Ocean-Based Renewable Energy Resources: Sustainable Solution to Growing Energy Demands

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Ocean-based renewable energy resources are considered the cornerstone for achieving sustainable blue growth because of their renewability and inexhaustibility. In the context of the growing demand for depleting and environmentally damaging fossil fuels, renewable energy resources provide sustainable solutions to ensure the energy security of a country. Marine Renewable Energy (MRE) resources are often used interchangeably to denote ocean-based resources. However, there are conceptual differences as MRE resources imply seawater's kinetic, potential, chemical or thermal properties. In this regard, the offshore wind falls under wind energy technology as a particular application and biofuels from marine biomass are regarded as a type of bioenergy. In line with this definition, ocean waves, tidal currents, tidal range, ocean currents, ocean temperature and salinity gradients fall under the rubric of MRE resources. Nevertheless, considering the more significant advantages, the potentials of all ocean-based renewable energy resources should be focused more than the conceptual symmetries and asymmetries.

The conventional utility of the ocean- based renewable energy resources lies in power generation, e.g., electricity through conversion technology. And these alternative sources of energy can contribute significantly to offset the traditional practices of greenhouse gas (GHG)-intensive electricity generation. Therefore, it is recognized as an important means to mitigate the adverse impacts of climate change by the Intergovernmental Panel on Climate Change (IPCC). The High-Level Panel for a Sustainable Ocean Economy (Ocean Panel) estimated that ocean-based energy solutions have the potential to reduce GHG emissions by nearly four billion tons of CO_2 equivalent per annum in 2030. Power generation through these resources has the enormous theoretical potential to produce a surplus after meeting the global energy demands. According to a 2020 International Renewable Energy Agency (IRENA) report, the estimated volume of global electricity production from all marine renewable technologies stands in the range of 45,000 to 1,30,000 terawatt-hours (TWh) per year, whereas the annual demand is 25,814 TWh. The ground-level reality is entirely different, as the cumulative global capacity to produce electricity through MRE resources in 2020 was only 535 megawatts (MW). The challenges to realising the true potential of ocean-based renewable energy resources are manifold. They stem from diverse areas of concern like technology, infrastructure, finance, policy, market, environment etc. Apart from the technological and financial inequality among the nation-states, the spatial distribution of the energy resources is also uneven across the globe. For example, waves are generally high at higher latitudes, while ocean thermal energy is mainly concentrated in the tropics. However, some general energy resources are available on every coast having utilitarian value to meet the local power demands.

The Bay of Bengal is considered as the lifeline of Bangladesh as it provides her only access point to the sea. It features a coastline of about 710 km extending from St Martin's in the south-east to the Sundarbans in the south-west. The long coastline and many small islands provide suitable locations for power generation due to the continuous presence of tides, wind and waves. In line with the global challenges, Bangladesh also faces similar obstacles due to the shortcomings in technological readiness. Of all the MRE technologies, tidal technologies feature the highest level of readiness and greater prospect for commercialization. However, in the context of Bangladesh, the progress is minimal despite having geographical suitability for power generation. Selecting a suitable spot is the first step in constructing a tidal power generation plant. The availability of high tide waves (>5m) and suitable embankment are two of the essential criteria in this regard. The other factors include considerable stability, locating away from the locality, transformation systems etc. Bangladesh has such coastal areas in Hiron Points, Sundarikota, Mongla, Char Changa, Cox’s Bazar, Golachipa, Patuakhali, Sandwip, Barishal etc. Those spots are potentially suitable for constructing a large tidal power plant as well as producing enough electricity from tidal waves. Being situated at the estuary of the Meghna river on the Bay of Bengal and having a tidal variation of 5-6m, Sandwip is the best spot for tidal power generation.

Wave is regarded as the secondary source of solar energy, which is abundant, accessible and sustainable. The kinetic energy contained in the wave energy is around 1000 times more than the wind. The available technological gateways of Wave Energy Converters (WEC) are broadly classified intothree: Oscillating Water Column (OWC), Oscillating Bodies (OB) and Overtopping. Considering Bangladesh's geographical and socio-economic context, OWC and Pelamis devices are the most suitable wave energy devices.

Name of the Station	Tidal Range (m)	Output Power (MW)
Sandwip	5.53	28.83
Cox's Bazar	3.54	11.82
Hiron Points	2.90	7.93
Golachipa	3.55	11.88
Patuakhali	3.54	11.82
Barishal	3.9	14.34
Sundorikota	4.78	21.54
Mongla	4.8	21.72
Char Changa	5.6	29.57
	Total	176.64

[Source: Roy, 2015]

Table 1: Probable Tidal Power Generation Stations and Estimated Output

The annual average of the wave power density is about 8-15 KWm-1 in the Bay of Bengal, which is considered a low concentration of energy (Boyle, 2012). Saint Martin, Kutubdia and Sandwip Islands can be considered the potential places where OWC's could be installed and power density would be optimal for cost-effective operation. The average wave height in Bangladesh's coastal area is about 1 to 2 metres, varying across the seasons. Based on everyday data on wave height, the average wave energy concentration is high between May and October in Bangladesh's coastal areas.

Wind energy has recently been popularised among the available avenues of renewable energy resources and the global scenario is moving fast in this regard. Bangladesh's long coastline provides a unique opportunity for wind turbines' electrification, and more techno-economic assessments should be conducted as early as possible. There are two wind battery hybrid power plants in Kutubdia, while another one in Chakaria of Cox's Bazar is being built. Several important plants are being planned in the coastal areas in order to tap the ocean-based wind energy, e,g, Matarbari 100 MW Wind Power Plant Project, Mongla 55 MW Wind Power Plant, Cox's Bazar 50 MW Grid-tied Wind Power Plant, Patuakhali 10 MW Wind Power Plant etc.

Location	Reference Height (m)	Annual-Average Wind Speed (m/s)
Cox's Bazar	10	2.42
Sandwip Island	5	2.16
Teknaf	5	2.16
Patenga Airport	5	2.45
Cumilla Airport	6	2.21
Khepupara	10	2.36
Kutubdia Island	6	2.09
Bhola Island	7	2.44
Hatia Island	6	2.08

[Source: Uddin et al., 2019]

Table 2: Feasibility of Wind Condition for Generation of Electricity at Different Places in Bangladesh

Harnessing the renewable and inexhaustible local resources to the fullest extent is key to ensuring the energy security of Bangladesh. The terrestrial energy resources are deemed limited due to the growing population. The ocean-based renewable energy resources are fundamental to achieving the Sustainable Development Goals (SDGs) and the National Determined Contributions (NDC) to tackle the adversities of climate change. In this regard, the Government of Bangladesh (GoB) has established a dedicated authority - Sustainable Energy Development Authority (SREDA), under the jurisdiction of the Power Division of the Ministry of Power, Energy and Mineral Resources. However, there should be a strong collaborative framework between SREDA and the maritime stakeholders like the Blue Economy Cell of the same ministry and other related authorities under different ministries. The coordination must be framed comprehensively to address issues like technological readiness, infrastructural development, developing commercially viable distributive mechanisms, etc.

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