Resolute Marine
Clean Water From Ocean Waves

Wave₂O™ in Cabo Verde

“Renewable Energy Development in Macaronesia and West Africa”
Praia, Cabo Verde
May 31, 2016

Winner of European Innovation Platform for Water (EIP Water) award (2016)
Winner European Technology Platform for Water (WssTP), SME award (2015)
Winner Overall Maritime Excellence Award (2015)
Winner FACCNE Award (2015)
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Ocean waves can help solve the global water crisis

- Worldwide, over 1.1B people lack access to adequate supplies of clean water (i.e. meet UN-mandated minimum requirements)
- Over 2.5 million people die every year as a direct result
- Seawater desalination is an IDEAL solution (70% of earth’s surface is oceans) but is an extremely energy intensive process
- Utility-scale water production requires large, long-term investments in infrastructure that are unaffordable to customers in our target markets
- The alternative solution, diesel driven desalination, is expensive and environmentally unsound

Fortunately, 40% of the most severely affected people in the world live in coastal areas with access to unlimited “free” energy from ocean waves
Our solution: the world’s first wave-powered desalination system (Wave\textsubscript{2}O\textsuperscript{TM}) that requires **NO ELECTRICITY** to operate.
At commercial stage a 15-WEC plant could produce 4,000 m³/day of fresh water.

- **Impactful**: Provides water for 48,000 people
- **Low capital cost**: $25M total cost
- **Quick recovery**: 6-year payback for customer
- **Financial return**: Equity IRR >25% in launch market
- **Low cost water**: $1.30/m³ before profit & financing
Desalination today involves either billion dollar facilities in the developed world or expensive, environmentally-unsound diesel generators at the local level. Wave$_2$O™ has been designed to displace diesel-driven desalination systems wherever there are adequate wave resources.
Global Addressable Market Estimate: $10B/Year (1)

Over 40% of the most severely affected people in the world live in coastal areas with access to unlimited “free” energy from ocean waves.

- South Africa - 4 District Municipalities
- Cape Verde/ECOWAS - Commercial pilot
- Morocco - Discussions underway
- Chile - Discussions underway
- Mauritius/Rodrigues - Commercial pilot
- Pacific Islands/Fiji - Discussions underway
- Camp Rilea, OR - Technical pilot

Addressable market $B/year
- $2B/y
- $1B/y
- $0.5B/y
- $0.2B/y

(1) = Water supply needed to fulfill World Resource Institute minimums in off-grid coastal communities x $1.00/m³
<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Capacity, m³/day</th>
<th>Water generation costs, $/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wave RO</td>
<td>1,000 – 3,000</td>
<td>0.70 – 1.30</td>
</tr>
<tr>
<td>CSP MED</td>
<td>&gt; 5,000</td>
<td>2.30 – 2.90</td>
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<tr>
<td>Wind RO</td>
<td>50 – 2,000</td>
<td>2.00 – 5.00</td>
</tr>
<tr>
<td>Solar SD</td>
<td>&lt; 0.1</td>
<td>1.30 – 6.50</td>
</tr>
<tr>
<td>Solar MEH</td>
<td>1 - 100</td>
<td>2.60 – 6.50</td>
</tr>
<tr>
<td>Wind MVC</td>
<td>&lt; 100</td>
<td>5.20 – 7.80</td>
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<tr>
<td>PV RO</td>
<td>&lt; 100</td>
<td>&gt; 6.50</td>
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<tr>
<td>PV EDR</td>
<td>&lt; 100</td>
<td>&gt; 10.40</td>
</tr>
<tr>
<td>Solar MD</td>
<td>0.15 - 10</td>
<td>&gt; 10.40</td>
</tr>
</tbody>
</table>

Reference:
“Roadmap for the development of desalination powered by renewable energy” PRODES. $1.30/€ exchange rate used. SD = Solar Distillation; MEH = Multiple Effect Humidification; MD = Membrane Distillation; CSP = Concentrating Solar Power; MED = multiple effect desalination; RO = Reverse Osmosis; EDR = Electro-Dialysis Reversed; MVC = Mechanical Vapor Compression
Social & Environmental Benefits

RME has a profitable business model that helps people around the world face one of the critical challenges of our time.

- 1.1 billion people worldwide lack clean drinking water; RME will help.
  - By 2020, RME will provide clean drinking water for 240,000 people, with much greater scale to follow;
  - Our system produces water at an approximate cost of $1.30/m³; diesel systems (our primary competition) are nearly triple the price, not taking into account environmental externalities.

- 2.6 million people die each year from water-related diseases; RME will help.
  - We produce water that is 99.9% pure and complies with U.S. EPA standards for drinking water safety;
  - RME is projected to save nearly 1,000 lives between now and 2020, with many more thereafter.

- Millions of women and children suffer most from the World Water Crisis; RME will help.
  - Women and children spend 200 million hours/day collecting water, or $29.5 million/day in lost productivity;
  - Our system reduces personal and community resources devoted to obtaining water.

- Existing desalination technologies depend on energy sources that pollute.
  - Large desal plants need co-located power plants that have many negative environmental impacts;
  - Smaller diesel-driven systems for local use produce pollution of several types, including carbon and sound;
  - Fossil fuel transport, storage and use are hazards for local communities that use diesel to produce water;
  - Our system has no adverse environmental impact and brine disposal issues are easily mitigated.
Extensive Research & Supply Chain Network

- US DOE (Funding)
- MIT (R&D)
- IMERC (R&D)
- Parker Hannifin (Desalination)
- Chubb (Insurance)
- Electra (Water utility)
- US DOI (Funding)
- Univ. Michigan (R&D)
- ITC (R&D)
- PPG Industries (Coatings)
- South Africa (DWA, DEA)
- Univ. Cape Verde (Social Impact)
- USACE (Testing support)
- Univ. Minnesota (R&D)
- HWU - ICIT (Social Impact)
- Fiberspar (Piping system)
- CSIR (R&D, Feasibility)
- INDP (Feasibility studies)
- AfDB (Funding)
- Tallinn University (Water system modeling)
- Bureau Veritas (Certification)
- Aquatera (Environment)
- Cape Verde (MTIE, MAHOT)
The Wave$_2$O™ pilot in Cabo Verde would have a production capacity of 500 m$^3$/day.
½ - scale WEC tested in North Carolina
Unique Deployment Methodology
**SEFA grant**

**Amount: USD $930,000**

**Purpose**

- Finance feasibility studies related to the proposed test site at Praia Grande
  - a) Includes wave resource assessment, bathymetric & geotechnical surveys, water quality assessment, Environmental Impact Assessment
  - b) Provides for local capacity building @ INDP
- Prepare final project design to estimate costs
- Calculate project bankability and prepare for pilot deployment including selection of local supply chain partners

**Work packages**

- WP1 – Site characterization of the bay of Praia Grande
  - a) Incl. training of INDP personal + purchase of equipment for INDP
- WP2 – Technical/financial feasibility
- WP3 – Management: Recruitment of a local project and procurement manager to oversee project implementation including consenting.
WP1 - Depending on budget, the zone of study could expand beyond the pilot location

Possible study area (to be confirmed at RFP evaluation)
The proposed Praia Grande site can accommodate significant scaling up to a commercial-scale plant (4,000m³/day or more).
The pilot presents numerous opportunities for project expansion or integration into other components of local economy.

Possible Wave₂O™ commercial deployment (4,000 m³/day)
Possible location artificial aquifer
Possible connection to Water distribution system (Mindelo)
Aquaculture project
Agriculture
Local community (Fishing)
Intermittent river
THANK YOU!

“Whiskey’s for drinking
Water’s for fighting over”
Attributed to Mark Twain