Microturbine Precise Power Systems

Data centers require continuous, high quality power. Spikes from lighting strikes and switching transients shut down computers. Motor starting and other high inrush loads cause voltage drops that also shut down computers. Brownouts have the same effect. Blackouts can leave reservation centers and other critical operations off line for days.

Microturbines provide precise power continuously. They have low operating costs, especially if the exhaust heat is used with an absorption chiller to cool the computers. They also have low acquisition costs. More importantly, they have high reliability.

The most popular microturbines use gas turbine-driven generator sets to produce high frequency power that is rectified to direct current and then inverted to 50 or 60 Hz. For critical power, microturbines use two separate inverters as shown below instead of one.

Figure 1 shows normal operation. (Dotted lines are control lines. Heavy lines are power lines.) The generator set runs at its maximum continuous duty rating. The first or critical bus inverter operates in a stand alone or grid-independent mode. It follows the load and provides the exact amount of power needed by the computer. The second or non-critical bus inverter parallels with the facility bus and operates in a grid parallel mode reducing the power purchased from the utility. It monitors the output of the generator set and the input to the critical bus inverter. It provides just enough power to the facility so that the total power consumed by the two inverters exactly matches the maximum continuous rating of the microturbine. Thus the microturbine operates at its most efficient and most economical point as well as having the highest possible load factor.

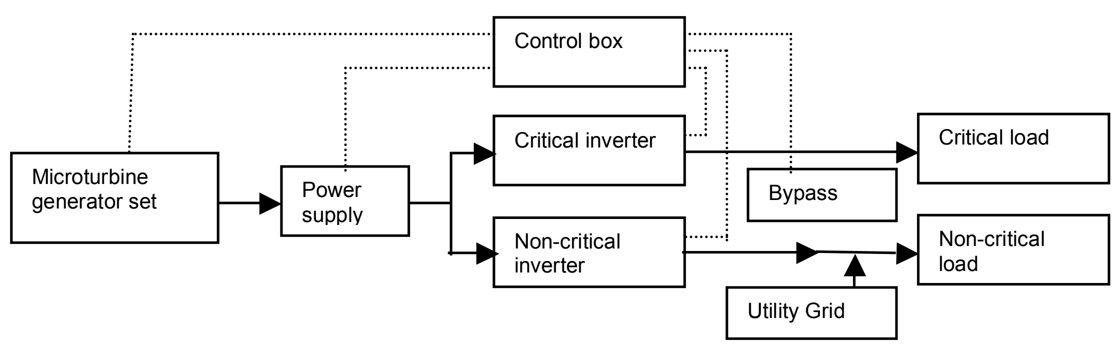

Figure 1 – Normal Operation

If the microturbine produces 30 kW and the critical inverter requires 20 kW for the computer, 10 kW will go to the non-critical inverter. If the computer loads drops and the critical inverter only needs 8 kW, 22 kW will go to the non-critical inverter. If the computer load steps up suddenly and the critical inverter now needs 24 kW, the micro turbine will not see a step load, as the non-critical inverter input will simply drop to 6 kW.

Note that all of the electricity consumed by the computers is converted to heat that must be disposed of or the computers will shut down. Using the exhaust heat from the gas turbine to power absorption chillers to provide the necessary cooling is both energy efficient and cost effective. This chiller can also cool the air coming into the microturbine thus increasing its rating and allowing it to operate at full power on hot days.

Figure 2 shows operation with the grid down. The non-critical inverter disconnects from the utility grid and the micro turbine continues to power the critical inverter. It continues to operate at full rpm so that it can handle any step loads.

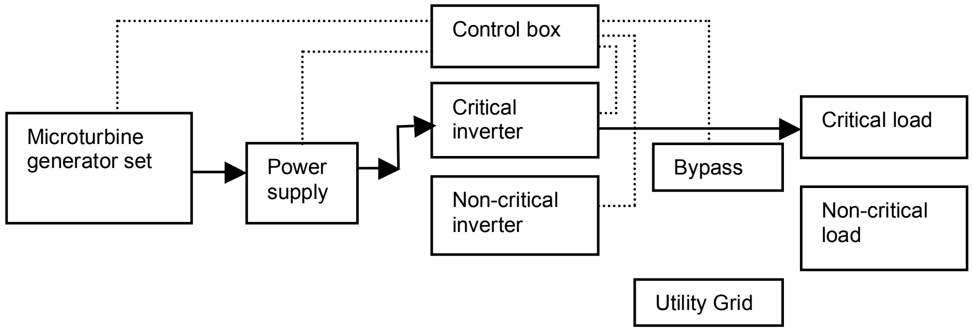

Figure 2 – Utility Grid Failure

Figure 3 shows operation with the microturbine down. The non-critical inverter, which is bidirectional, now supplies the critical inverter with the needed power.

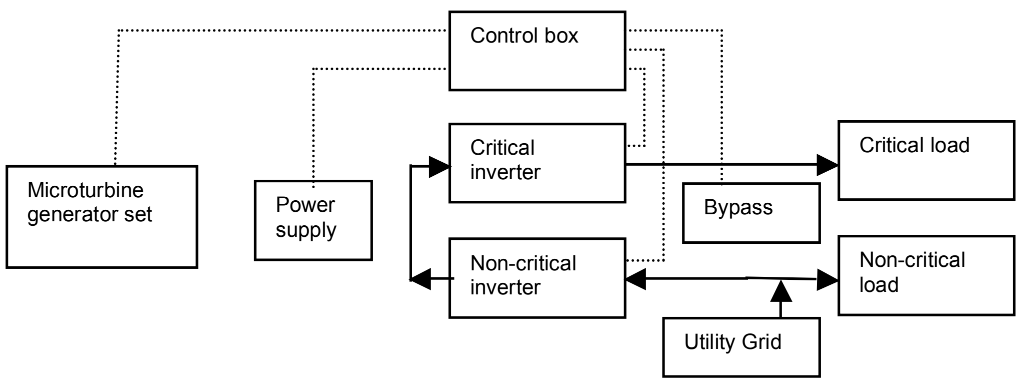

Figure 3 – Microturbine Down

Figure 4 shows the non-critical inverter supplying starting power for the micro turbine.

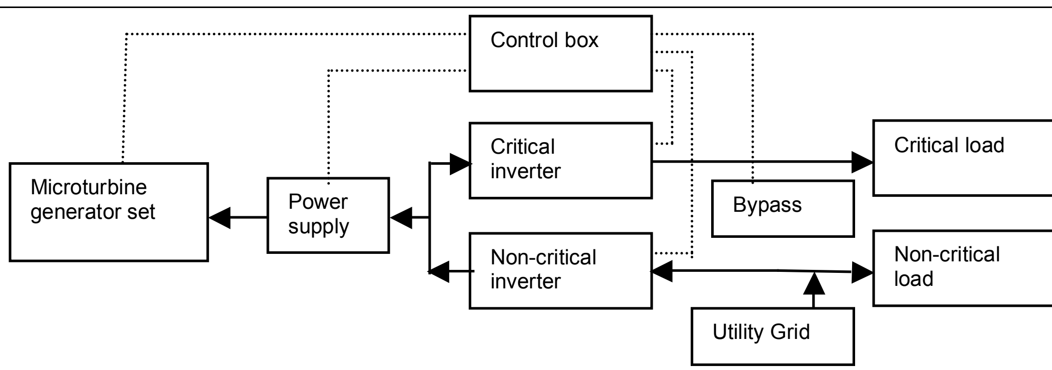

Figure 4 – Restarting the Microturbine

Figure 5 shows the non-critical inverter substituting for the critical inverter when the critical inverter is being serviced

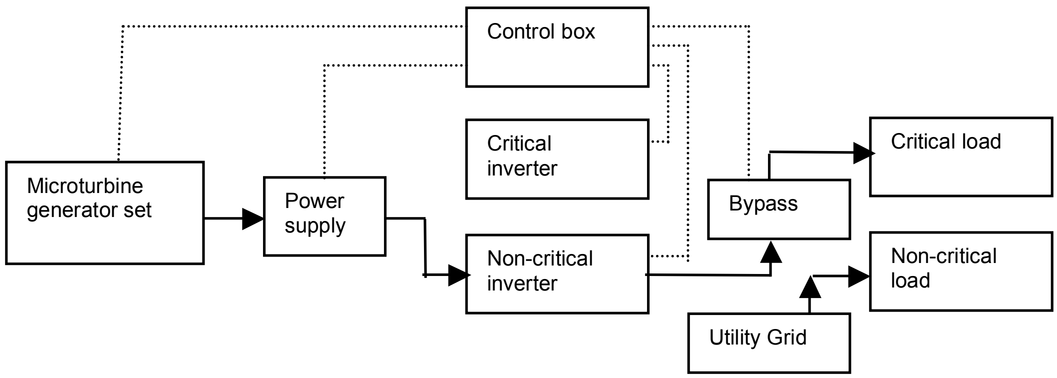

Figure 5 – Critical Inverter Being Serviced

Figure 6 shows the entire system being bypassed.

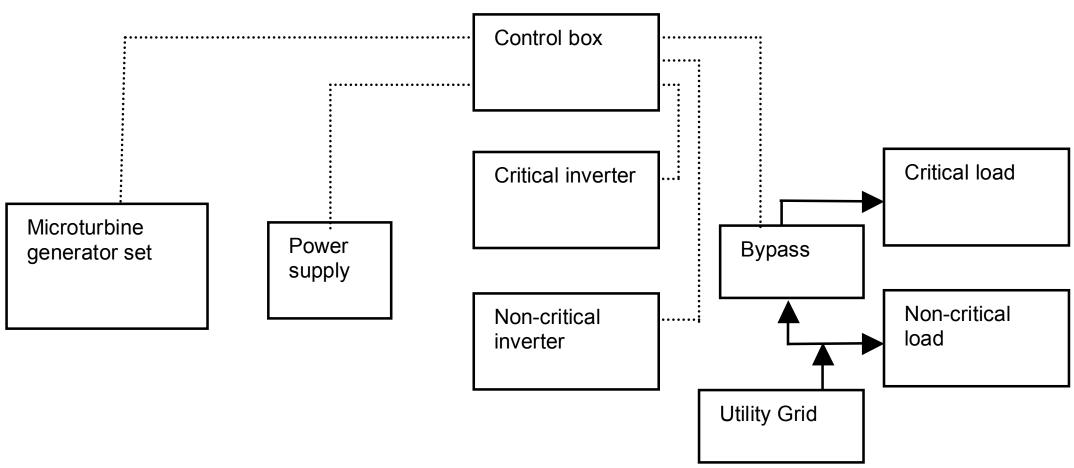

Figure 6 – System Bypassed

The microturbines can run on natural gas, propane and other fuels. If desired they can use natural gas as the primary fuel and switch over to propane on the fly if the natural gas supply is interrupted.

Microturbine systems are extremely flexible. Any number of units of any rating can be paralleled to handle any size data center. If desired, redundant units can be added to achieve the highest possible system reliability. Even with redundant units, the microturbines will still operate at their maximum continuous power where they achieve their highest efficiency and produce the maximum number of kWhrs.

Figure 7 shows a four-unit installation.

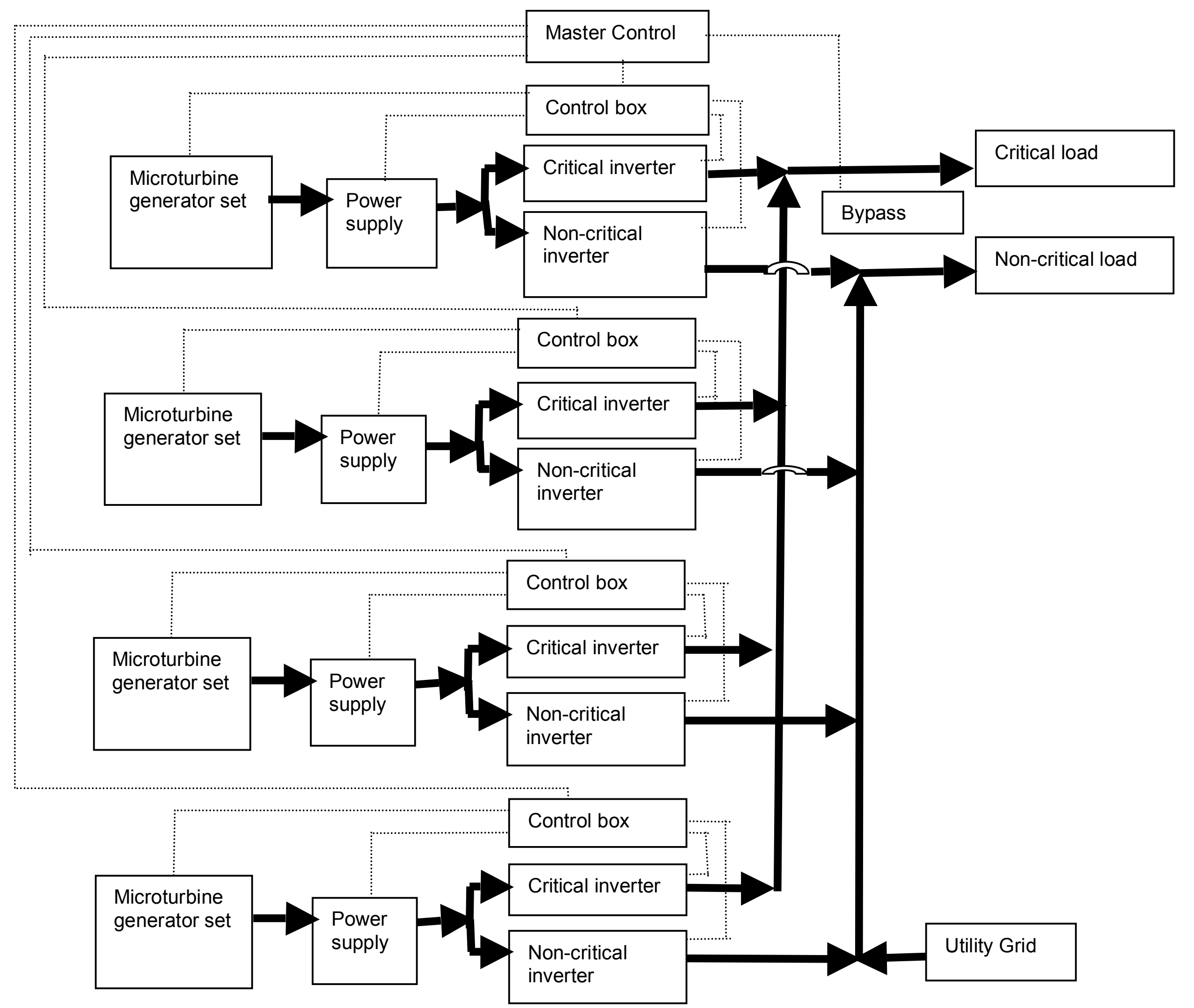

Figure 7 – Four-Unit Installation

Microturbines continue to run during a blackout. Other systems rely on batteries to keep providing power during utility interruptions. These batteries are generally discharged after no more than fifteen minutes. If the blackout lasts longer, then standby generator sets must be available and reliable. In addition, these standby sets must be large enough to power the chillers as well as the precise power system. All of the electricity consumed by computers is converted to heat. Without cooling, the computers shut down.

Microturbines have hot exhausts that can be used as the main energy source for absorption chillers. Absorption chillers use far less electricity than conventional electric chillers. If the utility grid is down, the non-critical inverter may well be able to provide the electricity needed by the absorption chiller.

During normal operation, the use of absorption chillers powered by the microturbine's exhaust provides substantial savings compared with electric chillers. This is not only economical but energy efficient as well.

Figure 8 shows a four-unit installation with absorption chillers.

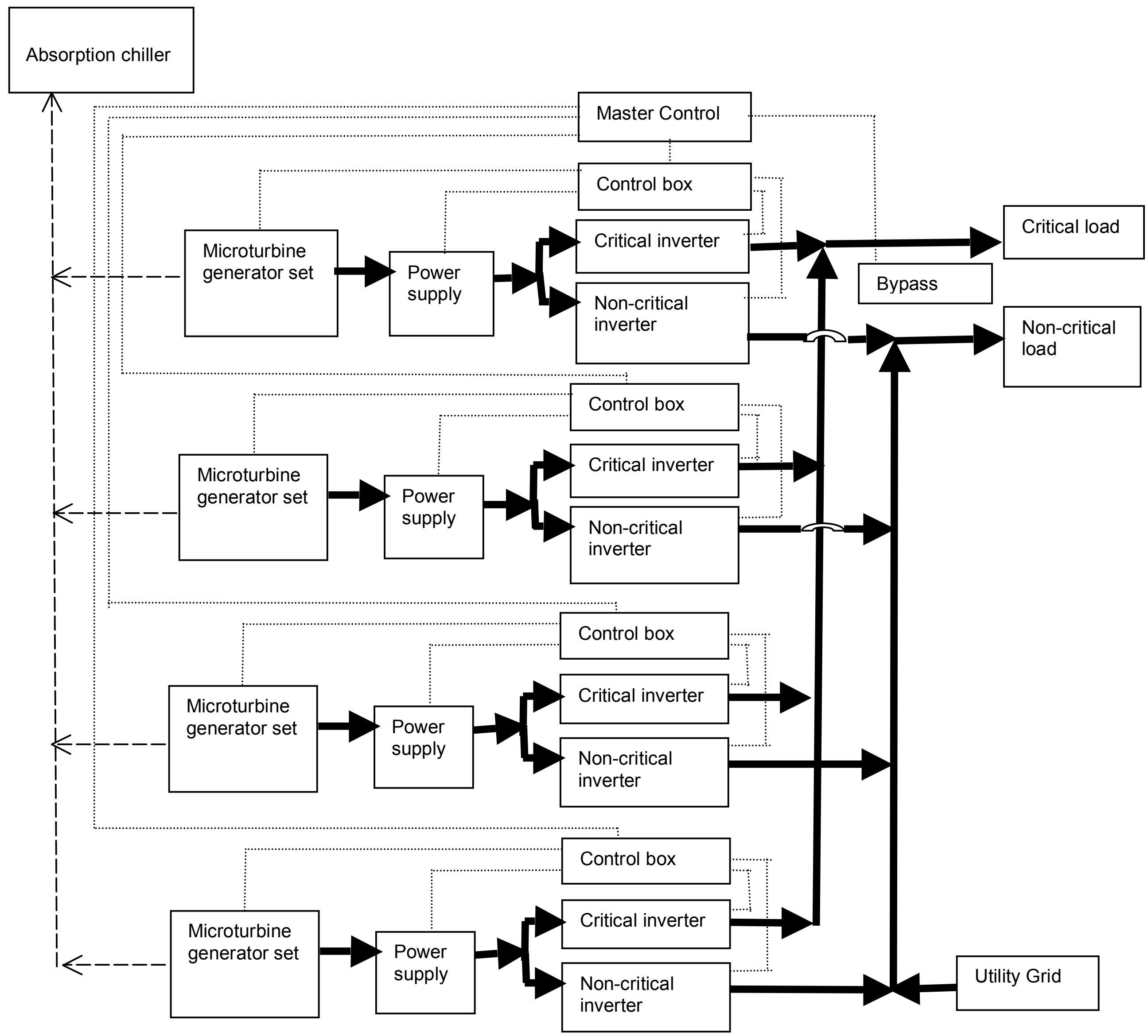

Figure 8 – Four-unit installation with absorption chillers

Microturbines provide reliable, precise power at competitive initial costs and low operating costs. Extremely flexible, they can match the needs of a very wide range of data systems.

U.S. Patent 6,977,466 was issued to Robin Mackay on 20 December 2005 and covers the basic concepts.

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