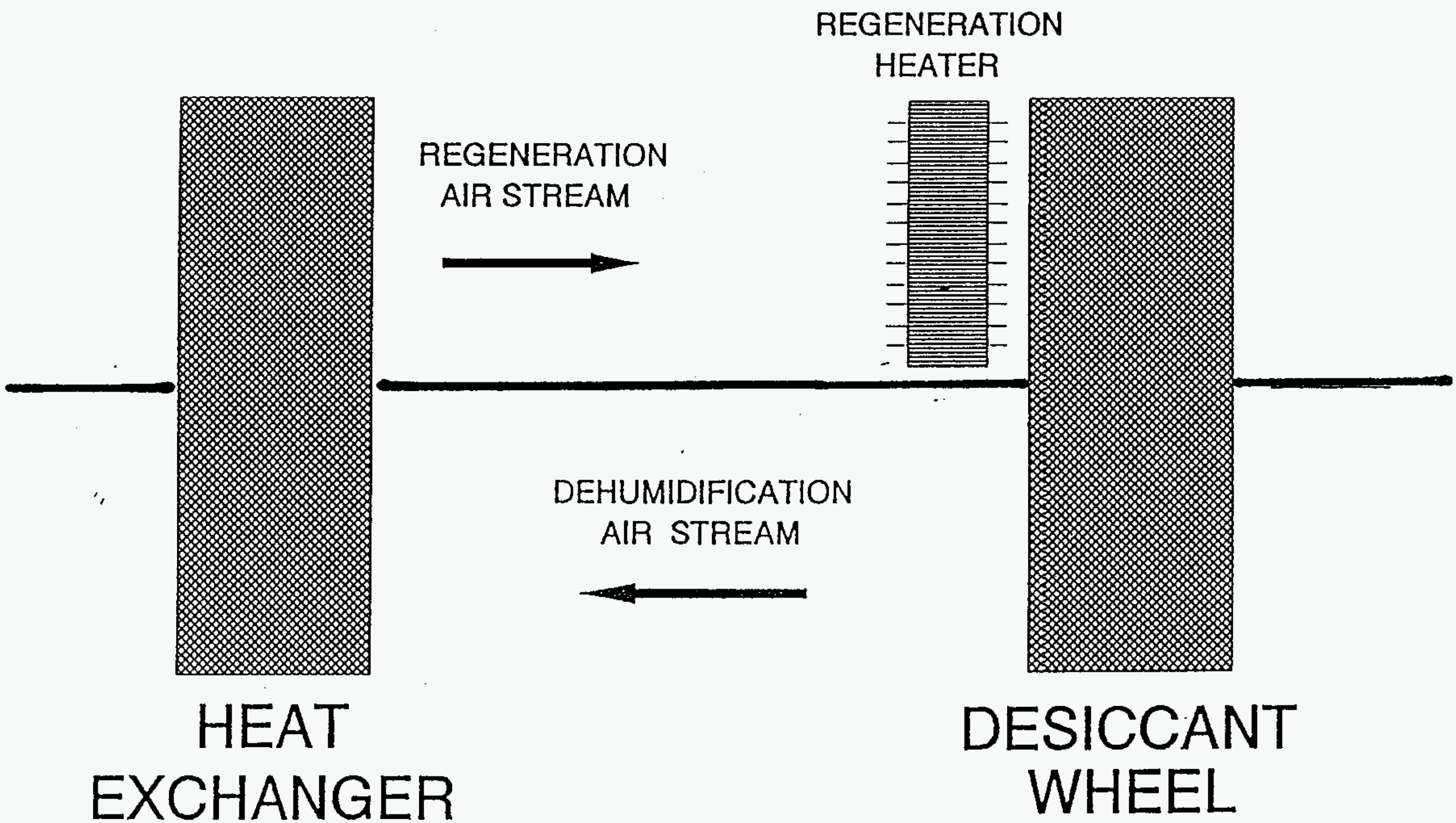


FIGURE 1.1 - TYPICAL DESICCANT DEHUMIDIFICATION SYSTEM

Desiccant System		
Energy and Annual Operating Costs		$22,082
Gas	22359 Therms	$8,496
Cooling	78234 Kwh	$5,476
Fan	74889 Kwh	$5,242
Peak	32 Kwh	$2,867

Cool - Reheat System - 45 Ton		
Energy and Annual Operating Costs		$25,828
Gas	9932 Therms	$3,774
Cooling	230585 Kwh	$16,141
Fan	18248 Kwh	$1,277
Peak	52 Kwh	$4,636

1-YEAR TEST RESULTS
ENERGY AND OPERATING COST COMPARISON
FOR
MARRIOTT COURTYARDS HOTEL — WEST PALM BEACH[2]

Figure 1.2

FIRST COST AND ANNUAL COST COMPARISON[3]
(H.E. Butt Store, San Antonio, Texas)

	Types of HVAC Systems		
		Conventional Vapor Compression	
	SuperAire	Dual Coil	Single Coil
Store conditions	75°F, 40%rh 0.5 cfm/ft²	75°F, 48%rh 0.8 cfm/ft²	75°F, 48%rh 1.0 cfm/ft²
HVAC system first cost			
a. System, delivered	$66,254	$60,324	$52,324
b. System installation	13,020	11,150	11,150
c. Duct system installed	17,146	28,711	31,249
Total First Cost	$96,420	$100,185	$94,723
Annual costs*			
a. Utility cost			
1. HVAC system	$10,440	$14,389	$17,355
2. Refrig., food cases	62,568	68,010*	68,010
b. Maintenance cost	1,824	1,746	1,746
Total Annual Costs	$74,832	$84,145	$87,111

* Costs are based on an electricity rate of $.0499/kWh and no demand charge and a gas rate of $.41/therm.

Figure 1.3

FEASIBILITY STUDY
FOR
FORT LAUDERDALE HI-RISE HOTEL

GAS-FIRED DESICCANT VS. EXISTING COOL/REHEAT SYSTEM

[NOTE: ANALYSIS FOR OUTSIDE AIR PORTION OF SYSTEM ONLY!]

System as designed:

28900 CFM outside air
62 DB/60.8 WB Leaving air (approx 78 GR/LB)
72 DB Delivery air
200 KW heating coils
Design heating temp 80 DB
Chiller efficiency 1.0 KW/TON (cool/reheat)
0.9 KW/TON (desiccant)

RESULTS:

	Existing	Desiccant
Tons	150.1	45.8
Cooling KWH	645,039	133,296
Reheat KWH	625,009	0
Heating KWH	299,364	0
Total KWH	1,569,413	133,296
Cooling gas MCF	0	7,907
Heating gas MCF	0	1,385
Annual oper cost	$102,012	$ 50,479

Figure 1.4

DESICCANT DEHUMIDIFICATION INSTALLATIONS IN THE SOUTHEASTERN STATES

ALABAMA	Liz Claiborne Clothing Warehouse -Montgomery (5 units-in process)	ICC
ARKANSAS	WalMart -Conway -Little Rock -Morrilton -Ash Flat -Pocahantas -West Helena	MUNTERS
FLORIDA	Fort Patrick AFB Commissary	ICC
	WalMart-West Palm Beach	MUNTERS
	Marriott Courtyard-West Palm Beach	MUNTERS
	Winn Dixie-Jacksonville	MUNTERS
	Swan Hotel-Disney World	MUNTERS
GEORGIA	Cub Foods Supermarket (2) -Atlanta	ICC
MISSISSIPPI	WalMart -Senatobia -Amory	MUNTERS
N. CAROLINA	Harris Teeter -Charlotte	MUNTERS
TEXAS	Appletree-Houston	MUNTERS
	H.E.B.-San Antonio	MUNTERS
	Fiesta-Austin	MUNTERS
	Tom Thumb-Dallas	MUNTERS
	WalMart -Livingston -Victoria -Corpus Christi -McAllen	MUNTERS

Figure 1.5

NOTES:

[1] Other systems are described in THE NATURAL GAS COOLING EQUIPMENT GUIDE published by The American Gas Cooling Center, 1515 Wilson Blvd., Arlington, VA (10/92)

[2] ASHRAE TRANSACTIONS 1992. V 98 Pt. 1

[3] TECH PROFILE "Commercial Desiccant-Based Cooling System" Gas Research Institute #0289LP18000

2.0 "Tecochill" - Gas Engine Driven Chiller

A gas engine-driven chiller employs the same cooling process as a conventional electric-powered system. The main difference is that the electric motor is replaced by an engine. This switch yields variable-speed operation capability, higher part-load efficiency, efficient high-temperature waste-heat recovery for domestic water heating or steam generation, and in the proper applications, reduced operating cost.

City Gas Company presently has two Tecochill gas engine chillers installed in our service territory. A Tecochill 160 ton natural gas engine chiller was installed at Green Briar Nursing Center in Miami on August 18, 1990. This system can supply all of the chilled water and most of the hot water for this facility. The demonstrated energy savings for both chilled water and hot water was 54%. Enclosed for your information is a "Chiller Application Report" for Green Briar which includes a comparison of the monthly energy costs for electric and gas engine chillers. Also enclosed is a recent Miami Herald article which includes an interview with the owner of Green Briar and a product specifications sheet for the Tecochill 125/150 ton chiller.

A Tecochill 150 ton natural gas engine chiller was installed at the Miami Vila Hotel in South Miami on November 16, 1991. This system can supply all the chilled water and most of the hot water for this facility. The calculated energy savings for both chilled water and hot water is 46%. Enclosed is a description of this application entitled "Miami Vila Hotel".

Before encouraging the use of Tecochill's gas engine chillers, City Gas Company conducted technical and economic evaluations on the use of gas engine chillers versus conventional electric chillers in Florida. This included site visits to about six Tecochill installations to discuss the operating costs, maintenance costs and equipment reliability.

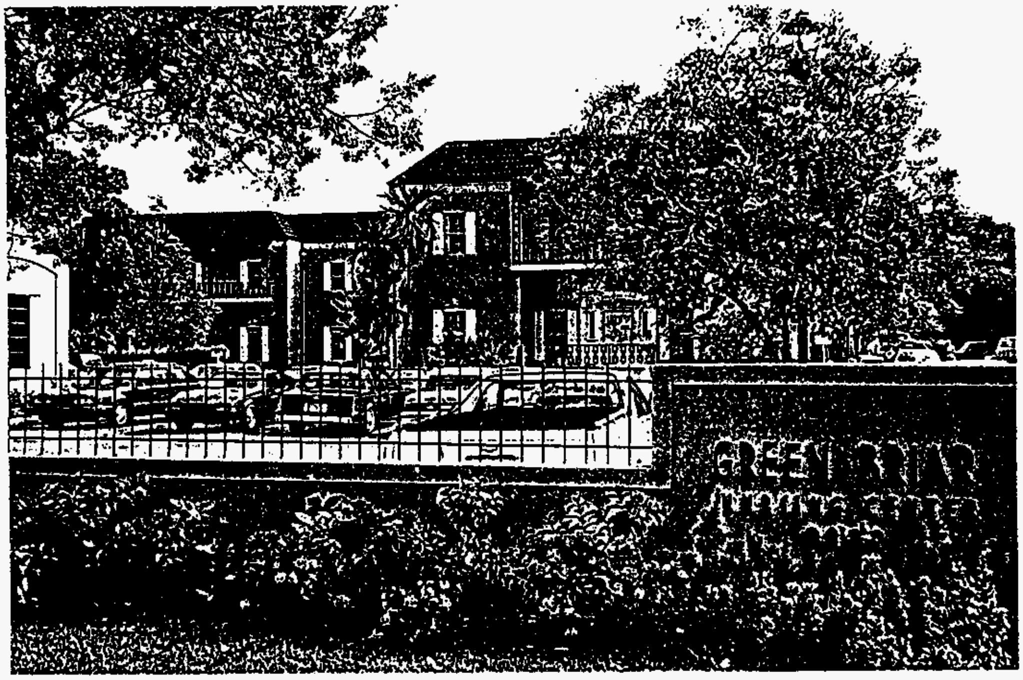
Our evaluations indicated that for a fair comparison of electric versus gas energy systems it is essential to consider the total energy supply system. This is necessary to compare total system efficiency, total capital costs and total energy costs. Table 2.1 - Total Energy Supply System shows the efficiency, capital cost and energy cost for a typical electric chiller system versus a natural gas engine system. For this analysis a 150 ton chiller size was used which is typical of the more than over 200 Tecochill units now operating in the U.S. in this size range.

The efficiency diagram in Table 2.1 shows that during the production of electricity 67% of the energy is wasted. This energy is lost as waste heat to the cooling tower, pond, river or ocean and through the smoke stack. Because these power plants are remotely located this waste heat is not used. When the losses for electrical transmission and distribution are accounted for the end user only has 30% of the energy that was consumed in the power plant. This is a tremendous waste of our energy resources. At the users site the electricity is used in an electric chiller with a typical electric motor efficiency of 90% therby providing 27% of the original energy to the shaft of the compressor which provides the air conditioning. Therefore the total system efficiency for this typical electric chiller system is 27%.

The efficiency diagram in Table 2.1 also shows that natural gas can be used directly in the gas engine chiller without the inefficiencies of electric power production to provide 28% of the original energy to the shaft of the compressor which provides the air conditioning. This 28% efficiency is not a significant improvement

TECOCHILL

Chiller Application Report



Green Briar Nursing Center Miami, Florida

The Green Briar Nursing Center demands a high level of comfort for its patients as well as energy savings. The Tecochill system has satisfied both with an energy savings of $4,567 (54%) during the first month of operation.

Richard Furman, engineering consultant on the project, commented during a recent visit: "The Tecochill system has surpassed our performance goals and initial energy savings estimates. It is definitely suited for our hot and humid South Florida climate."

The Green Briar Nursing Center is a 203 bed comprehensive and rehabilitative care center located in the Kendall area of Miami. This one and two story building consists of about 75,000 sq. ft., originally served by two electric reciprocating compressor chillers totaling 180 tons of capacity.

Installed and serviced by Airko Service, Inc., the new 160 ton Tecochill system was placed in operation in August, 1990 as an alternative to the existing electric chillers. The system runs on inexpensive, plentiful natural gas and is designed to make use of the waste heat from the engine to supply almost all of the hot water for the kitchen, laundry, and domestic loads. Started during the middle of the summer the Tecochill unit has been able to satisfy Green Briar's peak cooling demands.

City Gas Company of Florida provided support for installing the Tecochill system at Green Briar and, like many other natural gas utilities, continues to provide incentives to customers who use natural gas cooling.

KEY DATA

Installed: August 18, 1990
Availability: 98% - first month
Energy Savings: $4,567 - first month
Benefits: Energy savings and hot water recovery

CITY GAS COMPANY OF FLORIDA

160 TON
NATURAL GAS ENGINE CHILLER
MONTHLY ENERGY SAVINGS - AUG./SEPT.
GREEN BRIAR NURSING CENTER

Actual Energy Bills - Aug./Sept.

	1989	1990
NATURAL GAS	$ 2,039	$ 4,333
ELECTRICITY	$18,189	$10,799
TOTAL	$20,228	$15,132
DIFFERENCE		$ 5,096/MONTH

Changes in Energy Costs - Aug./Sept.

	1989	1990
NATURAL GAS		
BOILER	$ 1,167	-0-
CHILLER	-0-	$ 3,828
ELECTRICITY		
CHILLER	$ 7,228	-0-
TOTAL	$ 8,395	$ 3,828
SAVINGS		$ 4,567/MONTH (54%)

FOR FURTHER INFORMATION CONTACT:

City Gas Company of Florida
An NUI Company

955 East 25th Street
Hialeah, Florida 33013-3498
(305) 691-8710, ext. 220

TECOGEN INC.
A subsidiary of Thermo Electron Corporation

45 First Avenue
P.O. Box 9046
Waltham, MA 02254-9046
(617) 622-1400

FINAL EDITION

The Miami Herald

SUNDAY, DECEMBER 23, 1990

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Gas companies ignite battle for South Florida customers

By XOSE F. ALVAREZ-ALFONSO
Herald Writer

Gas companies would like more folks to be cooking like the Bianchis.

Each evening when Dinora Bianchi comes home from work, she cooks dinner for her family on a gas range.

And over the holidays, she plans to roast a turkey that she, her husband, Alexsandro, and their two young children will share with a few visiting family members at their home in the Northwest Dade community of Marbella Park.

The cost of cooking that meal on a gas range will be half of what the Bianchis would pay if they had an electric one, according to the U.S. Department of Energy. In fact, gas appliances in homes could reduce energy costs by as much as 40 percent.

Aggressive marketing

With the increasing popularity of gas-operated appliances, gas companies have begun an aggressive marketing campaign to promote natural and propane gas as a household energy source that's more efficient and less costly than oil or electricity.

In national ads, gas companies cite the Middle East crisis and warn of increases in the cost of oil.

In South Florida, gas companies are battling Florida Power & Light with a marketing strategy that says gas is 30 percent to 40 percent cheaper to use than electricity and more reliable. Several gas companies are offering free water heaters or $400 credits to homeowners who change over to gas.

Even though gas may be less expensive, the price of electricity is more stable, said FPL spokesman Ray Golden.

"Gas is in a market bubble, but as there's more demand the price of gas will go up," he said. "The price of electricity has reached a point where it won't fluctuate very much."

But the gas companies seem to be making inroads as an increasing number of homeowners choose gas over electricity to run their stoves, water heaters, clothes dryers and — just entering the residential market — central air-conditioning systems.

While the use of gas in northeastern states has been standard for decades, it is a relatively new fuel in South Florida, said Bruce Henning, of the economic analysis division of the American Gas Association, a trade group in Washington, D.C. The first pipes of natural gas were introduced in Florida in the 1960s.

The number of homeowners converting to gas has reached records, gas companies say.

In the past year, about 3,750 of the 350,000 homes in Dade County hooked up to gas lines.

During the last 12 months, 2,200 homeowners in Dade and Broward counties turned to City Gas Co. of Hialeah for service to run gas-operated appliances. That's an increase of almost 650 conversions from the previous year, when 1,552 residents switched to City Gas.

And during that same period, another 1,210 homeowners in South Florida called on Peoples Gas System to make their changeover to gas. That's up from 942 residents the previous year.

Expected to rise

By comparison, the number of Florida homes switching to gas may be small, but it is expected to continue to increase, Henning said.

"As the cost of electricity continues to go up, more people will be willing to turn to gas," he said. Statewide, about 20 percent of Florida's 5 million homes use gas.

Gas companies have successfully promoted energy efficiency to local residential builders. And builders have found that offering the option of gas appliances is an effective marketing strategy.

Codina Bush Homes, a subsidiary of the Codina Group, is a new convert to gas.

"City Gas approached us, and we saw it as a strong marketing tool," said Steve Suarez, president of Codina Bush Homes.

About 75 percent of the buyers who purchased homes in the two Southwest Dade Codina Bush communities chose gas. Lakes of Kendale is a neighborhood of 64 homes off Southwest 62nd Street and 149th Avenue. Lancaster Estates is a subdivision of 110 houses in Lakes of the Meadow near Southwest 47th Street and 154th Avenue.

"We show people the low energy cost with gas, and the savings are substantial," Suarez said. "They can dry three to four loads of clothes in a gas dryer for the same cost of one load in an electric one, and the gas dryer doesn't bake the heck out of clothes."

Consumers have more options with gas appliances, said Luis Alvarez, South Florida manager of sales and administration for Peoples Gas System.

Gas stoves and water heaters have been used for years in South Florida. But recently a number of manufacturers began pushing gas-operated clothes dryers, heaters and air conditioners.

While gas-operated air-conditioning units are available for homes, they tend to be expensive and not as efficient as electric units. But prices are expected to drop within a couple of years, when new types of units are widely available, said Joe Sitra, president of Miami-based Sitra Distributing Co.

Not new to him

Gas-operated air-conditioning units are nothing new to retired college instructor Alan Stratton.

"I've owned a gas-operated air conditioner since 1958," said Stratton, a Miami Beach resident. "Gas is a lot cheaper than electricity."

Frequent power surges and outages on Miami Beach were other reasons why Stratton turned to gas.

Fighting back

Electric utilities are fighting back with cost-cutting measures.

FPL has launched a number of programs that promise to save consumers money. It offers free home energy efficiency tests and tips on how to reduce electricity consumption. Its On Call program can save consumers up to $161 annually, according to a recent bill-stuffer.

The program includes what FPL calls an "energy management device" attached to a large appliance of choice, such as an air-conditioning system or pool pump. During periods of heavy electric demand, the customer agrees to let FPL turn off the air conditioner or pool pump for short intervals in exchange for a small discount on the monthly bill.

Gas companies, however, say th[at] because natural gas can be tak[en] from decomposing organic matte[r] the cost of supplying gas will alwa[ys] be less than electricity.

"It's very inexpensive to produ[ce] natural gas," said Jack Lange[,] president of City Gas. "Because g[as] is so inexpensive, even compani[es] like FPL use it to generate electr[ic]ity."

Buyers get choice

Builder Charles Goodpaste[r,] president of Miami-based Hami[...] Development, gives home buyers [a] choice of gas or electricity, b[ut] charges $1,000 extra for hom[es] that run entirely on electricity.

"In this age of power and fuel, [we] believe that gas is more efficient a[nd] less costly," he said.

GAS SUPPLIERS

Three companies in Dade County supply piped-in natural gas to residential customers. Their service areas are in scattered geographic pockets, and there is no clearinghouse to find out which company serves a particular area. However, the companies usually will refer callers to the correct supplier.

The natural gas suppliers are regulated by the Florida Public Service Commission.

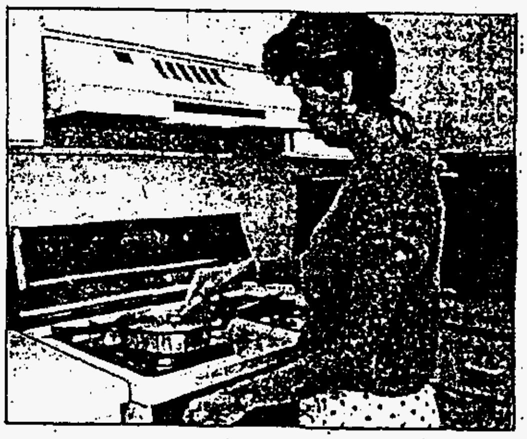
In addition, numerous companies provide bottled, or propane, gas service.

Here is a list of the PSC-regulated natural gas companies, their general service areas and telephone numbers for information.

■ Peoples Gas Co. serves the area generally east of I-95 from the Broward County line to the Old Cutler area. Call (305) 893-2522 from 8 a.m. to 5 p.m. weekdays.

■ City Gas Co. serves the area generally west of 27th Avenue, including many of the new subdivisions in Northwest and Southwest Dade. Call (305) 591-8710, ext. 210, from 8 a.m. to 5 p.m. weekdays.

■ Miller Gas Co. serves parts of the area from Southwest Eighth to 72nd streets between Southwest 87th and Krome avenues. Call (305) 271-7531 from 8 a.m to 4:30 p.m. weekdays.



ANDREW INNERARITY / Miami Herald Staff

COOKING WITH GAS: Dinora Bianchi makes dinner at her home in Marbella Park on a gas range.

TIM CHAPMAN / Miami Herald

LONG-TIME USER: Retired college instructor Alan Stratton has owned this gas-operated air conditioner since 1958.

Pipeline to gas is full of rules and regulations

By XOSE F. ALVAREZ-ALFONSO
Herald Writer

Russell Silverman thought his electric air-conditioning unit with a heat-recovery system was a big savings at his business, the Green Briar Nursing Home in Kendall. Then City Gas came knocking at his door.

"They came over and did a study of what I needed," he said. "And then they showed me some figures."

Silverman said he replaced a 210-ton electric air-conditioning system with a gas-operated 160-ton unit. He kept the nursing home's temperature at its usual 75 degrees.

Monthly operating costs dropped by 25 percent, or $4,700, he said.

"The system is great because it doesn't waste a thing," he said. "We use the hot air from the air-conditioning system to heat water for washing clothes and washing dishes. We can run our laundry and our dishwashers 24 hours a day and not run out of hot water."

While Silverman's supply comes through a pipeline, bottled gas is available where there's no access to natural gas.

Underground pipelines supply natural gas to many neighborhoods, but there are areas where there are no pipelines. In those areas, consumers have the option of using liquid propane gas, supplied either by an underground or above-ground tank, said Ryland Musick, a spokesman with the state fire marshal's office in Tallahassee.

"Propane is commonly used in newly developed areas or in rural areas where natural gas is unavailable," he said. There are more than 50 licensed propane gas companies in Florida, he said.

Propane can be about 10 percent more expensive than methane, said Ken Dunn, division sales and marketing manager for Public Gas. Propane, however, is still about 30 percent cheaper than electricity.

"It costs a little more than natural gas because we have to have tanks filled, unlike natural gas, which is pumped into the homes through pipes," he said. "Residential propane tanks are filled about three to four times a year."

Unlike natural gas suppliers, bottled gas companies are not regulated by the Florida Public Service Commission.

Because of regulations covering natural gas, suppliers often have difficulty providing gas service in newly developed areas, said Edward Mills, a state PSC spokesman. Before they can lay new gas lines, companies are required to provide a feasibility study, showing a demand in the planned area.

"A gas company can only extend pipes to its present contiguous system," Mills said. "And it can only extend the system when a feasibility study shows that the demand for gas will generate enough revenue to pay for the installation of those new pipes within a five-year period."

CITY GAS COMPANY OF FLORIDA

An NUI Company

MIAMI VILA HOTEL

The Miami Vila Hotel is a new 118 room hotel located in South Miami, Florida. This four story Mediterranean-style hotel was originally designed with individual room A/C units. When the owners asked the design engineer for a more energy efficient building design with lower operating costs, a natural gas engine chiller was suggested. City Gas Company prepared an energy and cost analysis for the owners comparing the operating and capital costs for the individual electric room A/C units versus a central gas engine chiller system. With hot water recovery from the engine to supply the hot water for the kitchen, laundry, swimming pool and domestic uses the gas engine chiller was the easy choice. City Gas Company provided an equipment rebate for the 150 ton Tecochill gas engine chiller and engineering assistance during design and installation.

This Tecochill 150 ton unit has operated since Nomember, 1991 providing all of the chilled water and most of the hot water for this new hotel. The owners of the hotel, who are pictured in the enclosed picture of the Tecochill unit, are very pleased with its operation including its energy efficiency (46% savings versus electric A/C units) and its high reliability (98.9% availability).

The owners of the Miami Vila Hotel had an additional benefit of owning a gas engine chiller that was demonstrated as a result of Hurricane Andrew that hit Miami in August 1992. During Hurricane Andrew the hotel lost electric power for more than a week. However all of the hotel's facilities, including the gas A/C system were able to operate with the help of a rental standby generator. The hotel quickly filled with guests whose homes had been damaged or destroyed. This Tecochill unit was a hero during one of the worst disasters in Miami. Facilities now can appreciate the added value of having gas cooling.

MIAMI DIVISION: 955 E 25TH STREET • HIALEAH, FL 33013-3498 • 305-691-8710 • FAX 305-691-7112
BREVARD DIVISION: 4180 SOUTH U.S. 1 • ROCKLEDGE, FL 32955-5309 • 407-636-4644 • FAX 407-633-6733
TREASURE COAST DIVISION: 1323 NW ST LUCIE WEST BOULEVARD • PORT ST LUCIE, FL 34986 • 407-871-2551 • FAX 407-871-2044

over the 27% efficiency for the electric system but since the engine is located at the users site the waste heat from the engine and exhaust can be recovered and used. This waste heat accounts for 50% of the input fuel. By combining the 28% shaft power output with the 50% recovery as hot water, the total system efficiency for this typical gas engine chiller system is 78%. This is a significant improvement from the 27% total system efficiency for the electric chiller system. This significant improvement in total system efficiency can significantly reduce operating costs and reduce emissions to the environment while reducing the need for new power plants in Florida. A more detailed evaluation of the efficiency of gas versus electric cooling systems can be found in a report by Timothy K. Costello for the People for Equitable Energy Rates, Inc. (PEER) entitled "A Comparative Overview of Gas and Electric Cooling Technologies in Connecticut" dated September 1990.

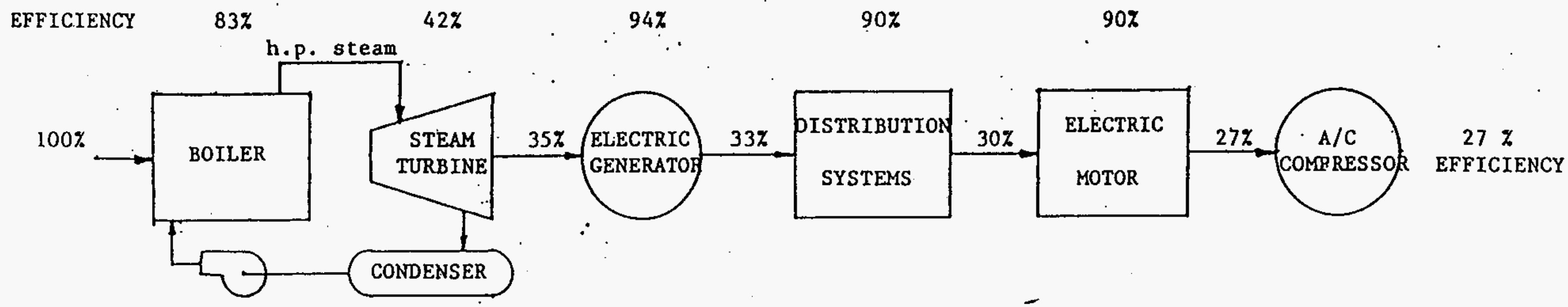
Table 2.1 also compares the capital cost for electric versus gas engine chillers for the total energy system that is required to support each additional ton of air conditioning. For a new electric chiller that requires 0.7 KW/ton and a new electric power plant that costs $1000/KW it requires $700/ton of capital for the power plant that supplies the new electric chiller. For this simplified analysis we have omitted the cost of the electric transmission and distribution system which is also required for this new load. The end user will typically pay about $300/ton for the equipment cost of a new 150 ton electric chiller. Therefore the total capital cost for the electric system is $1000/ton. For the natural gas system no additional production facilities are required and therefore no additional capital expense is required by the gas utility. However the natural gas engine chiller at $450/ton is about 50% more expensive for the end user. This higher chiller cost is due to a more complicated piece of equipment and low production volumes. This indicates the need for equipment rebates to offset the higher first cost to the end user. The total capital cost for the gas system is $450/ton. Therefore total capital can be conserved by using the gas engine chillers and avoiding the need to construct costly, new electric generating plants.

Table 2.1 also compares the energy costs for the end user for the production of chilled water only. This simplified analysis does not include the cost savings by displacing the hot water that is required at the user's site. Using typical commercial electric and gas rates in Florida and the energy required per ton of A/C for both electric and gas chillers the energy costs were calculated. The typical 150 ton electric chiller's energy cost is $0.052/ton·hr versus $0.032/ton·hr. for the typical 150 ton gas engine chiller. This demonstrates the significant energy cost savings potential for the end user. This simplified comparison does not include the added maintenance cost for the gas engine chiller or the added hot water savings for the gas engine chiller which will be included in the next operating cost comparison.

Table 2.2 presents the "Annual Operation Cost Savings" for a 160 ton natural gas engine chiller versus 160 ton electric chillers in South Florida. Operating costs are dependent upon a number of variables depending upon the specific application. Therefore Table 2.2 was compiled to evaluate a wide range of possible applications. The calculation methods used are shown in Table 2.2A. The top line of Table 2.2 shows the efficiencies of three possible electric chillers at 1.25 KW/ton, 1.0 KW/ton and 0.65 KW/ton. These various values were selected to represent older inefficient chillers at 1.25 KW/ton, typical existing chillers at 1.0 KW/ton and new high efficiency chillers at 0.65 KW/ton. Please note that these values are the integrated part load values (IPLV). The second line of Table 2.2 shows the equivalent full load hours of operation (EFLH) at 6000 hours per year and 3000 hours per year. The 6000 EFLH represents 8500 actual operating hours per year or a 70% load factor which is typical of hospitals, hotels or nursing homes in South Florida. The 3000

TABLE 2.1 - TOTAL ENERGY SUPPLY SYSTEM

ELECTRIC CHILLER SYSTEM



		POWER PLANT		ELECTRIC CHILLER		
CAPITAL COST	=	$ 700 / ton	+	$ 300 / ton	=	$ 1000 / ton
ENERGY COST	=	$ 0.075 / kwh	x	0.7 kw / ton	=	$ 0.052 / ton·hr

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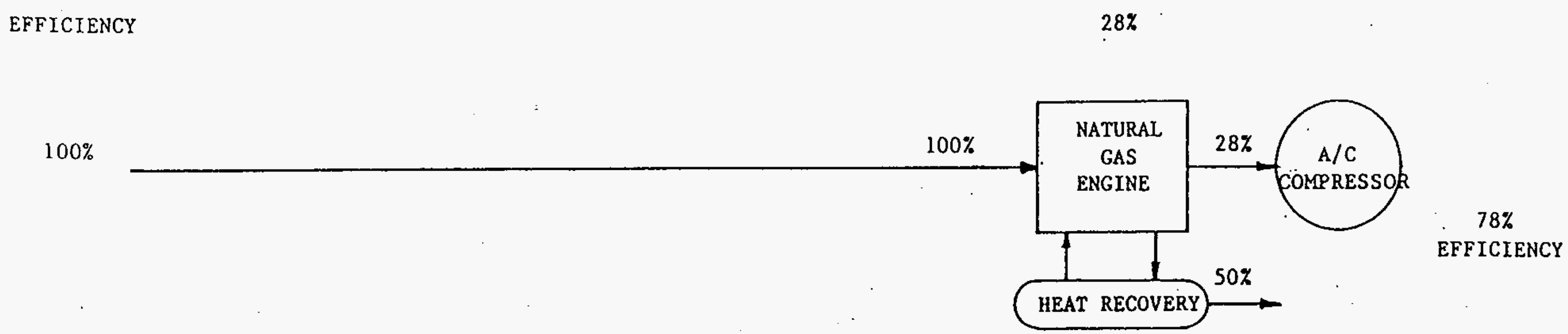
NATURAL GAS ENGINE CHILLER SYSTEM



		NATURAL GAS		GAS CHILLER		
CAPITAL COST	=	0	+	$ 450 / ton	=	$ 450 / ton
ENERGY COST	=	$ 4.50 / MMBtu	x	7060 Btu / ton hr	=	$0.032 / ton·hr

TABLE 2.2

SOUTH FLORIDA

ANNUAL OPERATING COST SAVINGS

160 TON CHILLERS

NATURAL GAS ENGINE CHILLER VS. ELECTRIC CHILLERS

ELECTRIC CHILLER EFF.	1.25 KW/TON		1.0 KW/TON		0.65 KW/TON	
FULL LOAD - HOURS/YR	6000	3000	6000	3000	6000	3000
SAVINGS - $/YR						
A/C + HOT WATER	$ 58,606	$ 36,503	$ 43,606	$ 27,503	$ 22,606	$ 14,903
A/C ONLY	$ 33,406	$ 23,903	$ 18,406	$ 14,903	($ 2,594)	$ 2,303

BASIS:	Natural Gas Cost	= $0.45/therm
	Electric Cost	= $0.05/KWH + $6.25/KW
	Gas Engine Chiller Efficiency	= 1.70 C.O.P. IPLV
	Add'l Maint. + Engine Replacement	= $0.01/ton·hr.
	Gas Engine Chiller Electric	= 3 KW
	Existing Boiler Efficiency	= 75%
	Chiller Capacity Factors	

Eq. Full Load (HR/YR)	Operating Hours (HR/YR)	
6000	8500	= 70.6%
3000	5500	= 54.5%

EFLH represents 5500 actual operating hours per year or a 54% load factor which is typical of an office building in South Florida. The third line of Table 22 shows the annual operating cost savings for each of these applications if all of the hot water can be used. The fourth line of Table 22 shows the annual operating cost savings if none of the hot water can be used at the site. Please note that the basis used for these savings calculations include: typical commercial gas and electric rates in South Florida; a gas engine chiller efficiency for a Tecochill 160 ton unit of 1.70 C.O.P. (IPLV at ARI conditions); an additional maintenance and engine replacement cost of $0.01/ton·hr; an auxiliary electric consumption for the gas chiller of 3 KW; and an existing hot water boiler efficiency of 75%. These input values are needed to account for the added maintenance costs of a gas engine chiller, the auxiliary electric required for a gas engine chiller and the hot water savings that can possibly be used at the site.

Table 2.2 shows that for most of the applications there is a significant operating cost savings for the gas engine chiller versus the electric chillers. Obviously the most dramatic savings occur when you are replacing old inefficient electric equipment. However, Table 2.2 also shows that even if a gas engine chiller is used in place of a new high efficiency electric chiller there is significant savings if there is a use for the hot water. Therefore we have targeted our marekting effort to applications like hotels, nursing homes, hospitals, manufacturing plants and buildings requiring reheat for humidity control. The applications that do not have significant operating cost savings are where there are no uses for the hot water, such as office buildings.

This operating cost savings analysis indicates that there are certain applications that are appropriate for gas engine chillers and certain applications that are appropriate for new high efficiency electric chillers. The electric and gas utilities' rebate programs should be coordinated so that the electric utilities focus on applications that do not have a large hot water demand and the gas utilities should focus on applications that can make use of the hot water. Since the electric utilities will benefit from the reduced demand to build new electric generating capacity from both the use of new high efficiency electric chillers and new gas engine chillers then it is logical that the electric utilities should offer rebates for both types of chillers.Table 2.2A shows the calculations that were used to determine the annual operating costs for electric and gas engine chillers.

Table 2.3 entitled "Electric Chiller Rebate Program" shows the impact on Florida Power & Light (FPL) of their present electric chiller rebate program for a typical application at Dadeland Towers. An old electric chiller at 1.20 KW/ton was replaced with a new high efficiency electric chiller at 0.68 KW/ton. This application will reduce electric demand by 100 KW at a cost to FPL of $10,555 for the rebate and lost revenue of $25,000/yr. For comparison a cost/benefit is computed for the rebate and the lost revenue. For this application the benefit to FPL of reducing demand by 100 KW cost $105/KW for the rebate and $250/yr/KW for the lost revenue.

Table 2.4 entitled "Proposed Gas Chiller Program" shows the impact on FPL of a gas engine chiller installation for this same application with no rebate offered by FPL. Since the gas engine chiller requires very little electricity (0.02 KW/ton) the demand reduction is significantly increased to 240 KW of demand or 2.4 times the demand reduction for the new high efficiency electric chiller. The lost revenue for FPL would be $56,730/yr and it was assumed for this analysis that no rebate was available from FPL. Therefore the benefit of this 240 KW demand reduction to FPL was $0/KW of rebate and $236/yr/Kw. Therefore it is less costly for FPL to obtain demand reductions with gas engine chiller installations than their present electric chiller rebate program. To obtain the same cost/benefit ratio as the FPL rebate program FPL could offer a rebate of $25,332 or 2.4 times the electric

TABLE 2.2A - SAMPLE CALCULATIONS

ANNUAL OPERATING COSTS - TECOCHILL VS. ELECTRIC CHILLER

-TECOCHILL CALCULATIONS-
(6000 EFLH w/Heat Recovery)

GAS COST : (A/C Capacity, Gas Rate, Eq. Full Load Hours per Yr., C.O.P.)

$$\frac{12{,}000\ BTU_c}{Hr \cdot Ton} \times 160\ Tons \times \frac{\$\ 4.50}{10^6\ BTU_f} \times 6000\ \frac{EFLH}{Yr} \Big/ 1.7\ \frac{BTU_c}{BTU_f} = \$\ 30{,}494\ /YR.$$

ELEC. COST: Tecochill (KW Load, $/KWH, Run Hrs/Yr, Demand $/KW·Mo, Months/Yr)

$$3.0\ KW \times \left(\frac{\$\ 0.05}{KWH} \times 8500\ \frac{Hr}{Yr} + \frac{\$\ 6.25}{Mo \cdot KW} \times 12\ \frac{Mo}{Yr}\right) = \$\ 1{,}500\ /YR.$$

ENGINE MAINT. + REPLACEMENT :

$$\$\ 0.01\ /Ton \cdot Hr. \times 160\ Tons \times 6000\ \frac{Hours}{Yr} = \$\ 9{,}600\ /YR.$$

HOT WATER SAVINGS : (MMBTU/HR, Gas Rate, EFLH, Boiler Eff.)

$$0.7 \times 10^6\ \frac{BTU}{Hr} \times \frac{\$\ 4.50}{10^6\ BTU} \times 6000\ \frac{Hr}{Yr} \Big/ 75\ \% = (\$25{,}200/YR.)$$

TECOCHILL ANNUAL OPERATING COST = $16,394 /YR.

-ELECTRIC CHILLER CALCULATIONS-
(6000 EFLH ; 1.0 KW/ton)

ELEC. COST: (Capacity, $/KWH, EFLH, IPLV KW/Ton) + (Capacity X $/Mo·KW X Mo X Full Load KW/Ton)

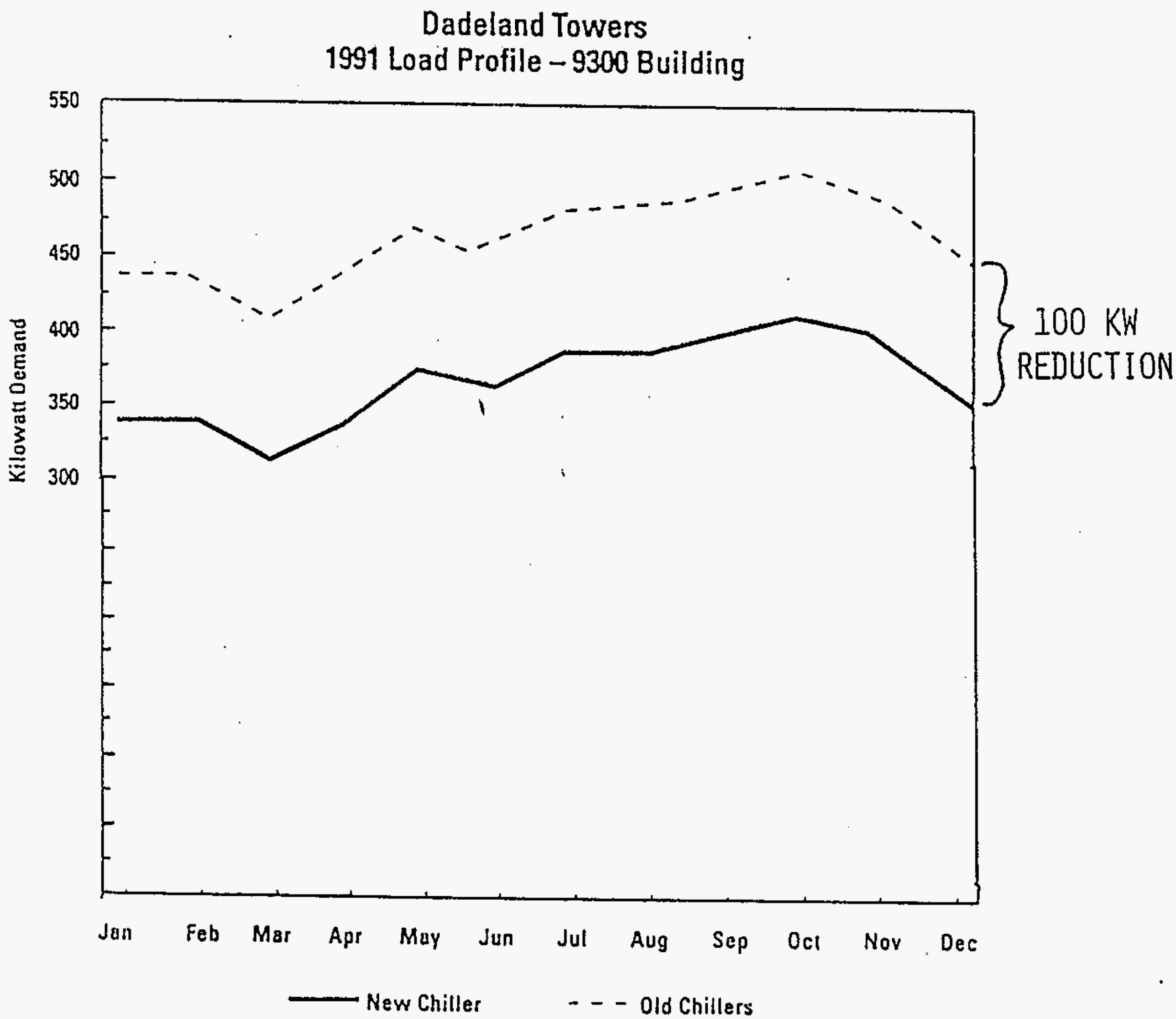
$$\left(160\ Tons \times \frac{\$0.05}{KWH} \times 6000\frac{Hr}{Yr} \times \frac{1.0\ KW}{Ton}\right) + \left(160\ Tons \times \frac{\$6.25}{Mo \cdot KW} \times 12\ Mo. \times \frac{1.0\ KW}{Ton}\right) = \$60{,}000/YR.$$

-SAVINGS-

ELECTRIC - TECOCHILL = ANNUAL SAVINGS

$60,000/YR - $16,394 /YR = $43,606 /YR.

TABLE 2.3 - ELECTRIC CHILLER REBATE PROGRAM



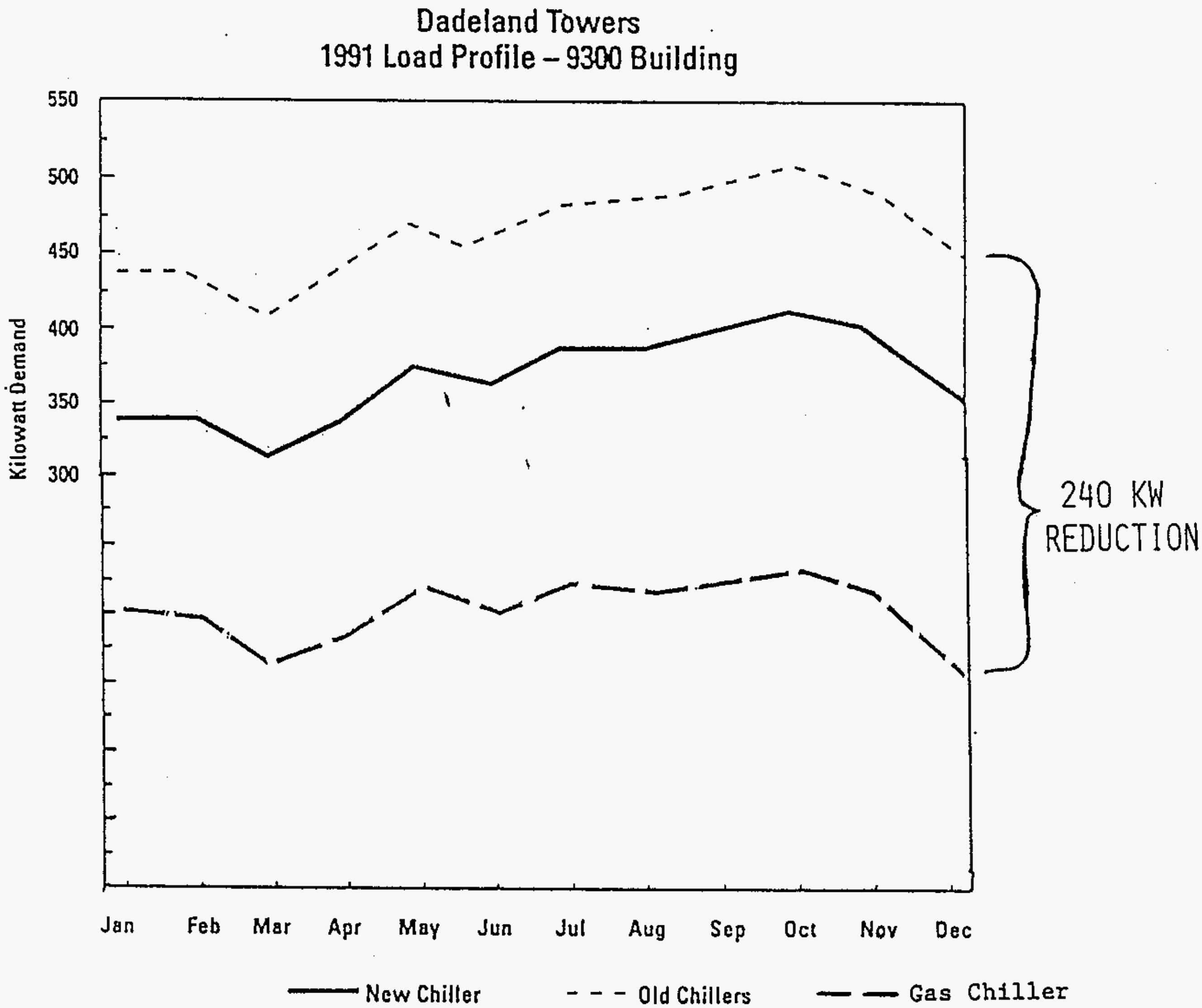
FPL COST BENEFIT ANALYSIS FOR FPL CHILLER REBATE PROGRAM

	KW/TON	KWH/YR[1]	ELEC. COST[2]	CUSTOMER SAVINGS
OLD ELEC. CHILLER	1.20	961,536	$ 57,692/YR.	--
NEW ELEC. CHILLER	0.68	544,871	$ 32,692/YR.	$ 25,000/YR.

1. 200 tons @ 4006 EFLH; 2. $ 0.06/KWH

	REBATE		LOST REVENUE
FPL COSTS:	$10,555	+	$ 25,000/YR.
FPL BENEFIT:	100 KW OF DEMAND REDUCTION		
FPL COST/BENEFIT:	$105/KW	+	$250/YR/KW

TABLE 2.4 - PROPOSED GAS CHILLER PROGRAM



FPL COST BENEFIT ANALYSIS FOR GAS CHILLER PROGRAM

	KW/TON	KWH/YR	ELEC. COST	CUTOMER SAVINGS
OLD ELEC. CHILLER	1.20	961,536	57,692	--
NEW ELEC. CHILLER	0.68	544,871	32,692	$ 25,000/YR.
NEW GAS CHILLER	0.02	16,026	962	$ 56,730/YR.

	REBATE		LOST REVENUE
FPL COSTS:	$ 0	+	$ 56,730/YR.
FPL BENEFIT:	240 KW OF DEMAND REDUCTION		
FPL COST/BENEFIT	$ 0/KW	+	$236/YR/KW

TABLE 2.5 - UTILITY CHILLER REBATE PROGRAMS

CONCLUSIONS

1. GAS ENGINE CHILLER REPLACEMENTS COST FPL LESS THAN ELECTRIC CHILLER REPLACEMENTS FOR THE SAME AMOUNT OF KW REDUCTION

2. THE LOST REVENUE FROM BOTH ELECTRIC AND GAS CHILLER REPLACEMENTS IS APPROXIMATELY THE SAME PER KILOWATT OF DEMAND REDUCTION

3. THE COST OF THE FPL ELECTRIC CHILLER REBATE CAN BE ELIMINATED BY USING THE EXISTING REBATES OFFERED BY THE GAS UTILITIES

4. APPLICATIONS THAT CAN MAKE USE OF THE WASTE HEAT FROM THE GAS ENGINE CHILLERS ARE SIGNIFICANTLY MORE ENERGY EFFICIENT AND OFFER GREATER COST SAVINGS FOR THE BUILDING OWNERS

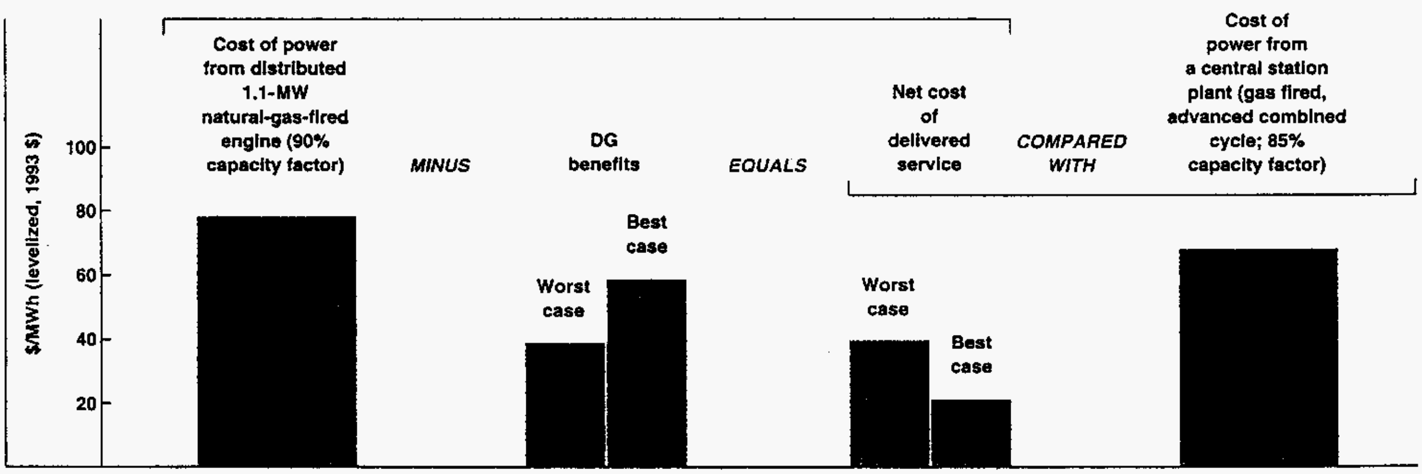
5. FPL SHOULD CONSIDER WORKING WITH THE GAS UTILITIES TO OFFER THE APPROPRIATE CHILLER OPTION (GAS OR ELECTRIC) FOR THE ENERGY REQUIREMENTS OF DIFFERENT BUILDINGS

6. THE FPL CHILLER REBATE PROGRAM SHOULD BE AVAILABLE FOR GAS ENGINE CHILLERS SINCE IT PROVIDES THE SAME BENEFITS TO FPL AS NEW ELECTRIC CHILLERS

DISTRIBUTED GENERATION CAN BE COST-EFFECTIVE Whether distributed generation is cost-effective depends largely on the site at which it is applied. This graph shows the results of a cost-effectiveness study EPRI researchers conducted for the use of a current-technology natural-gas-fired engine at an investor-owned utility site identified as offering high value for DG. The chart illustrates how the local benefits from DG (such as the deferral of T&D upgrades, reduced emissions, fuel diversity, and customer use of waste heat) can significantly reduce the higher initial cost of a DG technology. EPRI performed an analysis for the same site using fuel cell technology expected to be available in the year 2000 and found similar results.

TABLE 2.6

EPRI JOURNAL April/May 1993



chiller rebate for the gas engine chiller. Table 2.5 summarizes the results of this evaluation of rebates for electric and gas engine chillers.

By working together the electric and gas utilities should be able to modify their rebate programs to enable the most cost efficient electric demand reduction programs while increasing the utilization efficiency of the existing natural gas distribution system. The most dramatic increase in gas cooling equipment is occuring in New York where the Con Edison rebate of up to $500/ton is combined with the Brooklyn Union Gas rebate of up to $250/ton.

Table 2.2 shows that the best economics for end users in Florida exist when gas engine chillers are used for applications where the waste heat can be utilized and when high efficiency electric chillers are used for applications where the waste heat can not be used. Gas and electric utilities should target their marketing for these applications and refer leads to each other based upon the application. Since the gas engine chiller provides demand reductions for the electric utility, rebates should be available from the electric utilities. Only by combining the rebates from the electric and gas utilities can the end user by given a sufficient incentive to overcome the higher first cost of the gas engine chiller. Competing rebates for electric chillers and for gas engine chillers are counter productive and confuse the end users. There is a place for both rebates and gas and electric utilities should work together to identify the proper applications.

Table 2.1 compares the capital and operating costs for electric versus gas engine chillers. For this simplified analysis we have omitted the cost benefits of the reduced electric transmission and distribution (T&D) system that is possible with the gas engine system. A recent Electric Power Research Institute (EPRI) Journal, April/May 1993, cover story entitled "The Vision of Distributed Generation" evaluated the cost savings associated with the deferral of T&D up-grades, reduced emissions, fuel diversity and customer use of waste heat for a natural gas-fired engine generator. Table 2.6 from this EPRI study shows how the additional benefits from distributed generation (DG) can reduce the high initial cost of DG to produce a cost for power that is less than a central station, advanced combined cycle plant. Therefore any detailed comparison of natural gas alternatives to new electric plants should include the benefits of avoided power plant costs, reduced electric T&D costs, reduced emissions, fuel and equipment diversity and use of waste heat for improved energy efficiency.

3.0 CARRIER/TECOGEN - 25 TON ROOFTOP A/C SYSTEM

Several major HVAC manufacturers, including Carrier, York and Thermo King, are now marketing gas engine driven A/C equipment. These engine driven A/C systems employ the same cooling process as a conventional electric A/C system. The main difference is that the electric motor is replaced by an engine. This switch yields variable-speed operation capability, higher part-load efficiency, efficient high-temperature waste-heat recovery for domestic water heating and, in the proper applications, reduced operating cost. Within the gas engine-driven systems the gas engine chillers described in Section 2.0 represent the largest tonnage equipment while the gas engine heat pumps, described in Section 6.0, represent the smallest tonnage equipment. In the mid-size range of gas engine systems are the roof top package A/C systems and the split A/C systems incorporating seperate condensing and evaporating sections. Within this mid-size range there are various manufacturers including:

- Carrier/Tecogen
- Thermo King
- Yamaha
- Aisin
- Yanmar

City Gas Company does not presently have any Carrier/Tecogen-25 ton rooftop A/C units in our service territory. Our preliminary analysis indicates that these systems are similar to those already presented for the larger and smaller gas engine A/C systems in Sections 2.0 and 6.0. Those applications that have the highest energy efficiency and highest operating cost savings are those that employ engine heat recovery to produce hot water savings. Therefore applications like restaurants and motels should be appropriate uses for these mid-size engine A/C systems. Another potential application is to use the heat that is recovered from the engine to drive a desiccant dehumidifier. This should be an excellent application due to Florida's hot and humid climate.

4.0 HERRMIDIFIER - RESIDENTIAL DESICCANT DEHUMIDIFIER

The Gas Research Institute (GRI) is presently funding the development of a natural gas residential dehumidifier that was developed by Arthur D. Little, Inc. and manufactured by Herrmidifier Company. The first prototype unit is being field tested at City Gas Company's Test House in Miami, Florida. The system consists of a small desiccant dehumidifier package that uses a gas water heater as its source of thermal energy for regeneration of the desiccant.

The objectives of the field test are:

- obtain performance verification of the desiccant dehumidifier;
- determine the interactions of the desiccant dehumidifier with the existing electric-driven air conditioning system;
- determine the effects of the desiccant dehumidifier on the energy consumption and operational characteristics of the gas-fired water heater;
- assess the effect of the desiccant dehumidifier on indoor air quality and occupant comfort.

During the cooling season, the air conditioning system in a residential building performs two functions: temperature control (sensible cooling) and humidity control (latent cooling or moisture removal). Sensible cooling is needed to compensate for the heat produced in the space and transmitted through the building envelope and to cool the infiltration air. Latent cooling is required to dehumidify the infiltration air and absorb the humidity produced in the space. The sensible and latent loads together compromise the total cooling load on the space conditioning system.

Electric-driven vapor compression refrigeration (VCR) currently dominates the residential space conditioning market. Although these systems are well entrenched in the residential sector, there are two basic shortcomings. VCR systems achieve space humidity control by cooling the supply air up to the point of saturation. Under part load conditions (morning and evening hours, rainy or cloudy weather, etc.) that latent load may be higher than the sensible one. Residential VCR systems are controlled only in response to space temperature. A rise in humidity will not activate the VCR unit and results in discomfort for the occupants.

In areas of the country which experience high humidity conditions during warmer weather when air conditioning is required, a standard air conditioner will not meet the latent load if special considerations are not given. The capacity of the unit should match the calculated load as closely as possible. Unit sizing should be based on latent and sensible load calculations. This is, however, seldom done. The result is oversized units that do not get enough run time for humidity control and will experience a wider swing in space temperature. In applications where the humidity is high, lower thermostat settings are required to remove enough moisture to maintain comfort conditions. Thermostat set points of less than 77 enable VCR systems to run long enough to maintain fairly comfortable levels. Raising the thermostat setting to reduce energy bills will result in high humidity if latent loads are high.

The Herrmidifier, water heater-powered desiccant dehumidifier, is designed to supplement the dehumidification functions of a conventional air conditioning system. To simplify its construction and lower its first costs, the regeneration energy is provided by hot water from the conventional gas-fired hot water unit. This eliminates the need for a separate burner and associated controls.

The compact size of the unit facilitates both retrofit and new construction applications. The air drying capability of the hot water regenerated desiccant wheel is about 80 pints per day which is comparable to two large (40 pints/day) stand-alone electric units. This drying capacity, combined with that available from the air conditioning unit, will result in enhanced comfort conditions in the home for most of the annual operating hours in all regions.

The important feature of this unit that will favorably impact consumer acceptance is the minimal maintenance required. Unlike an electric-driven dehumidifier, which requires daily emptying of the condensed moisture, the desiccant dehumidifier discharges the removed moisture to the outside via a flexible duct. This added feature gives this new dehumidification product a clear advantage over dehumidification systems currently offered in the market place.

Installation of this system is as easy as that of a dishwasher. The ability to remove the moisture from the home and not dump it back as sensible heat, as is the case with current electric-driven dehumidifiers, further distinguishes this system from conventional alternatives.

The benefits to the user of the water heater-powered desiccant dehumidifier range from reduced operating costs to enhanced comfort conditions. Specifically, the owner can expect:

- reduced utility costs by increasing the thermostat set point by 3 F to 5 F. Each degree increase of the thermostat setpoint reduces the operating costs of the conventional electric-driven air conditioner by 8 to 10 percent.

- improved humidity control; the water heater-powered desiccant dehumidifier is designed to be controlled by a humidistat. Thus, it will be able to maintain the space humidity at acceptable levels during conditions of high humidity or part load.

  Examples of high humidity conditions are:
  - damp and cool spring and fall days, summer mornings and nights
  - vacancy periods when the home owner is away, especially during prolonged periods, such as a vacation, and the thermostat setpoint is set high to conserve energy.

5.0 "SEAHORSE" - GAS HOT WATER CONVERSION SYSTEM

The Seahorse Gas Hot Water Conversion System enables homeowners and commercial applications to convert their existing electric water heaters to natural gas or propane. The Seahorse is a completely self-contained water heating system that is located outside the building. The existing electric water heater is used as a storage tank for the hot water produced by the Seahorse unit. The Seahorse unit is normally mounted on the outside wall of the building. This is an advantage for those applications where it is not possible to locate a conventional gas water heater inside the building. Due to space requirement, location of equipment and venting requirements it is not always possible to replace an electric water heater with a gas water heater. The Seahorse unit also eliminates the need for an exhaust stack and eliminates the need for interior gas piping. Therefore for existing buildings with any of these requirements the Seahorse system may enable the conversion from electric to gas hot water.

The major advantage for the end-user is the energy cost savings by switching to gas hot water. Table 5.1 shows that the typical Florida home uses \$377/yr with electric hot water versus \$151/yr with natural gas hot water. This represents an annual savings of \$226/yr for the homeowner. Table 5.2 shows that the residential hot water by natural gas can save 55% of the energy versus electric water heating. Therefore with the same amount of energy it is possible to provide one Florida home with electric hot water or 2.2 Florida homes with gas hot water. With limited fuel and environmental resources this is an excellent opportunity to save energy in Florida.

The Seahorse unit enables the end-user to convert from electric to gas hot water and obtain the energy savings for those applications where a typical gas water heater can not be located inside the building. With a low cost supply of hot water it is also possible to convert the electric space heating system to natural gas. This is done with the addition of a hot water coil to the existing home's ductwork. This type of system is called a "combo heater" which is a combination of space and water heating systems. These systems provide both space and hot water heating from a single hot water tank. These combo heaters can be used with conventional inside the building gas water heaters or the Seahorse outside unit. The use of these combo heaters in Florida can improve energy efficiency by reducing the use of electric resistance heating in homes. They will also reduce the need for new generating capacity to satisfy the winter peaks.

Electric and gas utilities should work together to develop conservation programs for the use of gas hot water and gas space heating in Florida. This will save energy costs for the homeowner and reduce the need for costly, electric generating plants. Since the electric and gas utilities will both benefit from these conservation programs they should share in the rebates offered to encourage homeowners to use these new systems.

City Gas Company does not have any Seahorse units installed in our service territory. Table 5.3 summarizes the results of testing conducted by Public Service Company of North Carolina for various residential installations. Table 5.4 shows the estimated installed costs for both hot water and combination space/hot water installations. For additional information on the Seahorse please contact Robert T. Watkins, Senior Vice President - Marketing, Public Service Company of North Carolina. Another source of information is the City of Tallahassee, Gas Utility Department, who have installed several Seahorse units in their service territory. The manufacturer of the Seahorse, Gas-Fired Products, Inc., has a video tape that describes the operation of the unit, its savings potential and shows various installations.

TABLE 5.1

TYPICAL RESIDENTIAL ENERGY USE FOR HOT WATER IN FLORIDA

	ELECTRIC	GAS
ENERGY USE	4195 KWH/Yr	216 therm/Yr.
ENERGY COST	$0.09 /KWH	$0.70 /therm
HOT WATER COST	$377 /Yr	$151 /Yr
COST SAVINGS		$226 /Yr (60%)

TABLE 5.2

ENERGY EFFICIENCY FOR HOT WATER PRODUCTION

	ELECTRIC	GAS
ENERGY USE	4195 KWH/Yr	216 therm/Yr
FUEL USE	47.7 MMBTU/Yr	21.6 MMBTU/Yr
ENERGY SAVINGS		26.1 MMBTU/Yr (55%)

TABLE 5.3

SEAHORSE WATER HEATER
R&D Installation Information

*Note: Customer Charge or LP Tank rental not included.

89¢ a Gallon Propane Average
59¢ a Therm Natural Gas Average
32¢ per Month Average Electric Consumption @ 8¢ a KWH

LOCATION	CUSTOMER	STREET ADDRESS & TELEPHONE #	PSC REP	1991 INSTALL DATE	TYPE/SIZE AWH CONVERTED	OCCUP ANTS	AGES	OPER DAYS	ELEC USED KWHRS	GAS USED THERMS	TOTAL ENERGY COST	AVG ENERGY COST	AVG CYC PER DAY
MT. HOLLY **NATURAL**	Carl Teague	110 Jenkins (704) 827-3870	M Whitt	3/28	ELEC/30 GL COUNT TOP	2	35, 32	365	35.2	250	$147.90	$ .41 DAY $ 12.32 MTH $ 147.30 YR	9
ASHEVILLE **NATURAL**	John Davis	26 Nichols Hill (704) 645-5981	J Atkins	5/21	ELEC/62 GL STAND	2		370	36.8	290	$171.24	$ .46 DAY $ 14.07 MTH $ 168.93 YR	8
DURHAM **NATURAL**	Tom Snipes	603 Chivalry (919) 596-7117	T Snipes	5/31	ELEC/40 GL LOW-BOY	3	29, 29, 2	365	39.5	215	$127.96	$ .35 DAY $ 10.66 MTH $ 127.36 YR	6
DURHAM **NATURAL**	Kenneth Lanier	2008 Umstead (919) 383-8264	M Lasher	5/30	ELEC/52 GL	5	80, 50, 50 17, 16	365	70.0	584	$344.50	$ .94 DAY $ 28.71 MTH $ 344.50 YR	12
RALEIGH **NATURAL**	Bill McAulay	701 Scarborough (919) 833-6641	B McAulay	6/13	ELEC/47 GL LOW-BOY	4	35, 33, 11, 6	365	68.3	577	$340.29 HTG&AWH	$ .93 DAY $ 28.36 MTH $ 340.29 YR	13
GASTONIA **NATURAL**	Robert Ingraham	1851 Montclair (704) 865-6469	E Robinson	6/05	ELEC/52 GL STAND	2	42, 40	359	35.4	198	$117.76	$ .33 DAY $ 9.98 MTH $ 119.73 YR	5
CONCORD **NATURAL**	Jonathan Smith	505 Worthington (704) 784-4547	S Bowen	7/02	ELEC/40 GAL LOW-BOY	3	32,31,7	365	58.1	311	$185.17	$ .51 DAY $ 15.43 MTH $185.17 YR	8
STANLEY **PROPANE**	Mike Whitt	300 Morris Farm (704) 263-5182	M Whitt	3/20	ELEC/42 GAL CRAWL SPC	4	40, 32, 5, 2	365	47.7	496.7 GAL	$442.06 HTG&AWH	$ 1.21 DAY $ 36.88 MTH $ 442.06 YR	8
HENDERSONVILLE **PROPANE**	David Pierson	P.O. Box 1051 (704) 885-8210	D Rhew	5/29	ELEC/42 GL BOILER RM	2	57, 54	343	28.9	242 GAL	$ 215.38	$ .59 DAY $ 17.94 MTH $ 215.38 YR	9

TABLE 5.4

ESTIMATED COST OF TWO SEAHORSE UNITS INSTALLED IN 1991

HOT WATER & HEAT (BOTH HEAT PUMP CONVERSIONS)

*Converting Electric Heating and Hot Water to GAS...

Labor 3 hours @ $52.00	$156.00
Wiring Cost @ $65.00	65.00
Permit Local @ $15.00	15.00
30,000 BTU Coil (HVAC CONTRACTOR) with Pump and Duct Modifications	460.00
Materials - Piping, etc.	56.00
Public Service Company Cost (2 Jobs) Average	$752.00
Added Cost of Seahorse Estimate	$455.00
Total	$1,207.00

ESTIMATED COST OF SEVEN SEAHORSE UNITS INSTALLED IN 1991

WATER HEATING ONLY (ELECTRIC WATER HEATER CONVERSION)

*Converting Electric Water Heater to GAS.

Labor 2 1/2 hours @ $52.00	$130.00
Wiring Cost @ $65.00	65.00
Permit Local @ $15.00	15.00
Material & Piping	43.00
Public Service Company Cost (7 Jobs) Average	$253.00
Added Cost of Seahorse Estimate	$455.00
Total	$708.00

5/15/92
Robert T. Watkins, Sr.

6.0 YORK-RESIDENTIAL GAS ENGINE HEAT PUMP

A natural gas engine-driven heat pump (GHP) employs the same cooling process as a conventional electric heat pump or electric air conditioning which uses a vapor compression cycle. The main difference is that the electric motor is replaced by an engine. This switch yields variable-speed operation capability, higher part-load efficiency, efficient waste heat recovery for domestic hot water and, in most applications, reduced operating costs. A GHP has the added advantage of making use of the engine waste heat in the winter to provide additional heating to supplement the vapor compression cycle.

City Gas Company is very interested in new gas cooling technologies due to Florida's long cooling season and the need to reduce the need for new electric power plants. The gas engine heat pump has the potential to offer greatly improved gas cooling efficiency for residential and light commercial applications and dramatically increase gas use in Florida homes. This technology is already in widespread use in Japan with about 200,000 gas engine heat pumps installed in the last 7 years by 3 or 4 major manufacturers.

City Gas Company has been testing the efficiency and reliability of the Yamaha Gas Heat Pump in two different applications. The first application was a City Gas Company Office Building where a 2.5 ton Yamaha GHP has been operating since October 1990. This unit provides air conditioning for a class room and offices and operates for about 5,000 hours per year. The second Yamaha 2.5 ton GHP was installed in a City Gas Company test house in June 1991 to compare the operating costs of the Yamaha GHP with a conventional electric A/C system for a home application. City Gas is pleased with the reliability and efficiency of the Yamaha GHP.

Enclosed is a marketing brochure for the line of Yamaha GHPs from 1.3 tons to 15.8 tons. The unit that City Gas Company is testing is the 2.4 RT (3 HP) unit.

City Gas Company has conducted technical and economic evaluations on the use of GHPs versus conventional electric A/C systems in Florida. This included site visits to several Yamaha GHP installations in the U.S. and discussions with other gas and electric utilities that have been testing the York GHP. These evaluations have determined the operating costs, maintenance costs and equipment reliability for the York and Yamaha GHPs.

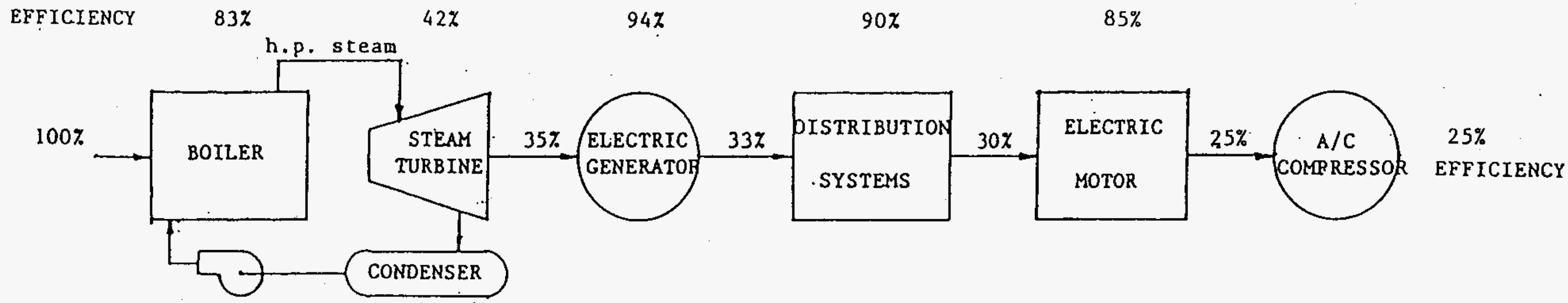
A good source of background information for the York GHP is a recent video tape by the Gas Research Institute (GRI) entitled "York Triathlon-Gas Heating and Cooling System".

Our evaluations indicated that for a fair comparison of electric versus gas energy systems it is essential to consider the total energy supply system. This is necessary to compare total system efficiency, total capital costs and total energy costs. Table 6.1 - Total Energy Supply System shows the efficiency, capital cost and energy cost for a typical residential electric A/C system versus a York GHP. For this analysis a 3 ton electric A/C system with a SEER of 10 (1.2 KW/ton) was used for comparison.

The efficiency diagram in Table 6.1 shows that during the production of electricity 67% of the energy is wasted. This energy is lost as waste heat to the cooling tower, pond, river or ocean and through the smoke stack. Because these power plants are remotely located this waste heat is not used. When the losses for electrical transmission and distribution are accounted for the end user only has 30%

TABLE 6.1 – TOTAL ENERGY SUPPLY SYSTEM

RESIDENTIAL ELECTRIC A/C SYSTEM (3 TONS)



		POWER PLANT		ELECTRIC A/C UNIT		
CAPITAL COST	=	$ 1200 / ton	+	$ 1000 / ton	=	$ 2200 / ton
ENERGY COST	=	$ 0.090 / kwh	x	1.2 kw / ton	=	$ 0.108 / ton·hr

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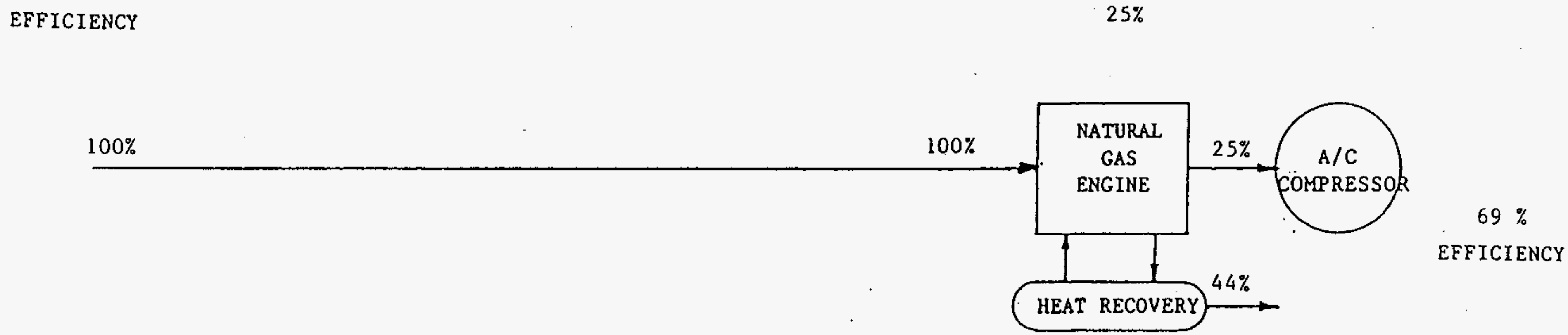
YORK NATURAL GAS ENGINE HEAT PUMP (3 TONS)



		NATURAL GAS		GAS HEAT PUMP		
CAPITAL COST	=	0	+	$ 2266 / ton	=	$ 2266 / ton
ENERGY COST	=	$ 7.00 / MMBtu	x	10,000 Btu / ton hr	=	$ 0.070 / ton·hr

of the energy that was consumed in the power plant. This is a tremendous waste of our energy resources. At the user's site the electricity is used in an electric A/C system with a typical electric motor efficiency of 85% thereby providing 25% of the original energy to the shaft of the compressor which provides the air conditioning. Therefore the total system efficiency for this typical electric A/C system is 25%.

The efficiency diagram in Table 6.1 also shows that natural gas can be used directly in the GHP without the inefficiencies of electric power production to provide 25% of the origianl energy to the shaft of the compressor which provides the air conditioning. This 25% efficiency is equal to the 25% efficiency for the electric A/C system but since the engine is located at the user's site the waste heat from the engine and exhaust can be recovered and used. This waste heat accounts for 44% of the input fuel. By combining the 25% shaft power output with the 44% recovery as hot water, the total system efficiency for the York GHP system is 69%. This is a significant improvement from the 25% total system efficiency for the electric A/C system. This significant improvement in total system efficiency can significantly reduce operating costs and reduce emissions to the environment while reducing the need for new power plants in Florida.

Table 6.1 also compares the capital cost for the electric A/C versus the York GHP for the total energy system that is required to support each additional ton of air conditioning. For a new electric A/C system that requires 1.2 KW/ton and a new electric power plant that costs $1000/KW it requires $1200/ton of capital cost for the power plant that supplies the new electric A/C system. For this simplified analysis we have omitted the cost of the electric transmission and distribution system which is also required for this new load. The end user will typically pay about $1000/ton for the installed cost of a new 3 ton electric A/C system. Therefore the total capital cost for the electric system is $2200/ton. For the natural gas system no additional production facilities are required and therefore no additional capital expense is required by the gas utility. However the installed cost of the York GHP at $2266/ton is about 2.3 times more expensive for the end user. This higher GHP cost is due to a more complicated piece of equipment and low production volumes. This indicates the need for equipment rebates to offset the higher first cost to the end user. The total capital cost for the gas system is $2266/ton. Therefore the total capital cost is about equal for the new electric A/C system and the York GHP system. The use of the York GHP can be an effective demand side management (DSM) program for electric utilities to reduce the need to construct costly, new generating plants. A recent paper presented at the 6th National Demand-Side Management Conference in Miami Beach on March 24-26, 1993 was entitled "The Role of Gas Heat Pumps in Electric DSM". This paper by Mark Fulmer of the Tellus Institute and Patrick Hughes of Oak Ridge National Laboratory presents the results of modeling of a hypothetical GHP rebate program for an electric utility to determine the GHP programs cost-effectiveness according to the societal test, total resource test, participant test and non-participant test. The results are quite positive for the electric utility system that was modeled as part of this study. This should be an excellent tool to determine the cost effectiveness for Florida's electric utilities. Due to needs for new power plants to satisfy the growth for air conditioning in Florida this may be an excellent DSM program which may provide better utilization of our natural resources.

Table 6.1 is a simplified presentation of the total energy supply system and does not include the potential cost savings to the electric utility of reducing the size of the transmission and distribution system needed to service the new residential A/C load in Florida. Since the electric A/C system represents the largest load in residences, the use of a GHP will significantly reduce the residential electrical load and significantly reduce the size and cost for electric transmission and distribution. This is a major reason for the widespread use of GHPs in Japan. In Japan the end user is required by the electric utility to pay for the larger electric service required if the residence has electric air conditioning. In this way the residential users with electric air conditioning are paying their share of the larger transmission and distribution system that is required. Any modeling that is conducted for the cost effectiveness of a GHP program should include the potential cost savings by reducing the size of the electric transmission and distribution system.

Table 6.1 also compares the energy costs for the end user for providing air conditioning only. This simplified analysis does not include the cost savings by displacing the hot water that is required at the user's site. Using typical residential electric and gas rates in Florida and the energy required per ton of A/C for both electric A/C and GHP the energy costs were calculated. The typical 3 ton electric A/C's energy cost is $0.108/ton·hr versus $0.070/ton·hr for the York GHP. This demonstrates part of the energy cost savings potential for the end user. This simplified comparison does not include the added hot water savings for the gas engine system which will be included in the next operating cost comparison.

Table 6.2 presents the "Annual Operation Cost Savings" for a 3 ton York GHP versus a 3 ton electric A/C system in South Florida. Operating costs are dependent upon a number of variables depending upon the specific application. For this comparison a typical South Florida home is used with a 3 ton A/C system and 3000 hours of operation per year. A typical 3 ton electric A/C system was selected with a SEER of 10.0 (1.2 KW/ton). The seasonal Coefficient of Performance (C.O.P.) for cooling for the York GHP in South Florida is 1.2 and requires 350 watts of auxiliary electric power for the pumps, fans and controls. Typical residential electric and gas rates in South Florida are used for this comparison. York has indicated that in 1994 their GHPs will be available with engine heat recovery to provide domestic hot water. Therefore Table 6.2 includes the cost for electric hot water and the cost for supplemental gas hot water when the York GHP is not operating. A typical South Florida residence will operate the A/C system 9 months of the year. Therefore supplemental gas hot water is included for the months of the year when the York GHP is not operating.

Table 6.2 shows that the electric A/C costs $972/yr plus $377/yr for hot water which is a total cost of $1349/yr. For the same home with a York GHP the A/C cost will be $819/yr ($630/yr for gas and $189/yr for auxiliary electric) plus $38/yr for supplemental hot water which is a total of $857/yr. The York GHP's annual savings of $492/yr is due to the low cost for gas versus electric A/C and the savings by recovering waste heat to provide domestic hot water. Table 6.2A shows the calculations that were used to determine the annual operating costs for the York GHP and the electric A/C system.

Since the GHP provides demand reductions for the electric utilities, rebates should be available from the electric utilities. Only by combining the rebates from the electric and gas utilities can the end user be given a sufficient incentive to overcome the higher first cost of the GHP. Competing rebates for electric A/C systems and for GHPs are counter productive and confuse the end users. Therefore it is necessary to quantify the cost effectiveness of a GHP rebate from Florida's electric utilities as a DSM program. This study should determine the appropriate rebate level. Then electric and gas utilities should work together for an effective program that can significantly decrease the need for costly, new electric generating capacity while improving the utilization efficiency of Florida's natural gas distribution system. City Gas Company is very interested in working together with other electric and gas utilities to develop these joint conservation programs.

TABLE 6.2

ANNUAL OPERATING COST SAVINGS

ELECTRIC A/C SYSTEM VERSUS YORK GHP

	ELECTRIC A/C		YORK GHP
ELECTRIC COST			
A/C	$ 972		$ 189 *
HOT WATER	$ 377		-
GAS COST			
YORK GHP	-		$ 630
HOT WATER	-		$ 38
ANNUAL OPERATING COST	$ 1349	1169	$ 857
YORK GHP SAVINGS			$ 492/Yr.

Basis: 3 ton residential A/C systems
3000 hours/yr (EFLH)
electric A/C = 10.0 SEER
York GHP = 1.2 C.O.P.
York Aux. Elec. = 350 watts
electric rate = $0.09/KWH
gas rate = $0.70/therm

TABLE 6.2A - SAMPLE CALCULATIONS

ANNUAL OPERATING COSTS - ELECTRIC A/C VS. YORK GHP

-YORK GHP CALCULATIONS-

GAS COSTS :

York GHP: $3 \text{ Tons} \times 3000 \frac{\text{Hr}}{\text{Yr}} \times 12000 \frac{\text{BTU}_c}{\text{Ton}} \times \frac{1.0 \text{ BTU}_f}{1.2 \text{ BTU}_c} \times \frac{\text{therm}}{10^5 \text{ BTU}_f} \times \frac{\$.70}{\text{therm}}$ = \$ 630/Yr.

Hot Water: $216 \frac{\text{therms}}{\text{Yr}} \times \frac{3 \text{ months}}{12 \text{ months}} \times \frac{\$0.70}{\text{therm}}$ = \$ 38/Yr.

ELEC. COST: $0.35 \text{ KW} \times 6000 \frac{\text{operating hours}}{\text{Yr}} \times \frac{\$0.09}{\text{KWH}}$ = \$ 189/Yr.

ANNUAL YORK GHP OPERATING COST = \$ 857/Yr.

-ELECTRIC A/C CALCULATIONS-

ELEC. COSTS:

A/C : $3 \text{ Tons} \times 3000 \frac{\text{Hr}}{\text{Yr}} \times 1.2 \frac{\text{KW}}{\text{Ton}} \times \frac{\$0.09}{\text{KWH}}$ = \$ 972/Yr.

Hot Water: $4195 \frac{\text{KWH}}{\text{Yr}} \times \frac{\$0.09}{\text{KWH}}$ = \$ 377/Yr.

ANNUAL ELECTRIC OPERATING COST = \$1349/Yr.

-SAVINGS-

ELECTRIC	-	YORK GHP	=	ANNUAL SAVINGS
\$1349/Yr	-	\$857/Yr	=	\$492/Yr.