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PRIMARY RESEARCH

Critical review on marine energy in Chile

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Abstract

The energy problem is more present these days, therefore, this article discusses the current state and potential future directions for research and technological advancement related to using renewable energy in high seas, including marine eolian energy, ocean currents, olas, and salinity gradients in Chile. The potential for renewable resources in the high seas is examined considering the technical articles published in scientific journals. The development of new possible energies in Chile, what is done and some projects. However, nothing can be really done without a sustainability view in the marine renewable energy. Chile offers a significant potential for marine renewable energy, but these resources are starting to be commercialize however, Chile requires a larger investment in the field, the establishment of an appropriate regulatory framework, and the deployment of large-scale demonstration projects in the ocean.

I. INTRODUCTION

Global warming is making the summer and winter seasons in Europe and some parts of the world quite unusual, with record temperatures being recorded. The emission of carbon is contributing to this, therefore, it is necessary to reduce them, [1] and at the same time have new sustainable energies. This calls for innovation and new adventures to be able to cover the world's energy demand, establishing standardized measures that promote the circular economy [2], in order to obtain a green design plan, which must be developed and adapted to our days, where more people are living in this world.

The population is 8.0 billion (on the 15th of November 2022) and is expected to be 10.9 billion by the end of the century. With this, and the increasingly strong implementation of technology, the energy shortage becomes more and more visible, even more so, with the recent war in Ukraine. Our high carbon emissions derived from power generation, transportation, etc., have drastically accelerated climate change and, therefore, not only must they be reduced, but alternative sources must be sought to slow down said changes.

Therefore, our country offers a coastline of 6,435 km in length where multiple and varied opportunities can be exploited.

The energy problem (Greenhouse gas emissions)

Reducing carbon emissions is essential in the coming years. and the EU objective in 2030 is to reduce 50% or 55% of carbon emissions [1].

Then, increasing taxes on carbon emissions has been a measure imposed by several countries, so people will consume less, and emissions will be reduced. Unfortunately, however, this hits people with lower incomes the hardest [3]. At the same time, this creates new and clean technologies, relative market competition and innovation among companies seeking new investors.

Lately, in Europe they have effectively increased the carbon fee by one euro per tonne of CO_2, leading to a 0.73% reduction in emissions over time. The United Kingdom has increased by 7 euros per tonne of CO_2, to more than 36 euros between 2012 and 2018, as consequence of this emissions in the electricity sector fell to 73% in the same period [3]. For this reason, taxes play a fundamental role in the translation towards sustainable energy.

In Chile, it is applied to CO_2 emissions since 2017, mainly in

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the energy and industry sectors. It applies to facilities that emit 25,000 t CO_2 or more, as well as those that release into the atmosphere more than 100 tons of particulate matter per year. The tax covers all fossil fuels [4].

Chile is the largest producer of copper industries in the world. The largest copper reserve is in Chile, the first country in the world in this production. [5], World copper production is 19,500 thousand tons, and Chile produces 5,600, that is, almost 30% of world production. This 30% is transported by sea, which will be regulated by international and national standards and in accordance with a blue economy [**?**]. Within these regulations, the most common currently is that of MARPOL Annex VI chapter 4, regulation 19, where it applies to all ships equal to or greater than 400 GT, by phases established by date, 2013, (phase 0), 2015 phase 1 , 2020 phase 2 and 2025 phase 3, which contain their maximum EEDI Energy Efficiency design Index , resolution adopted by OMI on July 11, 2011 MERPC.203(62), [6]. Even so, they continue to emit, this is only a measure to reduce gas emissions, therefore, it is not a renewable energy.

Understanding that the previous measures are for the control of greenhouse effect emissions, even so, with these measures and many others adopted by the maritime industry, it is believed that the emissions of international maritime transport of 755 Mt CO_2 equivalent in 2018 will follow a trajectory linear by 2030, towards the international maritime sector goal of halving emissions by 2050 compared to the 2008 level [7].

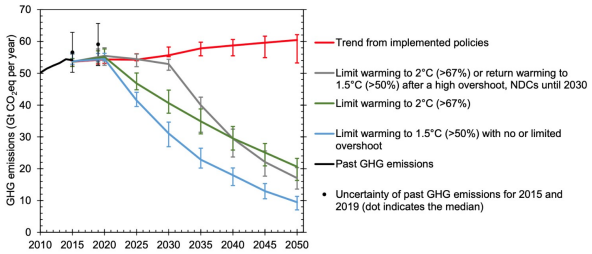

Fig. 1. Global GHG emissions of modelled pathways, and projected emissions

Source: The COP27 climate change conference status of climate negotiations and issues at stake policy department for economic [8]

Before, the available mitigation measures range from operational ones to high-capital technical solutions. Some of these techniques are air lubrication systems, wind energy, such as the cargo sailboat project of the Swedish company Wallenius Marine, which has designed a project for a wind-powered vehicle carrier that can transport from 6,000 to 7,000 vehicles, to reduce gas emissions by up to 90% for the Atlantic crossing.

The first ship will set sail in 2025 [9]. However, the category with the greatest potential is that of fuel and energy, which vary the number of barriers according to the type of fuel, influencing its storage, required machinery and the additional space that this entails, not to mention the supply infrastructure that in some cases applies.

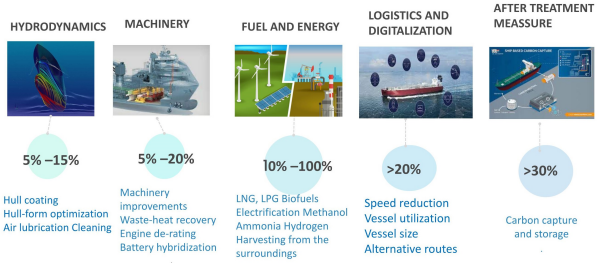

Fig. 2. GHG emissions reduction potential

Available technologies to decarbonize shipping

In this variety for larger ships, there are fewer alternatives, which are limited almost only to LNG and LPG, compared to smaller ships that circulate near the coast and travel shorter distances. For these there is a greater variety of propulsions, such as electric or hydroelectric power, including diesel/electric gas. For this reason, we must be attentive to the development of the propulsion of these ships in order to transfer these technologies to higher-altitude ships in the future [10].

Technologies available to decarbonize maritime transport and its potential to reduce GHG emissions. In a focus on fuels and energy.

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A. Availability of Energy in Chile

Chile offers a variety of important tidal currents such as the Chacao, Paso Ingles, 1ra y 2da Angostura, Paso Kirke [11]. In addition to the advantages that its waves and rivers offer us, we can classify the energies of the sea in [12]:

- Tidal energy uses the flow of the tides.
- Energy from ocean currents, obtained through the use of kinetic energy contained in ocean currents.
- Tidal thermal energy or thermal gradient uses the difference in temperatures between the bottom and the surface of the oceans.
- Blue Energy or osmotic power, produced from the difference in saline concentration of sea and river water.

Chile has a privileged wave energy potential worldwide. It is the largest energy resource in Chile, estimated at 240 GW, considering the more than 4,000 km of linear coastline [12]. However, studies have shown that there is a much smaller, but still significant potential coming from the tides [13].

B. But What is Already There?

The MERIC Technological Center installed the first full-scale marine energy converter in Chile her device was purchased by Enel Green Power and is installed two kilometers off the coast of Las Cruces, in the Fifth Region. From MERIC's measurement campaigns, [14] tidal resources are comparable to or greater than sites where the world's major tidal energy projects are being developed. Chile, due to the earthquakes, is an interesting field to experiment with, where there are already 30 inventions for energy from the sea, including desalination plants [15]. However, the cost of these technologies is quite high, which requires state financing.

Until now, the Port of San Antonio will have a green hydrogen plant with a wind power source 22 km from the port [16]. Another fast-advancing technology in wind farms, studies have been done for local farms located in Porvenir and Laguna Verde generating 90 KW for residential areas [17].

Now, if there were fields of wind farms, in the sea or coast, an issue that has already been investigated and projected for the Bay of Concepcion, generating 120 MW with 15 offshore wind turbines [18]. There are studies for floating wind platforms with depths of 50 to 80 meters and in other types of turbines with depths of 200 to 350 meters depth [19]. However, the associated costs of maintenance and inspections make it quite difficult. Even so, it continues to be investigated, finding varied information in this regard in recent years [20, 21, 22].

The role of the Navy should be a supervisory entity, in terms of pollution of the sea, that the concession given by the under the secretary of the Navy is respected, at the same time, obtain positions to inform the SHOA (Navy Hydrographic and Oceanographic Service), and update its publications, as well as if it affected in any way, the local coastal activity and its possible damages.

C. Questioning Of The Author

What would happen if Marine Energy in our country manages to achieve exceptional development in the next 50 years, but reaches the other extreme, and becomes a threat to the flora and fauna of the ocean and to human life? How much do we know about pollution regarding these new technologies? No conventional energy source (fossils) could have foreseen that it would end up destroying the planet. How different is the Maritime Energy that we want to adopt?

II. SUSTAINABILITY

According to the Cambridge dictionary Sustainability "is the quality of causing little or no damage to the environment and, therefore, capable of continuing for a long time" [23]. However, understanding sustainability is much more complicated, especially when we view it as an implementation science, where the lack of consistent definitions in the literature is rare [24].

A sustainability objective needs to be supported by 3 results, such as economic, social and environmental.

Fig. 3. Sustainability objectives (Source: Author)

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One way of thinking for the system about sustainable development, is for example, energy sources, how we can solve this problem in the population of low socioeconomic level removed from urban or large cities. Renewable energies can be the solution like the wind, the sun, the tides, even the waves.

The problem is to have access to these technologies, it can be a challenge, to have accessibility for anyone in some countries, so the government has to take additional measures and efforts.

III. GENERATION OF NEW ENERGIES

Undoubtedly, nuclear energy is the greenest, for the moment, however, what already happened in Japan in 2011 [25], gives rise to almost rule out our country completely due to seismic activities. Sierra Gorda in the Antofagasta region, is undoubtedly an ongoing project, including solar, wind, hydroelectric and battery power of a 220 kV power transmission line and a 33 kV/220 kV booster power substation. It is supposed to be 100% finished by 2023 [26].

Other interesting energy projects are underway in the Atacama region with a plant consisting of a 300 MW pumped hydroelectric plant that operates with seawater, located approximately 100 kilometers south of Iquique [27]. Some innovations in power generation from the sea are deep-sea hydrothermal vents on the seabed. Electricity can be generated through sulfide minerals that form in hydrothermal deposits on the seafloor, and these minerals can convert redox (reduction-oxidation) and thermal energy between hydrothermal fluids and seawater into electrical energy [28, 29, 30].

Then and better known is the kinetic energy generated by currents and eddies, which is linked to the Ocean General Circulation. Model (OGCM), (Eden & Boning, 2002). In turn, the structure of vertical eddies and the transfer induced by these in the Arabian Sea have recently been investigated [31]. As well as wave converters (WEC) already installed in various ports such as Spain (Valencia), Sweden, Italy, the Netherlands, and Germany [32].

IV. CONCLUSION

Global warming affects the environment in which we live, the future and future of the world are focused on it in a global context, hence the need and consistent measures adopted in various forums and organizations. In this context, our reality does not escape the phenomenon, so having a clear course that addresses these issues is not something desirable, but a priority to mitigate the effects of global warming. Our territory is home to a series of raw materials, which, combined with the productive capacity and willingness of those who have the destinies of our nation in their hands, acquire a substantial preponderance, making this challenge an opportunity to take leadership and generate a green industry.

Chile is a maritime nation and perhaps not yet a maritime power. However, the evidence supports that, throughout most of its history, different types of governments have made significant political efforts to transform the country into a maritime power and, over time, gain a better understanding of the benefits of reach this condition [33].

Compensating the economic cost that new technologies involve cannot always be beneficial for the final consumer, and consequently, the scientific study and the monetary value of the project that is decided to be undertaken in the future must be as "sustainable" as possible.

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