## Waves to Water Prize

# SUBMISSION FOR CONCEPT STAGE

## PROJECT NAME

*Sustainability Required*

### TEAM

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https://www.youtube.com/watch?v=Qu1kNEVhgK0

The system I designed is a completely new concept. The system can be deployed on shore and near shore. This eliminates the need for a watercraft boat or dingy to deploy the unit. The units I have researched are very limited on output capacity. Current systems react to the motion of the wave.

I designed the system to shape the flow of seawater through the system. The concept is based on the conversion of kinetic energy to potential energy and then back to kinetic energy. Employing this method increases the overall efficiency of the system when compared to legacy systems. My system is designed to be four times the order of magnitude when compared to the legacy systems currently in use. Key among these features is the use of a wave focuser and ramp that are combined at the front-end assembly. By using the two elements it doubles the amplitude of the incoming wave while maximizing the elevation [potential energy] of the seawater. Changing the configuration allows me to increase or decrease the flow of seawater though the system. This is an important capability as sea conditions are always changing. My system actively controls the process by staging the seawater in the primary impound area. After the wave shoots upwards as it leaves the ramp and focuser, (Fig 1) it then encounters an over-topping gate. The gate is hinged at the bottom with rubber attached to each side to prevent leakage. The gate is designed to fall inwards into the primary impound area. The gate has a series of floats mounted to the backside to act as a backstop raising the gate to the level of seawater held in the primary impound area. This design prevents seawater from draining out of the primary impound area back into the sea. The seawater is now staged for delivery [potential energy] into the secondary impound areas. The seawater is released from the primary to secondary impound areas with a series of wicket gates. The opening and closing of the gates are accomplished with a series of air cylinders. The gates are used to precisely control the flow and amount of seawater entering [kinetic energy] the secondary impound areas. As the sea water flows into the secondary impound area it fills and as it does raises a weighted buoyancy block. The precise weight of the block and amount of displacement is calculated at scale. Hurricane Dorian passed through the Bahamas leaving a massive trail of destruction. It appears the is no infrastructure left to support the remaining population who are in desperate search for water and food. The system I built can be air dropped or delivered by boat. It can be assembled in less than three hours with all the instructions for deployment consisting of 10 easy to follow illustrated steps with written instructions on the front and back side of a laminated card. My objective was to make it so intuitive with the illustrations that one did not have to depend on written instructions. I was greatly assisted when while demonstrating my prototype to get feedback from the dozens of people on the beach I showed them the system and their responses were used to better illustrate the device. The responses were overwhelmingly positive. The demographics included young and

old and many in between with people from all over the world with varying education levels.

The foundation of the technology is based on the conversion of kinetic energy to potential energy and back to kinetic energy. The system that I developed was so novel there was no existing complete knowledge base which could be used for my system from start to finish. I had to break the process down for individual hydrodynamic simulations. I was advised this was a relatively close approximation of the real-time values I presented from my journal I kept during the wave tank testing and the open ocean testing. The one thing I was particularly thankful for was the ability of the simulations to model more the top 20 wave conditions most likely to be encountered. I studied this information with historical wave data from NOAA. As you know there are variables with each location. There are several

modeling software programs. I am trying each of them to develop the most comprehensive wave modeling possible. To begin with I used the Wave Generation Simulation Flow 3D CFD software. CFD simulation showing different types of waves that can be set as boundary conditions in FLOW-3D. FLOW-3D lets you generate waves of varying complexity with wave-powered RO desalination using hydrodynamic simulated results. The second area I looked at was waves in open channel flows as the sea water entered the primary impound area. This is where I learned the wave shaping was controlled by the angles and pitch of the wave focuser and ramp.

To further my knowledge, I built a wave tank in my garage to validate my design and numerical assumptions. It was at this time I built the fist of two prototypes. I was able to test different configurations extensively. The next step was to take the prototype and deploy it in the ocean. In answering the question for" the reason it will work," The results of testing validated the ramp and wave focuser would increase the wave height by a factor of two. At full scale the wave focuser will be between 90-120 feet wide which dramatically increases the footprint. There are two reasons this is important, the first is the existing WEC devices have a relatively small footprint and thus limited on the amount of potential energy available. The second was to validate the increase in potential energy. This is one of the main reasons' efficiency tops out at such a high level. The process maximizes the potential energy output by taking a much wider area and focusing it into a much smaller area. The next element tested in the first prototype was the over-topping gate to validate it functioned as planned. The theory was to have the wave pass over the over-topping gate and rise to the level of the sea water that entering the primary impound area preventing it from flowing back down the ramp. I was ecstatic when it worked perfectly. I used some of the numerical methods used for modeling the hydrodynamics of the WEC as it related to the buoyancy block. Using the displacement vector of the body, m is the mass matrix, K

is the matrix of impulse-response function, Fexc, FEXT, Fmo, Fvis and Fres are the vector of the wave-excitation force, external force, mooring force, quadratic viscous drag term calculated using Morison's equation and net buoyancy restoring force. The external force includes the PTO force, multibody constraint forces and the resisting force from the RO system and for the reverse-osmosis desalination process. These were modeled using MATLAB SimScape Multibody and SimScape Fluids toolboxes. Additional modeling will be required at full scale. This process proved the technical feasibility of my system. There are additional elements with long history of form and function making it possible to model the other elements like the air cylinders, wicket gates, weighted blocks, hydraulic cylinders, hydraulic accumulators, pressure relief valves and the RO filters. The second prototype I built and tested validated the through put of the total volume of sea water entering the system and exiting. I used CFD simulation of a surface piercing flap to emulate my over-topping gate fitted with air cylinders that created compressed air that was piped into an air tank. That compressed air is what drives the air cylinders used to open and close the wicket gates. This was an important consideration when building the secondary impound area and the size of the buoyancy block that was attached to the hydraulic cylinders. I was able to align the data from the modeling to correctly estimate the size. It was so precise that I was able to match it to the shelf Katadyn PUR Survivor 35 Desalinator. The system is designed

to produce up to 80 gallons of freshwater per day. During the 3 days of testing the maximum amount of fresh water I could produces was 63 gallons. I am working to make the system completely autonomous so it can be used for disaster relief and recovery and in remote coastal communities. The system is designed to be up and running in less than 3 hours. The total number of steps to deploy is less than 10 making it intuitive and incredibly easy to deploy. Once it is set in place on the shore or floated out beyond the break and anchored, the Empress of the Seas is designed to operate autonomously 24 hours a day filling a water bag that can be easily pulled to shore for use and distribution where needed. The scale prototypes that I built were almost an exact match for the requirements laid out in the Waves to Water Challenge. The two-minute video addresses the Scalability and added Benefits. The additional benefits are realized in the scale of size which is realized in economies of scale. The smaller unit can produce 80 gallons per day at the smallest scale. The largest scale will produce more than 50 million gallons per day. Existing plants today cost in excess of 2 billion dollars. I can build my systems for a fraction of the costs based on price quotes from several vendors including shipbuilders in Denmark and Taiwan.

This technology is 100% wave to water. There are no intermediate steps, no motors used to pressurize the seawater. Any intermediate steps would come at the cost of efficiency. At scale this would reduce operational costs nearly 60 percent. Once

capitalized the cost to operate is nearly free making it an affordable alternative to fossil fuel powered systems. The most important benefit of all is that it does not generate any greenhouse gasses from the smallest to the largest systems. These two factors alone make it an attractive alternative to the roughly 15,000 desalination plants worldwide using fossil fuels. An additional major benefit is the cheap reliable production of fresh water making it an invaluable asset when it comes to providing irrigation for farming. This in turns leads directly to Food Security for a growing global population.

Regarding the development cycle, I have the major issues resolved. Now it simply becomes a matter of scale and fine tuning from the smallest to the largest systems. For the design stage, my plans are to work on an extremely light-weight platform that can be easily carried and launched. Also, I will fine tune the systems ability to operate autonomously with check valves that are tripped on the upwards and downward motion of the buoyancy block. I have more parts on the way to harden the process to handle an aggressive ocean environment. In figure 1. I think it demonstrates the principals surrounding the doubling of the amplitude of the incoming wave and its interaction with the over-topping gate. The next process is the seamless operation of the wicket gates, the filling of the sub impoundment areas, the hydraulic cylinders all combined in the process to deliver the highly pressurized sea water to the hydraulic accumulator and then being directed to the RO system. For the drink stage I am more than prepared to demonstrate the system. I have learned many important lessons in the process. Bottom line is that I will have the unit tested in the ocean long before the day for demonstrating the technology in the final drink stage.

The system that I designed produces freshwater. The systems are designed to operate over long periods of time with relatively little maintenance. The manufacturing of the smallest to the largest systems can be built entirely with off the shelf products. The only

thing that is not is the wave focuser and ramp. I am working with a company that makes Kevlar and carbon fiber material for the over-topping gate. The fact there are no motors makes it even more attractive not just in a disaster relief effort but in island communities and remote outposts. The energy water nexus has been broken with this system. One could provide a hotel with fresh water for all of its guests. The additional value proposition is to use the same hydraulics used to push water through a RO filter and use this high pressure in a closed loop tied to a hydraulic motor. The hydraulic motor would turn a permanent magnet generator and convert it to hydrogen. At this point you now have water and energy. Water to drink and energy to keep you warm and heat to cook your dinner. At full scale the system will produce 17 thousand liters of hydrogen a day. The hydrogen will complete the energy cycle making the entire cycle green in the production and distribution of the Hydrogen and freshwater. My

plan is to market the hydrogen and sell it in small bottles for people to use in their everyday lives. I think it would be possible to sell at least 2,000 water and hydrogen systems in the Caribbean alone. At full scale I will include a bottling plant for water and a plant to bottle the hydrogen with enough energy to meet the requirements for a household for nearly a week. The onboard hydrogen production allows one to eliminate the costly power cables. The hydrogen can be used in a fuel cell to convert it back to electricity. The goal is to have a completely green cycle from start to finish. An abundant supply of green water and hydrogen has the potential to eliminate droughts and provide food security as a major stabilizing force. Areas like Baja California will have the key components needed for development-water and energy. The absolute best of all is that it will be done while generating zero greenhouse gas emissions.

Currently, I am the only full-time member of the Team. I have been able to draw on a vast pool of knowledge through professional contacts that have technical knowledge in areas like Marine Biology, CFD analysis, ship building, materials experts, ocean engineers, marine biologist, manufacturing experts and mentors providing strategic insight, business models, marketing. The level of commitment can only be described when examining at the steps I have taken to ensure the success of this challenge. I am 54 years old. I left a position high paying position with the phone company as a senior engineer. I cashed out my entire retirement account to pay for the prototypes and then to pay for the patents in the United States, Mexico, China, Australia and South Africa. I am extremely committed. At no other time in history has mankind needed this technology more than right now. I am driven to succeed, and I am convinced that the introduction will be a major turning point leading to sustainability.

Supplementary Information: www.goldcoastwaters.com

Attachments below:

1. First Prototype

2. Second Prototype

3. Sketchup Drawing of scaled up version with an overall view of the entire platform. This system can be deployed further out. It is mounted on an Atlantic Class sea-going barge.

4. The mid-deck showing the wicket gates and buoyancy blocks inside the secondary impound area.

5. A view to the area below the secondary impound area where the hydraulic cylinders are placed. -beyond that there is the hydraulic accumulators, and series of Reverse osmosis filters.

THE FOUR-QUESTION NARRATIVE WORD COUNT: 2460 total words

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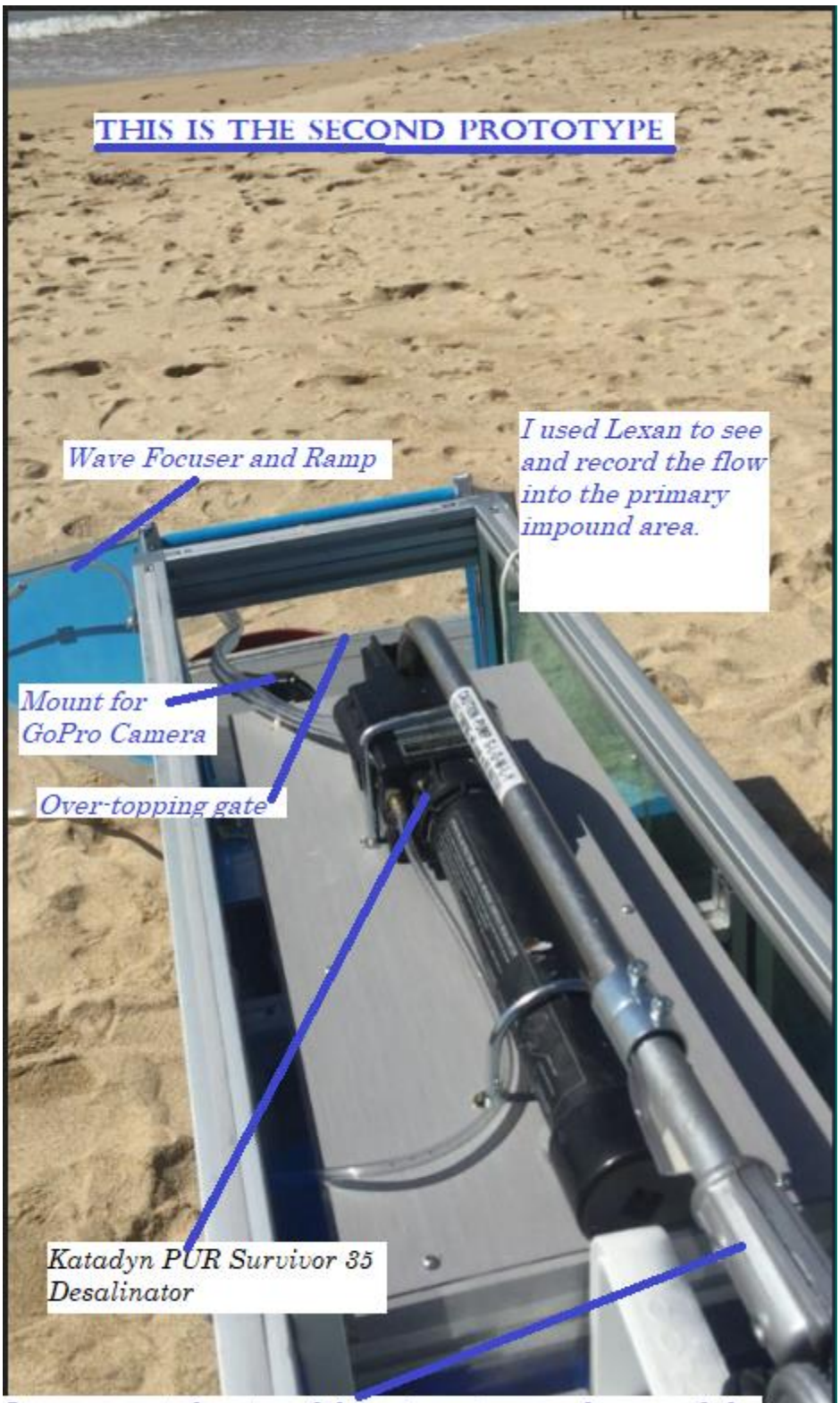
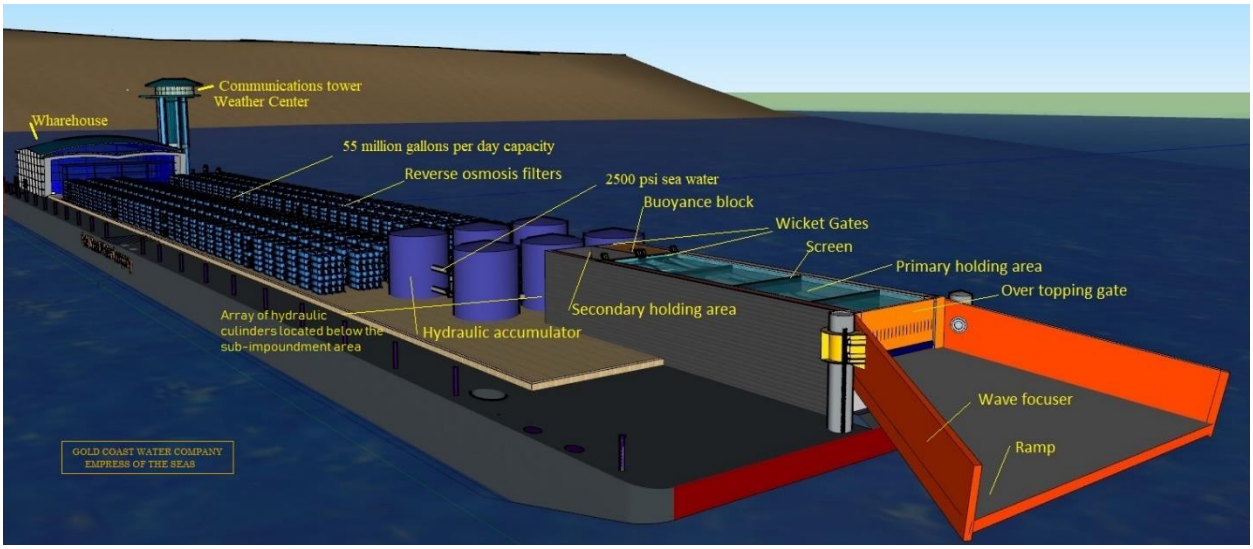
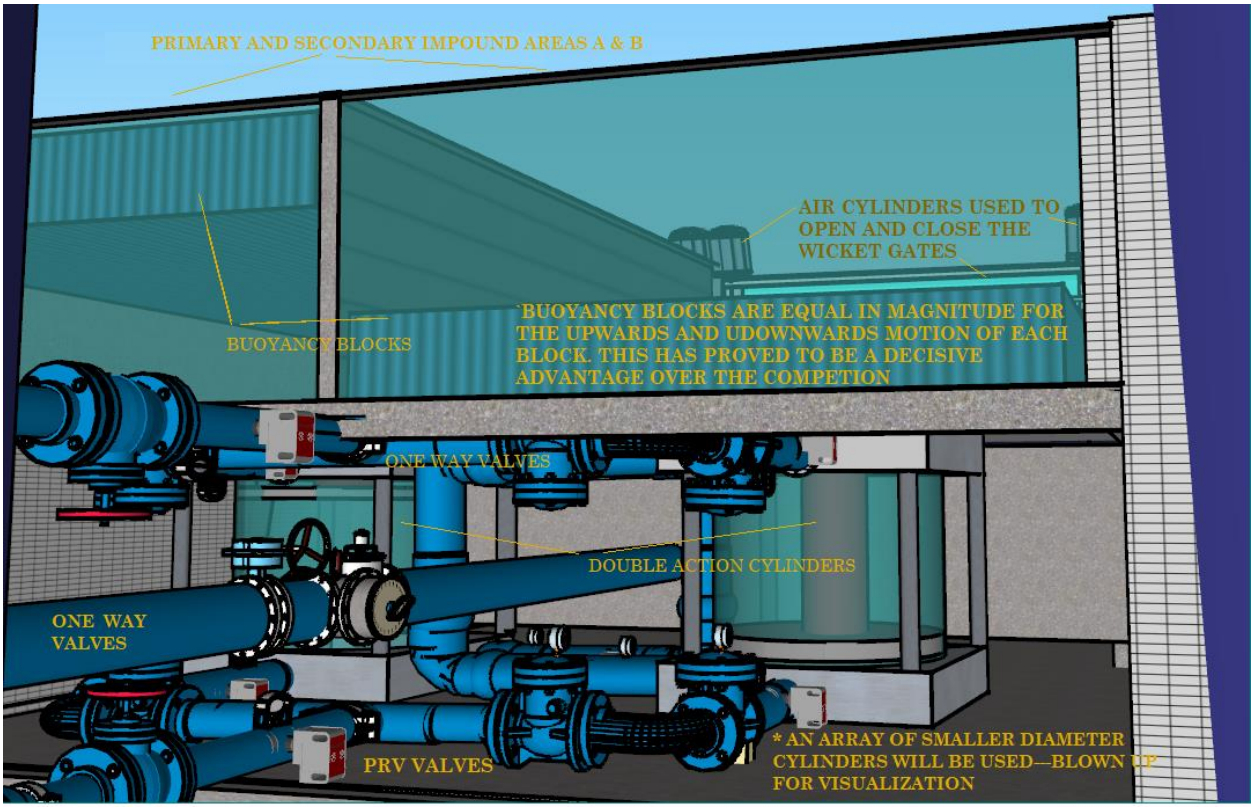
IN THE SECOND PROTYPE THE WAVE FOCUSER WAS WIDER THUS THE OVERALL FOOTPRINT INCREASED WHICH EQUATED TO A LARGER VOLUME OF SEA WATER PASSING THROUGH THE SYSTEM. THE KEY METRIC WAS THE RESULTS PRODUCED WITH THE CHANGE IN CONFIGURATION WITH THE PITCH OF THE RAMP AND THE WIDTH OF THE WAVE FOCUSER. iT WAS LATER THAT i LEARNED THE MAJORITY OF ENERGY AND MOVEMENT WAS CONTAINED IN THE FIRST 20 FEET SO i DESIGHED THE RAMP TO EXTEND TO THIS DEPTH. THIS IS WHEN I DISCOVERED THE THE ROCKING MOTION ENCOUNTERED BY WEC-WAVE ENERGY CONVERTERS WAS NEARLY ELIMINATED.




*It was mounted on top of the primary impound area and the handle is connected to the buoyancy block.*


Communications tower
Weather Center
Wharehouse
55 million gallons per day capacity
Reverse osmosis filters
2500 psi sea water
Buoyance block
Wicket Gates
Screen
Primary holding area
Over topping gate
Secondary holding area
Array of hydraulic culinders located below the sub-impoundment area
Hydraulic accumulator
Wave focuser
Ramp
GOLD COAST WATER COMPANY
EMPRESS OF THE SEAS


BUOYANCY BLOCKS A & B 180 DEGRES OUT OF PHASE LEAVING ONE IMPOUND AREA TO FILL AT A TIME
AIR CYLINDERS
WICKET GATES
* THE NUMBER OF IMPOUND AREAS AND BUOYANCY BLOCKS WILL DEPEND ON HISTORIAL AND REALIZED WAVE DATA


PRIMARY AND SECONDARY IMPOUND AREAS A & B
AIR CYLINDERS USED TO OPEN AND CLOSE THE WICKET GATES
BUOYANCY BLOCKS
BUOYANCY BLOCKS ARE EQUAL IN MAGNITUDE FOR THE UPWARDS AND UDOWNWARDS MOTION OF EACH BLOCK. THIS HAS PROVED TO BE A DECISIVE ADVANTAGE OVER THE COMPETION
ONE WAY VALVES
DOUBLE ACTION CYLINDERS
ONE WAY VALVES
PRV VALVES
* AN ARRAY OF SMALLER DIAMETER CYLINDERS WILL BE USED—BLOWN UP FOR VISUALIZATION