

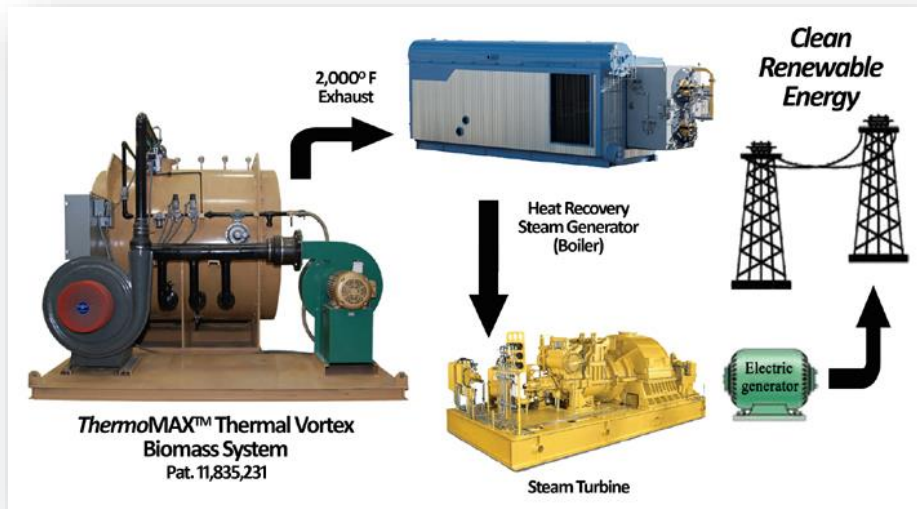
Conference on Energy and Coastal Resiliency:
Building Translational R&D to Solve Grand Challenges

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Palmas del Mar, Humacao, Puerto Rico

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“Waste-to-Energy (WtE) and Sargassum”

Before I discuss our innovative technology, I want to give a brief history of WtE. But first, a definition: “Waste-to-energy is defined as the process of generating useful energy, such as electricity or heat, from waste materials through combustion, particularly municipal solid waste.”

(www.ScienceDirect.com)



Historical Background

Early Beginnings (1870s – 1930s)

- **The first incinerator was built in Nottingham, England in 1874**
- **Early incineration systems lacked energy recovery**

Post-War Expansion (1940s – 1970s)

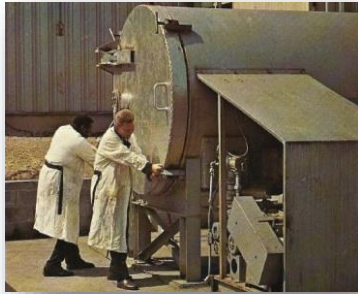
- **Widespread urban growth and increased waste generation**
- **First waste incineration with energy recovery appeared in the 1920s in Switzerland and the U.S.**
- **The 1960s - construction of WtE plants in North America.**

Environmental Concerns (1970s – 1990s)

- **Rise in public awareness and environmental activism**
- **Emission concerns (e.g., dioxins, furans, etc) strict regulations**
- **Technological advancements improved emissions control**



Rebirth of Thermal Vortex Technology (2009 – present)



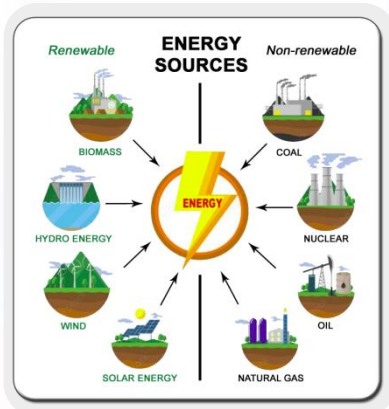
The first image is the very first version of the vortex technology, known as Ebenezer. Although it was quite large, it could only process up to 1.5 tons per hour.

The second is my patented design, lovingly known as MAX! It's capable of processing MSW up to 4 tons per hour for this smaller unit, and up to 8 tons per hour for the larger one. As far as sargasso, the smaller one can process up to 12.5 tons per hour.

The third image shows Bill Ruckelshaus, the first Director of the U.S. EPA. Bill was a close friend of the family and later became a powerful climate activist.



Renewable Energy



And now for a quick diversion. When people talk about new energy sources, they typically look to wind, solar, and even nuclear. Renewable energy refers to energy derived from natural sources that are replenished constantly and sustainably over time. So, the share of the overall energy market in the U.S. for the 4 most common renewable sources is as follows:

Source	% of market
Wind	~11%
Hydropower	~6%
Solar	~5%
Biomass	~1.3%



A tiny bit of technical...

I'm not going to dive in too deeply on the technical side. As I mentioned, you can find a large number of documents on the website link, which gives a great amount of detail to not only the technology, but the applications or fuel sources available.

For a quick background, **combustion** takes place when a fuel reacts with the oxygen in air to produce heat. A type of combustion is known as *stoichiometric combustion*, which is like the ultimate level, but is unattainable at 100%. However, our technology achieves a 99.998% combustion rate. The remaining .002% is given off as various gases.



A tiny bit of technical... (cont.)

There are 3 primary factors for combustion:

1. **Time** – also referred to as residence time. The longer waste material remains in the burning cycle, the more efficient the process. Our technology uses a patented process to reintroduce waste materials (typically ash) back upstream into the vortex, creating a virtually infinite burning cycle.
2. **Turbulence** – think of systems like convection ovens and Dyson vacuum cleaners. Our technology uses a 90mph tornado (lower end of an F1 tornado), packed into a 4-foot wide by 5-foot-long inside dimension chamber.
3. **Temperature** – our temperature range is between 1,800°F and 2,200°F, with typical around 2,000°F. According to the U.S. EPA, this is also the required temperature range to destroy pathogens and biologically active materials.



What makes us unique



What makes us unique is our innovative blending of multiple proven processes. We refer to this as Synergistic Iteration.

- **Synergy:** the interaction of elements that when combined, produce a total effect that is greater than the sum of the individual elements
- **Iteration:** the act of repeating a process with the aim of approaching a desired goal, or result

Two phases of our waste transformation process:

1. **Initial destruction/transformation/conversion phase... this is the Synergy part**
2. **Secondary exhaust scrubber phase that occurs internally... this is the Iteration part**



A tiny bit more of technical...

Here are a few of the most important differences between our technology and other systems:

- ✓ **Extremely high thermal efficiency of over 98%. What that means is that with whatever waste material is processed, 98% of its inherent BTU value remains, and only a 2% heat loss. Our chamber is made up of 13 ½ inches of fire brick, also known as refractory brick. With 2,000°F at 90mph inside, the outer metal shell will be whatever the ambient room temperature is.**
- ✓ **There are no harmful emissions. The super-heated exhaust contains:**
 $CO_2 = 6.979\% \text{ VOL}$ (We are classified by the U.S. EPA as a low emitter)
 $H_2O = 13.958\% \text{ VOL}$
 $O_2 = 5.583\% \text{ VOL}$
 $N_2 = 73.478\% \text{ VOL}$
- ✓ **High performance. If you consider the small size of the vortex chamber, being able to process up to 4 tons per hour from MSW. The High temperature and high turbulence ensures achieving what is known as complete-and-perfect combustion.**



A tiny bit more technical... *(cont.)*

- ✓ **High moisture content.** Because the waste materials are entrained into the chamber tangentially (meaning that it enters the chamber to match the internal flow of the vortex... no friction occurs), the materials are allowed to immediately begin the combustion process, even with 49% moisture.
- ✓ **Capable of mixing various waste materials.** Unlike any technology in the world, our patented process allows us to mix waste materials. Just like following a recipe, the BTU value of the waste material adds up based on the volume. For instance, MSW has a BTU value of 4,000 BTUs/lb. (8 million BTUs/ton), so if we process 4 tons of MSW, then the system is using 32 million BTUs in total. Shredded tires have 16,000 BTUs/lb, or 32 million BTUs/ton. That means 4 tons of MSW equals 1 ton of tires.
- ✓ **The system's burner can operate on natural gas, propane, or methane, and after 15 to 20 minutes, the external fuel source can be turned off, and the waste material becomes its own fuel, and can operate for 24 hours at a time as long as waste materials are processed.**



An enormous market potential

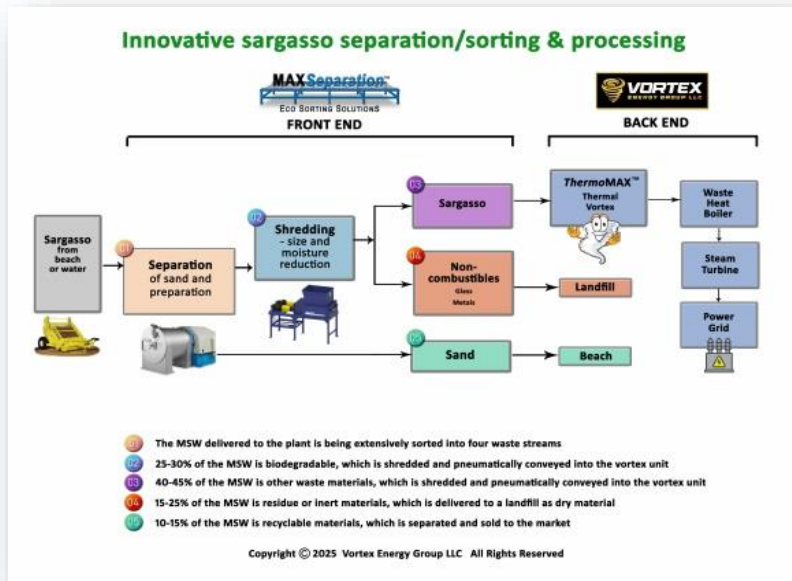
With features and benefits such as these, plus many more, thermal vortex technology stands alone in the WtE market all around the globe. This seemingly simple technology takes decades of proven and unproven data and helps to define a new path forward.

Our vortex technology has many different applications, also known as fuel sources. Here's a simple list of those applications, and the available market just in the U.S. based on volumes of various waste materials using U.S. EPA, U.S. Dept of Forestry, USDA, U.S. Dept of Energy, and the U.S. Dept of Interior, and others:

Application (fuel source)	U.S. Market
MSW	\$46 billion
Landfill Reclamation	\$134 billion +
Waste Coal (coal fines)	\$3.7 billion
Woody Biomass and Agricultural Waste	\$290 billion
Medical / Hospital / Infectious Waste	\$1.5 billion
Scrap Tires	\$569 million
Great Pacific Garbage Patch	\$63 billion



WtE and Sargassum



This is pretty much the purpose of my presentation today. This concept is something we have been working on for a while, and something we believe can really make a difference in people's lives.

As you can see from this image, this is a depiction of the separation/sorting process, and then the energy recovery portion. Don't tell some of my customers that are wanting WtE solutions for their fuel sources, but sargasso-to-energy is my favorite! And for good reason. Even MSW can offer the same level of environmental impact, plus remove waste, and generate electricity.

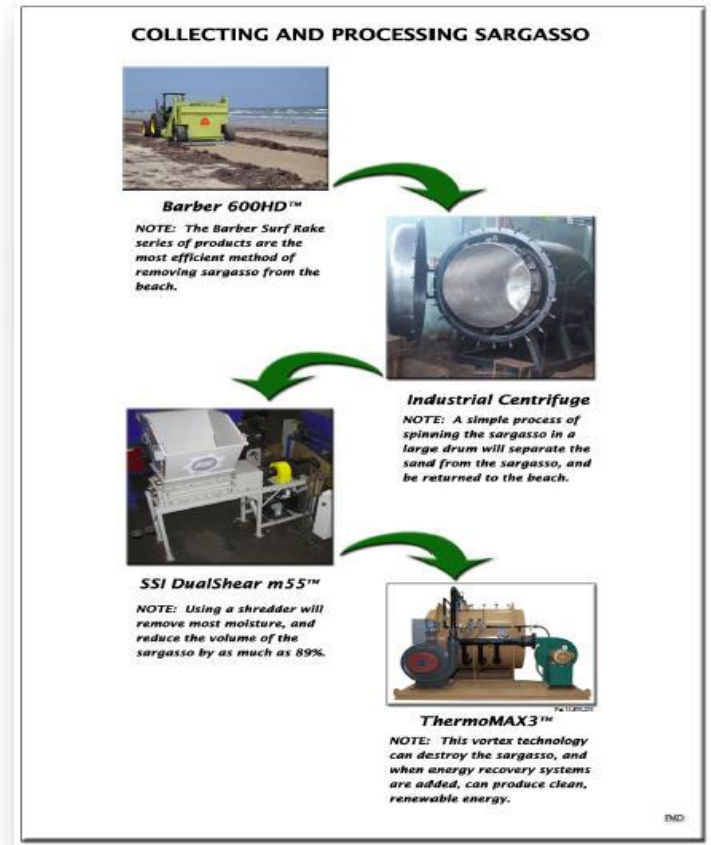


Collecting and Processing

With one application for sargasso that we are working on, the owner of a resort has told us that they rake up over 50 tons of sargasso each day along their entire beach area.

They wondered if we could handle that, and after considering the use of an industrial centrifuge (we call it a “salad spinner”), where a great deal of moisture is removed along with all of the sand collected, and the subsequent shredding, we can easily process up to 300 tons per day.

You can see how simple the overall process is to go from collection to processing, to eventually become electricity.



Quick Diversion... Landfills



Another quick diversion. The other issue facing Puerto Rico is the garbage and landfill crisis. This is something that has been a problem for a long time, and not just here.

All over the world, landfills pose a very real threat to public and environmental health, as well as a financial drain with no benefit. We want to be the solution for that too. I know the numbers from various sources show slightly different figures, but it's my understanding that of the 29 landfills on the island, 12 or 13 are either at or over capacity.



The exciting part... benefits

This is the information that I am most excited about. The **benefits** to the people of Puerto Rico. Not only will we be able to clean up the sargasso mess (and landfills), preventing any further environmental damage, but we will be getting rid of a massive volume of waste, and turning that into clean electricity. Our goal is to be able to provide that electricity for the island through microgrid concepts, in a more secure, sustainable, and lower cost method.

Not only can we offer **base-load generation** (refers to the minimum level of continuous power that a power grid needs to supply over a period of time to meet consistent demand), but we can do it for a fraction of the current cost of power generation. This is quite different from intermittent renewable sources such as wind and solar. The other factor is that we can generate this electricity inside a Cat 5 hurricane-proof building. The grid system (transmission and distribution) is equally susceptible to damage during a Cat 5 hurricane as are wind turbines and solar panels, but can be strengthened or buried underground.



But, there's more!

As I stated previously, having a chance to make a difference in people's lives has always been our motivation. I have a project I have been working on in a very small town in Nevada, where 72% of the population is low to moderate income, or LMI, a federal government classification. To know that we will be able to dramatically reduce their electricity costs, but we will also be creating up to 20 or more direct employment positions and also bringing in new revenues from indirect means.

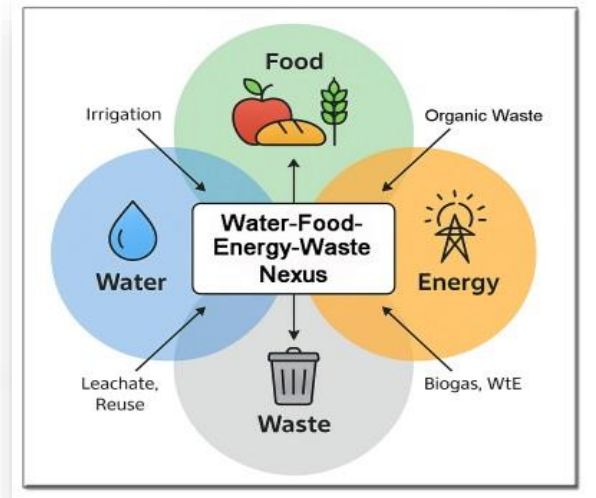
The impact we can provide here in Puerto Rico is exponentially higher on different levels. Without going into all of the specifics, the estimated LMI population on the island is ~80%. That's a staggering number, and one that I am extremely confident that we can make a difference. Like the founder of the US foundation Tunnel to Towers always says... *"Let us do good."*



Water-Food-Energy-Waste Nexus

Bringing all of this together, the concept of a Water-Food-Energy Nexus approach can be expanded to include waste. Most of us don't take the time to consider how water, food, energy, and even waste are connected-but they are. Everything is connected. What makes this an exciting concept to apply to our efforts is that it creates what is known as a circular economy.

A circular economy is defined as “an economic system based on the reuse and regeneration of materials or products, especially as a means of continuing production in a sustainable or environmentally friendly way.”



On behalf of Eduardo and my entire Team, thank you for giving me the opportunity to share some of this exciting information with you. As I had mentioned, we have a dedicated webpage with available downloads of the various documents and booklets covering this and a lot more.

Go to:

www.VortexEnergyGroup.com/PR



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