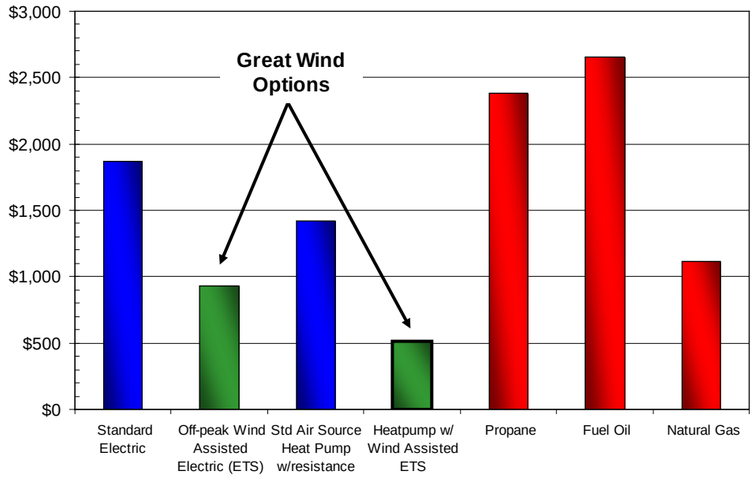
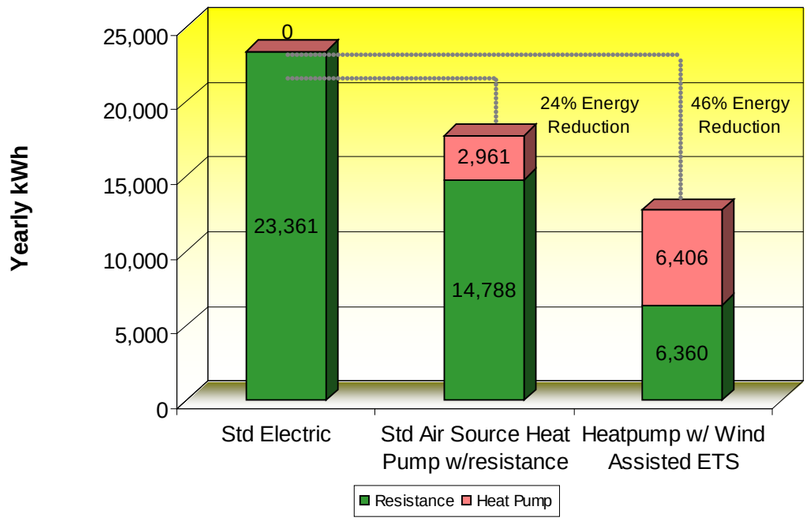
Operating Cost and Energy Consumption

End Users Estimated Annual Heating Cost Comparison



Energy Consumption Comparison



Notes: Data is tabulated based on Eagle, CO temperatures applied to a home that has a heat loss rate of 45,000 btu/hr.

Std ASHP: Heat pump is locked out at temperatures below 30^{o}. This is generally the case as it is at this temperature that the heat pump can't provide acceptable comfort.

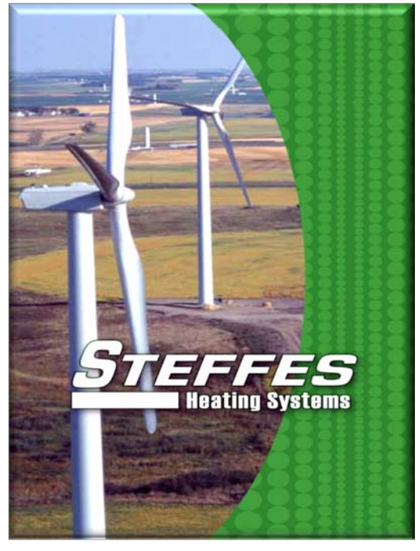
Heatpump w/Wind Assisted ETS: Heat pump is locked out at all temperatures below 0^{o}. The Comfort Plus has the ability to utilize the ASHP's efficiency, even at cool outdoor temperatures, and ensures great comfort at all times.

Electric rates of $.10/kWh standard rate and $.04/kWh off-peak rate. Fossil fuel costs of $1.10/therm for Natural Gas, $2.50/gallon for Propane and $3.80/gallon for Fuel Oil. Air Source Heat Pump is a 3-ton, 14SEER.

Report on the Synergy of Wind and Electric Thermal Storage (ETS)

"Wind Assisted Heating"

A Distributive Electric Storage Technology that is a Low Cost, Long Life "Renewable Thermal Battery"



Prepared by:

Paul Steffes PE
Steffes Corporation
3050 Hwy 22 N
Dickinson, ND 58601
701-483-5400
www.steffes.com

Synergy of Wind and Electric Thermal Storage (ETS) Wind Assisted Heating

Executive Summary

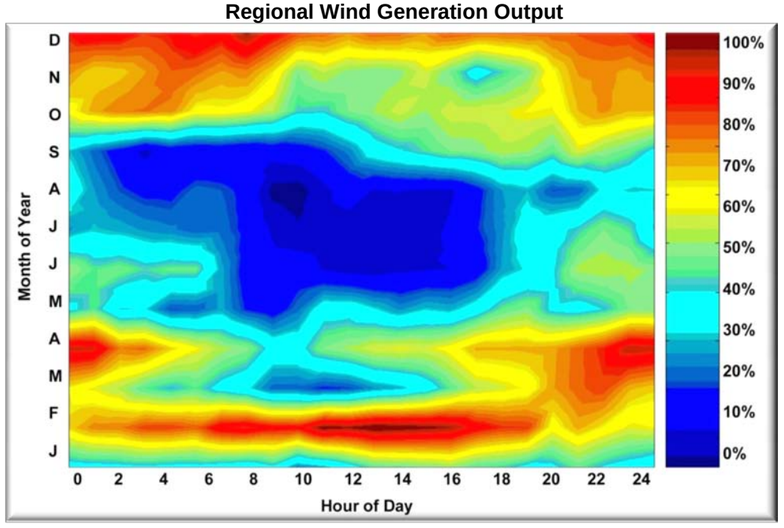
The synergy of wind energy and electric thermal storage (ETS) will help electric utilities achieve their renewable requirements today and fully utilize wind resources in the future. The synergy of wind energy and ETS can be referred to as “Wind Assisted Heating” and creates a winning situation for all parties, the wind industry, utilities, home and business owners, and the environment.

There are many challenges when trying to incorporate a large amount of wind generation into the Independent System Operator’s (ISO) transmission network. These challenges include the variability of wind, effectively utilizing the large amounts of wind available during off-peak winter hours, and maintaining a reliable and dependable electric supply. These challenges can be relieved with ETS.

Wind Power Available for Heating

Wind blows significantly more during heating months than it does during other times of the year as shown in the graph on the right. On average, wind blows more during off-peak than on-peak hours. The hourly and daily generation variability suggests ETS units need to be able to consume power when ample renewable energy is available.

Regional Wind Generation Output



Wind generators will typically produce 33-40% of nameplate rating on an annual basis. If a State has a 20% renewable requirement, this means that 50-60% of the State’s average electric demand would need to be installed wind generation to meet the Renewable Energy Standard (RES). This assumes all renewable power would come from wind, as wind is the most economical and leading candidate at this time.

For wind utilization efficiency, having Electric Thermal Storage space heaters, Storage water heaters, and other productive uses for the power will be beneficial. There is a mix of electric generation sources across the U.S. Most base load generators can only be turned down to a specific level, after which they must be turned off. Aftern introducing a significant amount of renewable energy into the grid, there will start to be times on windy off-peak nights when base load generation is at a minimum and there will be extra renewable energy that will have to find a productive use. As more renewable energy is added there will be increasing periods when ETS and other electric storage technologies will help to fully use the new renewable resources.

Heat Storage: Part of the Solution

Electric energy storage will improve the ability to “productively use” an increasing amount of variable renewable energy. A battery, where electricity is pumped in and then taken out on demand, would have great value. Currently, the cost, efficiency, and life of electro-chemical batteries can be prohibitive. Electric Thermal Storage (ETS) equipment is an efficient, long life, and low cost “thermal battery” for the electric grid. Steffes has placed almost 100,000 units in the field over the last 20 years and has proven that ETS units can withstand continuous daily deep cycles. Since ETS units are a fraction of the cost of electro-chemical batteries, we should first fill the ETS window of opportunity and then use electro-chemical batteries later, as needed. Electric Thermal Storage heating systems have the ability to make smart control decisions to optimize the use of renewable and off-peak energy for these purposes.

Think of ETS as a wind powered heating system. If the wind is not blowing this heating system uses another underutilized domestic resource, off-peak electricity.

Cost of ETS Units

A residential or small commercial ETS heating system costs about $30-$60 per kWh installed compared to a recent installation of a 7mWh Sodium Sulfur (NaS) Battery which was well over $500 per kWh. But not only is ETS a low cost Electric Storage Thermal Battery, included in the price is a heating system as well. An interesting question then can be asked, what is the value of an ETS system and who receives this value?

Thousands of ETS systems have been installed where consumers have paid $30-$60 per kWh simply for a low cost of operation heating system. There is extra value of Electric Storage to the Electric Utility or Electric Grid to help promote increased usage of Wind Assisted Heating systems.

Low Carbon Footprint AND Low Cost of Operation

Using an air source heat pump (ASHP), along with an ETS unit, will reduce electricity used for heating by approximately 50%. Having a portion of the heating requirement filled with renewable energy, in combination with the ASHP and ETS unit, drives the carbon footprint of the home heating system smaller and smaller as more renewable energy is added. There are ways to structure electric rates to encourage renewable and off-peak electric usage which ensures a low carbon space and water heating option and keep home heating costs low. (See graphs next page)

Dynamic Demand Response

In order to optimize renewable energy resources, each ETS wind assisted heating unit has the ability to respond to a Dynamic Demand Control System or the Smart Grid. The ETS control system will store electricity when any adequate renewable energy is available. This will allow other devices, such as water heaters and air conditioners, to maximize renewable energy sources and curtail electric consumption if there is a peak situation. ETS units can enhance power quality and could have the ability to do voltage and frequency control in the future.

Energy Independence

For every home using Wind Assisted Heating, we are better utilizing domestic energy resources and we can import approximately 20 fewer barrels of oil per year.

Conclusion

In conclusion, there is a great synergy with renewable power and ETS. Wind energy is the most cost effective renewable energy source today. On windy winter nights, wind generation will drive off-peak electric rates down, making wind assisted heating the low cost heating option. Due to the variable nature of wind, it is necessary to maintain grid reliability with some traditional baseload generation. Increased use of Electric Thermal Storage, referred to as Wind Assisted Heating, is one tool that readies the electric grid to productively use higher percentages of renewable energy. This will help ensure the new investment in wind generation is fully utilized, minimizing carbon emissions and keeping heating costs low

Steffes Corporation ▪ 3050 Hwy 22 N ▪ Dickinson, ND 58601 ▪ 701-483-5400 ▪ www.steffes.com