Cogeneration:
Increasing Efficiency of Thermal Output

Microgeneration:
Small, Localized Power Generation

Microgrids:
Shaping Future Energy Infrastructure

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Did you know?...

…That the world's first commercial power plant was a *cogeneration* plant?

Introduction

Cogeneration, also known as combined heat and power (CHP), is most widely known as the process used to simultaneously generate both electricity and useful heat. It is a well-known form of recycled energy. Some people simply refer to any power generation using steam as cogeneration. A benefit of cogeneration is that it makes better use of processing resources, and can also help to reduce greenhouse gases in current technologies.

Microgeneration, also known as micro power generation, is the small-scale generation of heat and power by individuals (residential), businesses (commercial), and communities (municipal). While it provides an alternative to the traditional centralized grid-connected power, it is sometimes adopted due to unreliable grid power, or to resolve remote access issues. Over recent years, it has also become known as an environmentally-conscious approach to reducing carbon impact.

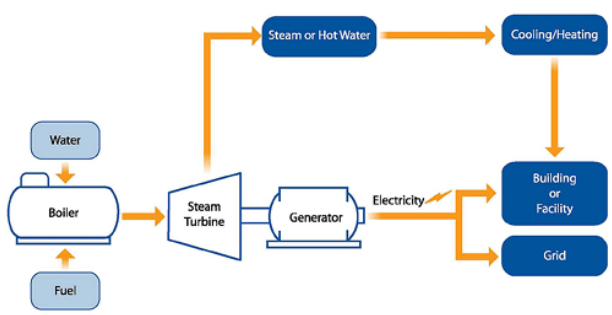
Our technology, namely the *Thermo*MAX™ Series Thermal Vortex System, is an example of this small-scale power generation concept. The purpose of this document is to offer some interesting details behind the process of cogeneration as well as the benefits of microgeneration, and how we can use both to provide cleaner, lower cost, sustainable energy while benefitting our local economies, and protecting our precious environment.

We will also discuss a concept known as microgrids, which was pioneered by the University of Wisconsin at Madison. This form of energy production should not be confused with micro power generation or microgeneration. We will explain how this process is considered to be one of the best ways to fix the energy production issues that we face today and in the future, as well as looking at the potential problems and roadblocks to implementing this strategy.

But first, perhaps we should answer the *"Did You Know?"* question. In 1882, Thomas Edison bought warehouse buildings in lower Manhattan in New York, at 255-257 Pearl Street. Known as the Pearl Street Station, this facility not only produced electricity for many of the businesses close by, but it also provided thermal energy in the form of heat for the area buildings. This was the first commercial power plant in the world, and it was a cogeneration plant.

Cogeneration

Heat exhaust, also known as thermal energy, is most commonly used as a means to heat water to produce steam, which is used by steam turbines to generate electricity. Cogeneration is the use of the thermal output to both produce electricity and distributed directly to provide heat for homes and buildings. In addition, thermal output can also be used in absorption chillers for cooling. Trigeneration is the process in which the heat exhaust is used for heating, cooling, and electricity. The image below shows the dual use of steam.



Cogeneration and trigeneration are becoming increasingly attractive options for businesses and consumers alike because of the cost, emissions, reliability, and power quality advantages that these systems can provide.

Two-thirds of the fuel used to make electricity today in the United States is wasted. The average efficiency of power generation in the United States has stagnated at around 33% since the early 1960's. The thermal losses in power plants total approximately 23 quadrillion BTUs of energy, representing 25% of the total energy consumption in the United States. With many power plants, this energy waste means higher than needed emissions of pollutants like sulfur dioxides, oxides of nitrogen, particulates, volatile organic compounds, and greenhouse gases.

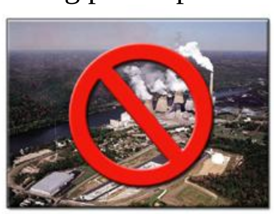
It is important to acknowledge that increasing the use of cogeneration systems is - and has been, for over one hundred years - one of the best technologies available for reducing greenhouse gas emissions and conserving fuel. However, since our technology doesn't produce these same harmful emissions, we are able to provide a much cleaner and more efficient energy production.

As previously described, power plants give off a great deal of heat that is considered to be wasted since it is not used in the production of electricity. Cogeneration captures this heat and puts it to good use, providing thermal energy in the form of direct heat, or used to generate steam.

Another definition of cogeneration is taking the heat exhaust from any number of heat sources, and "splitting" it to produce both electricity and thermal energy. This thermal energy can be distributed directly or used to produce steam. Our technology is most like this process, in that we use all of the heat that is produced by our vortex combustion chamber, and we divide the output for two and possibly three different purposes.

Microgeneration

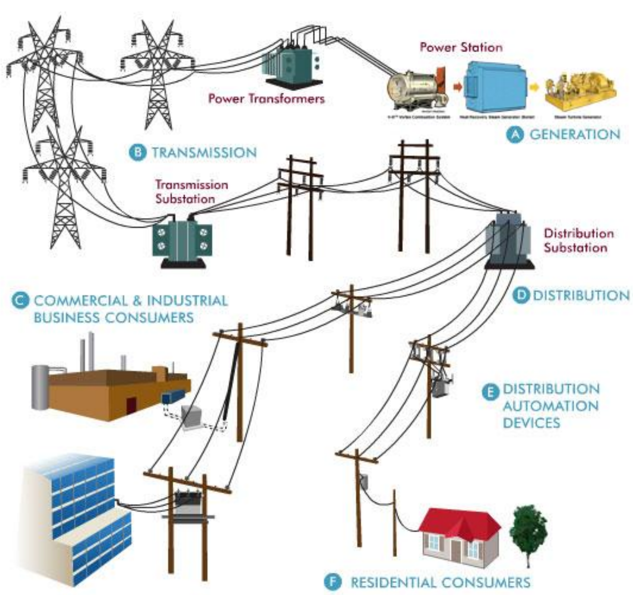
For the past few years we have been discussing the benefits of small, local power generation. These benefits can be financial, environmental, and energy related. They can also be more pleasing to look at than the big power plants.



Small-scale power plants offer other benefits, such as closer proximity to fuel sources. With our technology, using municipal solid waste (MSW) as an example, the trash collection trucks will only travel a few short miles to reach the final destination, saving on carbon emissions from the vehicles. Currently, collection trucks typically drive a dozen miles or so one way to a transfer station, where the MSW is then transported further to the landfill.

Microgeneration can dynamically balance the supply and demand for electric power, by producing more power during periods of high demand and high grid prices, and less power during periods of low demand and low grid prices. Additionally, microgeneration offers:

- Fewer transmission losses due to the proximity to the end user
- Reduced transmission load, thus reducing the need for costly upgrades
- Prevention of wide-scale grid outages and cascading failure events



Other benefits of small-scale power systems include the lower cost of installation, operation, maintenance, and upgrading. For example, a large waste-to-energy facility in the Chicago area was built for more than $438 million, which represented a cost of more than $750 for each person served. The plant never went online due to cost overruns and failure to meet EPA air quality standards.

Our technology can be installed for just about $100 per person served. Since our technology doesn't allow for production of any harmful emissions, we don't require the same expensive and complex exhaust scrubbers and other air pollution control equipment.

Small-scale power systems can also be upgraded to meet new and larger demands for service. In the event of a natural disaster, or destruction by other means, our system can be replaced quickly due to the modular design, and the use of commercially available components, such as the heat recovery steam generator and steam turbine. Our vortex combustion system can be mounted on low-boy truck trailers or on railroad cars for easier transportation.

The size and portability of this system offers a benefit for mobile and remote applications, specifically as a response to natural disasters in support of FEMA operations, to aid in the immediate cleanup efforts without harming the environment, and to supply much needed power on a temporary basis.

Microgrids

Microgrids are basically self-contained electrical systems, where electrical power is produced, transmitted, consumed, monitored, and managed all on a local scale. This is often known as islanding. In many cases, they can be integrated into larger, central grids, but their defining characteristic is that they can operate independently if disconnected from the whole.

Microgrids may be a hot topic among those forecasting key future trends shaping the world's energy infrastructure, but few significant state-of-the-art commercial microgrids are actually up and running in North America, the world's leading market for microgrids.

At present, regulations governing energy have not kept pace with emerging microgrid, also known as islanding, technology, frustrating any immediate progress. Yet current trends appear to make microgrids an inevitable augmentation of today's centralized-grid distribution system. Aggregation platforms that are similar to microgrids will be absolutely necessary if our energy infrastructure follows in the footsteps of telecomm and the evolution of today's Internet. No doubt the existing radial transmission grid will still provide the majority of power supplies to the industrialized world, but renewable distributed energy generation (RDEG) will also play a larger role in providing energy supply, reliability, security and emergency care services.

For decades, we've depended on an outdated, centralized system that wastes power and occasionally fails to meet everyone's needs, and is prone to cascading failure events. For example, the Northeast Blackout of August 14, 2003,s was a massive widespread power outage occurring throughout parts of the Northeastern and Midwestern United States and Ontario, Canada. The blackout affected an estimated 10 million people in Ontario and 45 million people in eight U.S. states.

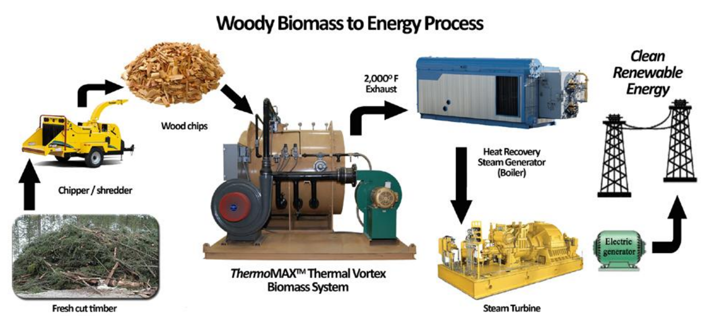
While this independence and the benefits of being cut off from the rest of the grid may at first appear to be a good thing, we are not proposing that communities take this drastic step. Instead, what we are recommending is a blending of the microgrid concept and the existing connection to a centralized grid, to form a hybrid system.

In our proposed system, the power would be generated on a local basis, and sold wholesale, through energy markets, or directly to the grid and the power utilities. A general rule of thumb is that 1,000 homes can be powered by each megawatt of electricity produced, so a small system that produces at least 6 MW of energy, will power approximately 6,000 homes. Obviously, calculations need to include commercial and industrial customers.

In an increasingly wireless era, transmission lines seem almost comically antiquated. In addition to them being costly and difficult to install, they account for huge losses in energy every year. Some analysts say that as much as 10 percent of the energy produced is lost just in getting it to its destination. Power utilities, their customers, and governments can't afford this anymore.

By drastically shortening the distance between where the energy is generated and where it is being used, microgrids eliminate the need for heavy-duty transmission infrastructure, and thus reduce the amount of energy simply being lost along the way.

Renewable energy sources have made distributed power much more practical. It's somewhat hard to imagine generating energy for small communities using natural gas or coal. Fossil fuel-based electricity requires complex plants and refineries that cost billions of dollars and serve millions of buildings. Below is a simple depiction of our system using woody biomass as the fuel source.



Our Blended Solution

Our solution is to blend the concepts of small-scale power generation with the self-contained, local electricity transmission and distribution. Both methods offer very appealing benefits, but may fall short of offering solutions to the energy needs of a small community.

With current sources of renewable energy microgeneration, such as wind farms or solar arrays, communities are limited to purchasing from power sources hundreds of miles away. Customers are further limited to using net metering or municipal aggregation, which may not apply to small communities, college and university campuses, school districts, military bases, or business parks.

Net metering was originally designed to allow individuals or small businesses to sell off the excess of their energy produced from on-site systems, receiving retail credits for this net energy. Most states have current legislation that set maximum limits, making it a very restrictive method for school systems or small communities to participate. Legislation is needed in each state to expand the allowable capacities, as well as remove restrictions that require the energy source to be on-site.

The deregulation of electricity services in most states has made it possible for cities, counties, villages and townships to establish aggregation programs, or buying groups that allow retail customers, namely residents and small businesses, to combine their purchasing power to achieve savings on electricity costs. When these local governments create these programs, it is known as municipal aggregation.

Currently, microgrids depend on smaller sources of power, most often from renewable energy sources such as wind or solar. Cost is a prohibitive factor for most small communities to receive sufficient power to supply the entire community or to warrant the typical upgrade and modification to the existing infrastructure.

While our blended solution may at first glance appear to be microgeneration, it is actually much more than that. Microgeneration deals mostly with the size of the power generating plant or facility, and microgrids focus on the distribution and transmission of the power produced.

Since the concepts of cogeneration, microgrids, and microgeneration relate more to the community-based waste management needs, we would most likely need to discuss using MSW as a fuel source. Our technology can easily handle the waste needs of a community between 35,000 and 50,000, depending on the ratio of residential to commercial or industrial clients. Other options are available to increase the efficiency and output, such as co-firing with other fuels like wood or scrap tires, which is the use of multiple fuel sources during the same combustion cycle.

The low end of the power production level would be 6 megawatts. In states that allow for co-firing, the expected output could easily reach or exceed 10 megawatts since wood has at least 2 times, and tires have 4 times the BTU or thermal value as MSW. As previously stated, each megawatt of electricity produced will serve 1,000 homes. This means that a single small system can provide power for 6,000 to 10,000 homes!

Our system should be viewed as a clean, sustainable means of augmenting or supplementing the energy needs for these communities. This will not only help to reduce local energy costs, but will help by reducing the existing transmission loads and need for expensive system upgrades. This is just one of the reasons that we recommend always staying connected to the grid. Another advantage to this setup is to ensure constant electricity flow if either the primary grid or the local source is cut off for whatever reason. Finally, this type of blended grid structure will relieve an already overloaded grid system, avoiding any need for costly upgrades.

In Summary

Cities, industries and military bases around the country are in various stages of implementing microgrid technology - just one component of a more efficient and dependable energy future. Our proposal of a blended approach will help us tailor these solutions to each community's specific needs. Our primary goal continues to be the implementation of environmental energy programs that also benefit our local economies. We have the opportunity to use common sense and take advantage of technologies that we have available right now.

In order to get any of these concepts in place, whether cogeneration, microgeneration, microgrids, or any type of blended solution, we must first tackle the issue of legislation, by removing the restrictive legal binds that we currently have in place. Over the past years, we have been proposing two simple steps that will ensure that our energy programs are addressed properly:

1. Allow for fast-tracking of all issues related to alternative or renewable energy programs, such as permits, legislation, funding, and more. This will ensure that these critical issues no longer get bogged down in the mess of bureaucratic red tape.

2. We also propose that alternative energy programs be given the same tax benefits that are currently only provided to renewable energy. This will encourage new technologies to emerge or be discovered, that could make a real difference in our desire for:

Energy Independence
Economic Strength
Environmental Health

Contact Us

For more information about these concepts, our ThermoMAX™ Thermal Vortex System technology, or any of our programs such as our legislative efforts, Veterans Initiative, Global Outreach, and others, please contact us at the following:

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You can also visit our site:

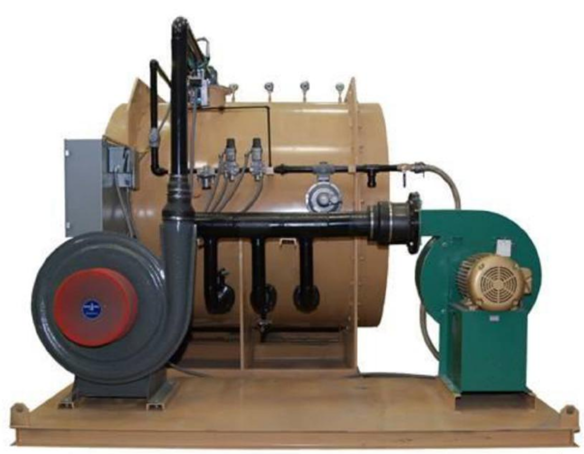
www.VanNattaWorldwide.com

THERMOMAX™

Thermogenic Maximum Eco Waste Destroyer

***Thermo*MAX3™ - 3 ton per hour vortex unit (MAX3™ for short)**

***Thermo*MAX6™ - 6 ton per hour vortex unit (MAX6™ for short)**



Patent Pending

Sideview of our *Thermo*MAX3™