SAFE WAVE
STREAMLIING THE ASSESSMENT OF ENVIRONMENTAL EFFECTS OF WAVE ENERGY

Project co-funded by the European Climate, Infrastructure and Environment Executive agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 – Environmental monitoring of ocean energy devices.

15th of June, 2023

SafeWAVE
Public Engagement Event
Malin Head, Ireland

Dr Luke Smith
University College Cork

University College Cork, Ireland
Coláiste na hOllscoile Corcaigh
cppu cleaner production promotion unit
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh
MaREI Centre for Marine and Renewable Energy

Average worldwide electricity consumption and wave power potential

17 Sep 2020

- 2021 & 2022 world-wide electricity consumption:

22,000 to 23,000 TWhs

(International Energy Agency, 2021, 2022)

- Estimate of potential power from waves
  - 32,000 TWhs (Reguero, et al, 2015)
  - 26,000 TWhs (Mørk et al., 2010)
  - 29,500 TWhs (IRENA, 2020)

Project co-funded by the European Climate, Infrastructure and Environment Executive agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 – Environmental monitoring of ocean energy devices.

SAFE WAVE STREAMLINING THE ASSESSMENT OF ENVIRONMENTAL EFFECTS OF WAVE ENERGY

5 Advantages of wave power over wind and solar

1. The energy density of waves is over ten times that of wind or solar per meter.
2. The availability of wave power is up to 90% while that of solar and wind is around 20-30%.
3. Wave energy has minimal impact on the environment whereas there have been questions raised about the environmental impacts of wind and solar.
4. Wave energy is complimentary to both wind and solar as waves tend to be stronger at night when there is no solar and waves follow the winds that made them by a number of hours. Both characteristics help to reduce the variability of renewable energy generation.
5. Waves are more predictable than either wind or solar which allows for better grid power management. [1-5 adopted from (Guo & Ringwood, 2021)].

Project co-funded by the European Climate, Infrastructure and Environment Executive agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 – Environmental monitoring of ocean energy devices.

SAFE WAVE

STREAMLINING THE ASSESSMENT OF ENVIRONMENTAL EFFECTS OF WAVE ENERGY

Project co-funded by the European Climate, Infrastructure and Environment Executive agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 – Environmental monitoring of ocean energy devices.

Ocean Literacy: A definition

Ocean literacy is an understanding of the ocean's influence upon you and your influence upon the ocean.

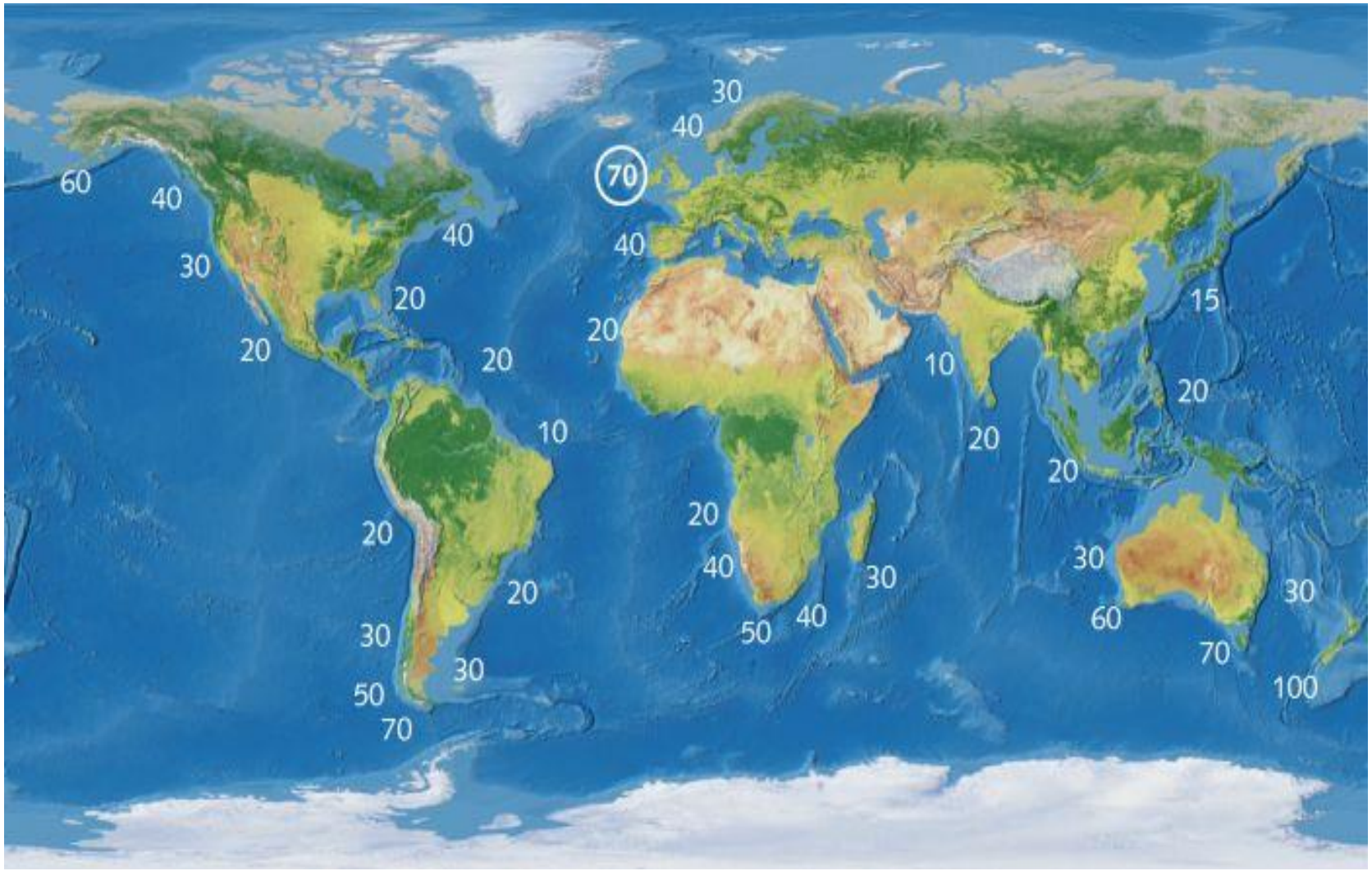
Project co-funded by the European Climate, Infrastructure and Environment Executive agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 – Environmental monitoring of ocean energy devices.

SAFE WAVE STREAMLINING THE ASSESSMENT OF ENVIRONMENTAL EFFECTS OF WAVE ENERGY

Wave Energy Environments

The strongest winds blow between 30˚ and 60˚ in latitude.

Western coastlines at these latitudes experience the most powerful waves.



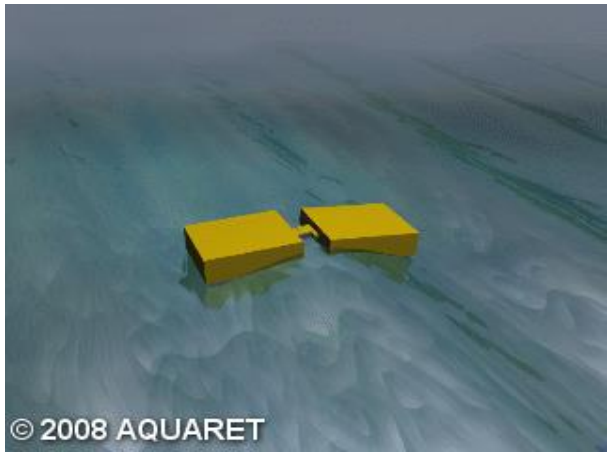
Wave Profile Devices

- If the physical size of the wave profile device is very small compared to the periodic length of the wave, this type of wave energy device is called a "point absorber".

- If the size of the device is larger or longer than the typical periodic wavelength, it is called a "linear absorber".

- More commonly they are collectively known as "wave attenuators".

Point Absorber



Wave Attenuators

An example in (virtual) action -- CorPower's PowerBuoy, but coming to a coast near you

- https://youtu.be/9qu2OIw4-p8

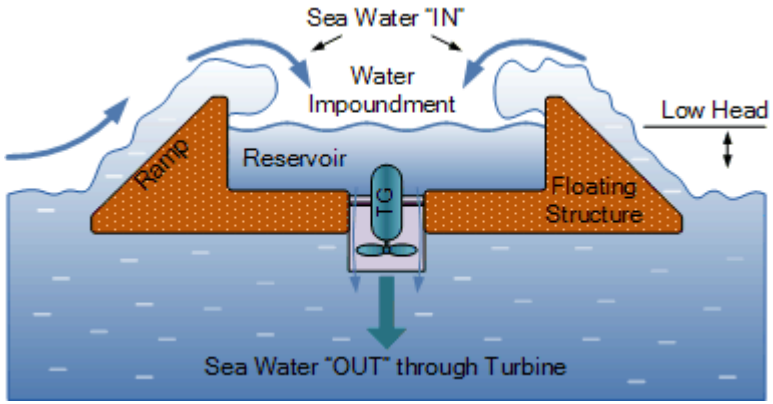
Project co-funded by the European Climate, Infrastructure and Environment Executive agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 – Environmental monitoring of ocean energy devices.

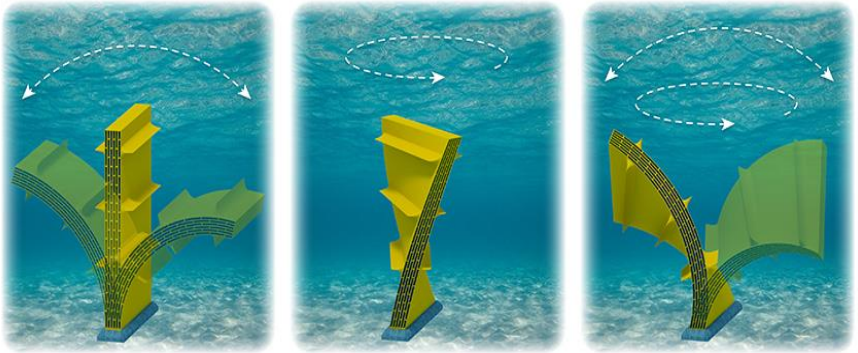
Many, many more than this one though

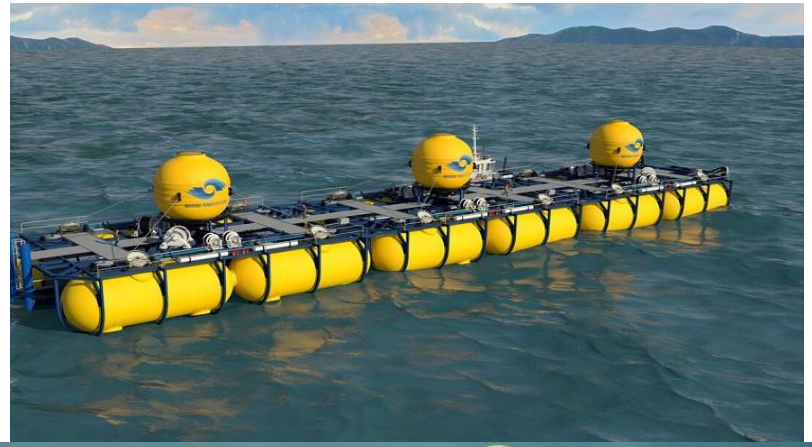
Title	Technology	Technology Developer	Country	Status	Project Scale
MW-Level Wave Energy Demonstration Project	Marine Energy, Wave	Chinese Academy of Sciences, Guangzhou Institute of Energy Conversion (GIEC)	China	In Operation	Test Site
PacWave North Test Site	Marine Energy, Wave	Oregon State University	United States of America	In Operation	Test Site
Eco Wave Power Wave Energy Power Station Jaffa	Marine Energy, Wave	Eco Wave Power Ltd.	Israel	In Operation	Array
Eco Wave Power Wave Energy Power Station Gibraltar	Marine Energy, Wave	Eco Wave Power Ltd.	United Kingdom	In Operation	Array
Runde Waves4Power Project Full Scale	Marine Energy, Wave	Waves4Power	Norway	In Operation	Single Device
Söderfors Project	Marine Energy, Riverine, Tidal, Wave	Uppsala University	Sweden	In Operation	Single Device
Mutriku Wave Power Plant	Marine Energy, Wave	Voith Hydro, Wavegen	Spain	In Operation	Array
SEM-REV Sea Test Site	Marine Energy, Wave, Wind Energy, Floating Offshore Wind	Ecole Central de Nantes (ECN)	France	In Operation	Subscale, Test Site
PLOCAN Marine Test Site for Ocean Energy Converters	Marine Energy, Wave, Wind Energy, Fixed Offshore Wind	Oceanic Platform of the Canary Islands (PLOCAN)	Spain	In Operation	Test Site
Runde Environmental Centre	Marine Energy, Wave	Havkraft AS, Waves4Power	Norway	In Operation	Test Site
Biscay Marine Energy Platform (BiMEP)	Marine Energy, Wave, Wind Energy, Fixed Offshore Wind	Biscay Marine Energy Platform (BiMEP)	Spain	In Operation	Test Site
Lysekil Wave Energy Site	Marine Energy, Wave	Uppsala University	Sweden	In Operation	Test Site
U.S. Navy Wave Energy Test Site (WETS)	Marine Energy, Wave	University of Hawaii	United States of America	In Operation	Test Site
EMEC Billia Croo Grid-Connected Wave Test Site	Marine Energy, Wave	European Marine Energy Centre (EMEC)	United Kingdom	In Operation	Test Site

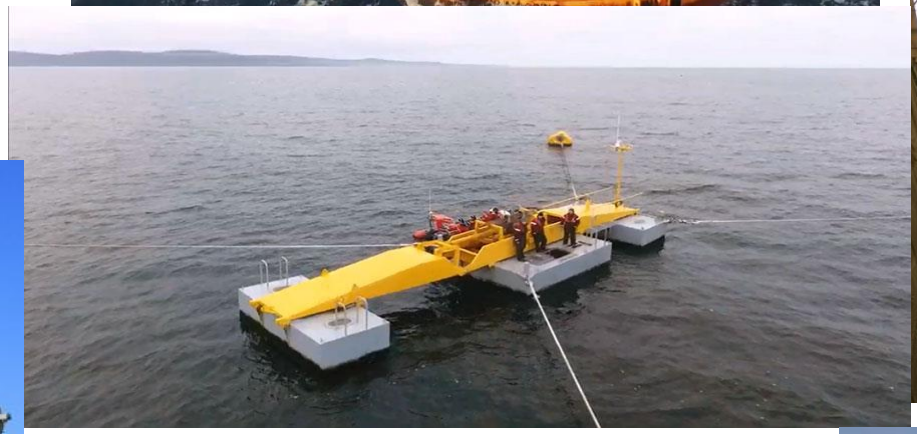
Project co-funded by the European Climate, Infrastructure and Environment Executive agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 – Environmental monitoring of ocean energy devices.

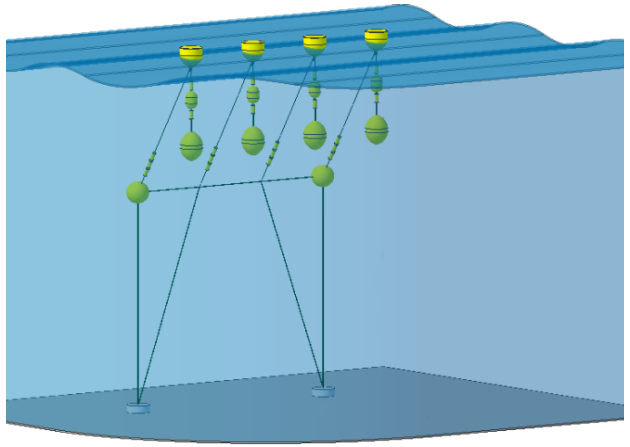
SAFE WAVE STREAMLINING THE ASSESSMENT OF ENVIRONMENTAL EFFECTS OF WAVE ENERGY


Sea Water "IN"
Water Impoundment
Low Head
Ramp
Reservoir
Floating Structure
Sea Water "OUT" through Turbine









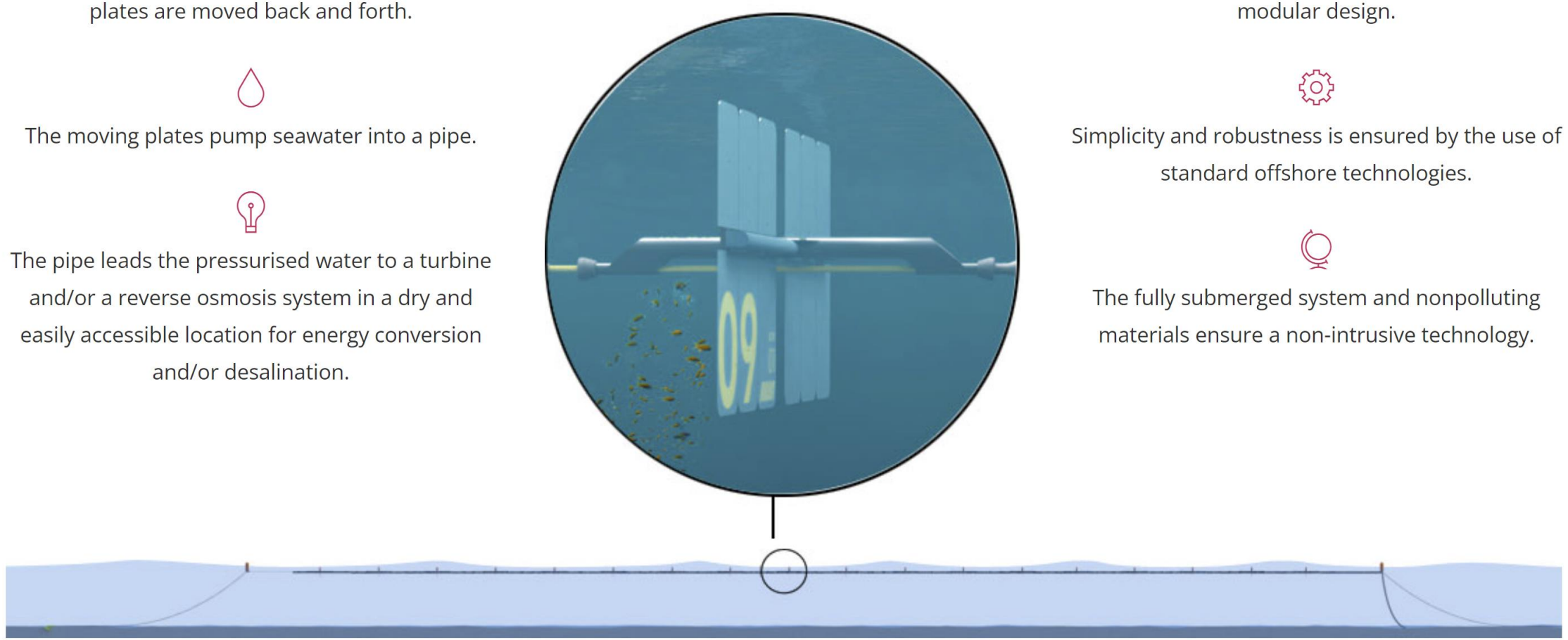
Project co-funded by the European Climate, Infrastructure and Environment Executive agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 – Environmental monitoring of ocean energy devices.

Wave Piston

When waves roll along the Energy collectors, plates are moved back and forth.

The moving plates pump seawater into a pipe.

The pipe leads the pressurised water to a turbine and/or a reverse osmosis system in a dry and easily accessible location for energy conversion and/or desalination.



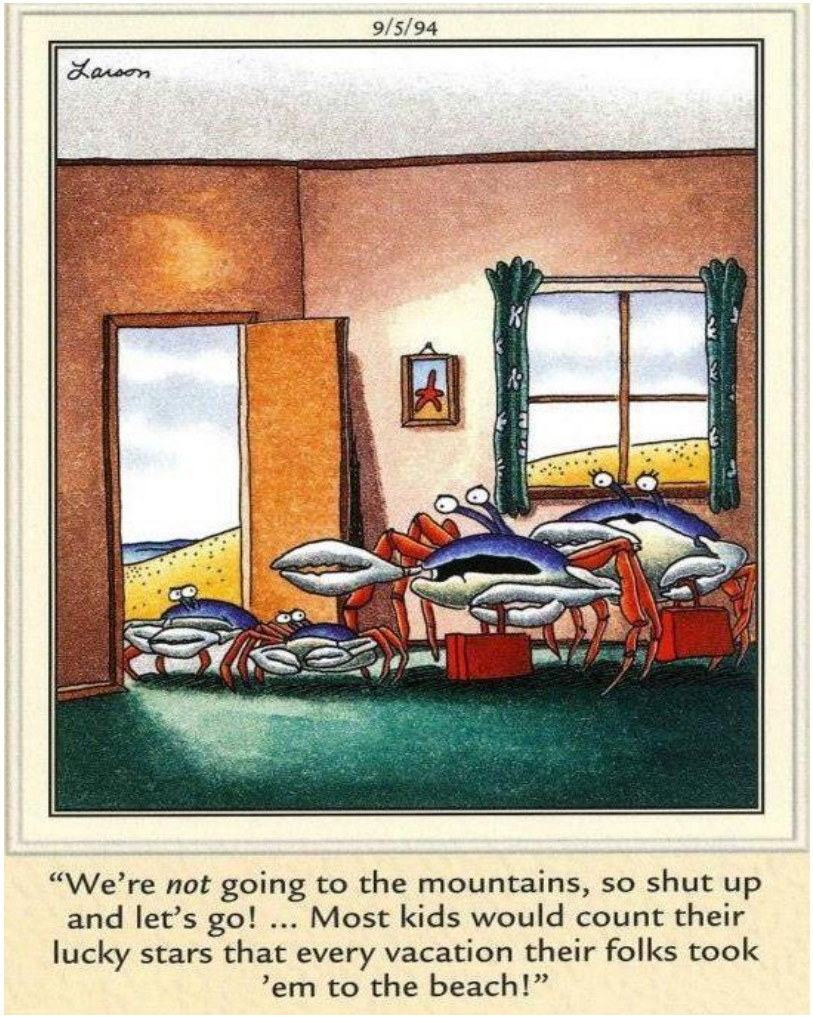
flexible structure, optimized mooring and modular design.

Simplicity and robustness is ensured by the use of standard offshore technologies.

The fully submerged system and nonpolluting materials ensure a non-intrusive technology.

Project co-funded by the European Climate, Infrastructure and Environment Executive agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 – Environmental monitoring of ocean energy devices.

My take on WE development within an ocean literacy context



Larson, Gary. (1994). A Far Side cartoon.

Project co-funded by the European Climate, Infrastructure and Environment Executive agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 – Environmental monitoring of ocean energy devices.

Note: slides 10 -13 composed of figures mercilessly ripped from Google Images. Their intent is just to show examples of different devices and no monetary or reputational gain was achieved from their reproduction here.

Bibliography

Guo, B., & Ringwood, J. V. (2021). A review of wave energy technology from a research and commercial perspective. *IET Renewable Power Generation*, *15*(14), 3065–3090. https://doi.org/10.1049/rpg2.12302

International Energy Agency. (2021). Key World Energy Statistics 2021 – Statistics Report. *IEA Publications*, 1–82. https://www.iea.org/reports/key-world-energy-statistics-2021/transformation

International Energy Agency. (2022). International Energy Agency (IEA) World Energy Outlook 2022. *Https://Www.Iea.Org/Reports/World-Energy-Outlook-2022/Executive-Summary*, 524. https://www.iea.org/reports/world-energy-outlook-2022

IRENA. (2020). Innovation outlook: Ocean energy technologies. In *International Renewable Energy Agency*. https://www.irena.org/publications/2020/Dec/Innovation-Outlook-Ocean-Energy-Technologies

Jackson, F. (2023, January 11). World's Most Powerful Wind Turbine. *Daily Mail Online*, NP. https://www.dailymail.co.uk/sciencetech/article-11619349/Worlds-powerful-wind-turbine-size-SEVEN-football-fields.html

Mork, G., Barstow, S., Kabuth, A., & Pontes, M. T. (2010). Assessing the Global Wave Energy Potential. *29th International Conference on Ocean, Offshore and Arctic Engineering: Volume 3*, 447–454. https://doi.org/10.1115/OMAE2010-20473

Reguero, B. G., Losada, I. J., & Méndez, F. J. (2015). A global wave power resource and its seasonal, interannual and long-term variability. *Applied Energy*, *148*, 366–380. https://doi.org/10.1016/j.apenergy.2015.03.114

Tethys. (2023). Grid connected wave energy devices in operation. Retrieved 13.06.2023 from https://tethys.pnnl.gov/grid-connection/grid-connected

University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

MaREI
Centre for Marine and Renewable Energy

Dr Luke Smith
aaronsmith@ucc.ie

Do you see any opportunities for Irish coastal communities in wave energy research and development?

Project co-funded by the European Climate, Infrastructure and Environment Executive agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 – Environmental monitoring of ocean energy devices.

SAFE WAVE
STREAMLINING THE ASSESSMENT OF ENVIRONMENTAL EFFECTS OF WAVE ENERGY

Focus group break-out: Some things to consider (only if you are at a loss about what all this might could mean for you and yours)

- If Ireland doesn't make the most of her competitive advantage in wind and wave energy, who will?
- Should this opportunity be left to multinational developers or can communities take a leadership role. If so, how?
- Do we need an equitable and democratic energy system or is it really not worth the hassle? (and there is hassle, do I have the time? Can I make the time? Could I put my time to better use?)
- How can we minimize the risk?
- What should be the role of government?
- Is thinking about catastrophic, society-ending scenarios too paranoid when contemplating how we want our energy system to develop?

Project co-funded by the European Climate, Infrastructure and Environment Executive agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 – Environmental monitoring of ocean energy devices.

Links to SafeWAVE video and survey

- Video: https://youtu.be/-kGM1BYFqTo
- Survey: https://forms.office.com/e/npdgVV3pnc

Or go to: https://windvalue.ie/ and look for the link to today's event