NREL WAVES TO WATER PRIZE PROGRAM: CAPABILITY MATRIX

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2022 Engineering for Change

IMPACT SERVICES

Engineering for Change (E4C) Impact Services leverage a proven methodology for supporting social entrepreneurs as they move technology innovations from concept to testing to scale-up. The program focuses on de-risking ventures by assessing their strengths and weaknesses and providing strategic and technical guidance to get them to their next stage of development. Through this program, E4C taps into its network of innovators, inventors, engineers, manufacturers, designers, and product developers, blending virtual assessment with rigorous in-person or virtual support. E4C Impact Services deliver timely access to customized guidance that effectively propels ventures and accelerating organizations forward. E4C Impact Services are also applied toward delivering large-scale innovation challenges to advance technology-based solutions for sustainable development.

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To read more about Wave Energy Desalination, please visit:
www.engineeringforchange.org/research/supporting-development-wave-energy-desalination-technologies-waves-water-engineering-change-partnership

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Authors:
Iana Aranda, E4C President
Alex Fairhart, (Former) Isle Utilities
Erin Peiffer, E4C Research Manager
Marc Santos, Isle Utilities
Sahar Shamsi, E4C Fellow

This research is in collaboration with:
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The National Renewable Energy Laboratory (NREL) is a national laboratory owned by the U.S. Department of Energy (DOE). NREL is the only federal laboratory dedicated to research, development, commercialization, and deployment of renewable energy and energy efficiency technologies. In June 2019, the U.S. Department of Energy (DOE) Water Power Technologies Office (WPTO) launched a prize to develop wave energy-powered desalination systems.

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Project Owners:
Tessa Greco, NREL; **Sebastian Grimm**, DOE; **Sarah Moore**, DOE; **Charles Scaife**, DOE; **Rukmani Vijayaraghavan**, DOE; **Jennifer Wiegele**, NREL

Sensitivity Matrix - DEIDENTIFIED

	Organization Categories		Disaster Relief					Commercial / Industrial				Municipal / Government / Residential			
No.	Parameter	Market/Adoption Barrier Guidance	DR 1	DR 2	DR 3	DR 4	DR 5	CI 1	CI 2	CI 3	CI 4	MGR 1	MGR 2	MGR 3	MGR 4
1	Cost	Low Barrier: **High cost** of water or energy in area of deployment (i.e. there is a driver), and **low cost** for procurement / deployment / O&M High Barrier: **Low cost** for water or energy in area of deployment (i.e. not a significant driver), and **high cost** for procurement / deployment / O&M	Medium Barrier Cost is always going to be issue	Medium Barrier O&M costs of greater concern than capital cost	Medium Barrier Not an issue in emergency response, but more of an issue in long-term recovery	Medium Barrier Not an issue in emergency response, but more of an issue in long-term recovery; O&M costs are critical	High Barrier O&M costs critical compared to capital cost	Medium Barrier O&M costs of concern, more costly than water/energy costs	Medium Barrier Both O&M and capital costs are of concern	Medium Barrier Cost is important, but industrial users will pay for good products	Low Barrier Cost reductions is major driver, energy is 30-60% of desal system operations	Medium Barrier High cost of water and energy in state, but other renewable options availible		Medium Barrier Application dependent, now systems need 2-5 year ROI	Medium Barrier Payback period on projects cannot be too long, and energy prices are high
2	Resource limitations and resilience	Low Barrier: Highly resource limited (i.e. there is a driver) High Barrier: Resources currently meet needs, or are satisfied by alternative technologies	Medium Barrier Water is a top priority until infrastructure is restored, bottled water used as alternative	High Barrier Greater interest in reinstating existing systems	High Barrier Always have access to a potable water source through boreholes/wells	Medium Barrier Groundwater resources available, but often need to import water	Medium Barrier Several other reliable / well-tested options already available, but limitations on water resources growing	Low Barrier Water-scarce areas/islands with high cost of water/electricity are target locations	Medium Barrier Open to other options as resources are not as available	Low Barrier Water scarcity in Africa is an issue due to population growth and industrialization	Medium Barrier Dependent on end-user location, but addional capacity is typical driver	Medium Barrier Energy is a larger driver than water diversification	Low Barrier Potable water is scarce	Low Barrier Water is needed for forward operating bases and resilience is new and bigger driver	Low Barrier Water is scarce in Carribean and desal projects are common
3	Scale or modularization needed	Low Barrier: Needing small scale or unclear on sizing requirements High Barrier: Requiring either a wide range of sizes, very large systems, or not allowing modularity *Note:* Large system application could be seen as a scaling opportunity; however, based on current technology state this may not be achievable and is therefore a barrier	Medium Barrier Portable systems up to 200kw are sufficient, larger systems for Hospitals migh requre 1-5 MW	High Barrier Need minimum of 50,000 L/day of drinking water	Medium Barrier Size needs depend on type of emergency response - e.g. 500 L / day needed for medical purposes	Medium Barrier Size needs depend on situation - usually 5 to 15 L/day/person	High Barrier Small scale but high output - 10 cubic meters / hour	Medium Barrier Need wide range of sizes depending on application, preferably modular	Medium Barrier Depends on the application, roughly 100 - 300,000 ML / day	High Barrier Small resorts need 5k cubic meters per day, but large systems need 50k cubic meters per day	Medium Barrier 0.5-1 mgd is typical and system can be modular	Low Barrier Typically looking for under a MW in power, size of system can vary	High Barrier Need enough electricity for 80,000 people; use wave-power geenrated energy in place of diesel in hybrid grids	Medium Barrier Large range of what is needed, but opportunities for small installations	Medium Barrier Hundreds of thousands of gallons to MGD sizing although some resorts have smaller system needs
4	Ease of deployment and installation needs	Low Barrier: Organization can handle logistics or are sophisticated in O&M High Barrier: Organization outsources and requires third party deployments	Medium Barrier Best opportunity deploying with "secondary" responders	Medium Barrier New tech best for early recovery phase after disaster relief	High Barrier Shipping a container takes too long in an emergency situation & is too costly; boreholes faster and cheaper	Medium Barrier Context dependent; will usually phase out and hand over to locals	Medium Barrier Have teams working in country, but need systems easy to hand off to locals and easy to maintain; looking for plug and play systems	Low Barrier Interested in containerized, pre-assembled system with energy generation being part of the system	High Barrier Need someone with the tech skills to manage installation, maintenance, operation and decommissioning of the system	High Barrier Can perfrom small technology upgrades but generally rely on contractors	Medium Barrier 20% of work is prefab, 80% of work is built on-site but require engineers for permanent systems in U.S.	High Barrier Require contracting for outside entity to construct project, typically through PPAs	High Barrier Will build/install solution and hand over to local technicians; hard to find people with necessary qualifications	Medium Barrier Contractors are needed, but established processes for deploying systems with contractors	Medium Barrier Contractors needed, but contractor construction and ops is common for Caribbean Desal systems
5	Operations and maintenance needs	Low Barrier: Organizations that have sufficient staff available for operating systems or already have agreements with contract operators High Barrier: Requiring significant additional support, or are new to outsourcing operations	Low Barrier Providing continuous O&M	Low Barrier O&M costs based on duration of deployed tech	Medium Barrier Works with local ministry of health for emergency response in parallel, using local staff	High Barrier O&M costs are critical	High Barrier O&M costs are critical, capital cost not as critical	High Barrier Ongoing O&M is costly	High Barrier Need someone with the tech skills to do ongoing O&M for this kind of more complex tech	Medium Barrier Hand-off to others for O&M, but contract operations are availible in Africa	Low Barrier Have large team of staff that can operate complex systems, O&M costs are generally passed on to owner	High Barrier Require external contractor to operate and maintain system	High Barrier Aim to have as little maintenance as possible, hard to find trained people to do O&M, language/cultural barriers	Medium Barrier Contractors are hired for demonstration, but DOD staff can operation tech after permanent installs	Medium Barrier Contract operations are common for desal facilities

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6	Reliability	**Low Barrier:** Organizations that have redundancy or ability for system to be out-of-service for short periods of time **High Barrier:** Organizations that require 24/7 operations with little flexibility for downtime	Medium Barrier Staff presence onsite for trouble shooting increases reliability, hybridized systems can minimize downtime	High Barrier Need resilient system	High Barrier Reliability of system is most important	High Barrier Need a mature, well tested system	High Barrier Looking for low O&M, no battery systems	Medium Barrier Depends on application, some coastal areas have several sources for desal so downtime not an issue	High Barrier Looking for reliable system - traditional RO very reliable	Medium Barrier Some Industrial users have their own system and don't rely on municipalities	Medium Barrier Most end-users(utilities) have n+1 redundancy, so reliability is less concern. certain installs allow for intermittent use	Medium Barrier Depends on the end goal, less of an issue for carbon neutrality but larger challenge for water service	Medium Barrier Want 100% renewable and continuous power		Medium Barrier Systems have redundancy but expectation is 95% updtime for desal faciilities
7	Outside incentives or support requirements	**Low Barrier:** Organizations not requiring outside funding or technical support **High Barrier:** Organizations that rely heavily on funding or technical support to pursue technology deployment	High Barrier Interested in technology if grant available	Medium Barrier NGO can fund device or have in-country office that buys/installs/trains	Low Barrier Essential items vary by country - can pick and choose what they need from a catalogue	Medium Barrier Emergency response is well funded, long term recovery is not; do work with partners	Medium Barrier Would need an exceptional system (low cost, low O&M, high output) to be considered	Low Barrier R&D arm may be interested in supporting development	High Barrier Financial support would make tech more attractive, but more interested in capacity building through knowledge transfer / upskilling of locals to maintain tech, or at least having someone come in to install / maintain	High Barrier Outside funding is generally required to advance projects in Africa and lack of O&M funding is an issue	Medium Barrier Outside funding would increase opportunities, but contract terms would require pre-procurement	High Barrier Any new projects would require some federal or state matching funding for projects to progress	Medium Barrier Hard to get things in-country; partnerships for deployment logistics	Medium Barrier Organization has funding for deployments if $1-3M is needed, but addtional matching funding is helpful	High Barrier Caribbean nations typically need additonal funding to support projects or don't have funding to consider environmental
8	Early-stage tech appetite	**Low Barrier:** Organizations with interest in early stage tech and have successfully deployed similar pilots or full-scale systems **High Barrier:** Organizations inexperienced with early stage tech or with low-risk profiles	Medium Barrier Buy-in from local organizations are key for considering earlier stage tech	Medium Barrier Have considered early-stage tech for disinfection previously; opportunity in Gaza	High Barrier Not seeing appetite for tech like this that is costly, high O&M, and requires highly skilled labor	High Barrier Tech needs to be mature and trialed in humanitarian response (very risk averse)	Medium Barrier Open to trying new tech when economically advantageous, but market is saturated with new tech	Low Barrier Have a history of working with earlier-stage tech providers	High Barrier Arup wouldn't develop tech in this area, but may support others developing this tech; don't have a history of working with very early stage tech	Low Barrier African market is open to new innovations and Desalytics often introduces new tech	Medium Barrier H2OInnovations open to new tech, but dependent on end users.	Medium Barrier Already doing some work with small hydro, battery installations and other techs	Low Barrier Interested in phasing out diesel for hybrid systems and moving into 100% renewable solutions	Low Barrier Program designed for basic research through advanced technology	Low Barrier Arid regions understand risks and are interested in early stage techs
9	Regulatory and permitting	**Low Barrier:** Organization is aware of regulatory landscape and does not see impediments **High Barrier:** Organization sees large regulatory hurdles or is not aware of potential challenges	Medium Barrier Haven't faced many hurdles in emergency context, but experience limited to power	Medium Barrier Not many regulatory hurdles, adapt to in-country laws; tech should be certified	High Barrier Proposed innovation from private companies is reviewed by experts and must be approved before use		High Barrier Not many issues during emergency response, but testing enforced by authorities in long term recovery; have to operate from home country standards (if higher), not in-country standards	Medium Barrier Emergencies exempt from adhering to Safe Water Drinking Act, but brine disposal is challenge	High Barrier Depends on context, but approvals and regulatory in Australia are pretty complex, could take several years	Medium Barrier Do not see many regulatory hurdles, but corruption can be a challenge for large installations	High Barrier Cannot do turnkey projects in U.S. without Engineering Consultant involement for permitting. Other coutries have lower barrier	High Barrier Need to get approvals from state and work with Coastal commission. Local Non-profits also get involved in projects	High Barrier Need licenses to operate, need to sign contracts	Medium Barrier Usually a research exception for earlier stage testing, but once permanent system then more complicated	Medium Barrier Onerous process but technical commissions may be more linent in Caribbean compared to US

E4C was founded by ASME as part of the Society's mission to advance engineering for the benefit of humanity. Engineering for Change (E4C) is powered by the American Society of Mechanical Engineers (ASME).

E4C's mission is to prepare, educate and activate the international engineering workforce to improve the quality of life of underserved communities around the world. We are a Knowledge organization with global community of 1,000,000+ that believes engineering can change the world. Founded in 2009 by ASME, IEEE and EWB-USA.

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