UNIVERSITY RETIREMENT COMMUNITY

Integrating CHP into Retirement Community

September 22 - 24, 2004

Presented by:

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CHP—Retirement Community Background

THE CHALLENGES

Offset high-cost of electricity while enjoying the benefits of heating the swimming pool, spa, and domestic hot water from clean natural gas.

BACKGROUND

Built in 2000, University Retirement Community at Davis (URCAD) is a 444,927 square foot upscale 277 unit retirement community located in the college town of Davis, California.

Peak Connected Load 768kW

Installation Purpose

- To heat swimming pool/spa, Domestic Hot Water, space heating, & heat underground parking garage
- To generate 75 – 85% electricity for onsite use
- To help harness energy future by controlling operational costs

Other Challenges

- Select a Technology
- Select a Manufacturer
- Space Constraints
- Noise/Vibration
- Meet Rule 21 Compliance
- Gas & Electric Metering
- Interconnection Agreement
- Obtain OSHPD Approval
- Committee Approval

CHP—Identify Thermal Loads

The Challenge

Installing System in Limited Space

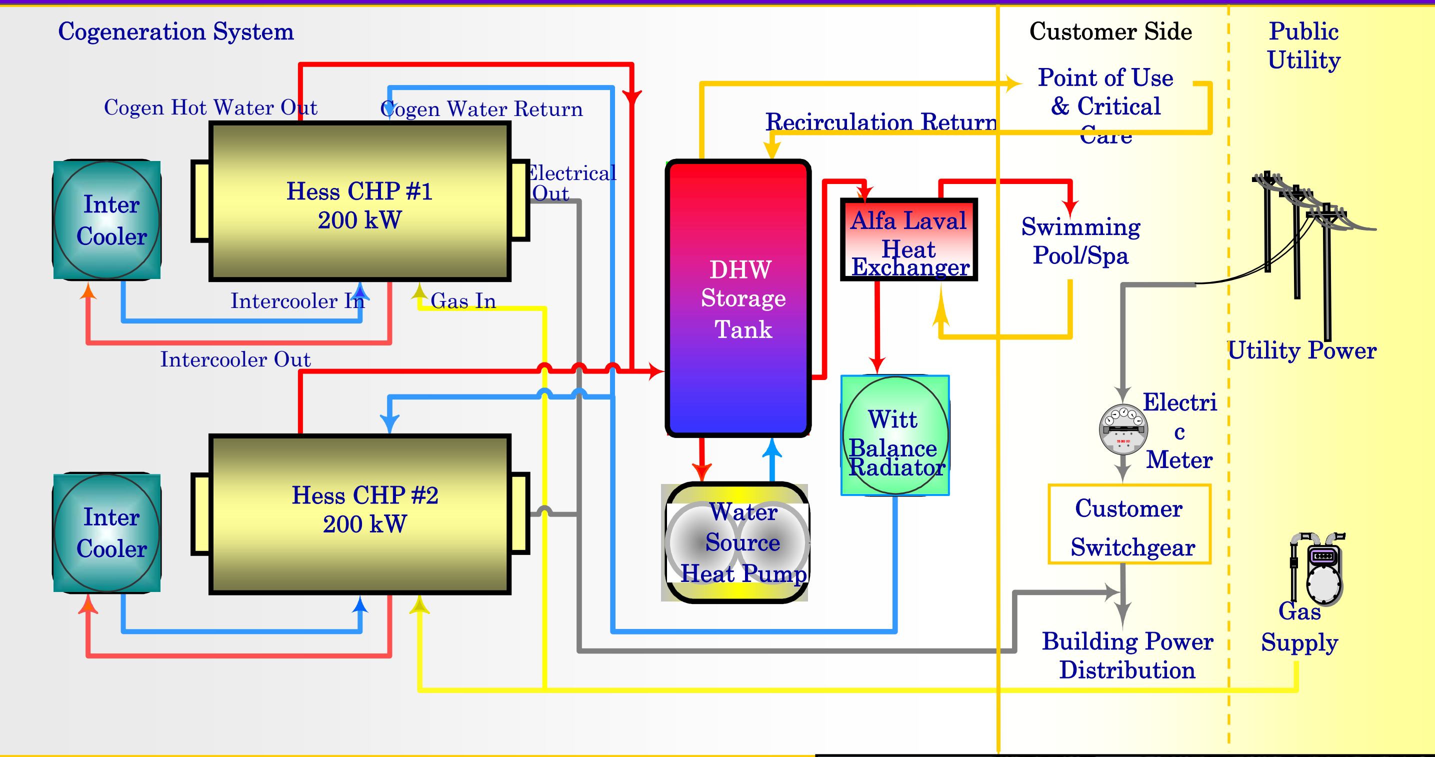
This is an award winning, non-profit full service community, which has such amenities as a heated spa, swimming pool, laundry facilities, delicatessen, dining room (600 meals/day), and an onsite 51-bed Healthcare Center.

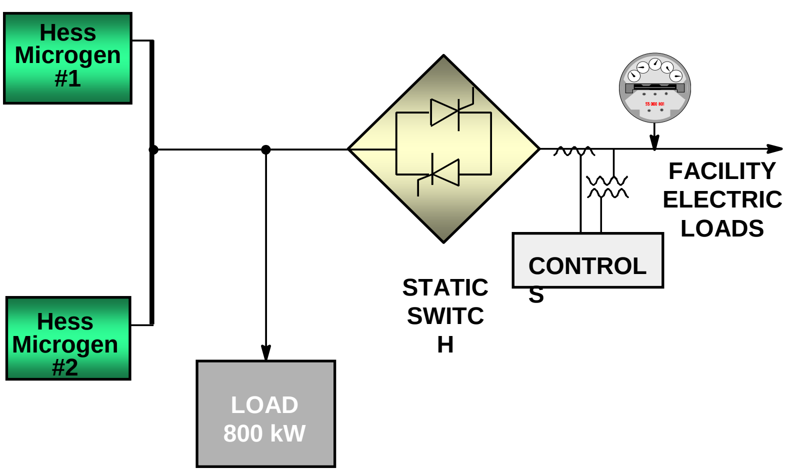
Measures

CHP—The System Design

The Challenge

Distance to Meters
Energy Balance





CHP—The Equipment

The Challenge

Select CHP Manufacturer

Engine Specifications

- Daewoo Heavy Industries Model GE12TIR, Inline 6-Cylinder, Replaceable Dry Liner
- Cycle 60 Hz (1800rpm)
- Prime 272PS (200kW)
- Compression Ratio 10.5 : 1
- Firing Order 1-5-3-6-2-4
- Individual Coil/Spark Plug
- Overhead Valve

Equipment Selected

- Two - 200 kW Hess Microgen
- Witt Balance Radiator
- Mark IV Controller
- Alfa Laval Heat Exchangers
- Beaird Industries—Maxim Critical Silencer
- Bell & Gossett Pumps

Equipment Specifications

- Electrical Output: 400 kW (nameplate)
- Fuel Consumption: 19.7 Th/hr
- Heat Rate: 10,274
- Electrical Efficiency: 35%
- Thermal Efficiency: 52%
- Combined Efficiency: 84%
- Weight: 7,140 lbs
- Dimensions: 11' 8" x 4' x 5' 10"
- Noise @ 3 Meters: <69 dba

CHP—The Location of Installation

The Challenge

Noise/Vibration

- Library Directly Over CHP System
- Residential Units Next to Library
- Exhaust Pipe Adjacent to Residential Units
- Intercooler Compressors Adjacent to Residential Units on Roof

- Installed Cost: $710,745
- California Self Generation Incentive Rebate: Level 3 - $213,333
- Annual Savings: $174,260
- Actual Payback: 2.86 Years
- Operation Since: August, 2003

The Challenge

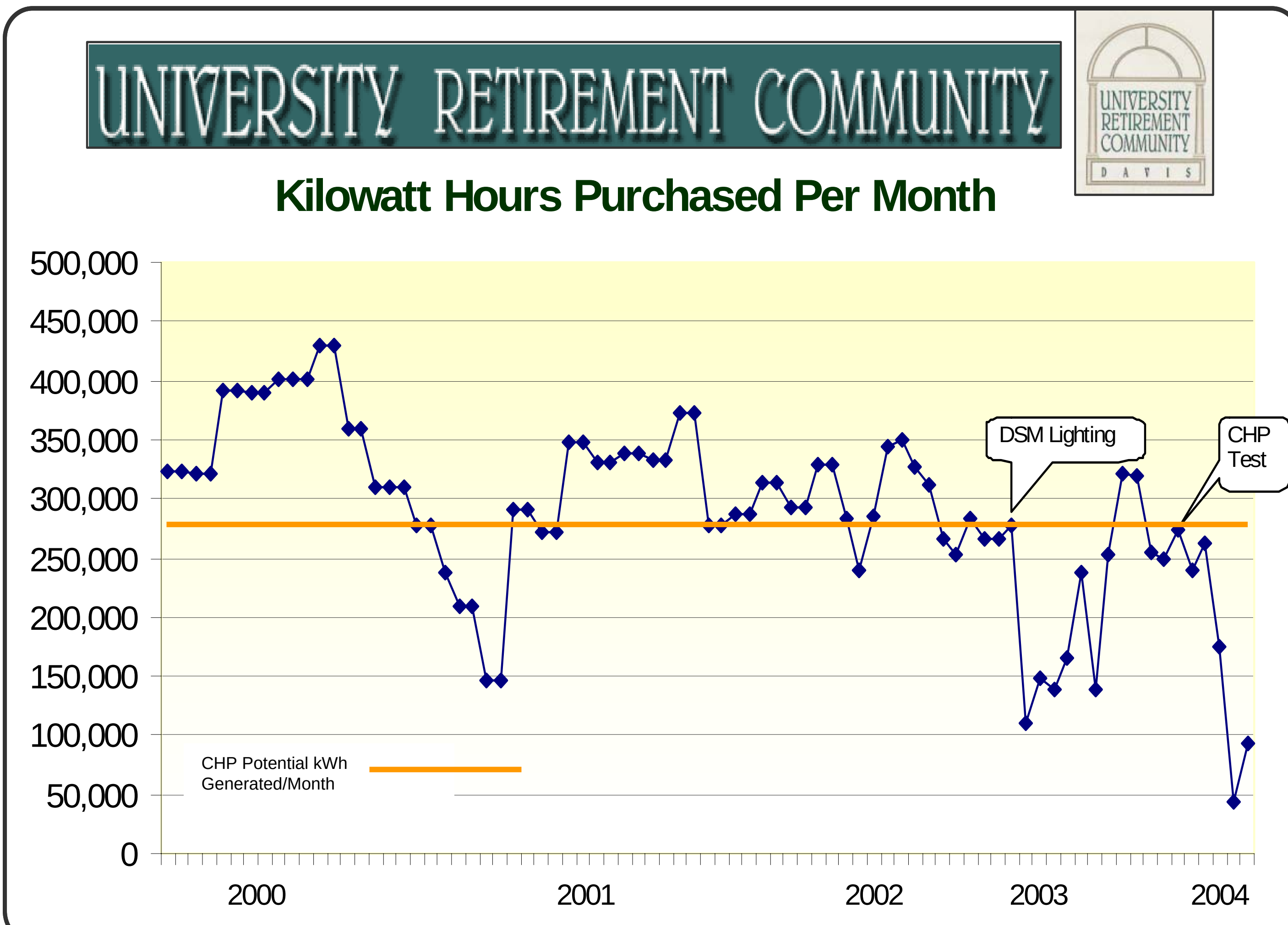
Meet All Thermal Requirements for Facility

The 1,250 square foot swimming pool is maintained at a comfortable 82^0 F for year round swimming while tenants can relax in the spa set at 100^0 F.

CHP—kWh Generated

SOLUTION SUCCESSES

- High reliability and system compatibility proven for hospital operations
- Hot water availability boosted 20% via innovative CHP installation
- Electricity produced is a byproduct from heating domestic hot water and swimming pool/spa
- More than 9,000 hours of combined operation
- CHP electrical generation ensures vital Retirement Community operations remain up and running 24 hours a day, 7 days a week

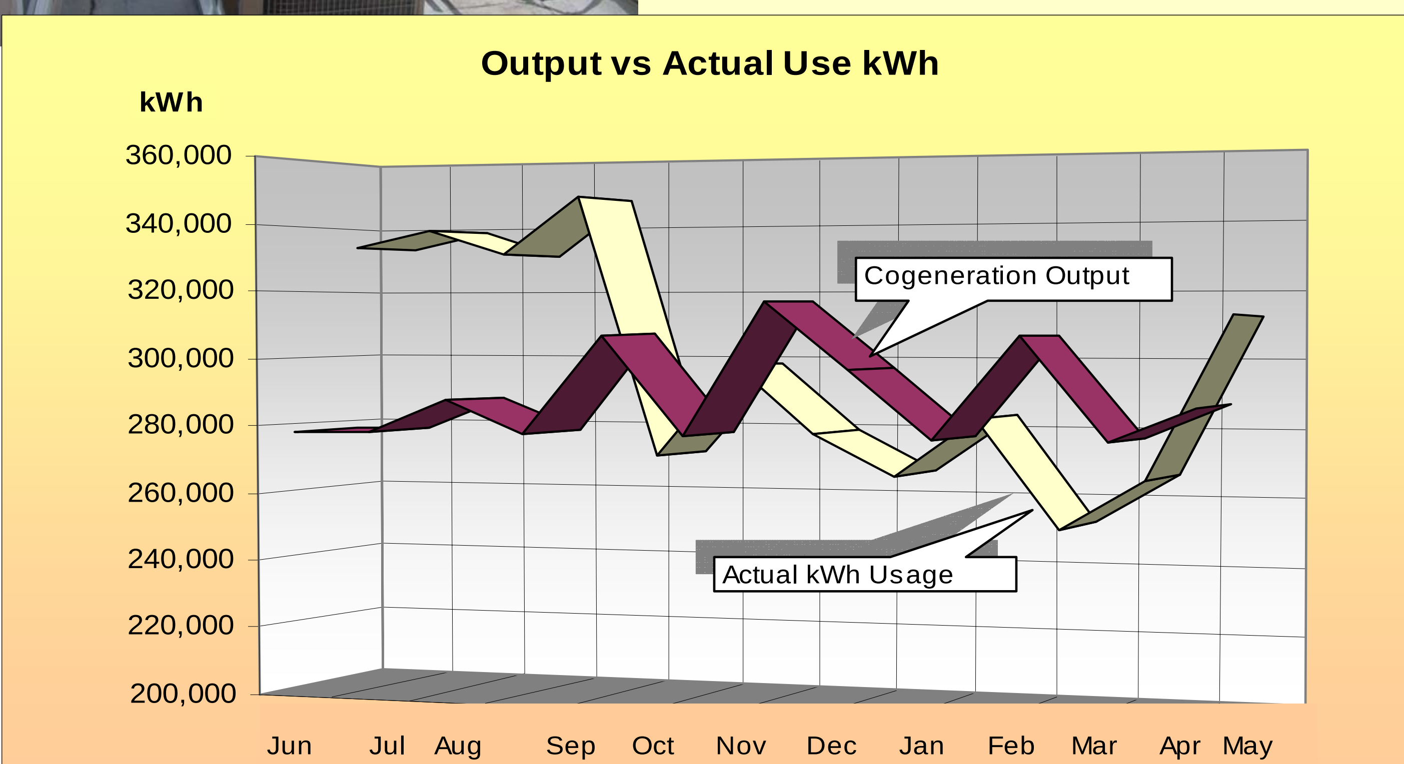


CHP—Load Following

The Results

Performance

- Total kWh Generated >1,500,000 kWh
- Heat Recovery 978,000 Btu/hr/module, or 1,956,000 Btu/hr total output (maximum thermal load demand)



Courtesey of RHT Energy

UNIVERSITY RETIREMENT COMMUNITY AT DAVIS;
A COMBINED HEAT & POWER CASE STUDY

Thomas A. Damberger, Ph.D., CEM
President, Golden State Energy

ABSTRACT

Electricity is like any other commodity, it is subject to the laws of supply and demand. If the demand increases; prices trend upward. If the supply component cannot increase to meet the new level of demand, a pressure to increase price is a nominal reaction to market forces. This is epitomized in what we experienced early in 2004 with the normally ubiquitous gasoline commodity.

When electricity prices quadrupled over the course of a few months, many were unprepared. The unprepared directly experienced a lack of commodity while others planned ahead with a diversified energy portfolio mitigating these risks. Because prices of electricity are highly volatile and will probably rise again, companies can make economic sense by incorporating certain technologies to better prepare their operation to manage energy costs—even during blackouts.

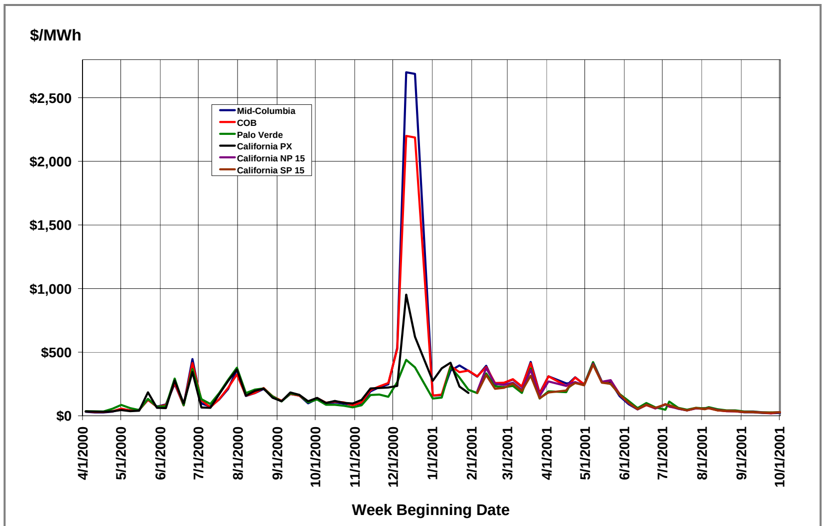
Due to the operational nature of hospitals and retirement facilities which operate 7/24, there are options to help reduce the cost of those operations. There are early market adopters of certain energy technologies who demand a high level of reliability and power quality 7/24 from their central plants. Telco-hotels and server farms are one such industry that requires this level of reliability and quality. These same technologies can also be adapted for hospitals and retirement facilities. And why not, when it comes to a human life hanging in balance based on the reliability of the utility grid or emergency generator? Any financial incentives or savings achieved are simply a secondary benefit when considering the reliability of the electricity commodity. University Retirement Community at Davis decided it was time to take control of their energy future thereby assuring a diversified, cost-effective, and reliable energy portfolio by adapting one of these technologies for their tenants.

INTRODUCTION

Total failure of the utility grid is not a new phenomenon in the U.S. It has happened many times in recent history. For example, in 1996, Western states lost power because of line sag; a squirrel provided a pathway of high voltage to ground, and was instantly vaporized on one of the transformers at a crucial time (Rocky Mountain Institute 8-14-03). In 1998, there were two power failures: ice storms took out power from eastern Canada and the U.S.

To get to the point, at the transmission level of the utility grid, over the past 30 years, few have noticed the lack of investment in the infrastructure of California, making it susceptible to a possible disruption. California is also extremely vulnerable is on the supply side of generation. These two critical issues met in a geopolitical confluence manifesting itself in May of 2000, just over two years after California restructured the monopolistic electricity market to a competitive energy market.

First indications of a pending electricity crisis started to emerge. During this time, shortages in electrical supply put the reliability of the entire grid system in jeopardy. The California Independent System Operator (CalISO) located in Folsom California, issued 32 Stage-1 and 16 Stage-2 Emergency Notices during four summer months of 2000. Rolling blackouts ensued and areas of the power grid were cycled off as determined by individual electric utilities. Their emergency plans were to simply keep power off in a given area for an hour to 90 minutes and then rotate to another geographic region. Post-blackout estimates of rolling blackouts and Stage-3 alerts cost Californians $1.7 billion in lost wages, sales, and productivity, and threatened to slow down an already weakened national economy. This was an unprecedented event in the history of California, which ultimately lead to political upheaval and the removal of a governor.



Non-Firm Peak Power Prices. Average of High and Low for Week

Figure 1 **Source: *Western Price Survey***

To meet this demand, capital investments in upgrades and new transmission lines must increase from their current level of $3 billion annually to roughly $5.5 billion annually over the next 10 years (Fama, 2004, p. 18).

Illustrating the dire need for energy in California, Senator Tom McClintock stated "California must add 30,000 megawatts of new electric power generating capacity over the next ten years."

Further exacerbating the problem, the price of electricity rose to $0.21 cents per kilowatt hour in California in 2001 (Figure 1), the state's Public Utilities Commission voted unanimously to reduce that to less than $0.07 cents per kilowatt hour. The state legislature then stepped in to control prices charged consumers throughout California—at rates lower than the utility companies were paying for electricity. It did not take long for the utilities to generate a debt that drove them near and/or into bankruptcy. This convergence of events set the stage for a continuing disaster that would impact utility rates for years to come. The volatility of electricity is one of the greatest variables in the cost of operation. If an organization can tightly control this commodity, it will have a direct impact on the bottom line.

Electricity has proven to be one of the most volatile of the commodities (Figure 2). The energy crisis triggered a $17.4 billion energy bond that will be repaid over the next 20 years by the ratepayers of the investor owned utilities.

A New Perspective on Energy

There are many studies outlining the vulnerability of the aging utility grid in the U.S. Only recently has Southern California Edison committed to $10 billion investment over the next five years in improving their electric system. This is a good start for their service territory, which up until now, was somewhat a neglected asset. Additionally, since our country was attacked by terrorists on 9/11, the grid has also become a major target. This is the first time in history that this subject has been brought to the surface as an acknowledged Achilles heel of the national energy infrastructure.

In a USA Today article by Tim Friend on 6-24-02 titled Power grid vulnerable to attack, report warns "*Extra-high-voltage transformers are cited as particularly vulnerable. The transformers are stocked in limited supply, and replacement can take months or years.*"

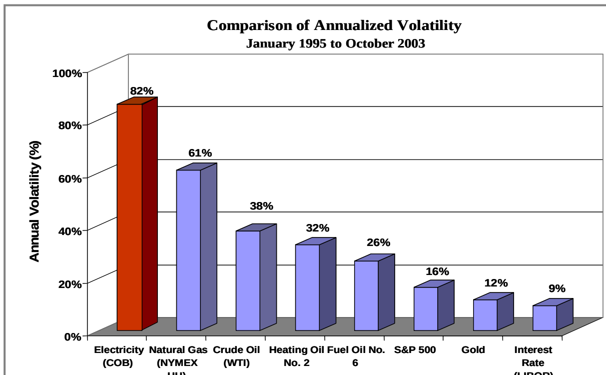


Figure 2 Source: Shell Energy

In an article written by Whit Allen, VP Sure Power Corporation titled Power-Grid Independence Means Better Homeland Security 1-14-03, "*DG offers a host of several national security benefits that would otherwise be jeopardized by a reliance on grid-based power*."

Allen summarizes with, "*The conventional electricity grid, in contrast, utilizes hundreds of thousands of miles of power lines and numerous substations - all open to attack at any point. In addition, multiple, small systems are less attractive target for saboteurs seeking to quickly and dramatically disable the nation's day-to-day operations*."

In a panel discussion at a conference on Grid Security, Paul Harmon from RW Beck stated "*As with essentially all infrastructure, electric power systems have vulnerabilities to external forces. Maintaining a completely "secure" transmission system is, therefore, impossible. The nature of the delivery network alone, long stretches of unguarded often remote overhead power lines and switchyards in isolated areas frame just some of the difficulty system owners/operators face in protecting their systems*."

UC Berkeley Professor Alex Farrell, Energy Resources Group, notes "Grid reliability has always been a concern, adding that historically the greatest stress on our transmission system has been weather. "Now we need to worry about the threat of malicious attacks," he says. DG is more secure because the natural gas distribution network on which most DG systems currently rely is primarily underground, while our high-voltage electric transmission system, which is largely above ground, is more vulnerable." (Farrell, 2004, p. 3)

As blackouts rolled across California in 1996, 2000, 2001, coupled with the massive outages that darkened the north-eastern U.S. in 2003, it became abundantly clear that, as much as we rely on the utility grid we must take a proactive approach to secure a reliable energy source. Most of the literature concludes that a distributed system is one of the most secure methodologies devised. One can equate the Internet and its use of the distributed system as one of reliability. According to the U.S. EPA Combined Heat & Power Partnership, use of generation (CHP) assets located near the point-of-use is the most efficient use of energy resources.

Energy security coupled with a keen interest in distributed generation (DG) has increased substantially over the past 10 years because of its potential to provide increased reliability from interrupted service. Combined heat and power delivers lower-cost power and reliability to the DG customer. At no cost to the utility, it also adds additional levels of security to the electric grid for other customers.

University Retirement Community at Davis

With the recent memory of the blackouts and price spikes, the management of the University Retirement Community at Davis (URCAD) decided to investigate the best way to take control of their energy future. The goals and objectives of this investigation were to offset the high-cost of electricity while enjoying the benefits of heating the swimming pool, spa, domestic hot water, and partially heat the underground parking structure from a single fuel—clean natural gas. Seemingly a daunting challenge, teams were formed to perform further research on the subject. Team members consisted of tenants, staff, management, and outside consultants. The team established overall objectives to:

- reduced energy costs/cost of operation
- reduced energy consumption
- reduced life-cycle costs
- improved power reliability
- improved energy security
- improved energy efficiency
- improved environmental quality

Figure 3 University Retirement Community at Davis

One element of their research jumped out as an easy task-turned-project. Changing incandescent lamps to compact fluorescent lamps (CFL) was easily justified and improved the lighting quality throughout the complex. The project saved over 139,000 kilowatt hours a month, qualifying for a rebate incentive of $2,084 from PG&E. The team demonstrated their ability to work together in a cohesive effort. This first successful project verified their unique profundity and efficacy of DSM efforts.

With the guidance of the commissioned engineering consultant, the team realized that somehow CHP was in their energy future. They also recognized that CHP systems are usually placed close enough to the thermal application improving overall fuel efficiency from about 33 percent up to over 80 percent. The team at URCAD focused on heat recovery (normally wasted energy) to heat the 1,250 square foot swimming pool, provide space heating, and generate hot water for the tenants, laundry, and restaurant. This improved efficiency not only yields significant savings in aggregate; the air quality is improved by reducing overall source emissions. Utilization of heat recovery from a CHP system is one of the most efficient uses of our natural resources. The spin-off benefit is generation of electricity, reducing the connected electrical load to Pacific Gas & Electric (PG&E). PG&E embraced the project and worked in partnership with the team, which reduces some of the strain off the local grid.

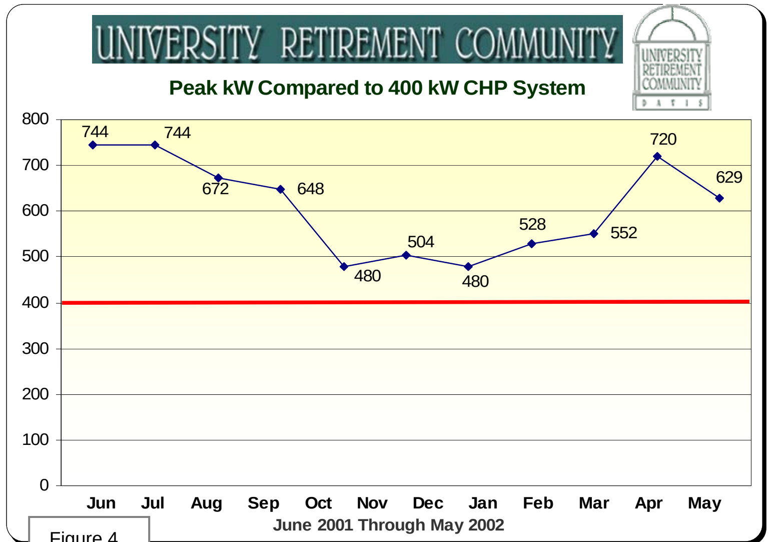


Figure 4

OVERVIEW

Built in 2000 on five acres, URCAD is a 332,000 square foot upscale retirement community located at 1515 Shasta Drive in the college community of Davis, California. This is an award winning, non-profit 277 unit full service community with such amenities as a heated swimming pool, spa, laundry facilities, delicatessen, dining room (serving 600 meals/day), and an onsite 51 bed Healthcare Center. The swimming pool remains at a comfortable 82^{O} F for year round swimming while tenants can relax in the spa maintained at 100^{O} Fahrenheit.

URCAD received an Award of Merit from the prestigious Golden Nugget Program, honoring the creative achievement, innovation, and effectiveness in architectural design. It has also been awarded two gold medals in the Best of Seniors Housing Awards, and it is the Grand Prize Winner of the Gold Key Awards 2000, which recognizes outstanding achievement in design.

As an award winning campus, these residential living apartments and cottages set a new standard for distinctive retirement living. All accommodations feature complete kitchens, individually controlled heat and air conditioning, emergency alert systems, and fire safety systems. The dining center serves about 600 meals each day with a restaurant-style ambience. Their laundry facility operates eight hours each day for the Healthcare Center and as a service for the tenants.

The URCAD central plant includes a domestic hot water system with two 1 million Btu Teledyne Lars boilers in parallel with a 1,200 gallon storage tank. There are two – 2 million Btu Teledyne Lars boilers for their water source heat pumps wherein water is circulated at 80^{O} Fahrenheit. A diesel fueled Onan emergency generator produces 500 kilowatt (kW) which serves the Healthcare Center and emergency lighting throughout the facility. The rest of the facility remains separate from this power source as required by state law regulating hospitals and healthcare operations.

Pacific Gas & Electric provides both gas and electric for the facility. A peak demand for the facility of 816 kW was registered during the July 2000 building commissioning process. Off-peak demand is 480 kW. Overall electrical consumption of the facility averages about 11,000 kilowatt-hours each day.

Energy Use by Cost Center

Energy use at URCAD is divided into several areas including: Food Preparation/Cooking, Healthcare Center, Laundry, General Lighting, Security/Egress Lighting, Space Heating/Cooling, DHW, and Swimming Pool/Spa heating. Energy security, coupled with the peculiarities of URCAD's energy needs, the local energy market, and technological alternatives, the decision to adopt a combined heat and power (CHP) system was somewhat an easy decision since it is a base-loaded 7/24 operation.

However, a complete engineering study was necessary to validate the team's findings. A key factor influencing the decision process was fundamentally founded on a base-loaded thermal profile, both minimum and maximum usage on a seasonal basis for a year. For this application to be cost effective it needed to be base loaded both electrically and thermally. The heat load became the focus for the thermal energy produced from the CHP plant. CHP is extremely efficient but requires ongoing maintenance. Maintenance costs can eat into savings, especially in any of the components have an

California Self-Generation Incentive Program					
Incentive category	Incentive offered	Maximum percentage of project cost	Minimum system size	Maximum system size	Eligible Technologies
Level 1	$4.50/W	50%	30 kW	1 MW	▪ Photovoltaics ▪ Fuel cells operating on renewable fuel ▪ Wind turbines
Level 2	$2.50/W	40%	None	1 MW	▪ Fuel cells operating on nonrenewable fuel and utilizing sufficient waste heat recovery
Level 3	$1.00/W	30%	None	1 MW	▪ Microturbines, internal combustion engines and small gas turbines utilizing sufficient waste heat recovery and meeting reliability criteria

Figure 5

unscheduled maintenance event. Such an event sometimes triggers a financial penalty by the utility as part of the interconnection agreement.

Review & Selection of a Technology

Integrating central plant systems with CHP for facilities incorporate multiple technologies for providing energy services to a single building or a campus of buildings such as found at URCAD. Electricity can be generated by implementation of generation assets using one or more of the many options including: internal combustion engines (ICE), combustion turbines, mini-turbines/microturbines, and fuel cells. A CHP system produces waste heat for power generation which is recovered for possible uses for absorption chilling, and hot water for use by the community.

The team reviewed various generating technologies including photovoltaics and wind power. Mini-turbines generate too much heat to electricity ratio to meet a balanced energy production for the facility. It became apparent that the ICE was one of the only choices due to the balanced heat production and electrical generation needed by URCAD operations. It is a good energy balance for the simultaneous production of heat and electricity.

In addition, it was determined that two units would be preferred to a single unit, because of the possibility of an unscheduled maintenance event. The risk of having a simultaneous failure with two cogeneration units at the same time would be minimized. Utility charges and penalties have the potential of wiping out an entire year of savings if such an event were to occur. Therefore the decision was made to proceed with selecting a manufacturer who produced a reliable cogeneration module in the 200 – 350 kilowatt range. Ultimately, the preferred manufacturer selected was Hess Microgen, located in Carson City, Nevada. This decision was based largely on the parent company's reputation, manufacturer specifications, and price ($710,745), all of which closely align with the energy needs of the complex. The price point of this turnkey installation and three-year maintenance package was extremely attractive.

California Self-Generation Incentive Program

Another factor that tipped the decision in favor of proceeding with a CHP system was Assembly Bill 970, signed by Governor Davis on September 6, 2000. It directed the California Public Utilities Commission to initiate certain load control and distributed generation with inducements of substantial financial incentives.

They were to develop an incentive program to encourage customers of investor-owned utilities to install distributed generation which operates on renewable fuel or contributes to system reliability.

The Self Generation Incentive Program as outlined in Figure 5 was adopted March 27, 2001. It provides incentives for customers of Pacific Gas and Electric (PG&E), Southern California Edison (SCE), San Diego Gas & Electric (SDG&E) and Southern California Gas Company (SoCalGas) to install photovoltaics, wind turbines, fuel cells, microturbines, small gas turbines, and internal combustion engines to provide some or all of their electricity for onsite use. Greater incentives are provided for generation using renewable fuel. There are no incentives for diesel-powered or back-up generation. The self generation units must be connected to the grid.

Under this California State mandated program, URCAD qualified for a $213,333 rebate which they received at the successful completion of the testing and acceptance process by PG&E.

Tax Implications

Coupling of the rebate program in California with the Economic Stimulus Legislation enacted in March of 2002, URCAD was allowed a bonus depreciation tax deduction of thirty percent applied to their CHP project. To qualify, a firm contract needed to be in place after September 11, 2001, and before May 5, 2003. These lexicons of benefits are not of common knowledge. Interestingly, many developers still do not know about or fully understand the benefits available for these types of projects. Many have missed the important benefits that this 2002-enacted legislation provides to the industry. Even more importantly some still do not fully appreciate the importance of their ability to quantify and fully capture these economic benefits, and to use them for DG/CHP projects, even for not-for-profit applications as URCAD.

Another consideration is the $350 Billion Jobs and Growth Tax Relief Reconciliation Act of 2003 increases to fifty percent the bonus depreciation deduction for projects that sign firm contracts after May 5, 2003 and before January 1, 2005, with potential extensions for many CHP projects until December 31, 2005.

According to Competitive Energy Insight, a consultant to the electric power and DG industry, the fifty percent bonus depreciation applies for the taxable year in which qualified depreciable property is placed in service. The remaining depreciable basis of the property must be reduced by the amount of the bonus depreciation applying standard IRS Modified Accelerated Cost Recovery Schedules (MACRS). The benefits apply to all U.S. based projects for Federal Tax Purposes and will also apply in some states for state income tax purposes.

Challenges of Installation

As with any hospital or similar facility, URCAD has space constraints for such an installation. The ideal location for this system was in the central plant facilities which are located in the basement—directly below the library. Concerns about emissions, noise, and vibration were of great debate prior to the installation, as was the selected technology.

Other challenges included technology reliability, permits for air, building, OSHPD (Office of Statewide Health Planning & Development), city, special use, PG&E's Rule 21 interconnection requirements, and finally, qualifying for the California Self Generation incentive program. OSHPD became involved when it was decided to provide preheated feed water to the Healthcare Center's boiler and DHW system. Any interconnection with the healthcare structure triggers a special permit by this agency of the State of California. All hospitals, skilled nursing, and Healthcare Centers are regulated by the OSHPD state agency.

Energy Balance

The engineering consultant creatively made full use of both electrical and thermal production. Aside from the kilowatt hours purchased from the utility (Appendix C), all Btu's produced by the system are utilized at the facility, including, but not limited to, radiant heat within the cabinet. Engineering design captured what was otherwise wasted heat produced within the cabinet by bringing in cold air at the generator side of the cabinet, and collecting the heated air at the engine side of the cabinet. The heated air is vented into the normally cool underground parking structure helping bring the temperature closer to a comfortable level. Theoretically, a lower operating temperature environment within the cabinets should extend the life of the cogeneration equipment.

Figure 6 2-200 kW Hess Microgen Modules

Manufacturer Technical Specifications

Specifications for the Hess Microgen 200 kW module closely match both thermal and electrical requirements for the facility. Aside from having the redundancy of two units, the electrical efficiency is rated at 35 percent while the thermal output of a single unit is rated at 1,021,042 Btu per hour with 19.7 Therms input. This closely aligns with the thermal requirements of the complex. Combined efficiency of the Hess Microgen product is listed at 84 percent. According to the manufacturer, the rich burn Daewoo internal combustion engine (ICE) heat rate is 10,274 Btu per kWh while the noise rating at three meters is < 69 dba. The heat rate assumes a maximum exhaust back pressure of 35 inches. Marathon Electric is the manufacturer of the generator which is an induction unit.

Figure 7 Heat Exchanger(s) Piping

Emissions Compliance Test
As part of the requirements for an Authority to Construct, the Yolo-Solano Air Quality Management District required a certification test to verify compliance with emission standards. On October 8, 2003, a compliance source test was performed on the two rich-burn Hess Microgen ICE's. All testing was performed under normal full load operating conditions for both engines.

The test protocol was conducted according to the CARB Method 100 which included concentrations of NO_X, CO, CO_2, and O_2 recorded using a Data Acquisition System in parts per million (ppm). Volatile Organic Compounds (VOC's) were determined according the EPA Method 18 protocol.

The 200 kW Hess Microgen module uses an advanced Daewoo ICE. In order to comply with local permitting, a validation test was run to confirm that the Daewoo engine could achieve the emission limitations of the South Coast Air Quality Management District (SCAQMD) regulations. Emission standards for this installation must meet 0.15 grams/BHPHR NO_X, 0.60 grams/BHPHR CO, and 0.15 grams/BHPHR ROG. For the purpose of this test, the Neutronics Enterprises Mark IV Air/Fuel Ratio Controller was used along with a DCL catalyst Model 2 DC-50. It was important that the catalyst be somewhat oversized to make certain that any instability from the engine could be compensated for within the range of the Mark IV Air/Fuel Ratio Controller.

Both units passed the stringent air quality emissions test for the AQMD. A chart of the test results is located in the Appendix B.

Process Description
The only modifications to this engine from the previous stability test "Report September 1, 2000" were to increase the size and flow of the gas regulator and to downsize the carburetor to an IMPCO 225 D. This was accomplished and the DCL 2 DC-50 catalyst was installed along with the Neutronics Mark IV Air/Fuel Ratio Controller.

After a normal start up and warm up, the Daewoo 11.5 liter engine was producing approximately 207 kW of electricity and the uncontrolled exhaust measured approximately 1500 PPM NO_X, 2100 PPM CO, and approximately 0.7% Oxygen. The engine appeared to be quite stable and producing consistent output power. Readings post catalyst made with the Testo analyzer indicated the oxygen content was approximately 0.4% (too lean) and the CO was reading zero with 100 to 200 PPM NO_X content. The NO_X reduction process requires additional CO for proper destruction. After richening the engine to approximately 0.5% raw uncontrolled oxygen (pre-catalyst) the controlled readings (post catalyst) became zero PPM NO_X, 10 to 30 PPM CO, and 0% Oxygen.

It became apparent that the stability of the engine was very acceptable and that the Mark IV Air/Fuel Ratio Controller was performing quite well. The oxygen target of the Air/Fuel Ratio Controller was adjusted both higher and lower in the bandwidth with very little change in the controlled emissions observed. The trim valve setting was adjusted to a slow position and all emission readings remained constant.

During California's Rule 21 compliance and interconnection test by PG&E, it was noted that the system was operating between 0.95 power factor lagging and 0.90 power factor leading. The planned maintenance schedule was filed with the utility as one of the requirements for the Self-Generation Program and to qualify for the rebate.

Operation & Maintenance
A maintenance chart was developed as a point by point schedule for maintenance of the cogeneration equipment. Under provisions of AB-939, URCAD prepaid for a three year contract for maintenance of the system. Hess Microgen will be providing full service of the system during the term of the contract. The maintenance schedule is listed in Appendix D. The cost for the three years of maintenance also qualified for the thirty percent incentive.

SUMMARY AND CONCLUSION

With the reality of taking control of our own individual energy future to stay competitive, relying entirely on the current infrastructure of the utility grid is somewhat problematic. History has clearly demonstrated transporting electricity hundreds, or thousands of miles have several risk components. These are made up of natural disasters, mechanical failures, human error, and yet another component of this century which has just been added to the list—Homeland Security.

With that aside, helping conserve our natural resources through the use of renewables, implementing conservation measures with DSM, and where applicable, using combined heat and power systems, we collectively add to our own security. As a reward for doing so, we receive several benefits, many of which are not entirely based on savings alone.

Concerns for noise and vibration in the library at URCAD have since been quelled with the diligent effort of the outside consultant. Use of pre and post-installation instrumentation technologies clearly demonstrated a negative impact, fully nullifying these concerns. The library area is quiet enough to hear someone breathing nearby.

Normally URCAD boilers would be used to generate the thermal needs of their community. Now they are using a combined heat and power system generating not only heat but the byproduct of electricity. With an annual savings of almost $175,000, their $710,333 investment corroborates the value of onsite generation. Aside from the financial savings, URCAD is a good neighbor by contributing to the energy security of the local area and improved the air quality. Their neighbors receive improved air quality, and the enhanced reliability of the grid, thanks to the team of visionaries at URCAD.

While there are post-installation warranty replacement activities and ongoing improvements to the cogeneration modules, performance of the system is nominal. Hess Microgen maintains a close presence to the installation assuring customer satisfaction.

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BIOGRAPHICAL

As a Certified Energy Manager and president of Golden State Energy in Carson City, Nevada, Thomas Damberger has over 23 years in the energy industry. He holds a Ph.D. is in Applied Management and Decision Sciences from Walden University—Minneapolis, and a Master of Public Administration from California State University—Long Beach.

Dr. Damberger's experience includes managing a $42 million energy budget for a major HMO including a $6 million capital remodel budget for DSM projects. He was instrumental in development and installation of distributed generation systems (installing the first 30kW Tecogen system on the West Coast), Demand-Side Management, project management, and overseeing installation of multiple fuel cells in a hospital setting. The United Technology Corporation (UTC Fuel Cell, formerly ONSI) produced the 200 kW phosphoric acid fuel cells used at these hospitals as demonstration of technology. At a hospital in Riverside he saved over $1,800 a day in a DSM lighting retrofit project.

In a related discipline he spearheaded two of the nation's first plasma-energy systems to destroy medical and hazardous waste. His innovative ability to bring together a team of project sponsors, advisory committee, and steering committee, resulted in raising over $1.5 million from outside sources. Permits were issued for both sites.

Dr. Damberger has received the prestigious Clean Air Award from the South Coast Air Quality Management District, and Special Recognition for Outstanding Contribution in Promoting an Environmentally Sustainable Energy Future from the Secretary of Energy at the United States Department of Energy. More recently, after completing several CHP systems, he entered into a structured transaction agreement of delivering outsourced commodities for school districts in California.

APPENDIX A

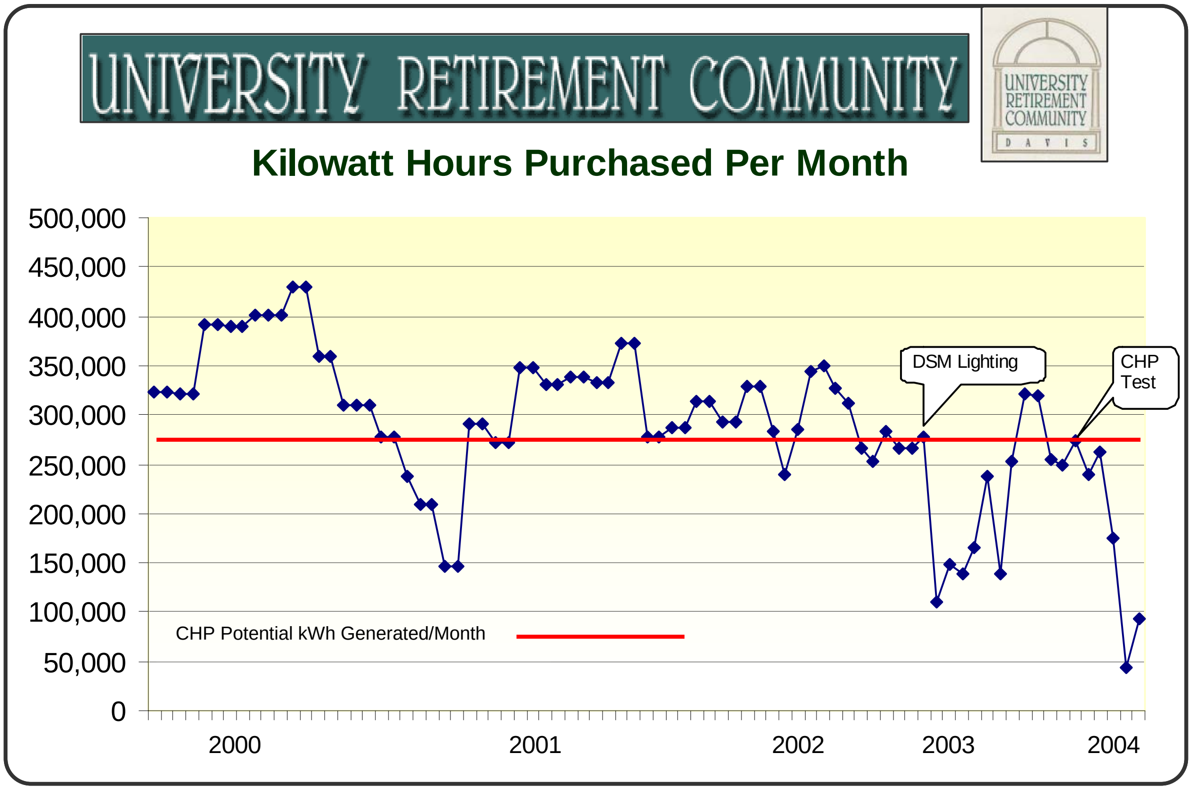
UNIVERSITY RETIREMENT COMMUNITY AT DAVIS
MAP OVERVIEW

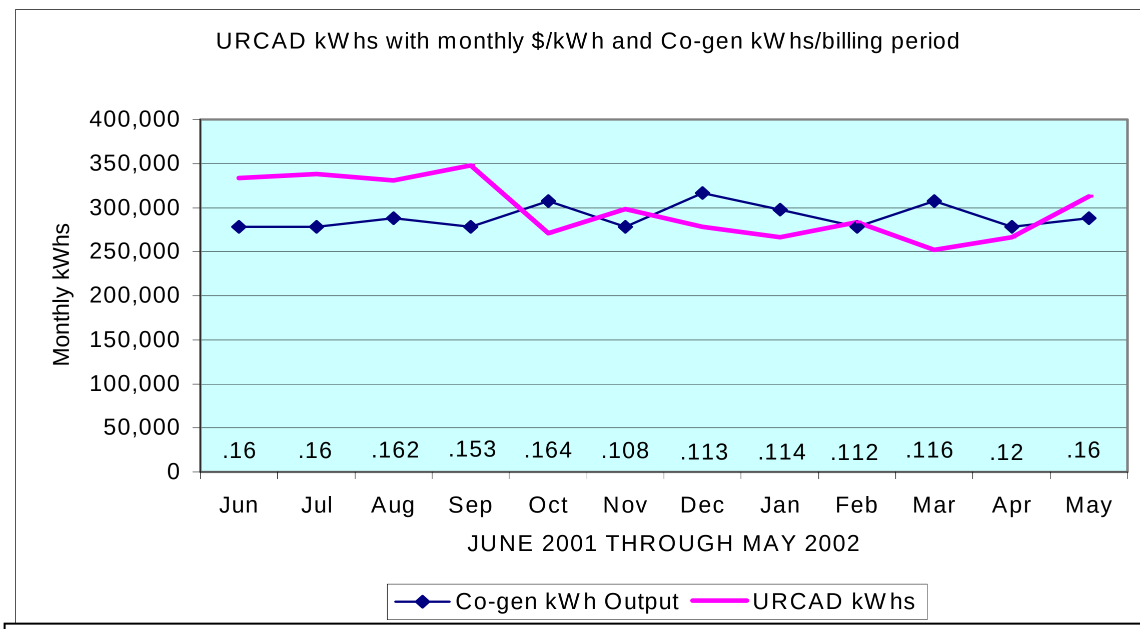
APPENDIX B

Emission Test Results

Parameter	Units	Run #1	Run #2	Run #3	Average	Permit Limit
Cogeneration Unit 1						
NO_X	ppmvd	14.28	19.18	86.53	40	--
	ppmvd @ 15% O_2	4.03	5.41	24.43	11.29	22
CO	ppmvd	32.37	14.54	0.68	15.86	--
	ppmvd @ 15% O_2	9.14	4.1	0.19	4.48	61
VOC	ppmv	1.54	1.03	0.54	1.04	--
	ppmv @ 15% O_2	0.43	0.29	0.15	0.29	128
O_2	%	0.00	0.00	0.00	0.00	--
CO_2	%	11.85	11.86	11.88	11.86	--
Cogeneration Unit 2						
NO_X	ppmvd	13.44	21.44	14.11	16.33	--
	ppmvd @ 15% O_2	3.80	6.05	3.98	4.61	--
CO	ppmvd	12.79	11.68	15.89	13.45	--
	ppmvd @ 15% O_2	3.61	3.30	4.48	3.80	61
VOC	ppmv	>0.5	>0.5	>0.5	>0.5	--
	ppmv @ 15% O_2	>0.1	>0.1	>0.1	>0.1	128
O_2	%	0.00	0.00	0.00	0.00	--
CO_2	%	11.89	11.85	11.83	11.85	--

APPENDIX C





Courtesy of RHT Energy

APPENDIX D

URCAD Maintenance Schedule		Initial Inspections			Hours				
	As Required	50	250	750	1,500	3,000	6,000	12,000	24,000
Oil & Oil Filter		X	X	X	X	X	X	X	X
Take Oil Sample		X	X	X	X	X	X	X	X
Inspect Air Filter		X	X	X					
Replace Air Filter					X	X	X	X	X
Inspect Belts/Hoses		X	X	X	X	X			
Replace Belts/Hoses	X						X	X	X
Inspect Electrical Connections	X	X	X	X	X	X	X	X	X
Inspect Coolant		X	X	X	X	X	X		
Replace Coolant	X							X	X
Inspect Plugs		X	X	X					
Replace Plugs	X				X	X	X	X	X
Check Racor		X	X	X					
Replace Racor Filter	X				X	X	X	X	X
Ohm Wires (record)		X		X					
Replace Wires	X				X	X	X	X	X
Compression Test					X	X	X	X	X
Retorque Head Bolts	X	X	X			X	X		
Adjust Valve Lash	X	X	X		X	X	X		
Inspect Generator		X	X	X	X	X			
Test Generator Insulation and Connections							X	X	X
Inspect Cview Connections		X	X	X	X	X	X	X	X
Inspect Intercooler Chiller		X		X	X	X	X	X	X
Document Fuel Consumption									
Document Average Exhaust Temp		X	X	X	X	X	X	X	X
Document Emissions Data					X	X	X	X	X
Inspect Charging System		X	X	X	X	X	X	X	X
Rebuild P-1 Pump	X							X	X
Inspect Main Breaker Contacts		X	X	X	X	X	X	X	X
Clean Unit	X	X	X	X	X	X	X	X	X
Flush Dump Radiator	X							X	X
Clean Generator Windings						X	X	X	X
Clean/Rotate Catalyst	X				X	X	X	X	
Replace Catalyst									X
Perform Top End Inspection	X							X	X