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by Sanaul Haque

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Assessing the Importance of Implementing Floating Solar Farms as a Climate-Resilient Energy Solution for Flood-Prone Bangladesh

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Research Problem:

Installing solar farms is a suitable source of renewable energy in Bangladesh, given the availability of vast empty lands. Bangladesh's solar power system provides electricity to roughly 14 percent of its population [1]. While solar farms on land may seem ideal, what happens when they are installed in flood-prone areas of Bangladesh? The floods, which carry mud, debris, and other small objects compromise the structural integrity of the panels. The remaining dirt on the panels prevents it from operating at its optimal capacity. [2]. This research aims to investigate the environmental and socio-economic benefits associated with the implementation of Floating Solar Farms. While also diving into the infrastructural and regulatory barriers that could hinder the adoption of floating solar technology. Moreover, it will provide strategies for their widespread use.

Research Questions:

1. *What challenges make it necessary for Bangladesh to adopt floating solar technology?*
2. *How do floating solar farms compare to land-based solar installations in terms of environmental sustainability and socio-economic impact?*
3. *What policy, regulatory, or financial barriers could restrict the large-scale adoption of floating solar technology in Bangladesh?*
4. *What strategies can be proposed to support the integration of floating solar into Bangladesh's renewable energy development and climate resilience efforts?*

Existing Literature

(1) Bangladesh aims to have a high-income economic status by 2041. For this to be attainable, they require an annual GDP growth of 8% [3]. Bangladesh can assist this by incorporating more renewable energy across the country. As it is one of the most densely populated countries, it is important to fully utilize its scarce land. This makes the implementation of large solar farms illogical when there is a plethora of more dense energy sources [5]. The districts with the largest land solar farms in Bangladesh, including Sirajgonj, Feni, Rangpur, and Gaibandha [6], also happen to be the few districts severely affected by floods.

(2) Floating solar farms are significantly more desirable than other aquatic renewable energy sources like hydropower, as they can produce the same amount of energy while using a mere 1.2% the space. Using floating solar farms minimizes land-use disputes and eliminates habitat conversions. PFVs are positioned such that they receive more sunlight than their land counterparts [7]. FPVs can have a longer lifetime than land PV if the right materials are used [8].

(3) When UNDP tested a few projects in Bangladesh, they deduced that while Bangladesh has immense potential to expand off-grid renewable energy, there was an absence of policies and appropriate institutions. There is a myriad of problems that hinder the scaling in Bangladesh, ranging from a lack of human capacity, institutional readiness, policy, finance, a lack of regional cooperation, a lack of a mature market, and the awareness level [4].

(4) SREDA has been assigned to develop guidelines for the usage of floating solar farms [9].

Methodology:

Quantitative Component:

A comparative site-based analysis will be conducted to compare floating solar farms with nearby land-based solar installations. Energy yield, land/water use efficiency, carbon footprint, and socio-economic indicators are the quantities measured

The data to be collected:

- Energy performance metrics (kWh generated per unit area, water cooling effects)
- Environmental indicators (evaporation reduction, local biodiversity impact, CO_2 emissions avoided)
- Socio-economic outcomes (local income generation, land-use conflicts avoided)

A sample of 10 floating solar sites and 10 comparable land-based solar sites will be selected for the experiment and measured. Statistical tests (t-tests, ANOVA) will be used to compare the energy and environmental performances of FPV and land PV, and regression models will be used to analyze factors influencing the socio-economic impacts.

Qualitative Component:

Conduct in-depth interviews with 10 FPV project managers and their engineers. Also, interview (IDIs) 15 local community members who were directly affected by the projects (land and water). Interview 5 of the policymakers involved directly with SREDA.

Arrange focus group discussions (FGDs) with community leaders from the areas where the projects were done and low-scale fish farmers to better understand preconceived notions about FPV and land PV, as well as potential barriers.

Ethical Considerations:

Ethical approval must be obtained from a recognized institutional review board before data collection. All research activities must adhere to internationally accepted ethical guidelines for social and environmental research.

Informed consent will be obtained from all participants before interviews or focus group discussions. Participants will be fully briefed on the purpose of the study, their involvement, and their right to withdraw at any time without any consequence. Participants' consent will be documented.

Confidentiality and anonymity will be strictly maintained for all participants, sites, and organizations involved in the study. Identifiable information will be coded and securely stored. Any sensitive project data provided by companies or government institutions will be handled under signed non-disclosure agreements (NDAs).

Steps will be taken to ensure that there is no harm to communities living around solar project sites. All data will be stored in encrypted digital formats and destroyed after the required retention period. The study will comply with both institutional policies and the data protection laws of Bangladesh.

Research Topic:

This topic is timely and nationally significant. As Bangladesh faces growing concerns regarding land constraints and climate vulnerability due to a growing population, the expansion of renewable energy requires innovative solutions instead of traditional land-based energy. Floating solar technology provides a climate-resilient and land-efficient alternative. By comparing the performance, environmental benefits, and socio-economic implications of floating versus land-based solar farms, this research provides critical evidence that can assist policymakers, energy planners, and climate adaptation strategies in Bangladesh.

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