

THE U.S. HAS THE ENERGY TRILEMMA ANSWER

The US deserves better. Yes, the global leader in developing energy solutions for the last 100 years deserves so much more than the current renewable solutions. America deserves products that create good long-term jobs, 100% US materials, and technology tied to the US, not China. So what is the solution for energy availability, affordability, and sustainability? Heat pumps. Industrial heat pumps increase the value of energy put into the pump yielding lower cost and also work with different types of energy like heat. Heat pumps also work with thermal energy storage to manage peaks and valleys in energy supply and demand. Successful use of heat pumps and thermal energy storage in the US for over 50 years has resulted in benefits for the US, humanity, and the environment.

Where does all this clean energy come from? Three of the largest energy sources available:

- Thermal solar from the sun
- Geothermal from the earth
- Waste heat from mankind

These three sources represent the largest available energy in our solar system, on Earth, and the largest generated by mankind. The use of thermal solar on earth is not only economical but good for balancing the total BTUs at the earth's surface. Today, photovoltaic solar panels are the popular answer but a cleaner more environmentally friendly solution exists with thermal solar.



Low-temperature thermal solar versus photovoltaic is a superior way to capture solar energy and offers the following:

- Less land use
- 100% US/local materials and labor
- Reduced total cost to society
- Lower carbon footprint
- No recycling or disposal issues

As great as thermal solar is it still has the issue of being intermittent. Lithium batteries can help with this issue but burden the planet with more environmental impacts. To help with storage heat pumps can work effectively with thermal energy storage devices while supporting a lower carbon footprint and better economics. The US has hundreds of thermal energy storage systems in place today with improvements for better economics and further

improvements to reduce the carbon footprint. Of course, some locations and seasons yield no generation from solar. For those locations, geothermal should be considered.

To date, geothermal has experienced a limited application but new drilling technology from the oil exploration industry can change that. The ability to reduce the cost of drilling, combined with improved downhole technology will also increase the number of profitable locations. To further reduce the cost of geothermal, the same industrial heat pumps and thermal energy storage systems for solar can be utilized on geothermal. This will support higher efficiency and the ability to store power during surplus times and deliver during peak demand. Furthermore, existing geothermal wells have the potential to increase output with heat pump efficiency

and balance the grid with thermal storage systems.

If the heat from the sun and earth's core was not enough, a third opportunity exists with mankind's largest energy waste, heat. Although it occurs in residential, commercial, and industrial applications our focus is on the \$50B / yr. recoverable industrial waste heat source. Unlike solar, industrial waste heat is usually available 24/7, but the real difference between waste heat sources and solar or geothermal is the fact that often industries spend money to expel heat. That is correct. Waste heat from many industries may be accumulated and you are paid to take it away. Each source of heat has equipment to acquire the heat and operational costs to run the facility. However, solar and geothermal do not pay you to remove the heat. This can easily change the economic footprint of waste heat from industry and commercial applications. In some situations, industries spend as much to get rid of waste heat as fuel costs to generate power. This accumulation of waste heat also reduces the overall carbon footprint by removing the equipment used to expel the heat. Other benefits include:

- Conservation of water
- Lower energy use in manufacturing
- Reduction in required land

Heat from the sun, earth, and mankind with US technology is the answer. So, why aren't we moving forward? Too much noise.

The marketplace today has so many products and distractions it is difficult for projects, investors, and inventors to find their way through it.

I bring this point up because I have been living in this space for the last 5 years. To find solutions and calculate their total cost, reliability, and environmental impacts is almost impossible. The total cost, reliability, and impact on the environment from heat pumps and thermal storage have 5 decades of history and are known.

Improvements to heat pumps, thermal storage, and the combination of the two with the right delivery system are not flashy or exciting, but it is one of the best solutions to the energy trilemma. After years of searching and investing AT&V has licensed technology from SolutiaTech and working with SolutiaTech on the ALBERT (Acquisition of Latent BTU Energy Requisition Technology) heat pump and the CRCES™ (Carbon Reduction Clean Energy Storage) thermal storage system has a great renewable solution. AT&V has wrapped the two technologies together in a holistic delivery mechanism and supports projects from finance to operations. Designs utilize US materials and US technology to economically capture and store energy from all three major sources of heat. ALBERT like other heat pumps leverages the energy it receives to increase the net output while CRCES™ thermal storage helps support the stabilization of the grid and deliver lower costs LDES (Long Duration Energy Storage). These two components working together and delivered in a complete unit are not only good for the US but also better for the environment and humanity versus other systems offered today. Improved security comes from components being 100% US manufactured and low-temperature

thermal solar does not have the risk of being compromised by EMP (Electric Magnetic Pulse). Better security through control of raw materials, control of logistics, creating more jobs at home, and protection against EMP all make the ALBERT and CRCES™ process superior to other solutions.

ALBERT and CRCES™ systems provide a solution that supports affordability, reliability, and sustainability with a scale that can supply the world. As an energy trilemma solution, heat pumps and thermal energy storage have provided improving economic energy solutions for over 50 years. With ALBERT and CRCES™, there are no hidden costs to society or consumers and substantial savings in Long Duration Energy Storage (LDES). Utilizing solar, geothermal, and mankind's largest energy waste heat this system has an endless supply of energy to harness for all markets. ALBERT and CRCES™ together truly deliver a lower carbon footprint, lower total cost, and reduced risk to materials and logistics all while improving national security.