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# White Paper on Energy, Disaster, Climate Change: Sustainability and Just Transitions in Bangladesh

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This year is 'Mujib Year'- a year-long celebratory year of Bangabandhu's birth centenary. Father of the nation of Bangladesh put people first and for whose sake he dreamt of building a Golden Bengal *"Sonar Bangla*", a concept resembles very closely the long-term Sustainable Development pathway for humanity as a whole.

This white paper is prepared to serve as guide for the decision makers in the context of Bangladesh, who look for quick understanding and solution around energy sector and the link of it with new technologies, sustainable development, disasters and climate change, need and areas of targeted capital investment and overall sensitive policy intervention points. This article is meant for presenting some quick take home messages for policy makers, project developers and funding agencies. This has been prepared from the findings of the deep dive scientific research studies presented in fourteen scientific peer reviewed articles written by the subject experts and compiled in this volume 1 of the Bangabandhu Chair Special Issue of the International Energy Journal. We limit the take home massages to top twenty action items:

1. It is important for a 21st century fast growing economy like Bangladesh to put Sustainable Human Wellbeing at the heart of the Energy System Planning to make it resilient to Resource depletion, Disaster and Climate change at the same time meeting the increasing energy demand.
2. For operationalising the conceptual framework of sustainable development and SDGs there is a need for directing investment focus on five kinds of capital at national and subnational level: human capital, knowledge capital, manmade physical capital like energy infrastructure, social capital like community resilience, natural capital like coastal nature-based erosion protection.
3. Instead of the generic prescription of source diversification of the energy sector in Bangladesh it is better to focus policy and investment priorities on some sensitive intervention points in the energy supply sector that can trigger leapfrog in sustainable energy development for Bangladesh with social justice for economic growth. Focusing on Geothermal energy sources and Hydrogen, Bangladesh can make full use of the national gas infrastructure with trained manpower in the sector through global cooperation within 17 interlinked Sustainable Developmental Goals of 2015. Geothermal sources in Bangladesh can be used for meeting energy demand for providing space cooling services directly.
4. In all new buildings- commercial or residential, - operational cooling energy demand can be drastically reduced by almost 25% through the installation of state-of-the-art window designs. These can be made mandatory for all new buildings being constructed through scientifically defined new standard specification for windows tilt position and appropriate reflective coatings. This can generate local employment as well.
5. Bangladesh can make use of all roof top spaces in a fast urbanizing economy to capture full potential of solar energy and distributing it through either micro grid systems or through grid integration. Emerging photovoltaic technologies with the plasmonic metal nanoparticles can be used to enhance solar cell efficiency. This can create new jobs, engage national experts, laboratories and make solutions cheaper.
6. With increased penetration of variable energy sources, need for energy storage will also increase. Energy storage technology has advanced much going beyond currently practiced technology choice in Bangladesh. So, there is need for engaging experts to constantly set standards for identification and recommendation of technology choice for faster adoption and production domestically.
7. Need for cross sectoral activity coordination through artificial intelligence-based network systems will increase with variable energy source penetration and storage technology integration. Like many other countries with electrification of vehicles increased penetration of intermittent renewable sources in the grid through smart metering system needs to be planned from now to reap medium term and long-term benefit as early adopter. In transport sector, focusing on expansion of public transport by making it comfortable, user friendly, efficient and electricity dependent can reduce import demand of fossil fuel, reduce air pollution, provide storage technology support and mitigate climate change.

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8. To manage power distribution through grid integration reliably through electric vehicles and solar rooftop systems, the power system can be managed better by introduction of Artificial intelligence, combining load shifting and Time of Use (ToU) based electricity pricing. ToU based electricity pricing will encourage the consumer to be aware of using electricity properly benefiting not only themselves but also the utility.
9. With all possible and likely changes in power system, conventional generators cannot support this high and sudden ramp up of power. Consequently, larger grid investment is needed to meet this high peak demand. Again, over current flow during peak-hours can adversely affect the transmission lines and reactive power controlling devices which needs prior planning and technically trained human capacity.
10. Introduction of micro grid in remote and rural areas of the country can reduce the feeling of alienation and neglect of the people living in such remote areas of Bangladesh. This can prevent or discourage such estranged communities from indulging in terrorism and other illegal measures to express any form of dissent. Implementation of solar energy can give rise to a cultural movement and massive paradigm shift of the minds of the common people.
11. Scope for introduction of new biodiesel technology in Bangladesh need not be ignored within the portfolio of domestic energy sources and production will help in creating decent jobs and enhancing self-reliance in energy.
12. Among the different forms of renewable energy sources available, solar energy has the highest potential and feasibility for energy production in Bangladesh and can potentially replace fossil fuels in the future combined with other forms of dispatchable energy to meet the country's growth in energy service demands. However, there has been a growing market for PV cells in the form of microgrids. All these can aid in significant infrastructure development, economic growth, clean environment and better health of the people thus fulfilling the promise of a "golden" Bangladesh. However, there is an immediate need for focusing on educational programmes to create targeted capacity in new energy sectors.
13. It is essential to map multiple risks to energy infrastructures in Bangladesh including seismic risk. There is need for implementation of comprehensive seismic zoning to get site-specific probabilistic seismic hazard map for all major engineering constructions. Disaster risk reduction monitoring measures must be included as mandatory codes in construction and subsequent operation and maintenance to ensure resilient critical infrastructures for Bangladesh.
14. Systematic comprehensive assessment of coastal hazards, changing pattern and their impacts on various communities should be based on scientific tools, long-term knowledge, understanding, and familiarity of the coastal communities to the interconnected human-nature interface in the coastal areas to minimize vulnerabilities. State of the art education programmes for people can create societal and human capital for risk management proactively and significantly reduce post disaster damages and subsequent losses.
15. There is a clear need for continuous knowledge and human capital building through regular updates and participation in educational curriculum, student training; researchers, scientists, technology developers, relief workers, recovery managers, policy makers, financial institutions, to get introduced and ready for a new 21st Century job market for climate service, energy transition studies, disaster risk study, risk reduction and risk mitigating services by expanding joint-,regional-, cross institutional collaborations.
16. A sustainable energy sector needs to adopt a systemic approach through retraining, professional knowledge upgradation now. It needs to focus not only conventional knowledge of generation, transmission and distribution but also storage which provides scope for new job creation, enterprise development, supply chain and business model.
17. The transformative change which is essentially going to be climate resilient and economy wide and fast for Bangladesh need to be led by social actors like educational leaders, investors, entrepreneurs, role models, citizens, consumers , households enabled and supplemented by national policies/ creating new business opportunities, innovative product design and science driven choice making.
18. Policy makers in Bangladesh are overwhelmed with the estimates, results, and model predictions produced by multiple international agencies. There are many highly qualified local experts in national institutions who can be involved to create a larger pool of national scientific consultative group to overcome biases and decipher flow of knowledge from external agencies to develop concrete actions plans for national priorities when it is aiming for developed country status in next two decades.
19. Energy, Disaster, Climate Change, Digital technology, Application of artificial intelligence are the core areas of 21$^{st}$ century new knowledge, research and learning. Each higher educational institute in Bangladesh need to start teaching these fields of study and can collaborate with regional lead institutions to catch up. This can enlarge quickly the locally available adequately skilled manpower who will be the new entrants in the job market to create a new cultural revolution for making sustainable development context dependent.
20. Communication material for building awareness of changing scientific understanding of developmental processes relevant for local context for various stakeholder groups including citizens is an urgent need to enhance social acceptability for effective and inclusive governance of accelerated transitions in multiple directions within a short period of time.