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Strategies used for knowledge dissemination and outreach in a renewable energy project

Estrategias utilizadas para la difusión y divulgación del conocimiento en un proyecto de energía renovable

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Abstract

This work describes the actions carried out by participants of the Mexican Center for Innovation in Ocean Energy project (CEMIE-Océano) to disseminate their advances and results, to the general public and to the scientific community. The project was set up to assess the energy potential in Mexican coastal areas related to waves, tides and currents, and salinity and thermal gradients, and also to investigate their expected environmental and social impacts. The main actions by the CEMIE-Océano dissemination, outreach and press area, 2017 - 2023, were the design, construction and administration of the project website, the regular publication of activities and major achievements on social media via Facebook and Twitter, and the editing of 28 scientific books and nine editions of a biannual newsletter. Eight work meetings, three conferences and a range of science dissemination seminars were also organized. With the strategies presented in this work, for a value close to 3% of the total project budget, the participation of all the collaborators was achieved. In addition, the CEMIE-Océano project is widely recognised within the community of scientists from Mexico and Latin America, and others interested in renewable energies and energy transition issues.

Keywords: CEMIE-Oceano project, ocean energy, dissemination, outreach.



Social Impact

This paper aims to address the dissemination and disclosure of the strategies and results obtained by the Mexican Center for Ocean Energy Innovation (Centro Mexicano de Innovación en Energía del Océano, CEMIE-Océano), the most important research project on marine renewable energies in Mexico, between 2017 and 2023. This project was framed within the federal strategy (LTE, 2015) to evaluate Mexico's renewable energy potential, with similar projects being CEMIE-Solar, CEMIE-Wind, CEMIE-Geo and CEMIE-Biofuels, all of which were developed through research consortiums of public and private universities, companies and government agencies.

Fourty three institutions and 840 people have participated in this project, some 500 students from bachelor to doctoral level, 250 scientists (professors, researchers and contracted staff), and about 90 people responsible for the financial operation of the project. The work of universities, government and private initiatives was coordinated by the Engineering Institute of the National Autonomous University of Mexico (Instituto de Ingeniería, UNAM), and has allowed the oceanographic and environmental conditions on Mexico's coasts to be evaluated, thus identifying the areas with most potential to host marine energy converter devices. From 2017 to 2023 the project was financed by the CONACyT-SENER (National Council of Science and Technology and the Mexican Ministry of Energy) mixed research fund. From the research, several devices and/or their components reached a Technology Readiness Level (TLR) 5, and important advances were made in the characterization of ocean energy converter devices, both numerically (*e.g.* Sosa, *et al* 2023), and through physical simu-

lation (*e.g.* Medina Rodríguez *et al.*, 2022; Villagomez *et al.*, 2023). Significant advances were also obtained related to the impact of marine renewable energies on the environment (*e.g.* Paredes *et al.*, 2019; Bernal-Camacho *et al.*, 2022; Martínez *et al.*, 2021), and recommendations related to the interconnection of renewable energies to the electrical grid (*e.g.* Olmedo-González, *et al.*, 2022) were produced.

In Mexico, there are major challenges related to electricity supply: energy-intensive areas do not generate their own energy, more than 2 million people do not have electricity from the grid in their homes and, regardless of the negative environmental effects, the nation's oil reserves are in steep decline. Although the production of electricity from renewable sources has slowed in recent years, marine sources are a feasible contribution to the national energy mix (Felix *et al.*, 2023).

The CEMIE-Océano project is organized in 2 groups of research lines: pillars and transversal lines. The pillars correspond to the renewable ocean energy sources: waves, tides and currents, thermal gradient and salinity gradient. The transversal lines are: ecology and environmental integration; materials, subsystems and components; grid integration and energy storage; physical and numerical simulation; business; human resource training and international collaboration; and dissemination, disclosure and press. Within the last line, the social impact of the project was evaluated through three main actions: (1) a web page and social networks, (2) the publication of books, and (3) the organization of events, both academic and for the general public, all of which are the focus of this paper.



Methodology

The line of work concerning dissemination, disclosure and press (DDP) has been coordinated by the EPOMEX Institute of the Autonomous University of Campeche and the Engineering Institute, UNAM. Society at large, as well as the project participants, has been informed of the progress of the 4 pillars and 8 transversal lines using 3 main channels.

The first corresponds to the design, construction, maintenance and updating of the website www.cemieoceanomx.com, and the administration of the social networks Facebook and Twitter FB/CEMIE-Oceano and @cemieoceanomx. The design of the logo, signage, typography and choice of the project's own colors was part of this objective, and were used by the participants when preparing reports and presenting results at conferences or science dissemination events.

Secondly, publications were included in the DDP activities. The books edited by CEMIE-Océano were reviewed by the CEMIE-Océano editorial committee and have ISBN registration and DOI (unique object identifier). Those books published before the pandemic in March 2020, were published in print and electronically. The latter versions are hosted on the <https://www.cemieoceanomx.com/libros/libros.php> subpage. The biannual publication of the CEMIE-Océano newsletter, which is free of charge and available at <https://www.cemieoceanomx.com/revista.html>, is also part of this line of action.

The third DDP responsibility focused on the organization of annual work meetings and congresses in which project participants, on a biannual basis, presented partial results and planned activities for the following stages. This action also included the organization of academic forums and science dissemination days. These activities are fundamental, since all participants, regardless of the transversal line or pillar to which they belong, learn first-hand of the results and actions that others have developed, which has encouraged the exchange of opinions and multidisciplinary work.

The main part of CEMIE-Océano's dissemination strategy has been the website. All publications on the social networks Facebook and Twitter are redirected to this page. The website has 7 sections: About Us, Lines of Research, CEMIE-Océano A.C., Dissemination, Publications, CEMIE-Océano Kids and Contact. The publications section contains the six-monthly bulletins, data on the books developed as part of the project, as well as works in reviews and congresses, theses and academic events derived from the project's work. It serves as a repository for the CEMIE-Océano books and the newsletter, and also houses descriptive information on theses, book chapters and journal articles. The website allows the user to search for scientific publications under different parameters and then redirects them, through the DOI, to the official pages where the works are published.

The posts that have been made on social media are classified into two types. The first are related to specific activities; for example, the graduation of a student, or the publication of a book or an article in a journal. For these activities, the action that is disseminated has already been completed at the time the post is made, and what is sought is to communicate the results. Several of these posts have had a high impact; for example, the editing of the Marine Mammals and Electrical Grids in Mexico books. The second type of post is related to activities that take place over the course of several days; for example, international conferences, dissemination seminars, as well as the oceanographic cruises carried out in the Caribbean and the Pacific by staff from the areas of currents, ecology and thermal gradient. Given that these actions were of great interest, an exhaustive approach was applied to their dissemination. The strategy was to post three times a day generally, so that the activities could be followed almost in real time. During these activities, comments and questions by people visiting the social media profiles of the projects were responded to quickly. In all cases, this action pro-



duced an increase in the number of website visits, as well as in the interactions with followers on social media.

During the COVID 19 pandemic, March 2020 - August 2021, the 1st CEMIE-Océano International Congress (August 2020) was held virtually, as well as the Virtual Workshop on Ocean Energy Sources 2021 sources (June 21 - 25, 2021), for which websites linked to the main page were developed. These pages allowed the registration of participants, interaction through virtual meetings, as well as access to materials and proceedings of each event. The experience acquired for these meetings have been replicated for subsequent CEMIE-Océano events, which, were held in hybrid format, with their own website to concentrate all the related information. Intensive dissemination actions have also been implemented for users who participate virtually, which includes speakers being requested to record their presentations as a video,

enabling those participating remotely to view the conferences afterwards, in the event of problems with internet connections. During these events, there is also someone from DDP in charge of monitoring social media to communicate questions and channel them directly to the speakers.

The CEMIE-Océano project began in January 2017 and, although its financing by the SENER-CONACyT fund ended in November 2022, the DDP line is still active, since large amounts of funding is not needed for the maintenance and operation of the website and its social networks, electronic book editing and publishing. These funds come from the non-profit CEMIE-Océano Civil Association. Once the objectives of the project proposed to the SENER-CONACyT fund had been met, this was the means selected by the project participants to continue with research and dissemination activities related to marine renewable energies in Mexico.

Implications

The website has been the means of dissemination to which all CEMIE-Océano activities are As of November 2022, when government funding ended, the page had had more than 159,000 visitors. Figure 1 shows the distribution February 2017 - November 2022. 76% of the users were from Mexico, 8.6% from the United States, 2.8% from Colombia, while users from France, Brazil, the United Kingdom, and Peru made up a further 1 %. The Facebook account has 3,340 friends, 50.3% of whom are women and 49.7% men. The Twitter account had 628 followers. Both social networks had 706 publications, obtaining a total reach on Facebook of 783,861, and on Twitter 305,854, interactions.

The events published with greatest impact on Facebook were the 8th International OTEC Symposium in January 2021 and the 2nd International CEMIE-Océano Congress in August 2022, this event also had the greatest impact on Twitter, with

17,980 impressions. It is worth noting that these social networks were used to disseminate only CEMIE-Océano's own activities or those of similar renewable energy organizations or projects; care was taken not to disseminate news or publications that were not related to the objectives of the project.

Regarding the theses database (<https://cemieoceanomx/tesis.php>), in the 5 years of the project, in 25 different institutions, 115 theses were registered, of which 59% correspond to undergraduates, 27% to a Master's degree, 16% to a Doctorate and 1% to specialization level. The articles and book chapters data base (<https://cemieoceanomx/articulos.php>) includes 127 articles that were published from 2017 – 2023. Figure 2 shows the distribution of the publications for each of the research line of the project.

Nine issues of the CEMIE-Océano newsletter were published in <https://www.cemieoceanomx/revista.html>. This bulletin describes the activities

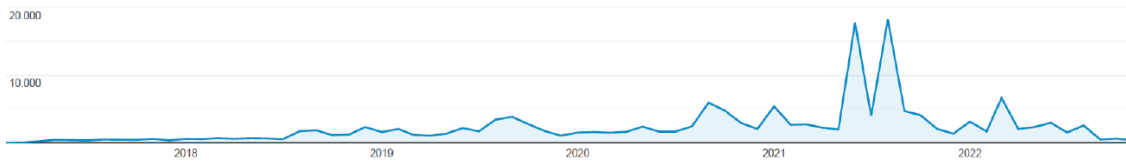


Figura 1. Figure 1. Number of visits to www.cemioceano.mx.

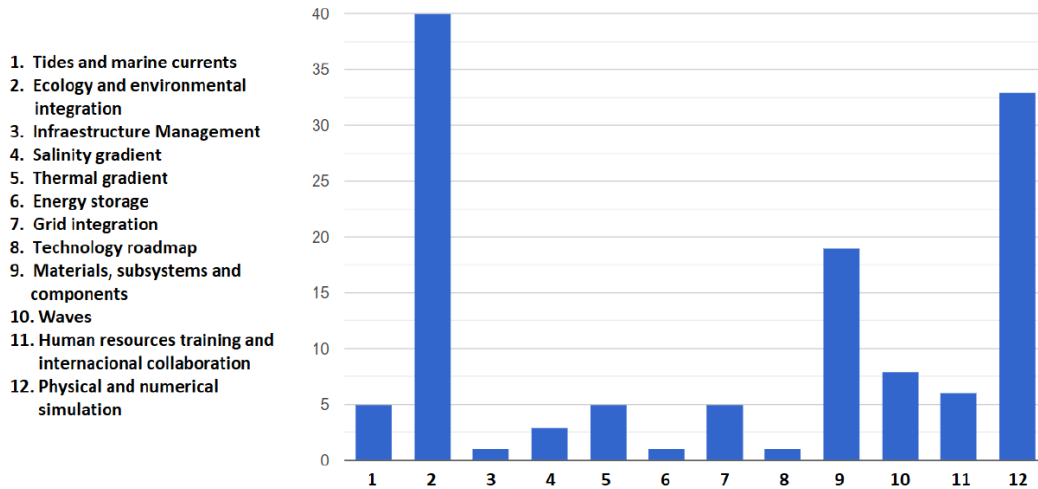


Figure 2. Distribution of published articles by line of work, CEMIE-Océano project.

of the participants, and also has articles of scientific dissemination that explain simply the findings obtained by the students and researchers involved in the project.

In addition to these means, the bulletin and books were also disseminated via mass mailings to the participants of the project, using tools such as MailChimp. The total number of downloads of the bulletin was 5,232, with issue 8 having the highest number (708).

The CEMIE-Océano books are store in <https://cemioceano.mx/libros/libros.php>. These books have been aimed at anyone interested in learning about marine renewable energies as well as at the scientific community.

The original proposal was to publish 7 books, yet by August 2023, 28 books have been published. Thanks to the ISBN and DOI that are linked to the CEMIE-Océano website, it is possible to know,

on a routine basis, the number of visits to, and downloads of, these products. Table 1 shows the titles of the books, their date of publication, the line of work to which they belong and the number of downloads. The most successful book published was the Atlas of Marine Mammal Distribution and Abundance in Mexican Waters (Heckelt *et al.*, 2018). Books related to ecology and environmental impact are the most numerous, followed by books in the lines of dissemination, outreach and press, thermal gradient and Grid Interconnection. Figure 3 shows the books published between 2017 and 2023, all the books are in Spanish except 8, which is in English.

To improve the dissemination of information on marine renewable energies across more sectors of the population, 20 high resolution infographics were published, covering all the lines of work in the project. These can be downloaded free of



Table 1. Books published in the CEMIE-Océano project.

| No | Title | Date | Downloads |
|----|---|------------|-----------|
| 1 | Ocean Thermal Energy Conversion (OTEC) | 12/06/2017 | 89 |
| 2 | Grid Interconnection and Energy Storage Systems | 12/19/2017 | 93 |
| 3 | Atlas of the Impact of the Ocean on Mexico's Climate | 09/12/2018 | 123 |
| 4 | Atlas of the Distribution and Abundance of Marine Mammals in Mexico | 12/10/2018 | 2165 |
| 5 | Electricity Grids: Wholesale Electricity Market in Mexico | 06/21/2019 | 1299 |
| 6 | Impact of the Ocean on Mexico's Bioclimate | 04/27/2020 | 274 |
| 7 | Energy from the Saline Gradient | 09/21/2020 | 535 |
| 8 | Atlas of Marine Mammal Distribution and Abundance | 09/24/2020 | 6209 |
| 9 | Foundation Design for Marine Turbines in Rocky Soils | 03/12/2021 | 406 |
| 10 | Birds of the Land of Swallows: Cozumel Island | 06/18/2021 | 443 |
| 11 | Impact of Sea Breeze and Wind on the Climate of Mexico | 06/25/2021 | 350 |
| 12 | 1er CEMIE-Océano Congress Abstracts | 24/08/2021 | 345 |
| 13 | Business Plan Focused on Research and Development Projects | 10/05/2021 | 382 |
| 14 | Guide for the Development of Life Cycle Analysis of Ocean Energies | 01/11/2022 | 469 |
| 15 | Climatology of Tropical Cyclones in Mexico | 01/12/2022 | 360 |
| 16 | Phytoplankton Catalog of Coastal Systems of the Gulf of Mexico and Caribbean Sea | 03/16/2022 | 470 |
| 17 | Terrestrial Vertebrates of Cozumel Island, Quintana Roo: Amphibians | 07/04/22 | 336 |
| 18 | Wave Power Energy in the Veracruz Coast, Mexico. A Geological-Geomorphological Evaluation of Suitable Sites for the Siting of Engineering Prototypes. | 07/12/22 | 297 |
| 19 | 2nd International Conference on Marine Energy CEMIE-Océano: Abstracts | 08/15/2022 | 430 |
| 20 | Current Status of Current Energy Devices | 08/12/2022 | 305 |
| 21 | Workshop on Technology Based Companies (TBC) and Business Models at CEMIE-Océano | 09/09/2022 | 257 |
| 22 | Spatial Distribution of the Energy Resource by Thermal Gradient in Mexican Seas | 10/04/2022 | 305 |
| 23 | Impact of the Ocean on the Climate of Coastal Zones in Mexico | 10/18/2022 | 291 |
| 24 | Environmental Assessment Methodology for Ocean Technologies | 10/19/2022 | 254 |
| 25 | Use of the Quality Function Deployment (QFD) Methodology for New Product Development: Nitriding with Stainless Steel Pastes to Increase Corrosion and Wear Resistance as a Case Study | 11/29/2022 | 493 |
| 26 | Technology Mapping Applied to New Materials Development: Nitriding of Stainless Steel Pastes as a Case Study | 11/29/2022 | 309 |
| 27 | Catalog of Aquatic Birds of the Ría Lagartos Lagoon | 04/01/2023 | 355 |
| 28 | Energy Potential of Marine Currents in Mexican Seas | 31/01/2023 | 263 |

charge from the website <https://cemieoceano.mx/infografias.html>. The total number of visits to this page has been 578.

Table 2 shows the type of events arranged, whether face-to-face, virtual or hybrid, the number of participants, the specific actions carried out by the DDP line and, if applicable, the link to where

the information or proceedings of the event can be downloaded.

We believe that the CEMIE-Océano project and its results have been successful and can be replicated. During the project, a dissemination and communication strategy was developed for both technical activities and for those of interest to the

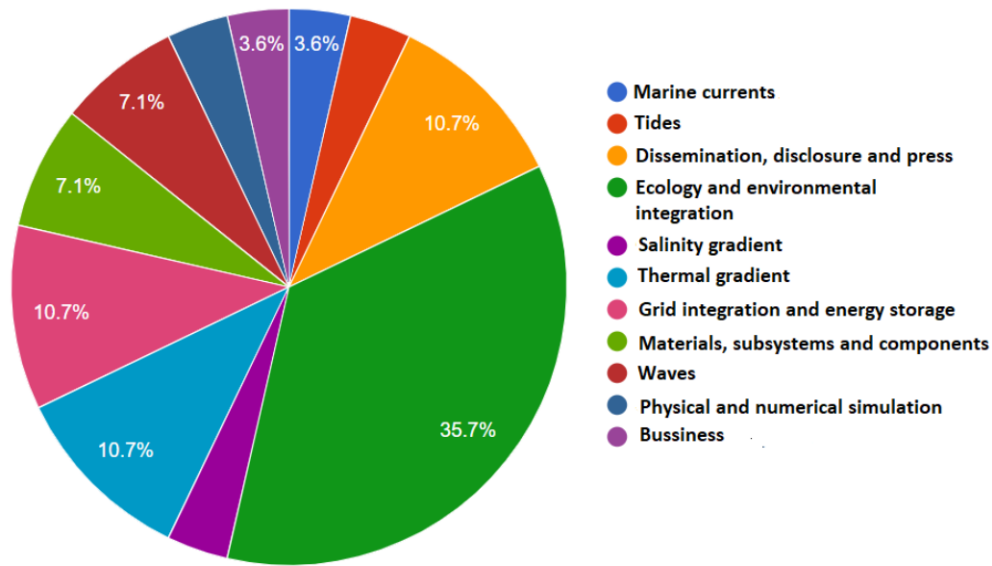


Figure 3. Books published by the CEMIE-Océano project for each line of research.

Table 2. Congresses and workshops held during the CEMIE-Océano Project.

| No | Number | Type | Participants | DDP actions | Link |
|----|---|-----------------|-------------------------------------|-----------------------------------|---|
| 1 | 1st International CEMIE-Océano Congress | Congress | 450 virtual | Website, dissemination, logistics | https://congresointernacional.cemioceano.mx/ |
| 2 | 2nd International CEMIE-Océano Congress | Congress | Hybrid: 85 face-to-face, 30 virtual | Website, dissemination, logistics | https://2docongresointernacional.cemioceano.mx/index.php |
| 3 | AMIP Special Session 2017 | Special Session | Hybrid: 8 face-to-face | logistics, dissemination | https://www.cemioceano.mx/AMIP.html |
| 4 | Virtual Workshop on Ocean Energy Sources 2021 | Workshop | 735 virtual | Website, logistics, dissemination | https://cemioceano.mx/tallervirtual/index.html |
| 5 | OTEC Congress | Congress | 80 virtual | Website | https://otecsypodium2020.cemioceano.mx/ |
| 5 | 3rd International CEMIE-Océano Congress | Congress | 80 face-to-face | Website, dissemination | https://3ercongresointernacional.cemioceano.mx/index.php |

general public, based on three actions: website and social networks, publication of a newsletter, infographics and books, and organization of meetings and congresses, with the website being the central action that supports the other activities due to its accessibility, as well as the large amount of informa-

tion that can be stored. This ranges from technical books to predominantly visual information such as infographics and includes the social networks Facebook and Twitter, which facilitate interaction between users and project participants. As stated in earlier this work, the interest of society, identified



through the increase in the number of visits to the website, interactions in social networks and consultation and downloading of academic products for each stage of the project, leads us to believe that

the project and its results have been a successful and replicable project for the general population and for the scientific community in Mexico and Latin America.

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