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## Final Report

# Market Survey to Assess Energy Performance of Selected Household Appliances

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## Disclaimer

This report, titled *Market Survey to Assess the Energy Performance Levels of Selected Household Appliances in Bangladesh*, has been prepared by Greenbud in collaboration with key stakeholders, including GIZ and SREDA. It provides a comprehensive assessment of the energy performance of selected household appliances in Bangladesh. The findings, analysis, and recommendations presented here are based on market surveys, consultations with stakeholders, and the available data at the time of publication.

While every effort has been made to ensure the accuracy and reliability of the data and analysis, Greenbud does not guarantee the completeness or accuracy of all information due to limitations such as variations in data sources, constraints in survey responses, and challenges related to testing infrastructure. The interpretations and recommendations should be considered for informational purposes only and are not intended to be legally binding or definitive.

Additionally, the report references international standards and methodologies, which may require adaptation to local contexts. Readers are advised to consult relevant regulatory bodies or experts before acting on the recommendations.

Greenbud disclaims any liability for decisions or actions taken based on the information provided in this report. Any errors or omissions are unintentional, and we welcome constructive feedback for future revisions.

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- **BDT**: Bangladeshi Taka
- **BDS**: Bangladesh Standards (Bangladesh Standard)
- **BERC**: Bangladesh Energy Regulatory Commission
- **BEE**: Bureau of Energy Efficiency (India)
- **BLDC**: Brushless Direct Current
- **BSTI**: Bangladesh Standards and Testing Institution
- **CAGR**: Compound Annual Growth Rate
- **CFM**: Cubic Feet per Minute
- **CFM/W**: Cubic Feet per Minute per Watt
- **EChob**: Energy Consumption of Hob
- **EEI**: Energy Efficiency Index
- **EU**: European Union
- **GB**: Guobiao (Chinese National Standards)
- **IEC**: International Electrotechnical Commission
- **IE**: International Efficiency (Efficiency Classes for Motors)
- **IS**: Indian Standard
- **kJ**: Kilojoule
- **kW**: Kilowatt
- **kWh**: Kilowatt Hour
- **LCCA**: Life Cycle Cost Analysis
- **MEPS**: Minimum Energy Performance Standards
- **MS**: Malaysian Standard
- **NBR**: National Board of Revenue (Bangladesh)
- **NEMA**: National Electrical Manufacturers Association (USA)
- **R&D**: Research and Development
- **R-600a**: Isobutane Refrigerant
- **SLS**: Sri Lanka Standard
- **SREDA**: Sustainable and Renewable Energy Development Authority (Bangladesh)
- **TCVN**: Vietnamese Standards (Tiêu chuẩn Việt Nam)
- **USD**: United States Dollar
- **Wh**: Watt Hour
- **η**: Thermal Efficiency (Greek letter Eta)

# Executive Summary

As Bangladesh undergoes rapid economic growth, urbanization, and increased electrification, the demand for household appliances has surged. This growth reflects a shift in living standards and consumer preferences, representing a significant step toward modernization. However, while this progress enhances living standards, it also presents substantial challenges, including escalating energy consumption and added strain on the national power grid. To address these challenges, it is crucial to focus on improving energy efficiency in household appliances. By enhancing energy efficiency, the country can mitigate rising energy demand, reduce greenhouse gas emissions, and align with sustainable development goals, ensuring long-term economic and environmental sustainability.

**The Regulatory Environment**

Bangladesh has established energy efficiency standards for certain household appliances, particularly refrigerators and ceiling fans. The Bangladesh Standards and Testing Institution (BSTI) has implemented standards such as BDS 1850:2012 for refrigerators and BDS 1860:2012 for ceiling fans. These standards include star rating systems that help guide consumers toward energy-efficient choices. However, there are significant gaps in the regulatory framework. Appliances like rice cookers, induction cookers, and household induction motors lack specific energy efficiency standards and labeling systems. This absence limits the promotion and adoption of energy-efficient models in these categories.

Key governmental and institutional players, including the Sustainable and Renewable Energy Development Authority (SREDA), BSTI, and the National Board of Revenue (NBR), play crucial roles in policy development, enforcement, and the promotion of energy conservation measures. Despite their efforts, Bangladesh's energy efficiency standards remain behind international best practices. For example, refrigerators in Bangladesh consume significantly more energy than those in developed markets, and the current labeling systems fail to provide comprehensive energy consumption data.

**Market Data Analysis**

An in-depth analysis of the market reveals varying levels of energy efficiency across different household appliances:

- **Refrigerators and Freezers:** The energy consumption of refrigerators in Bangladesh varies widely, with capacities ranging from 200 to 320 liters and energy consumption between 45.4 watts and 197 watts. The adoption of inverter technology, found in approximately 88% of surveyed units, has significantly reduced energy usage. The use of R-600a refrigerant has improved cooling efficiency and reduced environmental impact due to its lower global warming potential. Advanced insulation in 5-star rated models further minimizes energy loss.
- **Ceiling Fans:** Ceiling fans are common in Bangladeshi households, largely due to the tropical climate. Standard models consume about 75 watts, while energy-efficient models use as little as 60 watts. The airflow efficiency of locally available fans ranges from 2.93 to 3.81 cubic meters per minute per watt, which is below the international benchmark of over 4.0 cubic meters per minute per watt.

- **Rice Cookers and Induction Cookers:** These appliances are becoming increasingly popular, but the lack of standardized energy efficiency testing makes performance comparisons challenging. Rice cookers typically consume between 600W and 1,100W, while induction cookers consume between 1,200W and 3,500W. Variability in efficiency is due to differences in component quality and design.
- **Household Induction Motors:** Primarily used in appliances like water pumps, these motors range from 0.75 kW to 3 kW in power. They tend to be less efficient than international models that adhere to higher efficiency standards, such as the IE3 and IE4 classifications.

**Defining Minimum Energy Performance Standards (MEPS)**

To enhance energy efficiency, this report proposes the establishment of Minimum Energy Performance Standards (MEPS) for various appliances:

- **Refrigerators**: Adopt a MEPS equivalent to a 3-star rating under the BDS 1850:2012 standard, with a maximum energy consumption ratio of 0.069 kWh per liter. For a standard 400-liter refrigerator, this translates to approximately 955 kWh per year. A life cycle cost analysis reveals that, despite higher initial costs, 5-star models offer lower total costs over a 10-year lifespan due to significant energy savings.
- **Ceiling Fans**: Propose MEPS based on fan size, recognizing that many local fans fail to meet current minimum standards. Suggested minimum airflow efficiency values are 2.10 cubic meters per minute per watt for 56-inch fans, 2.50 for 48-inch fans, and 2.30 for 38-inch fans.
- **Rice Cookers**: Given the lack of existing standards, it is recommended to adopt a thermal efficiency of 70%, in line with regional standards, until local standards and testing facilities are established.
- **Induction Cookers**: Suggest adopting the Indian standard IS 19014:2022, with a MEPS of energy consumption not exceeding 195 Wh per kilogram, aligning with European Union standards.
- **Household Induction Motors**: Initially propose adopting IE1 efficiency levels as per IEC 60034-30-1, setting a baseline until local testing facilities and data are developed.

Robust testing protocols are essential for enforcing Minimum Energy Performance Standards (MEPS) and ensuring compliance:

- **Current Practices:** Established standards exist for appliances such as refrigerators and ceiling fans. However, appliances like rice cookers, induction cookers, and household induction motors lack specific local testing standards. This gap creates challenges in promoting energy efficiency for these products.

**Developing Testing Methods**: It is proposed to establish standardized testing methodologies for appliances that currently lack clear protocols:

- **Rice Cookers**: Measure the energy required to boil a specific amount of water under controlled conditions to assess the appliance's efficiency.

- **Induction Cookers**: Conduct thermal efficiency tests by evaluating the energy transferred to cookware, specifically measuring the time and energy needed to heat water from ambient temperature to boiling point.
- **Household Induction Motors**: Perform dynamometer testing to compare mechanical output with electrical input under various load conditions.
- **Capacity Building**: It is crucial to strengthen local testing laboratories by investing in advanced equipment and providing training for personnel to meet international standards. Standardizing test reports will enhance transparency and enable more accurate comparisons of appliance efficiency.

**Economic Analysis**

The adoption of energy-efficient appliances faces several economic challenges:

- **Price-Efficiency Dilemma**: Energy-efficient appliances typically have higher production costs due to advanced technologies and materials, which results in higher retail prices. In price-sensitive markets like Bangladesh, this poses a barrier to widespread adoption.
- **Energy Savings vs. Price**: Despite the higher initial costs, energy-efficient appliances offer substantial long-term savings:
    - **Refrigerators**: Energy-efficient models can save approximately 1,500 BDT per year, allowing consumers to recover the higher upfront costs within a few years.
    - **Ceiling Fans**: BLDC fans significantly reduce energy consumption, with a payback period of 2-3 years due to savings on electricity bills.
    - **Rice Cookers and Induction Cookers**: These appliances provide annual savings that can gradually offset the price difference over time.
    - **Household Induction Motors**: Efficient motors can recover their higher costs within two years through energy savings.
- **Supply Chain Dynamics**: High production costs are driven by the need for premium components and advanced manufacturing processes. Additionally, supply chain complexities, such as reliance on imported materials and multiple intermediaries, contribute to the elevated retail prices.

**Recommendations for the Future**

To address existing challenges and promote energy efficiency, the report recommends the following:

- **Policy Measures**:
    - **Establish and Enforce MEPS**: Formalize Minimum Energy Performance Standards (MEPS) for a wider range of appliances and ensure compliance through regulations and penalties.
    - **Expand Energy Efficiency Labeling**: Develop comprehensive labeling programs for more appliances to inform consumers and encourage manufacturers to prioritize efficiency.

    - **Financial Incentives**: Offer subsidies and tax breaks to manufacturers, provide consumer rebates, and reduce import duties on energy-efficient components.
    - **Appliance Replacement Programs**: Encourage consumers to replace inefficient appliances with energy-efficient models by offering discounted prices.
    - **Strengthen Institutional Frameworks**: Enhance the capabilities of institutions like SREDA, BSTI, and testing laboratories through training and resource allocation.
    - **Facilitate Green Financing**: Promote access to low-interest loans or grants for investments in energy-efficient technologies.
- **Consumer Awareness Campaigns**:
    - **Nationwide Campaigns**: Use various media platforms to educate consumers on the benefits of energy-efficient appliances.
    - **Educational Programs**: Partner with educational institutions and community organizations to foster a culture of energy conservation.
    - **Digital Platforms**: Utilize social media and online tools to reach broader audiences with interactive content.
    - **Incentive-Based Campaigns**: Promote financial incentives and collaborate with utility companies to encourage adoption.
    - **Targeted Outreach**: Develop tailored strategies to engage rural areas and diverse demographic groups.
- **Supporting Local Manufacturers**:
    - **Government Incentives for Innovation**: Provide financial support for research and development in energy-efficient technologies.
    - **Access to Advanced Technologies**: Establish technology hubs and training centers to equip manufacturers with modern tools and knowledge.
    - **Capacity Development**: Implement training programs focused on energy-efficient design and manufacturing processes.
    - **Streamline Supply Chains**: Incentivize local production of energy-efficient components to reduce costs and reliance on imports.
    - **Encourage Collaborations**: Facilitate partnerships with international firms for technology transfer and knowledge sharing.

The findings highlight the substantial potential for energy savings and the critical need to advance energy efficiency in Bangladesh. While progress has been made, especially in establishing standards for certain appliances, significant gaps remain. Addressing these gaps requires a comprehensive approach that includes regulatory improvements, economic incentives, capacity building, and extensive consumer education.

By expanding regulatory frameworks to cover a wider range of appliances, enhancing testing infrastructure, and offering financial incentives, Bangladesh can encourage both manufacturers and consumers to adopt energy-efficient technologies. Increasing consumer awareness about the long-term benefits and promoting cross-sector collaboration will further support this transition. Embracing energy efficiency is not only essential for reducing national energy consumption and mitigating environmental impacts, but also for enhancing the quality of life for citizens.

# 1. Introduction

## The Rising Tide of Energy Efficiency in Bangladesh

### 1.1 The Urgent Need for Change

Bangladesh stands at a pivotal moment in its development journey, where rapid industrial growth, urbanization, and the increasing electrification of households have resulted in a sharp rise in energy demand. The country's energy resources are under tremendous pressure, with the household sector contributing significantly to the national energy consumption. From refrigerators and freezers to ceiling fans, rice cookers, and induction cookers, these appliances are ubiquitous in homes across Bangladesh, representing both comfort and convenience. However, their widespread use also results in a significant energy consumption footprint.

The critical question for Bangladesh now is how to meet this growing energy demand while ensuring economic growth and environmental sustainability. Energy efficiency is not just a solution—it's a necessity. A more energy-efficient Bangladesh will reduce the strain on its energy resources, cut down on household electricity bills, and play an integral role in mitigating the adverse effects of climate change.

The urgency for promoting energy-efficient appliances is also tied to the country's goals outlined in the **Energy Efficiency and Conservation Master Plan (EECMP)**, led by the **Sustainable & Renewable Energy Development Authority (SREDA)**. The EECMP presents a roadmap to achieve substantial energy reductions in the residential sector, which alone can result in up to a 28.8% decrease in the total energy consumption in the residential sector. This is a significant target, given that households account for nearly 30% of the country's total energy use. If realized, these reductions would enhance Bangladesh's energy security while positioning the nation as a regional leader in energy conservation.

As the demand for electricity rises, so do the stakes. This report addresses the crucial need to evaluate and improve the energy efficiency of household appliances in Bangladesh. It explores the current market landscape, analyzes the energy performance of key appliances, and recommends policy measures to support the widespread adoption of energy-efficient products.

### 1.2 Scope of the Study

This report is the result of an in-depth market survey focused on assessing the energy performance of five key household appliances in Bangladesh: **refrigerators, ceiling fans, rice cookers, induction cookers**, and **household induction motors**. These appliances were selected because of their significant contribution to household energy consumption and their presence in almost every Bangladeshi home. The study was conducted to create a comprehensive picture of the current market and to understand the energy efficiency challenges posed by these products.
The primary objectives of this study are:

- **Mapping the current market**: Understanding the scale, production, imports, and overall market dynamics for these appliances.
- **Assessing energy performance**: Evaluating the energy consumption and efficiency of these products through market analysis and product testing.
- **Identifying market barriers**: Understanding the challenges faced by manufacturers and consumers in adopting energy-efficient appliances.
- **Recommending energy efficiency standards**: Proposing new measures to improve appliance efficiency, including the adoption of **Minimum Energy Performance Standards (MEPS)**.

The study also highlights the barriers to promoting energy-efficient appliances, such as the lack of consumer awareness, outdated standards, and market resistance to higher upfront costs. By addressing these challenges, this report aims to provide policymakers, manufacturers, and consumers with the insights needed to improve energy efficiency and reduce energy consumption at the household level.

## 1.3 The Path Forward

This report is structured to provide a logical flow from the current state of energy efficiency in Bangladesh to the recommendations necessary for fostering a more sustainable future. It begins with an in-depth analysis of the current market landscape, exploring the size of the market, the key players, and the challenges they face. This is followed by a detailed review of the regulatory environment, comparing Bangladesh's current energy efficiency standards with international best practices.

The core of the report focuses on the market performance analysis of each selected appliance, providing a thorough assessment of their energy consumption and efficiency levels. The report then moves on to establish Minimum Energy Performance Standards (MEPS) for each appliance, based on the findings from the data analysis and product testing. Additionally, it reviews the existing testing protocols and proposes improvements to ensure that appliances meet the new standards.

Finally, the report concludes with recommendations for future policy measures, focusing on how Bangladesh can continue to improve energy efficiency through consumer awareness campaigns, market interventions, and support for local manufacturers. These recommendations are designed to help stakeholders in Bangladesh drive the adoption of energy-efficient products and ensure that the nation remains on the path toward a sustainable and energy-conscious future.

By following this structure, the report not only sheds light on the current state of energy efficiency in Bangladesh but also provides a roadmap for creating a market where energy-efficient appliances are the norm. It underscores the importance of aligning the country’s energy efficiency efforts with global standards, ensuring that Bangladesh can achieve its sustainability goals while enhancing its energy security.

# 2. Current Market Landscape

In Bangladesh, the market for energy-efficient household appliances has been steadily growing, driven by a combination of economic growth, rising incomes, urbanization, and increased electrification. Consumers are now more aware of energy-saving technologies, which is reflected in their growing preference for energy-efficient appliances across the country. This trend is evident in the widespread use of appliances such as refrigerators, ceiling fans, rice cookers, induction cookers, and induction motors, which are integral to daily life in both urban and rural areas.

## 2.1 Energy-Efficient Appliances in Bangladesh

In Bangladesh, the market for energy-efficient appliances has experienced substantial growth over the last decade, driven by both government initiatives focused on energy conservation and the increasing availability of locally produced, affordable options. Key domestic manufacturers like Walton, Gazi, and PRAN-RFL have made notable strides in producing energy-efficient appliances to meet the needs of the Bangladeshi market, especially in widely used categories such as ceiling fans, refrigerators, and freezers. According to our survey, over 55% of these appliances are manufactured domestically, reflecting a strong trend toward local production, although imports still play a critical role in meeting overall demand.

To guide consumers in making energy-efficient choices, the Bangladesh Standards and Testing Institution (BSTI) has introduced a star rating system for certain appliances, such as refrigerators and ceiling fans. This rating system, which ranges from 1-star to 5-star ratings, helps consumers identify products that offer better energy efficiency, with 5-star rated appliances being the most efficient. While the presence of this labeling system is an essential step towards promoting energy conservation, its coverage is limited, as it currently does not include products like rice cookers or induction cookers, which remain popular in households across the country.

The Sustainable and Renewable Energy Development Authority (SREDA) in Bangladesh has implemented an energy labeling program to promote energy efficiency across various household appliances and industrial equipment. SREDA's energy labeling program is a crucial initiative aimed at enhancing energy efficiency across various appliances and equipment in Bangladesh. Established under the Sustainable and Renewable Energy Development Authority (SREDA), the program focuses on prescribing Minimum Energy Performance Standards (MEPS) and implementing a labeling system that categorizes appliances based on their energy efficiency. This regulation not only provides consumers with transparent information regarding the energy consumption of products but also encourages manufacturers to produce more efficient appliances. The Bangladesh Standards and Testing Institution (BSTI) is responsible for determining and revising these standards, ensuring compliance among traders and sellers. Initially, the program has targeted specific appliances such as ceiling fans, LED lamps, room air conditioners, and refrigerators, promoting a voluntary phase of MEPS and star rating labeling to guide consumer choices towards more energy-efficient options. By fostering a market-driven approach to energy efficiency, SREDA aims to reduce overall energy consumption, thereby supporting sustainable development goals in the country.

Despite the growing domestic production, the market remains segmented. Imported brands such as Samsung, LG, and Panasonic dominate the high-end segment with advanced energy-efficient models, although their higher price points make them less accessible to average consumers. Consequently, premium energy-efficient appliances are primarily found in urban markets where higher incomes and greater energy awareness influence purchasing behavior, whereas rural areas continue to favor lower-cost, less efficient appliances. Expanding awareness and accessibility for energy-efficient products, along with broader application of the BSTI star rating system, will be crucial to addressing these disparities and promoting energy efficiency more widely across Bangladesh.

### 2.1.1 Refrigerator

The refrigerator market in Bangladesh is a rapidly expanding sector, driven by increasing urbanization, rising disposable incomes, and a growing demand for energy-efficient home appliances. In recent years, the market has shown substantial growth, with both local and international players offering a wide range of products. This section delves into the market size, production capacity, and energy efficiency trends that characterize the refrigerator market in Bangladesh.

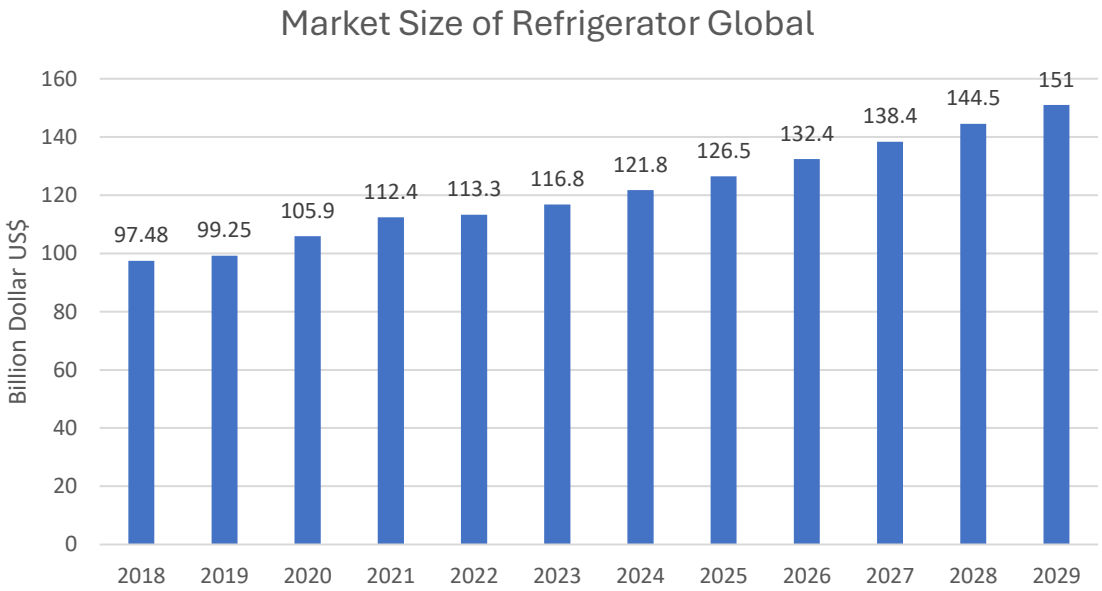



Figure 1*: Market Size of Refrigerator Global*

This chart illustrates the growth trend in the global refrigerator market from 2018 to 2029. It shows a steady increase in market size, rising from USD 97.48 billion in 2018 to a projected USD 151 billion by 2029. This represents a significant global demand for refrigerators, driven by various economic, technological, and demographic factors.[1]

In 2018, the market was valued just below USD 100 billion, and it surpassed the USD 100 billion mark in 2019.

The chart highlights a consistent upward trajectory, with the market growing at a solid pace each year. By 2024, the market size is expected to reach USD 121.8 billion, and by

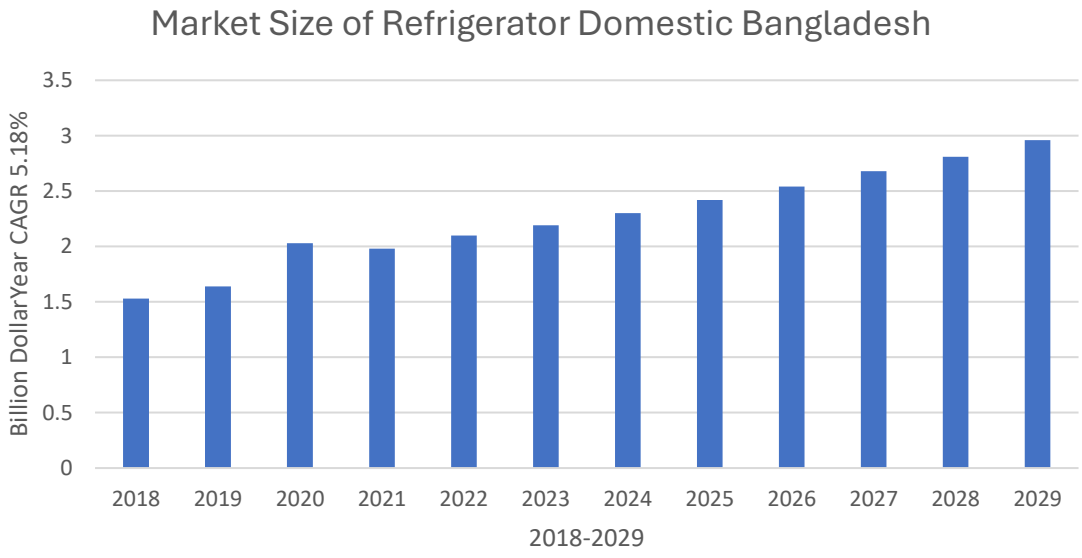



*Figure 2: Market Size of Refrigerator Domestic Bangladesh*

2029, it is projected to hit USD 151 billion.[1]This chart provides a visual representation of the growth trend in the refrigerator market in Bangladesh from 2018 to 2029. The chart indicates a steady increase in market size, with a Compound Annual Growth Rate (CAGR) of 5.18%. Starting at just over USD 1.5 billion in 2018, the domestic refrigerator market shows a consistent upward trajectory, projected to reach nearly USD 3 billion by 2029.[2]

The dominance of local manufacturers is a defining feature of the Bangladeshi refrigerator market. Over 95% of the market is controlled by domestic brands, with Walton, Minister, and Jamuna emerging as key players. Walton, in particular, has cemented its position as the leading brand, known for producing high-quality refrigerators at affordable prices, catering to a broad segment of Bangladeshi consumers.

Local manufacturers, such as Walton and Jamuna, have invested heavily in expanding their production capacities and integrating advanced energy-efficient technologies into their products. Walton has even ventured into vertical integration, producing critical components like compressors in-house, which gives the company a competitive edge in terms of cost control and quality assurance. On the other hand, global players like Samsung have recognized the potential of Bangladesh as a manufacturing hub, establishing facilities that not only contribute to local employment but also transfer advanced production technologies to the domestic market.

The trend towards energy efficiency is further evidenced by the widespread adoption of inverter compressor technology, which adjusts the compressor speed according to cooling demand. This innovation leads to significant energy savings, especially in a market where electricity costs are a major concern for households. Furthermore, R-600a refrigerant, known for its eco-friendliness and energy-efficient properties, is used in 100% of the surveyed refrigerators in Bangladesh. This universal adoption of R-600a reflects a strong market shift towards sustainability and adherence to global environmental standards.

In terms of energy efficiency ratings, approximately 88% of the locally manufactured refrigerators carry the highest BSTI 5-star rating, underscoring the emphasis manufacturers place on offering top-tier energy-saving options. A smaller proportion, around 2%, is rated 4-star, and about 10% of the models surveyed did not display any energy star rating. This suggests either older models or those that are yet to be certified for energy efficiency.

The demand for refrigerators in Bangladesh is growing at an annual rate of approximately 10%, with unit sales of around 3.3-3.5 million units each year. This robust growth highlights the increasing purchasing power of Bangladeshi consumers and the essential nature of refrigerators as household appliances. Notably, the mid-range price segment (BDT 40,000 to BDT 80,000) dominates the market, accounting for approximately 44% of all sales. These models typically include energy-efficient features like inverter compressors, offering a balance between price and performance that appeals to a broad base of consumers.

In summary, the refrigerator market in Bangladesh is not only growing in size but also evolving in terms of energy efficiency and technology. With a strong presence of local manufacturers and the increasing adoption of advanced, energy-saving technologies, the sector is well-positioned to meet the demands of a more environmentally conscious consumer base.

### 2.1.2 Ceiling Fan

The ceiling fan market in Bangladesh is a vital segment within the broader household appliance sector, particularly due to the country's tropical climate, where cooling solutions are essential year-round. This segment has seen consistent growth, driven by increasing urbanization, rising incomes, and consumer demand for energy-efficient and technologically advanced ceiling fans. With a growing focus on reducing electricity costs, energy efficiency has become a key differentiator in this market, attracting both local manufacturers and international brands.

This chart illustrates the projected global market size growth for ceiling fans from 2022 to 2030. The chart shows a steady increase in market revenue, starting at USD 11.49 billion in 2022 and growing to an estimated USD 17.50 billion by 2030, reflecting a Compound Annual Growth Rate (CAGR) of 5.4%.[3]

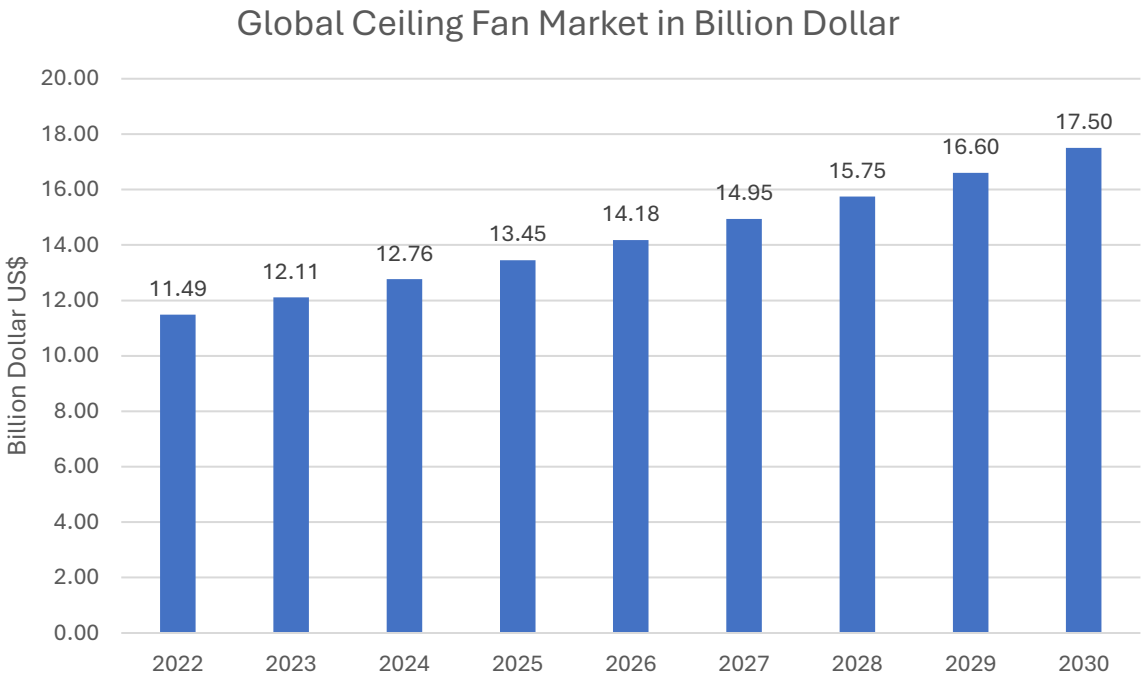
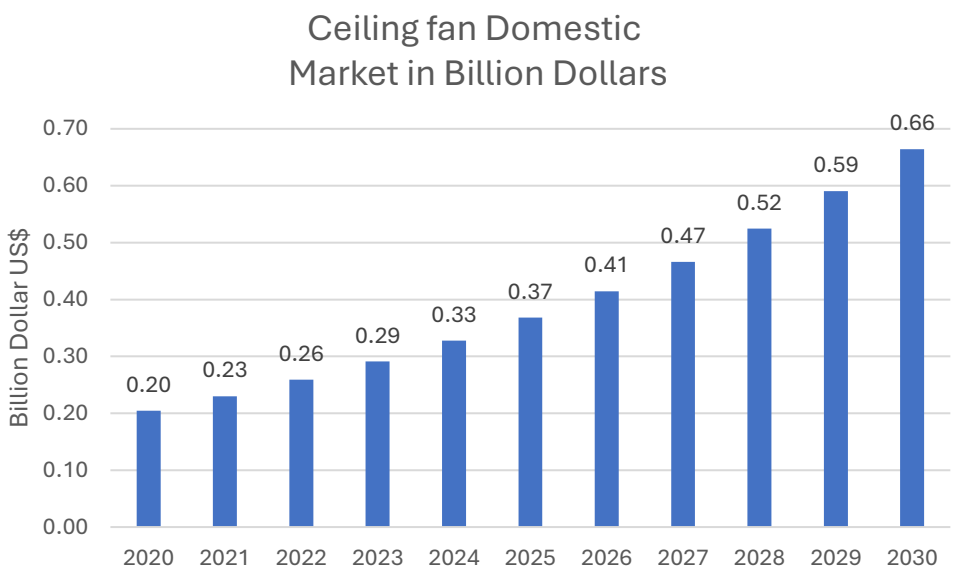



*Figure 3:Global Ceiling Fan Market in Billion Dollar*

In 2022, the global ceiling fan market generated USD 11.49 billion in revenue, and by 2025, the market is projected to reach USD 13.45 billion, reflecting strong growth driven by the increasing demand for energy-efficient ceiling fans. The adoption of energy-efficient technologies, particularly in emerging economies, plays a key role in this growth. By 2030, the market is expected to reach USD 17.50 billion, indicating a continued upward trend.[3]

This chart presents the projected market size growth for ceiling fans in Bangladesh from 2020 to 2030. It illustrates a robust Compound Annual Growth Rate (CAGR) of 12.5%, reflecting strong demand in the domestic market.

Figure 4:




Ceiling Fan Domestic Market in Billion Dollars

Starting from a market size of USD 0.20 billion in 2020, the ceiling fan market in Bangladesh is projected to grow steadily year-on-year. By 2025, the market is expected to reach USD 0.37 billion, driven by increased electrification, rising incomes, and growing demand for cooling solutions in residential and commercial spaces across the country. By 2030, the market is projected to reach USD 0.66 billion, underscoring the rapid adoption of ceiling fans and the growing consumer preference for energy-efficient models.[4]

Currently, the country's domestic manufacturers dominate the market, producing over 5 million units annually. Among these manufacturers, Walton, Gazi, PRAN-RFL, and Minister are prominent players, capturing a significant share of the local market. The majority of these brands have expanded their offerings to include energy-efficient fans, catering to the evolving preferences of Bangladeshi consumers.

Domestic production of ceiling fans has rapidly increased to meet the growing demand for energy-efficient models. Local manufacturers have invested in modern manufacturing facilities and technologies that enhance energy performance while reducing production costs. Brands like Walton and PRAN-RFL have introduced ceiling fans equipped with Brushless Direct Current (BLDC) motors, which offer superior energy efficiency compared to traditional ceiling fans with alternating current (AC) motors.

BLDC technology allows for greater energy savings by adjusting motor speed based on cooling needs, which reduces energy consumption without compromising performance. The survey data shows that about 90% of the surveyed ceiling fans operate with wattages between 65W and 85W, reflecting the market's tilt towards models that's not using the BLDC technology. A smaller proportion of fans, particularly those with BLDC motors, operate at an even lower wattage, further optimizing energy use.

In terms of motor speed, most ceiling fans operate within the 300-350 RPM range, with some premium models exceeding 370 RPM. This balance between speed and power consumption

is crucial for delivering adequate airflow while minimizing electricity use. The average air delivery for the ceiling fans surveyed ranged between 200-320 $m^3$/min, with the most energy-efficient models achieving air delivery levels of over 290 $m^3$/min while consuming less than 75 watts. This indicates a clear focus on performance without sacrificing energy efficiency.

Energy efficiency in ceiling fans has become a key factor for consumers, with approximately 88% of the surveyed models carrying a 5-star rating under the Bangladesh Standards and Testing Institution (BSTI) energy labeling program. This shows that manufacturers are aligning with global trends and local regulations to offer energy-efficient solutions. The 4-star rated fans account for about 4% of the market, while the remaining models do not yet display a star rating, suggesting a potential area for improvement in energy labeling compliance.

The demand for ceiling fans in Bangladesh is expected to grow by about 20-25% annually. This growth is largely attributed to the country's increasing electrification rates, especially in rural areas where ceiling fans are often the primary cooling solution. In urban centers, the rising middle class is driving demand for more aesthetically pleasing and technologically advanced fans, which combine energy efficiency with smart features such as remote control and speed adjustment.

Ceiling fans in Bangladesh are generally priced between BDT 2,000 and BDT 5,000, with energy-efficient models, especially those using BLDC motors, occupying the higher end of the price range. This price range has remained stable, making ceiling fans an affordable option for households looking to reduce electricity bills. The mid-range price segment, comprising fans priced between BDT 3,000 and BDT 4,000, dominates sales, accounting for approximately 50% of total market revenue. This balance of affordability and energy efficiency makes ceiling fans one of the most accessible energy-saving appliances in the Bangladeshi market.

The key challenge for ceiling fan manufacturers is the rising cost of raw materials, particularly for copper and steel, which are essential for motor production. Additionally, imported components for high-efficiency fans, such as electronic controls for BLDC motors, contribute to higher production costs, which can affect pricing for consumers. However, the growing consumer preference for energy-efficient fans presents an opportunity for manufacturers to expand their product lines and enhance market share by offering more advanced, eco-friendly models.

In conclusion, the ceiling fan market in Bangladesh is characterized by steady growth, a strong presence of local manufacturers, and increasing consumer demand for energy-efficient solutions. With technological advancements like BLDC motors and a focus on compliance with energy efficiency standards, the market is poised to continue its upward trajectory. Manufacturers are well-positioned to capitalize on this demand by offering products that not only meet consumer expectations for performance but also contribute to national energy conservation efforts.

### 2.1.3 Rice Cooker

The rice cooker market in Bangladesh represents a growing segment of the household appliance industry. As a staple cooking appliance, rice cookers are essential in most Bangladeshi homes, making their energy efficiency a crucial factor in reducing household

energy consumption. With the increase in urbanization and changing dietary habits, the demand for modern, energy-efficient rice cookers has seen steady growth.

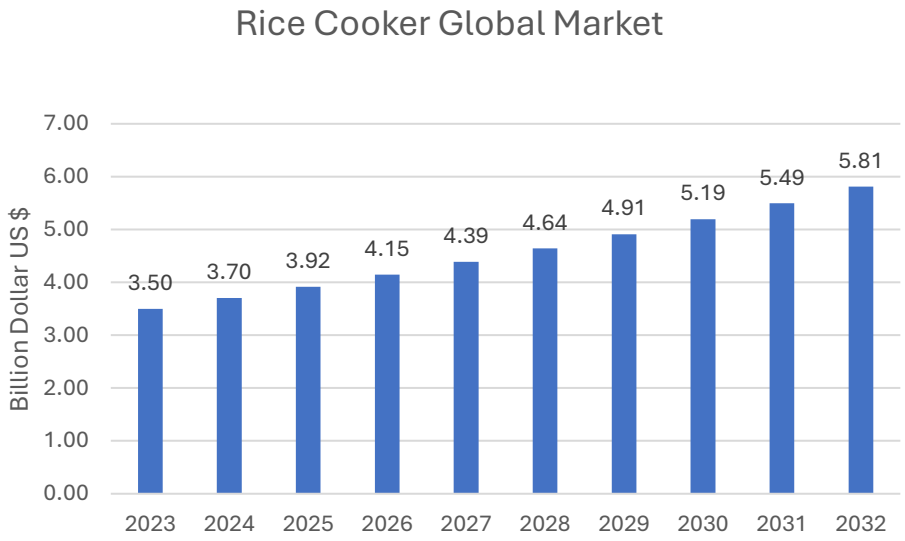



*Figure 5: Rice Cooker Global Market*

This chart presents the projected growth of the rice cooker market worldwide from 2023 to 2032. The market size, measured in billion dollars, shows a consistent increase over the years, reflecting a steady rise in demand for rice cookers globally.[5]

Starting from a market value of USD 3.50 billion in 2023, the global rice cooker market is expected to grow to USD 3.70 billion by 2024 and reach USD 4.15 billion by 2026. This growth is fueled by the increasing popularity of rice cookers as convenient and energy-efficient kitchen appliances, especially in regions where rice is a staple food.[5]

By 2030, the market is projected to hit USD 5.19 billion, and by 2032, it is expected to reach USD 5.81 billion, marking a significant increase from the base year. Factors driving this growth include technological advancements in rice cookers (such as multi-functionality and energy efficiency), rising incomes in developing economies, and the growing urban population, which increasingly relies on such appliances for convenience in cooking.[5]

The demand for rice cookers in Bangladesh is expanding, particularly as consumers transition from traditional cooking methods to more convenient, automated solutions. Rice cookers are now a common household item across urban and rural areas. According to market data, approximately 4 million units of rice cookers are sold annually in Bangladesh, with domestic manufacturers producing a significant portion of these appliances. Brands like Walton, PRAN-RFL, and Minister have captured a large market share by offering affordable and energy-efficient models that cater to the diverse needs of Bangladeshi households.

The price range for rice cookers varies significantly depending on the features and capacity. On average, the price for a basic model starts around BDT 1,800, while more advanced models with greater capacity and additional features, such as multi-functionality and automatic warming, can go up to BDT 6,500 or more. Despite price fluctuations, rice cookers remain an

accessible appliance for most households, making them a key contributor to the growing demand for energy-efficient kitchen appliances in the country.

Local manufacturers, including Walton, PRAN-RFL, and Kiam, are at the forefront of rice cooker production in Bangladesh. These companies have invested in modern manufacturing facilities that enable them to produce high-quality appliances with improved energy efficiency. Most rice cookers available in the market have a power consumption range between 700W and 1000W, which is relatively moderate compared to other household appliances, making them an energy-efficient solution for daily cooking needs.

The capacity of rice cookers in the market typically ranges from 1.8 liters to 4.6 liters, with 2.8-liter models being the most popular among consumers, accounting for approximately 40% of total sales. These models strike a balance between serving an average family size while maintaining efficient energy usage. The smaller 1.8-liter models are also highly demanded, particularly in rural areas or smaller households. Larger models, such as those with a 4.6-liter capacity, cater to larger families or small businesses like restaurants and food stalls.

The energy efficiency of rice cookers is a growing concern for both consumers and manufacturers. Consumers are becoming increasingly aware of the energy impact of their appliances, and manufacturers are responding by introducing features such as automatic shut-off and keep-warm functions to enhance energy conservation. The energy consumption of rice cookers in Bangladesh is relatively low compared to other kitchen appliances, but there is still room for improvement in terms of enhancing thermal efficiency and reducing standby energy consumption.

In terms of performance, rice cookers in Bangladesh are rated based on their power consumption and cooking capacity. The most energy-efficient models consume around 700 watts while delivering optimal cooking performance. However, more advanced models with higher wattage—such as 1000W to 1600W cookers—are available for those seeking faster cooking times and additional functionality, such as steaming and sautéing. These models, while slightly less energy-efficient, offer versatility that appeals to a broader consumer base.

The demand for rice cookers is largely driven by the convenience they offer in cooking a staple food, as well as by the increasing electrification of rural areas. Urban consumers, particularly in middle-income households, are prioritizing energy-efficient models to reduce electricity bills, while rural consumers are more focused on affordability and durability. The rise of dual-income households has also contributed to the demand for automated cooking appliances, as consumers seek time-saving solutions for meal preparation.
The introduction of smart rice cookers with features like remote control via smartphone apps is a growing trend, though these models are still in the early stages of market penetration. As consumer awareness about energy efficiency increases, the demand for advanced models that balance performance and energy consumption is expected to rise.

One of the main challenges faced by local rice cooker manufacturers is the competition from imported brands. International brands, primarily from China, India, and Japan, dominate the premium segment of the market, offering more technologically advanced and energy-

efficient models. However, local manufacturers are gradually closing this gap by enhancing their product offerings and improving the energy performance of their models.

Another challenge is the lack of widespread consumer awareness regarding the benefits of energy-efficient rice cookers. While the market for such appliances is growing, there is still significant potential to educate consumers about how energy-efficient appliances can lead to long-term savings on electricity bills and contribute to environmental sustainability.

Local manufacturers have the opportunity to capture a larger share of the market by focusing on affordability without compromising energy efficiency. Introducing rice cookers that meet global energy standards and incorporating features like automatic cooking modes, keep-warm functions, and smart technology can also enhance consumer appeal. Additionally, as government policies increasingly focus on energy conservation, manufacturers that align with these initiatives by producing energy-efficient rice cookers may benefit from incentives or support in expanding their production capacity.

In conclusion, the rice cooker market in Bangladesh is characterized by steady growth, with increasing demand for energy-efficient models. Local manufacturers like Walton, PRAN-RFL, and Kiam are well-positioned to capitalize on this demand by offering affordable, high-performance appliances that meet the evolving needs of Bangladeshi consumers. The market is poised for further growth, particularly as consumers become more conscious of energy efficiency and manufacturers continue to innovate with advanced features and technologies.

### 2.1.4 Induction Cooker

The market for induction cookers in Bangladesh has seen a significant rise in demand over recent years. This shift is largely driven by an increasing awareness of energy efficiency, urbanization, and the growing need for convenient cooking solutions in both urban and rural households. Induction cookers, known for their superior energy efficiency and faster cooking times, are becoming a popular alternative to traditional gas stoves and electric cooking appliances.

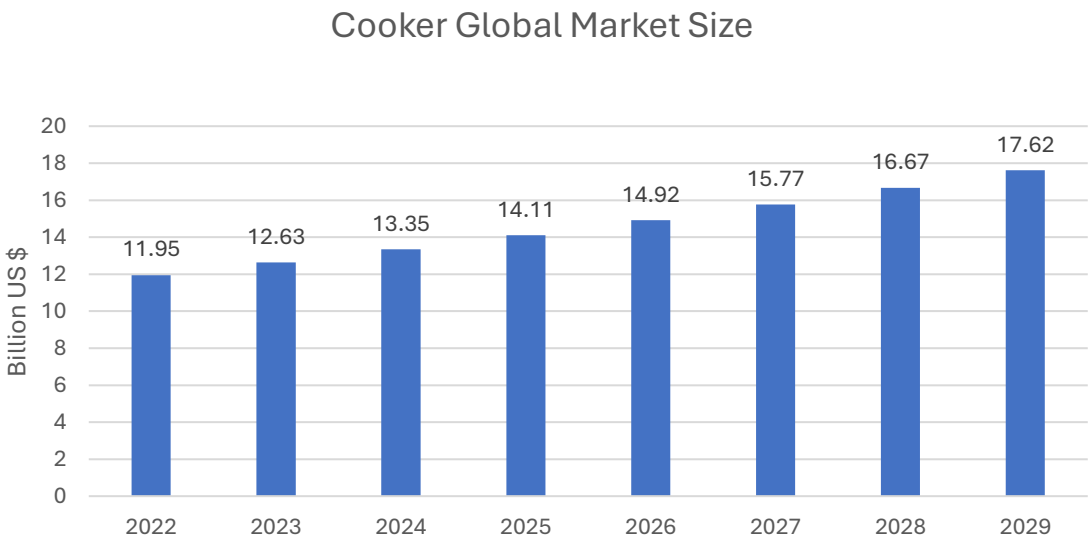



*Figure 6: Cooker Global Market Size*

This chart illustrates the projected growth of the global induction cooker market from 2022 to 2029. The market is shown to expand significantly, reflecting the increasing global demand for energy-efficient and time-saving cooking solutions.

In 2022, the market size is recorded at USD 11.95 billion, which steadily rises to USD 12.63 billion by 2023, demonstrating early signs of growth. The market continues to increase, reaching USD 14.11 billion by 2025, indicating a compound annual growth rate (CAGR) driven by technological advancements and consumer preferences for more efficient cooking appliances.[6]

By 2027, the market is forecasted to reach USD 15.77 billion, and it is expected to hit USD 17.62 billion by 2029, a substantial leap from the market size in 2022. This growth reflects the widespread adoption of induction cookers, particularly in urbanized regions where energy efficiency, safety, and modern cooking technologies are prioritized.[6]

This chart illustrates the projected growth of the domestic induction cooker market in Bangladesh from 2021 to 2030. The market is set to expand significantly, with a compound annual growth rate (CAGR) of 17%, reflecting the increasing demand for energy-efficient cooking solutions in the domestic market.

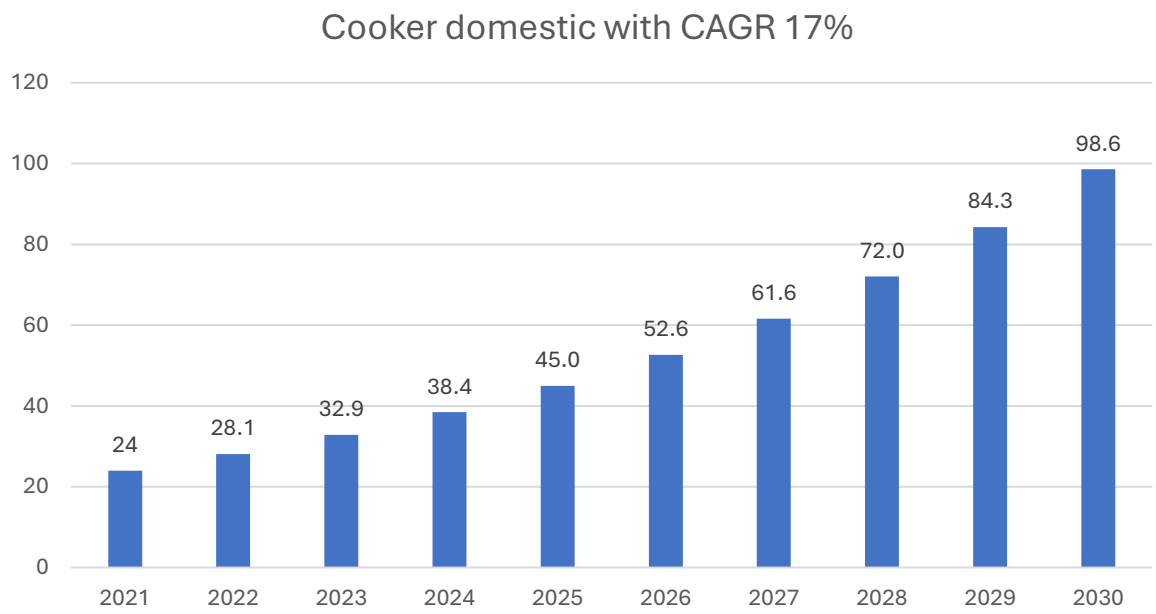



*Figure 7: Cooker domestic with CAGR 17%*

In 2021, the market size is recorded at twenty-four thousand, and by 2022, this number increases to 28.1 thousand, showing steady growth. As Bangladesh continues to adopt more modern cooking technologies, the market grows consistently, reaching thirty-eight thousand in 2024 and forty-five thousand in 2025.[7]

By 2027, the market size is projected to reach 61.6 thousand, with further growth leading to 84.3 Thousand by 2029. The forecasted market size for 2030 is 98.6 thousand units, indicating a near fourfold increase in market size over the decade.[7]

Induction cookers are rapidly becoming a staple in modern Bangladeshi kitchens, driven by the convenience they offer and their energy-saving capabilities. According to market data, sales of induction cookers have grown by 30-40% during the winter months, a trend closely linked to the recurring gas shortages that many households face.[7] The price range of induction cookers typically falls between BDT 3,750 and BDT 10,800, making them accessible to a broad segment of consumers. The growing middle class in urban areas is particularly driving demand for energy-efficient appliances, with induction cookers being at the forefront of this trend.

Domestic manufacturers such as Walton, PRAN-RFL, and Vision are making significant strides in capturing the market by offering affordable induction cookers with modern features. Additionally, imported brands from China, India, and Japan hold a substantial share of the premium market, offering more technologically advanced models with features like multi-cooking functions and digital interfaces. The market is expected to continue expanding as the benefits of induction cooking—such as energy savings and reduced cooking times—become more widely recognized.

The production of induction cookers in Bangladesh is heavily reliant on both local assembly and imported components. While local manufacturers like Walton and PRAN-RFL have established assembly lines for these appliances, many of the critical components—such as the induction coils, control panels, and digital interfaces—are imported from countries like China and India. This supply chain dynamic positions local manufacturers as assemblers rather than full producers, but they are increasingly focusing on improving the efficiency and quality of their products to meet both local and international standards.

Technological advancements in induction cooker models available in Bangladesh are focused on improving energy efficiency and cooking performance. For example, most induction cookers available in the market operate within a power consumption range of 2000W to 2200W, with some high-end models reaching up to 3500W. These appliances are designed to heat cookware directly, ensuring minimal heat loss compared to traditional gas or electric stoves, which contributes to their energy efficiency. Additionally, advanced features such as digital temperature control, pre-programmed cooking modes, and safety functions like automatic shut-off are becoming standard in many models.

Induction cookers are recognized for their superior energy efficiency. Unlike traditional gas stoves, which lose a significant amount of energy to the surrounding environment, induction cookers transfer nearly all the energy to the cooking vessel, resulting in faster cooking times and lower energy consumption. Studies show that induction cookers can be up to 90% efficient, compared to 55-60% for gas stoves and 65-70% for conventional electric stoves.[8]

The energy efficiency of induction cookers available in the Bangladeshi market is a key selling point, especially as consumers become more aware of the long-term savings associated with reduced electricity usage. Most induction cookers in the local market are equipped with smart sensors that adjust the power output based on the type of cookware and the temperature required, ensuring that energy is used efficiently. This is particularly beneficial in a country like Bangladesh, where the cost of electricity is a concern for many households.

The increasing urbanization in Bangladesh, coupled with rising disposable incomes, is a major driver of the growing demand for induction cookers. Urban households, especially those in cities like Dhaka and Chittagong, are increasingly opting for energy-efficient cooking solutions that save time and reduce energy costs. The convenience offered by induction cookers—such as faster heating, precise temperature control, and easy maintenance—has made them an attractive choice for modern kitchens.

In rural areas, the demand for induction cookers is also on the rise, although at a slower pace compared to urban centers. The government's ongoing efforts to expand electrification in rural regions are playing a key role in this shift. As more households gain access to reliable electricity, the adoption of electric cooking appliances, including induction cookers, is expected to increase.

However, one of the challenges faced by manufacturers in promoting induction cookers in rural areas is the cost of compatible cookware. Unlike gas stoves, which can use any type of pot or pan, induction cookers require cookware made from materials like cast iron or stainless steel that have magnetic properties. This added cost can deter some consumers, particularly in lower-income households.

Despite the growing demand, there are several challenges that the induction cooker market in Bangladesh faces. One of the primary challenges is the limited availability of local testing facilities that can certify the energy efficiency of these appliances according to international standards. Currently, most testing is conducted abroad, which increases costs for manufacturers and importers.

Additionally, the reliance on imported components for the production of induction cookers can create supply chain vulnerabilities, especially in times of global disruptions. Local manufacturers are working to mitigate these risks by exploring partnerships with regional suppliers and investing in more localized production capabilities.

Looking forward, the induction cooker market in Bangladesh is poised for further growth as consumers become more conscious of energy efficiency and the government continues to promote energy conservation. Local manufacturers like Walton, PRAN-RFL, and Vision have the opportunity to expand their product lines to include more energy-efficient models that meet global standards. Introducing smart technology, such as remote control via mobile apps and integration with home automation systems, could also help differentiate their products in a competitive market.

Furthermore, public awareness campaigns focused on the benefits of induction cooking—such as energy savings, reduced cooking times, and improved safety—could accelerate the adoption of these appliances across the country. The continued expansion of electrification in rural areas also presents a significant opportunity for manufacturers to tap into a growing market of first-time buyers.

In conclusion, the induction cooker market in Bangladesh is on a strong growth trajectory, driven by increasing consumer demand for energy-efficient, modern cooking solutions. While there are challenges related to component sourcing and testing infrastructure, the overall

market outlook is positive. Local manufacturers are well-positioned to capitalize on this demand by offering affordable, high-quality products that meet the evolving needs of Bangladeshi consumers.

### 2.1.5 Household Induction Motor

The household induction motor market in Bangladesh plays a critical role in the functioning of various home appliances such as refrigerators, washing machines, ceiling fans, and water pumps. As the nation continues its industrialization efforts and electrification expands into rural areas, the demand for household induction motors is steadily increasing. These motors are valued for their efficiency, durability, and relatively low maintenance requirements, making them essential components in a wide range of appliances.

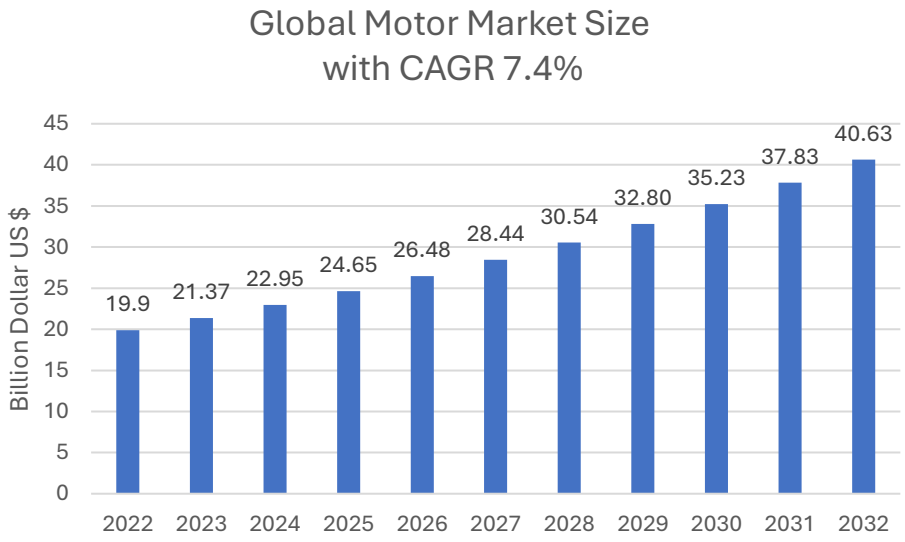



*Figure 8: Global Motor Market Size with CAGR 7.4%*

This chart represents the projected growth in the global household induction motor market from 2022 to 2032. Over this ten-year period, the market is expected to experience a compound annual growth rate (CAGR) of 7.4%, reflecting robust and continuous expansion due to increasing demand for energy-efficient appliances and technological advancements in motor design.[9]
Starting at USD 19.9 billion in 2022, the market size shows steady growth, reaching USD 21.37 billion in 2023 and continuing to rise through the following years. By 2025, the market is projected to hit USD 24.65 billion, with further expansion leading to USD 28.44 billion by 2027.[9]

This growth can be attributed to increasing adoption of energy-efficient household appliances, industrialization in emerging markets, and demand for motors with lower operational costs.

As the years progress, the market is expected to cross USD 30 billion by 2028, reaching USD 30.54 billion and continuing upward. By 2030, the global motor market size is projected to be around USD 35.23 billion, and by 2032, it is anticipated to surpass USD 40.63 billion.[9]

This chart represents the projected revenue growth for the Domestic household induction motor market from 2024 to 2030. Over this period, the market is expected to experience a compound annual growth rate (CAGR) of 4%, indicating steady and gradual expansion in the domestic demand for household induction motors.

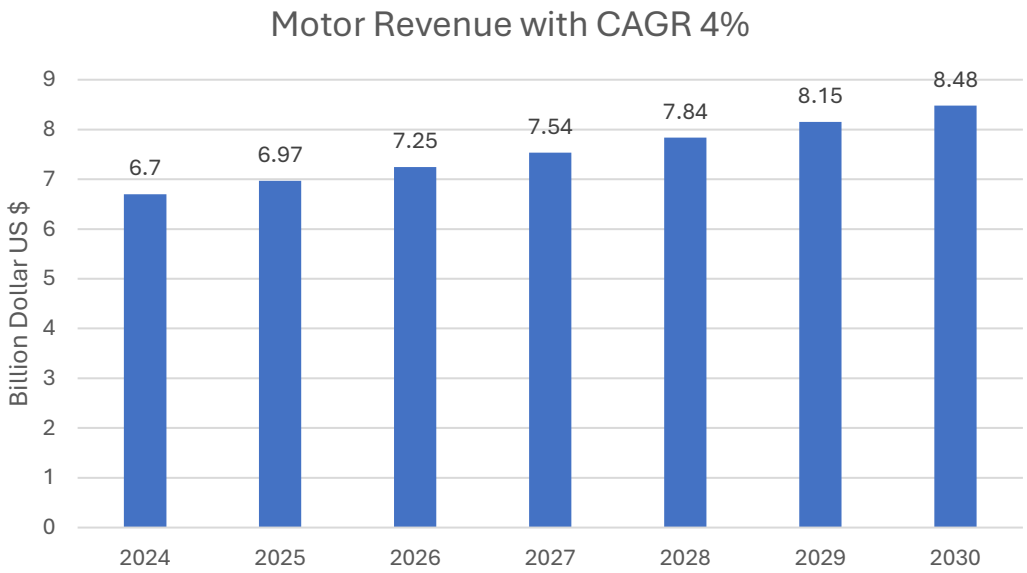



*Figure 9: Motor Revenue with CAGR 4%*

Starting at USD 6.7 billion in 2024, the revenue shows consistent growth, reaching USD 6.97 billion by 2025 and USD 7.25 billion by 2026. The upward trend continues, with the market reaching USD 7.54 billion in 2027 and USD 7.84 billion in 2028, reflecting the increasing need for induction motors in various household applications such as water pumps, air conditioning systems, and washing machines.[10]

By 2029, the market is projected to generate USD 8.15 billion in revenue, eventually rising to USD 8.48 billion by 2030.[10]

The demand for household induction motors in Bangladesh has been growing consistently over the last decade, largely driven by increased urbanization, rising disposable incomes, and a higher standard of living. The shift towards energy-efficient home appliances has also contributed to the market's expansion. Local manufacturers such as Gazi and PRAN-RFL are playing a significant role in catering to this demand, alongside imports from countries like China, India, and Japan.

While local production meets a significant portion of the demand, Bangladesh still relies heavily on imported components for assembling induction motors. Many local manufacturers operate primarily as assemblers, sourcing critical parts such as rotors, stators, and electronic control systems from international suppliers. The reliance on imported components presents both opportunities and challenges in terms of scaling up local production capabilities.

Bangladesh's household induction motor industry is largely categorized as medium- to large-scale, with domestic manufacturers focusing on the assembly of imported parts rather than full-scale production. Companies like Gazi and PRAN-RFL dominate the local market, producing motors that are used in a variety of household appliances. These companies import

key components—such as stators, rotors, and bearings—from countries like China and India, which are then assembled in their local factories.

The assembly process involves integrating these components to create induction motors that are customized for use in Bangladeshi households. The assembly of these motors ensures that local manufacturers can meet the market's demand without needing to invest in the complex infrastructure required for full-scale production. However, the reliance on imports also exposes manufacturers to risks such as price fluctuations in the global market and supply chain disruptions.

Despite these challenges, local manufacturers have made strides in improving their assembly processes, focusing on energy efficiency and durability. Companies like Gazi and PRAN-RFL have established themselves as trusted brands, known for producing reliable motors that cater to the needs of both urban and rural consumers.

The induction motor industry in Bangladesh has seen advancements in both the design and performance of motors, with a growing emphasis on energy efficiency. As energy consumption becomes a more pressing issue, manufacturers are increasingly focusing on developing motors that minimize power usage without compromising on performance.

Household induction motors available in the Bangladeshi market typically range in power from 0.75 kW to 3.73 kW, with many motors designed to operate at 1.5 HP or 2 HP. These motors are highly efficient compared to traditional alternatives, offering greater reliability and longer lifespans. The energy efficiency of induction motors has made them a preferred choice for a wide range of home appliances, helping households reduce electricity consumption.

The increasing focus on energy efficiency and cost savings is shaping consumer preferences in Bangladesh. As more households gain access to electricity, particularly in rural areas, the demand for energy-efficient motors is expected to grow. Consumers are becoming more aware of the long-term benefits of using energy-efficient appliances, including reduced electricity bills and lower maintenance costs.

Manufacturers like PRAN-RFL and Gazi have positioned themselves to capitalize on this demand by offering a range of motors designed for household appliances. These motors are priced competitively, making them accessible to a wide range of consumers. For instance, a 1.5 HP household induction motor from Gazi is priced around BDT 15,520, while smaller motors are available for as low as BDT 6,000, catering to both middle- and lower-income households.

Despite the positive growth trends, the household induction motor market in Bangladesh faces several challenges. One of the primary challenges is the lack of local manufacturing capabilities for critical components. While local manufacturers are proficient in assembling motors, they remain dependent on imports for key parts, which can be subject to price fluctuations and supply chain disruptions.

Furthermore, the absence of local testing facilities capable of certifying the energy efficiency of motors according to international standards presents a challenge for manufacturers looking to compete in the global market. Currently, most energy efficiency testing is conducted abroad, which increases costs and limits the ability of local manufacturers to innovate and improve their products.

However, these challenges also present opportunities for growth. The Bangladeshi government's focus on promoting energy efficiency through initiatives such as SREDA's energy labeling program provides a platform for manufacturers to differentiate themselves by offering more energy-efficient motors. By aligning their products with global standards, local manufacturers have the potential to expand their market share both domestically and internationally.

The household induction motor market in Bangladesh is poised for continued growth as the country's industrial and residential sectors increasingly prioritize energy efficiency. Local manufacturers like PRAN-RFL and Gazi are well-positioned to meet this demand, despite the challenges posed by reliance on imported components and limited local testing capabilities.

With the government's support through regulatory initiatives and the expanding electrification of rural areas, the future looks promising for the household induction motor industry. As manufacturers continue to innovate and improve their products, Bangladesh is set to become a significant player in the global market for energy-efficient household motors.

The push towards energy-efficient appliances in Bangladesh is gaining momentum, yet several significant market barriers hinder widespread adoption. Both manufacturers and consumers face distinct challenges that limit the promotion and market penetration of energy-efficient technologies.

## 2.2 Understanding Market barriers

Promoting energy-efficient appliances in Bangladesh presents unique challenges due to a variety of market barriers. These obstacles hinder the adoption of sustainable products, making it difficult to achieve the country's energy efficiency goals. Key barriers include a lack of consumer awareness and education, high upfront costs of energy-efficient appliances, limited local manufacturing capabilities, and inadequate testing and regulatory infrastructure. Addressing these challenges is essential for fostering an environment where energy-efficient products can thrive, reducing energy consumption, and supporting Bangladesh's commitment to sustainable development.

### 2.2.1 Lack of Awareness and Consumer Education

One of the key barriers to promoting energy-efficient appliances is the lack of consumer awareness and education. Many consumers are unaware of the long-term cost savings and environmental benefits associated with energy-efficient products. Although energy-efficient appliances can reduce electricity bills and improve performance, the initial higher upfront costs deter price-sensitive consumers, especially in rural areas.

The concept of energy efficiency, often encapsulated in labels or ratings, is also not well understood by a significant portion of the population. As a result, consumers often prioritize the upfront purchase price over the long-term energy savings that energy-efficient appliances offer.

### 2.2.2 Higher Initial Costs for Energy-Efficient Appliances

Energy-efficient appliances tend to have a higher upfront cost compared to their less efficient counterparts, which can be a significant deterrent in price-sensitive markets like Bangladesh. This is especially true for rural consumers who may not have access to financing options that would enable them to spread out the cost over time. Additionally, energy-efficient models often require advanced technology, leading to higher manufacturing costs, which are passed on to consumers.

For example, in the case of refrigerators, the demand for energy-efficient models is growing, but consumers often opt for cheaper, less efficient models due to affordability. Similarly, energy-efficient ceiling fans, induction cookers, and rice cookers tend to be priced higher, limiting their adoption despite their long-term benefits.

### 2.2.3 Limited Local Manufacturing Capabilities

In Bangladesh, many manufacturers are still focused on assembling appliances rather than producing energy-efficient models from the ground up. For instance, household induction motors, ceiling fans, and other appliances are often assembled using imported components. This dependence on imports not only increases production costs but also limits the ability of manufacturers to innovate and incorporate the latest energy-efficient technologies.

The lack of local manufacturing capabilities for energy-efficient components also creates a supply chain bottleneck, where manufacturers must import key parts at higher costs, which in turn limits their ability to competitively price their products in the domestic market. This reliance on imports increases lead times and further drives up costs.

### 2.2.4 Inadequate Testing and Regulatory Infrastructure

Although Bangladesh is taking strides in establishing energy efficiency standards, the testing and regulatory infrastructure is still developing. The absence of robust local testing labs capable of certifying appliances according to international energy efficiency standards creates a gap in verifying the performance of locally manufactured and imported appliances.

For instance, local laboratories do not currently have the capacity to test rice cookers and induction cookers per international standards. As a result, manufacturers are forced to rely on international testing labs, which can be prohibitively expensive and time-consuming. This limitation restricts manufacturers' ability to demonstrate the energy efficiency of their products, making it harder to gain consumer trust and promote energy-efficient appliances.

The market for household appliances in Bangladesh is flooded with low-cost, less efficient imports that provide tough competition for local manufacturers trying to promote energy-

efficient products. These lower-cost products, often from countries like China and India, attract budget-conscious consumers, thereby making it difficult for energy-efficient models to capture a significant market share.

Furthermore, the lack of stringent enforcement of energy efficiency labeling and standards means that consumers can still easily purchase non-compliant, inefficient appliances. This market saturation with cheaper, non-efficient options dilutes the impact of the energy efficiency movement.

Overcoming these market barriers requires a multifaceted approach involving consumer education, financial incentives, investment in local manufacturing, and the development of a robust regulatory framework. By raising awareness of the benefits of energy-efficient appliances, expanding financing options, and strengthening testing and certification infrastructure, Bangladesh can pave the way for wider adoption of energy-efficient products. These efforts will not only contribute to lowering household energy costs but also support the nation's broader environmental goals, fostering a sustainable and resilient future for all.

## 2.3 Growth and Trends:

Despite the challenges, the demand for energy-efficient appliances in Bangladesh is growing, fueled by several key market drivers. The convergence of urbanization, rising incomes, and greater access to electricity is shaping consumer behavior and driving the market towards adopting more efficient technologies.

### 2.3.1 Increasing Electrification and Urbanization

Bangladesh has made significant progress in electrification, especially in rural areas. As more households gain access to electricity, the demand for household appliances, including energy-efficient models, is rising. Urbanization is another major driver of growth, with more people moving into cities and adopting modern living standards that include energy-efficient appliances such as refrigerators, ceiling fans, and induction cookers.

In urban centers, consumers are becoming more conscious of the benefits of energy-efficient appliances, especially as electricity tariffs increase and people become more aware of their carbon footprints. This trend is pushing manufacturers to introduce appliances that not only meet consumer demand for modernity but also provide energy-saving benefits.

### 2.3.2 Rising Disposable Incomes

Rising disposable incomes, particularly among the burgeoning middle class, are leading to higher demand for home appliances. Consumers now have more spending power, enabling them to invest in higher-quality, energy-efficient products. This trend is particularly evident in urban areas, where consumers are more inclined to purchase energy-efficient refrigerators, ceiling fans, and induction cookers to save on energy costs in the long run.

As consumer preferences shift towards more efficient and technologically advanced products, manufacturers are responding by offering a wider range of energy-efficient appliances to cater to this growing demand.

### 2.3.3 Government Initiatives and Regulatory Push

Government initiatives, such as SREDA's energy labeling program and the Energy Efficiency and Conservation Master Plan (EECMP), are playing a pivotal role in driving demand for energy-efficient appliances. These initiatives aim to raise awareness about the benefits of energy efficiency and encourage the adoption of energy-saving technologies.

The government's focus on reducing national energy consumption by promoting energy-efficient household appliances has created a conducive environment for manufacturers to innovate and expand their product lines. Additionally, the upcoming enforcement of Minimum Energy Performance Standards (MEPS) is expected to further push manufacturers to improve the efficiency of their appliances, ultimately driving market growth.

### 2.3.4 Technological Advancements in Appliance Manufacturing

Technological advancements are enabling the production of more energy-efficient household appliances. For example, refrigerators are now equipped with inverter technology, which allows for variable speed operation, resulting in significant energy savings. Similarly, ceiling fans with brushless direct current (BLDC) motors consume less power while delivering the same airflow as traditional models.

In the induction motor market, advances in motor design and the incorporation of variable frequency drives (VFDs) are helping manufacturers produce more efficient motors that consume less energy. These innovations are crucial in meeting the growing consumer demand for energy-efficient appliances that provide long-term savings.

### 2.3.5 Market Trends Shaping Consumer Behavior

Consumer behavior in Bangladesh is increasingly shaped by the growing awareness of environmental sustainability and the need to reduce energy consumption. As electricity costs rise, consumers are more motivated to switch to energy-efficient appliances to lower their monthly utility bills.

Another key trend is the rising demand for multi-functional and smart appliances. Consumers are seeking appliances that offer greater convenience and control, such as smart rice cookers and induction cookers with remote control features. These innovations not only meet the demand for convenience but also align with the broader push towards energy efficiency.

Despite challenges such as market barriers and competition from low-cost imports, the demand for energy-efficient household appliances is expected to continue rising as consumers become more aware of the long-term benefits of reducing energy consumption.

# 3. The Regulatory Environment

Bangladesh's regulatory framework for energy efficiency is still evolving, with some key areas of progress and several gaps that need to be addressed. The country's journey towards establishing energy efficiency standards has begun with specific focus areas such as refrigerators and ceiling fans, while other household appliances like rice cookers and induction cookers remain unregulated in terms of energy efficiency. Below is an overview of the current regulatory environment, the existing standards, and the gaps that need to be bridged.

## 3.1 Existing Energy Efficiency Standards and Labels

**3.1.1. Refrigerators and Freezers – BDS 1850:2012** (Energy efficiency rating of household refrigerators, refrigerator-freezers and freezers) Bangladesh currently follows the BDS 1850:2012 standard for household refrigerators, refrigerator-freezers, and freezers. This standard specifies the requirements for energy efficiency labeling for electric refrigerators that use the vapor compression system. It also outlines the test methods to determine the energy consumption of refrigerators that meet compliance. This labeling system provides consumers with clear, quantifiable information about the energy performance of these appliances, helping to guide purchasing decisions. However, this standard is currently under revision, aiming to further tighten energy performance requirements and ensure alignment with modern global best practices. This revision is expected to strengthen the push towards more energy-efficient models in the market.

**3.1.2. Ceiling Fans – BDS 1860:2012** (Minimum Allowable Values of Energy Efficiency and Energy Efficiency Grades for AC Electric Fans) For ceiling fans, Bangladesh introduced the BDS 1860:2012 standard, which provides the framework for the energy efficiency labeling system for these appliances. This standard focuses on measuring the energy efficiency of ceiling fans by calculating the airflow (in cubic meters per minute) per watt of power consumed. The star rating system, based on this calculation, helps classify fans from 1-star (lowest efficiency) to 5-star (highest efficiency), making it easier for consumers to choose energy-saving options.

For example, a 1400mm ceiling fan with a 5-star rating must have an energy efficiency value of at least 3.45 $m^3$/min.W, whereas a 1-star fan of the same size will have an efficiency value of 3.15 $m^3$/min.W.

**3.1.3. Household Induction Motors – BDS 1139:1986** (Three-phase induction motors) The BDS 1139:1986 standard covers three-phase induction motors with technical specifications, including voltage up to 11 kV and Class A, B, and E insulation. This standard applies mainly to industrial motors, and while it provides a regulatory framework, it is not actively enforced for household induction motors in Bangladesh. Manufacturers producing household induction motors do not currently test their products against this standard because it is not mandatory by law. This lack of enforcement creates a regulatory gap, leaving the household induction motor market largely unregulated in terms of energy efficiency.

### 3.1. 4 Gaps in Standards for Rice Cookers and Induction Cookers

One of the critical gaps in Bangladesh's energy efficiency regulatory framework is the absence of standards for rice cookers and induction cookers. These appliances are becoming increasingly popular in households due to their convenience and energy-saving potential, but without a standard to regulate their efficiency, consumers have little guidance on which models are the most energy-efficient. Unlike refrigerators and ceiling fans, where star ratings and labeling provide transparency, the rice cooker and induction cooker markets lack any form of energy efficiency labeling or standardized testing in Bangladesh.

This gap creates challenges for both consumers and policymakers. Without regulations, manufacturers are not incentivized to improve the energy efficiency of these products, leading to higher energy consumption at the household level. Furthermore, the absence of standardized testing protocols means there is no way to compare local products with global benchmarks, which could be essential for pushing the industry toward more energy-efficient production.

### 3.1.5 Opportunities for Improvement

The introduction of energy efficiency standards for rice cookers, induction cookers, and household induction motors would fill a critical gap in Bangladesh's regulatory environment. Such standards would not only help consumers make informed purchasing decisions but also encourage manufacturers to innovate and adopt energy-saving technologies. The ongoing revision of the refrigerator and freezer standards, coupled with the relatively new ceiling fan standard, indicates that Bangladesh is moving in the right direction. However, expanding these efforts to include all major household appliances will be essential for achieving the country's energy efficiency and conservation goals.

Moreover, enforcing compliance with the BDS 1139:1986 for household induction motors and introducing mandatory testing for all household appliances will help to ensure that the products available in the market meet minimum energy performance standards (MEPS). The establishment of such a framework would also facilitate the future introduction of energy labeling, further promoting energy conservation and sustainability.

The regulatory framework for energy efficiency in Bangladesh is a work in progress. While significant strides have been made with standards for refrigerators, freezers, and ceiling fans, there is a clear need to expand this framework to other essential household appliances like rice cookers, induction cookers, and household induction motors. By addressing these gaps and enforcing compliance with existing standards, Bangladesh can significantly improve its energy efficiency landscape, reduce energy consumption, and contribute to global efforts in combating climate change.

## 3.2 Governmental and Institutional Players:

In Bangladesh, the promotion and enforcement of energy efficiency across various sectors, including household appliances, is guided by a network of governmental bodies, institutional players, and research organizations. These entities collaborate to develop standards, conduct research, implement regulations, and engage with the private sector to promote the adoption

of energy-efficient technologies. This chapter provides a comprehensive overview of the key stakeholders involved in advancing the energy efficiency agenda in Bangladesh.

### 3.2.1. Sustainable and Renewable Energy Development Authority (SREDA)

The **Sustainable and Renewable Energy Development Authority (SREDA)**, under the Ministry of Power, Energy, and Mineral Resources (MPEMR), is the driving force behind Bangladesh's energy efficiency efforts. Established in 2012, SREDA's mission is to promote energy conservation and renewable energy adoption across the country. SREDA plays a pivotal role in shaping national policies and creating frameworks to reduce energy consumption and promote energy-efficient practices in households, industries, and commercial sectors.
SREDA's key responsibilities include:

- Developing national policies, standards, and strategies, such as the **Energy Efficiency and Conservation Master Plan (EECMP)**, which outlines targets for energy savings and the adoption of energy-efficient appliances.
- Coordinating the implementation of energy efficiency labelling programs, like the star rating system for household appliances.
- Supporting the development of **Minimum Energy Performance Standards (MEPS)** for household appliances and promoting public awareness of energy conservation.
- Collaborating with other institutions to facilitate energy efficiency projects and capacity-building initiatives.

SREDA's efforts are integral to achieving the national energy savings target of 20% by 2030, which focuses heavily on the adoption of energy-efficient household appliances such as refrigerators, ceiling fans, air conditions and induction motors.

### 3.2.2. Bangladesh Standards and Testing Institution (BSTI)

As the national standards body, the **Bangladesh Standards and Testing Institution (BSTI)** is responsible for the development, enforcement, and monitoring of standards across various sectors, including household appliances. BSTI has established several key standards related to energy efficiency.

BSTI's critical functions include:

- Establishing and updating standards in line with international best practices, particularly for energy-intensive household appliances.
- Issuing certification and energy efficiency labels based on appliance performance.
- Collaborating with local manufacturers and importers to ensure compliance with these standards.

### 3.2.3. Power Division (Ministry of Power, Energy, and Mineral Resources)

The **Power Division**, under the Ministry of Power, Energy, and Mineral Resources, plays a vital role in implementing policies that enhance Bangladesh's energy security and efficiency. The Power Division oversees the implementation of the **Energy Efficiency and Conservation**

**Master Plan (EECMP)**, in coordination with SREDA. It also facilitates projects and programs aimed at promoting energy-efficient technologies across sectors, from households to industries.

Key roles of the Power Division include:

- Providing policy support for energy efficiency initiatives and programs.
- Allocating resources and budgets to fund energy efficiency projects.
- Engaging with international stakeholders to secure technical and financial support for energy efficiency advancements.

The Power Division also works closely with national and international agencies to promote renewable energy, improve electricity access, and encourage the adoption of energy-efficient appliances in Bangladesh.

### 3.2.4. Bangladesh Energy Regulatory Commission (BERC)

The **Bangladesh Energy Regulatory Commission (BERC)** is responsible for regulating the energy market in Bangladesh, covering electricity, gas, and petroleum sectors. BERC's role in promoting energy efficiency includes setting energy tariffs and encouraging energy conservation measures. As part of its mandate, BERC works with other regulatory bodies to support energy efficiency initiatives.

BERC plays a key role in:

- Ensuring that energy pricing policies align with national goals to reduce energy consumption.
- Supporting the implementation of energy efficiency programs by incentivizing the use of energy-efficient appliances through energy tariff structures.
- Monitoring and regulating energy consumption patterns in various sectors, including residential, commercial, and industrial.

### 3.2.5. National Board of Revenue (NBR)

The **National Board of Revenue (NBR)** plays a crucial role in the promotion of energy-efficient appliances by regulating the tax and duty structures associated with their import and production. NBR's taxation policies significantly impact the affordability and adoption of energy-efficient appliances in Bangladesh. For instance, lower taxes and import duties on energy-efficient products can help make them more accessible to consumers, while higher taxes on less efficient appliances can discourage their use.

NBR's functions in relation to energy efficiency include:

- Setting tax rates for energy-efficient and non-energy-efficient appliances, influencing market pricing and consumer preferences.
- Collaborating with government bodies like SREDA and BSTI to implement tax policies that support energy efficiency goals.

- Creating fiscal incentives for manufacturers and importers of energy-efficient products, helping to reduce overall energy consumption in Bangladesh.

NBR's ability to differentiate between efficient and inefficient appliances in terms of tax benefits could play a pivotal role in shaping consumer choices and boosting the market for energy-efficient appliances.

### 3.2.6. Testing Laboratories and Research Institutions

Testing laboratories and research institutions are vital for verifying the energy performance of appliances and ensuring they meet the required standards. In Bangladesh, the Bangladesh Standards and Testing Institution (BSTI) operates key labs that conduct testing for several household appliances, including fans, refrigerators, and air conditioners, to ensure compliance with national standards. Bangladesh University of Engineering and Technology (BUET) is another primary institution conducting energy performance testing on various household appliances. However, while these institutions cover a range of products, there remains a need to expand infrastructure and capacity to include testing for appliances like rice cookers, induction cookers, and other emerging energy-efficient devices. Expanding testing capabilities across both BSTI and BUET, along with the support of commercial testing labs like SGS, UL, TUV SUD etc, is essential to fully meet the standards and support the energy efficiency goals in Bangladesh.

Key activities of testing labs include:

- Conducting laboratory tests to measure energy efficiency and performance metrics of appliances.
- Collaborating with BSTI and SREDA to provide data that informs energy efficiency labelling and certification.
- Developing new testing methodologies to align with evolving global standards for household appliances.

In the absence of comprehensive local testing facilities, international collaborations with organizations are critical. These international bodies have stepped in to provide testing services for appliances like rice cookers and induction cookers, ensuring compliance with global standards.

### 3.2.7. International Collaborators

International organizations such as GIZ, the United Nations Development Programme (UNDP), and the World Bank play a key role in promoting energy efficiency in Bangladesh. These organizations provide technical assistance, capacity-building, and funding for projects aimed at improving energy performance in household appliances. Additionally, international bodies contribute to testing and certifying appliances that lack local testing facilities, ensuring that appliances meet international energy efficiency standards.

These international collaborations strengthen Bangladesh's regulatory framework by:

- Providing expertise in developing energy efficiency policies and standards.
- Facilitating technology transfer and best practices from other countries.
- Supporting the local implementation of energy efficiency initiatives through funding and technical support.

The regulatory framework for promoting energy efficiency in Bangladesh is a coordinated effort between key governmental bodies such as SREDA, BSTI, and NBR, alongside testing labs, research institutions, and international partners. However, challenges remain, particularly in the establishment of local standards for certain appliances and the development of comprehensive testing facilities. Addressing these gaps will be critical for ensuring that Bangladesh meets its energy efficiency targets and fosters a market for energy-efficient appliances.

## 3.3 Global Comparisons and Gaps:

Bangladesh's journey towards improving energy efficiency through regulatory frameworks and energy standards is crucial for both economic and environmental sustainability. However, when compared to global best practices, there are significant gaps that must be addressed to drive the adoption of energy-efficient appliances. This section will explore how Bangladesh's existing regulatory framework stacks up against international standards and highlight areas where improvements can be made.

### 3.3.1. Energy Efficiency Standards and Minimum Energy Performance Standards (MEPS)

Globally, Minimum Energy Performance Standards (MEPS) play a critical role in regulating the energy consumption of household appliances. MEPS set the baseline for energy efficiency that all appliances must meet before entering the market.

- **United States**: The U.S. Department of Energy (DOE) mandates stringent MEPS for most household appliances. For example, refrigerators must meet specific annual energy consumption limits based on their size and features. For a 16 cubic feet top-mounted refrigerator, the MEPS is approximately 410 kWh/year.

- **European Union**: Under the Ecodesign Directive, the EU mandates MEPS for a wide range of appliances, with refrigerators typically requiring energy consumption under 150 kWh/year for higher energy classes like A+++. The EU also mandates that ceiling fans must achieve a minimum airflow efficiency of 3.5 $m^3$/min per watt for the most efficient models.

- **India**: In India, refrigerators with a capacity of less than 300 liters must meet a star rating criterion with an energy consumption of 330-350 kWh/year for 3-star rated models. Ceiling fans, on the other hand, are expected to have an energy efficiency of at least 4.0 $m^3$/min per watt for 5-star models under the Bureau of Energy Efficiency (BEE) framework.

**Bangladesh's Efficiency requirements and Gaps:**

In contrast, Bangladesh has made strides in developing BDS 1850:2012 for household refrigerators and BDS 1860:2012 for ceiling fans, which sets basic energy efficiency requirements. However, these standards lag behind international MEPS. For instance:

- **Refrigerators**: The current efficiency rating in Bangladesh under BDS 1850:2012 set a general energy efficiency baseline but is not as stringent as those in the EU or the U.S. For instance, a refrigerator of around 200 liters in Bangladesh consumes over 450 kWh/year, compared to less than 300 kWh/year for similar units in more developed markets.

- **Ceiling Fans**: The newly introduced BDS 1860:2012 outlines airflow efficiency values ranging from 2.93 $m^3$/min per watt to 3.81 $m^3$/min per watt for ceiling fans, depending on the size and star rating. While this is an important step forward, higher standards, such as achieving 4.0 $m^3$/min per watt for 5-star rated models like in India, should be targeted.

- **Household Induction Motors**: Bangladesh has BDS 1139:1986 for three-phase induction motors, but the standard is outdated and does not focus on household single-phase motors, which are widely used in fans and pumps. Globally, the efficiency standards for these motors are much higher. For example, India mandates that single-phase induction motors used in household applications achieve an efficiency of at least 80%. However, in Bangladesh, this segment remains unregulated, and manufacturers are not required to test household motors for energy performance.

  **Rice Cookers and Induction Cookers**: Bangladesh lacks any established MEPS or standards for rice cookers and induction cookers. Internationally, countries like Japan and South Korea have advanced energy efficiency standards for these appliances, ensuring that they meet stringent consumption limits. In contrast, rice cookers sold in Bangladesh could consume anywhere between 600W to 1000W, with no standardized testing for efficiency. Similarly, induction cookers, which are inherently more energy-efficient than gas stoves, have no MEPS in place to regulate or benchmark their performance.

### 3.3.2. Energy Efficiency Labelling and Star Rating Systems

Internationally, energy efficiency labelling systems are robust, helping consumers easily identify the most efficient products.

- **United States**: The ENERGY STAR label is a well-recognized and voluntary program that helps consumers identify products that are 10-20% more energy-efficient than the standard MEPS.

- **European Union**: The EU Energy Label is mandatory and provides a detailed energy efficiency rating, with products rated from A+++ to G. The label shows annual energy consumption and other key performance indicators, such as noise levels and efficiency during standby mode.

- **India**: India's Bureau of Energy Efficiency (BEE) operates a Star Rating Program, which rates appliances from 1-star (least efficient) to 5-star (most efficient). Ceiling fans, refrigerators, and air conditioners are all covered under this system, with 5-star refrigerators consuming as low as 300 kWh/year for smaller models.

**Bangladesh's Labelling Gaps:**

- **Refrigerators**: Bangladesh's star rating system, defined by BDS 1850:2012, assigns stars based on energy efficiency but lacks the depth of the EU or Indian frameworks. The label does not provide consumers with a comprehensive view of annual energy consumption, and higher energy-efficient products (A+ or A++) are not easily distinguishable from basic models.

- **Ceiling Fans**: **BDS 1860:2012** introduced star ratings for ceiling fans, ranging from 1-star to 5-star models, with 5-star models achieving airflow efficiencies of 3.81 $m^3$/min per watt. This is a positive step, but further public awareness and consumer education are needed to promote higher-star-rated fans over lower-efficiency models.

- **Household Induction Motors**: While the BDS 1139:1986 standard covers some aspects of induction motor performance, there is no mandatory energy labelling requirement for motors used in household appliances. This is a significant gap, as consumers have no reliable way to compare the energy efficiency of different motors available in the market.

- **Rice Cookers and Induction Cookers**: The absence of a labelling system for rice cookers and induction cookers means that consumers cannot differentiate between high-efficiency and low-efficiency models. This lack of information creates a significant barrier to promoting energy-efficient products in these categories.

### 3.3.3. Testing and Certification Infrastructure

Internationally, robust testing and certification systems ensure compliance with MEPS and labelling programs.

- **United States**: The Department of Energy (DoE) conducts rigorous testing for compliance with MEPS, and the Federal Trade Commission (FTC) enforces energy labelling regulations. All appliances undergo mandatory testing before being approved for sale.

- **European Union**: In the EU, compliance with energy efficiency standards is tested at accredited labs, and non-compliance can result in heavy fines or market withdrawal.

**Bangladesh's Testing and Certification Gaps:**

While BSTI oversees the certification of appliances for meeting the required standards, its capacity for testing energy efficiency, particularly for appliances like rice cookers, induction

cookers, and induction motors, remains underdeveloped. There is no mandatory testing for rice cookers and induction cookers, and local manufacturers are often not equipped to test their products against international standards. Furthermore, household induction motors, although covered by BDS 1139:1986, are rarely tested in compliance with energy efficiency metrics due to the lack of enforcement.

### 3.3.4. Fiscal and Regulatory Incentives

Globally, fiscal policies such as tax rebates and credits have been used to promote energy-efficient products.

- **United States**: The Energy Policy Act provides tax credits to manufacturers and consumers who purchase or produce energy-efficient appliances. Rebates are offered for products that exceed the ENERGY STAR criteria.

- **European Union**: Many EU member states provide financial incentives to consumers for purchasing high-efficiency appliances. Subsidies and tax incentives for manufacturers further encourage the production of energy-efficient products.

**Bangladesh's Fiscal Policy Gaps:**

The National Board of Revenue (NBR) plays a critical role in determining import duties and taxes. However, there is no structured differentiation between energy-efficient and non-energy-efficient products in terms of tax benefits or higher import duties. Introducing tax rebates or import duty reductions for energy-efficient appliances could help stimulate market growth. Additionally, penalizing the import of inefficient appliances with higher taxes could encourage the adoption of more energy-efficient technologies.
While Bangladesh has made important steps toward regulating the energy efficiency of certain household appliances, significant gaps remain. Learning from global best practices, the country has the opportunity to strengthen its regulatory framework, enhance its testing capabilities, and incentivize the market to prioritize energy-efficient technologies. By addressing these gaps, Bangladesh can ensure its place on the global stage as a leader in energy efficiency and sustainable development.

# 4. Market Data Analysis: Understanding Energy Efficiency in Appliances

## 4.1 Refrigerators and Freezers:

Refrigerators and freezers are among the most energy-intensive appliances in Bangladeshi households, making them a key focus area in energy efficiency efforts. The growing market for these appliances, coupled with rising electricity prices, has pushed both consumers and manufacturers to pay closer attention to energy consumption patterns, cooling efficiency, and insulation quality. The survey conducted provides a comprehensive overview of the

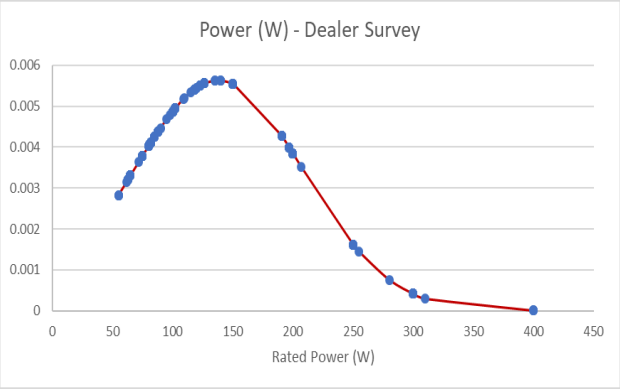
models currently available in the local market, revealing a wide variation in energy performance.

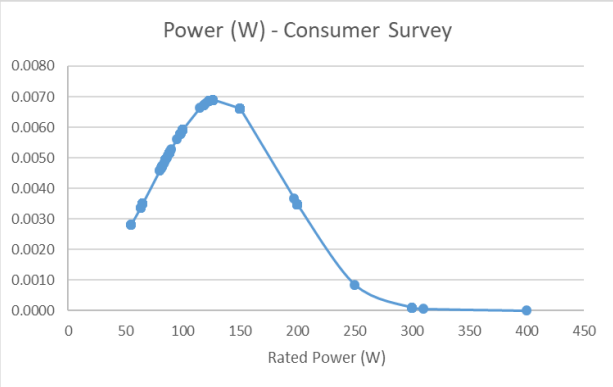
**Energy Consumption Patterns**: Refrigerators and freezers in Bangladesh typically range from 200 liters to 320 liters in capacity, with energy consumption spanning from as low as 45.4 watts to as high as 197 watts depending on the model and technology used. The introduction of inverter technology has been a game changer, significantly reducing energy consumption in newer models. Inverter refrigerators, which account for approximately 88% of the units surveyed, adjust their compressor speed based on cooling demand, consuming less energy compared to traditional on-off compressors.

The energy consumption of refrigerators is not only affected by the size of the appliance but also by its usage patterns, ambient temperature, and the quality of insulation. Older models, still in circulation in rural and low-income urban households, are much less efficient, consuming significantly more energy than their newer counterparts.

The rated power of 286 models sold in the market was collected from the dealer survey. Out of 3,315 responses from the consumer survey, only 238 have provided sufficient data to identify the rated power. These values from both parties were plotted on a normal distribution curve, as shown in the figure below. The standard deviations are 70.82 and 57.50, with mean values of 138.19 and 132.29, for dealer survey and consumer survey respectively.

These graphs can be used to determine the percentage of equipment within a given value or range of rated power. However, this data is not directly applicable for deriving




**Cooling Efficiency**: Cooling efficiency, which directly affects both the performance and energy consumption of refrigerators, has improved notably in recent years, particularly in models that use R-600a refrigerant. R-600a, or isobutane, is more energy-efficient and has a significantly lower global warming potential (GWP) compared to traditional refrigerants like R-134a (tetrafluoroethane). R-600a operates at lower pressures, which enhances energy efficiency and reduces the overall energy consumption of the appliance. Additionally, R-600a is a hydrocarbon refrigerant, making it less harmful to the environment, whereas R-134a is a hydrofluorocarbon (HFC) with a higher GWP, contributing more to climate change. The survey indicates that over 90% of new refrigerators sold in Bangladesh now use R-600a, reflecting a positive shift towards environmentally friendly and energy-efficient technologies.

Moreover, refrigerators are rated based on their ability to maintain optimal internal temperatures with minimal compressor usage. Models with a higher star rating demonstrate superior cooling efficiency, maintaining low internal temperatures without frequent cycling of the compressor, thus reducing electricity consumption.

**Insulation Levels**: Insulation plays a critical role in determining the energy efficiency of refrigerators and freezers. Well-insulated models can retain cold air longer, reducing the need for the compressor to run frequently. The survey found that most locally manufactured refrigerators feature enhanced insulation, particularly in 5-star rated models. These models use advanced polyurethane foam insulation, which reduces thermal bridging and minimizes energy loss.

Refrigerators and freezers with poor insulation tend to consume more energy as the compressor has to work harder to maintain the set internal temperature. The trend toward better-insulated models is growing, driven by consumer demand for appliances that reduce electricity costs. However, older models and some low-cost variants still exhibit suboptimal insulation, leading to higher energy consumption.

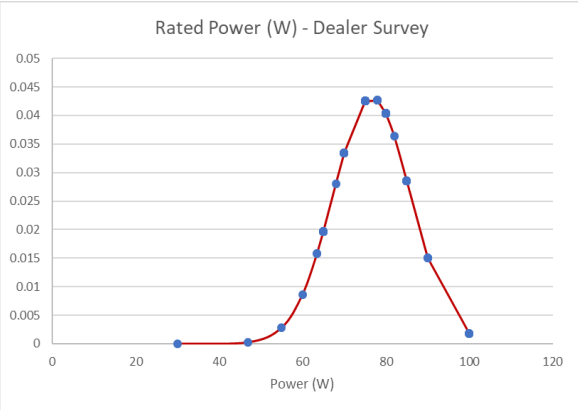
## 4.2 Ceiling Fans:

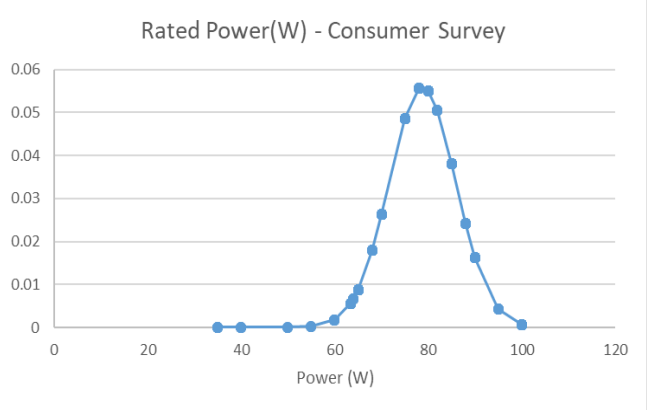
Ceiling fans are a ubiquitous feature in Bangladeshi households, especially in areas where air conditioning is not an option due to economic or infrastructural limitations. Given the tropical climate, ceiling fans are often used for extended periods, making their energy efficiency a crucial factor in overall household electricity consumption. The study highlights significant variations in the energy consumption and airflow efficiency of ceiling fans, particularly when comparing standard models to more energy-efficient ones.

**Energy Consumption**: The average energy consumption of ceiling fans in the Bangladeshi market is approximately 75 watts for standard models. However, with the advent of 5-star rated energy-efficient fans, energy consumption can be as low as 60 watts. The shift toward energy-efficient fans is largely driven by rising electricity costs and government initiatives promoting energy savings.

The rated power of 136 models sold in the market was collected from the dealer survey. Out of 3,399 responses from the consumer survey, about 90% have reported the rated power. As explained under refrigerator rated power section above, plotting normal distribution curves of the rated power is not directly applicable for deriving MEPS.

The standard deviations are 9.24 and 7.13, with mean values of for dealer survey and consumer survey respectively.



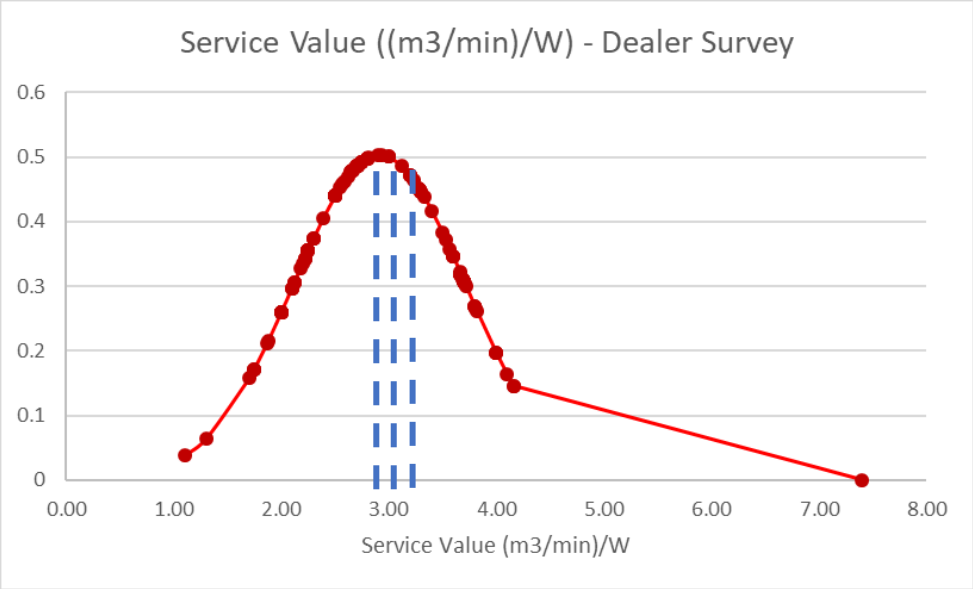




**Airflow Efficiency**: Airflow efficiency, measured in cubic feet per minute (CFM) per watt, is a critical performance metric for ceiling fans. Efficient fans deliver more airflow per unit of energy consumed, providing better cooling with lower electricity usage. The survey found that locally available ceiling fans have airflow efficiency ranging from 2.93 to 3.81 CFM per watt.

Fans with higher CFM per watt ratios not only provide better cooling but also reduce the need for additional cooling appliances, contributing to overall energy savings in households. In comparison, international markets have ceiling fans that achieve airflow efficiency ratios upwards of 4.0 CFM per watt, indicating that there is still room for improvement in the Bangladeshi market.

Service values of the models sold in the market were calculated from the manufacture published air flow rate and rated power data. But no confirmation was received as to whether the standard testing method specified in the MEPS sections were followed in measuring power and air flow rate. Therefore, it is not accurate to use the normal distribution curve of the market survey to determine the MEPS. However, graph is indicated below. It has a mean of 2.91 and standard deviation of 0.79. Proposed MEPS are marked on the graph in blue dashes.

Air flow rate could not be collected from the market survey as consumers are unware of the values and hence service values could not be calculated.



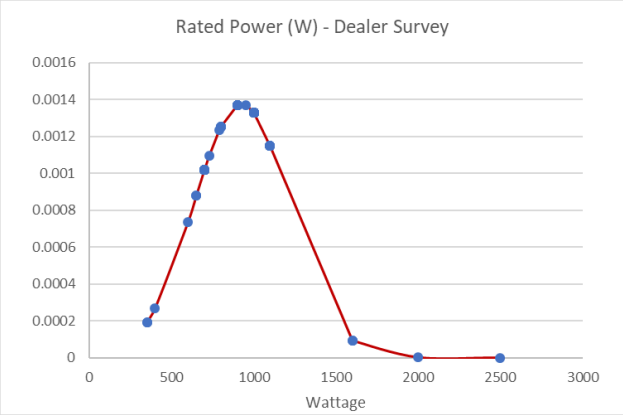

## 4.3 Rice Cookers and Induction Cookers:

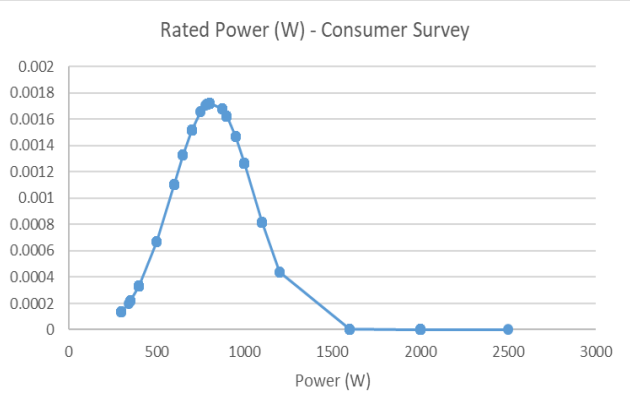
The adoption of rice cookers and induction cookers in Bangladeshi households is on the rise, particularly in urban areas where gas supply can be unreliable. These appliances offer energy-efficient cooking solutions, yet there are significant differences in performance and energy consumption between local and international models. The survey revealed insights into the energy consumption patterns and cooking efficiency of these appliances, showing the need for standardized energy testing protocols in Bangladesh.

**Rice Cookers**: Rice cookers in the local market typically range from 600 watts to 1,100 watts in power consumption, with most models falling within the 1.8-liter to 3-liter capacity range. Local brands such as Walton and RFL have introduced rice cookers that are competitive in terms of price and energy consumption, but the lack of standardized testing for energy efficiency makes it difficult to assess their true performance compared to international standards.

The rated power of 66 models sold in the market was collected from the dealer survey. Out of 1,494 responses from the consumer survey, 1303 have reported the rated power. As explained for previous appliances above, plotting normal distribution curves of the rated power is not directly applicable for deriving MEPS.

The standard deviations are 290.12 and 230.65, with mean values of 925.23 and 818.01, for dealer survey and consumer survey respectively



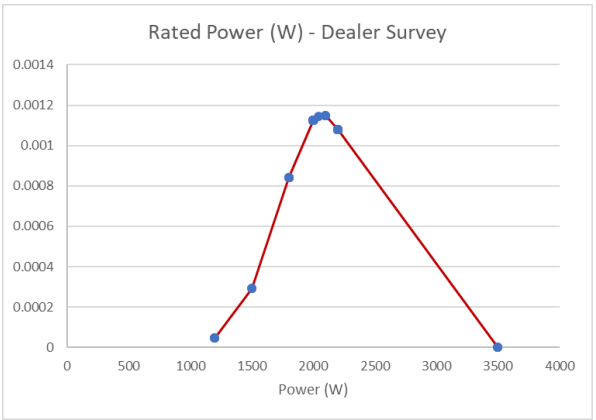



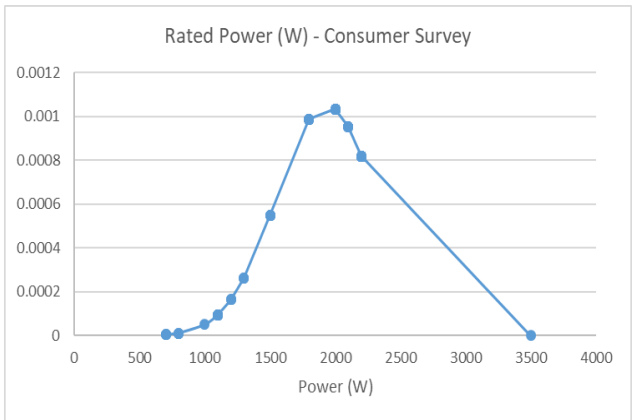

Internationally, energy-efficient rice cookers are designed to optimize energy use by employing features such as automatic shut-off and warming modes that consume minimal power. These features are not always available in local models, which could result in higher energy consumption during prolonged cooking or warming cycles.

**Induction Cookers**: Induction cookers in the local market have gained popularity as an alternative to traditional gas stoves. These appliances typically consume between 1,200 watts and 3,500 watts, depending on the model and cooking load. The study found that while induction cookers offer significant energy savings compared to gas stoves, there is still variability in their efficiency based on the quality of components and design.

The rated power of 84 models sold in the market was collected from the dealer survey. Out of 342 responses from the consumer survey, 209 have reported the rated power. As explained for previous appliances above, plotting normal distribution curves of the rated power is not directly applicable for deriving MEPS.

The standard deviations are 346.72 and 380.24, with mean values of 2074.30 and 1932.54, for dealer survey and consumer survey respectively.



International standards for induction cookers emphasize precise temperature control and energy efficiency during cooking. In comparison, local models often lack these advanced features, which can lead to less efficient energy use during cooking processes. Additionally, the absence of standardized testing for induction cookers in Bangladesh further complicates efforts to assess their true energy performance.

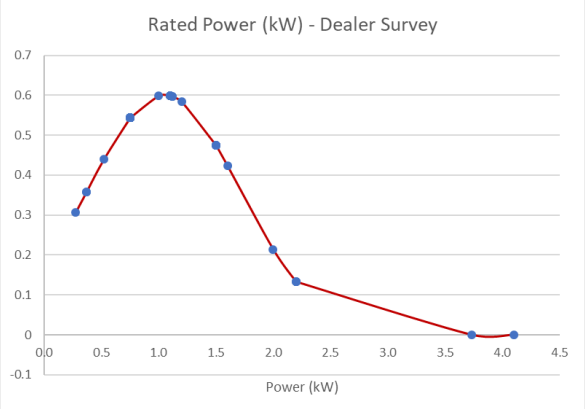
## 4.4 Household Induction Motors:

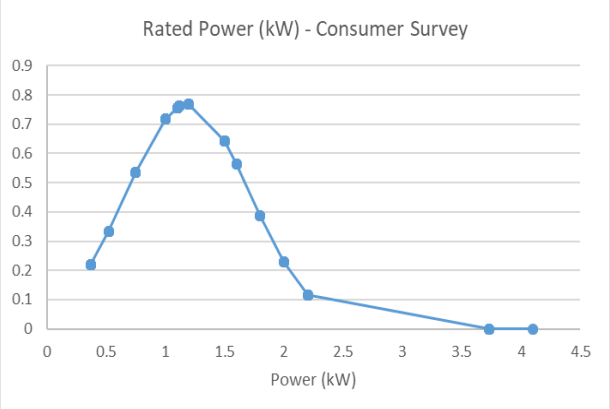
Household induction motors are a vital component in a wide range of appliances, from water pumps to fans. Their energy efficiency is critical in reducing household electricity consumption, particularly in regions where electricity costs are high. The survey of household induction motors in Bangladesh highlights both the strengths and weaknesses of the local market compared to global energy-efficient models.

**Energy Consumption**: Household induction motors surveyed in Bangladesh generally range from 0.75 kW to 3 kW in power, with most models falling around the 1.1 kW mark. These motors are widely used in applications such as water pumps and fans, where continuous operation is often required. The study found that while local motors are relatively efficient, they still lag international best practices, particularly in terms of energy efficiency and operational longevity.

The rated power of 63 models sold in the market was collected from the dealer survey. Out of 1186 responses from the consumer survey, 1,054 have reported the rated power. As explained for previous appliances above, plotting normal distribution curves of the rated power is not directly applicable for deriving MEPS.

The standard deviations are 0.66 and 0.52, with mean values of 1.05 and 1.19, for dealer survey and consumer survey respectively.




**Efficiency Comparisons**: Globally, induction motors are subject to stringent energy efficiency standards, such as IE3 and IE4 classifications, which ensure higher performance with lower energy consumption. In Bangladesh, however, the majority of household induction motors do not meet these higher efficiency standards, mostly are within IE1 and IE2 classification motor, leading to greater energy consumption over time. The adoption of more energy-efficient motors in household appliances could significantly reduce overall electricity consumption in the residential sector.

## 4.5 Benchmarking Global Best Practices:

When comparing Bangladeshi appliances to global best practices, it becomes clear that while progress has been made, there is still significant room for improvement in terms of energy efficiency. Appliances such as refrigerators, ceiling fans, and induction cookers have seen improvements in efficiency, particularly with the introduction of inverter technology and energy-efficient designs. However, there remains a gap between local products and the most efficient models available globally.

**Global Best Practices**:

- **Refrigerators**: Energy-efficient refrigerators in leading international markets typically consume around 100–150 kWh per year. By comparison, refrigerators in Bangladesh often exceed this range, though the adoption of inverter technology is beginning to reduce energy consumption.

- **Ceiling Fans**: In global markets, the best-performing ceiling fans achieve airflow efficiency ratios of approximately 4.0 CFM per watt or higher. While some efficient models in Bangladesh approach this standard, they generally remain slightly below the benchmark.

- **Induction Cookers and Rice Cookers**: Globally, top-rated induction and rice cookers include advanced features such as automatic shut-off, temperature control, and low standby power consumption. These features significantly improve energy efficiency but are less common in the Bangladeshi market, where testing and energy performance standards are still developing.

- **Household Induction Motors:** Internationally, the *IEC 60034-30-1* standard is widely recognized among industrial and commercial users for defining energy efficiency classes of induction motors. This standard sets benchmarks for efficiency, including classifications such as IE1 (standard efficiency), IE2 (high efficiency), IE3 (premium efficiency), and IE4 (super-premium efficiency). However, in the Bangladeshi market, the household induction motors commonly used—particularly for water pumps—are not rated using international or local standards.

  According to the findings of the market survey, water pumps hold a significant share of household induction motor applications, with capacities typically ranging from 0.75 kW to 1 kW. These motors are often less efficient compared to their international counterparts and lack adherence to energy performance benchmarks. Incorporating standards such as *IEC 60034-30-1* could significantly enhance the energy efficiency of household induction motors, reduce energy consumption, and align local manufacturing practices with global best practices.

**Opportunities for Improvement**: To close the gap between local products and global best practices, Bangladesh needs to implement more stringent energy performance standards and improve the testing infrastructure for household appliances. Doing so will not only reduce

energy consumption but also enhance the competitiveness of local manufacturers in the global market.

# 5. Defining Minimum Energy Performance Standards (MEPS)

## 5.1 Setting the Baseline: Refrigerators

Refrigerators are one of the most critical household appliances, operating continuously throughout the year to preserve food and other perishable items. As a result, they account for a significant portion of household energy consumption. With global technological advancements, the refrigerator market has witnessed the introduction of innovative features such as frost-free technology, smart connectivity, magnetic cooling, sustainable refrigerants, and even robotics. The growing global emphasis on energy conservation and addressing the environmental impact of refrigerants further underscores the need to enhance the energy efficiency of these appliances.

In line with Bangladesh's Energy Efficiency and Conservation Master Plan, which targets a notable reduction in energy consumption by 2030, it is essential to establish a Minimum Energy Performance Standard (MEPS) for refrigerators. MEPS sets a mandatory baseline for energy efficiency, ensuring that all refrigerators sold in Bangladesh meet specific performance standards. This not only reduces overall energy consumption but also encourages manufacturers to innovate and produce more energy-efficient appliances. The initiative aligns with Bangladesh's broader sustainability goals and helps consumers save on energy bills while contributing to a more sustainable environment.

Currently, refrigerators in Bangladesh adhere to the BDS 1850:2012 standard, developed by the Bangladesh Standards and Testing Institution (BSTI). This standard provides a star rating system (ranging from none to 5 stars) based on annual energy consumption per volume for different classes of refrigerators. While the standard exists, it is important to note that MEPS for refrigerators has not yet been fully adopted in the country, leaving room for improvement in regulatory enforcement. By setting stringent MEPS, Bangladesh can ensure that energy-efficient refrigerators become the norm, driving the market towards sustainability while ensuring affordability for consumers.

**National and International Minimum Energy Performance Standards and Test Standards for Refrigerators**

Globally, the adoption of MEPS for refrigerators has been a key strategy for reducing energy consumption. Countries such as the UK and Australia have had mandatory energy labeling and MEPS for refrigerators since the 1990s. The UK, under the European Directive, introduced energy labeling for refrigerators and freezers in 1995, with MEPS following in 1999. Australia implemented mandatory energy labeling in 1986. Internationally, the testing of refrigerator energy consumption and performance evaluation is governed by the IEC standards, specifically IEC 62552-1, 2, 3:2016.

According to the International Energy Agency (IEA), it is projected that by mid-2030, nearly all household appliances sold globally must match the energy efficiency of today's most efficient models. At a minimum, MEPS should set a target of 279 kWh/year or lower for refrigerators. Economies that have already met this benchmark are encouraged to raise their standards to meet an intermediate target of 223 kWh/year or less.[11]

A detailed comparison of national and international MEPS will be provided in the table below, showcasing recent developments in energy performance standards from neighboring and developed countries. It is important to note that while climate conditions and testing standards may vary between regions, normalizing energy consumption figures (based on annual energy consumption) can provide a consistent benchmark for setting MEPS.

| Country | Minimum Energy Performance Standards (MEPS) | MEP Level as given by the standard | Normalized MEPs* |
|---|---|---|---|
| **Bangladesh** | BDS 1850 : 2012 | | |
| **China** | GB 12021.5, 2015 | | 408 kWh/yr |
| **USA** | Directive 2009/125/EC of the European Parliament and of the Council and repealing Commission Regulation (EC) No 643/2009 | 0.285av + 233.7 where av is the adjusted volume | 269 kWh/yr |
| **European Union** | Directive 2009/125/EC of the European Parliament and of the Council and repealing Commission Regulation (EC) No 643/2009 | EEI of 125 | 250 kWh/yr |
| **UK** | EU Ecodesign regulation | EEI of 125 | 250 kWh/yr |
| **Indonesia** | Minsiter of Energy and Mineral Resources, "Minimum Energy Performance Standards for Refrigerators," 2021 | (0.85 x adjusted volume) + 270 kWh | 499 kWh/yr |
| **India** | IS 17550 | AEC < (0.180* Vtot+279) | 280 kWh/yr |
| **Malaysia** | MS IEC 62552 | - 25 % ≤ Star index | |
| **Brazil** | PORTARIA INTERMINISTERIAL Nº OI/MME/MDIC/MCTIC , DE 14 DE MAIO DE 2018. | | 524 kWh/yr |
| **Canada** | | 0.285av + 233.7 where av is the adjusted volume | 269 kWh/yr |
| **Sri Lanka** | **SLS 1690** on Minimum Energy Performance standard (MEPS) for Household Refrigerators. | 6 Wh/ litre/day | 876 kWh/yr |
| **Japan** | Energy conservation regulations for energy consumption equipment manufacturers | 0.281V3 + 112 | 254 kWh/yr |
| **South Africa** | COMPULSORY SPECIFICATION FOR ENERGY EFFICIENCY AND LABELING OF ELECTRICAL AND ELECTRONIC APPARATUS (VC 9008) | EEI of 75 | 580 kWh/yr |

**Note:**

The normalization process ensures comparability across different climates and testing standards by standardizing the energy consumption figures. The reference temperature of

24°C is used, representing an average between 16°C and 32°C, and the calculation includes refrigerators with a 300L fresh-food compartment and a 100L freezer compartment. The normalized figures offer an accurate comparison of annual energy consumption (kWh/year) across various regions.

**Bangladesh MEPS for Refrigerators**

In Bangladesh, the BDS 1850:2012 standard by BSTI is currently in use as part of the voluntary energy labeling program for refrigerators. This program encourages manufacturers and importers to use energy labels as a marketing tool to attract energy-conscious consumers. From the market survey and analysis conducted on 286 different refrigerator models from 27 brands available in Bangladesh, the results reveal significant variations in energy consumption across different star-rated products. The plot created from this data compares the star rating with the energy consumption per unit volume, providing a clear view of how different models perform in terms of energy efficiency.

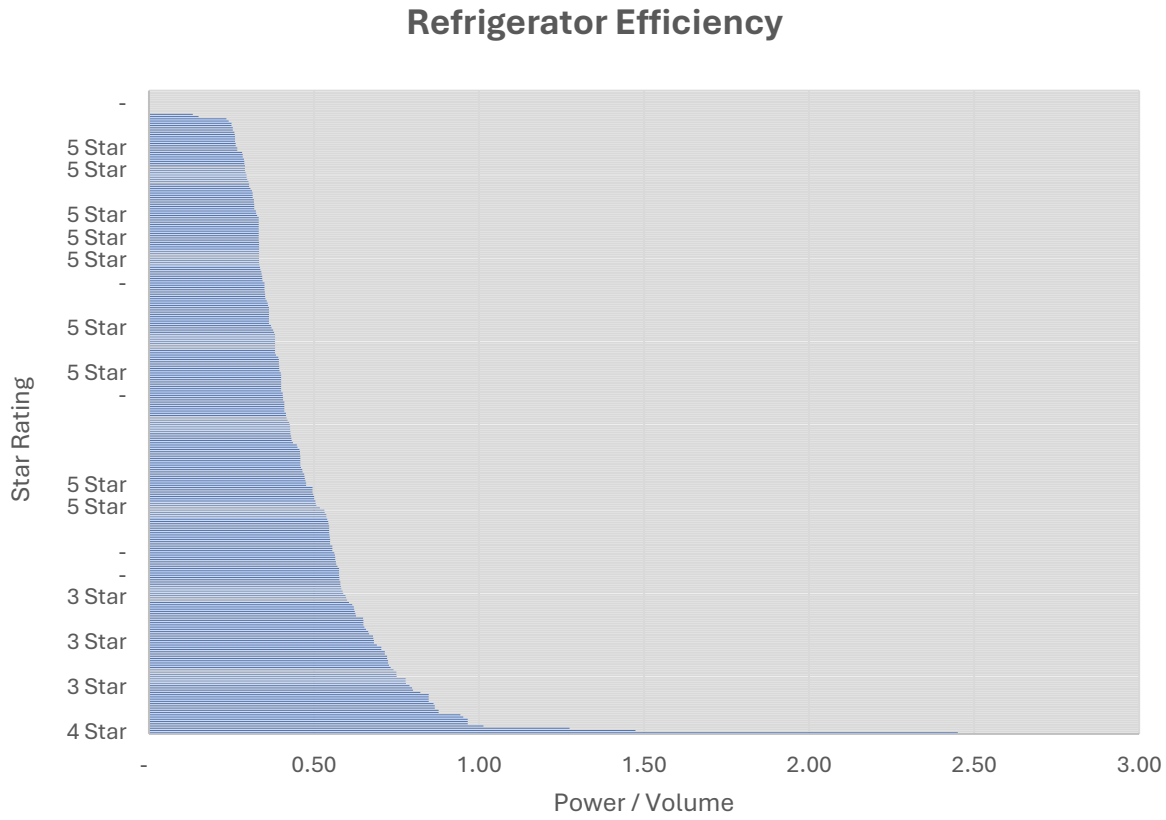



*Figure 10: Refrigerator star rating and Power/Volume Comparison (Source: Market Data Analysis)*

From the data analyzed in the market survey, the graph clearly demonstrates that the products with a "5-star" rating offer the highest energy efficiency, consuming significantly less power relative to their volume compared to lower-star-rated models. Notably, all the products with a lower energy efficiency still maintain at least a "3-star" rating. This finding underscores the prevalence of relatively efficient models in the market. Additionally, it was observed that 10 models lacked sufficient data for comprehensive energy efficiency calculations, but all surveyed models were capable of maintaining a freezer temperature of -

18°C and a refrigerator temperature of 0°C to +5°C, making "Power per Volume" a consistent and reliable indicator of energy efficiency.

The market survey further revealed that none of the available products were rated "1 Star" or "2 Star," with the lowest rated models still carrying a "3 Star" label. This suggests that, while the current energy labeling system provides some level of consumer guidance, the standards set in 2012 may no longer align with the technological advancements made in refrigerator energy efficiency. Therefore, the star rating system needs updating to reflect the progress in energy-efficient refrigerator technologies and to continue encouraging manufacturers to produce models that meet or exceed global energy performance benchmarks.

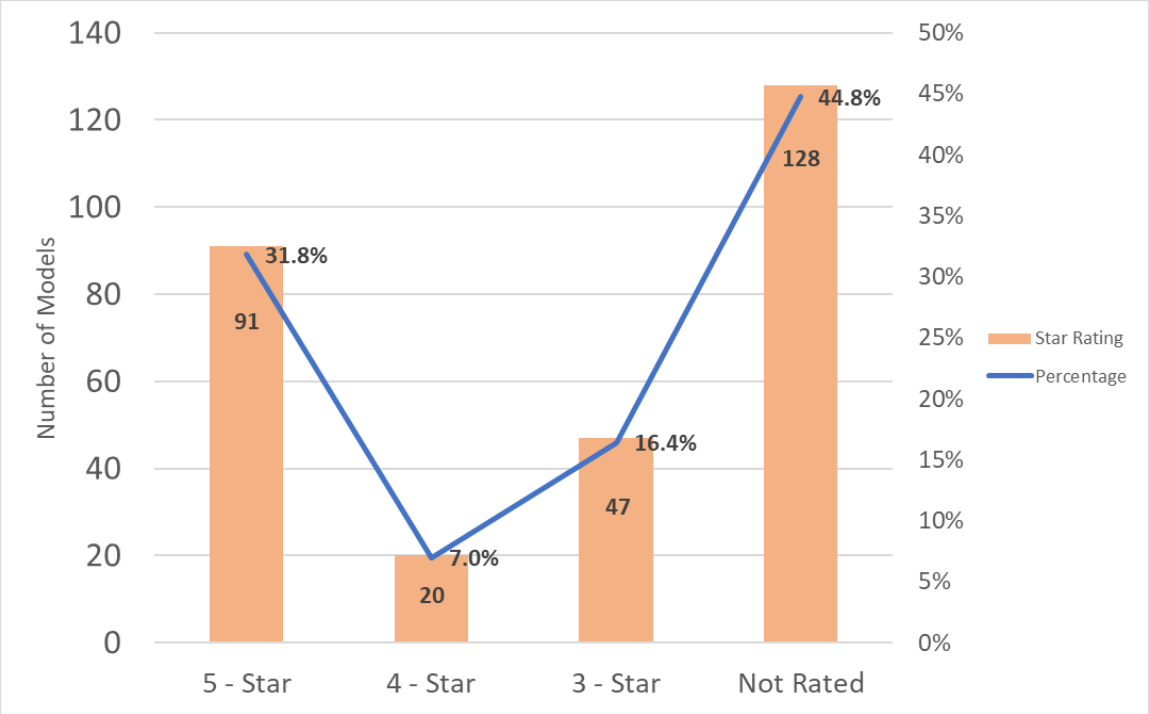



*Figure 11:Star ratings of the models surveyed*

Finally, it is recommended to adopt a a Minimum Energy Performance (MEP) level equivalent to a “3-Star” rating under the BDS 1850:2012 standard established by BSTI, specifically for Class 4 refrigerators. A "3-Star" rating under this standard corresponds to a maximum energy consumption ratio of 0.069 kWh per liter of storage volume. This energy efficiency level, when applied to a standard 400-liter refrigerator (comprised of a 300-liter fresh-food compartment and a 100-liter freezer compartment), translates to an estimated annual energy consumption of approximately 955 kWh. Establishing this as the minimum efficiency standard will help ensure that refrigerators in Bangladesh meet a baseline level of energy performance, encouraging manufacturers to produce models that are more energy-efficient while providing consumers with better options.

**Life Cycle Cost Analysis for Refrigerators**

Life Cycle Cost Analysis (LCCA) offers a comprehensive understanding of the total cost of ownership of an appliance over its entire operational lifetime. While many consumers primarily focus on the initial purchase price of equipment, LCCA studies reveal that the operating costs, particularly energy consumption, often constitute a larger portion of the overall lifetime costs. This is particularly true for appliances like refrigerators, which operate continuously. Therefore, energy costs play a critical role in the long-term expenses associated with such equipment.

An energy-efficient refrigerator may have a higher upfront cost compared to an inefficient one, but its reduced energy consumption over the years can lead to significant savings, resulting in a lower overall life cycle cost. To illustrate this, we conducted an LCCA comparison between a 3-star and a 5-star refrigerator, based on the following assumptions:

- **Lifetime**: 10 years for both models
- **Operational time**: 24 hours per day, 365 days per year, with a diversity factor of 66%
- **Average electricity cost**: BDT 7.50 per kWh
- **No maintenance or disposal costs were considered**

The analysis focuses on the most common refrigerator capacities used by consumers, ranging from 200 to 320 liters. The prices of these models, as well as their energy consumption, were averaged based on the market data collected.

| | 3 Star | 5 Star |
|---|---|---|
| **Initial Cost** | 40,373 | 44,041 |
| **Energy Cost** | 89,815 | 51,560 |
| **Total Cost (BDT)** | 130,188 | 95,601 |

This LCCA model allows consumers to see the long-term financial benefits of choosing energy-efficient appliances, despite the higher initial purchase price of a 5-star refrigerator. Over a 10-year lifespan, the energy cost savings of a 5-star model can outweigh its upfront cost, making it a more economical choice in the long run. This analysis highlights the importance of factoring in energy efficiency when making purchasing decisions and supports the push for stronger Minimum Energy Performance Standards (MEPS) to guide both manufacturers and consumers toward more sustainable choices.

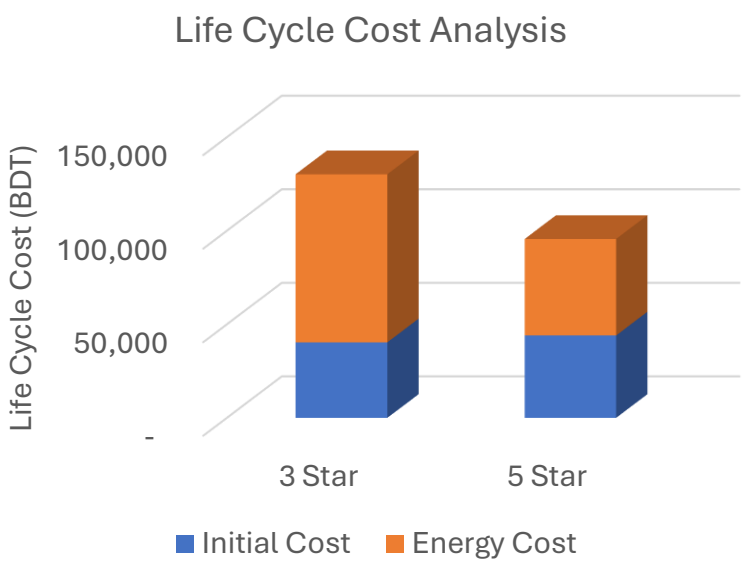



Figure 12: Life Cycle cost analysis of refrigerators

## 5.2 Setting the Baseline: Ceiling Fan

The MEPS for ceiling fans will establish a baseline for energy efficiency requirements, ensuring that all ceiling fans sold in Bangladesh meet specific performance standards. This initiative aims not only to reduce energy consumption but also to drive innovation among manufacturers, encouraging the development of more energy-efficient fan models. This measure is anticipated to generate significant energy savings while raising awareness among consumers about the long-term benefits of energy-efficient appliances.

**National and International Minimum Energy Performance Standards and Test Standards for Ceiling Fans**

Globally, many countries have either adopted or are in the process of developing enhanced Minimum Energy Performance Standards (MEPS) and test protocols for ceiling fans. However, significant gaps remain, providing room for further tightening of these standards to realize energy savings. Countries like India have implemented stringent MEPS, leading to the development of super-efficient ceiling fans that use 50-60% less electricity, largely due to technologies like Brushless Direct Current (BLDC) motors and optimized blade designs. However, despite the introduction of these efficient technologies, it is estimated that only 3% of ceiling fans in India meet these high-efficiency standards, though the adoption rate of ceiling fans in Indian households exceeds 90%. In terms of testing, most countries use the IEC 60879 standard to assess the energy efficiency of ceiling fans. The United States has developed its own test protocol, which differs slightly from the IEC approach, but both methods are designed to ensure fans meet energy efficiency standards across markets.

*Table 1:Examples of national and international minimum energy performance standards (MEPS) and test standards for ceiling fans*

| Country | Minimum Energy Performance Standards (MEPS) | MEP Level |
|---|---|---|
| U4E (united4efficiency.org) by UNEP (United Nations Environment Program) | MODEL REGULATION GUIDELINES FOR ENERGY-EFFICIENT CEILING FANS | 4.10 $m^3$/min/W |
| Brazil | The Interministerial Order No. 2 of June 29, 2017 establish Minimum Energy Performance Stadards (MEPS) for ceiling fans. Pl nº 02/2017 | 0.96 $m^3$/min/W |
| Canada | Energy Efficiency Regulations, 2016 PART 2 DIVISION 1 SUBDIVISION L Ceiling Fans | 1.075 $m^3$/min/W |
| China | GB 12021.9-2021 | 3.00 $m^3$/min/W |
| India | IS 374-2019 Notification number S.O. 2210(E) dated May 12, 2022 | 4.00 $m^3$/min/W |
| Malaysia | MS 2574:2014 | |
| Pakistan | PS:1/2021 | 3.15 $m^3$/min/W |
| Sri Lanka | SLS 1600:2011 | |
| Thailand | TIS 205-2530 | |
| United States of America | 10 CFR § 430.32 - Energy and water conservation standards | 2.10 $m^3$/min/W |

Note: For India, fan testing air velocity measurements below 0.25 metres per second (15 metres/minute) are discarded, while for IEC 60879, air velocity measurements below 0.15 metres per second (9 metres/minute) are discarded. For the United States of America, the test protocol is from U.S. Department of Energy (2022a).

**Bangladesh MEPS for Ceiling Fans**

In Bangladesh, the BDS 1860:2012 standard is the official guideline for ceiling fan energy efficiency. This standard includes a star rating system, ranging from 1-star to 5-star ratings based on the fan's energy consumption and airflow efficiency (measured as service value in $m^3$/min per watt). However, this standard does not fully address the potential energy savings that could be achieved through the adoption of modern technologies like BLDC motors and advanced fan blade designs.

To remain competitive globally and meet the country's energy conservation goals, Bangladesh's current star rating of ceiling fans will require updates that reflect the latest technological advancements. These updates will encourage local manufacturers to produce higher-efficiency products while giving consumers more energy-efficient options. The revised standards will allow Bangladesh to not only reduce energy consumption but also enhance its standing in the global market as a proponent of sustainable energy practices.

**Current Energy Efficiency Standards and Best Available Energy-Efficient Ceiling Fans**

The energy efficiency of ceiling fans is primarily measured by their service value, which is the ratio of airflow (in cubic meters per minute) to power consumption (in watts). Higher service values indicate more energy-efficient fans, as they can move more air while consuming less power. This measurement is critical in countries with warm climates like Bangladesh, where ceiling fans are widely used.

The BDS 1860:2012 standard governs the energy efficiency of ceiling fans in Bangladesh, using a star rating system that categorizes fans based on their service value. The ratings range from 1-star to 5-star, with higher ratings indicating better energy efficiency. The energy efficiency values are categorized by the fan's size (measured in mm) and type, including capacitive-type fans commonly used in Bangladeshi households.

The best-performing ceiling fans available globally, particularly those using BLDC motor technology, significantly outperform traditional models in terms of energy efficiency. These fans can achieve service values exceeding those of conventional fans, thereby offering the potential for significant energy savings if adopted more widely in Bangladesh.

*Table 2:BDS 1860:2012 Energy Efficiency values of star rated ceiling fans of varying diameters*

| Type | | Specification (mm) | Energy Efficiency value [$m^3$/ (min.W)]. | | | | |
|---|---|---|---|---|---|---|---|
| | | | Energy Efficiency Stars | | | | |
| | | | 1 | 2 | 3 | 4 | 5 |
| Desk fan, box fan, wall fan, slide fan and floor fan | Capacitive type | 200 | 0.54 | 0.57 | 0.60 | 0.66 | 0.71 |
| | | 230 | 0.64 | 0.67 | 0.70 | 0.77 | 0.84 |
| | | 250 | 0.74 | 0.76 | 0.79 | 0.85 | 0.91 |
| | | 300 | 0.80 | 0.83 | 0.86 | 0.92 | 0.98 |
| | | 350 | 0.90 | 0.92 | 0.95 | 1.02 | 1.08 |
| | | 400 | 1.00 | 1.03 | 1.06 | 1.15 | 1.25 |
| | | 450 | 1.10 | 1.15 | 1.19 | 1.31 | 1.42 |
| | | 500 | 1.13 | 1.19 | 1.25 | 1.35 | 1.45 |
| | | 600 | 1.30 | 1.36 | 1.43 | 1.54 | 1.65 |
| Ceiling fans | Capacitive type | 900 | 2.75 | 2.81 | 2.87 | 2.91 | 2.95 |
| | | 1050 | 2.79 | 2.86 | 2.93 | 3.02 | 3.10 |
| | | 1200 | 2.93 | 3.00 | 3.08 | 3.15 | 3.22 |
| | | 1400 | 3.15 | 3.24 | 3.32 | 3.39 | 3.45 |
| | | 1500 | 3.33 | 3.43 | 3.52 | 3.60 | 3.68 |
| | | 1800 | 3.47 | 3.57 | 3.67 | 3.74 | 3.81 |

**MEPS for Ceiling Fans in Bangladesh**

Based on the field surveys conducted in Bangladesh, local manufacturers such as Walton, Super Star, and Jamuna are among the leading producers of energy-efficient ceiling fans, with service values ranging from 2.3 to 4.16 $m^3$/min/W. In contrast, lower-priced models available in the market generally exhibit lower energy efficiency, with service values below 2.5 $m^3$/min/W. Imported models from brands like Havells and Orient are available in the market but are priced higher while offering similar service values to local brands. Notably, one BLDC (Brushless Direct Current) model from Walton

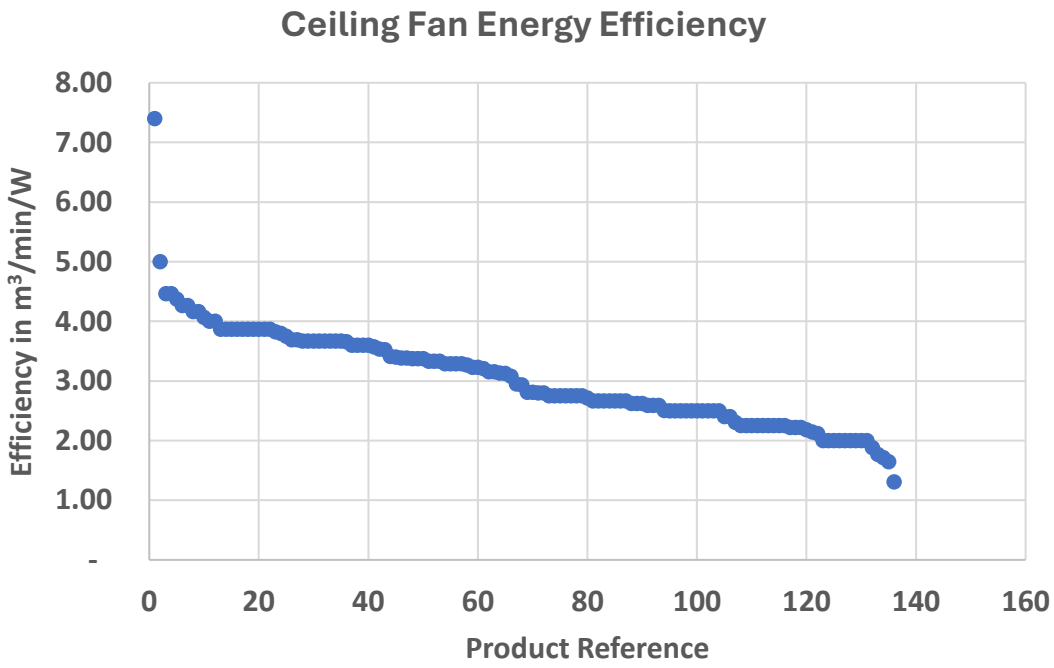



*Figure 13: Ceiling Fan Energy Efficiency*

demonstrated an impressive service value of 7.4 $m^3$/min/W, showcasing significant energy-saving potential.

From the survey results, data was collected from 136 different fan models across various brands. A graph plotting the data has been developed to compare the energy efficiency (service value) of the ceiling fans surveyed. To establish Minimum Energy Performance Standards (MEPS) for ceiling fans in Bangladesh, it is essential to build on the framework provided by the country's existing standards. Specifically, the MEPS should align with the values, testing procedures, and specifications detailed in the BSTI 1860:2012 standard, which is the current national standard for assessing ceiling fan energy efficiency. By adopting these established standards, the MEPS development process can make efficient use of Bangladesh's existing lab facilities and testing capabilities, ensuring consistency and ease of implementation across the industry

**Market Survey Findings on Ceiling Fan Usage**

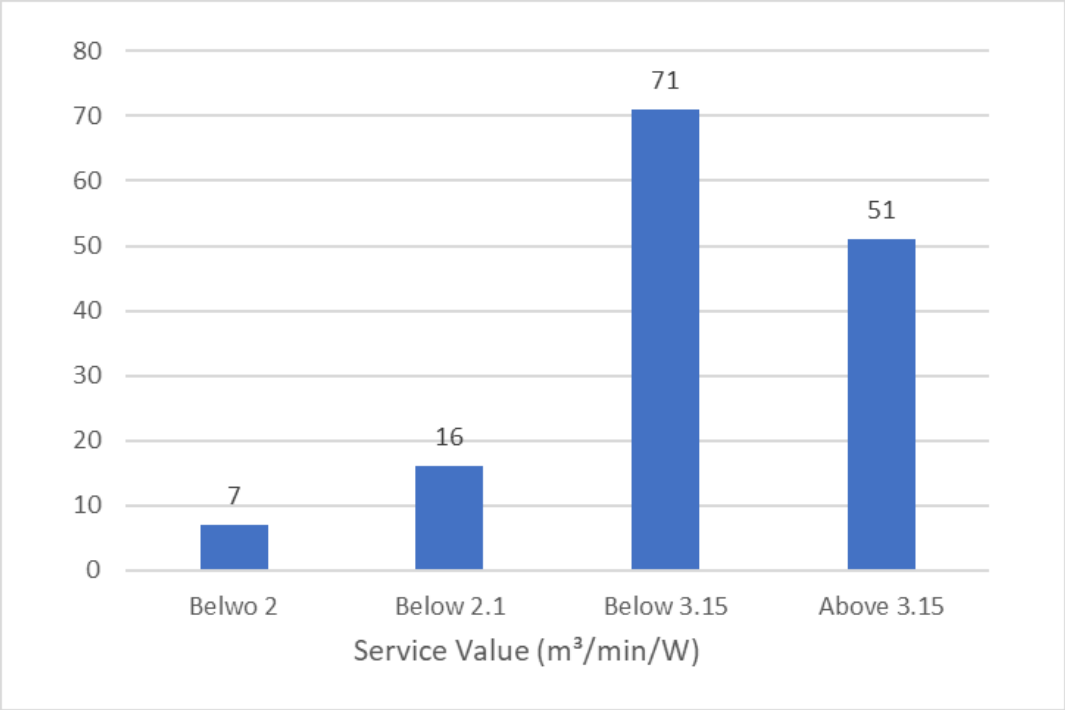
The survey revealed that 97% of households in Bangladesh use 56-inch, 48-inch, and 38-inch diameter ceiling fans, with 56-inch fans accounting for 80% of the market, followed by 48-inch (10%) and 38-inch (7%). The breakdown of the 136 fan models from 84 surveyed showed that 56-inch fans dominated the market with 90% of the models, while 48-inch and 38-inch fans accounted for 5% and 4%, respectively.

The points below highlights the minimum service values established for these ceiling fan sizes, based on market data and current standards:

- 56-inch (1400 mm) fans: Minimum service value of 3.15 $m^3$/min/W
- 48-inch (1200 mm) fans: Minimum service value of 2.93 $m^3$/min/W
- 38-inch (900 mm) fans: Minimum service value of 2.79 $m^3$/min/W

**Proposing MEPS for Ceiling Fans**

The survey data revealed that 58% of the 122 models of 56-inch fans surveyed did not meet the BSTI minimum service value of 3.15 $m^3$/min/W, indicating that the current standard may be too high for immediate market adoption. Therefore, the MEPS for ceiling fans in




Bangladesh should be proposed carefully to avoid significant pushback from manufacturers and ensure smooth implementation.

For 56-inch ceiling fans:

- Out of the 122 models, seven models had service values below 2.00 $m^3$/min/W, and 16 models (13%) had service values below 2.10 $m^3$/min/W.

- Based on this data, it is proposed that the MEPS for 56-inch ceiling fans be set at 2.10 $m^3$/min/W, which is achievable by most manufacturers and reflects a reasonable improvement in energy efficiency without causing market disruption.

For 48-inch ceiling fans:

- Of the seven 48-inch fan models surveyed, only two models exceeded the BSTI minimum service value, while one model (14%) had a service value below 2.5 $m^3$/min/W.
- Therefore, it is proposed that the MEPS for 48-inch ceiling fans be set at 2.50 $m^3$/min/W, reflecting a balance between market capabilities and energy efficiency goals.

For 38-inch ceiling fans:

- Of the five 38-inch fan models surveyed, only one model had a service value above the BSTI minimum, while one model (20%) had a service value below 2.3 $m^3$/min/W.
- Based on this, it is proposed that the MEPS for 38-inch ceiling fans be set at 2.30 $m^3$/min/W.

Setting appropriate MEPS for ceiling fans will not only encourage the production of more energy-efficient models but also contribute to Bangladesh's broader energy conservation goals. The proposed MEPS values reflect a practical and achievable improvement in energy efficiency for the local market, encouraging manufacturers to innovate while remaining competitive. These measures will ultimately help reduce national energy consumption and promote the adoption of sustainable practices across the country.

## 5.3 Setting the Baseline: Rice Cooker

Rice being the staple food of most Asian Countries, rice cooker serves a great support to residential and commercial facilities. Unlike conventional gas or biomass stoves, rice cookers have better cookware, enclosed chambers resulting in faster cooking times, precise temperature control and automatic shutoff. These features improve energy efficiency and cut down energy waste and heat losses. Additionally, the cookware is easy to clean and offer safety advantages; since the outer bowl remains cool, making them ideal for households.

For the purpose of the study, electric rice cookers with heating coil as the heat source has been considered. Induction cookers are not considered here and addressed separately. Along with the rapid electrification of the nation and people having access to electricity supported by being an affordable household appliance, Bangladesh is facing demand surges for rice cookers since 2018. This is triggering both local manufacturers and importers to flood the market with products. Hence, it is important to develop Minimum Energy Performance Standards (MEPS) to curtail inefficient products entering the market and to stimulate market transformation.

The MEPS for rice cookers are based on in the electrical energy input to the measured thermal output of the unit.

**Market Data Summary for Rice Cookers**

The market survey on household usage of rice cookers identified 86 models from 27 different brands, which includes both manufactured locally and imported. The rated input power of these models varies from 350W to 2500W. Market penetration is over 70% of the models of 700W and 1100W. Notably, the majority of the models, 35 in total, operate at 1000W, and 19 models operating at 700W. This data highlights the popularity of mid-low-range power levels.

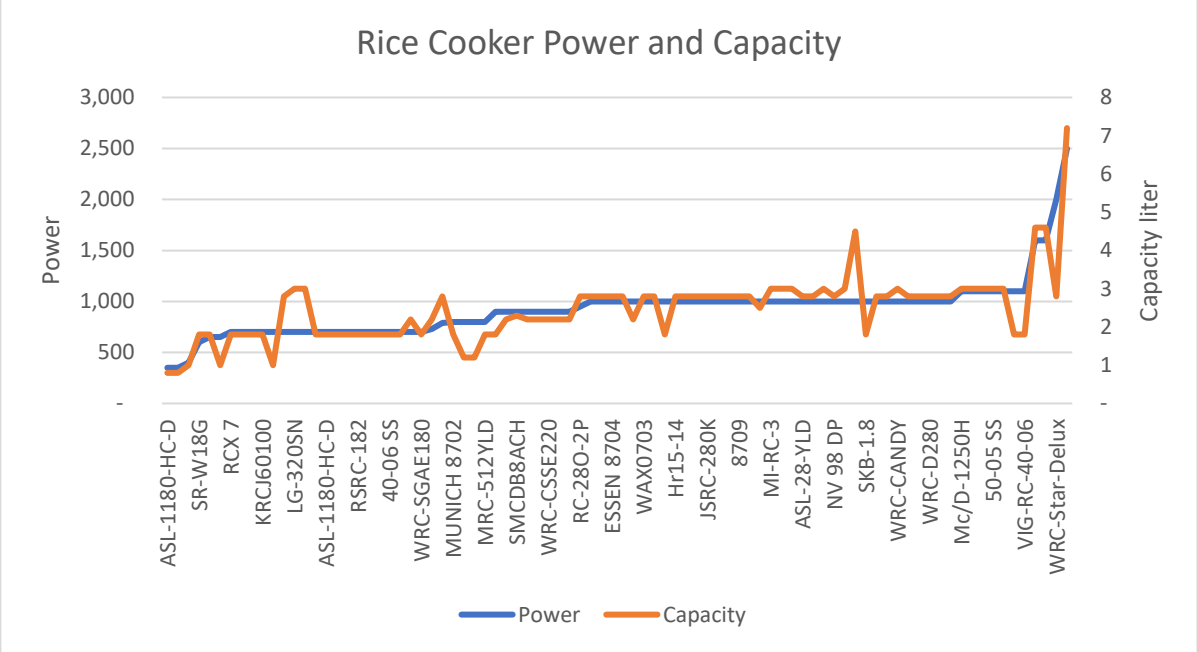



*Figure 14: Rated Power of the Rice cookers identified during the Market Survey*

The main objective of this survey was to collect detailed data that would inform the development of MEPS, ensuring that rice cookers in the market meet a baseline of energy efficiency. However, the survey faced significant challenges:

1. The only relevant parameter available to be collected from the survey was input power which is an important metric, but it is not sufficient to assess the overall energy efficiency or performance of the cookers.
2. The only other parameter was the inner bowl capacity, but no performance related data published by manufacturers such as cooking efficiency, keep warm power consumption nor heat conversion efficiency. This lack of information limits the ability relate survey data to set appropriate performance standards.

Given the limitations in the available data, further efforts are needed to gather more comprehensive performance information, either through manufacturer collaboration or independent testing.

**International MEPS and Test Standards for Rice Cookers**

As a result of the increasing popularity and usage of rice cookers, various countries and international organizations have developed standards to regulate the performance, safety, and energy efficiency of rice cookers. These standards aim to ensure minimum performance levels, consumer safety, promote sustainability, and reduce the environmental impact of rice cookers. However, compared to other household appliances, standards applicable to rice cookers are relatively recent and not as globally recognized. Six such regional and internationally applicable standards, listed below, have been considered for the study. These standards specify performance testing methods, minimum energy performance standards, and act as labeling programs. While these standards all address similar objectives, they differ in their scope, methodology, and regulatory requirements.

- **Malaysia** – Suruhunjaya Tenaga, Energy Commission - *GUIDE ON MINIMUM ENERGY PERFORMANCE STANDARDS FOR RICE COOKER, 1ST APRIL 2020*
- **Vietnam** - MEPS and Labelling for Electric Rice Cookers: *TCVN 8252:2015 (applied by 24/2018/QD-TTg)*
- **Indonesia** - MEPS and Labelling for Rice Cookers (*MEMR Decision No. 115/2021*)
- **Taiwan** - *Neng-ji-zi No. 10805000370, Electric Rice Cooker Energy Conservation Label Energy Efficiency Standard and Marking Methods*
- **International** - *IEC 63399:2024 - Household and Similar Electrical Rice Cookers - Methods for Measuring the Performance*

The recently introduced *IEC 63399:2024* applies to household and similar electrical rice cookers. This document defines the main performance characteristics that are of interest to the user and specifies methods for measuring these characteristics. Its introduction marks a significant step towards establishing globally recognized testing methodologies and performance metrics for rice cookers, providing greater uniformity across international markets.

Testing for compliance under each of these standards involves measuring the input power of the cooker and calculating the energy absorbed based on the temperature rise of water in the inner vessel. The thermal efficiency (η) is determined by dividing the theoretical power output (derived from measured energy consumption) by the measured input power.
Comparison of the key features, differences, and similarities of the listed standards are summarized in the table below.
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*Table 3:Key Similarities and Differences of Standards*

| Feature | Suruhunjaya Tenaga, Energy Commission 2020 (Malaysia) | TCVN 8252:2015 (Vietnam) | MEMR Decision No. 115/2021 (Indonesia) | Neng-ji-zi No. 10805000370 (Taiwan) | GB 12021.6-2008 (China) |
|---|---|---|---|---|---|
| **Energy performance requirement** | Efficiency (ɳ) | Efficiency (Eff) | Energy Intensity (Watt.Hour/ Liter) | Thermal efficiency (ɳ) | Thermal efficiency (ɳ) |
| **Testing Protocols** | MS 2024 | Specific testing methods | Specific testing methods | Specific testing methods | Specific testing methods |
| **Product Labeling** | Yes, energy label | Yes, Star Rating system | Yes, energy star rating | Yes, energy label | Yes, Energy efficiency tiers |
| **Global Applicability** | National (Malaysia) | National (Vietnam) | National (Indonesia) | European Union-specific | National (China) |
| **MEPS level** | 70% | 72% | 250 x $V^{-1/3}$ watthour/liter. | 70% | 72% |

**Bangladesh Energy Efficiency Standard for rice cookers**

Unlike other household appliances such as ceiling fans and refrigerators, rice cookers do not have a formalised BSTI standard, but a proposed testing methodology in accordance with IEC 63399:2024 - Household and Similar Electrical Rice Cookers. But currently any official testing to be done on this basis. Therefore, to implementation of MEPS is done preferably in accordance to the IEC testing methodology, which is an international standard organisation development.

As discussed in the previous chapter, the market survey revealed that no data is available on the parameters necessary to establish Minimum Energy Performance Standards (MEPS). Therefore, the performance of the samples must be tested in third-party laboratories, and the results can then be used to correlate the survey outcomes with the performance of the rice cookers.

Several local and regional laboratories were contacted to test the performance of sample rice cookers. However, none of the identified laboratories, despite confirming their ability to conduct the tests, were able to perform the tests in accordance with the required protocol. As a result, an alternative method to the market survey results must be used to define the MEPS for induction cookers

**Proposed Minimum Energy Standards for Rice Cookers**

The unavailability of test data and relevant market survey information compels the use of an alternative method to define MEPS for induction cookers. The next best option is to adopt a regional MEP value suitable for local conditions.

There are several international standards, as described in previous section. IEC 63399:2024 is an International standard which has been developed for describing standard test procedure for household rice cooking appliances and it does not specify minimum performance levels. Malaysian standards, specified a thermal efficiency-based grading system which rates the equipment from 1 to 5.

**7. STAR RATING**

7.1. The star rating shall be in accordance with Table 1 below:

| Rated power, P (W) | Efficiency, $\eta$ (%) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| P ≤ 400 | ≥ 65 | ≥ 70 | ≥ 75 | ≥ 80 | ≥ 85 |
| 400 < P ≤ 600 | ≥ 66 | ≥ 71 | ≥ 76 | ≥ 81 | ≥ 87 |
| 600 < P ≤ 800 | ≥ 67 | ≥ 72 | ≥ 77 | ≥ 82 | ≥ 89 |
| 800 < P ≤ 1000 | ≥ 68 | ≥ 73 | ≥ 78 | ≥ 83 | ≥ 91 |
| 1000 < P ≤ 2000 | ≥ 69 | ≥ 74 | ≥ 79 | ≥ 84 | ≥ 93 |

Table 1 : Star Rating

Note : Star Rating will be given by certification body appointed by the Commission in the test report or assessment letter

**8. MEPS REQUIREMENT**

A COA will only be issued upon fulfillment of all of the following requirements:

8.1. The MEPS rating to be achieved shall be 2-Star.

*Table :Performance rating of Malaysian Standard*

The Chinese Regulation GB 12021.6 established in 2008 and revised in 2017, establishes minimum performance standards, specifying energy efficiency tiers.

Table 4*: Energy Efficiency Tiers of GB 12021.6:2008x*

| Rated power (W) | Thermal efficiency (%) | | | | |
|---|---|---|---|---|---|
| | Energy efficiency tiers | | | | |
| | 1 | 2 | 3 | 4 | 5 |
| P≤400 | 85 | 81 | 76 | 72 | 60 |
| 400<P≤600 | 86 | 82 | 77 | 73 | 61 |
| 600<P≤800 | 87 | 83 | 78 | 74 | 62 |
| 800<P≤1000 | 88 | 84 | 79 | 75 | 63 |
| 1000<P≤2000 | 89 | 85 | 80 | 76 | 64 |

For rice cookers with metallic inner pot, the minimum energy performance standard (MEPS) is set on tier 4, while for non-metallic inner pot rice cookers, the MEPS is set on tier 5.

Furthermore, Taiwan as part of China defines a MEP level of 97% based on calculation of Thermal Efficiency Factor. This can be normalized to a Thermal Efficiency level of 70%.

Table 5*: MEP level of Neng-ji-zi No. 10805000370 of Taiwan*

Table I MEPS for Electric Rice Cookers

| MEPS for thermal efficiency value(%} |
|---|
| 72.0 |

Note:

1. The Electric Rice Cookers denoted in this announcement are those meeting the definition in CNS 2518. The calculated thermal efficiency value shall be rounded off to one decimal place. Thermal efficiency(%) equals the cooker heating capacity(Qt)( sensible heat capacity (Ql ,Wh) plus latent heat capacity (Q2 • Wh)) divided by Total energy consumption(E, Wh).

2. sensible heat and latent heat are defined by the following equation:

   sensible heat capacity $Q_1 = 1.16x(W_1+W_2)x(T_2-T_1)$

   latent heat capacity $Q_2 = \Delta wx0.6269$

   $W_1$: mass of distilled water at a rate of 64% of cooker's inner container (kg)

   $W_2$: mass of distilled water added to the outer container (kg)

   $T_1$: initial distilled water temperature($^0$C)

   $T_2$: highest distilled water temperature ($^0$C)

   $\Delta w$ : water evaporation(g}

3. The tested thermal efficiency value shall not be lower than the standard value shown in the table above. The tested value should be at least 97% or more of the product declared value. Both criteria must be met.

Given the significant similarities between regional countries in terms of climate, energy consumption patterns, and market conditions a MEP can be adopted by Bangladesh until the relevant local standards are established. Regional countries share comparable socio-economic contexts, infrastructure, and energy usage trends, making them a practical benchmark for setting energy performance regulations for rice cookers in Bangladesh. Additionally, the test procedures outlined in IEC 63399:2024 is well-established and can be readily implemented in Bangladesh and the accredited laboratory services can use for equipment testing at the initial implementation stage. These laboratories, which are equipped to perform the required testing in accordance with the standard's protocols, can provide reliable and standardized test results.

**Proposed MEPS, Thermal Efficiency (ɳ) = 70%**

## 5.4 Setting the Baseline: Induction Cooker

Unlike conventional gas or electric stoves, induction cookers use electromagnetic fields to directly heat cookware, resulting in faster cooking times and precise temperature control. This technology improves energy efficiency, as it heats only the pot and not the surrounding air, minimizing wasted energy. Additionally, induction cookers are easy to clean and offer safety advantages; since the cooktop remains cool to the touch, the risk of burns is significantly reduced, making them ideal for households.

For the purpose of the study, Induction cooker that has only electromagnetic induction heating as the heat source has been considered. Products which contain electric heating unit have not been considered. Since the induction cookers are becoming increasingly popular, it is important to develop Minimum Energy Performance Standards (MEPS) to reduce energy consumption and to stimulate market transformation.

The MEPS for Induction cookers are based on in the electrical input at maximum and the measured thermal output of the unit.

**Market Data Summary for Induction Cookers**

The market survey on household usage of induction cookers identified 84 models from 26 different brands, showcasing a diverse range of options for consumers. The rated input power of these models varies significantly, ranging from 1200W to 3500W. Notably, the majority of the models, 38 in total, operate at 2000W, accounting for 45% of the offerings. The second most common power rating is 2200W, which includes 28 models and represents 33% of the total. This data highlights the popularity of mid-range power levels, catering to various cooking needs and preferences among households.

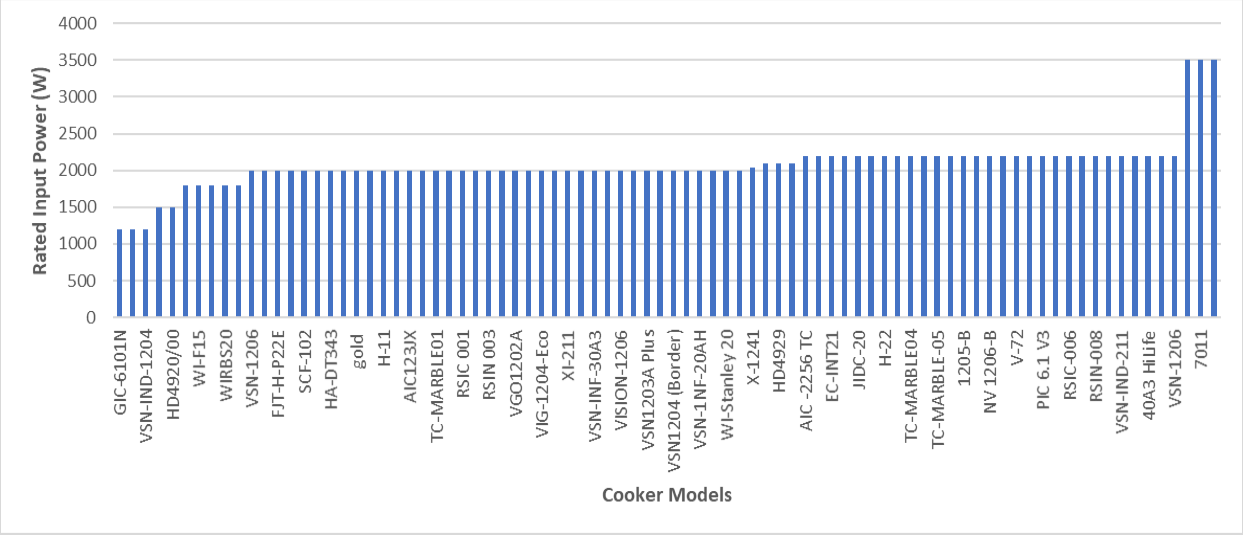


*Figure 15: Rated Power of the Induction cookers identified during the Market Survey*

The main objective of this survey was to collect detailed data that would inform the development of MEPS, ensuring that induction cookers in the market meet a baseline of energy efficiency. However, the survey faced significant challenges:

3. The only relevant parameter available to be collected from the survey was input power, which is an important metric, but it is not sufficient to assess the overall energy efficiency or performance of the cookers.
4. There is no performance related data published by manufacturers such as cooking efficiency, standby power consumption, or heat conversion efficiency. This lack of information limits the ability relate survey data to set appropriate performance standards.

Given the limitations in the available data, further efforts are needed to gather more comprehensive performance information, either through manufacturer collaboration or independent testing

**International MEPS and Test Standards for Induction Cookers**

As a result of increasing popularity and usage of Induction cookers, various countries and international organizations have developed standards to regulate the performance, safety, and energy efficiency of induction cookers. These standards aim to ensure minimum performance levels, consumer safety, promote sustainability, and reduce the environmental impact of the induction cookers. However, compared to the other household appliances, standards applicable to induction cookers are relatively recent and not globally speeded as much. Five such regional and internationally applicable standards, listed below, have been considered for the study. These standards specify performance testing methods, minimum energy performance standard and act as a labelling programs. While these standards all address similar objectives, they differ in their scope, methodology, and regulatory requirements.

- IS 19014: 2022 Household Electric Cooking Appliances
- TCVN 13372:2021 Energy Efficiency standard for induction hobs – Vietnam
- IEC 60350-2:2017 - Household electric cooking appliances - Part 2: Hobs - Methods for measuring performance – International
- Ecodesign Regulation (EC) No 66/2014 - European Union
- GB 21456-2024 - Energy Efficiency and Evaluation Method for Household Electric Cooking Appliances
- Code of Practice on Energy Labelling of Products- 2024 – Hong Kong

Testing for compliance under each of these standards involves measuring the input power of the cooker at maximum capacity and calculating the theoretical energy consumed based on the temperature rise of water in a standard test vessel. Performance level has been defining in two distinct methods in these standards.

1. The thermal efficiency (ɳ) is determined by dividing the theoretical power output (derived from measured energy consumption) by the measured input power.
2. Energy Efficiency Index(EEI) is determined by amount of energy required to heat up a kilo gram of water (Wh/kg)

Comparison of Key Features, Differences, and Similarities of the listed standards have been compared in the below table.

*Table 6:Key Similarities and Differences of Standards*

| Feature | TCVN 13372:2021 (Vietnam) | IS 19014:2022 (India) | IEC 60350-2:2017 (International) | Ecodesign Regulation (EC) No 66/2014 (EU) | GB 21456-2024 (China) |
|---|---|---|---|---|---|
| **Energy performance requirement** | Energy efficiency index (Wh/kg) | Energy efficiency index (Wh/kg) | Not specified | Energy efficiency index (Wh/kg) | Thermal efficiency (Ƞ) |
| **Testing Protocols** | Specific testing methods | Specific testing methods | Specific testing methods | Specific testing methods | Specific testing methods |
| **Product Labeling** | Yes, energy label | Yes, Star Rating system | No direct labeling requirement | Yes, energy label based on Ecodesign compliance | Yes, energy label |
| **Global Applicability** | National (Vietnam) | National (India) | International | European Union-specific | National (China) |
| **Environmental Considerations** | Limited to energy efficiency | Primarily energy efficiency | Limited to energy efficiency and safety | Extensive, including recyclability and carbon footprint | Limited to energy efficiency |

Note: Code of Practice on Energy Labelling of Products 2024 – Hong Kong has been derived from GB 21456-2024.

**Bangladesh Energy Efficiency Standard for Induction cookers**

Unlike other household appliances such as ceiling fans and refrigerators, induction cookers do not have a BSTI standard, or any applicable standard enforced by other agencies in Bangladesh. Therefore, to implement an MEPS, it is important to establish how energy efficiency is measured, what is the protocol for testing and what is the acceptable level of efficiency.

As discussed in the previous chapter, the market survey revealed that no data is available on the parameters necessary to establish Minimum Energy Performance Standards (MEPS). Therefore, the performance of the samples must be tested in third-party laboratories, and the results can then be used to correlate the survey outcomes with the performance of the cookers.

Several local and regional laboratories were contacted to test the performance of sample induction cookers. However, none of the identified laboratories, despite confirming their ability to conduct the tests, were able to perform the tests in accordance with the required protocol. As a result, an alternative method to the market survey results must be used to define the MEPS for induction cookers

**Proposed Minimum Energy Standards for Induction Cookers**

The unavailability of test data and relevant market survey information compels the use of an alternative method to define MEPS for induction cookers. The next best option is to adopt a well-established international standard that is suitable for local conditions.

There are several international standards, as described in previous section. IEC 60350-2:2017 is an international standard which has been developed for describing standard test procedure for household electric cooking appliances and it does not specify minimum performance levels. It has been referred in both TCVN 13372:2021 and IS 19014:2022 in defining the testing protocols.

In contrast to other standards, GB 21456-2024 has specified a thermal efficiency based grading system which rates the equipment from 1 to 5.

*Table 7:Performance rating of GB 21456-2024*

| **Rated and Measured Thermal Efficiency, η(%)** | | **Energy Efficiency Grade** |
|---|---|---|
| Rated Power of Heating Unit > 1200W | Rated Power of Heating Unit ≤ 1200W | |
| η ≥ 90 | η ≥ 88 | 1 |
| 90 > η ≥ 88 | 88 > η ≥ 86 | 2 |
| 88 > η ≥ 86 | 86 > η ≥ 84 | 3 |
| 86 > η ≥ 84 | 84 > η ≥ 82 | 4 |
| η < 84 | η < 82 | 5 |

The Ecodesign Regulation (EC) No 66/2014 (EU) establishes minimum performance standards, specifying the effective year on which the values will be implemented. Meanwhile, IS 19014:2022 (India) outlines a minimum performance level and introduces a Star Rating system that reflects enhanced performance.

*Table 8:Ecodesign Regulation (EC) No 66/2014 (EU) establishes minimum performance standards*

| **Date of Enforcement** | **Electric hob (Energy consumption in Wh/kg)** |
|---|---|
| From 1 year after the entry into force (2015) | **EC hob <210** |
| From 3 year after the entry into force (2017) | **EC hob <200** |
| From 5 year after the entry into force (2019) | **EC hob <195** |

*Note: EC*hob is the energy consumption calculated per 1000 g water in Wh;

*Table 9: IS 19014:2022Star Rating Band for Induction Hob Valid from Date of launch to 31st December, 2024*

| Star rating | Energy Consumption, Ehob (Wh) |
|---|---|
| 1 Star * | 200 ≥ **E hob >**194 |
| 2 Star * * | 194 ≥ **E hob >**188 |
| 3 Star * * * | 188 ≥ **E hob** >182 |
| 4 Star * * * * | 182 ≥ **E hob** >175 |
| 5 Star * * * * * | **E hob** ≤175 |

*Note: E*hob is the energy consumption calculated per 1000g water in Wh;

Given the significant similarities between India and Bangladesh in terms of climate, energy consumption patterns, and market conditions, the IS 19014:2022 standard can be effectively adopted by Bangladesh until the relevant local standards are established. Both countries share comparable socio-economic contexts, infrastructure, and energy usage trends, making Indian standard a relevant and practical benchmark for setting energy performance regulations for induction cookers in Bangladesh. Additionally, the test procedures outlined in IS 19014:2022 are well-established and can be readily implemented in Bangladesh and the accredited laboratory services in India can be used for equipment testing at the initial implementation stage. These laboratories, which are equipped to perform the required testing in accordance with the standard's protocols, can provide reliable and standardized test results.

**Proposed MEPS, $E_{hob}$ = 195Wh/kg**

Taking all above facts in to consideration it is proposed to higher ceiling go 1 star rating of IS 19014:2022, which is $E_{hob}$ = 195Wh/kg as the MEPS for induction cooker of the Bangladesh. This value is also in line with the minimum performance standards, specified in Ecodesign Regulation (EC) No 66/2014 (EU) effective since 2019.

**Rationale for the Proposed System**

Based on the above analysis, **IS 19014:2022 (India)** appears to be the most suitable standard for **Bangladesh** for the following reasons:

1. **Regional Compatibility**: Bangladesh and India share similar socio-economic characteristics, energy challenges, and appliance market conditions. The **Bureau of Energy Efficiency (BEE)** Star Rating system used in India is well-suited to the region and is already familiar to consumers and manufacturers.
2. **Energy Efficiency Focus**: Like Bangladesh, India is focused on **reducing energy consumption** in households. The **energy performance metrics** outlined in IS 19014:2022, especially its emphasis on **active cooking efficiency** and **standby consumption**, align well with Bangladesh's national goals of improving energy efficiency.
3. **Affordability**: Compared to other international standards, the Indian standard is likely to be more **affordable and accessible** for local manufacturers, which can help make energy-efficient induction cookers more affordable for consumers in Bangladesh.

## 5.5 Setting the Baseline: Household Induction Motor

This task will concentrate mainly small-scale induction motors used in household mainly for water pumping purposes. These pumps will be used mainly to transfer water, boost water pressure, landscape, waste water disposal etc. With the increasing emphasis on energy conservation, there is a growing need to enhance the energy efficiency of appliances to reduce national energy consumption and promote sustainability. This is aligned with Bangladesh's broader goals under the Energy Efficiency and Conservation Master Plan, which targets a significant reduction in energy use by 2030.

The development of Minimum Energy Performance Standards (MEPS) for induction motors is a critical step in this effort. MEPs establishes a baseline for energy efficiency, ensuring that all induction motors sold in Bangladesh meet minimum energy performance requirements. This will not only help reduce energy consumption but also drive innovation among manufacturers to produce more energy-efficient models, contributing to the country's energy conservation goals.

The MEPS for induction motors will focus on factors such as mechanical output, motor type, electrical input and overall energy consumption under different load conditions. By adopting these standards, Bangladesh will align with international best practices, ensuring that domestic induction motors sold in the country are both cost-effective for consumers and environmentally sustainable. This initiative is expected to lead to significant energy savings while enhancing consumer awareness about the benefits of energy-efficient induction motors.

**Market Data Summary for Household Induction Motors**

Water pumps hold a significant share of the induction motors used in households, driven by their need for water transfer usage. The global market for domestic water pumps are valued at USD 11.2 billion in 2023 and is expected to reach USD 15.3 billion by 2032, growing at a compound annual growth rate (CAGR) of about 3.6%.[9]

In Bangladesh the market penetration was low as 15% within the range of 0.75kW to 1kW, with the low capacities being the most popular.

This growing demand for water pumps highlights the importance of setting Minimum Energy Performance Standards (MEPS) to drive energy efficiency. By ensuring that water pumps sold in the market meet these standards, energy consumption can be reduced significantly, contributing to the national goals for energy conservation.

**National and International Minimum Energy Performance Standards and Test Standards for Household Induction Motor**

Internationally induction motors use the international standard of IE defined by IEC 60034-30-1, which is very popular among industrial and commercial users for induction motor efficiency. International Electrotechnical Commission (IEC) has developed the International

Efficiency (IE) classes through collaboration with the National Electrical Manufactures Association (NEMA), CEMEP, the Japan Electrical Manufacturers' Association (JEMA), the Institute of Electrical and Electronics Engineers (IEEE) and other international organizations. Table 2 below highlights some key examples of MEPS and test standards in various countries. These standards are crucial as they provide the benchmark for energy efficiency in induction motors, helping reduce national energy consumption.

*Table 10: Examples of national and international minimum energy performance standards (MEPS) and test standards for Induction motors*

| Country | Minimum Energy Performance Standards (MEPS) | Standards |
|---|---|---|
| **Australia / New Zealand** | 2001 – IE2 | |
| **China** | 2002 – IE1<br>2006 – IE2<br>2012 – IE3 | GB 18693 harmonized with IEC |
| **European Union** | Directive 640/2009<br>2011 – IE2<br>2014 – IE3<br>2023 – IE4 | IEC 60034-30-1 |
| **India** | 2012 – IE2 | IS 12615: 2018 |
| **Japan** | 2014 – IE3 | |
| **USA** | Energy Policy Act<br>1997 – IE2<br>2007 – IE3 | |

**Bangladesh MEPS for Induction Motors**

Bangladesh currently do not have any efficiency standard adopted for induction motors. There is no claim from the leading manufacturers for an efficiency standard for motors nor they publish efficiency data of the motors in their literature.

It is recommended for Bangladesh to align with IEC standards for motors as it the most widely used standard by most of the countries to develop MEPS. However, as manufactures do not publish motor efficiency, market survey does not provide useful feedback in deciding a MEPS. Therefore, selected samples have to be tested and the final MEPS has to be decided based on the test results and the marked share of the samples tested.

Initially, IE level 1 efficiency can be recommended as a minimum standard and test condition as given by IEC 60034-2-1. These updates will help Bangladesh remain competitive in the global market while also contributing to the country's energy conservation objectives

Following table indicate the minimum efficiency values specified for different motors in the IE1 standard efficiency class.

Table 11*: Minimum 50 Hz efficiency values defined in IEC/EN 60034-30-1:2014 (based on test methods specified in IEC 60034-2-1:2014*

| Output (kW) | 2 pole | 4 pole | 6 pole | 8 pole |
|---|---|---|---|---|
| 0.12 | 45 | 50 | 38.3 | 31 |
| 0.18 | 52.8 | 57 | 45.5 | 38 |
| 0.2 | 54.6 | 58.5 | 47.6 | 39.7 |
| 0.25 | 58.2 | 61.5 | 52.1 | 43.4 |
| 0.37 | 63.9 | 66 | 59.7 | 49.7 |
| 0.4 | 64.9 | 66.8 | 61.1 | 50.9 |
| 0.55 | 69 | 70 | 65.8 | 56.1 |
| 0.75 | 72.1 | 72.1 | 70 | 61.2 |
| 1.1 | 75 | 75 | 72.9 | 66.5 |
| 1.5 | 77.2 | 77.2 | 75.2 | 70.2 |
| 2.2 | 79.7 | 79.7 | 77.7 | 74.2 |
| 3 | 81.5 | 81.5 | 79.7 | 77 |

# 6. Testing Protocols and Methodology

## 6.1 Current Testing Practices:

Testing the energy efficiency of household appliances is critical to ensure compliance with energy efficiency standards and to encourage the promotion of energy-efficient products in the market. In Bangladesh, the testing protocols for appliances like refrigerators and ceiling fans are well established, while appliances like rice cookers, induction cookers, and household induction motors face challenges due to the absence of specific local testing standards.

**Refrigerators and Freezers**

The Bangladesh Standards and Testing Institution (BSTI) has set clear energy efficiency standards for household refrigerators through **BDS 1850:2012**, which specifies the requirements for the energy efficiency labeling of household refrigerators, refrigerator-freezers, and freezers. This standard outlines the necessary protocols for energy consumption measurement, which is conducted based on the appliances' cooling capacity and insulation effectiveness. The protocol ensures that refrigerators sold in the local market meet international standards for energy conservation. However, revisions are expected as the demand for updated and stricter efficiency standards grows.

**Ceiling Fans**

Ceiling fans in Bangladesh are subject to the **BDS 1860:2012** standard, which outlines requirements for testing airflow per watt and other energy consumption metrics. This relatively new standard has improved the ability of local manufacturers to test ceiling fans in compliance with global energy efficiency benchmarks. The testing includes measurement of the cubic feet per minute (CFM) of airflow and wattage consumption, ensuring that consumers can compare efficiency through the star rating system, which is applied based on the test results.

**Rice Cookers and Induction Cookers**

Currently, there are no specific local standards in Bangladesh for testing the energy efficiency of rice cookers and induction cookers. This gap presents a significant challenge for promoting energy efficiency in these appliances. As a result, many local manufacturers and importers rely on international testing protocols when applicable, but this process is not standardized across the market. Efforts to establish a standardized testing method for these appliances, in alignment with international norms, are needed to regulate their performance effectively.

**Household Induction Motors**

Testing for household induction motors in Bangladesh is currently limited. The existing standard, **BDS 1139:1986**, covers three-phase induction motors, primarily used in industrial settings. However, for household induction motors, there is no mandatory testing enforced under this standard, which leaves a significant gap in verifying their efficiency. While manufacturers may use service efficiency calculations to estimate performance, a comprehensive testing protocol tailored for household induction motors remains absent.

While Bangladesh has made strides in regulating the testing of certain household appliances, there is still much work to be done in establishing comprehensive testing protocols for rice cookers, induction cookers, and household induction motors. As the market grows and the demand for energy-efficient appliances increases, developing robust, standardized testing methods is crucial to ensuring that these products meet international standards and contribute to the country's energy conservation goals. This chapter highlights the need for future efforts to introduce these protocols and expand the scope of energy efficiency testing for all household appliances.

## 6.2 Developing Robust Testing Methods:

The current state of energy efficiency testing in Bangladesh shows a clear need for the development and implementation of standardized testing methods across various household appliances. While standards like BDS 1850:2012 for refrigerators and BDS 1860:2012 for ceiling fans have paved the way for the regulation of energy efficiency in these products, there remains a gap in the testing protocols for rice cookers, induction cookers, and household induction motors. This chapter outlines recommendations to develop robust testing methods for these appliances, in line with both BSTI and IEC standards.

### 6.2.1. Rice Cookers

As of now, Bangladesh lacks a defined testing standard for rice cookers. Drawing on international best practices, the energy efficiency of rice cookers can be measured using the *Guide on Minimum Energy Performance Standards (MEPS)* adopted by several countries. This guide evaluates the amount of energy required to cook a given volume of rice or water, ensuring the appliance's efficiency. The recently introduced *IEC 63399:2024 - Household and Similar Electrical Rice Cookers - Methods for Measuring the Performance* specifies the main performance characteristics of rice cookers that are of interest to users and defines methods

for measuring these characteristics. These include thermal efficiency, energy consumption, and performance metrics such as cooking time and power consumption. Adopting such a comprehensive standard could provide a robust framework for establishing energy efficiency benchmarks for rice cookers in Bangladesh.

**Proposed Testing Methodology**:

- **Efficiency Measurement**: The key metric for rice cookers would be the energy required to boil a specific amount of water. This can be standardized by testing the energy consumption per liter, using consistent environmental and voltage conditions (230V, 50Hz).
- **Environmental Controls**: Tests must be conducted in a controlled environment, with precise temperature settings to ensure consistency across different models. Testing under various load capacities will give a complete picture of energy efficiency performance.

**Rationale**: By adopting this standardized testing methodology, Bangladesh can ensure that rice cookers meet energy efficiency criteria that align with global standards. This will enhance the transparency of energy performance for consumers, while also encouraging manufacturers to innovate toward higher efficiency.

### 6.2.2. Induction Cookers

Induction cookers are relatively new in the Bangladeshi market, and no local standards currently exist for measuring their energy efficiency. However, the IS 19014:2022 standard used in India can be adapted for use in Bangladesh. This standard evaluates both the energy consumption and the thermal efficiency of induction cookers.

**Proposed Testing Methodology**:

- **Thermal Efficiency Testing**: The test measures the ratio of energy consumed to heat cookware in comparison to the amount of energy input. This ensures that the induction cooker is transferring maximum energy to the cooking vessel.
- **Simulated Cooking Test**: A simulated test, where water is heated to boiling, would serve as the performance benchmark. The energy used over a specified period, such as 20 minutes, would give a clear indication of the cooker's efficiency.
- **Standard Cookware**: The use of standardized cookware during the tests, with specific ferromagnetic properties, ensures consistency across all tests.

**Rationale**: The adoption of this method will help regulate energy consumption in induction cookers sold locally, aligning Bangladesh with global practices. This will not only enhance market transparency but will also enable Bangladesh to promote energy-efficient cooking solutions.

### 6.2.3. Household Induction Motors

While a standard exists for three-phase induction motors in Bangladesh (BDS 1139:1986), it is outdated for modern household applications. Testing standards need to focus on energy

consumption, mechanical efficiency, and power output across various load scenarios, with specific benchmarks for household induction motors.

**Proposed Testing Methodology**:

- **Dynamometer Testing**: Efficiency would be tested using a dynamometer to assess the ratio of mechanical output to electrical input. This testing method can be conducted under different load conditions to ensure comprehensive data on efficiency.
- **Service Factor**: Implementing a service factor rating that measures motor performance under different conditions will ensure that manufacturers produce motors capable of efficient operation in real-world environments.

**Rationale**: Updating the testing methods for household induction motors is essential for promoting energy-efficient motors that meet modern standards. This will not only reduce energy consumption but also lower household energy costs in Bangladesh.

### 6.2.3. Adapting International Best Practices for Local Context

**Current Challenge**: The absence of local testing methods for several household appliances makes it challenging to regulate the market effectively. Relying on international test results does not always reflect the real-world usage conditions in Bangladesh.

**Recommendation**: While adopting international standards is essential, it is also necessary to adapt these standards to the local context. This involves:

- Conducting environmental assessments to understand the impact of local climate on appliance performance, particularly for cooling and heating appliances like refrigerators, rice cookers, and induction cookers.
- Collaborating with local institutions and testing labs to conduct sample-based testing under conditions that mimic typical Bangladeshi household environments.

This localized approach will ensure that the energy efficiency ratings reflect the actual performance of appliances in the country, leading to better-informed consumers and manufacturers.

### 6.2.4. Collaboration with International Testing Organizations

**Current Challenge**: Due to limited local testing facilities, many appliances, such as rice cookers and induction cookers, cannot be tested locally according to international standards.

**Recommendation**: Collaborating with international testing organizations and IEC-accredited laboratories can help bridge the gap. These organizations can provide expertise and advanced testing capabilities until local facilities are fully equipped. Over time, knowledge transfer and capacity building should aim to develop local labs that can perform these tests independently, aligning with international standards.

### 6.2.5. Capacity Building for Local Testing Laboratories

**Current Challenge**: Local testing laboratories in Bangladesh lack the necessary equipment and expertise to test several types of household appliances for energy efficiency.

**Recommendation**: A comprehensive capacity-building program should be initiated, targeting local testing labs such as those managed by BSTI. This program should focus on:

- Procuring advanced testing equipment capable of measuring energy consumption and performance of a wider range of appliances.
- Training laboratory personnel in testing protocols based on IEC and BSTI standards.

This initiative would not only enhance the testing capabilities of local labs but also promote self-sufficiency in conducting energy efficiency testing across the country.

### 6.2.6. Standardization of Test Reports

**Current Challenge**: Test reports are often inconsistent, making it difficult to compare energy efficiency across different models and brands of appliances.

**Recommendation**: We recommend the introduction of a standardized test report format for all household appliances, including rice cookers, induction cookers, refrigerators, ceiling fans, and induction motors. This format should include:

- Power consumption data under different operational modes.
- Comparison of energy performance to minimum efficiency performance standards (MEPS).
- Clear labeling of energy efficiency ratings based on standardized testing protocols.

A uniform reporting system will ensure greater transparency and make it easier for consumers and policymakers to make informed decisions based on energy performance.

The development of robust, standardized testing protocols is critical for ensuring the accuracy and reliability of energy efficiency data in Bangladesh. By adopting international standards, adapting them to the local context, and building local testing capacity, Bangladesh can establish itself as a leader in promoting energy-efficient appliances. These efforts will not only support the country's energy conservation goals but also enhance the competitiveness of local manufacturers in the global market.

## 6.3 Proposing New Testing Standards:

To align Bangladesh with international best practices in energy efficiency and meet the growing demand for energy-efficient appliances, it is imperative to propose new testing standards for rice cookers, induction cookers, and household induction motors. This section outlines the specific testing methods, proposed changes, and calculations required to support the development of Minimum Energy Performance Standards (MEPS) for these appliances.

### 6.3.1. Rice Cookers: Proposed Testing Standards and Calculations

Currently, Bangladesh lacks specific testing standards for rice cookers. We propose adopting the Guide on Minimum Energy Performance Standards (MEPS) as a basis for testing, with the following adjustments to reflect local usage conditions and energy consumption patterns.

**Proposed Testing Methodology**:

- **Energy Consumption Test**: The core metric for testing rice cooker efficiency is energy consumption per unit of cooked rice or water. The test involves measuring the energy required to cook 1 liter of water, simulating standard rice-cooking conditions.

- **Standardization of Test Conditions**:

    - **Ambient Temperature**: The test should be conducted at a room temperature of 25°C, with a voltage supply of 230V, 50Hz, which aligns with local power grid conditions.
    - **Water Volume**: The rice cooker is filled with a fixed amount of water (e.g., 1 liter), and the energy consumed to bring it to boiling point and maintain cooking temperature is recorded.

**Efficiency Calculation:**
The energy efficiency is calculated by determining the energy consumed during the cooking process in relation to the temperature rise in the water used. The formula provided for calculating the energy efficiency (η) is:

$$\eta = \frac{1.16 \times G \times (T2 - T1)}{E} \times 100$$

Where:

- η is the energy efficiency percentage,
- G is the volume of water before the test (in kilograms),
- T1 is the initial water temperature (in °C),
- T2 is the highest temperature reached after the test (in °C),
- E is the energy consumption (in Wh).

**Measurement Conditions:**

- **Supply Voltage and Frequency:** 230V, 50Hz.
- **Water Volume:** The water volume used for testing should be 80% of the maximum rated capacity of the rice cooker.

These conditions ensure that the rice cooker operates under typical household usage scenarios, giving a reliable measure of energy efficiency.

### 6.3.2. Induction Cookers: Proposed Testing Standards and Calculations

Induction cookers, which currently have no standard testing protocol in Bangladesh, can benefit from adopting and localizing the IS 19014:2022 standard. This standard emphasizes both thermal efficiency and energy consumption during simulated cooking scenarios.

**Proposed Testing Methodology**:

- **Thermal Efficiency Test**: This test assesses the energy transferred from the cooker to the cookware by heating water from ambient temperature to boiling point.

- **Efficiency Calculation**:
  - **Energy Input**: Measure the energy consumed by the induction cooker during the test, using a power meter.
  - **Energy Output**: Calculate the energy absorbed by the water using the formula:

$$\text{Energy Output (kJ)} = m \cdot c \cdot \Delta T$$

Where:

- m is the mass of water in kilograms (1 liter = 1 kg),
- c is the specific heat capacity of water (4.18 kJ/kg°C),
- ΔT is the change in temperature from ambient to boiling point (assumed to be 75°C for this test, from 25°C to 100°C).

- **Efficiency Percentage**:

$$\text{Thermal Efficiency (\%)} = \frac{\text{Energy Output (kJ)}}{\text{Energy Input (kJ)}} \times 100$$

Example calculation for a typical induction cooker:

$$\text{Energy Output} = 1\text{ kg} \times 4.18\text{ kJ/kg°C} \times 75\text{ °C} = 313.5\text{ kJ}$$

If the energy input is measured at **0.2 kWh**, converting to kJ:

$$\text{Energy Input} = 0.2\text{ kWh} \times 3600 = 720\text{ kJ}$$

The thermal efficiency would be:

$$\text{Thermal Efficiency (\%)} = \frac{313.5}{720} \times 100 \approx 43.5\%$$

By implementing these proposed testing standards for rice cookers and induction cookers, Bangladesh can establish a robust framework for assessing and promoting energy-efficient appliances. These new methodologies, adapted from international best practices, will pave the way for more accurate energy labeling and consumer awareness, ultimately contributing to reduced energy consumption across the nation. The establishment of MEPS based on these testing methods will create a foundation for a more sustainable appliance market, aligning Bangladesh with global energy efficiency goals.

# 7. Economic Analysis

## 7.1 The Price-Efficiency Dilemma

Energy efficiency improvements in household appliances often lead to a dilemma for both manufacturers and consumers in Bangladesh. On one hand, manufacturers must invest in advanced technology, better materials, and more efficient production methods to create energy-efficient products. On the other hand, these improvements typically result in increased production costs, which may be passed on to consumers through higher retail prices. The challenge lies in finding a balance between enhancing energy efficiency and keeping prices competitive for the cost-sensitive Bangladeshi market.

For refrigerators and freezers, the adoption of inverter technology and energy-efficient refrigerants like R-600a has significantly improved energy performance. However, these improvements come with a cost. Inverter compressors and more efficient insulation materials increase manufacturing costs, which translates to higher retail prices. The survey data shows that energy-efficient refrigerators range from 40,000 to 80,000 BDT, reflecting the additional investment required for energy-saving technologies. Consumers face the dilemma of paying more upfront for energy-efficient models or opting for cheaper, less efficient alternatives.

Similarly, in the case of ceiling fans, energy efficiency improvements like the introduction of energy-efficient motors and optimized blade designs have led to better airflow per watt. These fans, often rated with 5-star energy labels, are priced higher than their conventional counterparts. For example, energy-efficient ceiling fans typically fall within the 2,000 to 3,500 BDT range, whereas less efficient models can be found for as low as 1,500 BDT. The higher cost is justified by the long-term savings in electricity bills, but not all consumers are willing to make this trade-off.

Rice cookers and induction cookers face a similar scenario. Energy-efficient models, which consume less electricity and provide faster cooking times, are priced higher due to the use of advanced heating elements and better insulation. While consumers are becoming more aware of the benefits of energy-efficient cooking appliances, the price difference still poses a barrier. The price of rice cookers, for example, ranges from 2,000 to 4,000 BDT for energy-efficient models, whereas conventional models can be found for less.

In the case of household induction motors, manufacturers in Bangladesh primarily focus on assembling rather than full-scale production. Energy efficiency improvements, such as using better-quality windings or more efficient motor designs, increase the cost of components, which in turn raises the retail price. While efficient motors provide long-term savings in electricity costs, the initial price hike may deter consumers from opting for these models, especially in a price-sensitive market.

Overall, the price-efficiency dilemma presents a challenge for both manufacturers and consumers. While energy-efficient appliances offer significant long-term savings, the higher upfront costs pose a barrier, particularly in a market where price sensitivity is high. Balancing

the cost of efficiency improvements with affordability is essential for promoting wider adoption of energy-efficient technologies in Bangladesh.

## 7.2 Energy Savings vs. Price:

The economic viability of energy-efficient appliances in Bangladesh is increasingly relevant as electricity prices rise and consumers seek to reduce their utility bills. While energy-efficient appliances typically come at a higher upfront cost, the potential long-term savings often outweigh this initial investment. This section provides an analysis of how energy-efficient appliances—refrigerators, ceiling fans, rice cookers, induction cookers, and induction motors—offer substantial energy savings and cost benefits over time.

**Refrigerators and Freezers**

Energy-efficient refrigerators, particularly those with inverter technology, can significantly reduce electricity consumption compared to traditional models. The household survey data indicates that non-inverter refrigerators in Bangladesh consume about 500 kWh annually, while energy-efficient models can lower this figure to approximately 300 kWh per year.

At an average electricity tariff of 7.50 BDT per kWh, this reduction translates into annual savings of around 1,500 BDT. Over the lifespan of a refrigerator (10-12 years), a consumer could save between 15,000 to 18,000 BDT. Although the initial price difference between energy-efficient and standard models can range from 8,000 to 12,000 BDT, the energy savings make up for this cost within the first several years of use, making the purchase of energy-efficient refrigerators economically viable.

**Ceiling Fans**

The price-efficiency dilemma for ceiling fans is particularly notable due to the growing availability of Brushless Direct Current (BLDC) ceiling fans, which are significantly more energy-efficient than traditional models. BLDC fans consume around 35 watts, compared to standard ceiling fans that consume approximately 75 watts.

For a typical household using a ceiling fan for 12 hours daily, a BLDC fan can save about 175 kWh annually compared to a traditional fan. At a tariff of 7.50 BDT per kWh, this results in yearly savings of approximately 1,312.50 BDT. The price difference between a traditional ceiling fan (approximately 3,000 BDT) and a BLDC fan (around 6,000 BDT) can be recouped within 2-3 years of usage due to these energy savings. Over the typical lifespan of a fan, these savings continue to accumulate, making BLDC fans a sound long-term investment.

**Rice Cookers and Induction Cookers**

Energy-efficient rice cookers and induction cookers are designed to reduce electricity consumption through more precise temperature control and efficient heating mechanisms. The household survey data shows that inefficient rice cookers consume around 0.5 kWh per cooking cycle, while energy-efficient models can reduce this to 0.3 kWh.

A household that uses a rice cooker twice daily can save approximately 146 kWh annually, translating to about 1,095 BDT in yearly electricity savings. Over a 5-7 year lifespan, this results in savings of 5,500 to 7,700 BDT, offsetting the higher upfront cost of energy-efficient models (1,500 to 2,000 BDT more than standard models).

For induction cookers, which are more efficient than conventional electric stoves, the savings can be even more pronounced. Induction cookers consume 25-30% less electricity than traditional models, especially when used frequently, making them an attractive option for households that prioritize energy conservation.

**Household Induction Motors**

In Bangladesh, household induction motors are predominantly used for water pumping, with typical usage averaging around four hours daily. A standard 1.5 HP motor consumes about 4.47 kWh per day, while an energy-efficient motor could reduce this consumption to around 3.13 kWh, saving approximately 1.34 kWh daily.

Over the course of a year, this would result in savings of about 489 kWh, or approximately 3,667 BDT annually at current electricity tariffs. Given that the price difference between an energy-efficient and standard motor is typically around 5,000 to 7,000 BDT, these savings can cover the additional upfront cost within two years of use. Over the motor's lifespan, these savings continue to accrue, making energy-efficient induction motors a highly cost-effective solution for households reliant on water pumps.

The analysis reveals that while energy-efficient appliances may come with a higher initial cost, the long-term savings in electricity bills make them a financially sound choice for consumers in Bangladesh. Whether it’s refrigerators, ceiling fans, rice cookers, induction cookers, or induction motors, the economic benefits of energy efficiency far outweigh the initial price premium, especially as electricity costs rise and the need for energy conservation becomes more urgent. With a growing awareness of these benefits, consumer adoption of energy-efficient appliances is likely to increase, contributing to national energy savings and environmental sustainability.

## 7.3 Supply Chain Dynamics and Pricing

The pricing of energy-efficient appliances is heavily influenced by the complexities of the supply chain, starting from raw material procurement, manufacturing, and distribution to retail. For energy-efficient appliances, the cost structure typically involves higher upfront expenses related to advanced technologies, improved materials, and energy-saving components. This section explores the dynamics of the supply chain for various appliances—refrigerators, ceiling fans, rice cookers, induction cookers, and household induction motors—and how the adoption of energy-efficient technologies impacts pricing at each stage.

**Raw Material Procurement**

Energy-efficient appliances often require premium materials and components, which increases the initial manufacturing cost. For example, the production of energy-efficient

refrigerators requires advanced insulation materials, higher-quality compressors, and improved refrigerants that reduce energy consumption. Similarly, BLDC (Brushless Direct Current) motors used in ceiling fans are more expensive than traditional motors due to the need for rare earth materials used in permanent magnets.

In the case of household induction motors, particularly those used for water pumps, efficient motor designs rely on higher-grade copper windings and superior steel for laminations, contributing to higher material costs. These advanced materials, although costly, are essential for ensuring the long-term efficiency and durability of energy-efficient appliances.

**Manufacturing and Assembly**

The manufacturing process for energy-efficient appliances typically involves more sophisticated technologies, precision engineering, and quality control mechanisms. For instance, the production of BLDC fans requires specialized manufacturing equipment to handle sensitive electronic components and magnets. Similarly, rice cookers and induction cookers that adhere to energy-saving standards must integrate more advanced temperature control systems and durable heating elements.

In Bangladesh, many manufacturers operate as assemblers, particularly in the household induction motor sector, where they import key components and assemble them locally. This reliance on imports adds to the production cost, especially with fluctuating import duties and international shipping costs. Energy-efficient appliances, which often rely on cutting-edge technologies sourced internationally, face higher production costs due to these factors.

**Distribution and Retail Channels**

Distribution networks play a significant role in the final pricing of energy-efficient appliances. As products move from manufacturers to wholesalers, retailers, and eventually consumers, each intermediary adds a markup to cover transportation, storage, and handling costs. For imported components and appliances, this markup can be even higher due to the additional logistics and customs fees involved.

In the case of energy-efficient appliances like refrigerators and ceiling fans, which require specialized handling to prevent damage to sensitive components, transportation and warehousing costs can further inflate prices. Additionally, energy-efficient appliances tend to be marketed as premium products, leading retailers to apply higher profit margins.

Online marketplaces and direct-to-consumer sales have somewhat reduced the layers of markups by allowing manufacturers to sell energy-efficient products directly to consumers. However, in regions where online penetration is low, traditional retail channels still dominate, often resulting in higher end-user prices due to the multiple layers in the supply chain.

**Pricing Impact of Efficiency Improvements**

Energy efficiency improvements introduce a dual dynamic in the pricing structure. On one hand, advanced energy-efficient technologies, such as inverter technology in refrigerators

and BLDC motors in ceiling fans, increase production costs, which are typically passed on to consumers. On the other hand, these higher prices are often offset by the long-term energy savings that these appliances provide.

The supply chain dynamics for energy-efficient appliances in Bangladesh reflect the complexity of balancing higher production costs with the potential for long-term savings. While raw materials and advanced technologies drive up the initial cost, the efficiency improvements offered by these appliances lead to substantial reductions in energy consumption, ultimately benefiting consumers. The role of distribution channels, import duties, and retail markups further influence the final price, but as consumer awareness of energy efficiency grows, the demand for these appliances is expected to rise, making them more accessible in the long run.

# 8. Recommendations for the Future

## 8.1 Policy Recommendations

As Bangladesh strives to improve energy efficiency across key sectors, implementing robust policies and market interventions is essential. These policies can drive the adoption of energy-efficient appliances, encourage innovation, and enhance the long-term sustainability of the country's energy resources. Below are key policy recommendations to promote energy-efficient appliances, reduce energy consumption, and support national sustainability goals.

**Establishing and Enforcing MEPS (Minimum Energy Performance Standards)**

A strong recommendation is to formally establish Minimum Energy Performance Standards (MEPS) for appliances such as rice cookers, induction cookers, and household induction motors. These MEPS would set clear minimum thresholds for energy efficiency that manufacturers and importers must comply with to sell their products in Bangladesh. MEPS should be periodically reviewed and updated to match advancements in global energy efficiency standards and emerging technologies.

The enforcement of MEPS should be mandatory, with stringent penalties for non-compliance, and the standards should cover a broad range of appliances including refrigerators, ceiling fans, and other high-energy-consuming household items.

**Promoting an Energy Efficiency Labeling Program**

The introduction of a comprehensive energy efficiency labeling program is crucial for empowering consumers with information on the energy performance of household appliances. Bangladesh should build upon the existing star rating system and expand it to cover more appliances, particularly rice cookers, induction cookers, and household induction motors, which currently lack coverage under any standard labeling scheme.

Energy labels should prominently display the appliance's star rating, energy consumption, and estimated energy savings. This would enable consumers to make informed decisions and

incentivize manufacturers to improve their products to achieve higher ratings. The labeling program must be supported by public awareness campaigns to educate consumers on the benefits of purchasing energy-efficient products.

**Offering Financial Incentives for Energy-Efficient Appliances**

Financial incentives can be a powerful tool to encourage both manufacturers and consumers to adopt energy-efficient technologies. The government should consider implementing the following incentive programs:

- **Subsidies for Manufacturers**: Local manufacturers who produce energy-efficient appliances should receive subsidies or tax breaks, which would lower the production cost and enable them to compete more effectively with imported products.
- **Consumer Rebates**: Offering rebates or discounts on energy-efficient appliances can help mitigate the higher upfront costs for consumers. For example, a rebate system for purchasing BLDC ceiling fans or energy-efficient refrigerators would encourage wider adoption among households, particularly those in lower-income brackets.
- **Reduced Import Duties for Energy-Efficient Components**: Lowering import duties on key components like energy-efficient motors, compressors, and insulation materials could reduce the cost of producing energy-efficient appliances locally. This would enhance the competitiveness of Bangladeshi manufacturers in both the domestic and export markets.

**Appliance Replacement Programs**

The government could also consider launching a national appliance replacement program where households are incentivized to trade in their old, inefficient appliances for energy-efficient ones at a discounted price.

**Introducing Performance-Based Incentives for Manufacturers**

To encourage innovation and continuous improvement in appliance energy efficiency, the government should establish performance-based incentives. These incentives could reward manufacturers that exceed the energy efficiency requirements set by MEPS with financial support or recognition programs. Additionally, manufacturers that demonstrate significant reductions in energy consumption through advanced product designs could receive research grants to further innovate.

**Strengthening Institutional Frameworks and Capacity Building**

To effectively implement energy efficiency policies, targeted capacity development is essential for institutions such as SREDA, BSTI, and relevant testing laboratories, each playing a unique role. For SREDA, capacity building should focus on enhancing policy-making, program management, and public awareness campaigns related to energy efficiency. This includes training in regulatory oversight, as well as developing tools for tracking and assessing the impact of energy efficiency initiatives.

For BSTI, capacity development should prioritize strengthening technical standards, certification processes, and compliance enforcement mechanisms. Investing in specialized training and modernizing testing methodologies will allow BSTI to establish and maintain rigorous energy efficiency standards.

Testing laboratories require upgrades in technical capabilities and equipment to perform accurate, comprehensive tests on various appliances, meeting both national and international standards. Building skilled teams with expertise in advanced testing protocols will ensure that labs can validate the performance of energy-efficient appliances.
A strengthened institutional framework would enable better coordination between these organizations, ensuring effective policy development, implementation, and monitoring, ultimately driving higher standards of energy efficiency across the appliance market.

**Facilitating Access to Green Financing**

The government should promote access to green financing for businesses and consumers seeking to invest in energy-efficient appliances. This could involve partnerships with financial institutions to offer low-interest loans or grants for manufacturers investing in energy-efficient technology and for consumers purchasing high-efficiency appliances. Expanding green financing options would make it easier for all stakeholders to participate in the energy transition.

By implementing these policy recommendations, Bangladesh can accelerate the adoption of energy-efficient appliances, reduce overall energy consumption, and enhance its energy security. A combination of regulatory measures, financial incentives, and consumer education is essential to foster a market where energy-efficient products are the norm, benefiting both the environment and the economy.

## 8.2 Consumer Awareness Campaigns

Raising consumer awareness about the benefits of energy-efficient appliances is essential to driving market demand and promoting sustainable consumption. Given that energy-efficient appliances often come with a higher upfront cost, it is crucial to communicate the long-term financial savings, environmental benefits, and improved performance associated with these products. Here are several strategies to effectively increase consumer awareness in Bangladesh and encourage the adoption of energy-efficient appliances.

**Nationwide Public Awareness Campaigns**

A large-scale, nationwide public awareness campaign is necessary to reach a broad demographic across urban and rural areas. This campaign could leverage various media platforms—television, radio, social media, and print—to promote the use of energy-efficient appliances. The key messages should focus on:

- **Cost Savings**: Highlight how energy-efficient appliances, though potentially more expensive initially, lead to significant savings on electricity bills in the long term. Real-

world examples or case studies can illustrate how consumers benefit financially over time.

- **Environmental Impact**: Emphasize the role that energy-efficient appliances play in reducing carbon emissions and lowering energy demand. This could appeal to environmentally conscious consumers and align with global sustainability trends.
- **Health and Comfort**: Show how energy-efficient appliances, such as refrigerators and fans, can improve indoor comfort, enhance air quality, and reduce noise levels, making homes more comfortable and healthier to live in.

Government bodies like SREDA, in collaboration with appliance manufacturers and retailers, could take the lead in executing these campaigns.

**Educational Programs and Workshops**

Partnering with schools, universities, and local community organizations to provide educational programs on energy efficiency can help create a culture of sustainable living from an early age. These programs should focus on educating students and their families about the importance of conserving energy and choosing energy-efficient appliances.

Workshops can be organized to demonstrate how energy-efficient appliances work, how to interpret energy labels, and how consumers can calculate potential energy savings. These workshops could also offer practical advice on appliance maintenance and usage habits that reduce energy consumption, such as setting refrigerators to optimal temperatures or using fans efficiently.

**Energy Efficiency Label Campaigns**

Expanding on the existing energy labeling program is key to empowering consumers to make informed purchasing decisions. An energy efficiency labeling campaign could include:

- **Visibility of Labels**: Retailers should ensure that energy efficiency labels are prominently displayed on all relevant appliances. Labels must be easy to understand and provide clear information about the appliance's energy consumption and efficiency rating.
- **Educational Videos and Leaflets**: Develop educational videos and printed materials that explain the meaning of the star rating system, how to compare energy consumption between different products, and the potential long-term savings from energy-efficient models. These materials should be available at appliance stores and online platforms.
- **In-Store Displays and Engagement**: Appliance retailers could set up in-store displays that compare the energy consumption and cost savings of energy-efficient appliances versus traditional models. Sales staff should be trained to explain the benefits of these appliances to consumers, focusing on both financial and environmental advantages.

**Social Media and Digital Platforms**

Given the increasing use of digital platforms in Bangladesh, leveraging social media, websites, and mobile apps can play a significant role in raising awareness. Social media campaigns can target various demographics, particularly younger, tech-savvy consumers, to showcase the ease and benefits of using energy-efficient appliances.

Interactive tools such as online calculators can be developed, allowing consumers to estimate the potential savings they would make by switching to energy-efficient appliances. Additionally, influencer marketing and partnerships with popular social media personalities can be used to spread messages about energy efficiency in relatable and engaging ways.

**Incentive-Based Campaigns**

Providing incentives for consumers to switch to energy-efficient appliances can significantly drive adoption. A campaign that promotes rebates, discounts, or tax incentives for energy-efficient appliances could be highly effective. These incentives can be promoted through billboards, local newspapers, or online channels, ensuring that consumers are aware of the financial benefits they could receive by upgrading to energy-efficient models.

Collaborations with utility companies could further bolster these efforts by offering rebates on electricity bills for households that purchase energy-efficient appliances. Utility companies could also include informational inserts in monthly bills to educate customers on how they can reduce their energy use through appliance upgrades.

**Collaboration with Retailers**

Retailers play a critical role in influencing consumer choices. A partnership with major appliance retailers to offer exclusive promotions and financing options for energy-efficient appliances could help make these products more accessible to a wider range of consumers. Retailers could also offer extended warranties or buy-back programs for energy-efficient appliances, reducing consumer hesitation to invest in new, more efficient products. Furthermore, retailers can organize demonstration events where consumers can learn firsthand about the benefits of energy-efficient products and how they outperform traditional models in terms of both energy consumption and performance.

**Targeted Campaigns for Rural Areas**

To ensure that awareness campaigns reach rural households, where access to information may be limited, targeted outreach efforts are essential. Local government offices, rural development agencies, and community leaders can play an important role in spreading awareness about the availability and benefits of energy-efficient appliances.

Radio programs, local newspapers, and community gatherings can be used as platforms for disseminating information on energy-efficient products. Additionally, mobile units could travel to rural areas to showcase energy-efficient appliances and provide information on how these products can improve household energy consumption.

To increase the adoption of energy-efficient appliances in Bangladesh, a comprehensive consumer awareness campaign is necessary. By educating consumers about the long-term financial, environmental, and comfort benefits of energy-efficient products, and offering incentives to make them more accessible, Bangladesh can accelerate the transition towards sustainable energy use. These campaigns should be tailored to reach various demographics across both urban and rural settings, ensuring widespread awareness and promoting energy-conscious decision-making.

## 8.3 Supporting Local Manufacturers

The growth and adoption of energy-efficient appliances in Bangladesh rely heavily on the capabilities and willingness of local manufacturers to innovate and improve their production processes. While international brands often have access to advanced technologies and resources, local manufacturers face unique challenges such as limited access to cutting-edge technologies, higher production costs, and competition from imports. However, with the right strategies and support, local manufacturers and assemblers can significantly enhance their competitiveness and contribute to the growth of energy-efficient appliances in Bangladesh.

**Incentivizing Innovation through Government Support**

To foster innovation and efficiency improvements, it is crucial that local manufacturers receive direct support from the government. This could take the form of subsidies, tax breaks, or grants specifically designed for manufacturers who invest in research and development (R&D) of energy-efficient technologies. Such incentives would lower the barriers to innovation and encourage manufacturers to prioritize energy efficiency in their product lines. Additionally, a public-private partnership model could be introduced to stimulate collaboration between the government, manufacturers, and international technology experts. By providing access to global best practices and new technologies, local manufacturers can improve their product quality and enhance energy efficiency.

**Enhancing Access to Cutting-Edge Technology**

Local manufacturers and assemblers often lag behind international competitors due to a lack of access to the latest manufacturing technologies and processes. To bridge this gap, the government, along with industry associations, can establish technology hubs where manufacturers can gain access to advanced machinery, tools, and equipment necessary for producing high-efficiency appliances.

These hubs could also serve as training centers where manufacturers and engineers can learn about new technologies such as smart manufacturing systems, automation, and energy-efficient designs. Such centers would help local manufacturers develop the capacity to produce high-quality, energy-efficient appliances that meet international standards.

**Capacity Development and Training Programs**

A major constraint faced by local manufacturers in Bangladesh is the shortage of skilled labor, particularly in the areas of advanced manufacturing and design. To address this, there needs

to be a focused effort on capacity building through training programs tailored to the needs of manufacturers and assemblers.
These programs should provide hands-on training in energy-efficient design, manufacturing processes, and quality control. Partnerships with international organizations and universities could be established to bring in technical expertise, ensuring that local manufacturers are equipped with the knowledge and skills needed to produce appliances that meet the growing demand for energy efficiency.

Moreover, these programs could promote the adoption of modern testing methods, helping local manufacturers adhere to energy efficiency standards such as MEPS. Training in testing protocols and compliance requirements would enable manufacturers to certify their products, increasing consumer trust and market competitiveness.

**Supporting Research and Development (R&D)**

Innovation in the energy efficiency space cannot be achieved without sustained investment in research and development. Local manufacturers should be encouraged to establish in-house R&D departments or collaborate with universities and research institutions to develop more energy-efficient products.

To support this, the government could introduce R&D tax credits for manufacturers investing in energy efficiency projects. Additionally, creating a national innovation fund that provides grants and low-interest loans to manufacturers working on energy-efficient product designs would help accelerate innovation. Local R&D efforts could focus on optimizing materials, improving appliance design for energy conservation, and exploring new energy-saving technologies.

**Collaborations and Knowledge Sharing**

Collaboration between local manufacturers and international firms is another way to foster innovation and improve efficiency. International collaborations can facilitate knowledge transfer, giving local manufacturers access to advanced technologies, manufacturing techniques, and product designs.

Trade shows, expos, and industry workshops can serve as platforms where local manufacturers meet with international experts to exchange ideas and form partnerships. These events could also feature discussions on global energy efficiency standards and how local manufacturers can align their products to meet these standards.

Such collaborations can also extend to the supply chain, where local manufacturers can partner with international suppliers of high-quality, energy-efficient components to enhance the overall energy performance of their products.

**Streamlining the Supply Chain for Energy-Efficient Components**

Local manufacturers often face higher costs for energy-efficient components due to supply chain inefficiencies. By streamlining the supply chain, local manufacturers can access critical

components such as energy-efficient motors, fans, compressors, and heating elements at more competitive prices.
To achieve this, the government could create incentives for local suppliers of energy-efficient components, reducing the reliance on imports and fostering a domestic ecosystem for energy-efficient parts. Local sourcing of components would not only lower costs but also shorten lead times and improve the overall sustainability of the manufacturing process.

**Creating Financial Incentives for Local Manufacturers**

To promote the production of energy-efficient appliances, the government can introduce targeted financial incentives for local manufacturers. For example, subsidies or rebates could be offered to manufacturers who meet or exceed specific energy efficiency benchmarks in their production processes.

Additionally, a green financing program could be established to provide low-interest loans to manufacturers investing in energy-efficient technologies and production upgrades. Such financial support would help manufacturers reduce production costs and pass on the savings to consumers, making energy-efficient appliances more affordable and accessible.

# 9. Conclusion

As Bangladesh continues its journey towards sustainable development, the transition to energy-efficient technologies, particularly in the household appliance sector, stands as a critical area for transformation. The market survey, performance analysis, and extensive stakeholder consultations conducted throughout this project have provided invaluable insights into the current state of energy efficiency in household appliances, as well as the challenges and opportunities that lie ahead.

## 9.1 Key Findings

The market survey revealed a dynamic and growing demand for household appliances in Bangladesh, driven by increasing urbanization, rising incomes, and expanded electrification. However, this growth also comes with heightened energy consumption, making it essential to integrate energy-efficient solutions into this expanding market. Key findings from the survey and analysis include:

- **Energy Performance Gaps**: Although there has been progress in establishing energy efficiency standards for certain appliances like refrigerators and ceiling fans, other commonly used appliances, such as rice cookers, induction cookers, and household induction motors, still lack established standards. This absence of specific energy performance standards and testing protocols for these appliances prevents an accurate assessment of their energy consumption. Without these standards and protocols, it is challenging to determine the efficiency levels of these appliances, thereby hindering efforts to promote energy-saving practices in these categories.
- **Market Barriers**: Local manufacturers face significant challenges in adopting energy-efficient technologies due to the high costs of production, limited access to cutting-edge technologies, and competition from imported products. Consumers, on the other hand, are often price-sensitive, and energy-efficient appliances tend to have a higher upfront cost, creating a dilemma between price and long-term savings.
- **Regulatory Gaps**: Although Bangladesh has taken commendable steps toward developing energy efficiency standards for certain appliances, there remains a need to expand regulatory frameworks to cover a broader range of household appliances. For instance, while refrigerators and ceiling fans have standards in place, rice cookers, induction cookers, and household induction motors remain outside the scope of existing regulations.
- **Potential for Energy Savings**: The analysis of energy performance metrics across all surveyed appliances highlighted significant potential for energy savings by replacing inefficient models with energy-efficient alternatives. In particular, transitioning to more efficient ceiling fans, induction motors, and rice cookers could lead to substantial reductions in energy consumption, aligning with Bangladesh's national energy conservation goals.
- **Stakeholder Collaboration**: The consultations with manufacturers, retailers, and government agencies underscored the importance of a collaborative approach to advancing energy efficiency. Stakeholders have expressed the need for greater policy support, financial incentives, and capacity-building programs to help local

manufacturers compete in a market increasingly defined by energy efficiency standards.

## 9.2 The Path Forward

The path forward for Bangladesh lies in embracing a comprehensive approach to energy efficiency, where all stakeholders—government bodies, manufacturers, retailers, and consumers—play a critical role in shaping the future of energy consumption in the country. As the findings from this report indicate, significant opportunities exist for Bangladesh to not only reduce its national energy demand but also position itself as a leader in the region in terms of adopting energy-efficient technologies.

To achieve this, several steps are necessary:

1. **Expanding Regulatory Frameworks**: Bangladesh must expand its energy efficiency regulations to cover a broader range of household appliances, including rice cookers, induction cookers, and household induction motors. The implementation of proposed Minimum Energy Performance Standards (MEPS) for these appliances will be essential in promoting energy-efficient products in the local market.
2. **Enhancing Testing Infrastructure**: The establishment of robust testing protocols, aligned with international standards, will ensure that locally manufactured and imported appliances meet required energy efficiency levels. Government investment in testing laboratories and capacity-building initiatives for local manufacturers will help drive compliance with these standards.
3. **Financial Incentives for Manufacturers**: To encourage local manufacturers to invest in energy-efficient technologies, the government should introduce financial incentives such as tax breaks, grants, and subsidies for R&D activities. These incentives will lower the cost of production and enable manufacturers to offer competitively priced energy-efficient appliances.
4. **Raising Consumer Awareness**: Consumer awareness campaigns will be pivotal in driving demand for energy-efficient products. By highlighting the long-term cost savings and environmental benefits of using energy-efficient appliances, consumers can be encouraged to make informed purchasing decisions that align with national energy conservation goals.
5. **Collaboration Across Sectors**: Finally, the government must foster a collaborative environment where the private sector, public institutions, and research organizations work together to promote energy efficiency. This can be achieved through public-private partnerships, industry forums, and technology exchange programs that bring together key players to drive innovation and sustainability in the appliance market.

By taking these steps, Bangladesh can lead the way in energy-efficient technology adoption, setting a benchmark for other developing nations in the region. As the country continues to grow, embracing energy efficiency will not only support its environmental and economic objectives but also contribute to a more sustainable and resilient energy future for all its citizens.

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