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Review Article

Harvesting the Tides: Integrating Renewable Marine Energy Generators into Commercial Port Infrastructure

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ABSTRACT

The energy demand at seaports is assessed in this article, along with the major energy consumers. In order to meet this energy demand with marine renewable energy sources, we examine numerous approaches. The best wind, photovoltaic, wave energy converters for installation at ports are reviewed. The energy demand development and port expansion plans are taken into account while creating a prospective analysis for the port of Valencia. We arrive to the conclusion that ports should take the lead in achieving energy independence by integrating renewable marine energy into their infrastructure.

Keywords: Wave Energy, Ports, Photovoltaic Energy, Wind Energy, Marine Renewable Energy, Greenhouse Gases

Introduction

Ports of entry use a lot of energy. Currently, depending on the type of consumer, a range of sources are used to meet the energy demand in ports. For instance, the current yard equipment used to handle cargo moving through port terminals often burns fossil fuels like petrol or oil, while the remaining port customers are primarily powered by electricity provided by the relevant distribution firm.

Since these terminals, particularly those devoted to the processing of containers, employ a lot of electrical machinery (ship-to-shore cranes, refrigerated container connections, etc.), they are the main source of energy demand at ports. However, there are additional locations where energy consumption arises, such as the common areas of ports (roads, open docks, etc.).

The ECOFYS research “Potential for Shore Side Electricity in Europe,” which was released in January 2015,[2] estimates that by 2020, the total energy demand of all merchant ships calling at European ports will be 3,543 GWh annually. According to the same study, this figure equates to roughly 0.1% of the total amount of energy consumed in Europe in 2012. The potential demand from the SPS is around 52 GWh per year, according to the report released by the Spanish Port System Authority (SPS) state port authority in October 2016 titled: “Measures for the provision of electrical supply to ships in the ports of general interest”.[3] There is a need to investigate alternative methods of generation that ensure autonomy and feasibility through self-supply because there aren’t many ports in the SPS that can fulfil the anticipated energy demand that will be needed in the near future.

When transitioning to cleaner generation sources and elevating the importance of generation from renewable sources, the goals outlined in the EU Commission message “Clean Power for Transport: European Strategy on Alternative Fuels,” COM (2013),[4,8] should be taken into account. The aforementioned prompts us to look for energy sources other than conventional fossil fuels to meet the increase in demand that is being created in ports and is anticipated to increase, primarily due to regulatory requirements to reduce emissions at a global level (and therefore also in maritime transport).

Energy efficiency presents ports with a chance to grow by reducing their reliance on conventional energy sources due to the uncertainty surrounding the evolution of energy prices, particularly in regards to fossil fuels. In this essay, we will assess the potential application of wave, wind, photovoltaic maritime energy converters to provide energy into a commercial port like Valencia. The port's energy usage is reviewed in Section 2 of this essay, with an emphasis on the energy produced at the port of Valencia. Section 3 reviews several maritime renewable energies that can be installed in port infrastructure. the modelling and calculation of the installed power of various marine energy producers in the Valencia port.

Marine renewable energies suitable for ports' infrastructures

The places that are closest to the eventual customer should be prioritised as the most ideal locations.

However, other factors including use compatibility, environmental impact, social impact, neighbourhood influence must be taken into account while choosing the best location.

The marine energy resources and their viability for seaport energy utilisation are briefly described and discussed below.

Offshore wind power

Since installation, operation, maintenance costs can only be justified when scaled up in offshore wind farms, large-scale wind energy production is disregarded for ports.[5-6] Some wind turbines can be integrated into port infrastructure, however installing a windfarm requires more space than is typically offered by the major ports.

Ocean thermal energy conversion (OTEC)

The temperature difference between the deep, cold ocean and the warm, tropical surface waters is used to generate power. OTEC facilities operate a power cycle and generate electricity by pumping massive volumes of deep, cold seawater and surface seawater. Recently, first OTEC commercialization has become economically appealing in tropical island communities where a substantial proportion of electricity production is relied on oil because to rising electricity costs, growing worries over global warming, a political commitment to energy security.[7]

However, this technology is only viable for large-scale production in offshore locations.

Marine current energy

Utilising the kinetic energy of sea currents is how to do this. Underwater wind turbines are used to convert this energy into usable form.[8] Due of the insufficient strength of the undersea currents near ports to power turbines, its use to ports is quite limited.

Tidal energy

Utilising tides caused by the gravitational pull of the sun and moon is known as tidal energy. Only places with a large variation between high and low tide are suitable for it.

Its foundation is the storage of water in a reservoir that has valves that permit water to enter for electric generation.[9] Since there is no discernible tide difference in Valencia, its application is impossible.

Wave energy

The usage of wave motion is known as wave energy. Since it depends on the friction between the air and the sea's surface, it happens erratically. The full potential of this technology is still being developed.[10]

If all locations with energy density from waves more than 5kW/m are taken into account, there is a potential of around 32,000 TWh per year, according to the Intergovernmental Panel on Climate Change (IPCC).[9] Europe is thought to have a potential of 1,000 TWh/year.[10] The so-called shoreline devices, which are wave power converters, merit particular attention because they can be coupled to port infrastructures, saving money on long-distance wire and deep-water anchoring.

Wind, photovoltaic and wave generators deployment assessment at the port of Valencia

The resource was assessed to be around 5.5 m/s based on a recent assessment report for the installation of wind energy generators at the port of Valencia, which is consistent with estimates from[6,7] when using the relevant extrapolation.

There are a number of choices for the deployment, whose total energy output would be around 37 GWh. According to estimates, this energy may provide about 50% of Valencia's port's energy requirements.

Figure 1

On the roof of a new vehicle storage silo, about 12,650 solar panels with a combined capacity of 5.5 MW and an annual net output of 8 GWh might be installed, providing nearly 10% of Valencia's entire energy needs.

Finally, there is a chance that wave energy converters will be built within the new breakwater of the port extension. This decision was made because it is uncommon to have the opportunity to design and construct the converter and breakwater at the same time. This presents us with the chance to create synergies and, as a result, lower the budget than if we built the two structures separately.

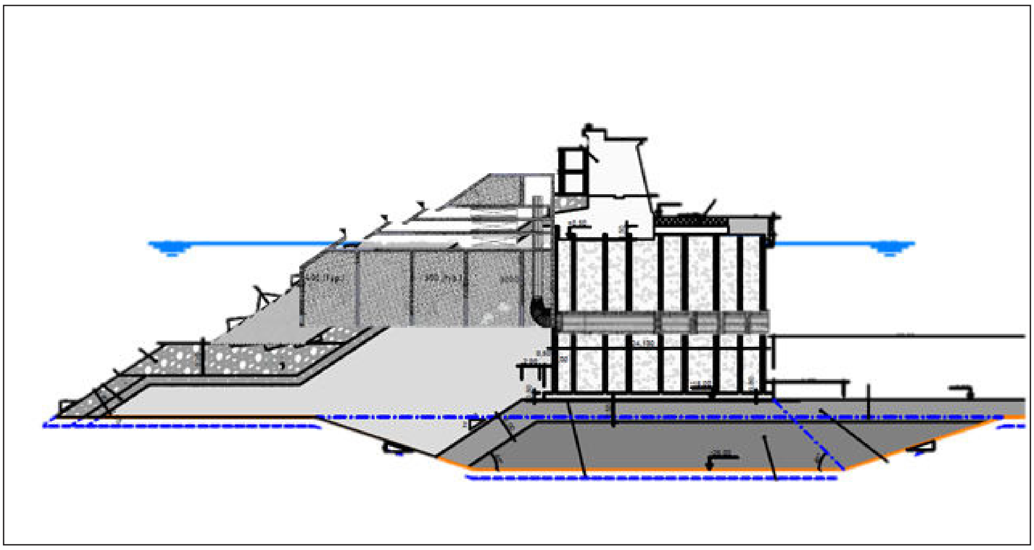

Figure 2.Simulation of OBREC integration into the new port's breakwater
source: port authority of valencia

The estimated annual energy production is 3 GWh. If we could secure the required funding for the three projects, the combined energy output might reach 48 GWh annually, which would be sufficient to meet 70% of Valencia's entire energy requirements. Based on the statistics, we predict that the three projects indicated above might lower the carbon footprint of the Port of Valencia by 25%.

Conclusion

Future increases in maritime transportation will result in significant energy demand from several sources, most likely from renewable ones. However, this energy shouldn't be taken straight from the grid or converted into electricity using fossil fuels; instead, we need to discover another method to ensure the ports' energy independence. Ports feature open areas, fences, breakwaters, other infrastructure that could be used to install renewable energy generators. Compared to other areas, such as off-shore or on-shore, this deployment has a little impact on the environment. The budget for the farm building might be viewed as part of the infrastructure if a port expansion is used as a justification for the installation of renewable energies in ports, the additional cost shouldn't be as high as if the farm is built on an existing port infrastructure.In this research, wave, wind, solar energy have been evaluated. The first findings are encouraging, as we might convert about 70% of the total electricity from the grid into renewable energy to meet the port's energy requirements. There are still certain financial and legal restrictions that need to be removed, but it won't be long before our ports have renewable energy generators installed to satisfy the Paris commitments.

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