



FANS

Solar Appliance Technology Brief

MAY 2021

EFFICIENCY FOR ACCESS COALITION

This fan technology brief is one in a series of insight briefs developed to synthesize the latest market intelligence and chart a pathway to commercialization for a set of off- and weak-grid appropriate appliance and productive use technologies most relevant to catalyzing energy access and achieving Sustainable Development Goals.

The first iteration of the [LEIA Technology Summaries](#) was published in 2017 to help the newly established Efficiency for Access Coalition navigate a nascent market. At the time there was limited data and research available on market trends and off/weak-grid appliance performance. This fan brief updates and expands on these summaries, bringing together the latest insights on market and technology trends, consumer impacts, and pathways to scale for fans. You can access briefs on all technologies that are a part of this series [here](#).

This brief was developed by CLASP and Energy Saving Trust as part of the Low Energy Inclusive Appliances programme, a flagship programme of the Efficiency for Access Coalition. It is a catalyst for change, accelerating the growth of off-grid appliance markets to boost incomes, reduce carbon emissions, improve quality of life and support sustainable development.

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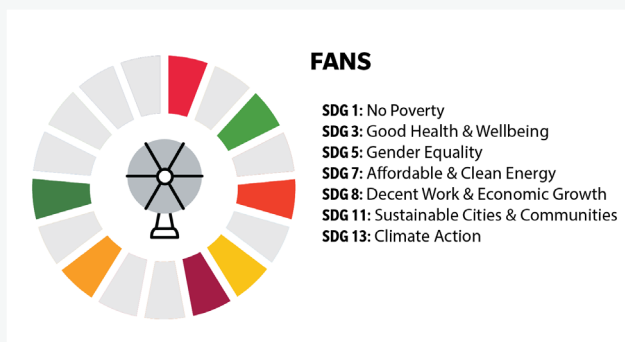
Introduction

Fans provide cost-effective cooling energy services that can be life saving, especially for people living in extremely hot conditions. Compared to other appliances, fans are relatively low-cost, making them the most demanded cooling appliances in the world, with more than 290 million fans sold in 2019.

A fan consists of a series of rotating blades attached to an impeller, which is powered by electric motors to generate a directed flow of air. Fans provide cooling and comfort through increasing air circulation and speeding up the evaporation of sweat on the human skin, but they do not lower air temperatures directly.¹

A typical fan includes basic elements such as fan blades, a base, motor, finger guard, and motor housing.² At present, manufacturers and distributors primarily offer three types of fans to household consumers: table fans for cooling small spaces, pedestal fans that provide height and oscillation for convenient operation, and ceiling fans for cooling larger spaces (Figure 1). To deliver different levels of cooling service, fan sizes – defined as the diameter of the blades – vary based on the fan type, with ceiling fans typically having the largest blades.³

The motor is the most critical driver of energy consumption in fans, with blade design also impacting overall energy performance. While fans that use alternating current (AC) motors are more prevalent in the market, fans that use brushless DC (BLDC) motors are rated highly by customers because they deliver superior energy performance and are low-noise.



Fans enable increased economic activities by allowing people to work more productively and work longer hours serving their customers. On agriculture and livestock farms, they provide active cooling and humidification for farm animals. When used in households and health clinics, fans reduce exposure to pollution and disease-carrying insects, leading to improvements in users' health and well-being.

Fans are used in household, commercial, agricultural, and healthcare settings. Evidence indicates that individual productivity reduces by as much as 4% for each one degree Celsius (°C) increase in average surrounding temperature.⁴ By providing comfort for people living and working in hot and humid environments, fans can help increase productivity, and enable them to work more efficiently, comfortably and for longer hours indoors. When used in households and health clinics, fans reduce exposure to pollution and disease-carrying insects, leading to improvements in users' health.⁵ On agriculture and livestock farms, fans provide air circulation⁶ and humidification for livestock and reduce the risk of insect-transmitted diseases.⁷

Figure 1. Different Types of Fans Commonly Available in the Global Market and their Blade Size Ranges



1. Forthcoming report: Efficiency for Access Coalition, Market Opportunity for High Efficiency Permanent Magnet Motors in Off-and Weak-Grid Appliances, 2020.

2. Intro to Fans, <https://www.broughtoneap.co.uk/fan-intro/>

3. Efficiency for Access Coalition, The State of the Off-Grid Appliance Market, 2019, <https://storage.googleapis.com/e4a-website-assets/Clasp-SOGAM-Report-final.pdf>

4. Efficiency for Access, The Socio-Economic Impact of Super-Efficient Off-Grid Fans in Bangladesh, 2019. https://storage.googleapis.com/e4a-website-assets/EForA_ImpactofFans_Final.pdf

5. Ibid

6. Active cooling is a heat-reducing mechanism that is typically implemented in electronic devices and indoor buildings to ensure proper heat transfer and circulation from within.

7. Creoven. 2020. Data Retrieved from <https://www.creoven.eu/fans-in-agriculture>

State of Play

Compared to other off-grid appliances, the off-grid fan market is relatively mature due to a high penetration rate, relatively affordable product price and high efficiency. As anticipated in the 2017 LEIA technology summaries, improvements in price and efficiency have unlocked greater demand for fans. In India, Nigeria, and Bangladesh, where local climate conditions are a major driver of demand, the penetration of fans is more than 70% in urban areas and roughly 40% in rural areas.⁸ Since the fan market is well-established, consumers are fairly sensitive to price and products that show incremental improvements in cost and energy efficiency are likely to stand out among competitors.

Average fan efficiency has increased significantly, primarily due to improvements in motor efficiency.

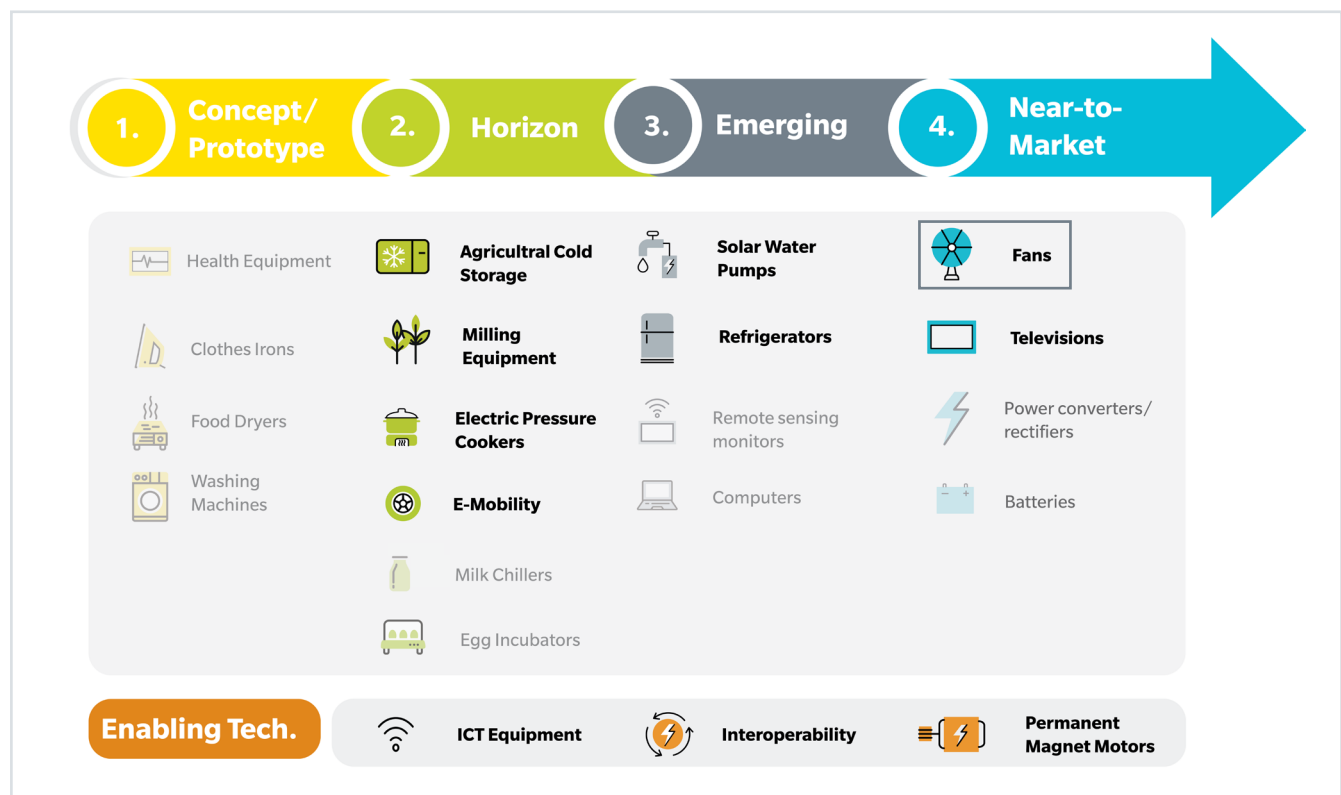
Between 2018 and 2019, the average efficiency of fans tested by Efficiency for Access improved by 49%.⁹ These efficiency improvements may be due to the increasing number of fan manufacturers adopting BLDC motors into their product design, which can be up to 39% more efficient than typical AC motors.¹⁰ In addition to adopting highly efficient motors, improving fan blade design can also lead to further efficiency

improvements. For example, twisted and tapered blade designs can provide higher airflow at the same speed and increase the efficiency of fans by 15%.¹¹

Average fan price has dropped 47% over a two-year period. Between 2016 and 2018, the average price of fans dropped from US\$2.7 to US\$1.9 (in terms of US\$ per inch of fan diameter).¹² This trend signals that the fan market has become highly commoditized and competitive, leading to falling prices.

Fan pricing varies based on motor type. On average, fans using DC motors are 1.7 times more expensive than fans using AC motors of comparable size. Motors account for 25-36% of the fan price and the average cost of the BLDC motors and controller for fans is US\$15 per unit when purchased in bulk.¹³ While they have a higher up-front cost, fans that use BLDC motors are more efficient and durable, enabling customers to reduce operational and maintenance costs and fan manufacturers to provide longer warranties (up to 10 years in some cases).¹⁴ Sustained market growth for off-grid fans could help drive significant gains in the price and efficiency of BLDC motors, further inspiring manufacturers and distributors to invest more heavily in the market.

Figure 2. Relative Maturity of Select Appliances



8. Efficiency for Access Coalition, The State of the Off-Grid Appliance Market, 2019.

9. Efficiency for Access Coalition, 2021 Appliance Data Trends, 2021: <https://storage.googleapis.com/e4a-website-assets/2021-ApplianceDataTrends.pdf>

10. Ibid

11. Efficiency for Access Coalition, The State of the Off-Grid Appliance Market, 2019.

12. Efficiency for Access Coalition, 2021 Appliance Data Trends, 2021.

13. Forthcoming report: Efficiency for Access Coalition, Market Opportunity for High Efficiency Permanent Magnet Motors in Off-and Weak-Grid Appliances, 2020.

14. Efficiency for Access Coalition, 2021 Appliance Data Trends, 2021.

The price of a fan varies by market, showing demand-driven differences due to regional preferences and sales volume. Data collected between 2018 and 2021 indicates that the retail price of pedestal fans averages \$20 to \$26 USD in India and Pakistan respectively and more than \$40 USD in key markets in East and West Africa (i.e. Kenya, Nigeria, and Sierra Leone).¹⁵ The price difference is a result of strong consumer demand for fans in South Asia due to the climate conditions, local manufacturing capability, as well as the large market size. 99% of global fan sales take place in South Asia (Table 1).¹⁶

Market Insights

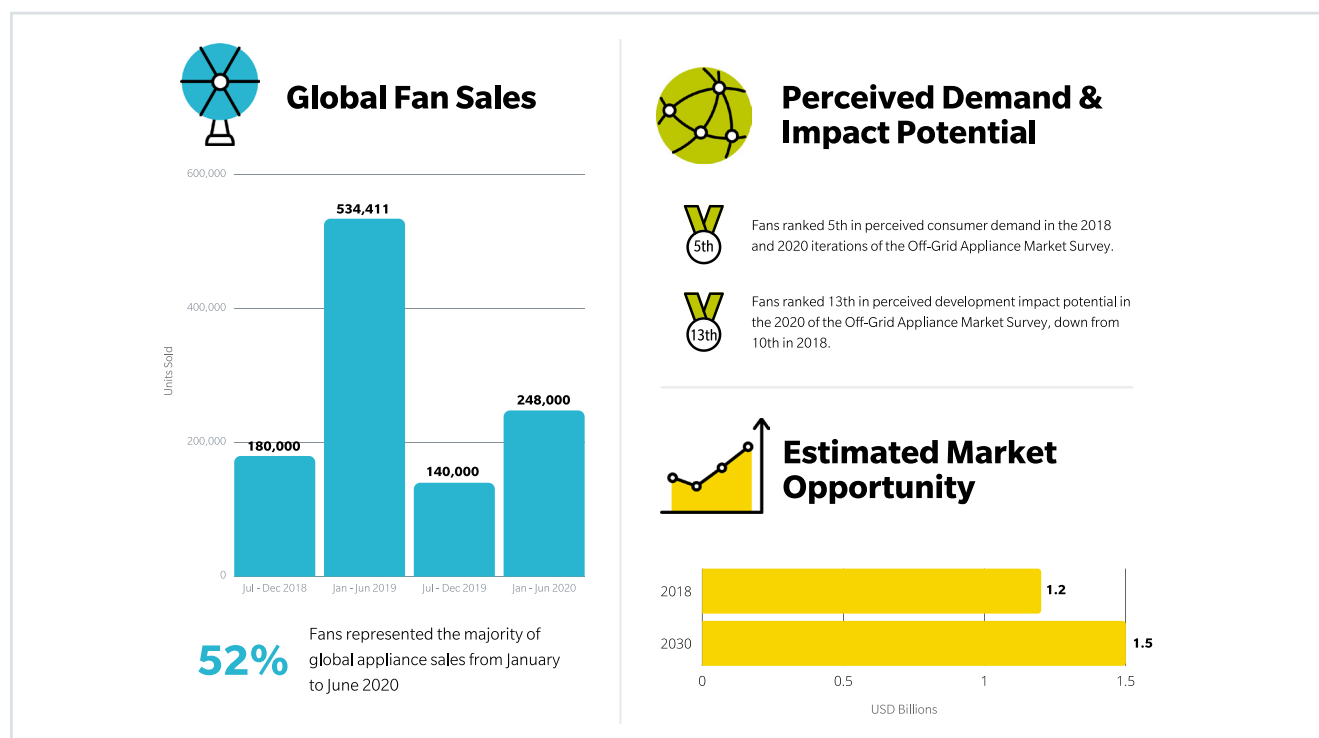
Fans are one of the most commonly sold appliances in the world. Over 290 million on- and off-grid units were sold globally in 2019.¹⁷ GOGLA affiliates¹⁸ reported selling 670,000 off-grid fans globally, with the majority sold in Pakistan, Bangladesh and India, compared to just 8,200 refrigerator units sold in the same year.¹⁹ Fan sales are seasonal and most in South Asia happen between January-June. While global fan sales are relatively high compared to other appliances, the off-grid fan market still has the potential to grow significantly. According to a recent survey, fans rank fifth in terms of perceived consumer demand in the next three to five years.²⁰ It is projected that the obtainable market size of off-grid fans will reach US\$1.5 billion and 48 million households by 2030 (Figure 3).²¹

Consumer awareness of DC fans contributes to their high penetration rate in South Asia.²² In Bangladesh, surveyed shop owners indicated that the main driver for off-grid fan sales is from on- and weak-grid consumers who perceive DC fans as more energy efficient. Shop owners also reported that consumers looking for solar fans are grid connected customers seeking a solution that does not depend on grid electricity and is able to operate during load shedding.²³ These factors – a hot climate, perceived energy savings, and capability to mitigate grid reliability challenges – contribute to making South Asia, particularly India and Bangladesh, the largest off-grid fan market. In contrast, fan penetration is low in East Africa, likely due to cooler temperatures, but pockets of high demand exist in West Africa and South Africa where the climate is hotter (Figure 3).²⁴

Implementation of favorable tax policy is vital to overcoming affordability barriers and accelerating energy-efficient off-grid appliance market growth.

Tax exemptions can carry a significant cost in terms of foregone government tax revenues. Therefore, it is difficult for distributors to receive tax exemptions on solar appliances. Nevertheless, in some countries, governments are implementing tax policies to promote off-grid fan markets and make the products more affordable to consumers. For example, India lowered its goods and services tax for off-grid fan components by 5% to encourage business-to-business imports and local assembly and manufacturing.²⁵

Figure 3. Off-Grid Fan Market Overview



15. Efficiency for Access, market scoping data, 2018 to 2021.

16. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data: January – June 2020. https://storage.googleapis.com/e4a-website-assets/global_off_grid_solar_market_report_h1_2020.pdf

17. Euromonitor International 2020. Data Retrieved from <https://www.euromonitor.com/>

18. Affiliates include GOGLA members, companies selling products that meet Lighting Global Quality Standards, and appliance companies of the Global LEAP Awards or Low Energy Inclusive Appliances programme.

19. GOGLA, Efficiency for Access and World Bank, Global Off-Grid Solar Market Report H1 2020 (Sales and Impact Data) (2020): <https://www.gogla.org/resources/global-off-grid-solar-market-report-h1-2020-sales-and-impact-data>.

20. Efficiency for Access Coalition, Off-Grid Appliance Market Survey, 2020, <https://efficiencyforaccess.org/publications/off-grid-appliance-market-survey-2020>

21. Efficiency for Access Coalition, The State of the Off-Grid Appliance Market, 2019.

22. GOGLA, Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data: January – June 2020.

23. Efficiency for Access Coalition, The Appliance Market in Bangladesh, 2019, <https://storage.googleapis.com/e4a-website-assets/The-Appliance-Market-in-Bangladesh-Retailers-Perspective-Final-Draft.pdf>

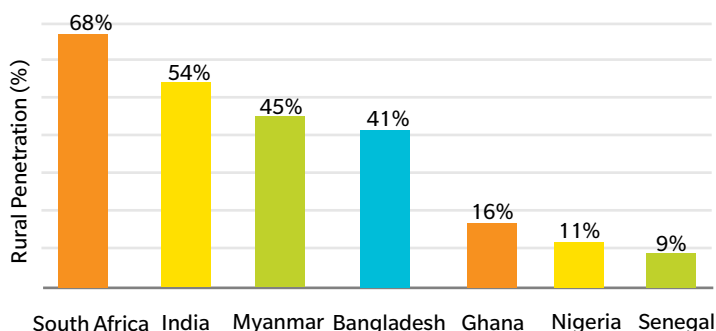
24. Efficiency for Access Coalition, Appliance Data Trends, 2021.

25. Efficiency for Access Coalition, The State of the Off-Grid Appliance Market, 2019.

Table 1. Recent Regional Sales of Off-grid Fans

Time Period	South Asia	East Africa	West Africa	Sub-Saharan Africa
Jan - Jun 2019	512,264	2,526	9,985	13,412
Jul - Dec 2019	110,531	2,034	26,181	28,388
Jan - Jun 2020	232,121	1,939	10,106	12,327

Figure 4. Estimated Rural Penetration of Electric Fans²⁶



Consumer Impacts

Existing research shows that fans unlock significant social and economic impacts, and contribute to nine of the United Nation's Sustainable Development Goals (see Box on page 3). Key highlights include:

Increased productivity and comfort: Fans increase productivity and comfort by allowing people to work longer hours and enabling them to move work indoors when necessary. In a telephone survey of over 1,600 off-grid fan consumers in Bangladesh, 81% believed that their lives had improved because of access to fans.²⁷ Households responded that their fans extended their productive time by an average of 2 hours and 20 minutes a day.²⁸ The COVID-19 pandemic has amplified the value of fans, with many people around the world spending more time at home.

Contribution to income-generation: Most business owners who participated in the consumer survey in Bangladesh indicated that their fan has enabled them to serve more customers and reported an increase in revenue since purchasing their fan.²⁹ Mohammed Rezaul Karim procured a Global LEAP Awarded off-grid TV and fan for his small shop located next to a police check in Cox's Bazar, Bangladesh. When asked about profits during an in-person interview, Rezaul responded "I've seen a 25% increase in business since purchasing the TV and fan."³⁰

Empowering women: Fans offer increased productivity and comfort for women performing chores in hot and humid conditions. In Bangladesh, women often cook, process food, and take care of children in traditional mud houses that are too hot for indoor activities. 65% of survey respondents in Bangladesh stated that using a fan allows their family to shift activities like food processing indoors.³¹ The ability to work inside contributes to overall comfort and safety, and productivity. This productivity gain help women save time from household chores and to pursue higher-value paid work and education, contributing to women's empowerment.³²

Reduced risk of diseases and indoor air pollution: Fans have proven to be life-saving in preventing adverse health conditions and reducing mortality and morbidity associated with severe heatwaves.³³ Research shows that using a fan can help regulate the core body temperatures and reduce the likelihood of heat strokes during heat waves when the ambient temperature is at 42°C.³⁴ Indoor air pollution is reported to cause over 100,000 premature deaths every year. Since women, children and the elderly are more likely to spend more time in poorly ventilated households, their exposure to indoor air pollution and mold allergens is disproportionately high. By reducing humidity and increasing airflow, fans can help reduce the health risks associated with indoor air pollution, as well as the prevalence and spread of mold allergens that cause respiratory diseases. The increased airflow from fans also reduces exposure to mosquitoes. In many countries, mosquitoes are carriers of serious, life-threatening diseases like dengue fever and malaria, and fans offer a simple but effective defense against them.³⁵

26. Efficiency for Access Coalition, The State of the Off-Grid Appliance Market, 2019.

27. Efficiency for Access Coalition, The Socio-economic Impact of Super-efficient Off-grid Fans in Bangladesh, 2020.

28. Ibid

29. Ibid

30. Efficiency for Access Coalition, Consumer Spotlight Series, 2020, URL: TBD

31. Efficiency for Access Coalition, The Socio-economic Impact of Super-efficient Off-grid Fans in Bangladesh, 2020.

32. Efficiency for Access Coalition, Appliance Data Trends, 2021

33. Ibid

34. Electric fan use in heat waves: Turn on or turn off?, Temperature 2016; 3(3): 358–360. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5079223/>

35. Efficiency for Access Coalition, The Socio-economic Impact of Super-efficient Off-grid Fans in Bangladesh, 2020.



BOX 1

SECURITY AND COMFORT IN A WARMING WORLD

Bangladesh has seen a significant increase in average temperatures in the last 60 years and is expected to experience 2.8°C of warming in the next four decades. As temperatures rise and the frequency of extremely hot days and nights increases, fans will play an important role in helping communities adapt. Customer survey results from over 1,600 off-grid fan purchasers confirm the high impact potential of energy-efficient off-grid fans in Bangladesh. Data show significant gains in productivity, health and energy access at the household level, and opportunities for fans to play a large role in broader market creation efforts for energy-efficient off-grid appliances.

Fozle Rabbi has all of the comforts of a modern home. He owns a range of appliances and electronic devices that keep his family cool, fed, and entertained. However, the constant blackouts caused by an unreliable power supply prevent Fozle from using many of these devices when he needs them most. When blackouts occur, Fozle and his family are

forced to endure stifling and dangerous temperatures without modern cooling equipment. Motivated to secure a more reliable power supply, Fozle installed a SHS on his rooftop and purchased four DC table fans from Super Star Group, a leading manufacturer, importer and distributor of electrical appliances and equipment.

For Fozle, his solar home system and fans provide an added layer of security. Unlike poorer rural households that may not be able to afford off-grid appliances, affluent households like Fozle's see owning a SHS appliance package as a necessity to continue enjoying a service that they are already accustomed to. Fozle no longer has to worry about when power will return during a blackout. He now has access to the appliances he needs to stay comfortable and safe throughout the day. "I enjoy my afternoon reading while cooling down with the fan," Fozle stated as his small table fan hummed quietly in the background.

Current Success and Remaining Challenges

Successes

Fans are getting more efficient: doubling efficiency is possible through adoption of BLDC motors. An assessment comparing the efficiency of BLDC motor and AC motor fans in Pakistan indicated that the pedestal and ceiling fans with BLDC motors are substantially more efficient. The average efficiency of pedestal fans has improved by 92%, and ceiling fans by 32%. For one of the models tested, efficiency improved by over 200% after the upgrades.³⁶ The efficiency improvement of fans could create positive spillover effects for other motor-driven cooling appliances, such as evaporative air coolers.

Between 2016 and 2018, the average price of fans dropped by 47%. While DC fans are still on average more expensive than AC fans due to the higher cost of BLDC motors, sustained growth in the off-grid fan market could help drive cost reductions for BLDC motors. Manufacturers are also engaging in innovative business strategies to further increase affordability. For example, two manufacturers in Pakistan began importing machinery to manufacture BLDC motors locally to reduce import costs.

Challenges

Lack of quality benchmarks make it difficult for stakeholders to compare and differentiate the quality of fans independent from SHS kits. Cheap and generic fans have flooded the off-grid market because there is limited regulation and no set industry standards for off-grid products. Efficiency for Access testing efforts also uncovered

that the most common points of failure for off-grid fans were related to inaccurate performance reporting³⁷, safety and a lack of warranty and user manual.³⁸ As a result, consumers often struggle to navigate quality and energy consumption considerations when making their purchase. Early feedback suggests that bottom of the pyramid consumers make purchase decisions primarily based on price when it comes to fans, given the lack of guidance on product quality.³⁹ There is an opportunity to further establish quality criteria to help buyers distinguish high-quality, efficient off-grid appliances from low quality ones.

The penetration for fans in rural markets remains low in Sub-Saharan Africa. Despite the latent demand and large market potential, the distribution of fans in the Sub-Saharan Africa is uneven in urban and rural areas. In Ghana, for example, the urban market penetration for fans is 51%, which is significantly higher than the rural market penetration of 16%.⁴⁰ These gaps in market penetration are reflective of larger gaps in product availability and offerings between urban centers and rural communities.

Cost-effective last mile distribution of appliances is challenging. In Kenya, for example, there are 13.5 million rural residents not connected to an all-season road, reducing the likelihood of being able to access an off-grid appliance.⁴¹

Lack of financing is one of the main factors limiting access to off-grid appliances. A critical constraint in the off-grid fan market is access to financing, which is highly limited for market actors across the supply chain, as well as consumers. Therefore, a lack of financing options for consumers and suppliers is a major challenge for the development of market growth.



36. Efficiency for Access Coalition, Appliance Data Trends, 2021.

37. Performance reporting requires that certain performance metrics and units are presented on packaging and other consumer-facing materials.

38. Efficiency for Access Coalition, Appliance Data Trends, 2021.

39. Efficiency for Access Coalition, The Socio-economic Impact of Super-efficient Off-grid Fans in Bangladesh, 2020.

40. Efficiency for Access Coalition, The State of the Off-Grid Appliance Market, 2019.

41. Ibid



Affordability Improvements

The price of energy-efficient fans needs to decrease further in order for rapid growth of the market to occur. The use of BLDC motors makes fans more energy-efficient, but it also increases their price. For markets that have high import duties, local manufacturing and assembly could potentially help reduce the price of BLDC fans and make them more affordable for consumers.



Focus on consumer awareness

Fan distributors need to focus on consumer awareness to upsurge product sales, especially in rural markets. Consumers in general have a very limited understanding of fan technical specifications and quality, and they primarily rely on price when making purchase decisions. People living in rural areas prefer to purchase from people they know, making purchase decisions primarily through word of mouth, which can increase the risk of misinformation. Distributors need to assess consumer behaviors and deploy effective marketing tactics to increase consumer awareness about good quality fans.



Appropriate standards and policies

There is a need for appropriate standards and policies in favor of energy-efficient fans. Standards and labelling initiatives - both at national and international levels - are critical to promoting energy-efficient fans while protecting consumers. Currently, there is no formal framework in place to evaluate the quality of off-grid fans. To help market actors differentiate product quality for standalone off-grid fans, Efficiency for Access piloted a quality assurance framework to test and evaluate products based on quality criteria.⁴⁴ To support the fan market's sustainable growth, it is essential to align and drive consensus on key quality criteria among product manufacturers, programmes and policymakers and use the criteria to guide the market towards higher quality.



Effective last mile distribution strategies

Distributors need to establish a strong supply chain and an effective last mile distribution strategy to reach more rural consumers. A close-knit network of distribution points, as well as a sufficiently developed road infrastructure, are needed to ensure safe delivery of higher value appliances. For example, Super Star Group organizes regional sales team retreats to maintain a strong connection with their fan distributors, dealers and retailers. Strong field sales forces can enable fan distributors to achieve higher rural household penetration and overcome last mile distribution challenges.



Access to financing

Access to financing is needed at every level of the fan ecosystem. Microfinance, bank loans, results-based financing and PAYGo are different financing schemes that should be available to fan suppliers, distributors and consumers. Financing is typically a significant barrier for small or local distributors who lack capital investments. Results-based financing mechanisms can play a vital role in expanding global fan markets and increasing affordability for end users. For example, an RBF mechanism implemented by CLASP supported the sale of 194,000 best-in-class, super-efficient off-grid fans in Bangladesh.

42. Efficiency for Access Coalition, Appliance Data Trends, 2021.




43. Efficiency for Access Coalition, The Socio-economic Impact of Super-efficient Off-grid Fans in Bangladesh, 2020.

44. Efficiency for Access Coalition, Quality Assurance for Off-Grid TVs and Fans: Lessons Learned and Paths Forward, 2020. <https://efficiencyforaccess.org/publications/quality-assurance-for-off-grid-tvs-and-fans>

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