

# **Impact of Solar-Powered Hybrid Cold Storage Solutions on the Agricultural Supply Chain in Bangladesh**

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## **Abstract**

Bangladesh's agricultural supply chain faces major challenges due to post-harvest losses and the high cost of traditional cold storage systems. This paper compares a solar-hybrid cold storage hub with a conventional system powered by grid electricity and a diesel generator. The comparison focuses on capital expenses and yearly operational costs, focusing on fuel and electricity as the main distinguishable factor between the two systems. This will help us to understand the financial realities of either approach when it comes to the agricultural supply chain. To provide another fair benchmark, the Levelized Cost of Cooling (LCOC) is calculated, showing the cost per kilowatt-hour of cooling for each system. The study also estimates how much agricultural produce could be preserved each year by adding such a cold storage solution, and how this preservation translates into higher farmer revenues at harvest-time market prices. The results suggest that solar-hybrid cold storage offers a more sustainable and economically viable option when considering the whole picture, from adding it to the supply chain to operating it over its lifetime. Our findings also suggest that such a system could be used as a hub for farming communities to store their produce for any amount of time in optimal conditions, strengthening food security and resilience in Bangladesh's agricultural supply chain.

## **Keywords**

Solar PV, Cold Storage, Supply Chain, Post-harvest losses.

## **Biographies**

**Fahim Ahmed** is an undergraduate student in the Department of Mechanical and Production Engineering (MPE) at Ahsanullah University of Science and Technology (AUST). His research interests lie in renewable energy, refrigeration, and the application of solar technologies in agricultural cold chain systems. He has strong competencies in design, robotics, and mechanical system analysis, with practical experience in automation and prototype development. He has also participated in projects related to robotics and simulation of mechanical systems, where he applied engineering principles to real-world problem solving. Beyond academics, he has demonstrated teamwork and technical creativity in multidisciplinary projects. His academic and involvement in multifarious projects reflect his aspiration to contribute to the advancement of sustainable energy technologies and the integration of robotics into mechanical engineering applications.

**Md. Mahdi Islam** is pursuing his Bachelor's degree in Mechanical and Production Engineering (MPE) at Ahsanullah University of Science and Technology (AUST). His areas of interest include fluid mechanics, HVAC systems, and sustainable energy-efficient technologies. He has developed skills in engineering design, technical paper writing, and collaborative project development. In addition to his coursework, he has been involved in academic research documentation, prototype design, and drafting technical manuscripts. He has participated in design-focused academic projects and workshops, further enhancing his technical and analytical abilities. His dedication to learning and

applying design principles has enabled him to contribute effectively to team-based projects. He aims to integrate his technical expertise, design capability, and writing skills to develop innovative engineering solutions that serve both industry and society.

**Kashbian Niloy** is an undergraduate student of Mechanical and Production Engineering (MPE) at Ahsanullah University of Science and Technology (AUST), Dhaka, Bangladesh. His academic and research interests include thermal systems, refrigeration, and renewable energy applications, particularly focusing on sustainable cold storage and solar-based solutions for rural communities. He has experience in academic writing, project-based research, and technical documentation. Beyond academics, he has demonstrated strong leadership skills through coordinating group projects, mentoring peers, and actively participating in team-based competitions. He has also been engaged in extracurricular activities that showcase his ability to manage teams, communicate effectively, and deliver results under pressure. His long-term vision is to contribute to the development of energy-efficient technologies that can improve agricultural sustainability in Bangladesh.