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# Cogeneration's Role in the Emerging Energy Markets

A Report From the University of Colorado

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## FACTS ABOUT CU

The University of Colorado at Boulder (UCB) is the flagship of the four campuses of the University of Colorado. It consists of four colleges and five professional schools, covering 786 acres, with more than 200 buildings and complexes. There is also a 147-acre research park just east of the main campus.

## THE COGENERATION SYSTEM

The utilities required to satisfy the university's electrical, steam and chilled water needs are generated at the cogeneration facility located in the center of the main campus. The building housing this cogeneration facility was constructed in 1909, at this time it contained a cogeneration facility. The original facility produced 1/100 the capacity of the new facility, yet it was housed in the same area. This existing facility burned coal until April 16, 1932, when the last coal train to pass through the campus on the Colorado and Southern tracks whistled at the campus crossing at 8:45 in the evening. This signaled the end to the cogeneration era at the Boulder campus until September 27, 1992, when once again the university began commercial operation of the new cogeneration facility.

Implementation of the Public Utilities Regulatory Policy Act of 1978 (PURPA) encouraged the development of cogeneration facilities due to their inherent energy efficiency. The federal government en-

couraged the development of cogeneration facilities by removing several major obstacles that historically deterred its full development. The three primary benefits afforded to “qualifying facilities” under PURPA are:

- Utilities are required to purchase electricity from and provide backup service to cogenerators at non-discriminatory rates.
- Cogenerators are exempt from regulation as public utilities.
- Electric utilities are required to interconnect and operate in parallel with cogeneration facilities.

It was because of this act, coupled with the fact that the university is interested in energy conservation, reliable energy supply, has a large utility load and wishes to save money that we proceeded with our project.

The facility now houses:

- 2- 23,000 Hp dual fuel turbines driving, two 16.5 MW generators
- 1- 1.25 MW steam turbine generator
- 2- HRSG's each capable of producing 86,000 lb./hr steam
- 2- 120,000 lp./hr stand-by dual fuel boilers
- 3- absorption chillers with a total capacity of 3200 ton/hr of chilled water
- 2- air compressors which supply campus control air

The energy required to support the teaching, research, and housing on campus this size is considerable. The energy used by the main campus during 1995, equaled:

Electricity = 169,083,988 kWh Steam = 400,000 k-lb.

Chilled wtr = 2,400,000 tons

The natural gas consumed to produce this energy = 2,175,050 MMBtu.

## THE COGENERATION SYSTEM PROCESS—PHASE 1

One of the problems I find often is that people get so wrapped up in solving the immediate day-to-day problems they fail to recognize and define the large ones that affect their strategic positions. One problem facing the university in the late 80s was the declining conditions of critical boiler systems in the heating plant. Chillers which would not operate due to age, under-rated PSCo electrical service lines

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which feed the campus, and aged electrical distribution lines that the campus owned and maintained, compounded the situation. After defining these problems and prioritizing them it became obvious that the boiler and electrical systems required immediate actions or otherwise the campus critical utility services would be at risk.

Options to address these concerns included replacement of existing systems in kind at a substantial cash outlay or to install a cogeneration system which would provide a pay-back, which was also consistent with the university's desire to be energy efficient and to provide highly reliable utility services. A financial proforma was performed, which indicated that a cogeneration system could be added to the existing facility providing significant savings when compared to the "business as usual" condition.

The university acquired a 15-year Power Purchase Agreement (PPA) with our local utility in the winter of 1988. This was the last fixed price PPA issued by the Public Service Co. and allowed the university to sell power to the Utility at a predetermined rate over the 15-year period. On January 1, 1989, the PUC granted a moratorium on fixed-price power sales agreements from PSCo. This seemed to end the further development of cogeneration (systems built for the purpose of generating electricity specifically for sale rather than use, "PURPA machines") facilities in Colorado.

## THE COGENERATION SYSTEM PROCESS—PHASE 2

Early in 1989, the university had evaluated what the proper approach would be to secure a new cogeneration facility. Should we hire an engineering firm to evaluate the cogeneration options or, solicit proposals and let industry optimize the system for us? We hoped that a turnkey design/develop contract would provide a greater variety from which to choose and a turnkey performance contract which included liquidated damages to lessen the risk for the university. The university team decided to pursue the turnkey design build option. Had I the opportunity to do it over, I would choose differently.

The university selected a diverse group of in-house individuals to serve on a committee to evaluate the proposals. The group consisted of three engineers, one MBA, the director of purchasing, the vice chancellor for administration, and the legal counsel for the university. Utilizing this diverse group, provided proper consideration to all proposal

facets, which became extremely important.

A Cogeneration Plant Request for Proposal was issued in 1989. It was the desire of the university team to allow the bidders to use their creativity in sizing the facility. Minimum performance and construction standards were provided and strict liquidated damages were written which included; noise, vibration, emissions, fuel use and schedule. Both a construction contract and a long-term natural gas contract were negotiated with the successful proposal team.

The university explored building its own pipeline to transport natural gas from in-ground reserves. Eventually an existing pipeline company offered the university an excellent transportation rate and agreed to build a new pipeline onto the campus. The university had all the benefits while someone else built and maintained the pipeline, largely because that company knew the university was not afraid to undertake the project itself. In the end, the university decided against buying reserves in the ground, but negotiated a long-term price with a supplier, thus guaranteeing its fuel costs into the next decade.

To finance the facility, the university issued \$41 million dollars in certificates of participation; to be paid off over 15 years through utility cost savings and power sales to PSCo.

The engineering necessary to utilize two gas turbine generators and utilizing a dual fuel system capable of supplying 33 MW of power was not an unusually difficult task. Pairing each turbine with a heat recovery steam generator to produce steam for use in heating or cooling various areas on campus was not a stumbling block either. However siting the system into an existing building where there was sometimes as little as three inches of clearance between machine and sandstone wall made the project unique.

The location and modifications to the existing facility were definitely the challenge on this project. The waste heat boilers were housed inside the existing building with the combustion turbines immediately outside. Engineering work included all the modifications to the existing structure. Throughout the design process, the appearance of the structure had been a constant concern, and all architectural modifications required approval from a university architectural committee made up of faculty, students and staff. The technology was proven. There are plants like this working all over the country. The real engineering feat was to fit this thing inside an incredibly confined space and integrating it into an existing facility.

Actual construction began in earnest in the fall of 1990. As a basis, the university offered an existing steam plant, housed in a sandstone structure built in 1909, which required extensive and careful modifications. The facility was basically gutted and a temporary structure erected to support the roof. The construction involved two main phases: having new boilers in place for steam generation by the November 1, 1991, deadline and completing performance testing of the gas turbines in September, 1992.

Demolition included work on three sides of the existing building and piece-by-piece removal of two, four-story, brick boilers with associated equipment and piping inside the structure. Isolation and tie-in activities required numerous plant shutdowns. Since the existing plant provided steam for both heating and cooling needs on campus, the shutdowns occurred for only a few hours, usually around midnight on weekends. Of special concern to the university was its ability to maintain a suitable environment for their long-term research projects.

The cogeneration plant meets all the electricity requirements for the main campus and east campus. Additionally, up to 10 megawatts of power is exported continually to Public Service Company of Colorado to fulfill the terms of the power sales agreement. The plant is operated and maintained by 14 full-time staff within the Department of Facilities Management. Service contracts provide for major maintenance on specialized equipment such as the gas turbines. In calendar year 1993, the cogeneration plant utilized 2.1 billion cubic feet (bcf) of natural gas to produce over 160 million kilowatt-hours of electricity. The plant has met or exceeded all performance expectations.

## POWER OPTIONS

### **The Goal**

I believe the primary goal of utility managers today is to optimize the relationship between cost and reliability when purchasing electricity. Said another way—to achieve the lowest possible cost consistent with the institutions need for supply reliability.

Times are tough and getting tougher for university administrators forced to find ways to curb rising costs without cutting quality and reliability of service. To do both may seem impossible. More than ever, there is a need for strategic planning, priority setting and evaluating everything we do or buy. I believe it means a change of attitude in how

we manage our utility budgets. A more aggressive attitude is now required. Previously you paid the going rate for electricity. You were not concerned about transmission, distribution, and generation. You trusted the Public Utilities Commission (PUC) to assure that the rates were fair. It is time to take a closer look at these big ticket items. What are you getting for your buck?

Users had no option but to buy from the monopoly or go without. Telephones, natural gas and electricity were good examples. But times have changed and are continuing to change. You have seen the change that occurred in the telephone and natural gas industries, electricity is around the corner.

In the past, when attempting to reduce expenditures in your utility system, you may have felt as though you were dealing with an adversary and as though you had no options.

In addition to monetary concerns, it is my opinion that system reliability will degrade in the future as suppliers rush to cut costs to meet the new competitive market demands. Major suppliers are reducing work forces, hesitating to replace aged equipment until absolutely necessary, delaying new generation projects and finding ways to cut corners with maintenance expenditures. Reserves in this region have decreased from 40%, 25 years ago, to 15% today. At a major research university, loss of power to the campus can be catastrophic, both in lost research and direct cost. This is a major consideration at CU, Boulder.

## **History**

The following actions by the Federal Regulatory Energy Commission (FERC) have played and will continue to play a major role in the electric utility industry.

### *1. Public Utilities Policy Act of 1978*

This act encourages the development of the cogeneration facilities by requiring utilities to buy electricity generated by cogenerators at avoided costs and hence improving the efficient use of finite energy resources. The concern for efficiency was prompted largely by the oil embargo of the mid 70s and was termed "the morale equivalent to war" by then President, Jimmy Carter. The 1970's was a period of major development of large generation facilities by utilities. This, coupled with the development of cogeneration systems and the energy conservation effort, resulted in excess available power.

## *2. Energy Policy Act of 1992*

This act required utilities owning transmission facilities to provide transmission service to other non-utility electric generators. The utilities had the option to post their pricing guidelines or tariffs with the fed's but only 21 of the 137 have done this. Therefore, wholesale power producers are required to negotiate rates for transmission in many cases. This becomes increasingly complex when trying to wheel power across longer distances where several transmission system owners are involved. Many processes involved getting orders from FERC on a case-by-case basis.

### **The Strategy**

#### *Number 1*

Your university holds the attributes that allow money to be saved. Universities must recognize these attributes, i.e., the large controllable natural gas and/or electric load, standby fuel reserves, large steam hosts, etc., and use them to their advantage.

#### *Number 2*

I believe all successful strategies to achieve lower energy costs emerge from the exercise of sovereignty or control over the utility supply and distribution system contracting processes. Put in other terms, when FERC requires the unbundling of electric services and the individual components are each separately available for purchase, then several opportunities will exist which are comprised of combinations of these components.

It is necessary then that you know the opportunity costs when choosing between options. If, for instance, an end-user decides to buy electricity from the utility company at an ostensibly favorable rate, that decision should reside in an environment wherein the end-user knows the available cost of each component. The choice to accept a price from the utility will include a number of factors, only one of which may be money. The utility may bring an aggregating attribute to the party along with management services, or it may bring favorable transmission capacity which thickens delivery reliability.

### **Options**

#### *Buying the Commodity (Electricity)*

Electricity is soon to become a commodity. It soon will be traded in a competitive marketplace—lots of sellers and lots of buyers, similar

to that which occurred in the telephone and natural gas industries. It is expected that new policy will eventually reduce electric rates to consumers. The price you pay would then be determined by supply and demand, rather than the cost to produce. The questions remains; how much, and for how long, and at what expense to reliability.

### *Securing Transmission and Distribution Service*

Wholesale transportation access became available as a matter of law in 1992, through the Energy Policy Act. This means that utilities are compelled to wheel power for each other and to other non-utility generators.

The University of Colorado is a political subdivision of the state, and as such, is entitled to those rights granted other wholesale buyers and sellers of electricity. This results in access to bulk power markets by wholesale customers. Today's price for bulk power is about 1.5 cents for interruptible and 3 cents for firm electricity delivered at transmission voltage. This means that if you are connected to the transmission system you may have the capability of accessing power at this price. If not, you may be able to pay an additional distribution charge of 1.6 cents/kW to get this power. How does this compare with your current rate?

### *Financing Opportunities*

Universities have the ability to capture tax exempt financing. A percentage or two savings in the interest rate relates to millions of dollars per year for large utility projects. This, coupled with possible lower cost of generation equipment as a result of the questionable short-term market for new power sources and low natural gas prices, may make self generation an option for consideration.

## CONCLUSIONS

1. The electric industry is moving towards a market in which competition will thrive and a market in which opportunities will exist for your university. The key is to be involved early while electric suppliers have available low cost excess capacity, similar to that which happened in the natural gas transportation industry. When unbundling occurred, the best opportunities disappeared first.

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2. One caution about early involvement. Some entities may try to persuade you to sign up now with a long term contract in an effort to secure a cushion in the new competitive market place. Be sure you understand the components which make up the offer and solicit information from multiple persons who will be in the market soon.
  3. Reliability is a major consideration at a research institution like that of the University of Colorado @ Boulder. Loss of power for even 15 minutes during a cold winter day could have catastrophic effect on campus life and research at our university, the result of which could turn you quickly from a hero for saving dollars to a goat because of lost research.
  4. Investigate the possibility of accessing the bulk power markets and compare these to self-generation or an energy service.

**The key to our dilemma is achieving a BALANCE between price and reliability. Each institution must evaluate how this balance is to be achieved. It is my opinion that combinations of various options can achieve the desired balance.**

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#### ABOUT THE AUTHOR

**Mr. G.J. Swoboda, P.E.**, is an engineering graduate of the University of Nebraska at Omaha and has practiced for the past 25 years as a professional engineer, providing engineering, construction, commissioning, operations and maintenance for large power projects in the utilities and petroleum industries. For the last 8 years Mr. Swoboda managed the Engineering and Utilities Division of the University of Colorado, Boulder campus.