DTOceanPlus

Advanced design tools for ocean energy systems innovation, development and deployment

DURATION: 40 months (2017-2021) | BUDGET: €8,000 k

TECHNOLOGIES

VALUE CHAIN

CONTEXT

The Ocean Energy Forum Roadmap indicates that ocean energy could meet 10% of the European Union's electricity demand by 2050. The oceans could therefore play an important role in meeting one of Europe's biggest challenges today. This is to ensure the energy transition from a system based on fossil and imported fuels to a flexible and interconnected system based on clean, renewable and sustainable domestic resources. T**echnologies for exploiting wave and tidal resources are not yet mature enough to be used on a large scale because of the still very high Levelized Cost of Energy (LCOE). This can be addressed with appropriate tools and processes that support market growth and technological innovation.**

OBJECTIVE

To develop a software suite of open source advanced tools for the selection, development and deployment of ocean energy systems.

MAIN ACHIEVEMENTS

- Identification of end user needs
- Development of numerical tools for structured innovation, stage-gating, deployment and evaluation of wave and tidal farms, from the subsystem to the whole farm
- Integration of the tools and testing with real world deployments in order to achieve a TRL6 software
- Market analysis of the ocean energy sector

CONCLUSION

DTOceanPlus project made it to develop and demonstrate an open source sotftware suite of second generation design tools for ocean energy technologies including sub-systems, energy capture devices and arrays. These tools support the entire technology innovation process, from concept, through development, to deployment. More broadly, the project also provided an industry standard for communicating technology descriptions throughout the sector. To complement the numerical work, an extensive market analysis of the ocean energy sector is publicly available.

AVAILABLE RESOURCES

- **TRL6 open-source software suite** and associated documentation available on GitLab
- **Digital representation** for ocean energy systems at different levels of aggregation and accounting for different levels of complexity to standardise the data formats
- 33 **public reports** about development and testing, training material, data management
- 5 reports detailing **market analysis** for the ocean energy sector
- **8** open access **scientific publications**
- 1 global **data base** and 3 open source **data sets**

PARTNERS

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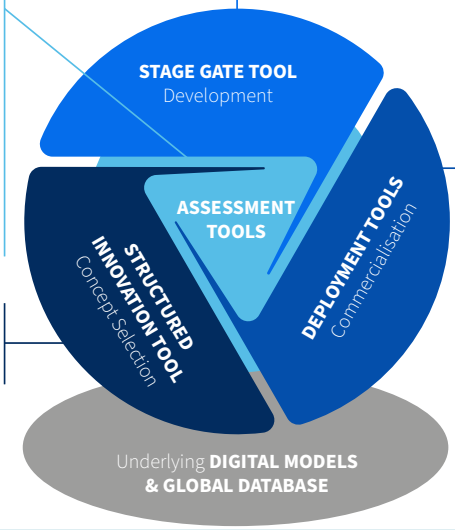
DTOCEAN+ DESIGN TOOLS

Brand-new tool assisting decision-making using metrics to measure, assess and guide technology development

Upgraded versions of the tools providing objective information to the developer or investor on the suitability of a technology and project:

- Performance and energy yield
- Lifetime costs
- Reliability, availability, maintainability and survivability
- Environmental and social acceptance



New and upgraded versions of the tools supporting optimal device and array deployment:

- Site characterisation
- Machine characterisation
- Energy capture
- Energy transformation
- Energy delivery
- Station keeping
- Logistics and marine operations

Brand-new tool for concept creation, selection and design

Tools and documentation available on GitLab

SCIENTIFIC PUBLICATIONS

- Garcia-Teruel *et al.* (2022) **Design limits for wave energy converters based on the relationship of power and volume obtained through multi-objective optimisation.** *Renewable Energy*. 200, 492–504 > doi.org/10.1016/j.renene.2022.09.053
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- Kerr *et al.* (2021) **Implementing Radical Innovation in Renewable Energy Experience Curves**. *Energies*. 14, 2364 > doi.org/10.3390/en14092364
- Roberts *et al.* (2021) **Bringing Structure to the Wave Energy Innovation Process with the Development of a Techno-Economic Tool.** *Energies.* 14, 8201 > doi.org/10.3390/en14248201
- Tunga *et al.* (2021) **Addressing European Ocean Energy Challenge: The DTOceanPlus Structured Innovation Tool for Concept Creation and Selection.** *Energies*. 14, 5988 > doi.org/10.3390/en14185988
- Yang Y. & Sønderkær Nielsen J. (2021) **Availability-Based Selection of Electricity Delivery Network in Marine Conversion Systems Using Bayesian Network.** *Energies*. 14, 3574 > doi.org/10.3390/en14123574
- Ruiz-Minguela *et al.* **(2020) Review of Systems Engineering (SE) Methods and Their Application to Wave Energy Technology Development**. *Journal of Marine Science and Engineering.* 8(10), 823 > doi.org/10.3390/jmse8100823
- Topper *et al.* (2019) **Reducing variability in the cost of energy of ocean energy arrays.** *Renewable and Sustainable Energy Reviews.* 112, 263-279 > doi.org/10.1016/j.rser.2019.05.032
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- Yang Y. & Sørensen J. D. (2020) **Probabilistic Availability Analysis for Marine Energy Transfer Subsystem Using Bayesian Network**. *Energies.* 13(19), 5108 > doi.org/10.3390/en13195108