COMBINED HEAT AND POWER & DISTRIBUTED GENERATION

Combined Heat and Power (CHP) describes an energy production system that produces not only electricity, but also useful thermal energy, typically in the form of steam. These systems are normally small in comparison to utility systems and located at a thermal and electric energy users facility. As such, it is a shift from electric generation at large central station utility boilers to **Distributed Generation (DG)** at the individual users facilities for the capacities capable of being produced by the CHP system. In this light CHP and DG must be considered simultaneously. There are both opportunities and challenges in this discussion. These will be discussed below.

The role of CHP/DG in the overall discussion of fuels in the future is simply stated, to Maximize Efficiency to minimize fuel consumption, minimize environmental emissions and provide an opportunity for continued growth into the future.

In a traditional electric utility boiler system (those facilities that produce electricity at relatively remote locations solely for sale to the public over a large distribution "grid"), steam generated by a boiler is passed through a steam turbine driven generator in order to produce electricity. After passing through the turbine and losing one third of its heat energy along the way, the steam is condensed to begin the cycle again. Because utility boilers have no use for the steam after it has passed through the turbine generators, the heat energy lost from the steam as it condenses is subsequently wasted to the environment via the air or water, providing at best no benefit to the producer; at worst a thermal impact on the environment.

Unlike an electric utility plant that wastes up to two-thirds of the original heat energy of the steam directly to the environment, a CHP, or "co-generation" system beneficially uses the remaining heat energy for further work at the CHP's facility, or neighboring facilities. Depending upon the primary needs of the thermal user facility, this steam may be used in any or all of the following useful ways:

- distributed to buildings for room heating and/or hot-water supplies;
- used in labs or hospitals for sterilization;
- distributed to industrial facilities to heat processes and to operate pumps or other machinery;
- used for food preparation;
- used to run chillers for facility cooling needs.

In some systems, this steam is then returned to the powerhouse where it is condensed to begin the cycle again. In other systems with multiple users, the steam is fully depleted of its energy, leaving only condensate water that can either be returned to the plant (to save on water treatment costs) or discharged to the sewer.

Due to their ability to make best use of all energy contained in the steam generated by the boilers or combustion turbines, CHP systems typically

> ***have a much higher efficiency in terms of energy produced per unit of fuel consumed than a traditional electric utility boiler. Theoretical efficiencies of a CHP system can approach 85%; actual efficiencies range from 55% to 70%. In contrast, traditional electric utility boiler systems typically approach efficiencies of only 33%. The steam provided by CHP facilities also displaces steam that would otherwise be generated in conventional steam boilers. CHP thus provides energy savings at both the industrial facility and the electric generating station. In industrial settings with high power consumption as well as a need for thermal energy, CHP provides an avenue to meet both of these needs in a manner that is not only energy efficient but environmentally efficient.***

Like electricity, steam has little storage capability. However, unlike electricity, there are significant (and costly) limitations on a user's ability to transport steam to distant locations greater than one to two miles (the primary advantage of electricity in today's world). For all practical purposes, this means that the energy is used where it is produced, potentially providing benefit for transmission grids that may be constrained due to rapid growth. Additionally, there can be both a positive and negative impact on the supply of electricity to optimal sizing of CHP systems sometimes necessitates the need for a net excess electric generation above the needs of a facility. This necessitates supplying excess electricity to the grid to maintain efficiencies and economic return. Approximately 7% of our current national electricity supply comes from this source. It has been said that if CHP were applied to all applications where thermal energy is needed, we could see a significant reduction in the energy needed to produce the electricity we use today. It is primarily because of these points that the main obstacles to greater implementation exist.

Distributed Generation (DG) must not be limited to a discussion of CHP. It must be considered in light of any locally generated electricity from whatever energy source is available. These could include the full range of alternatives including: Wind, Solar, Geothermal, Hydroelectric, and other advanced energy systems where combustion is not a major factor in the ultimate electric generation. Suffice-it-to-say, any technology must be economically competitive in an environmentally and globally competitive world.

Obstacles to Distributed Generation & Combined Heat and Power

While there are varying degrees of environmental benefit for all DG and CHP Technologies ranging from Zero air emissions from wind (other than dead birds), solar and Hydroelectric to those of purely efficiency savings of CHP depending on the fuel used. As mentioned above, the relative value of this is technology specific for now and into the future. However, each technology should be assessed holistically over its full lifecycle with regard to total environmental benefit or degradation across air, land, water, animals, the total health benefit to the people the technology is supposed to serve. Assuming that all these technologies are environmentally beneficial, there are six obstacles restraining the greater application of DG/CHP: Economic, Utility Resistance, Transmission Limitations, Power Quality, Supply/Demand Timing, and Back-up Power requirements.

Financial & Economic Capital Recovery:

With the assumption that any energy project must stand on its own with regard to the capital spending requirements for individual corporations, institutions or government and commercial facilities, tremendous complications exist with locating any energy producing system at any facility where the final product or service in not energy. Cost and availability of capital, competition (local, national or global) and shareholder value are significant considerations for any project. The givens of any project evaluation are the current cost of electricity delivered to the facility and the price that the company can sell its excess electricity for to the local utility or open market, if one exists.

In most cases, the capital investment for DG/CHP systems exceeds a payback evaluation of 3.5 years generally accepted as a reasonable return rate for capital investment. With increased pressure for greater returns for shareholders many companies are looking for payback in less than one or two years. As such, many, if not most, projects go unevaluated and undeveloped.

Utility Resistance: Displaced Generating Capacity and Revenue, Backup Power, Wholesale and Retail Market Competition… Who in their right mind would support anything that would cut their load, potentially increase competition and cut revenues for their company and share-holders. They could go to jail.

Transmission Limitations: (Substation/transformer design & interconnection…)

Power Quality: (Frequency Quality and Matching, Spicks, AC/DC/AC Conversion…)

Demand and Generating Capacity Balance: (Peak, Intermediate, Base Loading, Time-of-Day…)

Backup Power: (Native Load Protection, Spinning Reserve Ownership & Cost, Wholesale/Retail Market considerations…)

The following is a real world discussion of energy efficiency as seen in the industrial facility.