Blackouts, Lighting and Microturbines

The massive eastern blackout of August 2003 has renewed concerns about electric reliability and the adequacy of existing transmission lines. Upgrading the present system would be lengthy and expensive. A better solution might be to reduce the load on the lines by having microturbines take over the task of lighting buildings.

Lighting represents 40% to 50% of the electricity consumed in most commercial buildings. Microturbines can provide this electricity at much higher efficiency than the utility grid. Lighting is an ideal application for microturbines because the loads are fixed, the units only operate at full power, there is no need for standby, and the potential for beneficial use of the exhaust heat is much higher.

The initial cost is self-amortizing and borne by the user, not the transmission company. Yet the user would save money while conserving energy and enjoying greater reliability. The technology is fully proven.

Lighting is the largest electric load in offices, stores, light manufacturing, and other commercial buildings. It is also a significant load in large factories. Microturbines are ideally suited to provide this power. The key is to have them provide electricity only for lighting. Let the electric utility handle the rest of the loads. There should be no paralleling between the microturbines and the grid or even between any of the individual microturbines. The exhaust heat from the microturbine should be used to heat, cool or dehumidify the facility. Thus the system should pay for itself in energy savings.

Any type of lighting lends itself to this concept – fluorescent, high intensity discharge, even incandescent. Consider a large store with 1,000 fluorescent fixtures each consuming 116 watts for a total of 116 kW. One 26 kW microturbine should be able to power 224 of these fixtures or 22% of the total lighting load. Four microturbines should be able to power 896 fixtures or 90% of the lighting load. The remaining 10% could be powered by the electric utility along with all non-lighting loads.

Whether one unit or four units are installed, there would be no reason to parallel microturbines or to parallel with the electric grid. Each would be connected only to 224 fixtures. With no alternate source of power connected to the microturbine, there is no load sharing, no reverse current relays and no breakers with high interrupting capacity. There is also no concern with step loads because the loads are constant. With no connection to the electric utility's grid, there is little need for coordination or negotiation with the power company.

Redundant units for standby are no longer necessary. A minimum installation would have just one microturbine. If it were down, 78% of the lighting would still be on. With the microturbine running and the grid down, 22% of the lighting would still be available, a substantial improvement over no lights at all. Note that some lighting would always be on without interruption. This reduces liability concerns from injuries caused by darkness. It also lessens the potential for shoplifting, looting and vandalism.

Now consider an installation with four units. If one microturbine were down, 78% of the lighting would still be available. However if four microturbines were running and the grid went down, 90% of the lighting would still be available.

Standby generator sets are sometimes used to back up the electric grid. But they produce no energy or cost savings and have questionable starting reliability. These sets take time to come on line. The building is dark in the interim. If there is high intensity discharge lighting, the building may remain dark even after power is restored. This kind of lighting can take at least five minutes before restarting and up to fourteen minutes before full brightness.

Often there are critical loads such as cash registers and credit card readers. Installations with four microturbines could include a transfer switch to drop one of the four lighting buses and provide 26 kW to the critical bus. 67% of the lighting would still be available and the cash registers would work.

In sharp contrast to conventional cogeneration, all 26 kW of microturbine generating capacity purchased for lighting will be used. Compare this to an installation where both lighting and non-lighting loads are to be satisfied with 26 kW units and the peak is 110 kW. Four microturbines will not be sufficient so five must be bought plus a sixth for standby. 156 kW of generating capacity will be purchased to satisfy a 110 kW load. Compared with a lighting only installation, the capital cost for microturbines will be 41% higher. Paralleling, load sharing and other equipment will further increase cost. And note that fully independent, unparalleled units are always going to be more reliable

Operating economics are much improved when the units are used only for lighting. The 26 kW units will run at their maximum continuous rating, their highest efficiency point. With essentially a 100% load factor when running, they generate more kWhrs per installed kW. In conventional cogeneration systems, the microturbines must load-follow and be prepared to accept step loads. Thus they never operate at full capacity or maximum efficiency and generate fewer savings than they would in fixed load situations such as lighting. .

In most facilities, lighting will have a higher annual load factor than most other devices. This allows microturbines used for lighting alone to produce more savings per installed kW, especially as the lights will generally be on during peak and mid-peak utility rate periods when electricity costs are highest.

The economics of any cogeneration system are largely dependent on the availability of thermal load. If the exhaust heat from the microturbines is used to air condition or heat a facility, there will be high thermal utilization when the weather is very hot or very cold. However, the requirement for heating and cooling diminishes rapidly when the temperatures are mild. If the microturbines only provide electricity for lighting, less than half as many microturbines will be installed. Less than half as much exhaust heat will be produced, so there will be more time when all the exhaust heat can be profitably used.

One of the challenges in economic evaluation of conventional cogeneration systems is predicting the electrical and thermal load profiles. This becomes much simpler in loads such as lighting. Projecting how many hours the lights will be on determines the electricity consumption. As noted above, the probability of greater thermal utilization is much higher and also more predictable.

Microturbines unfortunately lose power on hot days. (Unhappily, this occurs when air conditioning loads are greatest!) Typically they will produce 20% less power on a 95°F day than they will on a 59°F day. However, the majority of the facilities mentioned have requirements for a certain percentage of fresh air to be induced into the building. This air is cooled as necessary. But the air that is being induced must be matched by an equivalent amount of air that is being rejected. It should be possible to extract conditioned air from the building for the microturbine. If so, the microturbine's inlet temperatures will not exceed the temperature in the facility. Even on a very hot day, the microturbine will only see 75°F or 80°F inlet air.

The exception to this would be when a warm building is being opened up and the lights are needed. In this case a simple temperature sensor could turn off a portion of the lights until the building is cooled to an acceptable level.

To increase the microturbine's rating further at a relatively low cost per kW, assume that the air entering the microturbine is already cooled and dehumidified. A cooling coil could be placed in front of the microturbine's air inlet to reduce the temperature, thus further increasing the available power. Because the air is already dehumidified, there should be only a sensible load with no latent load.

Most microturbines generate high frequency power that is rectified to direct current and then inverted back to 50 or 60 Hertz. Developing a ballast that will accept high frequency power or direct current would eliminate the need for the microturbine to have an inverter except perhaps a small one for starting. This would significantly reduce cost and eliminate inverter losses.

Today thousands of microturbines have accumulated millions of operating hours. Most of the natural gas-fueled units use the exhaust heat beneficially. They boast emission levels that have been certified as a small fraction of the best reciprocating engines. Maintenance is scheduled just once per year and downtime is short. This is a fully proven technology.

Deploying microturbines for lighting will provide substantial savings and increased reliability for the user. It will massively reduce the nation's energy consumption and the need for additional transmission lines.

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