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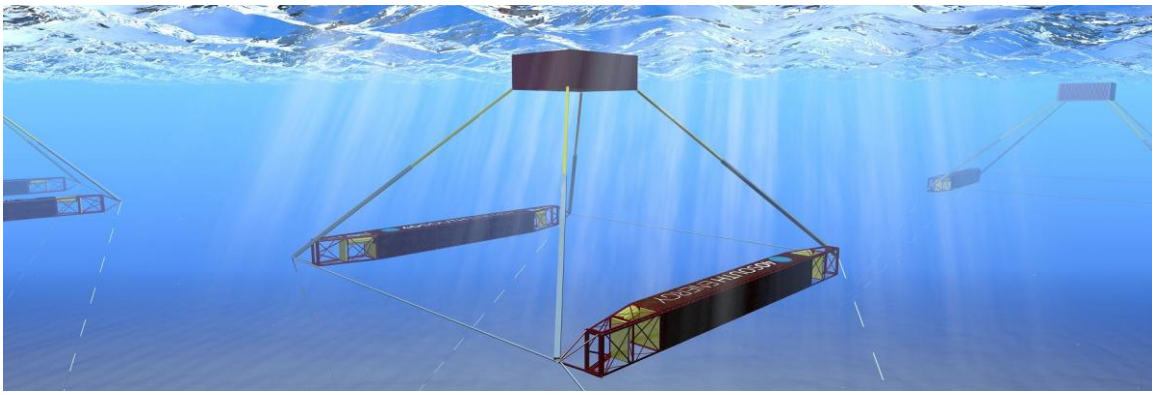
40South Energy Wave Energy Converters



40South Energy's R115 200 kW machine. Image courtesy of 40South Energy.

Wave Energy Converters for all sea conditions

In the latest edition of our newsletter, LRI interviewed Michele Grassi, CEO at 40South Energy, a developer of wave energy converters (WECs). 40South Energy has reached the commercial stage for their H24/25kW and for the R115/200kW WEC devices, and are currently developing larger units.

40South Energy

40South Energy is a wave energy developer with a design concept borne from mathematician and CEO Dr Michele Grassi in 2005. The company has been operating since 2008, and has strong links with Plymouth University in the UK. It has established offices in both London and Italy.

40South Energy produces WECs of different sizes and power ratings and is fully commercial having already deployed single units for clients, including one R115 for a large utility company.

Wave Energy Converters (WECs)

40South Energy produce H24/25kW and R115/200kW machines, and is currently developing H100/100kW, R380/500 kW and R1300/2 MW models. The H-type units are designed to operate in the shallow water, nearshore environment while the R-type models are designed for offshore installations.

Timeline

2005 - Michele Grassi (CEO) had idea for innovative wave energy converter.

2008 - 40South Energy Ltd formed in London to begin development of WEC, testing first small-scale prototype devices that year.

2010 - Italian bank Monte dei Paschi di Siena provided a loan to help finance the construction of the first full scale pre-commercial prototype of 150kW.

2010 - Zurich agreed to insure technology (for Third party damages) based on security measures demonstrated during summer testing.

2011 - Full-scale, second generation 200kW prototype machine tested offshore.

2012 - Sold first R115/200kW machine to Enel Green Power.

2012 - Awarded a significant grant by Regione Toscana for the development of next generation machines.

2013 - Completed construction and installation offshore of 200kW device, producing electricity commercially for the first time. Sold additional six R115 units and one R1300/2MW to three distinct clients.

2013 - Expanded client base globally, and began development of prototype 500kW device which was also to aid in the design of the next stage 2MW machine in 2014.

2014 - Development of commercial H24/25kW device.

2015 - Development of commercial 2MW device of type R and of commercial 100kW device of type H.

2016-2017 - Global commercialization of product line.

2018 - Complete industrialization and production serialization of the WT25 and WT100 power trains used in all the wave devices.

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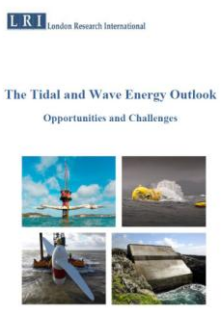

A comprehensive industry analysis with company case studies and commercial and investment outlook. This invaluable resource features the most up to date information available for investors, developers and those interested in the Marine energy sector.

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H-type Device System Design

The H24 model is a wave energy converter (WEC) for near-shore, shallow water applications (between 5 and 12 meters of depth). The H-type devices is different from most other WECs in design in that it sits fully submerged in the water.

The H24 consists of a moving member - called Upper Member (UM) - running on a horizontal path under the action of sea waves. An electro-mechanical transmission system (TEP), controlled by a program running on a programmable logic controller (PLC), is able to control the UM motion, and convert a certain percentage of its kinetic energy in electric power. The machines have a very high capacity factor, and are resilient to storms and passively protected against large waves.

H24 model (25 kW)	
Location (near-shore)	**Capacity factor**
Mediterranean Sea	10-20%
Ocean	20-40%

The footprint of each H24 device is 9m x 14m and they weigh 15 tonnes, including mooring. The device is transportable by a conventional HGV, and can be towed into situ without the need for any specialist equipment.

H-type Installation

The electrical cable will typically be integrated into pre-existing structures (jetties, breakwaters, docks) or, alternatively, can be directed to an aquaculture facility, a lighthouse, a platform for environmental monitoring, a pumping system or similar. As well as the novel underwater feature of these devices, they have the advantage that they are extremely cheap and easy to install. The units are moored in the nearshore environment. The device is towed to its location and sunk into place. A single unit can be installed and functional in a few hours, and within a few days a whole wave farm could be in operation. Typically, machines will be installed about 100m from the shoreline which will incur an installation and transmission cabling cost of around EUR 10,000.

H-type O&M

In marine energy, operations and maintenance are critical to the success of a project. For this reason, the H machines have been designed to minimise this factor. Resistance to the water environment was one of the key areas for the research effort during the development process of 40South Energy's WECs. The O&M cost for the H-type machines can vary between 2-4% of the original capex annually. The H24 has a guaranteed duration of 15 years with regular maintenance.

R-type Device System Design

By adopting the unique, fully submerged position in the water, the design of the R-type ("rail-type") devices is similar to that of the H-type. Peak (nominal) power output for the R-type devices is 200 kW, and they have a footprint of 40m x 40m. They require a minimum depth of 40m.

40South's R-type devices follow the same design as the R-type and have an upper (UM) and lower (LM) member, with the UM being nearer the water surface and the LM being deeper. The depth of each member varies depending on site and sea conditions. These two members are exposed to different levels of energy and so move differently with relative motions. Energy is extracted from this relative motion through the electromechanical system. Each device has an onboard control system that automatically varies the unit's depth in real time in response to the wave conditions so that production is always optimised. This allows the extraction of wave energy in almost any sea conditions.

R115 model (200 kW)	
Location (offshore)	**Capacity factor**
Mediterranean Sea	24-35%
Ocean	45-55%

This ability to react and adapt to the environment is one of the key strengths of the 40South design and allows the capacity factor of the machines to be very high, with survivability guaranteed by non-exposure to storms. This also has the added benefit that the devices are not site specific and can operate in similar conditions with similar outputs all over the world.

R-type Installation and O&M

The R-type devices weigh 50 tonnes including mooring and, similar to the H-type do not require any specialist installation equipment and therefore they are cheap and easy to install. The device is towed to its location and attached to the gravity-based moorings which hold it in place. The gravity based mooring allows the machines to be installed in sandy or muddy sea bottom locations.

Typical applications

Grid connected	Utility scale generation	Centralised utility scale generation or distributed community scale generation. This can be as standalone units, in wave energy parks, or in arrays. Each H24 unit requires 6m of coast and 80m² surface area, so an array of 50 units would require around 300m-400m of length.
	Community scale generation	
	Harbours	Large areas just outside harbour protection structures are often unused by ships. This is an ideal location to deploy one or several of 40South Energy's H-type WECs.
	Airports	There are opportunities to install WECs in water near airports which is usually restricted to shipping traffic.
Non-grid connected	Island sites	Both the H24-25kW and R115/ 200kW models are well suited to non grid-connected locations such as island sites
	Desalination	The WECs can be used in association with desalination plants to produce desalinated water

Typically, R-type machines will be installed about 1,000m from the shoreline which will incur an installation and transmission cabling cost of around EUR 100,000. Depending on the site, the O&M cost for the R-type machines can vary between 3-4% of the original capex annually.

Business Model

The majority of funding for the development of 40South Energy's machines has come through private investment. For the H machines, 40South Energy are seeking near-shore sites globally for users who are interested in electricity generation by methods alternative to diesel, solar or wind power. These include island communities, resorts, or villages in isolated locations. Due to their design, the H-type WECs can be installed in almost all near-shore marine environments and can extract energy from all sea conditions. 40South Energy are already developing wave energy parks using these machines in the Mediterranean and the Maldives – the machine does not have to be tailored to a specific wave climate. The H24 machines have a list price of EUR 60,000 plus VAT.

The R machines are well suited for grid supply of electricity at a very competitive price. The R115/200 kW model is available for EUR 400,000 plus VAT.

In the medium term, 40South Energy foresees the wave energy market (both near-shore and offshore) as being in line with that of offshore wind. Their goal is to develop wave energy machines over the next 5-15 years which can compete directly with offshore wind turbines in terms of both cost and power output. At present, the levelised cost of energy (LCOE) of their machine can vary approximately between EUR 0.18 and 0.30 depending on location. A single 25kW machine has a cost of EUR 60,000, while larger machines cost EUR 2.00 per nominal watt of power. A 2 MW machine will therefore cost EUR 4 million. It is then necessary to add 10-20% to the cost for site development.

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Summary

- Unique, depth adjustable fully submerged design
- Operation possible in all weather and sea conditions, resulting in high capacity factor
- Gravity based mooring system allows for device installation in sites with a soft seabed
- Low system cost
- Seeking global project sites

For More Information on 40South Energy

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