

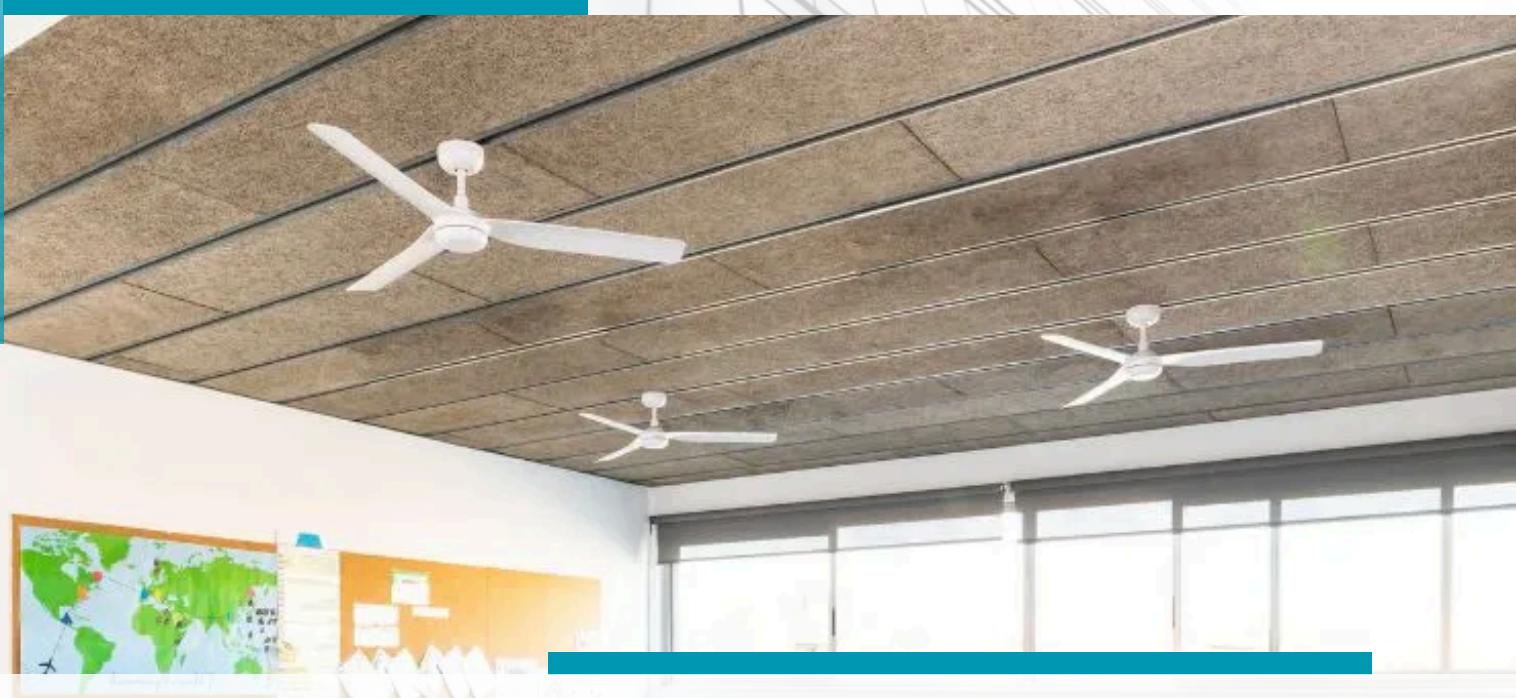


PREM JAIN MEMORIAL TRUST

Advancing Net Zero Goals in
Educational Institutions:

THE IMPACT OF SUPER-EFFICIENT FANS

November 2025



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A big thank you to all who contributed to the “Advancing Net Zero Goals in Educational Institutions: The Impact of Super-Efficient Fans”! We would not have been able to research and compile this document without the time and contributions of the following individuals and groups:

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PREM JAIN MEMORIAL TRUST

Prem Jain Memorial Trust was formed in the year 2018 to continue with the legacy of Dr. Prem C. Jain to promote innovation and sustainability. The mission of **Prem Jain Memorial Trust** is to create, establish and maintain a sustainability paradigm through education, recognition, and nurturing of our present and future generations. The Trust aims at identifying future leaders who can be a catalyst for the global development of sustainability and can create awareness and advocacy about the environment. It also wishes to nurture India's young talent by educating and informing them about sustainable development ecosystems.

Dr. Prem Jain, architect of the modern green building movement has **ushered in a paradigm shift in the way buildings are conceived and designed worldwide**. He has facilitated India's stands tall in the global green building movement and aspired for "**Bharat to emerge as Jagat Guru in Sustainable Built Environment**".

Dr. Prem Jain began to think about Sustainability as a lifestyle way back in the 1970s. Over a half-century of dedicated work, he thought and spoke a language that was somehow larger than life, and worked his passion for his 'Janani Janmabhoomi' burnt bright through his life's work and accomplishments. He is also referred to as the 'Father of Green Buildings' in India. The 'green revolution' he started is the foundation for the legacy of PJMT, in the hope that we can balance the need for growth and safety of our beautiful planet earth.

FOREWORD

*Dr. Shailesh Kr. Agrawal
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As the global community advances toward a carbon-neutral future, the education sector stands at the forefront of this transformative journey. Universities, schools, and research institutions are no longer just centres of knowledge — they are living laboratories for sustainability. The growing urgency to achieve Net Zero emissions has inspired a wave of innovation across campuses worldwide, driving the adoption of cleaner technologies, efficient energy systems, and environmentally responsible design principles. Within this context, even the simplest components of our built environment, such as ventilation and cooling systems, have become powerful catalysts for change.

Super-efficient fans, advanced air management systems, and intelligent building controls represent more than incremental improvements in comfort and efficiency. They embody a new paradigm where technological innovation aligns seamlessly with environmental stewardship. By dramatically reducing energy consumption, minimizing carbon footprints, and improving indoor air quality, these innovations contribute directly to the realization of Net Zero goals. Such technologies exemplify how engineering ingenuity can help educational institutions lead by example — demonstrating that sustainability and performance are not competing objectives, but complementary aspirations.

The transition to green campuses is also being shaped by emerging trends that redefine how we design, operate, and experience learning environments. Smart sensors, renewable energy microgrids, and data-driven energy management platforms are enabling institutions to monitor and optimize their sustainability performance in real time. Meanwhile, the integration of biophilic design, passive cooling strategies, and circular economy principles is reshaping architecture and operations to promote both human well-being and ecological balance.

Moreover, sustainable learning environments extend beyond infrastructure. They cultivate a culture of environmental responsibility among students, faculty, and staff — nurturing the next generation of leaders equipped to navigate the complexities of a low-carbon world. Green campuses thus serve as incubators for innovation, collaboration, and social impact, transforming sustainability from an abstract ideal into a lived educational experience.

As we look toward the future, the convergence of technology, policy, and behavioural change will continue to define the trajectory of sustainable education. The deployment of super-efficient systems, renewable energy integration, and net-positive design will move institutions closer to carbon neutrality. More importantly, these advancements will inspire a collective mindset that places sustainability at the heart of learning and community development.

This publication is both a reflection of progress and a call to action. It highlights the transformative potential of innovative technologies and forward-thinking design in shaping greener, smarter, and more resilient campuses. In doing so, it reminds us that every watt saved, every innovation deployed, and every student empowered brings us one step closer to a truly sustainable future.

SPECIAL MESSAGE

*Payal Jain
Founder Trustee
Prem Jain Memorial Trust*

My beloved Father Dr. Jain said in his book, Path of Green:

“The continuous reduction in building energy usage coupled with the increasing use of renewables has shifted focus towards Net Zero Energy Buildings (NZEB) which can be potentially grid independent. At one end of the spectrum are new buildings, which are increasingly becoming energy efficient. Simultaneously, at the other end are existing buildings which offer equal opportunities for energy efficiency and improvement in the overall health & wellbeing of the people who occupy them”

As India moves steadily toward its **Net Zero Carbon goals**, our educational institutions will play a defining role in shaping the next generation of innovators, designers, architects and engineers, guiding them to learn how to think, build, and innovate for a sustainable future. The shift to a low-carbon world begins with awareness, understanding, and practical action—and that foundation starts in our classrooms, labs, and design studios.

Energy efficiency is still the fastest and most effective way to move toward net zero. And among all the electrical devices we interact with every day, the **ceiling fan**—a simple, almost invisible part of homes across India—offers one of the biggest opportunities. It is the primary source of ventilation in homes, schools, colleges and workplaces. By adopting super-efficient fan technologies, we can significantly cut energy use, reduce emissions, and take a meaningful step toward a carbon-neutral future.

This PJMT toolkit, **Advancing Net Zero Goals in Educational Institutions: The Impact of Super-Efficient Fans** is a call to action—for students, faculty, and professionals in technical disciplines. It encourages young minds to see how every design decision, every watt saved, and every innovation directly contributes to a more sustainable world.

As we build capacity and strengthen our knowledge of energy systems and electrical accessories, we empower a generation that will design for efficiency, build for resilience, and live for sustainability. Together, we can ensure that the dreams of Net Zero are not just goals but realities shaped by education, innovation, and collective responsibility.

INTRODUCTION

**Mr. Dhruv Jain,
Principal Counsellor
GT Academy**

Advancing Net Zero Goals in Educational Institutions: The Impact of Super-Efficient Fans - A Toolkit for Educational Institutions is a collaborative effort between **GT Academy** and the **Prem Jain Memorial Trust**, supported by the contributions of students, faculty members, and industry experts. This initiative brings together diverse perspectives to create a practical and comprehensive resource aimed at helping educational institutions **adopt, implement, and promote super-efficient ceiling fans** across their campuses — in classrooms, laboratories, hostels, and administrative spaces.

The toolkit provides **step-by-step guidance, data-backed insights, and actionable strategies** to simplify the transition from conventional to energy-efficient technologies. It emphasizes the idea that institutions are not only centers of learning but also spaces that can demonstrate responsible energy use in practice.

A key focus of this initiative is to integrate **principles of energy efficiency and conservation into academic and operational frameworks**. By doing so, schools and colleges can encourage both faculty and students to link classroom learning with real-world applications — transforming sustainability from a topic of discussion into a visible, measurable outcome. This approach nurtures future professionals who understand the importance of resource efficiency and climate-responsive design.

The initiative also reflects a shared commitment to **environmental stewardship, technological advancement, and improved quality of life**. Adopting super-efficient fans in educational institutions can significantly reduce electricity consumption, lower operational costs, and serve as a live demonstration of climate-conscious decision-making for the broader community.

In addition, the toolkit encourages institutions to explore the **establishment of dedicated Energy Efficiency Laboratories** or demonstration areas. These facilities can serve as hubs for student-led projects, innovation, and performance monitoring — promoting hands-on exposure to sustainable technologies while supporting national and global climate goals.

Ultimately, this toolkit serves as both a **resource and an invitation to act**. It calls upon schools, colleges, and universities to **lead by example**, embed sustainability into their operations, and cultivate awareness among their communities. By applying the methods outlined here, educational campuses can become **living laboratories of sustainability**, contributing meaningfully to India's transition toward a more energy-efficient future.

We extend our best wishes to the community as it steps forward in embracing **super-efficient fans for a sustainable tomorrow**.

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1. Energy Efficiency: A Growing Need

Ceiling fans are among the most common household appliances in India, found in nearly every home, school, and college. While they may seem simple, fans are responsible for a significant share of electricity use in the country. With millions of fans running for long hours each day, even small improvements in their efficiency can make a vast difference in reducing energy consumption and electricity bills.

In recent years, India has been shifting towards energy-efficient solutions to address the issues of **growing electricity demand and climate change challenges**. Traditional fans, however, continue to dominate the market, many of which consume more power than necessary. To address this, Super-Efficient Fans have emerged as a breakthrough innovation. These fans use **advanced technologies** such as **Brushless Direct Current (BLDC) motors**, which allow them to deliver the same airflow while consuming up to 50% less electricity compared to conventional fans.



Conventional Fan



BLDC Fan (Super-Efficient)

Super-efficient fans are more than just an upgrade in technology—they represent a shift towards smarter energy use in everyday life. By reducing electricity consumption without compromising comfort, these fans contribute directly to lowering household expenses, cutting peak electricity demand, and reducing the overall carbon footprint. As India advances toward its goals of energy efficiency and climate resilience, the adoption of such innovations highlights how small changes at the consumer level can drive large-scale sustainability impacts.

1.1 Importance of Energy Efficiency Across Sectors

Energy efficiency has emerged as a key driver of sustainable growth across all sectors—residential, commercial, industrial, and transportation. According to the **International Energy Agency (IEA, 2024)**, improvements in energy efficiency have the potential to deliver over 40% of the reductions in greenhouse gas emissions needed by 2030 to align with global climate targets.



Residential Sector: Appliances such as lighting, fans, and air conditioners account for nearly 30–35% of household electricity uses in India. Super-efficient appliances can reduce this demand by 20–40%, easing the pressure on the grid.



Commercial Sector: Buildings consume about 33% of India's total electricity, with HVAC and lighting systems being the largest contributors. Energy-efficient solutions can save up to 50% of this demand.



Industrial Sector: Industries remain the largest energy-consuming sector, using nearly 45% of the total energy in India. By adopting efficient motors, boilers, and process optimization, industries can cut consumption by 15–20%, translating into significant cost savings.



Transport Sector: With the rapid growth of electric vehicles, energy-efficient designs and charging infrastructure are critical. The **Bureau of Energy Efficiency** highlights that efficiency measures in this sector could save **65 million tonnes of oil equivalent (Mtoe)** by 2030.

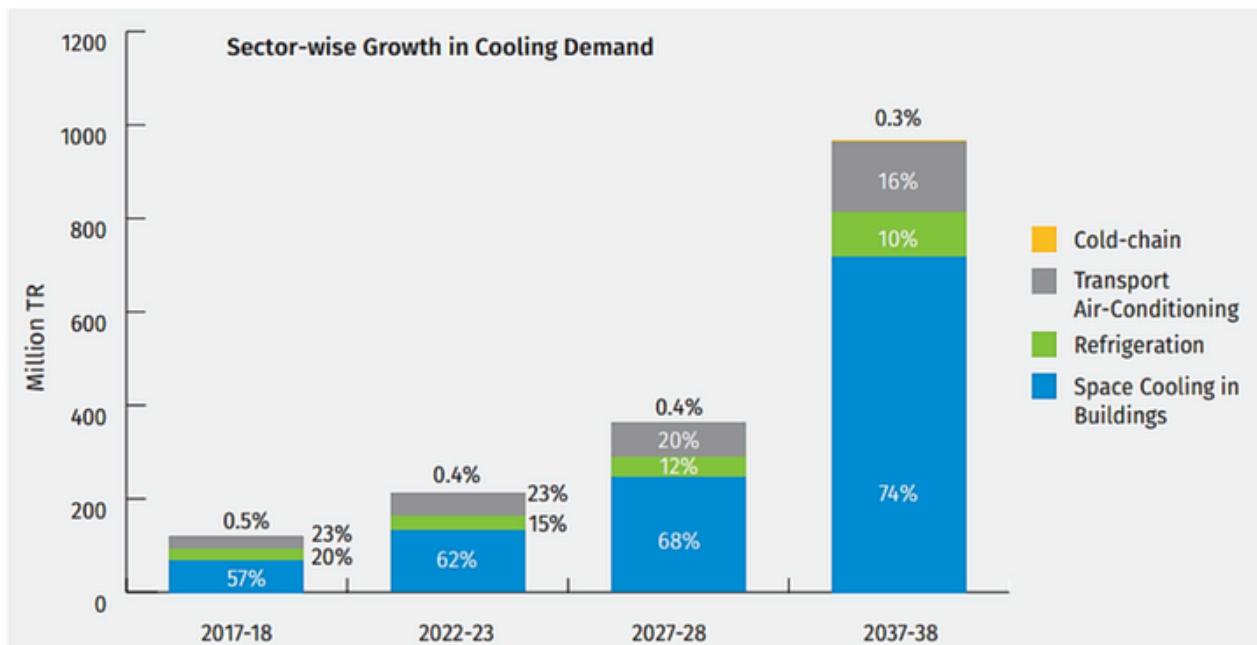
Thus, energy efficiency is no longer an optional choice but a necessity for energy security, reduced carbon emissions, and economic competitiveness.

1.2 India's Energy and Cooling Needs

India is one of the fastest-growing energy consumers in the world. With **rapid urbanization, rising incomes, and increasing access to electricity**, the demand for cooling has expanded significantly. Cooling is no longer considered a luxury—it has become a necessity for ensuring comfort, productivity, and health in hot climatic conditions.

Currently, the **residential sector** accounts for nearly **24% of India's total electricity consumption**, with fans, air conditioners, and refrigerators being the dominant appliances. Ceiling fans alone are present in over 90% of Indian households, making them one of the most widely used cooling solutions in the country.

Projections indicate that India's cooling demand will grow **eightfold by 2037–38**, as per the **India Cooling Action Plan (ICAP)**. This rising demand creates immense pressure on the electricity grid and increases dependency on fossil fuels unless energy-efficient technologies are adopted.



In this context, super-efficient fans play a key role. They provide affordable and sustainable cooling, reduce peak electricity demand, and contribute directly to India's climate commitments of reducing energy intensity and lowering greenhouse gas emissions.

2. Understanding Fan Energy Consumption

Ceiling fans are often perceived as low-energy appliances, but collectively, they carry a **large energy footprint**. In India, ceiling fans account for around **40% of residential electricity consumption**, making them one of the most significant contributors to household energy use after lighting and cooling appliances.

India already has a ceiling fan stock of **over 500 million units**—equivalent to almost **half of the global stock**. With the growing popularity and affordability of fans, this number is projected to rise sharply, reaching **950 million units by 2038**. Such a massive expansion underscores the urgent need to adopt energy-efficient technologies to prevent a proportional increase in electricity demand and emissions.

The energy consumption of a fan depends on multiple factors, including:

- **Motor Efficiency** – Conventional fans use induction motors, which are less efficient compared to modern brushless DC (BLDC) motors.
- **Power Rating** – Standard ceiling fans typically consume between 70–80 watts, while super-efficient fans can operate at less than 35 watts.
- **Usage Duration** – In India, fans often operate for 12–18 hours per day during peak summer months, leading to significant cumulative energy consumption.
- **Number of Installations** – With over 500 million fans installed nationwide, even small improvements in efficiency can translate into substantial energy savings.

Recognizing this, the **Bureau of Energy Efficiency (BEE)** upgraded the **Standards & Labeling Program** for ceiling fans in **2023**, making it a **mandatory category**. Today, all ceiling fans sold in India must carry an **energy efficiency star rating label**, helping consumers make informed choices.

As highlighted in the **India Cooling Action Plan (ICAP)**, replacing conventional fans (≈ 70 W) with energy-efficient fans (≈ 50 W) could yield **10–15% energy savings by 2027–28**, with the potential for even higher savings in the long term.

In short, **every watt saved per fan translates to gigawatts saved at the national scale**—demonstrating why efficient fan adoption is a critical part of India's energy transition.

2.1 Comparing Conventional Fans, Energy-Efficient and Super-Efficient Fans

Ceiling fans may look the same on the outside, but when it comes to energy consumption, there is a huge difference in electricity bills and overall energy demand. Broadly, ceiling fans fall into three categories: **Conventional Fans, Energy-Efficient Fans, and Super-Efficient Fans**.

This means a single super-efficient fan can save **40–50% energy** compared to a regular one. When scaled to millions of households, schools, offices, and public institutions, these savings translate into massive reductions in electricity bills and carbon emissions.

- Conventional Fans (Existing): These are the most common in Indian households which were sold before the mandatory star labelling came into effect in 2023. They usually consume around **70–80 watts** of power. While affordable, they place a large burden on electricity demand when used in millions of households.
- Energy-Efficient Fans: These fans are designed with improved motors and blade designs to cut down electricity use. They consume **50–52 watts** (least energy efficient fan as per the latest BEE star label program), offering 15–25% savings compared to erstwhile models.
- Super-Efficient Fans:** Powered by advanced **Brushless DC (BLDC)** technology, Super-Efficient fans operate at **25–35 watts** without compromising airflow and sit at the top of the energy efficiency ratings in BEE's star labelling program for ceiling fans. They provide **50% or more savings**, making them the most sustainable option for households, schools, offices, and hostels.



Table 1: Comparison of Conventional, Energy-efficient & Super-efficient fans

Type of Fan	Typical Power Consumption (Watts)	Efficiency Level	Savings Potential	Remarks
Conventional Fans (Existing)	70–80 W	Low	Baseline	Most common; high energy burden at scale
Energy-Efficient Fans	50–52 W	Medium	15–25% savings vs. conventional	Improved motor/blade design; now widely available
Super-Efficient Fans	25–35 W	High (BLDC technology)	50% or more savings vs. conventional fans	Best long-term choice; higher upfront cost but quick payback through savings

The transition from conventional to super-efficient fans is not just about technology—it's about **reshaping India's energy future**. With nearly **950 million fans projected by 2038**, switching to Super-Efficient fans can drastically cut residential electricity consumption, reduce dependence on coal-based power, and align with India's clean energy goals.

3. What Are Super-Efficient Fans?

Super-Efficient Fans are primarily BLDC (Brushless Direct Current) fans, designed with **advanced motor technology and optimized blade aerodynamics** to deliver the same comfort as conventional fans while consuming significantly **less power**. These fans are rapidly gaining popularity in the Indian market due to their **energy-saving potential** and precise **speed control features**.

Typically rated as 5-star appliances, Super-efficient fans achieve a **service value** of around 6, which is substantially higher than the 1-star rated fans where service value lies in the range of 4-4.5. While most Super-efficient fans are BLDC-based, some models under development utilize Switched Reluctance Motors (SRM) or Synchronous Motors, offering alternative pathways to super efficiency.

According to the **Bureau of Energy Efficiency (BEE)**, Super-Efficient fans operate in the range of 25–35 watts without compromising on air delivery, compared to conventional ceiling fans that usually consume 70–80 watts.

3.1 What makes a fan “Super-Efficient”?

A ceiling fan becomes super-efficient through the optimized combination of a **high-efficiency motor** (primarily Brushless DC motors), **aerodynamically designed blades**, **smart electronic controllers**, and **carefully selected materials** that reduce energy losses. Together, these advancements significantly lower electricity consumption, extend product life, and improve user comfort without compromising performance.

Key Components Driving Efficiency:

I. Motor Technology

i. **Induction Motors:** Most standard fans in India use single-phase induction motors consuming **50–52 W** of electricity. While cost-effective, these motors are energy-intensive.

ii. **Brushless DC (BLDC) Motors:**

- Consume only **25–35 W** while delivering the same air delivery as induction fans.
- Use **electronic commutation**, which eliminates brushes, reduces friction and wear, and allows precise speed control.
- Are **50–60% more efficient** than regular induction fans, saving up to **₹1,000–1,500 per year per fan** in electricity bills (assuming 12–15 hours daily use).

iii. **Switched Reluctance Motors (SRMs):**

- Emerging alternative, operating without permanent magnets, reducing cost and maintenance.
- Currently demonstrated efficiency levels similar to BLDC (**~34 W consumption**).



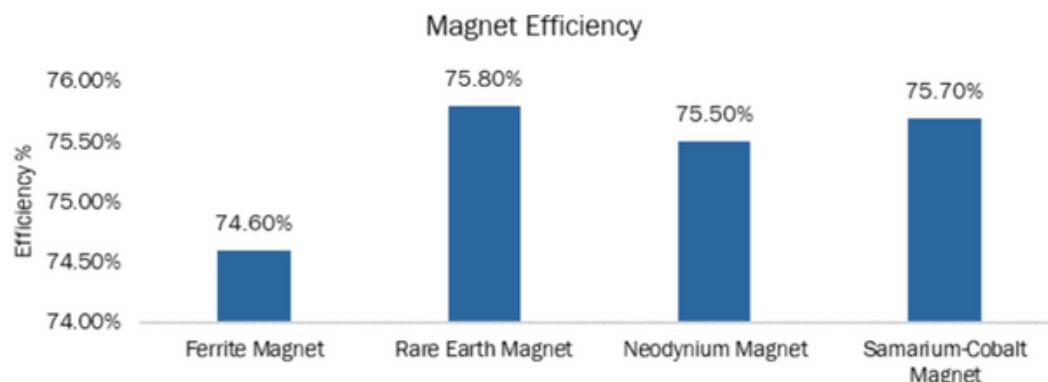
Fact: India has over **500 million ceiling fans installed**. If even **50% were converted to BLDC models**, annual savings could exceed **20 billion kWh** (equivalent to the annual electricity consumption of a state like Himachal Pradesh). Source: BEE & EESL, 2023.

II. Magnet Selection in Motors

Magnets form the backbone of motor performance for BLDC fans. Efficiency and cost trade-offs guide their selection:

- Neodymium Magnets (NdFeB):** Strongest commercially available permanent magnets, enabling compact and highly efficient BLDC motors.
- Samarium-Cobalt Magnets:** High temperature stability but costlier, used in select advanced motors.
- Ferrite Magnets:** Low cost and corrosion-resistant but lower magnetic strength, often used in induction motors.

High-performance magnets (*like neodymium*) contribute to the superior efficiency of BLDC motors, though they increase motor cost.



III. Blade Design & Material Choice

- Aerodynamics:** Blades with optimized angles and curves move more air at lower speeds, reducing turbulence and energy use.
- Materials:**
 - PVC:** Lightweight and cost-effective, reducing motor load.
 - Aluminum:** Durable, rust-resistant, and suited for humid climates.
 - GFRP Laminated Composite:** Combines strength, corrosion resistance, and design flexibility, increasingly used in premium models.
 - Steel:** Strong but heavier, leading to higher energy demand compared to composites.

Fact: Studies indicate that improving blade aerodynamics alone can reduce fan power consumption **by 10–15%** without motor changes. Source: TERI, 2022

IV. Controllers & Smart Features

- Modern BLDC fans come with compact, **high-quality electronic controllers** that minimize energy loss.
- Remote control and IoT-enabled features (like timers and sleep modes) optimize usage, further saving **5–10%** energy.
- Smart integration with home automation allows users to maximize efficiency by operating fans at optimal speeds instead of maximum settings.

A super-efficient fan is not just about a single innovation but the synergy of multiple components:

- BLDC motors powered by high-strength magnets.
- Aerodynamic blades made of lightweight composites.
- Compact controllers that minimize electrical losses.
- Smart features enabling user-friendly energy savings.

The result: Fans that consume 50–60% less electricity, last longer, and provide quieter, smoother airflow compared to conventional models.

3.1.1 Benefits of Super-Efficient fans – Energy, Savings & Comfort

Super-Efficient Fans offer multiple benefits that go beyond simply reducing electricity consumption. Their advanced technology combines high-efficiency BLDC motors, optimized blade designs, and smart controls to deliver a superior balance of performance, cost savings, and user comfort.

1. Energy Efficiency

- **Lower Power Consumption:** Super-Efficient fans consume only **25–35 watts**, compared to **70–80 watts** for existing fans. This translates into **50–65% less electricity use** per fan.
- **Reduced Grid Load:** In a country like India with over **500 million ceiling fans in use (BEE, 2024)**, mass adoption of Super-Efficient fans could reduce national electricity demand by **15–20 GW** annually.
- **Climate Benefits:** Lower electricity demand directly reduces coal-based power generation, leading to significant cuts in carbon emissions.

2. Cost Savings

- **Household Savings:** Running a fan for 10 hours daily over a year cost approximately:

Conventional Fan: ₹2,000 - ₹2,500/year
SEF (BLDC): ₹800 - ₹1,000/year

 Savings with BLDC Fans: ₹1,200–₹1,500 per fan annually

- **Payback Period:** With prices of Super-Efficient fans now starting around **₹3,000**, most households recover the additional cost within 1–2 years of usage.
- **Cumulative Impact:** In households with 3–4 fans, switching to Super-Efficient fans can save ₹4,000–₹6,000 per year, making them a practical long-term investment.

3. Comfort & Performance

- **Stable Air Delivery:** Despite consuming less power, Super-Efficient fans maintain better air delivery of 220–240 m³/min, comparable to conventional fans.
- **Silent Operation:** BLDC motors and aerodynamic blades minimize noise and turbulence, making them ideal for bedrooms, classrooms, and offices.
- **Smart Features:** Many Super-Efficient fans come with remote controls, timers, inverter compatibility, and IoT integration, improving convenience and comfort during usage.
- **Voltage Fluctuation Resistance:** BLDC technology ensures stable performance even during low voltage, a common issue in many regions.

3.1.2 BEE Star Rating Criteria



The **Bureau of Energy Efficiency (BEE)** plays a crucial role in transforming India's fan market by introducing clear and mandatory star rating standards for ceiling fans. Since Jan 2023, manufacturers can only sell star-rated fans, and every unit must display a star label at the point of sale.

How Does BEE Measure Efficiency?

To evaluate the performance of a ceiling fan, BEE uses a metric called Service Value (SV)*:

$$\text{Service Value (SV)} = \frac{\text{Air Delivery (m}^3/\text{min})}{\text{Power Input (Watts)}}$$

- **Higher SV = More air delivered per unit of power consumed.**
- Fans with $SV \geq 6.0$ qualify for a **5-Star rating**.
- Conventional induction fans often have SV values of 4 and above, while BLDC-based super-efficient fans achieve **6.0 and above**.

*The service value of a fan is a measure of its energy efficiency, calculated by dividing its air delivery (in cubic meters per minute or CMM) by its power consumption (in watts).

A higher service value indicates a more energy-efficient fan, meaning it moves more air for less electricity, which translates to lower energy bills and a higher BEE (Bureau of Energy Efficiency) star rating.

Star Rating Chart for Ceiling Fans

BEE defines the thresholds for star ratings based on fan efficiency. While actual values may differ by **blade sweep** size (900 mm, 1200 mm, 1400 mm), the general efficiency pattern for sweep size > 1200mm is as follows:

Star Rating	Service Value (SV)	Typical Wattage	Fan Category
★ (1 Star)	≥ 4.0 to < 4.5	47–53 W	Energy Efficient fans
★★ (2 Star)	≥ 4.5 to < 5.0	42–47 W	Improved fans
★★★ (3 Star)	≥ 5.0 to < 5.5	38–42 W	Mid-efficiency
★★★★ (4 Star)	≥ 5.5 to < 6.0	35–38 W	High-efficiency
★★★★★ (5 Star)	≥ 6.0	≤ 35 W	Super-Efficient Fans

(Source: Bureau of Energy Efficiency, 2023 Guidelines)

Note: Service Value levels may see an increment of 0.5 for each rating w.e.f. Jan 2026

3.2 Key Specifications and Air Delivery Standards

The efficiency of a ceiling fan is determined not only by how much electricity it consumes but also by how effectively it circulates air. To ensure both comfort and energy savings, the Bureau of Energy Efficiency (BEE) specifies performance benchmarks for ceiling fans, which are primarily assessed through **air delivery and service value**.

1. **Air Delivery** refers to the volume of air a fan circulates, measured in Cubic Meters per Minute (CMM).
 - **Standard Requirement:** To qualify under BEE's star rating program, a ceiling fan must deliver a minimum of 210–220 CMM, depending on its blade sweep size.
 - **Comfort Assurance:** This ensures that while reducing energy consumption, the fan continues to provide adequate cooling comfort.
2. **Service Value (SV)** is the ratio of air delivery (CMM) to power input (Watts).
 - **Efficiency Benchmark:** A higher service value indicates better energy efficiency.
 - **Example:**
 - A **35W** super-efficient fan delivering 220 CMM has an SV of ~6.3.
 - A **70W** conventional fan delivering the same 220 CMM has an SV of ~3.1.
 - This shows that super-efficient fans deliver the same comfort at nearly half the power consumption.
3. **Blade Sweep Sizes and Performance:** Ceiling fans in India are commonly available in blade sweep sizes of **900 mm, 1050 mm, 1200 mm, and 1400 mm**.
 - The **minimum air delivery** requirement varies with blade size, but in all cases, BEE ensures that fans deliver sufficient airflow to maintain comfort.
4. **Star Rating Criteria**
 - The BEE star rating system is based on Service Value (SV).
 - Fans with $SV \geq 6.0$ are awarded the highest 5-star rating.
 - Lower service values correspond to fewer stars.

A super-efficient fan is not just about consuming fewer watts. It is about maintaining or even improving air delivery while using significantly less electricity—delivering both comfort and savings.

3.3 Current Technologies in Super-Efficient fans

The evolution of ceiling fans from conventional induction-based designs to **super-efficient fans** is a result of technological breakthroughs in motors, controllers, and connectivity. Today, Super-Efficient fans combine **energy efficiency, user convenience, and adaptability** to modern living standards.

Three key technologies are driving this transformation: **Induction motors, BLDC motors, and solar-powered systems**.

1. Induction Motor Technology - The Evolving Classic:

Induction fans are the most common type of ceiling fans in India and have been used for decades. They are known for being simple in design, durable, and easy to maintain. These fans work on the principle of electromagnetic induction—when alternating current (AC) is supplied, it creates a rotating magnetic field in the stator, which makes the rotor turn and drive the blades.

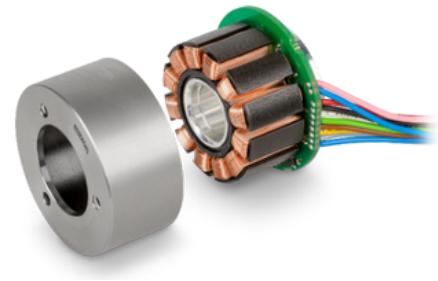
Earlier, induction fans were usually low-rated (mostly 1-star) and consumed about 70–80 watts, making them less energy-efficient. But in recent years, manufacturers have started improving this technology, and by 2025, some 5-star rated induction fans are available in the market.



- Air delivery: ~210 CFM
- Service Value: 6
- Rating: 5-star category
- **Future Potential:** With more design improvements, better motor windings, and use of improved materials, induction fans may reach 25W consumption in the future. This would be equal to a Service Value of 8.4, meaning they could become almost as efficient as today's BLDC fans.
- **Why This Is Important:** Induction fans are still the most widely used type in India because they are affordable. Improvements in this technology mean that energy savings can reach a larger section of consumers, especially in price-sensitive markets where BLDC fans are still considered costly. improvement of around 30–35% compared to current best-performing models.

2. BLDC Motors – Efficient & Inverter Compatible:

Brushless Direct Current (BLDC) technology has emerged as the leading solution for energy-efficient ceiling fans. BLDC fans use permanent magnets and electronic controllers to operate, unlike conventional induction motors that rely on electromagnetic induction. This design reduces energy losses and allows precise control of speed, making BLDC fans far more efficient.



- **Current Best Available Technology:** Today, top-performing BLDC ceiling fans consume as little as 28W of power while delivering about 220–230 CFM of air, equivalent to a service value (SV) of 8.2. These fans are also inverter-compatible and often come with remote-control or smart-control features.
- **Future Potential:** With ongoing advancements, BLDC fans are expected to reach efficiencies close to 20W of power consumption, delivering SVs of 10 or higher. This would represent an improvement of around 30–35% compared to current best-performing models.

3. Solar-powered fans—off-grid/rural areas

Solar-powered fans are designed to run directly on solar photovoltaic (PV) power, making them highly useful in rural and off-grid areas where access to electricity is limited. These fans reduce dependence on the grid and contribute to clean energy adoption. However, their efficiency depends on solar panel quality, battery storage, and availability of sunlight.

- **Current Best Available Technology:** Today, solar ceiling fans consume around 35–40W of power, delivering 200–220 CFM of air, with many models integrated with BLDC motors for improved efficiency. They typically run on 12V/24V DC supply and can be paired with small solar home systems.
- **Future Potential:** With better solar panels, energy storage, and motor design, solar fans could achieve 25–30W power consumption while delivering higher airflow (up to 240 CFM). This would make them more reliable, efficient, and suitable for wider adoption in rural and peri-urban areas.

Other Motor Technologies

While BLDC is the most common, other advanced motor technologies are also used in high-efficiency fans, particularly in industrial applications. These include:

- **Switch Reluctance Motors (SRMs):** These motors have a simple, robust construction with no magnets or windings on the rotor, making them highly reliable.
- **Permanent Magnet Synchronous Motors (PMSMs):** Often used in industrial fans, PMSMs are known for their high efficiency, precise speed control, and compact design. They are a good choice for applications requiring high precision and variable speed.

4. Current Ceiling Fan Industry Overview

India's ceiling fan market continues to be one of the largest and fastest-growing segments of the cooling sector. Driven by rising temperatures, rapid urbanization, and the demand for affordable cooling, fan sales are projected to reach **90–95 million units** in 2026, with ceiling fans alone accounting for nearly 75% of this demand (~60 million units). With over **500 million ceiling fans** already in use, India represents not only a vast consumer base but also a major opportunity for energy efficiency upgrades.

The market is undergoing a significant **transition towards energy-efficient brushless direct current (BLDC) fans**, as consumers and policymakers increasingly focus on saving electricity and promoting sustainability. With electricity prices on the rise and government initiatives driving energy-efficient appliances, BLDC technology is gaining ground rapidly. BLDC fans consume only 25–35 watts compared to 70–80 watts used by conventional induction motor fans—translating into **50–65% energy savings**.

Supportive government policies, such as the **BEE Standards & Labeling Scheme** (mandatory star rating for ceiling fans since 2023) and incentives under schemes like UJALA for LEDs, are further accelerating adoption. By 2025, BLDC fans already account for 25–28% of total sales, up from just 10–12% in 2022. Projections suggest that BLDC penetration could reach 45–50% of annual sales by 2027 and dominate the market by 2030.

Major players such as Atomberg, Versa Drives, Crompton, and Havells are leading this transition. Atomberg, a BLDC technology pioneer, recorded more than 200% growth in 2023–24, while the premium efficient-fan segment as a whole has been growing at a CAGR of ~25% between 2023 and 2025. Increasing consumer preference for IoT-enabled smart controls, remote operation, and variable speed settings is driving innovation and making efficient fans a mainstream choice.

4.1 Market Landscape

The ceiling fan market in India represents one of the largest cooling appliance segments globally, both in terms of installed base and annual sales. With over 500 million ceiling fans already in use in 2025, India accounts for nearly 50% of the global ceiling fan stock. This makes fans a critical part of the country's residential and commercial energy footprint.

Annual demand for fans remains strong, with **85–90 million units sold in 2025**, of which ceiling fans contribute around 70–75% (~60–65 million units). Demand is expected to remain robust, largely due to:

- **Rising temperatures and climate change impacts**, increasing the need for affordable cooling.
- **Urbanization and housing growth**, with millions of new households being added each year.
- **Affordability**, as ceiling fans continue to be one of the lowest-cost cooling solutions compared to air-conditioners and coolers.

The **average lifespan of a ceiling fan in India is 10–12 years**, but many households continue using fans for 15–20 years, leading to a huge installed base of outdated, inefficient units. This has created a replacement market potential that is larger than new sales—an area increasingly targeted by manufacturers and government programs.

From a technology perspective, the market is split into three broad categories:

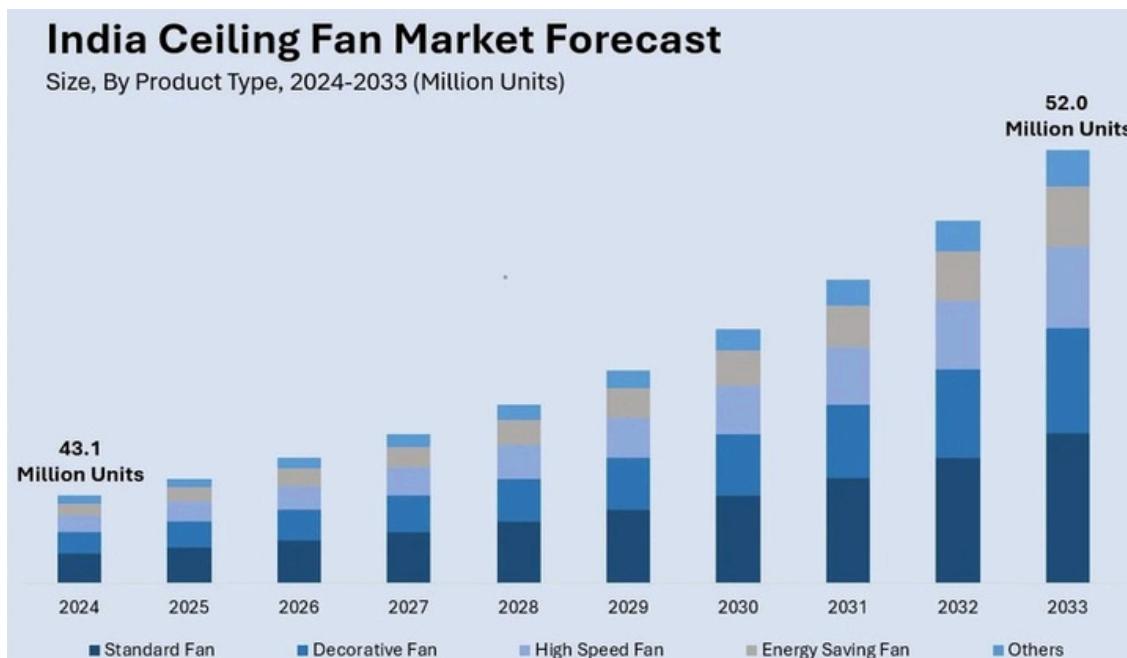
- **Conventional (Existing) induction motor fans** – still dominate, but their share is steadily declining.
- **Energy-efficient induction motor fans** – consume 50–52 watts; positioned as entry level fans.
- **Super-Efficient BLDC fans** – consume only 25–35 watts; fastest growing segment.

Price remains a **key decision** factor. Increasingly, consumers are willing to invest in **premium, efficient models** for long-term savings, especially in urban and semi-urban markets.

The **geographic demand** is also diverse:

- **Urban households** are shifting faster to premium BLDC and smart fans.
- **Rural and semi-urban households** continue to rely heavily on low-cost conventional models, but programs similar to UJALA and CSR-led replacement schemes are being designed for ceiling fans too in order to gradually expand their access to energy-efficient alternatives.

Overall, India's fan industry stands at a **crossroads in 2025**: the market is massive and growing, but the opportunity lies in **accelerating the replacement of old, inefficient fans** with super-efficient technologies that align with the country's energy and climate goals.



4.2 What's Changing with New Technologies?

The ceiling fan industry in India is undergoing a rapid technological shift. For decades, most fans relied on induction motors, consuming 70–80 watts per unit. However, with the demand for energy savings and smarter appliances, manufacturers are embracing **new-age technologies** that significantly transform both performance and efficiency.

Key Technological Shifts:

- **BLDC (Brushless Direct Current) Motors**
 - Reduce power consumption by 50–65% compared to induction motors.
 - Typical wattage: 25–35W vs. 75W (conventional).
 - Longer motor life, lower noise, and compatibility with inverters/solar.
 - Market adoption growing from 10–15% in 2023 to ~35% projected by 2025–26.
- **IoT-Enabled & Smart Fans**
 - Fans with Wi-Fi, Bluetooth, and app-based control are entering mainstream homes and institutions.
 - Features: remote speed control, sleep timers, integration with voice assistants like Alexa/Google Assistant.
 - These smart features combine convenience with energy management (e.g., auto-adjust speed based on room conditions).



- **Solar-Powered Fans**

- Particularly useful in off-grid rural areas or schools with unreliable electricity supply.
- Reduce dependence on grid electricity while supporting India's renewable energy targets.
- Paired with rooftop solar systems in educational campuses or community centers.

- **Design Innovations**

- Lightweight, aerodynamic blade designs for higher air delivery at lower power input.
- Availability of customized models for institutional bulk buyers (e.g., schools, colleges, offices).



4.3 Price Trends: Are Efficient Fans Affordable?

For years, the adoption of energy-efficient ceiling fans was slowed by the **perception of a high upfront cost**. Conventional fans with induction motors remained dominant, largely due to their affordability. However, this cost advantage is quickly shrinking as efficient technologies scale up and competition drives prices down. The market now offers a spectrum of choices, each with a distinct balance of initial cost and long-term savings.

- **Energy-Efficient Fans:** These models represent the accessible entry point into fan efficiency. With a power consumption of around **50-52W**, they are a significant upgrade from existing fans. Their price point of **₹1,500 to ₹1,800** is only slightly higher than their older counterparts. These fans are seeing strong adoption, especially in Tier-2 and Tier-3 cities due to their lower costs.
- **Super-Efficient BLDC Fans:** At the top of the efficiency spectrum are fans with Brushless DC (BLDC) motors. Consuming only **25-35W**, they are the most powerful and efficient option available. While their average price of **₹2,800 to ₹3,500** seems high, the significant energy savings mean the **payback period is exceptionally short—just 1.5 to 2 years**. Prices for these fans have dropped by 20-25% since 2018 due to economies of scale, making them a more attractive long-term investment than ever before. IoT-enabled "smart" models, while costing a bit more at **₹4,000 to ₹5,000**, offer advanced features like remote control and scheduling.

Fan Type	Avg. Price	Power Use	Annual Cost (₹ at 8 hrs/day, ₹6/unit)	Payback Period
Energy-Efficient	₹1,500	50W	~₹900	~3 years
BLDC SEF	₹3,000	30W	~₹550	~2 years

5. FAN REPLACEMENT STRATEGY: REPLACING OLD FANS

India has one of the largest installed bases of ceiling fans in the world, with more than **500 million units in use by 2025**, and demand continues to rise every year. A large portion of this stock consists of old, inefficient induction fans that consume **70–80 watts** each, far higher than the 25–35 watts consumed by modern super-efficient fans. Since fans run for long hours in most households and institutions, the cumulative energy wastage from outdated fans is enormous.

The **Fan Replacement Program** being run by Bureau of Energy Efficiency as part of its **Demand Side Management Program (DSM)** in various DISCOMS, focuses on systematically phasing out these inefficient models and replacing them with **BLDC-based or 5-star rated induction fans**. Such programs are not only cost-effective but also one of the fastest ways to achieve large-scale electricity savings in the cooling sector.

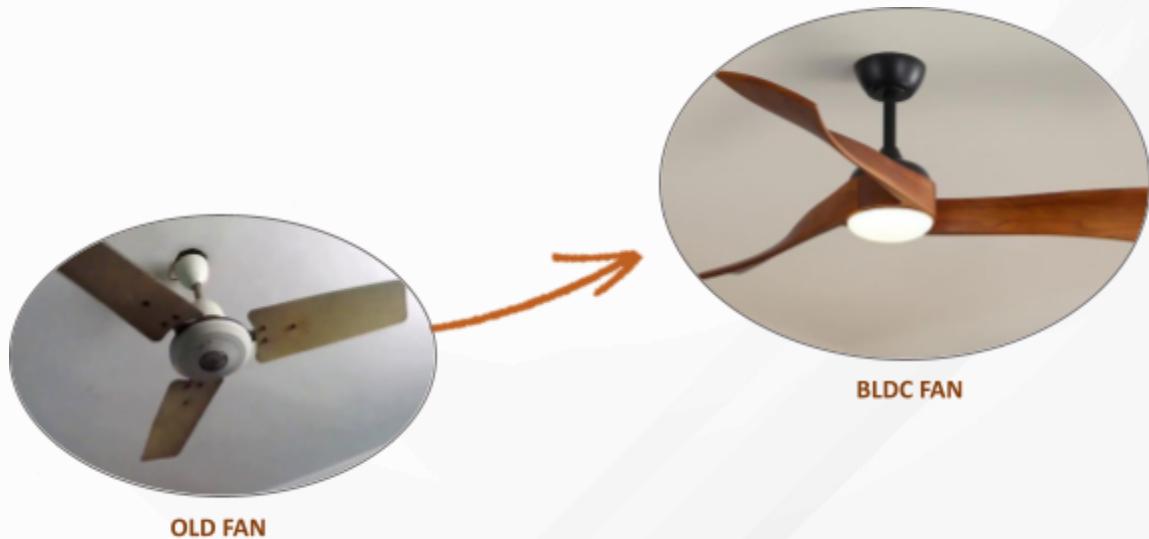
By reducing energy consumption at the appliance level, replacement programs can:

- Lower electricity bills for households and institutions.
- Reduce peak demand pressures on the power grid.
- Cut carbon emissions and align with India's climate commitments.

In this section, we discuss the structure of the **Fan Replacement Program**, its target groups, the stakeholders involved, how the process works, and the overall benefits of large-scale adoption.

5.1 What is the Fan Replacement Program?

The Fan Replacement Program is a large-scale initiative designed to accelerate India's transition from conventional ceiling fans to Super-Efficient Fans such as BLDC fans and 5-star rated induction fans. The core idea is simple: replace old, inefficient fans consuming 70–80W with efficient models consuming only 25–35W, without compromising comfort or air delivery.



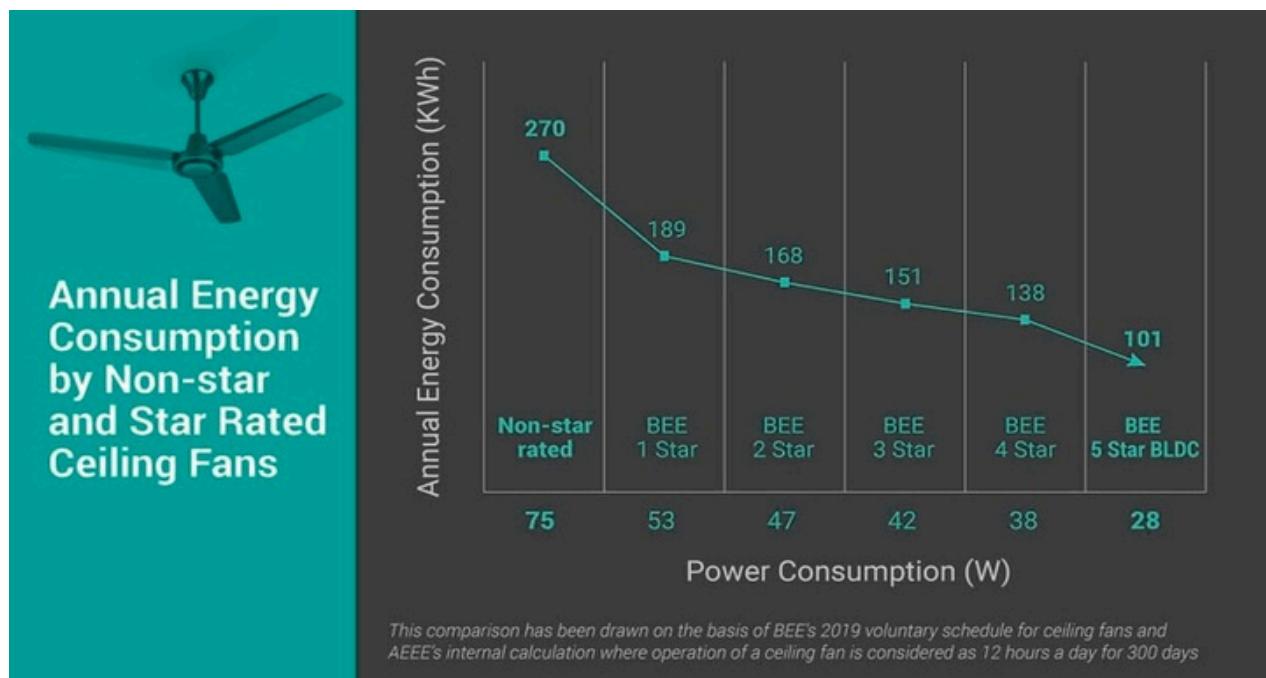
How the Program Works

The Fan Replacement Program is designed as a structured intervention to overcome common barriers such as high upfront cost, lack of awareness, and continued use of functioning old fans. Key features include:

- **Exchange & Buyback Schemes:** Consumers exchange old fans for efficient models at discounted prices.
- **Bulk Procurement:** Schools, colleges, hospitals, and residential replace existing fan stocks at once, bringing down procurement costs.
- **Utility/DISCOM Partnerships:** Electricity distribution companies (DISCOMs) provide rebates or on-bill financing, allowing consumers to pay gradually through electricity bills.
- **CSR & Government Support:** Many programs are supported by EESL, DISCOMs, and corporate CSR initiatives, especially targeting government schools and rural households.
- **End-to-End Services:** Service providers such as Cypress Infratech manage uninstallation, installation, logistics, and certified e-waste disposal, ensuring smooth implementation.

Benefits at a Glance

- **Consumers:** Lower bills and improved comfort.
- **Institutions:** Long-term operational cost reduction, compliance with sustainability mandates.
- **Nation:** Reduced electricity demand, lower carbon emissions, and avoided investments in additional power capacity.



Source: AEEE

5.2 Target Audience for the Fan Replacement Program

The Fan Replacement Program is designed to benefit both **institutions with large fan usage** and **households with every day cooling needs**. By focusing on these groups, the program ensures both **scale** and **widespread impact**.



Institutional Consumers

Institutions operate fans in bulk and for long hours, making replacements highly impactful.

- **Schools & Colleges:** Classrooms and lecture halls often run fans for 8–10 hours daily.
- **Public Buildings:** Railway stations, libraries, temples and bus depots—high-usage zones—see immediate benefits.



Residential Consumers

Households form the largest segment, as ceiling fans are used across the country.

- **Urban Homes:** Typically have 3–5 fans, savings of **₹3,000–4,000 annually** per household.
- **Rural Homes:** Fans are often the **primary cooling option**, and Super-Efficient fans work better with **inverters and solar power**, reducing reliance on unstable grid supply.

Scenario	Old Fan (75W)	SEF (30W)	Annual Savings
1 School (100 fans, 10 hrs/day)	27,000 kWh	10,800 kWh	16,200 kWh (~ 1.2 - 1.4 lakh)
1 Household (4 fans, 10 hrs/day)	4,320 kWh	1,728 kWh	2,592 kWh (~₹3,000–4,000)

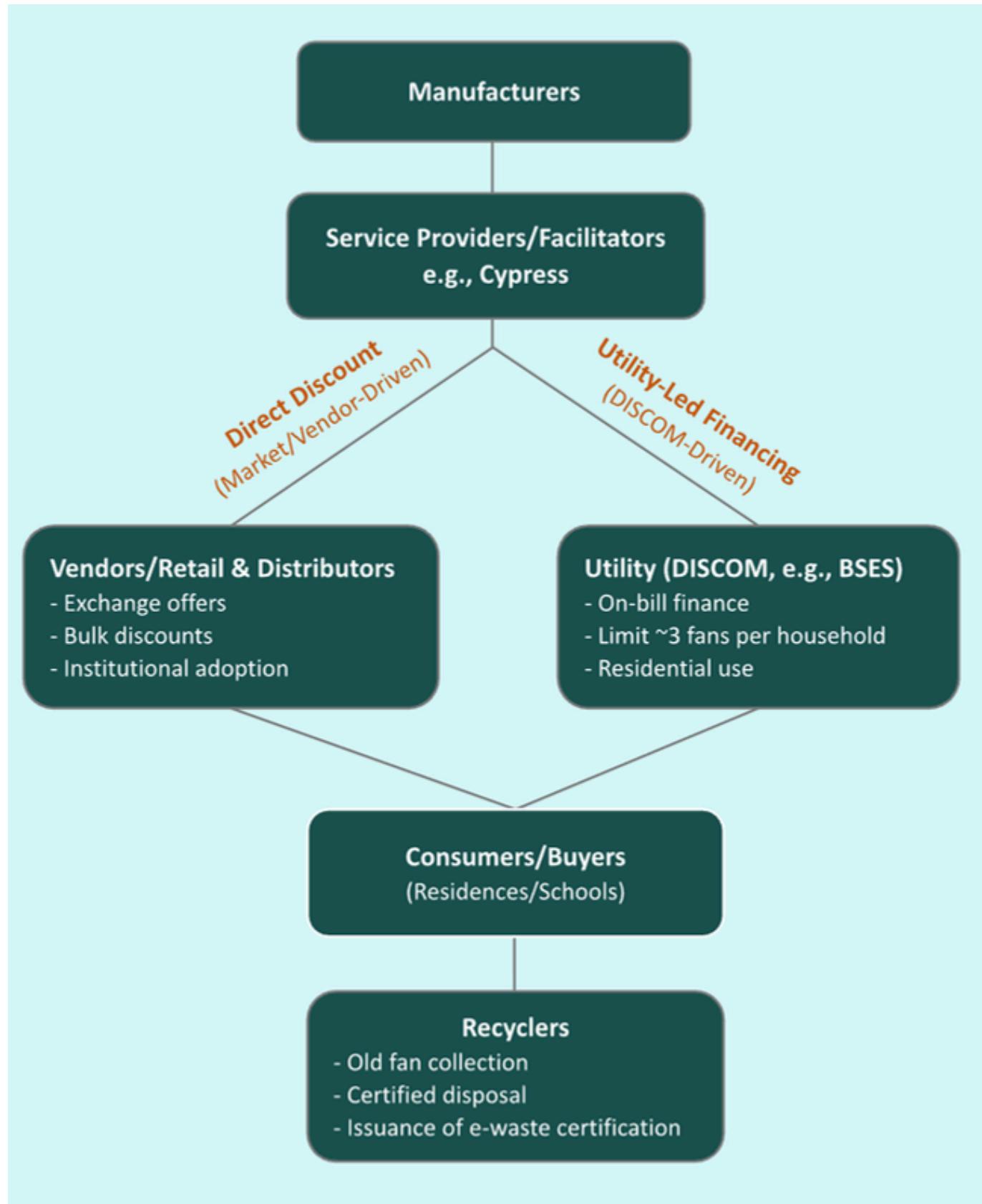
Source: AEEE

5.3 Stakeholders in the Super-Efficient Fan Ecosystem

The success of the Fan Replacement Program depends on the coordinated efforts of multiple stakeholders. Each plays a unique role in ensuring smooth replacement, adoption, and sustainability.

Stakeholder	Role in the Ecosystem	Examples
Manufacturers	Develop and supply BEE 5-star rated fans (BLDC and efficient induction models) that meet efficiency and air delivery standards.	Atomberg, Crompton, Havells, Orient, Superfan
Recyclers	Handle collection, dismantling, and certified e-waste disposal of old fans to ensure environmental compliance.	Authorized e-waste facilities
Service Providers / Facilitators	Provide end-to-end solutions —from audits, procurement, installation, and logistics to disposal and certification.	Cypress Infratech, EESL-led programs
Buyers / Consumers	Adopt and use Super-Efficient fans, benefitting from lower energy bills, better comfort, and sustainability gains .	Households, schools, hospitals
Policy & Utility Bodies	Create enabling environment through standards, incentives, and financing mechanisms .	BEE, DISCOMs, State Energy Departments

FAN REPLACEMENT PROGRAM – TWO ADOPTION PATHWAYS



6. Key Market Players and Innovative Companies

The super-efficient fan (SEF) market in India has grown rapidly over the last decade, with multiple companies competing through **advanced technologies, smart features, and institutional tie-ups**. Below are some of the key players:

1. Atomberg Technologies

- **Innovation:** India's pioneer in BLDC ceiling fans, Atomberg brought super-efficient fans into the mainstream.
- **Unique Features:**
 - Ultra-low energy use (**28–35W**).
 - Remote-controlled and IoT-enabled models.
 - Inverter compatibility, running **3–4x** longer on backup power.
- **Institutional Impact:** Known for **bulk procurement tie-ups** with hostels, offices, and government facilities.
- **Growth:** Atomberg reported **200% sales growth in 2023**, becoming the leader in the SEF segment.



2. Orient Electric

- **Innovation:** Smart ceiling fans with IoT-based controls, app connectivity, and integration with Alexa/Google Assistant.
- **Unique Features:**
 - BLDC technology with 50–65% lower power consumption.
 - Designer range catering to both efficiency and aesthetics.
- **Institutional Impact:** Focuses on **smart campus adoption** programs.



3. Havells India

- **Innovation:** Strong focus on BEE 5-star rated fans and durability.
- **Unique Features:**
 - High air delivery with 30–35W power consumption.
 - Focus on durability and after-sales service.
- **Institutional Impact:** Targeting schools, **government buildings, and housing projects** with Super-Efficient fans.



4. Crompton Greaves Consumer Electricals

- **Innovation:** Hybrid fans combining energy efficiency with affordability.
- **Unique Features:**
 - BLDC technology fans under ₹2,000 (entry-level Super-Efficient fans).
 - Options for both premium and mass markets.
- **Institutional Impact:** Supplying Super-Efficient fans under **DISCOM-driven DSM programs** and bulk procurement channels.



5. Superfan (by Versa Drives Pvt. Ltd.)

- **Innovation:** India's first manufacturer to launch BLDC ceiling fans (2012).
- **Unique Features:**
 - Models with 28W consumption.
 - Strong emphasis on sustainability and recyclability.
- **Institutional Impact:** Early adoption in **government programs, CSR initiatives, and eco-schools**.



7. Government Support: Schemes, Incentives & CSR Initiatives

The transformation of India's ceiling fan market is being accelerated by strong policy backing and institutional support. Both central and state-level initiatives are creating the right environment for large-scale adoption of super-efficient fans, while private companies are contributing through CSR programs.

1. POLICY & REGULATORY SUPPORT

- **Super-Efficient Equipment Program (SEEP)**
 - Proposed by BEE during the 12th Five-Year Plan under the Market Transformation for Energy Efficiency (MTEE), SEEP laid the foundation for subsequent initiatives such as the Standards & Labeling Programme.
 - The program aimed to accelerate the market adoption of 35W super-efficient ceiling fans, compared to the typical 70W fans in the market.
- **BEE Star Labeling Program**
 - In 2023, the Bureau of Energy Efficiency (BEE) made star labeling mandatory for ceiling fans, ensuring that all products display their efficiency rating at the point of sale.
 - The rating is based on service value (air delivery per watt), guiding consumers towards energy-efficient purchases.

2. UTILITY-LED PROGRAMS

- **Demand Side Management (DSM) Initiatives**
 - DISCOMs like BSES in Delhi have launched replacement schemes where households can adopt Super-Efficient fans with little upfront cost, often through on-bill financing.
 - Such programs are modelled after the successful UJALA program for LEDs, which distributed 370 million LED bulbs nationwide.
- **Scaling Potential**
 - If similar DSM programs are rolled out across India's 60+ DISCOMs, the combined annual demand could run into millions of Super-Efficient fans per year, easing grid loads and lowering peak demand.

3. INCENTIVES AND MARKET ENABLERS

- **State-Level Subsidies:** Some state governments offer incentives or rebates on Super-Efficient fans under energy efficiency programs.
- **Carbon Credit Opportunities:** Large-scale replacement programs may generate carbon credits under voluntary carbon markets, adding financial viability for bulk procurement projects.

4. CSR & INSTITUTIONAL SUPPORT

- **Corporate Social Responsibility (CSR) Programs:**
 - Many companies support energy efficiency initiatives in schools and government institutions by donating or subsidizing Super-Efficient fans.
 - These projects not only cut energy bills for schools but also create awareness of sustainable practices among students.
- **Public-Private Partnerships:** Collaborations between manufacturers, service providers, and CSR arms of companies are enabling end-to-end solutions (procurement, installation, and safe disposal of old fans).

8. Vision for 2030: Scaling Fan Efficiency in India

India's ceiling fan market is at the threshold of a major transformation. With nearly **1 billion fans projected by 2038**, the shift from conventional induction motors to super-efficient BLDC and advanced technologies is not just desirable, but essential for sustainable growth. By 2030, fan efficiency will be central to India's broader energy transition and climate commitments.

1. Efficiency as the New Norm

- With BEE's **mandatory star rating**, inefficient fans are gradually being phased out.
- By 2030, the majority of new ceiling fans sold are expected to be **4-star and 5-star rated**, making super-efficient fans the industry standard.

2. Technology Pathways

- BLDC as Benchmark:** BLDC motors are expected to dominate the market, consuming only 25–35W while maintaining high air delivery.
- Smart & IoT Fans:** Integration with smart home systems will allow energy monitoring and adaptive cooling.
- Solar-Powered Solutions:** In rural and off-grid areas, solar-compatible fans will bridge access and efficiency.
- Next-Gen Induction Fans:** With innovations, induction fans could approach **25–30W consumption**, offering an affordable alternative to BLDCs.

3. Market Transformation Goals

- Market Share:** Super-Efficient fans projected to capture **at least 50% of total sales by 2030**, up from ~25% in 2025.
- Replacement Scale:** Over **200–250 million inefficient fans** could be replaced by 2030 through bulk procurement, DSM programs, and CSR initiatives.
- Energy Savings:** Estimated annual savings of **20–25 TWh**, equivalent to powering millions of homes.
- Carbon Impact:** Avoidance of **15–20 million tons of CO₂ emissions annually** through efficiency improvements.

4. Ecosystem Development

Achieving this vision requires a strong ecosystem involving:

- Manufacturers:** Scaling production of Super-Efficient fans with advanced designs.
- Vendors:** Offering affordable, accessible distribution networks.
- Service Providers:** Ensuring installation, financing, and e-waste management.
- Government & Utilities:** Supporting DSM, financing schemes, and policy enforcement.
- Institutions & CSR:** Driving adoption in schools, hostels, government offices, and public buildings.

5. The Road Ahead

By 2030, India has the opportunity to make super-efficient fans the new standard for households, institutions, and workplaces. The transition will be driven by three pillars:

- **Innovation:** Scaling up technologies like BLDC, smart connectivity, and solar-ready fans.
- **Affordability:** Reducing costs through mass manufacturing, bulk procurement, and financing options so that efficiency is accessible to all.
- **Adoption at Scale:** Expanding both new sales and replacement programs across residential, institutional, and government sectors.

If implemented effectively, the replacement of inefficient fans with super-efficient models will deliver some of the largest energy savings from any single appliance category. By 2030, Super-Efficient fans could save the country 20–25 TWh of electricity annually, cut 15–20 million tons of CO₂ emissions, and reduce consumer electricity bills by thousands of crores every year.

This vision is not distant—it mirrors the transformation achieved through the LED lighting revolution, where affordability, mass adoption, and strong policy support combined to deliver impact at scale. Ceiling fans can be the next success story in India's clean energy journey.

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