Pitfalls of Cogeneration

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ABSTRACT

There are a number of pitfalls that will cause a cogeneration project to be unsuccessful. If success is measured in a project's ability to meet the proforma expectations in overall utility savings and return on investment, then anything less than that will render a project unsuccessful. However, partial success still may be acceptable. For instance, if a project pencils out to have a return on investment of 35% and attains only a 28% savings overall, that project still returns greater than normal returns compared to other investments and can be deemed successful, even if it does not meet initial expectations. Hence, the primary concern is when a project fails abjectly. When the returns are considerably less than what can be earned in conservative investments, then the project would be said to have failed.

LACK OF RUN TIME

The first pitfall is lack of run time which is attributed to failures caused by design shortcomings, maintenance shortcomings, or the combination of both. If the design of the system causes innumerable shutdowns and the vendor makes every attempt to correct those design shortcomings, the project will probably turn itself around and become successful. It is when those efforts reach a stone wall and neither the vendor nor his major suppliers can solve the problem or simply do not have the resources to continue with the solutions and so simply walk away from the project.

That very problem, lack of resources, has caused much of the consternation surrounding the efficacy of small-scale cogeneration. There have been too many vendors that, after a few years of operation, have been unable to capitalize their company sufficiently and have ceased to exist leaving the users to fend for themselves in finding qualified maintenance outlets and solving major design shortcomings. This is a major pitfall of small-scale cogeneration.

Therefore, if a system fails to operate for the required number of hours it was designed, the overall savings will be less. The most common reason for run-hour shortfall is not design shortcomings but maintenance considerations.

One such company with which the author has had direct experience, manufactured units in the 10- through 30-kilowatt sizes. These units were well designed and manufactured and were given test runs before being installed at the customers site; and virtually all installations included an "Extended Warranty and Maintenance" contract. That meant that the manufacturer-vendor entered into contract to supply all routine maintenance and replacement parts and components at no other charge than the client was paying in a production-arrears contract. In this case it was based on number of run hours per month. A service technician was scheduled to visit all installations at least once a month routinely. No installations had any telemetering-of-performance functions, operational proof or automatic feedback. It was up to the client to inform the company of any forced downtime. However, because the units were often installed on roof tops and other "out of sight out of mind" places, the client did not know when a unit might be down. The units had hour meters incorporated into their design, which was the basis for the maintenance contract billing.

Often, a technician would visit a job site to find the cogenerator not operating and learn that the number of hours of run time for that month was just a percentage of the previous month's total. Yet, the unit did not appear to have any obvious repair problems. What had happened was that the unit ran out of oil and was automatically shut down by the oil pressure sensor to prevent destruction of the engine due to lack of lubrication.

It was determined that as a unit aged, its oil consumption increased considerably and the oil reservoir, usually only that amount contained in the crankcase, was insufficient to last a full operating month before it was depleted and the unit shut down. Not only did the client not receive the anticipated utility savings and economic benefits, but the manufacturer-vendor did not receive its full maintenance payment because of lack of run hours. One solution was to dispatch service technicians more frequently to those job sites until a more permanent solution, i.e. increasing the oil-reservoir capacity, was found. Unfortunately, that manufacturer went out of business before that design modification was made, but subsequent manufacturers learned from those mistakes and included expanded oil reservoirs plus telemetering in their designs.

RATE CHANGES

A second pitfall that may occur in a cogeneration project's ability to meet its proforma design in economic savings is when the utility changes its rate structure and or its rates. Rate structure is when an electric utility changes from a straight-energy-charge rate based on cents per kilowatt to a structure that includes both energy charge and demand charge. When this occurs, the energy charge usually is reduced substantially, and the demand charge is imposed based on a kilowatt usage in any given 15-minute period. While the overall cost to the client for electricity may not be significantly different, the savings that the cogenerator will produce may be affected if the cogeneration system goes down during the peak-demand time for 15 minutes or more. If that should occur, the client is billed for the total maximum monthly demand and gets no credit for the kilowatt rating or production of the cogenerator for that entire month, even if the cogenerator were only down for a half hour out of the entire month.

Utilities are writing their interconnect contracts in such a way that they may be worded that they're year-to-year contracts. Therefore, if a client starts out with an energy-only rate structure, the contract may be changed after a its anniversary date to a time-of-use contract that now includes demand charges. These kinds of contracts put an even greater demand on not only preventive maintenance, to insure the system will run through peak demand times, but also on the timing of maintenance so that it does not occur during peak-demand times requiring the unit to be shut down for inspection, oil changes, and other preventive-maintenance chores.

Outright rate changes may also affect the economic savings of a cogeneration system. Should a utility reduce its rates in its service area, the cogeneration user will still get the benefits of having displaced a certain number of kilowatts he would have purchased from the utility, but now those kilowatts would be at a lower rate than when he first purchased his cogeneration system. Rate reductions are not very common, but with the deregulation of electricity becoming more popular and customers having the ability to choose who their electricity supplier will be, savings will occur in those areas. As of this writing it is uncertain just how much the deregulation of electricity will affect overall kilowatt costs, but at present, 2-3 % seems to be the number most independent producers are quoting.

FUEL-RATE STRUCTURE

Fuel-rate structure will normally not change during the life of a cogeneration system. However, this may be a proper time to talk about how fuel rates may affect a cogeneration project from the beginning. While PURPA required utilities to allow cogeneration systems to be interconnected with them for purposes of standby power and sell-back provisions, it did not necessarily grant cogeneration systems the same fuel rate as the utilities themselves. However, in many parts of the country gas providers have sold natural gas to cogeneration installations at the same rate as it sells to the utility. Other gas companies will give the cogeneration client a large-customer rate, which may approach that of the utility. Yet other gas companies may simply negotiate a rate with the cogeneration client. Some gas companies will sell their gas at the same rate as the client qualified for in the first place, regardless of the cogeneration system in place.

The cogeneration system will cause an increase in the amount of gas used by the facility since the fuel is used for both heating and electrical generation, but there will be an offset in the gas that had previously been used for heating water via the client's in-house water heaters. The overall gas sales in the area will be less due to the higher efficiency produced by the cogeneration system. Nevertheless, there is no universal cogeneration gas rate available throughout the country. In comparing the "cogeneration" gas rate from a California gas supplier to that of a Virginia gas supplier, the difference was about $.09/therm, with the Virginia supplier calling the rate "Large General Service," and it was higher than the California rate.

Suffice it to say that the fuel costs go into the equation when a cogeneration system is being analyzed for economic savings, and unless the gas supplier decides to change the classification of the client during the life of the cogeneration system, the initial rate structure will not change.

Other fuels that may be used in the cogenerator's engine drive may be diesel oil, propane, and methane. Few of these fuel suppliers have special rates for cogeneration systems, and negotiated rates will prevail based upon annual usage.

POWER FACTOR

The displacement of kilowatts by use of an on-site generator may be significantly affected if the power factor of the facility is low. Power factor is the term applied to the efficiency with which supplied power is used within the facility. A high power factor means that electrical power is being utilized effectively, while a low power factor indicates poor utilization of electrical power.

Therefore, power factor is a measure of the real power-producing current in a circuit relative to the total current in that circuit. It indicates how much real work is being done relative to the total amount of current drawn by an electrical device.

Low power factor in a facility means that the supplying generator, whether it is the central utility's generator or the on-site (co)generator, must put out more power in the form of kVA, or kilovolt amps, to accomplish the real work needed to be done within the facility. kVA power is referred to as Apparent Power. The real work is referred to as Real Power and is measured in kilowatts (kW). The relationship between Apparent Power (kVA) and Real Power (kW) is displayed in a Power Triangle as shown in Figure 1. The angle between kVA and kW is called theta (Θ) and is the power factor percentage of the facility. (See Figure 1)

The other leg of the triangle opposite theta represents Reactive Power (kVAr). This power serves no useful function, but is an indication of the drain on your power supply that is performing no useful benefit to the work at hand. If the power factor were unity (1.0), there would be no Reactive Power (kVAr) and therefore, no drain on the power being supplied. Where the electrical power being supplied is being used for lighting or heaters, which are resistance loads, the power factor would be unity. However, washing machines, compressors, refrigerators, pumps, all of which use induction motors to drive them, have inductive loads and usually run at lagging power factors of 0.8 or less. These devices will drag down the overall facility power factor, including that power used to supply lights or heaters.

What this means in cogeneration work is that when a cogenerator is installed in a facility with a low power factor, the generator must produce more work to maintain the same kilowatt displacement advertised in the contract. Usually, this is not always possible, and what happens is that the generator in the cogeneration machine will produce the advertised current in amperes, but only a percentage of that current will be available for useful work. The result is a decrease in the displaced kilowatts. A client may then argue with the cogenerator supplier that the cogenerator is not putting out the advertised kilowatts. The cogenerator supplier may counter by increasing the output of the cogenerator, which increases the current, but only at a sacrifice in fuel consumed, which would be higher than the contract initially showed. The customer may then complain about the fuel usage's (which he pays for) not being in line with the contract.

In either case the savings to the client will be less than advertised.

If the utility imposed a power-factor penalty to the client reflective of the kVA it needed to produce to supply the client with the needed kW, then the client's cogenerated power would offset that power that was purchased from the utility, and the power factor penalty would be less. That savings would then justify the cogenerator's lesser output as the combination of cogenerated power, and savings in power-factor

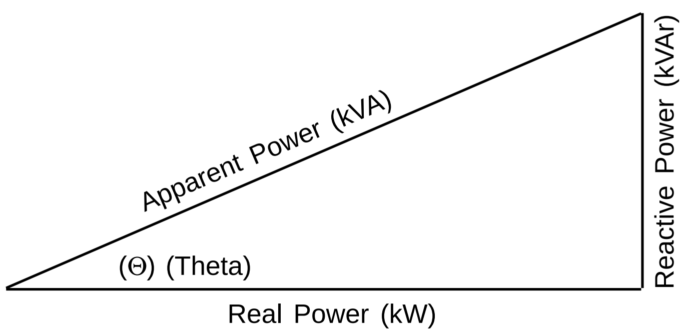

Figure 1.

penalty would increase the overall savings the cogeneration system is providing making for a happy client. Unfortunately, few utilities impose a power-factor penalty on loads that reflect the small-scale cogenerator's optimum clients. In other words, when the facility's overall kW usage is relatively small compared to the utility's total output, power-factor penalties are usually ignored.

However, low power factor hurts the client in other ways, too. The current flowing through electrical system components, such as motors, transformers, and wires, is higher than necessary to do the required work. This results in excess heating, which can damage or shorten the life of those components and, in extreme cases, even cause fires. Low voltage conditions may also prevail, which result in dimming of lights and sluggish motor operation, especially the starting of electrical motors where starting-current requirements are 5 to 6 times that of normal operating current.

Correction to a facility's low power factor can be accomplished by the use of capacitors added to the facility's power-distribution system. They act as reactive current generators, which helps offset the inductive current devices in the system, thereby increasing the overall power factor in the facility.

The pitfalls of cogeneration are not something that should thwart the investigation and eventual inclusion of this type of energy conservation into a responsible client's thinking. The benefits in economic savings, conservation of fuel savings, and ecological savings should be included in the new words being coined today—Green Power—as beneficial as wind power, hydro power or geothermal power. Careful attention to vendor selection, machine design, utility attitude and facility capabilities will overcome most, if not all, of these pitfalls and make cogeneration a viable method of energy conservation.

Mr. Kolanowski's article has been abstracted from his recent book, *Small-scale Cogeneration Handbook*, published by The Fairmont Press, 700 Indian Trail, Lilburn, GA 30047.

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