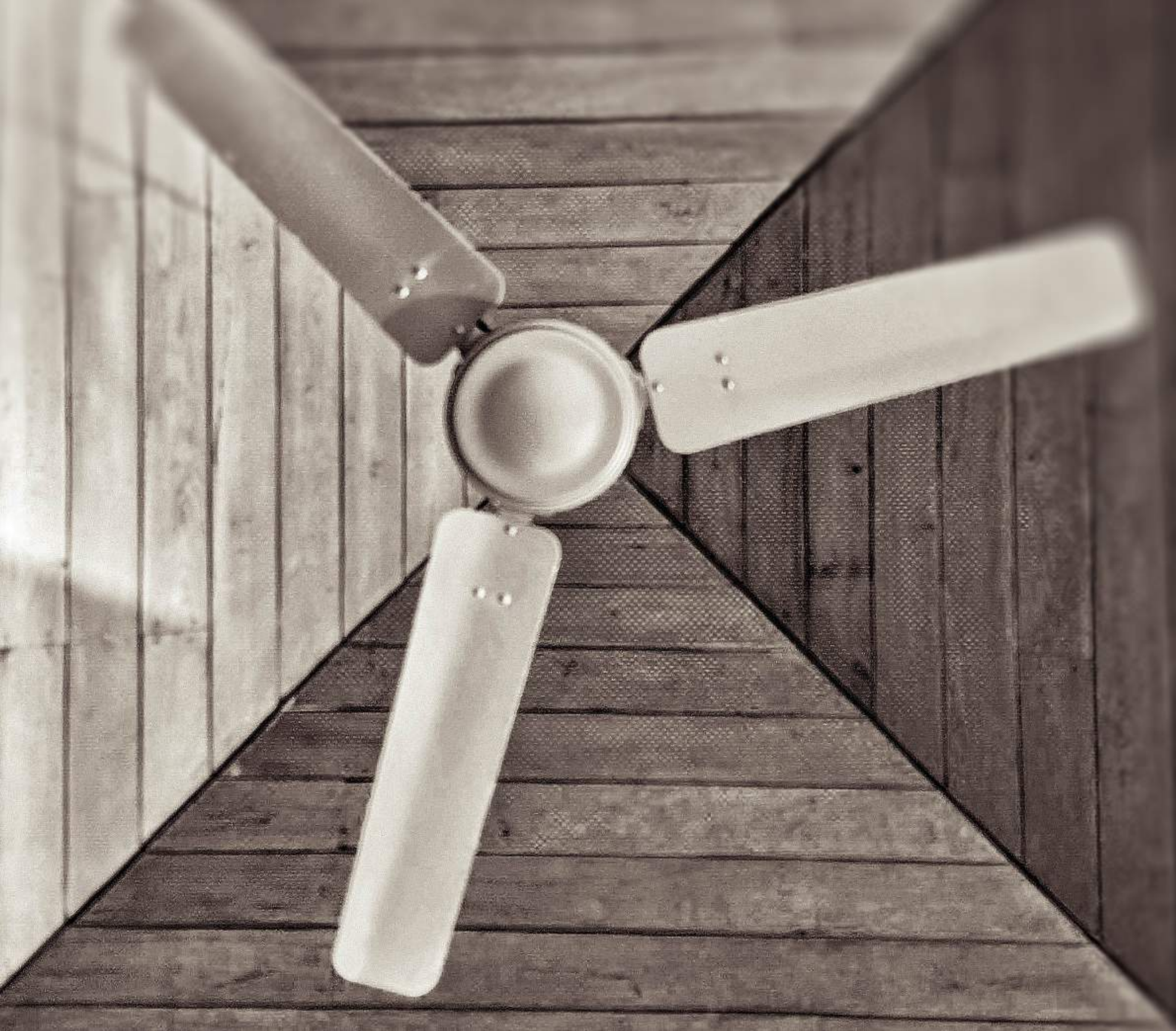
Business Model for Scaling Up Super-Efficient Appliances

A Deep Dive on Ceiling Fans in India

Dhruvak Aggarwal and Shalu Agrawal

Report | February 2022



CEEW's **Shalu Agrawal** (top) collecting perspectives on energy efficiency from consumers and **Dhruvak Aggarwal** (bottom) discussing sales of Super Efficient fans with a retail store owner.

Images: CEEW

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The Council on Energy, Environment and Water (CEEW) is one of Asia's leading not-for-profit policy research institutions. **The Council uses data, integrated analysis, and strategic outreach to explain — and change — the use, reuse, and misuse of resources.** The Council addresses pressing global challenges through an integrated and internationally focused approach. It prides itself on the independence of its high-quality research, develops partnerships with public and private institutions, and engages with the wider public.

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In ten years of operations, The Council has engaged in 278 research projects, published 212 peer-reviewed books, policy reports and papers, created 100+ new databases or improved access to data, advised governments around the world nearly 700 times, promoted bilateral and multilateral initiatives on 80+ occasions, and organised 350+ seminars and conferences. In July 2019, Minister Dharmendra Pradhan and Dr Fatih Birol (IEA) launched the CEEW Centre for Energy Finance. In August 2020, Powering Livelihoods — a CEEW and Villgro initiative for rural start-ups — was launched by Minister Mr Piyush Goyal, Dr Rajiv Kumar (NITI Aayog), and H.E. Ms Damilola Ogunbiyi (SEforAll).

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The Council's current initiatives include: A go-to-market programme for decentralised renewable energy-powered livelihood appliances; examining country-wide residential energy consumption patterns; raising consumer engagement on power issues; piloting business models for solar rooftop adoption; developing a renewable energy project performance dashboard; green hydrogen for industry decarbonisation; state-level modelling for energy and climate policy; reallocating water for faster economic growth; creating a democratic demand for clean air; raising consumer awareness on sustainable cooling; and supporting India's electric vehicle and battery ambitions. It also analyses the energy transition in emerging economies, including Indonesia, South Africa, Sri Lanka and Vietnam.

The Council has a footprint in 22 Indian states, working extensively with state governments and grassroots NGOs. It is supporting power sector reforms in Uttar Pradesh and Tamil Nadu, scaling up solar-powered irrigation in Chhattisgarh, supporting climate action plans in Gujarat and Madhya Pradesh, evaluating community-based natural farming in Andhra Pradesh, examining crop residue burning in Punjab, promoting solar rooftops in Delhi and Bihar, and rural microgrids in Meghalaya.

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Dhruvak is a Research Analyst at The Council. He works on demand-side management of power supply and the intersection of energy markets, regulation and decarbonisation. He holds a Master of Philosophy in Technology Policy from the University of Cambridge and a Bachelor of Technology in Mechatronics engineering from Manipal University Jaipur.

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As a Senior Programme Lead, Shalu leads The Council's work on residential energy access, demand-side management, and power sector reforms. She uses data to study the changing energy landscape and devises strategies to ensure universal access to affordable, reliable, and sustainable energy. She recently led India's first comprehensive residential energy survey. A Chevening scholar, Shalu holds an MSc from University College London and a BTech from IIT Roorkee.

"Beyond just making energy-efficient technologies affordable, business models must now focus on building trust in these technologies across the supply chain. That is the only way to capture and retain benefits of energy-efficiency at scale."

"Curiously, an omnipresent appliance like the ceiling fan has so far been on the margins of the efficiency discourse. As we aim to accelerate action on energy transition, innovative interventions to make super-efficient fans affordable and accessible can help unlock significant energy and carbon savings."

Acknowledgments

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Finally, our outreach team, editors and designers, who guided us through the publication and outreach process. We are very grateful to the entire team and especially convey our warm thanks to Kartikeya Jain and Alina Sen for their role in ensuring that the report meets CEEW’s quality standards.

As per the India Residential Energy Survey, over 90% of Indian households use ceiling fans for cooling and ventilation.

Image: iStock

Contents

Acronyms

AC	air conditioner
BEE	Bureau of Energy Efficiency
BLDC	brushless direct current
BRPL	BSES Rajdhani Power Limited
CBITC	Central Board of Indirect Taxes and Customs
CEA	Central Electricity Authority
CRT	cathode-ray tube
DA	demand aggregator
DSM	demand-side management
EESL	Energy Efficiency Services Limited
EMI	equated monthly instalment
ESC	energy service centre
ESCO	energy service company
FoR	Forum of Regulators
GeM	Government e-Marketplace
GST	Goods and Services Tax
HAREDA	Haryana Renewable Energy Development Authority
IBEF	India Brand Equity Foundation
IEA	International Energy Agency
INR	Indian National Rupee
IRES	India Residential Energy Survey
LED	light-emitting diode
MFI	micro-finance institution
MIS	management information system
MoEFCC	Ministry of Environment, Forests and Climate Change
MoHUA	Ministry of Housing and Urban Affairs
MoP	Ministry of Power
MoRD	Ministry of Rural Development
MoSPI	Ministry of Statistics and Programme Implementation
NBFC	non-banking financial company

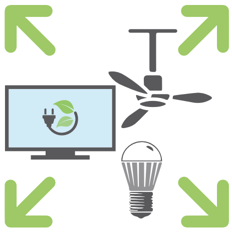
OBF	on-bill financing
OEM	original equipment manufacturer
PMAY	*Pradhan Mantri Awas Yojana*
PRGFEE	Partial Risk Guarantee Fund for Energy Efficiency
REC	Rural Electrification Corporation
SE	super-efficient
TV	television
UJALA	*Unnat Jyoti by Affordable LED for All*
UP	Uttar Pradesh
USD	United States Dollar

Users of energy-efficient ceiling fans are concentrated in large urban areas like Delhi and Mumbai.

Image: Dhruvak Aggarwal/CEEW

Executive summary

In a climate-constrained world, energy efficiency can be an effective compass to identify solutions that could yield carbon, energy, and resource savings. The International Energy Agency (IEA) projects that 40 per cent of the emission cuts required to reach global climate goals would come from energy efficiency (Fischer 2021). In developing countries like India, energy efficiency is much more than a climate imperative and can unlock diverse developmental opportunities.



There exists a vast scope for scaling up super-efficient appliances, particularly lights, fans, and televisions

India has achieved near-universal access to electricity in recent years, but there remain gaps in power supply reliability and quality (Agrawal, Mani, Jain, et al. 2020). One way to plug these gaps is to ameliorate the financial disincentive for power distribution companies (discoms) to supply reliable electricity in areas with low revenue recovery. This can be achieved by enhancing energy use efficiency among poorly served, low-income households (Phadke et al. 2019).

There exists a vast scope for scaling up super-efficient appliances, particularly lights, fans, and televisions (TVs), which form the bulk of the appliance inventory in India (Agrawal, Mani, Aggarwal, et al. 2020). But challenges like high upfront cost, limited availability in local markets, and low awareness of benefits hold consumers back from actively adopting efficient variants (Chillayil and Kottayil 2021). This study focuses on scaling up super-efficient variants of one of the most commonly used household appliances: ceiling fans.

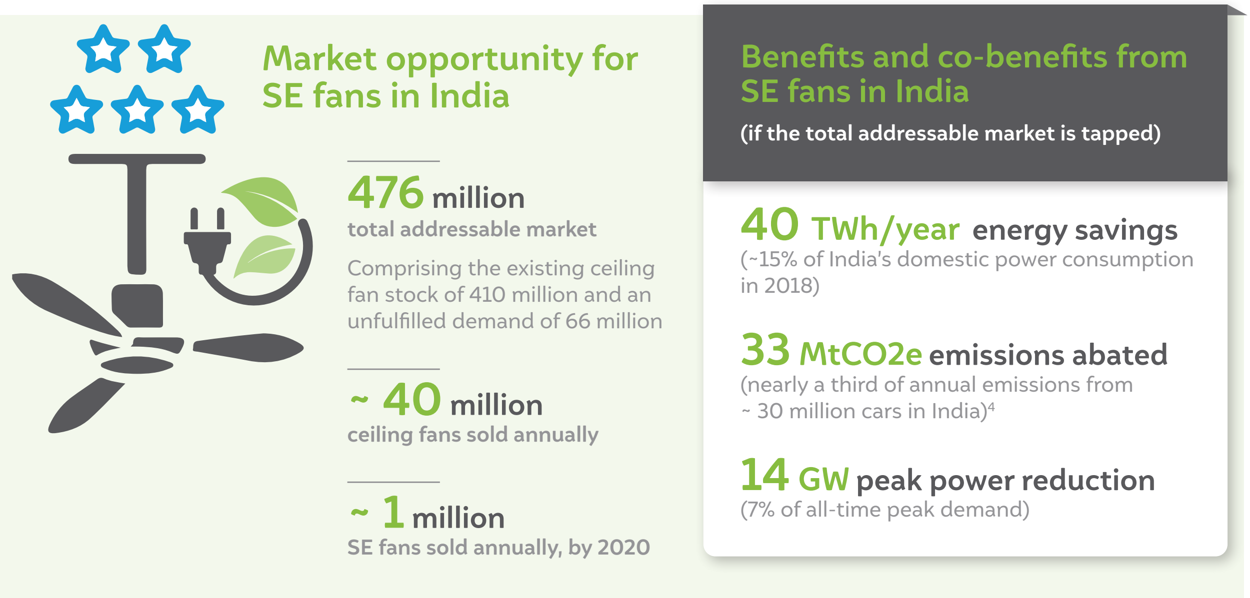
The business case for super-efficient ceiling fans

Conventional fans use induction motors and consume about 75 W at top speed. Super-efficient (SE) fans, using brushless direct current (BLDC) motors and improved fan blade design, use 28-35 W at top speed. Manufacturers of these fans in India include newer players such as Atomberg, Halonix Technologies, Oceco and Ram Ratna Electricals, as well as incumbents in the fan industry such as Havells, Orient Electric, Crompton and Usha.

Of the 90 per cent of Indian households using ceiling fans, only 3 per cent use energy-efficient variants (Agrawal, Mani, Aggarwal, et al. 2020). As per CEEW's India Residential Energy Survey (IRES), the adoption of energy-efficient fans, though low, is concentrated in large urban centres like Delhi and Mumbai, and among higher-income households. In India, ~40 million ceiling fans are sold annually, of which less than three per cent currently comprise SE models. This puts the potential annual market for SE fans at INR 12,000 crore

(~USD 1.64 billion).[1] The total addressable market for SE fans in India's residential sector stood at an estimated 476 million (~INR 1,42,800 crore or USD 20 billion) as of 2020.[2] This includes 410 million ceiling fans already in use in households and an unfulfilled demand of 66 million.[3] Figure ES1 illustrates the direct and positive spill over effects from scaling up SE fans in India.

Figure ES1 India presents a huge opportunity for energy and emissions savings through SE fans



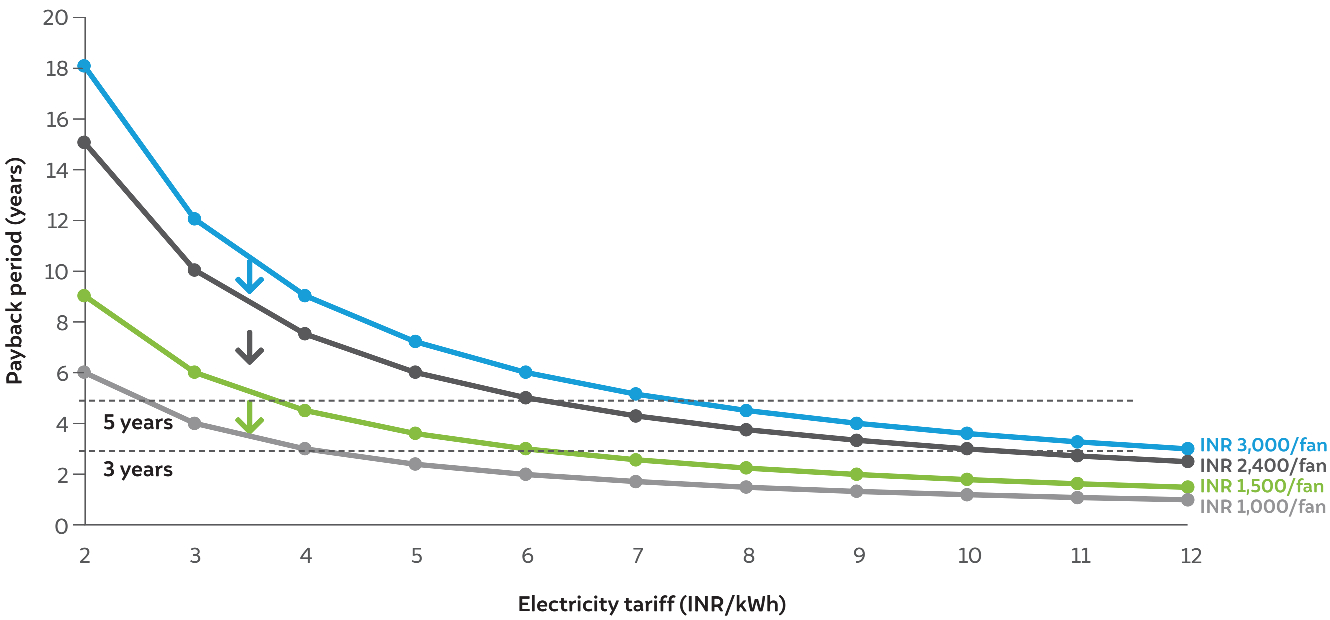
Source: Authors' analysis based on Agrawal, Shalu, Sunil Mani, Karthik Ganesan, Abhishek Jain, and Johannes Urpelainen. 2020. "India Residential Energy Survey (IRES) 2020 Data." New Delhi: Council for Energy, Environment and Water; Frost & Sullivan (2018) and stakeholder interactions.

The monetary savings accrued through energy savings are shared between the consumers, the discom, and the state government, depending on the tariff structure in vogue in each state. For example, in Uttar Pradesh (UP), rural domestic consumers and those below a "lifeline" consumption threshold receive tariff subsidy from the state government, over and above an implicit cross-subsidy.[5] As per our estimations, replacing one conventional ceiling fan with an SE fan in all of the domestic consumers' home could save INR 1,573 crore (USD 215 million) in subsidies for the state government and INR 270 crore (USD 37 million) in cross-subsidies for the state's discoms.

1. At an average price of INR 3,000 (USD 41) per fan.
2. At an average price of INR 3,000 (USD 41) per fan. We use fan ownership rates from the IRES to estimate the total addressable market (TAM). These estimates do not include demand for fans associated with the rise in housing stock due to population growth, since our focus is on near-term market potential. For readers' reference, the housing stock may potentially grow at a compounded annual growth rate of one per cent over the next decade, reflecting a potential decadal population growth rate of 10 per cent in 2021-2031.
3. Unfulfilled demand is estimated as the number of bedrooms that do not have a ceiling fan, using data from IRES.
4. Using India's grid emission factor is 0.82 tonnes CO_2 per MWh (CEA 2018). Annual emissions from cars in India in 2020 were 115 $MtCO_2e$ (Soman et al. 2020).
5. Electricity tariffs for some consumers, such as commercial and industrial consumers, are higher than the average cost of supply, while for others such as residential consumers, it is lower. This mechanism of charging higher tariffs to some consumers in order to charge lower tariffs to others is known as cross-subsidy.

By switching from a conventional to an SE fan, an average residential consumer would save ~INR 500 (USD 7) per year.[6] These savings are adequate to recover an SE fan's current average retail cost (~ INR 3,000 or USD 41) in six years, which is lower than a fan's technical life (10-15 years) but not attractive enough. The payback period is even higher for low-income consumers paying a subsidised electricity tariff, as shown in Figure ES2. SE fans currently occupy a small share of the fans market, implying untapped economies of scale. Achieving these economies would reduce fan prices, thereby improving the payback period. We observe that a drop in the retail prices of SE fans by half would make the payback period attractive (three years or less) for consumers paying INR 6 per kWh and above. Consumers paying lower tariffs would need further financial support to bring down the payback period to under three years (e.g., consumers paying INR 4 per kWh would need support of INR 500).

Figure ES2 Economies of scale could help make SE fans making attractive to most consumers



Source: Authors' analysis.

Note:

1. The coloured lines show how the payback period would change for consumers paying various power tariffs as SE fan prices reduce. The current retail price is around INR 3,000 (USD 41), while the price discovered in EESL's latest bulk procurement rounds is INR 2,400 (USD 33). SE fans would be competitive with conventional fans at INR 1,000 – 1,500 (USD 14-21).
2. "Delhi" refers to the National Capital Territory of Delhi.
3. Tariff ranges vary among Indian states. For example, in Uttar Pradesh they are in the range of INR 3-7 per kWh, while in Maharashtra they are INR 1.12-11.71 per kWh.

Barriers to scale-up of SE fans

Under the *Unnat Jyoti by Affordable LED for All* (UJALA) programme implemented by the Energy Efficiency Services Limited (EESL), nearly 370 million LED bulbs have been distributed across India since 2015 (MoP 2021). However, efforts to distribute energy-efficient ceiling fans (50W) under UJALA met with limited success, with uptake of only 2.4 million units (MoP 2021). More recent schemes by discoms in Delhi and Haryana have also seen subdued

6. Assuming an average electricity tariff of INR 6 per kWh and an exchange rate of USD 1 = INR 73.

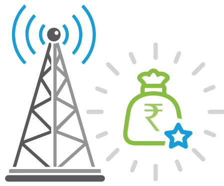
consumer interest. Our assessment of these models, based on stakeholder consultations, suggests four critical barriers to the scale-up of SE fans:

i. **Difficulty in maintaining an efficient logistics chain**: While the UJALA programme worked well for LED lamps, the ceiling fans programme faced damaged inventory during storage and transportation and leakages in revenue recovery from sales. This was due to reliance on distributors hired on an *ad hoc* basis for the programme, who were not trained in handling relatively complex appliances like ceiling fans.

ii. **Gaps in providing reliable last mile support and services**: Since consumers require deeper technical support while purchasing fans, such as an understanding of the features, installation support, repair and maintenance support, etc., the distribution channels used during UJALA were not as effective. Inadequate technical support led to a much lower sales rate, which caused the warranty period of inventory to expire before the actual sale, leading to further losses to EESL.

iii. **Lack of awareness about replacement programmes and the benefits of SE fans**: This has resulted in low uptake of discoms' own replacement schemes. Messaging channels and methods have been unable to create an organic demand among consumers for SE fans.

iv. **Lack of flexible financing options for consumers**: Previous business models have not provided financing and purchase options to end-consumers at scale. The on-bill financing (OBF) model proved too risky for demand aggregators (DAs) due to information gaps in inventory management and challenges in recovering the cost of appliances via power bills.



Financial incentives by discoms and financing options could help bridge the affordability gap

The business model for diffusion of SE fans at scale

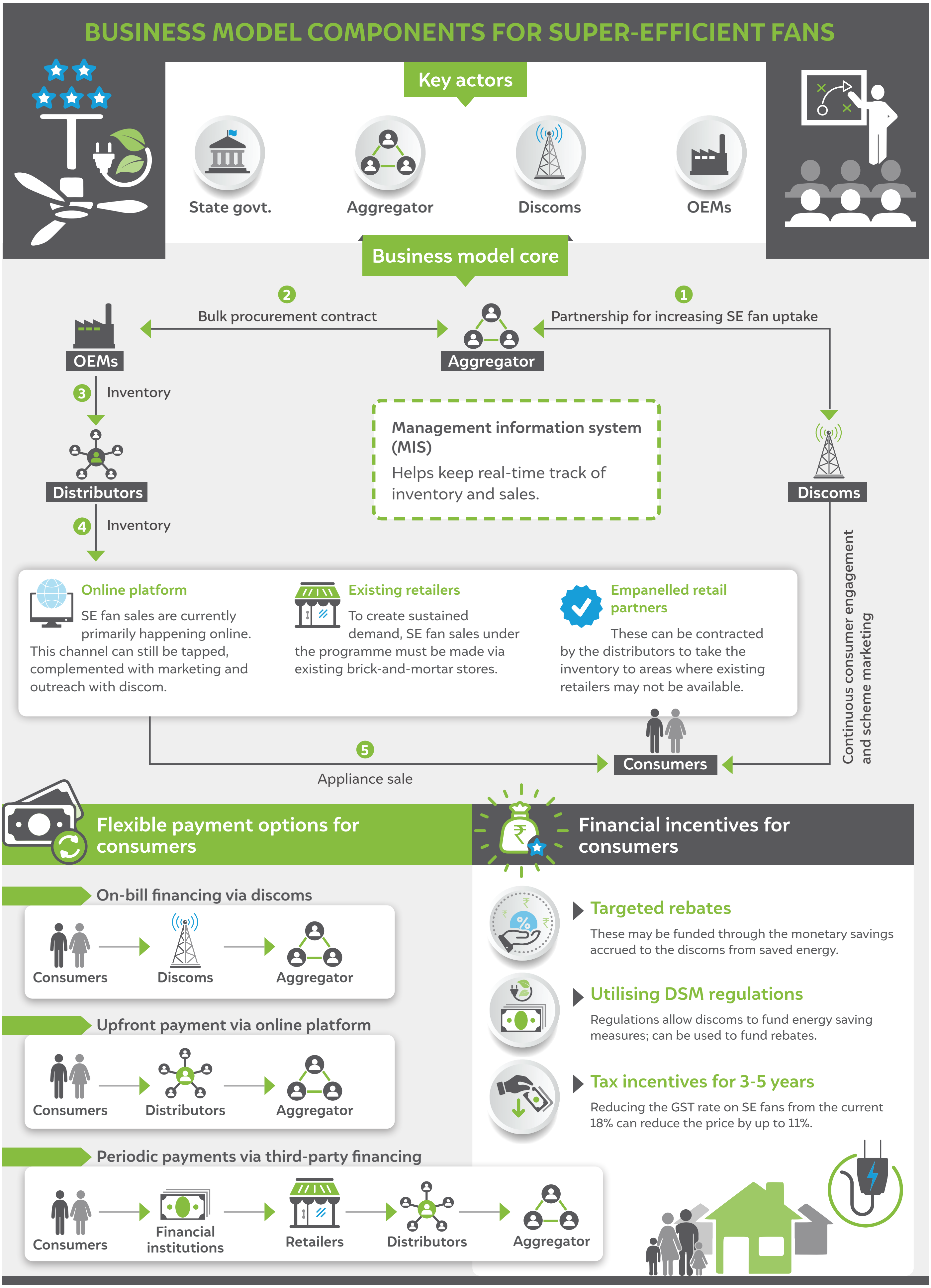
Drawing on the above insights, stakeholder consultations, a small survey of consumers in the Indian state of Uttar Pradesh and an assessment of other business models (*Cash for Coolers* programme in Mexico, and SELCO's direct-to-consumer model), we propose a business model with the following features to increase the diffusion of SE ceiling fans.

1. **Demand aggregation and bulk procurement** for rapid price reduction in the retail price of SE fans.
2. **A robust multi-channel distribution network** to ensure last mile availability and servicing of SE fans. This would primarily include a partnership between the DA and original equipment manufacturers (OEM) to leverage the latter's existing distribution and retail network. Online platforms (such as EESL Mart) can be utilised where consumers have already adopted online appliance purchases, such as in tier-1 and tier-2 cities (Pahwa et al. 2021). Fans can be sold through brick-and-mortar retail stores where distributors have established relationships with retailers. In other areas, OEMs, the DA and discoms can jointly identify and empanel strategic points of sale.
3. **A management information system (MIS)** for efficient coordination between the various actors and maintaining a transparent record of sales and inventory movement in real-time.
4. **Innovative consumer engagement strategies led by discoms and the DA** to create awareness about the programme and the product benefits among consumers, and other actors, such as retailers and local technicians.
5. **Multiple payment options** to make it easier for consumers to purchase higher-priced appliances like SE fans. These may include i) upfront payment via retailers, online platforms or channel partners, ii) OBF, enabled and managed via the MIS, and iii) third-party financing options through partnerships with microfinance institutions (MFIs) and non-banking financial companies (NBFCs).

As observed for the UJALA programme for LED lamps, it may take a few rounds of bulk procurement by the DA to bring SE fan prices well below market prices and make them affordable for low-income consumers (Chunekar et al. 2017). To manage the demand risk, the DA should initially tap the middle- to high-income consumers concentrated in urban areas and increasingly target the low-income consumer segment as the product prices drop over time. Tapping nodes of aggregate demand such as social housing schemes, commercial buildings and institutional spaces (schools, health centres, government offices) could significantly boost the bulk procurement efforts in the initial phases and help reduce prices. A parallel provision of appropriate financial incentives by discoms and financing options could help bridge the affordability gap for low-income households until market transformation is achieved. These incentives could be:

- **Rebates on purchasing SE fans**, which could be funded by monetary savings for the state discoms and governments associated with reduced energy consumption in the domestic sector. Alternatively, rebates could be financed through expenses allowed for discoms under Demand-Side Management (DSM) regulations. The model must be accompanied by a robust monitoring, reporting and verification (MRV) exercise to validate the energy (and hence, monetary) savings.
- **Lower goods and services tax (GST) on SE fan models** for a predetermined period of 2-3 years. Ceiling fans currently attract a GST rate of 18 per cent. Bringing them to the 12 per cent slab would reduce the retail price by about INR 150. Reducing the slab further to 5 per cent would reduce the retail price by another INR 180, bringing the price down to about INR 2,670 (an 11% reduction).

Image: Dhruvak Aggarwal/CEEW



BUSINESS MODEL COMPONENTS FOR SUPER-EFFICIENT FANS
Key actors
State govt.
Aggregator
Discoms
OEMs
Business model core
2 Bulk procurement contract
1 Partnership for increasing SE fan uptake
OEMs
Aggregator
3 Inventory
Distributors
Management information system (MIS)
Helps keep real-time track of inventory and sales.
Discoms
4 Inventory
Continuous consumer engagement and scheme marketing
Online platform
SE fan sales are currently primarily happening online. This channel can still be tapped, complemented with marketing and outreach with discom.
Existing retailers
To create sustained demand, SE fan sales under the programme must be made via existing brick-and-mortar stores.
Empanelled retail partners
These can be contracted by the distributors to take the inventory to areas where existing retailers may not be available.
5 Appliance sale
Consumers
Flexible payment options for consumers
On-bill financing via discoms
Consumers
Discoms
Aggregator
Upfront payment via online platform
Consumers
Distributors
Aggregator
Periodic payments via third-party financing
Consumers
Financial institutions
Retailers
Distributors
Aggregator
Financial incentives for consumers
Targeted rebates
These may be funded through the monetary savings accrued to the discoms from saved energy.
Utilising DSM regulations
Regulations allow discoms to fund energy saving measures; can be used to fund rebates.
Tax incentives for 3-5 years
Reducing the GST rate on SE fans from the current 18% can reduce the price by up to 11%.

The proposed business model can be extended to other commonly used appliances (such as lights, TVs), though with changes based on product characteristics, the extent of market transformation, and supply chain cost structure. Scaling up super-efficient appliances can have spillover effects beyond the electricity value chain and it can give a boost to the domestic manufacturing industry, associated high-skilled jobs, and economic value addition. Insights and the model proposed in this study could be adopted by other developing countries facing similar aspirations and constraints to devise their own energy-efficiency interventions. Besides energy and emissions savings, such interventions would enhance living standards by enabling access to reliable energy services at lower costs.

Super-efficient ceiling fans consume half as much energy as conventional ceiling fans.

Image: Dhruvak Aggarwal/CEEW

1. Study motivation

In a climate-constrained world, energy efficiency can be an effective compass to identify solutions that could yield carbon, energy, and resource savings. The International Energy Agency (IEA) projects that 40 per cent of the emissions cuts required to reach global climate goals would come from energy efficiency (Fischer 2021). In developing countries like India, energy efficiency is much more than a climate imperative and can unlock diverse developmental opportunities.

Energy efficiency can ameliorate discoms' disincentive to enhance reliability of supply in areas with low revenue recovery

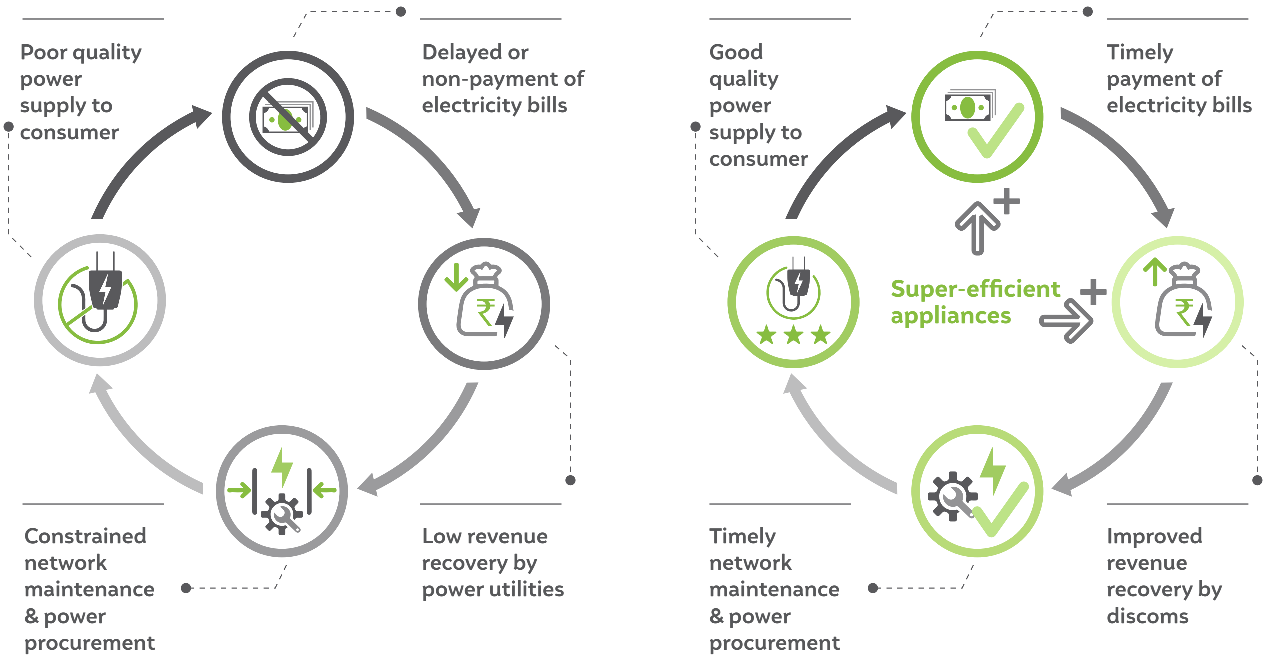
1.1 Energy efficiency as an enabler of energy access

India has seen tremendous progress in enabling energy access to its vast population over the past two decades. As per IRES, 97.6 per cent of Indian homes are connected to the grid as of April 2020 (Agrawal, Mani, Jain, et al. 2020). However, electrification is a necessary but not sufficient condition for meaningful energy access. As per the survey, an average Indian home receives a daily power supply for 20.6 hours, with an even lower supply duration noted in rural areas of states like Bihar, Haryana, Jharkhand, and Uttar Pradesh (Agrawal, Mani, Jain, et al. 2020). Further, about a fifth of the households reportedly face low voltage supply and voltage fluctuations, with a higher incidence in rural areas.

These access gaps can be partly explained by the lack of financial incentives for discoms to ensure reliable electricity supply in areas with low revenue recovery, typically those with a higher share of low-income consumers (Aklin et al. 2016; Phadke et al. 2019). In the fiscal year (FY) 2019-20 alone, discoms in India reported an aggregate technical and commercial (AT&C) loss of 21 per cent linked to gaps in energy billing and poor revenue collection efficiency (Power Finance Corporation 2021). Delayed or non-payment of electricity bills by residential consumers, who find the electricity bills unaffordable, could account for a significant share of discoms' losses across Indian states (Balani et al. 2020). When constrained by inadequate revenue recovery, discoms lack the incentive to strengthen the electricity distribution network or procure adequate power to service such consumers. As a result, a vicious cycle of low payment rates and low revenue recovery keeps many households deprived of reliable electricity services (Figure 1).

One way of ameliorating this disincentive is to enhance the efficiency of energy use, particularly among low-income consumers. This would allow consumers access to similar levels of end-use services while lowering the energy bills, which could potentially improve payment behaviour. Further, this would help reduce financial losses for discoms and subsidy burden on state governments (Phadke et al. 2019). The saved financial resources could then be redeployed by the discoms towards improving the reliability of power supply.

Figure 1 Super-efficient appliances can upturn the vicious cycle of low revenue recovery and poor-quality supply



Source: Authors' analysis

1.2 Uptake of energy-efficient appliances in India

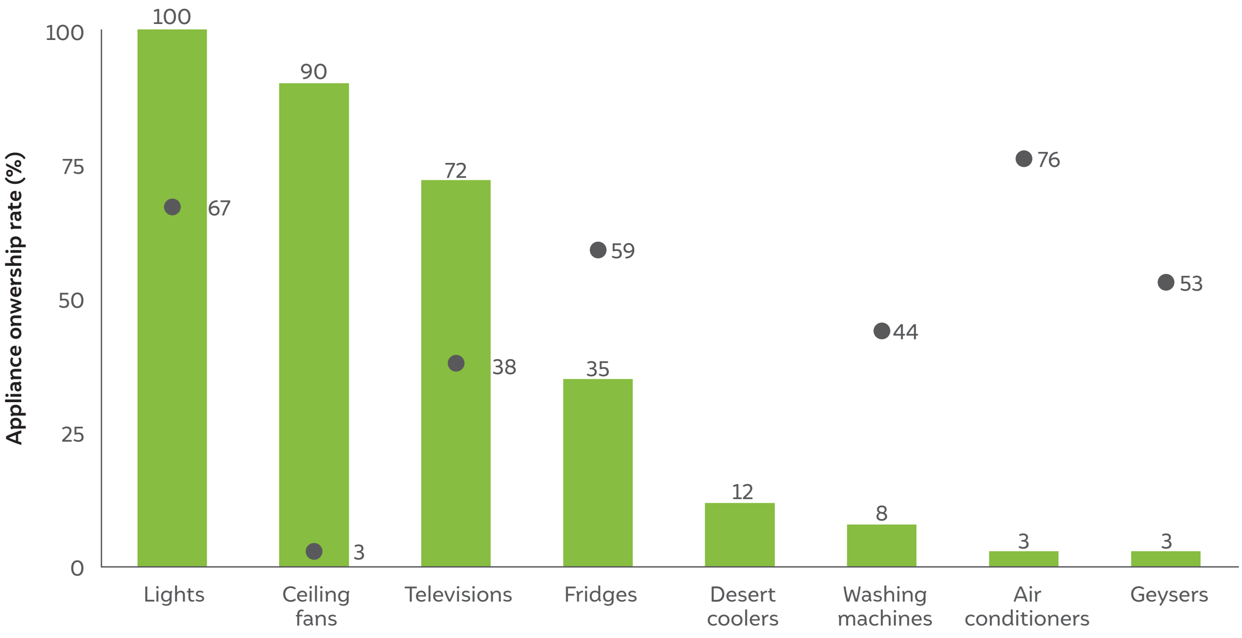
As per IRES data, a majority of electrified Indian homes use only basic appliances like lights, fans, and televisions (TV), with moderate-low ownership of other appliances (Figure 2). Studies show that lights, fans, and TVs account for more than half of the total residential electricity demand in India (Ali 2018; Kaul et al. 2020). They form an even greater share of the household electricity consumption pie (~80 per cent) among low-income households (Kaul et al. 2020).

However, a significant proportion of the current stock of lights, fans, and TVs comprises of inefficient technology (Figure 2). While energy-efficient light-emitting diodes (LEDs) now comprise two-thirds of lighting stock in Indian homes, incandescent bulbs and tubular fluorescent lamps still account for 13 per cent and 5 per cent of total stock, respectively (Agrawal, Mani, Aggarwal, et al. 2020). In the case of TVs, inefficient cathode-ray tube (CRT) models still comprise 40 per cent of the total stock, even though the market has moved away from CRT technology.

The most striking case is that of ceiling fans. Despite being under a voluntary energy labelling programme for more than a decade, only three per cent of households report using star-labelled (i.e., efficient) ceiling fans across India.[7] More importantly, the demand for these essential appliances is far from saturated, judging by their market sizes (IBEF 2020).

7. India's Bureau of Energy Efficiency (BEE) launched the Standards and Labelling (S&L) programme in 2006 to provide consumers information on energy performance of appliances (through star labels) available in the market and to facilitate uptake of energy-efficient products.

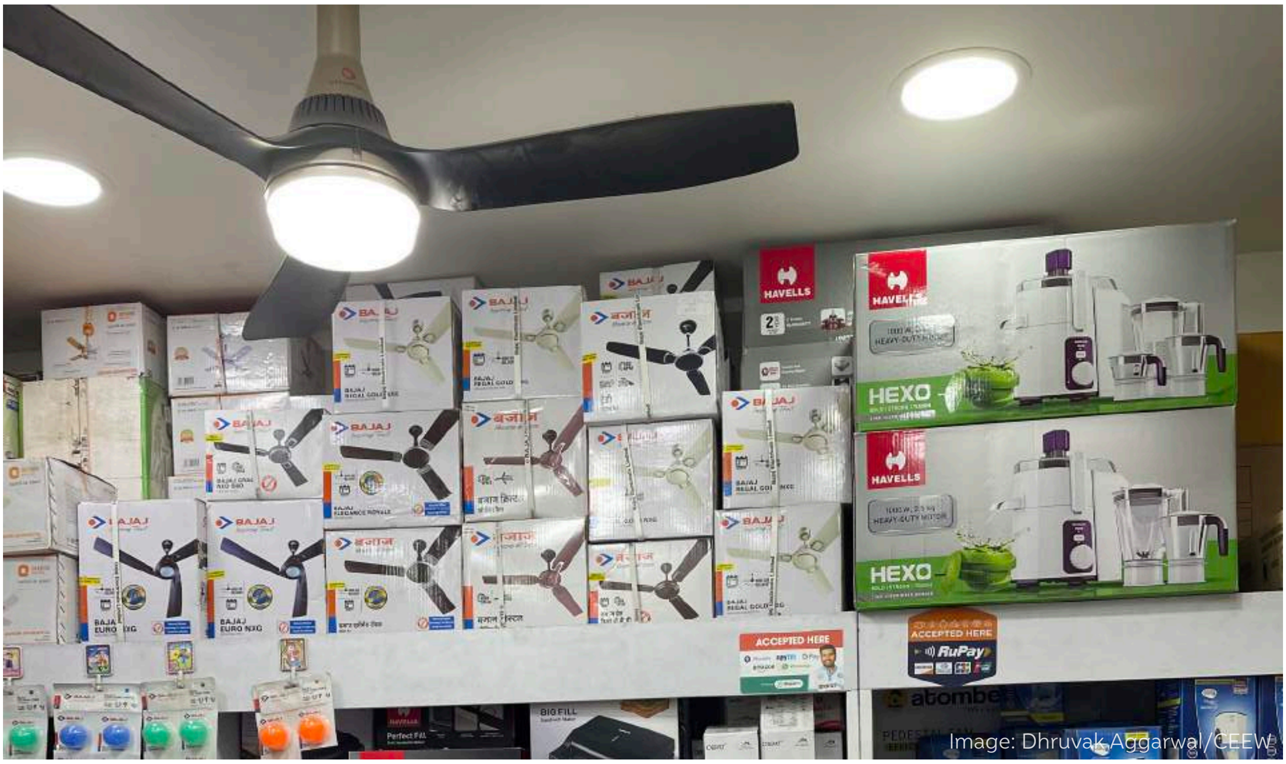
Figure 2 **There is a huge scope to promote super-efficient appliances, particularly ceiling fans, in India**



Source: Authors' adaptation from Agrawal, Shalu, Sunil Mani, Dhruvak Aggarwal, Chetna Hareesh Kumar, Abhishek Jain, and Karthik Ganesan. 2020. "Awareness and Adoption of Energy Efficiency in Indian Homes: Insights from the India Residential Energy Survey (IRES 2020)." New Delhi: Council for Energy, Environment and Water.

Note:

1. Ownership rates of washing machines, air conditioners and geysers are somewhat conservative due to higher non-response from well-to-do households during the survey. We estimate the share of energy-efficient appliances based on household response to whether a given appliance is star-labelled.
2. Desert coolers do not fall under BEE's S&L programme as of February 2022.



Stock of ceiling fans in a multi-appliance retail outlet in Lucknow, Uttar Pradesh.

1.3 Study objectives

The above discussion indicates vast scope for energy and associated cost savings by promoting the adoption of energy-efficient appliances, particularly lights, fans, and TVs which form the bulk of the appliance inventory in India. However, a host of challenges hold back consumers from actively choosing these over conventional models (Chillayil and Kottayil 2021). These challenges are most apparent in the case of ceiling fans, which have seen limited supply and uptake of efficient products (see Box 1).

BOX 1 Barriers to the uptake of super-efficient appliances, including fans

High upfront cost: The Indian fan market is divided into segments based on retail prices: 'economy' (less than INR 1,500 or USD 20), 'standard' (INR 1,500 – 2,499) and 'premium' (more than INR 2,500 or USD 34). SE fans are currently priced at about INR 3,000, falling in the premium segment, while the economy and standard segments comprise 50-60 per cent of the market (Frost & Sullivan 2018). The higher cost of SE appliances, including fans, is the primary barrier to their uptake (Agrawal, Mani, Aggarwal, et al. 2020).

Information asymmetry: Only about a quarter of Indian households are aware of BEE's star labels that help consumers distinguish appliances by their efficiency (Agrawal, Mani, Aggarwal, et al. 2020). Energy labelling of ceiling fans is voluntary, which means conventional models (without any label) are also allowed in the market. Hence, consumers lack adequate signals about making informed decisions based on the energy performance of fans.

Limited availability in the market: Households often cite unavailability at the local retail shops as a reason for not purchasing energy-efficient appliances (KPMG et al. 2018). This may be partially explained by the limited focus of smaller fan manufacturers on the energy-efficient models due to higher input costs and the absence of minimum performance standards (Agrawal, Mani, Aggarwal, et al. 2020). Further, due to their higher price tag, uncertain demand from consumers, limited awareness and scepticism about the benefits of these appliances, retailers often do not prefer to stock these appliances.

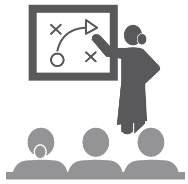
Inadequate access to finance: A notable share of low-income households is willing to take credit to purchase appliances such as ceiling fans and TVs than higher-income households (Agrawal, Mani, Aggarwal, et al. 2020). However, access to financial services for making these purchases is restricted among low-income households due to the absence of collateral and credit history, and variable incomes (Ravi 2019).

Ceiling fans (also referred to as just "fans" interchangeably in this report) have remained in the voluntary Standards and Labelling (S&L) programme since 2009, and until September 2019, covered only the 1200 mm sweep size (Abhyankar et al. 2017; BEE 2019), leading to a slow market transformation towards higher efficiency. Technological developments in the motor and fan blade design have improved ceiling fan efficiency significantly. Fans rated at about 50 W at top speed, using conventional induction motors, were rated 5-star until 2019 and 1- or 2-star from September 2019 onwards (BEE 2009; Shah et al. 2015; BEE 2019). In comparison, commercially available fans using BLDC motors consume anywhere between 28 – 35 W and are rated 5-star as per BEE's latest rating schedule. However, the market share of these SE fans is currently minuscule, underscoring the need for interventions to unlock the market potential of this technology.

Through a deep dive on ceiling fans, this study:

Investigates the business case for scaling up SE fans in India,

Proposes a demand-side business model that can help the SE fans market to break out of the current low equilibrium of demand and supply, and



Discusses strategies to target such interventions towards low-income consumers, which would have positive spillover effects on the discoms' financial health and their ability to provide quality electricity services.

It is worth highlighting that this study only focuses on a demand-side business model for scaling up SE fans. Creating a sustainable industry around this new technology would require complementary efforts to strengthen the manufacturing supply chain of components and the final product as well as technology and industrial policy interventions (Kamat et al. 2020).

The rest of the report is organised as follows. Chapter 2 discusses the business case for SE ceiling fans. Chapter 3 highlights the experience of past business models in scaling up SE appliances and relevant lessons for this work. Chapter 4 proposes a business model and associated interventions that could help scale up SE fans in India. Chapter 5 concludes.

Ceiling fans consume about a quarter of an average household's total electricity consumption.

Image: iStock

2. The business case for SE fans

Conventional fans use induction motors and consume about 75 W at top speed. Super-efficient (SE) fans, using BLDC motors and improved fan blade design, use 28-35 W at top speed. Manufacturers of these fans in India include both newer players such as Atomberg, Halonix Technologies, Oceco and Ram Ratna Electricals as well as traditional players such as Havells, Orient Electric, Crompton and Usha.

Presently, SE fans comprise less than 3% of ceiling fans market

The market for SE ceiling fans is currently grossly underpenetrated, and a massive business opportunity lies in tapping this market. Adoption is much higher in urban centres such as Delhi, Mumbai, Gurdaspur, Ajmer, and among higher-income households. This chapter assesses the business case for expanding the uptake of SE fans by shedding light on the market potential, benefits, and co-benefits of scaling up SE fans in India. It also provides a granular assessment of payback periods for consumers and the distribution of savings across stakeholders for select Indian states.

2.1 Market opportunity

We estimate that the total addressable market for SE ceiling fans in India is about 476 million (~INR 1,42,800 crore or USD 20 billion).[8] We define the addressable market as the total potential demand for SE ceiling fans in the residential sector, comprising of: i) the entire existing stock of ceiling fans (potential replacement purchases) of about 410 million, and ii) the unfulfilled demand (potential first-time purchases) of about 66 million.[9] These estimates are based on primary data from IRES, a nationally representative survey of 14,580 households in India (Agrawal, Mani, Ganesan, et al. 2020).[10]

The serviceable available market is substantially smaller than the addressable market, at ~40 million fans (Figure 3). This is the number of ceiling fans sold annually in India. Even though the Indian fan market was expected to grow rapidly after FY 2016-17, by the end of FY 2020-21, the industry was set to contract by 12-15 per cent due to the impact of COVID-19

8. At an average price of INR 3,000 (USD 41) per fan.

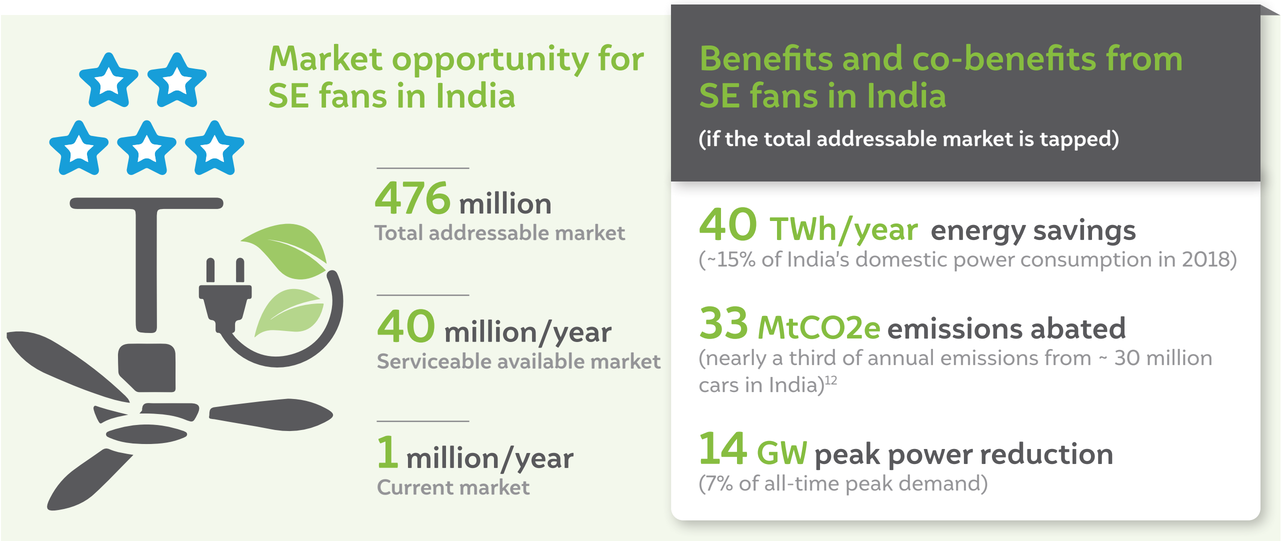
9. Our estimates of the total addressable market do not include demand for fans associated with the rise in housing stock due to population growth, since our focus is on market potential in the near term. For readers' reference, the housing stock may potentially grow at a compounded annual growth rate of one per cent over the next decade, reflecting a potential decadal population growth rate of 10 per cent in 2021-2031.

10. To estimate the existing ceiling fan stock, we multiply the fan ownership rates from IRES with the number of domestic power consumers (households) in each state. We estimate the unfulfilled demand for ceiling fans as the difference between the total number of bedrooms in a household, and the total number of ceiling fans used by the household, wherever this difference is positive. This follows from the assumption that each bedroom must have at least one ceiling fan in a tropical country like India. We do not consider the growth in demand for fans in the commercial and industrial sectors. The India Cooling Action Plan (ICAP) projects a ceiling fan stock of 600-700 million by 2027-28 (MoEFCC 2019). A large part of this growth may be in the commercial and industrial sectors.

(Business Line 2021). This puts the ceiling fans market in FY 2020-21 at roughly the same size as FY 2016-17, at about INR 7,000 crore (~ USD 960 million) (Frost & Sullivan 2018), and the potential annual market for SE fans at INR 12,000 crore (USD 1.64 billion).

However, the star-labelled ceiling fans comprise just 9 per cent of annual ceiling fan sales (Mathew et al. 2019). Of this, the share of the SE ceiling fans is even smaller, with roughly 1 million units being sold annually.[11] The current market is much smaller than the serviceable market due to challenges highlighted in Box 1, indicating that a large market can be tapped through innovative business models which overcome these barriers.

Figure 3 India presents a huge opportunity for energy and emissions savings through SE fans



Source: Authors' analysis based on Agrawal, Shalu, Sunil Mani, Karthik Ganesan, Abhishek Jain, and Johannes Urpelainen. 2020. "India Residential Energy Survey (IRES) 2020 Data." New Delhi: Council for Energy, Environment and Water.; Frost & Sullivan (2018), and stakeholder interactions.

2.2 Benefits and co-benefits

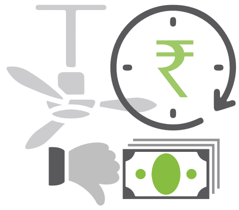
The primary benefits of SE fans are energy savings and the resultant monetary savings. Our analysis shows an annual energy saving potential of nearly 40 terawatt-hours (TWh) of electricity if the entire addressable market is tapped.[13] This is equivalent to about 15 per cent of India's residential electricity consumption of 274 TWh in FY 2017-18 (MoP 2019). A detailed methodology of this estimation is given in Annexure 1.

11. As per conversations with industry stakeholders.

12. Annual emissions from cars in India in 2020 were 115 $MtCO_2e$ (Soman et al. 2020).

13. We use data on state-wise fan usage patterns from IRES, and the assumption that a conventional fan consumes 75 W at top speed, while an SE fan consumes 32 W. Our estimate diverges from earlier estimates of energy savings from fans, such as by Abhyankar et al. (2017), primarily due to different assumptions of size of existing stock and annual hours of usage of fans. We assume a national average consumption pattern of 8 hours daily for 8 months in a year. For state-specific usage pattern, see Annexure 1.

There are also substantial co-benefits associated with energy savings, including deferment of investments in energy generation capacity, required to service increasing energy demand, and emissions mitigation due to lower energy requirements. Concomitant with the potential annual energy saving of 40 TWh, the emissions mitigation potential from replacing all non-SE fans is about 33 million tonnes CO_2 equivalent ($MtCO_2e$) per year.[14] Further, assuming a peak co-incidence factor of 0.7 (Abhyankar et al. 2017), ensuring that the entire ceiling fan stock comprises SE models would also free up nearly 14 GW of generation capacity required during peak demand periods. While these estimates of potential energy savings, avoided emissions and peak demand reduction would only be realised over time, they demonstrate the scale of benefits that India can tap into by transforming its fans market.



The payback period for SE fans at current prices is not attractive enough

2.3 The business case

At the current retail price, the payback period of an SE fan is not attractive enough. The use of a 32 W SE fan in place of the conventional 75 W fan for 8 hours a day for 8 months would save a consumer 83 kWh per year. At an average electricity tariff of INR 6 per kWh (USD 0.08) for domestic consumption, the switch from conventional to SE fans would yield an annual cost saving of about INR 500 (~ USD 7) per year.

A consumer looking to buy a new fan, either as a first-time purchase or to replace an existing fan at the end of its useful life, would incur an incremental cost of about INR 2,000 (USD 27) in buying an SE fan. This is assuming that the default purchase would have been a conventional fan priced at INR 1,000 (USD 14). The incremental cost would be recovered over four years with the savings from the SE fan. On the other hand, for a consumer looking to replace an existing fan before the end of its useful life, we compare the savings with the full retail cost of an SE fan (INR 3,000 or USD 41), which would be recoverable via the savings over six years. After the payback period, consumers would earn pure savings for the rest of the fan's technical life. Depending on the nature of the purchase and assuming a minimum life of 10 years, this would be INR 2,000 – 3,000.

Although payback periods of four and six years are lower than a fan's technical life, they are not attractive enough from a consumer perspective. For low-income consumers paying a subsidised electricity tariff, the payback period is even higher, as shown in Figure 4.[15]

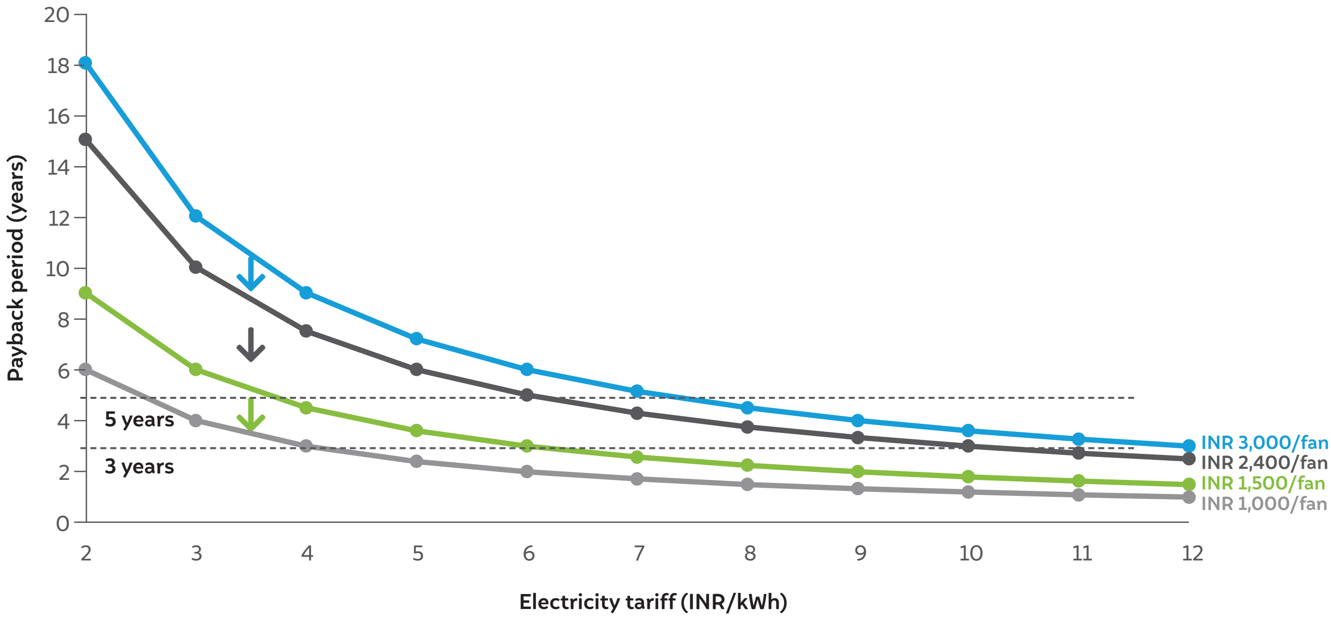
An intervention to bring down the price of SE fans through demand aggregation and bulk procurement could make the payback period attractive. Figure 5 demonstrates that SE fan prices would have to come down by half to make the payback period attractive (3 years or less) for consumers paying INR 6 per kWh and above.[16] Consumers paying lower tariffs may need further financial support to switch to SE fans.

14. Using India's grid emission factor is 0.82 tonnes CO_2 per MWh (CEA 2018).

15. Electricity tariffs in India are telescopic, implying a higher electricity charge for higher consumption (divided into slabs on a volumetric basis). This means that consumers in the lower consumption slab in a month face lower average tariff per kWh, which is either cross-subsidised by other consumers of the same discom or explicitly subsidised by the state government, or both.

16. Here we assume an average usage of 8 hours per day for 8 months annually, from IRES, which would save 83 kWh/year.

Figure 4 **There is a need for interventions to reduce the price of SE fans and make the payback period attractive for consumers**



Source: Authors' analysis.

Note:

1. The coloured lines show how the payback period would change for consumers paying various power tariffs as SE fan prices reduce. The current retail price is around INR 3,000 (USD 41), while the price discovered in EESL's latest bulk procurement rounds is INR 2,400 (USD 33). SE fans would be competitive with conventional fans at INR 1,000 – 1,500 (USD 14-21).
2. "Delhi" refers to the National Capital Territory of Delhi.
3. Tariff ranges vary among Indian states. For example, in Uttar Pradesh they are in the range of INR 3-7 per kWh, while in Maharashtra they are INR 1.12-11.71 per kWh.

Such financial support could come from the subsidy and cross-subsidy savings to the state governments and discoms from an energy efficiency programme. That is because the cost of electricity supplied to domestic consumers is recovered through multiple components: the effective tariff paid by consumers, cross-subsidy provided as part of the tariff by discoms, and in some cases, tariff subsidy provided by the state governments. Thus, for each kWh of energy saved, the consumers would save the per kWh tariff of the consumption slab in which they fall; the discom would earn an amount equivalent to the cross-subsidy, and the state government would save the subsidy amount, if any.

Consequently, the quantum of monetary benefit to each stakeholder depends on the tariff structure in vogue in each state. Using a sample of five states, Table 1 shows that financial savings from each unit of energy saved in the lowest tariff slab for discoms and state governments are more than for energy saved in the highest tariff slab (see Annexure 1 for methodology). However, this is not true for urban consumers in Bihar and Uttar Pradesh. Further, in some states, discoms may lose revenue for each unit of energy saved by a high-paying consumer.

Table 1 **Financial savings from energy efficiency for the discoms and state governments are higher at the lowest energy consumption slab**

	Financial savings at the lowest consumption slab (INR/kWh)			Financial savings at the highest consumption slab (INR/kWh)		
	Discoms	State govt.	Consumers	Discoms	State govt.	Consumers
Bihar	1.82	3.98	2.12	-0.13	1.83	6.22
Delhi	4.27	3.20	0	0.62	Nil	8.00
Maharashtra	5.83	Nil	1.12	-4.76	Nil	11.71
Odisha	1.90	Nil	0	-0.48	Nil	6.20
Uttar Pradesh	0.19	3.15	3.00	-0.49	Nil	7.00

Source: Authors' analysis based on state-wise tariff structures.

Notes:

1. Negative numbers imply the concerned actor would incur a net loss with every unit of energy saved.

2. Odisha and Maharashtra state governments do not provide tariff subsidy to domestic consumers.

3. Consumers in the lowest slabs in Delhi and Odisha do not pay any energy charges.

Table 1 also reveals that incentives to invest in SE fans are split both horizontally (between consumers, discoms, and state governments) as well as vertically (within the residential consumer segment). Discoms stand to benefit more from enhanced energy efficiency in those segments where the consumers face lower incentives to save energy. Thus, discoms and state governments could share part of their savings from energy efficiency with the consumers in the lower consumption slab, which would incentivise the latter to adopt efficient appliances. Box 2 illustrates the quantum of these savings, using the case study of the Uttar Pradesh state.

In summary, our analysis illustrates that the case for scaling up SE fans in India is strong. However, at the current market price, the payback period of investing in an SE fan would not be attractive for consumers paying subsidised electricity tariffs. There is a need for a business model that could create both supply push and demand pull by bringing down technology prices and enabling large-scale distribution of SE fans to make these accessible and affordable for a majority of consumers.

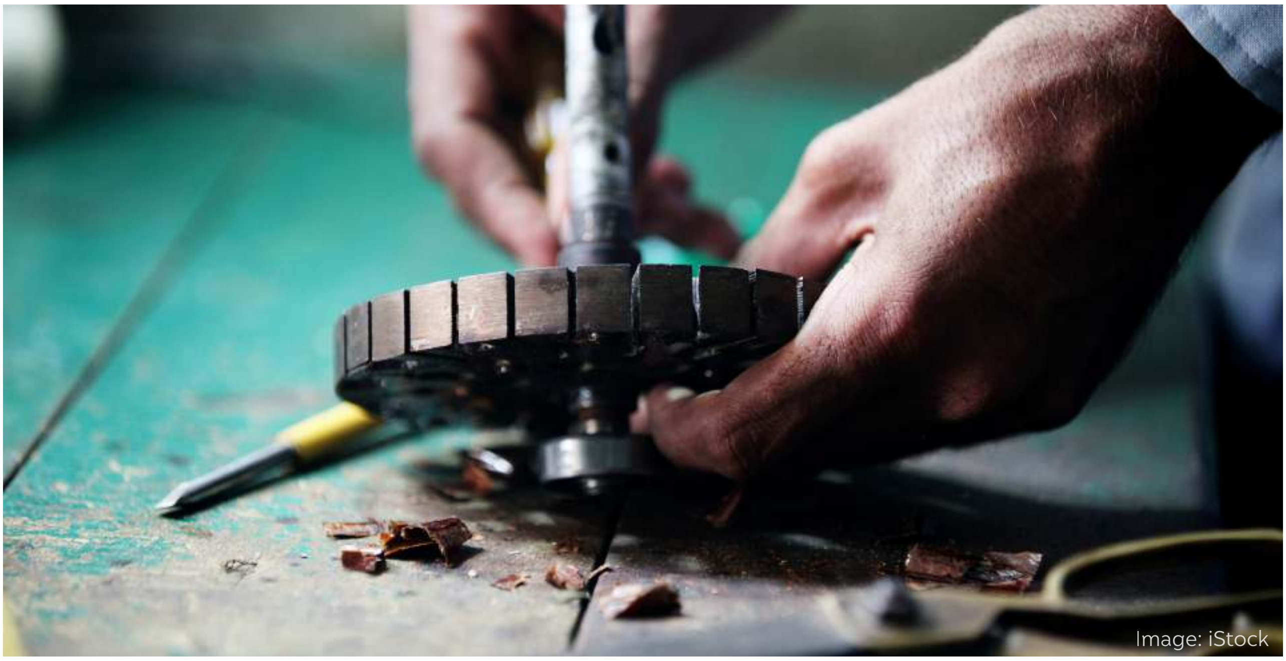
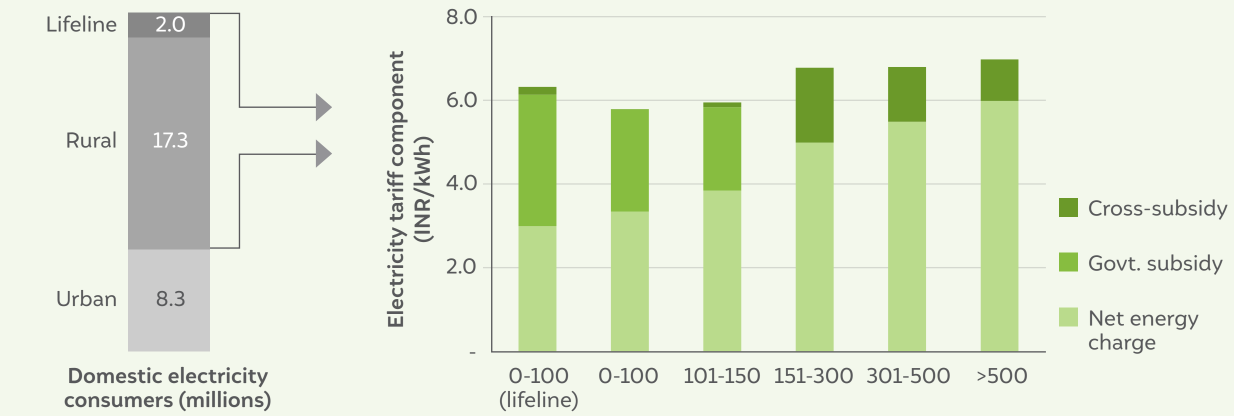


Image: iStock

BOX 2 Energy and cost savings from SE fans: the case of Uttar Pradesh

Uttar Pradesh (UP), a northern Indian state, has the country's largest domestic consumer base of 27.5 million. Of these, 30 per cent are urban consumers, while the remaining are in rural areas or consumers categorised as "lifeline" connections. Both rural and lifeline consumers receive significant tariff support in the form of direct government subsidy and cross-subsidy (Figure 5). In contrast, urban consumers pay energy charges upwards of INR 5.5 per kWh.

Figure 5 The rural and lifeline consumers in UP receive a significant subsidy and cross-subsidy support



Source: CEEW analysis based on data from UP tariff order for FY 2021-22

A state-wide intervention to replace one conventional fan in each home with an SE fan could help the state lower its annual energy demand by about 2,300 GWh, or ~5.4 per cent. This, in turn, would significantly mitigate carbon emissions and help lower the state's peak power demand by 830 MW, or ~3.5 per cent. More importantly, this would yield significant subsidy and cross-subsidy savings for the state government and discoms, respectively (Figure 6). Besides, lower electricity bills due to the intervention could also help consumers pay their bills on time, leading to improved revenue recovery, which is currently about 25 per cent in rural UP. Discoms would need to take supplementary steps to improve billing and collection practices in order to capture these benefits. In fact, the estimated subsidy savings over a five-year period would be enough to provide 50 per cent discount on SE fans for the currently subsidised consumers (~16 million), assuming that bulk procurement at this scale brings down the SE fan prices by a quarter.

Figure 6 Besides significant energy and emissions savings, UP can substantially reduce its subsidy burden through SE fans

Energy and emissions savings if all domestic consumers replaced a conventional fan with SE fan in UP	Benefits over 5 years if all lifeline and rural domestic consumers replaced a conventional fan with SE fan in UP
~2,300 GWh/year **Energy savings (5.4% of annual domestic sales)**	INR 15,730 million (USD 215 million) **Reduced subsidy burden for state government**
~1.87 MtCO2eq/year **Emissions avoided**	INR 2,700 million (USD 37 million) **Saved cross-subsidy revenue for discoms**
830 MW **Potential peak demand reduction (3.5% of state's peak demand)** (assuming a coincidence factor of 0.7)	INR 7,540 million (USD 103 million) **Reduced losses due to improved revenue recovery** (assuming recovery increases to 50 per cent)

Source: CEEW analysis based on data from IRES 2020 and UP tariff order for FY 2021-22

Thus, discoms and the state government could invest part of these expected savings as discounts on SE fans for consumers paying subsidised tariffs (~57 per cent of all domestic consumers), to incentivise their uptake. At INR 2,400 per fan, it would cost about INR 1,900 crore (USD 260 million) to provide a 50 per cent discount to these consumers. The ratio of this cost to the benefits accrued to the discoms and the state government over 10 years (technical life of SE fans) is 0.5, indicating that over the technical life of the fans, the benefits are twice as much as the cost. Other states could similarly design incentives for SE fans and other appliances based on the expected monetary benefits.

3. Lessons from national and international experiences

Image: iStock

Several attempts have been made in the past to scale up super-efficient appliances. In this section, we discuss the experience of four popular business models from India and elsewhere to derive key lessons that could be relevant for devising the scaling-up strategy for SE fans. We also discuss consumer perception about adopting SE fans, drawing on a small primary survey.

3.1 What can we learn from past business models?

We reviewed four business models/interventions designed to address the key barriers to increased uptake of energy-efficient appliances (see Figure 7 for key features). These are:

I. the UJALA programme implemented by EESL since 2015 in India,[17]

II. the fan replacement programmes implemented by discoms in Delhi, Mumbai, the state of Haryana,

III. *Cash for Coolers*, a World Bank-backed air conditioner (AC) and refrigerator replacement programme implemented in Mexico between 2010 and 2014, and

IV. the business model of SELCO India, an off-grid solar lighting solutions company.

Figure 7 Business models implemented so far have tried to address challenges using various tools

	Unnat Jyoti by Affordable LED for All (UJALA) (2015-present)	Discoms' fan programmes (2019-2022)	*Cash for Coolers* programme in Mexico (2009-2012)	SELCO's direct-to-consumer model (1995-present)
Focus appliance(s)	LED lamps, ceiling fans	Ceiling fans	ACs, refrigerators	Solar lighting systems
Key actor	EESL (super-ESCO)	Discom	Secretariat of Energy, Government of Mexico	SELCO India (private entity)
Price reduction strategy	Demand aggregation	Demand aggregation without physical procurement + rebate on upfront cost by discom	Targeted subsidy	No price reduction
Retail channels	EESL kiosks at discom offices, post offices, petrol pumps, etc.	Existing distributors and dealers	On-site replacement by retailers	Local retailer/energy service centre
Consumer incentives	Replacement of old lamp (in some areas)	Buy-back of old fan for limited stock	Energy consumption-linked subsidy + credit line	Credit available from financial institutions; tailored repayment strategies
Outcomes	367 million LED lamps distributed	50,000 fans targeted	1.9 million households reached	350,000 solar home systems sold until February 2012
Strengths	Rapid market transformation	Use of local supply chain for logistics	Strong incentives for replacement	Targeted at low-income consumers; development of local supply chain; extensive pre- and post-sales consumer engagement
Weaknesses	High-cost logistics, gaps in information management led to difficulty in offering flexible financing	Limited uptake due to poor awareness	Low potential for replication in Indian context due to poor electricity consumption data	Slower pace of uptake of appliances

Source: Authors' analysis

17. Energy Efficiency Services Limited (EESL) is a Government of India-backed super-energy-service company (ESCO). It is a joint venture of state-owned NTPC, Power Finance Corporation (PFC), Rural Electrification Corporation (REC) and POWERGRID.

We conducted a detailed literature review on these models along with semi-structured interviews with key personnel engaged in their implementation.[18] We discuss the key takeaways from this exercise as follows:

1. **Demand aggregation and bulk procurement** can be an effective method for rapid price reduction of super-efficient appliances and market transformation. LED lamps saw a price reduction by a factor of ten and an increase in market share from five to 46 per cent in a span five years through this approach (Kamat et al. 2020). Consequently, about 367 million LED lamps were sold under UJALA (MoP 2020). However, the ceiling fans component of UJALA did not see a similar success due to challenges in inventory management and logistics, effective last mile distribution and technical support, and lack of financing options for buyers. While the consumption-linked subsidy approach in Mexico led to 1.9 million households replacing their cooling appliances (Davis et al. 2014), it also had a significant fiscal implication.
2. **Financial incentives and financing options**, along with a reduction in upfront price through demand aggregation, can potentially increase uptake among consumers . For example, discoms in Delhi offer INR 815 (USD 11) as a subsidy (about a third of the market cost) to retail consumers purchasing SE fans through their programme (BRPL 2021). In Mexico, consumers were offered a subsidy amount based on their electricity consumption, as well as a line of credit in case they were unable to afford the reduced price (World Bank 2010). Under UJALA, the OBF option was made available, under which consumers could pay for the appliance cost as instalments added to their monthly electricity bills. While convenient for consumers, this approach presented challenges in the verification of sales and financial risk due to consumer defaults on instalments.[19] Implementation of OBF beckons the need for a robust data management system that digitally records the number of sales made, links these sales to consumer details through the discoms' database, and makes this information available to relevant actors in the supply chain.
3. **A strong supply chain with last mile service delivery** is critical to the success of any large-scale programme. Under the UJALA model, millions of LEDs were distributed through a well-connected network of wholesale distributors and retail kiosks managed by EESL along with power utilities. However, a parallel attempt to sell energy-efficient fans under UJALA had a less encouraging outcome.[20] While centralised logistics for LED lamps under the UJALA model were cheaper, for more voluminous appliances such as fans, a decentralised distribution and inventory management mechanism would be required to manage logistics costs. Participation of local retailers is also essential as they influence consumers' purchase decisions heavily (Agrawal, Mani, Aggarwal, et al. 2020). This was the centrepiece of SELCO's early operations. The benefits of including local retailers would be:
   - Inclusion of a grassroots stakeholder whose advice consumers trust while purchasing appliances,
   - Creation of local capacity to provide timely after-sales services, and
   - Creation of an organic demand for SE fans even after the programme implementation.

A strong supply chain with last-mile service delivery would be critical to scaling up SE fans

18. These included experts responsible for designing and executing the two business models from India. We could not interview any relevant stakeholder involved in the implementation of the *Cash for Coolers*. Refer to Annexure 3 for further details.

19. Due to high incidence of non-payment of power bills and gaps in recording sales made, some discoms (and therefore, EESL) could not recover the cost of LED lamps through instalments.

20. The UJALA programme for ceiling fans has only sold about 2.4 million fans (50 W variants) till date (MoP 2021).

4. **Effective consumer engagement** must be a part of any business model for awareness creation on the benefits of super-efficient appliances and the programme itself. While a nationwide awareness campaign was core to the success of the UJALA scheme for LEDs, inadequate consumer engagement emerged as one of the critical reasons for the low uptake of SE fans, as also under the discoms' model. Engagement also includes obtaining regular feedback from users of the product to ensure quality and grievance redressal, which would help build consumers' trust in the product and the programme. This is also important to understand consumers' needs and concerns and must feed into the marketing strategy and programme design, for example, incentives and payment options.

3.2 What do consumers think about SE fans?

Though several studies have investigated consumer perception towards efficient appliances in general, these insights are not wholly applicable to specific appliances. The evidence on consumer perception towards SE fans is scarce. So, we conducted a small primary survey with around 80 urban consumers from Mathura and Bareilly districts in the state of Uttar Pradesh during February 2021. Of a sample size of 80, 76 participants responded to the survey. The following are some key takeaways from the survey.

1. **Awareness of SE fans currently is low**. Only about 17 per cent of the respondents expressed awareness of star-labelled or SE fans.

2. **Consumers with prior awareness of SE fans are more likely to adopt it**. When asked about willingness to replace an old fan with an SE fan, 92 per cent of those aware of SE fans gave an affirmative response, compared with 76 per cent of those who learnt about it for the first time.

3. **Willingness to pay for SE fans is much lower than their prevailing retail price**. On average, respondents were willing to pay INR 1,350 (USD 18.5) for an SE fan, which is less than half the retail market price of INR 3,000 (USD 41). Only a fifth of all respondents were willing to spend INR 2000-3000 on SE fans.

4. **Availability of financial incentives could increase the buy-in for SE fans**. Around 60 per cent of respondents were willing to replace their old ceiling fan with an SE fan if given a 50 per cent discount on the price.

5. **Most consumers would prefer OBF over third-party financing**. Of the respondents willing to replace old fans, only 12 per cent said they would like to avail a loan, but ~80 per cent expressed a preference for OBF that could allow payment for the replacement through energy savings as part of their monthly electricity bills.

Though the findings are from a small sample and not statistically representative of all Indian households, they provide useful insights on consumer attitudes towards pricing and preferred payment modes. They also underscore the role that consumer engagement and financial incentives can play in unlocking the demand for SE fans.

4. Business model to scale up SE fans

Image: Shalu Agrawal/CEEW

This section discusses the design of a new business model to increase the uptake of SE ceiling fans, drawing on insights from the business case analysis, stakeholder consultations, and consumer survey. We also discuss the implementation modalities of the proposed model and considerations for extending it to other appliances.

4.1 Key elements of the proposed business model

Demand aggregation and bulk procurement for rapid price reduction: The DA can be an ESCO, like the Government of India-backed EESL, or even discoms. Based on load research and market potential studies in the discom control area, the DA would float tenders to procure SE fans from OEMs in bulk, at a unit price that is lower than the market price. Thus, the DA would play the role of facilitator of market transformation by guaranteeing offtake from OEMs, thereby mitigating their volume risk in new technology investments. Bulk procurement could include extended warranty (~ 3-5 years) for consumers to cover incremental repair and maintenance costs.

A robust distribution network, leveraging multiple channels: This is to ensure last mile availability and servicing of SE fans. The DA and OEM could partner to leverage the latter's existing distribution and retail network. Online platforms (such as EESL Mart) can be utilised where consumers have adopted online appliance purchases. Fans can be sold through brick-and-mortar retail stores where distributors have established relationships with retailers. In other areas, OEMs, the DA and discoms can identify and empanel strategic points of sale (see section 4.2.1).

A MIS for efficient coordination between the various actors: The DA and wholesale distributors would use it to keep track of the inventory at critical hold points; discoms would integrate the MIS with their consumer database to verify consumer details, such as contact information, power consumption, arrears on power bills, etc.; retail-level distributors would use it to record sales to discom-verified consumers; and finally, it can be used to efficiently operationalise convenient repayment options for consumers and for deploying targeted financial incentives (see section 4.2.2).

Innovative consumer engagement strategies to create awareness about the programme and the product: As a consumer-facing entity, discoms can play a vital role in engaging with consumers through various media: advertisements through printed and online power bills, SMS blasts, and virtual or in-person demonstration sessions in neighbourhoods. The engagement strategy used would have to be tailored for different consumer segments. For instance, consumers in peri-urban and rural areas trust the advice of retailers and depend on local technicians (colloquially referred to as "electricians") for appliance purchases and repairs. Creating awareness among these stakeholders and building their technical capacity for repairs and maintenance of SE fans would be essential to ensure their mass uptake.

Flexible payment options for consumers: Wherever upfront payment is inconvenient, consumers may prefer to pay for ceiling fans using other options. The MIS would help transparently keep track of sales and link them to consumer details in real-time, making implementation of OBF smoother. OBF would also allow easier disbursement of additional discounts and subsidies to consumers, wherever required, by simply not adding monthly instalments to power bills and only charging the upfront price. Partnerships with financial institutions, like micro-financiers, non-banking financial companies and online wallets would allow easy operationalisation of third-party financing and low-cost credit.

4.2 Implementation modalities

The demand aggregator should initially tap the middle- to high-income consumers and increasingly target the low-income consumer segment

To scale the uptake of SE fans among low-income consumers, the proposed model would have to use a range of instruments. Recall from section 2.3 that monetary benefits for the discom are higher from enhanced efficiency in the lower energy consumption slabs than the higher ones. However, logistically, it would be easier to sell higher volumes in a shorter duration among high- and middle-income consumers who are geographically concentrated in urban centres and would have an attractive payback period. Further, it would take a few rounds of bulk procurement by the DA to bring SE fan prices well below market prices and make them affordable for low-income consumers (Chunekar et al. 2017).

In order to manage the demand risk, the DA should initially tap the middle- to high-income consumers concentrated in urban areas and increasingly target the low-income consumer segment as the product prices drop over time. Based on the consumer segment being targeted, suitable distribution channels and financial incentives will have to be deployed.

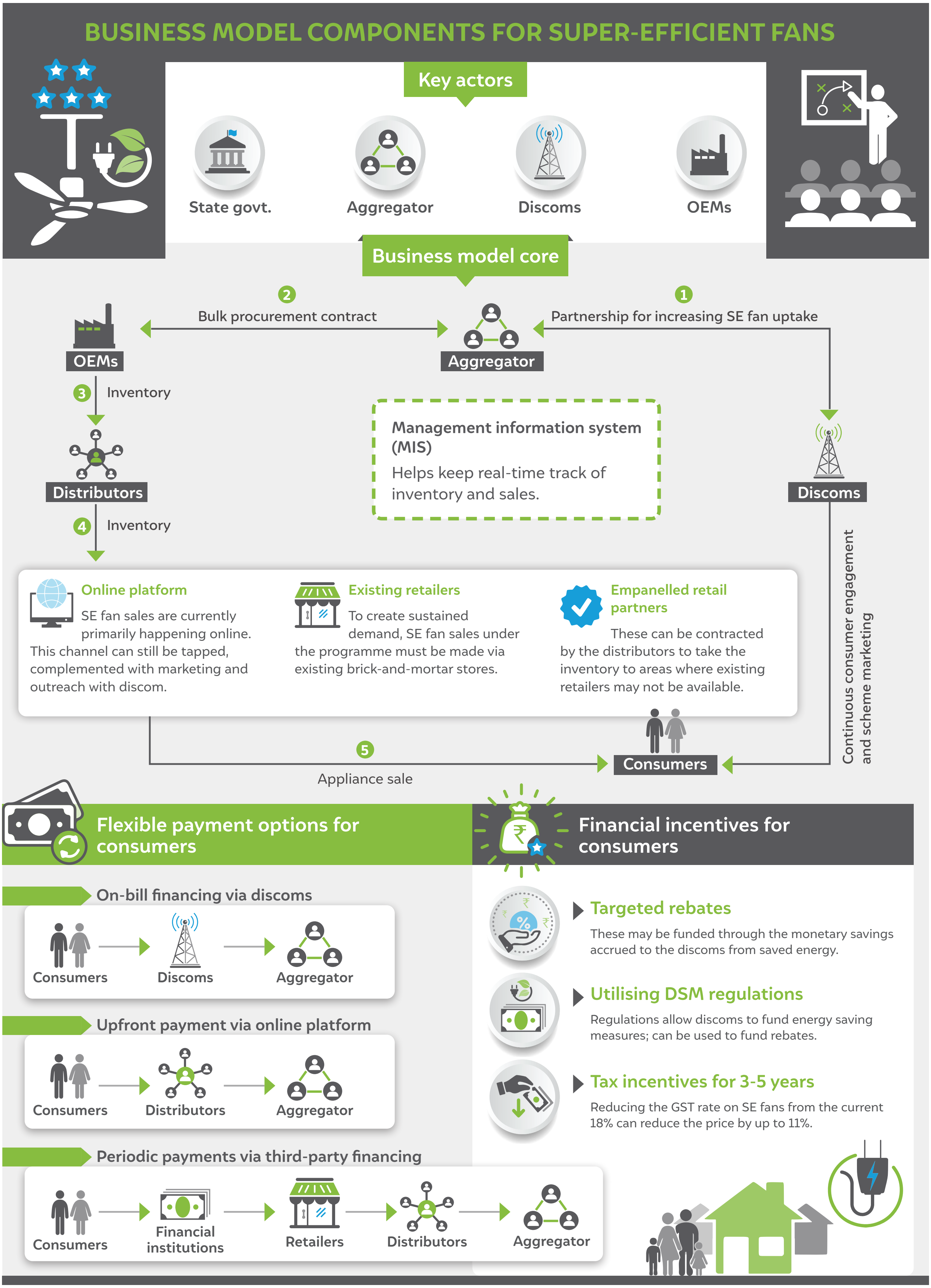
4.2.1 Distribution channels

The proposed business model will need to employ different retail channels in order to reach different consumer segments.

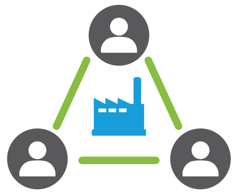
Online platforms for the e-commerce savvy, urban consumers: Nearly a quarter of urban consumers in India are expected to buy consumer durables online by 2023, while about 85 per cent will leverage digital means to make a purchase decision (Jain et al. 2019).[21] During and after the pandemic in 2020, the share of online sales of consumer durables has increased from 8-9 per cent to about 15 per cent (Dutta 2020). Thus, online sales channels such as EESL Mart[22] may be leveraged to reach urban consumers in the initial phases of the model. Further, twice the proportion of urban consumers use online methods for electricity bill payments as rural consumers (Agrawal, Mani, Jain, et al. 2020). Discoms' online payment portals may be used to popularise the benefits of SE fans and influence consumers' purchase decisions. This may influence decisions on appliance purchase towards SE fans at the start of the consumers' decision journey, when it may be more effective (Agarwal et al. 2019).

21. Jain et al. (2019) define a 'digitally influenced sale' as: "if the buyer uses internet during any stage in the purchase cycle". This can be to access online comparisons, reviews, unboxing videos, etc., or to make the final purchase.

22. EESL Mart is an online platform used by EESL to provide information on its products, register interest from consumers in buying the products, and passing the query on to OEMs.


BUSINESS MODEL COMPONENTS FOR SUPER-EFFICIENT FANS
Key actors
State govt.
Aggregator
Discoms
OEMs
Business model core
2 Bulk procurement contract
1 Partnership for increasing SE fan uptake
OEMs
Aggregator
3 Inventory
Distributors
Management information system (MIS)
Helps keep real-time track of inventory and sales.
Discoms
4 Inventory
Online platform
SE fan sales are currently primarily happening online. This channel can still be tapped, complemented with marketing and outreach with discom.
Existing retailers
To create sustained demand, SE fan sales under the programme must be made via existing brick-and-mortar stores.
Empanelled retail partners
These can be contracted by the distributors to take the inventory to areas where existing retailers may not be available.
Continuous consumer engagement and scheme marketing
5 Appliance sale
Consumers
Flexible payment options for consumers
On-bill financing via discoms
Consumers
Discoms
Aggregator
Upfront payment via online platform
Consumers
Distributors
Aggregator
Periodic payments via third-party financing
Consumers
Financial institutions
Retailers
Distributors
Aggregator
Financial incentives for consumers
Targeted rebates
These may be funded through the monetary savings accrued to the discoms from saved energy.
Utilising DSM regulations
Regulations allow discoms to fund energy saving measures; can be used to fund rebates.
Tax incentives for 3-5 years
Reducing the GST rate on SE fans from the current 18% can reduce the price by up to 11%.

Channel partners and local retail outlets to reach a wider consumer base: Even though the online mode of retail purchase is increasing across tier-2, 3 and 4 cities,[23] a large share of consumer durables sales come from more traditional channels. Post-pandemic sales in tier-2 and 3 cities picked up primarily in the offline channel (Dutta 2020), and 40-60 per cent of consumer durables sales are still expected to be through unorganised retail stores (Das 2021). As in the case of the UJALA scheme (KPMG et al. 2018), this indicates that to achieve scale, last mile supply chains need to be strengthened.



The demand aggregator could partner with OEMs to leverage their existing supply chain to increase reach

For this, the DA could partner with OEMs to leverage their existing network of distributors and retailers. Fans can be sold through brick-and-mortar retail stores where distributors have established relationships with retailers. In other areas, OEMs, the aggregator and discoms can jointly identify and empanel strategic points of sale, such as discom payment counters, banks, post offices for last mile distribution. It would also be essential to train these actors on making and recording sales and providing after-sales maintenance services to consumers in the local area.

The channel of distribution, based on targeted geography and warranty obligations, would need to be specified in the bulk procurement contract between the OEM and the DA. Since current sales of SE fans are largely limited to online platforms, OEMs stand to gain through this business model as it promises to increase sales through physical retail stores. Further, as manufacturers of the technology, they would also be best placed to train technicians and repairmen to provide maintenance services to consumers, an essential component in building consumers' trust in the technology.

4.2.2 Financing options and financial incentives

Consumers in the lower consumption slabs would require financing support and/or financial incentives to bridge the gap between the price of SE fans and their paying capacity. In the latest round of bulk procurement for SE ceiling fans, EESL has discovered a price of INR 2,400 (~ USD 30). This is much lower than the retail price of comparable products in the open market (INR 2,800 – 3,000, ~ USD 40), yet significantly higher than the typical price of conventional fans available in the market (INR 1,000 – 1,500, USD 14-21). The following avenues could be tapped to overcome the affordability barrier.

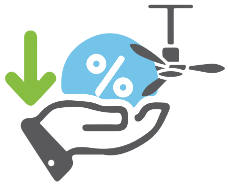
Low-cost credit: About a fifth of Indian households express interest in purchasing appliances using credit (Agrawal, Mani, Aggarwal, et al. 2020). Enabling this option would allow the DA to reach a wider consumer base, which may not be able to bear the upfront cost of an SE fan in the initial rounds of bulk procurement. This may be operationalised in a couple of ways:

a. *Online financing options:* There is a substantial appetite for using low-cost credit to purchase consumer durables, especially using online modes and in tier-2 and 3 cities (Research and Markets 2021). OEMs and the DA can partner with financial institutions and NBFCs to offer low- or no-interest credit to a larger consumer base making online appliance purchases.

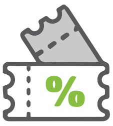
b. *Partnerships with MFIs:* MFIs provide collateral-free loans with flexible repayment terms to low-income households (Reserve Bank of India 2021). The DA could enter into a tripartite agreement with the OEM and MFIs to offer financing options to low-income consumers. To

23. Classification of cities based on population (RBI 2016): Tier-1 (population ≥100,000), tier-2 (50,000-99,999), tier-3 (20,000 – 49,999), tier-4 (10,000 - 19,999).

mitigate their risk, the MFIs would require the DA to assure in their contracts with OEMs and distributors: 1) timely delivery of the product, 2) product quality and 3) adequate after-sales services. The DA could also help scale cheap credit through financial institutions by providing a loan guarantee, a form of Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE)[24] (BEE 2015) for retail consumers.



Lowering the GST on SE fans could boost the efforts to make them affordable



Discounts and vouchers: Part of the savings accrued to the discoms and state governments from enhanced energy efficiency could be redirected to offer discounts to consumers on their purchase of the fan. Discoms could additionally socialise the costs incurred in providing targeted discounts through DSM regulations. DSM regulations, notified by the State Electricity Regulatory Commissions (SERCs) allow for the recovery of discoms' costs for energy conservation measures through the annual revenue requirement from power tariff (FoR 2017). Discounts may be enabled via vouchers provided by discoms during marketing activities and redeemed by consumers at the point of sale. Alternatively, this could be linked to the clearance of arrears on power bills by consumers. Such incentives can help accelerate the process of market transformation (V. K. Singh et al. 2019).

Tax incentives with a sunset clause: Ceiling fans currently attract 18 per cent GST. A typical SE fan costs about INR 3,000 (USD 40) in the retail market, including tax. This implies that the cost of bringing the fan to the consumer, on which the tax rate is applied, is about INR 2,550 (~ USD 34). Bringing fans to a lower tax slab of 12 per cent would reduce the retail price by about INR 150 (USD 2). Reducing the slab further to 5 per cent would reduce the retail price by another INR 180, bringing it down to about INR 2,670 (~ USD 35).

Thus, lowering the GST on SE fan models for a predetermined period of 2-3 years could further boost the efforts to make these affordable for Indian consumers. Such a move would also provide a strong signal to consumers and the industry that scaling up SE fans is a policy priority. Precedence of this exists in the lighting industry, where the GST rate on LED lamps was reduced to 12 per cent (Mahendru 2017), while other lighting fittings continue to attract a higher tax rate of 18 per cent (CBITC 2021).

4.2.3 Replacement of old fans

While the potential demand for new purchases is significant, a massive potential also lies in replacing the existing stock of inefficient fans. The business model may include the option of replacements, where consumers can be given an additional cash discount for handing over the old appliance. However, operationalising the same would require strict monitoring of the disposal or recycling of old models in an environmentally safe manner and make sure that they do not make their way into low-income households via the secondary market.

24. The PRGFEE guarantees repayment of a maximum 50 per cent of loan amount provided for energy efficiency projects via the ESCO route. Support is available for projects in government buildings, private buildings having commercial and multi-storey residential accommodations, municipalities, small & medium enterprises and industries.

BOX 3 Buildings as nodes for bulk demand for super-efficient appliances

The power of demand aggregation in discovering lower prices lies in the scale of aggregation. This is particularly true for technologies that would require existing players to invest in new manufacturing capacities. Further, the business case for replacement of old fans is likely to be stronger in commercial buildings than households due to longer usage hours and higher electricity tariffs. Thus, anchoring the large-scale rollout with bulk consumers would help the DA manage its demand risk.

Commercial and government buildings

In FY 2019-20, commercial buildings were estimated to cumulatively consume 8 per cent of total electricity consumption in India (MoSPI 2021), projected to rise to 11 per cent by 2030 (NITI Aayog 2015). Seeking to control its energy footprint, the Government of India (GoI) instructed all ministries and departments to retrofit lighting and cooling appliances (fans and ACs) with energy-efficient variants (MoP 2017). State governments also mandated the use of LED lights in their offices (Malik 2017; HAREDA 2018). EESL has so far installed 1.3 million indoor LEDs, 300,000 ceiling fans and 35,000 ACs in government buildings (EESL 2021) as well as railway stations, airports and industries (Garnaik 2020).

A similar approach of targeting commercial and government buildings, that typically pay higher tariffs than residential consumers, can be followed for other super-efficient appliances. The Government e-Marketplace (GeM) portal can provide a convenient channel for these sales (K. Singh and Chunekar 2021). Discoms and state governments can start by mandating the replacement of old appliances in their offices and residential colonies with energy-efficient variants. This would provide assistance to the DA in managing demand risk, moving larger volumes of inventory and reducing the retail price of new technologies more rapidly.

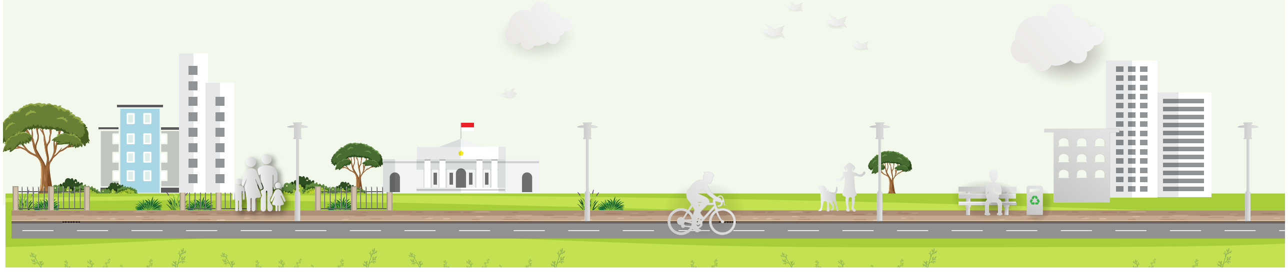
Pradhan Mantri Awas Yojana

Another node could be the *Pradhan Mantri Awas Yojana* (PMAY) or the social housing scheme. Launched in 2015, the scheme's urban component, PMAY (U), intends to provide housing for all urban families in India by 2022.

As of September 2021, 11.4 million urban houses have been sanctioned under PMAY (U), of which ground has been broken on about 9 million, and 5.1 million have been completed (MoHUA 2021b). About half of the completed houses have been under the 'beneficiary-led construction or enhancement' (BLC) vertical (MoHUA 2021a). In its ongoing second phase, PMAY (Gramin) aims to construct nearly 10 million additional houses by 2022 (MoRD 2021).

Presently PMAY lacks an explicit focus on efficient appliances, although its technology sub-mission is designed to promote the use of environmentally friendly, energy-efficient and disaster-resistant materials and construction technologies. Occupants of affordable housing projects have been found to increase their appliance ownership due to aspirational reasons on moving from slums to permanent houses, as well as due to household practices such as cooking, washing, leisure, etc., shifting indoors from outdoors (Debnath et al. 2019a). This, in turn, can lead to economic distress due to higher electricity bills (Debnath et al. 2019b).

A convergence between PMAY and the proposed business model could provide an opportunity to reach out to more than 20 million Indian households. As the scheme's partner, the DA could facilitate the PMAY beneficiaries to purchase super-efficient appliances at discounted prices through designated channels or housing developers. The cost of appliances can be recovered through the credit facility available under the scheme. Such a convergence would help meet multiple policy objectives of providing housing for all, saving energy (and emissions) and improving the economic well-being of low- to middle-income citizens.

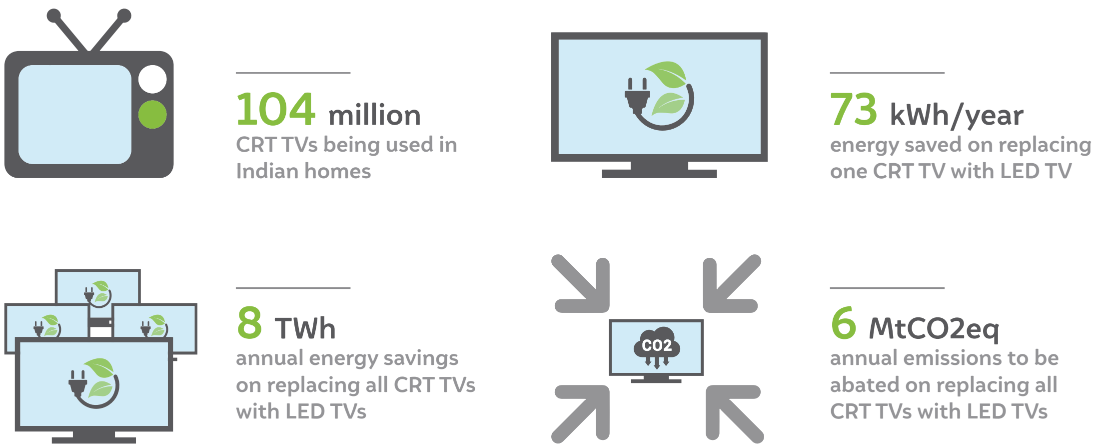


4.3 The model's applicability to other appliances

The proposed business model can be extended to other commonly used appliances (such as lights, TVs), though with changes as per the characteristics of the product, consumer preferences, extent of market transformation and supply chain cost structure. Here, we discuss the model's applicability to TVs.

Over the past decade, the TV market in India has undergone a transformation towards more efficient technology. Flat-panel TVs have seen steep cost reductions driven by favourable import policies (Research and Markets 2020), the introduction of smaller sized models (IBEF 2020) and increasing penetration of direct to home (DTH) technology (IBEF 2021). More efficient technologies, namely liquid crystal display (LCD) and LED TV screens, are price-competitive with conventional models (Dutta 2015). Since 2018, BEE has excluded CRTs from its performance standards schedule, indicating their absence from the active market (BEE 2017). However, household surveys show that ~60 per cent of Indian homes still use the inefficient CRT models (Agrawal, Mani, Aggarwal, et al. 2020). Thus, interventions should now focus on accelerating replacements of CRT TVs, which could annually save 8 TWh of electricity and mitigate 6 $MtCO_2e$ of emissions.

Figure 9 Market size of the CRT TV segment and benefits from converting into SE TVs



Source: Authors' analysis

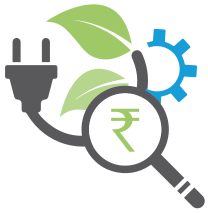
The proposed business model could also be employed to drive TV replacements, with an additional component of cashback on exchanging the old model. Further cost reduction through demand aggregation would help convert low-income consumers, who may still be purchasing CRT models (in the secondary market). E-commerce comprises nearly a third of all TV sales (Mukherjee and Malviya 2021), indicating that online channels could also be tapped. However, in order to reach rural markets, a demand aggregation model would have to leverage the local retailer network, which is trained in handling the appliance. Hence, using the existing network of retailers and distributors would be key.

5. Conclusion

Image: Dhruvak Aggarwal/CEEW

Energy efficiency must be the "first fuel" in transitioning to a decarbonised system (Motherway 2019). Reducing energy consumption is the best way to save resources spent on generating energy and consequent emissions. In the Indian context, energy efficiency unlocks further benefit dimensions. Super-efficient appliances can help extend critical services to consumers who cannot afford them in the status quo while helping discoms improve their revenues.

Ceiling fans provide one such critical service. For a rapidly developing, tropical country like India, it makes sense to make the most efficient fans the default option for consumers. Our analysis indicates a huge market opportunity for scaling up SE fans in India with several positive spillovers in the form of reduced energy and peak power demand, emissions mitigation, and subsidy and cost savings for state governments, discoms as well as consumers.



The focus of energy efficiency programmes must not be to solely reduce the one-time cost of appliances

Given the current payback period from investment in SE fans, innovative business models are needed to bring down the upfront cost and bridge the availability and awareness gaps. The centre piece of the model proposed in this study is demand aggregation, aimed at bringing SE fans within the affordability of most households. However, the focus of energy efficiency programmes must not be solely on bringing down the one-time cost of appliances. While this should be the first priority, there are critical supporting elements without which gains from energy efficiency may not be fully realised.

I. **Requirement of financial incentives**: Despite the fall in prices, many consumers facing subsidised tariffs may not find it economically attractive to invest in SE fans. To achieve rapid market transformation, such consumers must be provided with further incentives to switch to SE fans. Discoms can provide flexible repayment options through power bills, and state governments can provide additional rebates from the monetary resources saved. The DA can help provide access to cheap credit through partnerships with OEMs, MFIs and loan guarantee mechanisms.

II. **Awareness creation and consumer engagement**: Consumers are influenced by retailers, friends and family, and the internet while making an appliance purchase decision (Jain et al. 2019; Agrawal, Mani, Aggarwal, et al. 2020). It is critical that energy efficiency programmes are supported by tailored awareness creation programmes for consumers and retailers on the benefits of SE fans. Employing existing distributors and retailers for demand aggregation programmes, as suggested in this study, would also require financial incentives for these actors, in close consultation with OEMs.

III. **Measurement and evaluation of savings**: Marketing and outreach strategies must be built on evidence of energy savings to build trust in the product. Going beyond the deemed savings method, the rollout of SE fans must be accompanied by mechanisms to measure and evaluate actual savings.

Scaling up demand for SE fans can have spillovers beyond the electricity value chain. Higher demand has the potential to spawn a manufacturing industry that caters to markets beyond the domestic market. New and efficient technologies would also provide opportunities for high-skilled jobs and avenues for greater economic value-addition. Many tropical, developing countries in Africa, the Americas and Southeast Asia have much the same needs as India, with similar affordability constraints and aspirations for economic growth. The insights and model proposed in this study could be adapted by other countries to devise their energy-efficiency interventions. Besides energy and emissions savings, such interventions would enhance living standards by enabling access to reliable energy services at lower costs.

Annexures

Annexure 1 Methodology used to estimate monetary and energy savings, and co-benefits

Estimation of monetary savings from saved energy at the state and national levels involves estimation of three key metrics: 1) annual energy savings per conventional fan replaced with SE fan, 2) total energy savings at the state and national level, and 3) the per kWh monetary savings and its distribution across actors in the electricity value chain. Estimation and assumptions for each of these is explained below.

A1.1 Annual energy savings per fan

We estimate the annual energy savings per fan as:

Annual kWh savings per fan =
(75 W – 32 W) * daily hours of use * annual months of use * 30 / 1000

Here, we assume the energy consumption of conventional and SE fans to be 75 W and 32 W, respectively. The assumption of 32 W for an SE fan is conservative, based on the actual performance of lab-tested SE fans and stakeholder interactions. We also use state-specific values for the hours and months of fan use. These vary significantly, as per household responses to a primary survey (IRES), summarised in Table A1.

Table A1
Daily hours of fan use and annual months of use for states

Authors' compilation using IRES 2020 data (Agrawal, Mani, Ganesan et al. 2020).

State	Daily fan use (hrs.)	Fan use months
Andhra Pradesh	7	9
Assam	8	7
Bihar	9	6
Chhattisgarh	8	7
Gujarat	9	8
Haryana	9	6
Himachal Pradesh	9	7
Jharkhand	8	7
Karnataka	7	9
Kerala	7	10
Madhya Pradesh	8	7
Maharashtra	9	9
National Capital Territory of Delhi	12	7
Odisha	7	7
Punjab	13	8
Rajasthan	9	7
Tamil Nadu	7	11
Telangana	7	9
Uttar Pradesh	9	7
Uttarakhand	9	7
West Bengal	8	7
All India	8	8

A1.2 State and national level energy savings

The cumulative state and national level energy savings would be dependent on the number of SE fans sold. This is equivalent to the existing stock of conventional fans and the unmet demand for fans. We assume that a consumer making a first-time purchase for a ceiling fan would buy a conventional fan since this is currently the least cost option. To estimate the existing ceiling fan stock, we multiply the fan ownership rates from IRES with the number of domestic power consumers in each state. We estimate the unfulfilled demand for ceiling fans as the difference between the total number of bedrooms in a household and the total number of ceiling fans used by the household, wherever this difference is positive. This follows from the assumption that each bedroom must have at least one ceiling fan in a tropical country like India. Table A2 shows our estimates of existing stock and unmet demand in each state.
It should be noted that IRES covers 21 most-populous Indian states of a total of 36 Indian states and Union Territories (Agrawal, Mani, Ganesan, et al. 2020).

Table A2 Existing ceiling fan stock and new buys for each state

State	Domestic consumers (million)	Potential new buys (million)	Potential replacements (million)	Domestic consumers (million)
Andhra Pradesh	12.3	0.3	23.6	24.0
Assam	5.6	2.7	13.1	15.8
Bihar	15.2	8.9	29.7	38.6
Chhattisgarh	4.5	1.4	7.7	9.1
Gujarat	11.2	3.5	22.5	26.0
Haryana	4.2	0.9	6.6	7.5
Himachal Pradesh	1.2	0.7	2.3	3.0
Jharkhand	4.2	2.9	9.0	11.8
Karnataka	10.8	4.5	15.6	20.1
Kerala	7.0	2.2	20.2	22.4
Madhya Pradesh	11.2	5.9	17.8	23.7
Maharashtra	23.6	3.7	42.8	46.4
National Capital Territory of Delhi	3.4	0.4	8.1	8.5
Odisha	7.8	2.3	14.6	16.9
Punjab	5.4	1.3	12.9	14.1
Rajasthan	11.2	4.7	21.2	25.8
Tamil Nadu	17.3	1.8	31.1	32.9
Telangana	8.2	0.6	14.9	15.5
Uttar Pradesh	27.1	11.5	55.5	67.0
Uttarakhand	1.7	0.7	2.8	3.6
West Bengal	18.6	5.1	37.6	42.8
All India	212	66	410	476

Source: Authors' compilation using IRES 2020 data (Agrawal, Mani, Ganesan et al. 2020).

A1.3 Per kWh monetary savings

Electricity tariffs in India are telescopic. Consumption is divided into slabs on a volumetric basis; the per kWh rate of electricity is lower in the lower slabs, and as energy consumption increases, the per kWh rate also increases. This means that consumers in the lower consumption slab in a month face a lower average tariff per kWh, which is either cross-subsidised by other consumers of the same discom or subsidised through tariff subsidy by the state government or both.

Thus, for each kWh saved in a consumption slab, discoms save the amount of cross-subsidy built into the tariff for that slab, while the state government saves the tariff subsidy provided as per the tariff schedule. Consumers save the effective tariff they face, equivalent to the difference between the notified tariff and the subsidy provided by the state government, if any.

We estimate the monetary savings for consumers, discoms and state government as:

- Savings on bills per consumer (INR) = energy savings per fan (kWh) * (tariff (INR/kWh) – tariff subsidy (INR/kWh))
- Discom monetary savings (INR million) = total energy savings (million kWh) * (average cost of supply (INR/kWh) – (tariff (INR/kWh) – tariff subsidy (INR/kWh))
- State government monetary savings (INR million) = total energy savings (million kWh) * (tariff subsidy (INR/kWh))

A1.4 Estimations for Uttar Pradesh

Using the methodology as described above, we have estimated consumption slab-wise and total savings for the state of Uttar Pradesh (UP). The assumptions and results are shown in Table A3 and Table A4.

Table A3 Parameters estimated for UP

S. No.	Parameters	Values	Assumptions and data source
1	Domestic consumers (million)	27.5	UP tariff order in FY 2021-22
2	Energy savings per fan (kWh/year)	83	Assuming a 32 W fan replaces a 75 W fan being used for 8 hours and 8 months in a year
3	Total energy savings (GWh/year)	2,286	Estimated
4	Energy sales to domestic consumers (GWh/year)	42,374	UP tariff order in FY 2021-22
5	Savings as a share of energy sold to domestic consumers in FY 2019-20	5.4%	Estimated
6	Annual subsidy savings from rural and lifeline consumers (INR million)	3,150	Estimated, using the tariff structure prevalent in UP (see Figure 6)
7	Total subsidy outlay for domestic consumers (INR million)	54,520	UP tariff order in FY 2021-22
8	Subsidy savings as a share of annual subsidy outlay in FY 2019-20	5.8%	Estimated
9	Potential reduction in peak power demand (MW)	830	Assuming a 32 W fan replaces a 75 W fan and a peak co-incidence factor of 0.7

Source: Authors' analysis using sources as indicated.

Table A4 Consumption-wise estimations of savings for UP

Parameters	Lifeline and rural consumers by their consumption slabs						
	0-100 (lifeline)	0-100	101-150	151-300	301-500	>500	All consumers
No. of consumers (million)	1.99	8.95	4.86	2.13	1.19	0.13	19.2
Energy savings (GWh)	165	743	403	177	99	11	1,598
Annual monetary savings in INR million							
Consumer bill savings (A)	496	2,488	1,553	886	544	63	6,029
Subsidy savings for government (B)	521	1,819	807	-	-	-	3,146
Cross-subsidy savings for discom (C)	31	4	47	318	130	10	540
Total savings for discoms and state government (B+C)	552	1,823	1,143	460	219	20	4,217

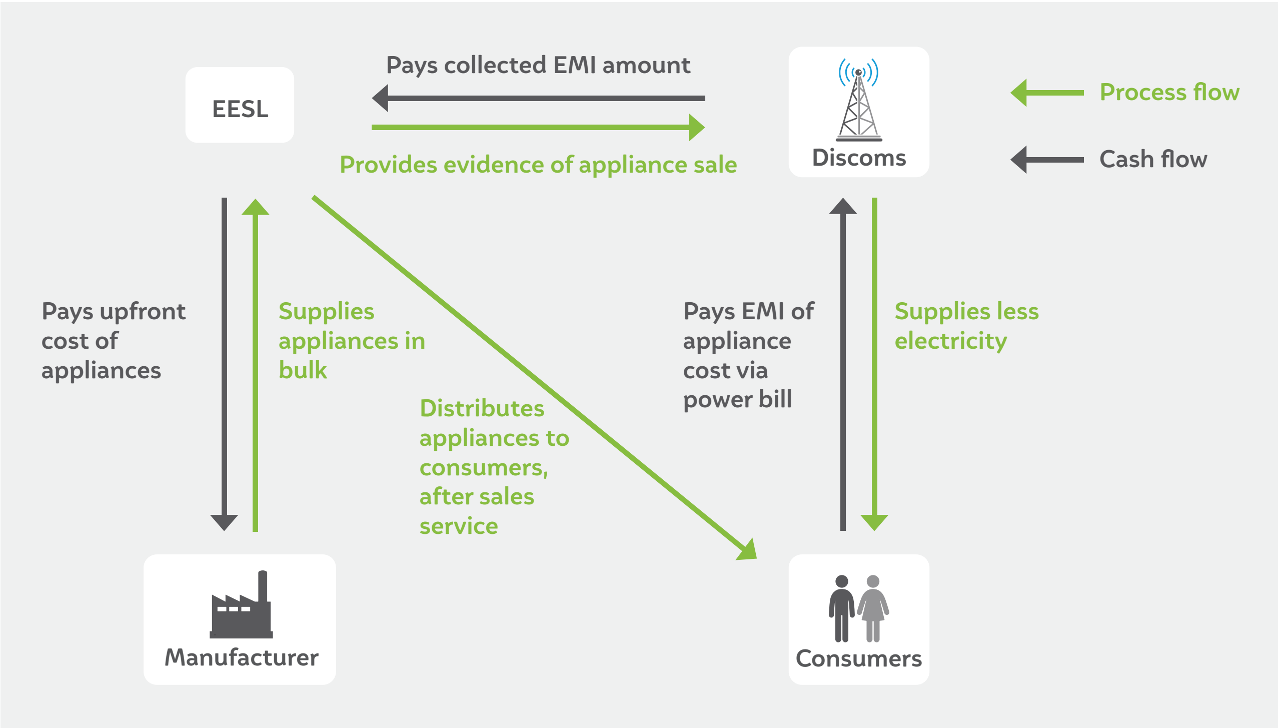
Source: Authors' analysis.

Annexure 2 Detailed review of existing business models

A2.1 EESL's UJALA model

The programme was initiated by the EESL in 2015, with the objective of making LED lamps accessible to all consumers. The model initially implemented the OBF model (Figure A1). The functions of each stakeholder under the OBF model are given in Table A5.

Figure A1 UJALA early-stage OBF model



Source: Authors' illustration

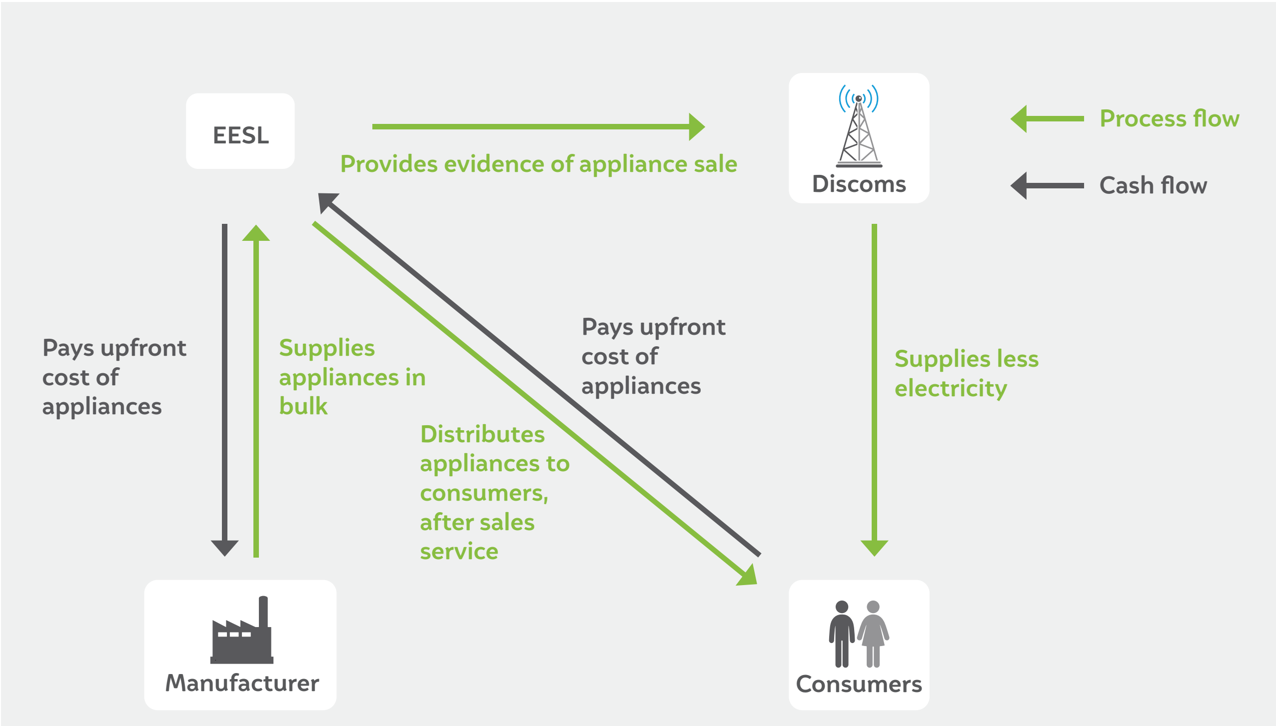
Stakeholder	Functions
EESL	• Floating tenders for procuring LEDs and bearing upfront procurement cost • Maintaining the LED inventory • Setting up distribution kiosks at discom offices, post offices, etc. • Collection of beneficiary details • Maintaining dedicated call centres to provide after-sales services to beneficiaries
Discoms	• Collection of monthly payments towards the LED cost from consumers • Providing premises for distribution kiosks and call centres
Manufacturers/ suppliers	• Supplying EESL with tendered stock at the required location • Providing 3-year warranty on the supplied product • Replacing faulty products in the warranty period

Table A5
Functions of stakeholders under UJALA early-stage OBF model

Source: Authors' analysis

As the prices dropped to about INR 40-50 (USD 0.6) per LED, the number of consumers opting for the OBF model dropped, and most consumers opted to pay the price upfront (Figure A2).

Figure A2 **UJALA modified its business model to remove OBF when LED prices fell sharply**



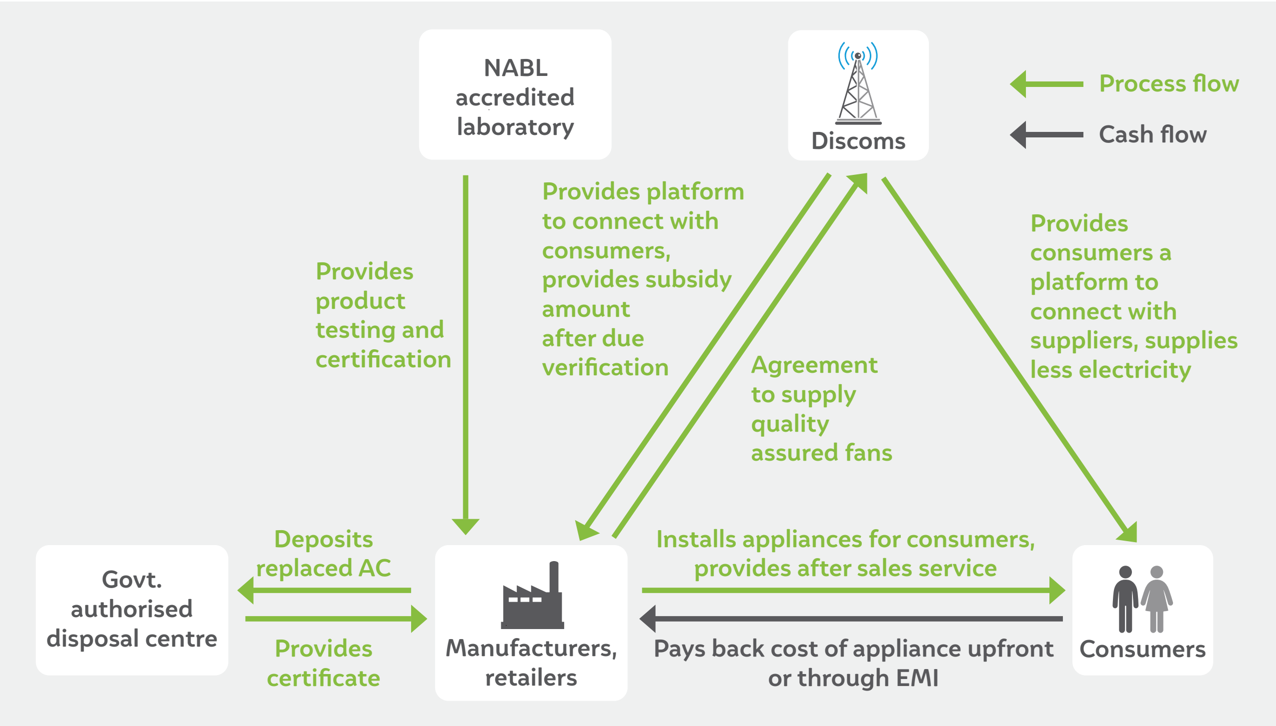
Source: Authors' illustration

The UJALA model provides key learnings in how demand aggregation can help rapidly transform an appliance market to higher efficiency.

A2.2 Discoms' fan replacement model

Discoms in Delhi, Mumbai and Haryana are running or have run schemes for the replacement of fans with energy-efficient variants. Under the schemes, the liability of supplying new appliances, replacing and disposing of old appliances, and providing after-sales services is on the manufacturers (Figure A3, Table A6).

Figure A3 Discoms' on-site replacement model



Source: Authors' illustration

Stakeholder	Functions
Discoms	• Floating tenders for procuring energy-efficient appliances • Providing a registration platform to consumers to avail the benefits of the scheme • On-site verification of consumer • Subsidy disbursement to retailers, based on relevant documentation
Manufacturers/ suppliers	• Maintaining appliance inventory • On-site verification of consumer • Supplying new appliance on-site; replacement of the old appliance • In case of ACs, disposal at a government authorised centre • Collection of beneficiary details • Collection of payments towards appliance cost from consumers (upfront or EMI) • After-sales services

Table A6 Functions of stakeholders under discoms' fan replacement model

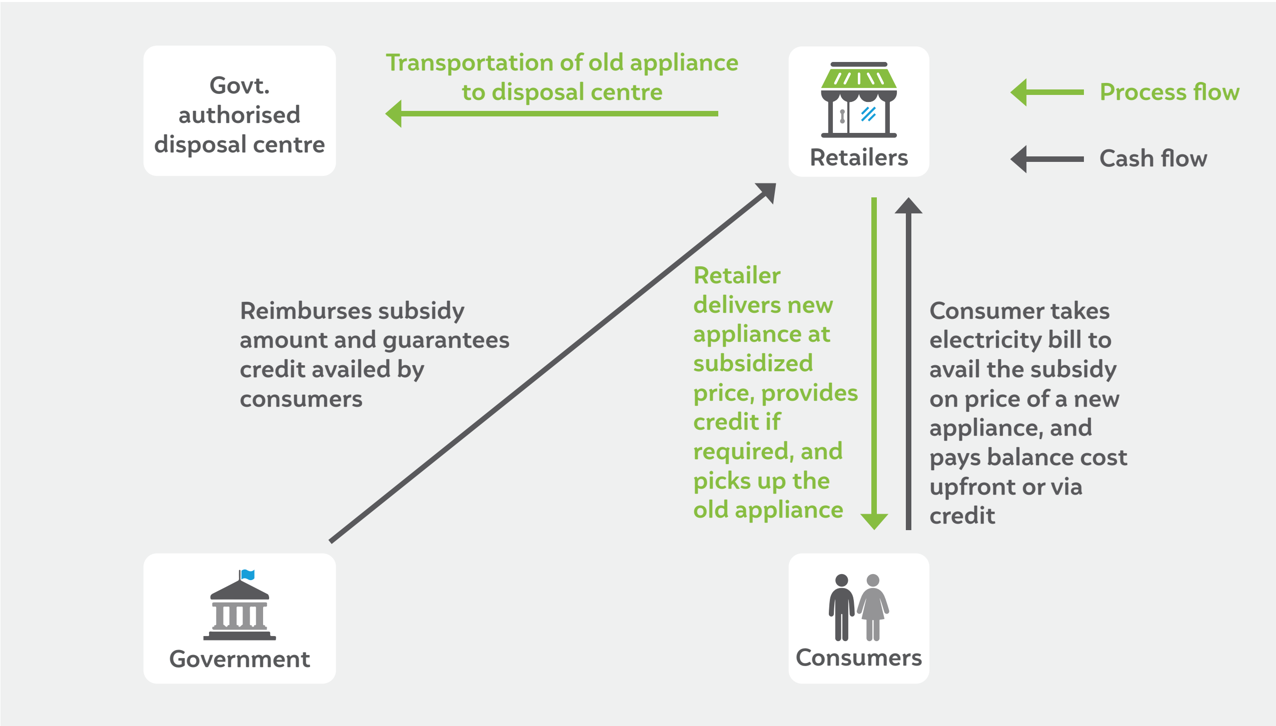
Source: Authors' analysis

This model shows how demand aggregation can work without physical procurement by the DA and is an example of discoms providing rebates to consumers on SE fans.

A2.3 Mexico's *Cash for Coolers* model

The efficient cooling appliances project was launched in 2008 and overseen by the Secretariat of Energy (SENER), the department of energy of Mexico's federal government. The programme provided subsidies on the upfront cost of new appliances, based on consumers' consumption level for trading in the old refrigerators and ACs, and the option of paying back the balance amount via credit (Figure A4) (World Bank 2010). The functions of each stakeholder are given in Table A7.

Figure A4 Mexico's *Cash for Coolers* model



Source: Authors' analysis

Table A7 Functions of stakeholders under *Cash for Coolers*

Source: Authors' analysis

Stakeholder	Functions
Government	• Providing registration platform to consumers to avail of the replacement scheme • Payment of subsidy amount to retailers • Guaranteeing the credit line availed by consumers
Manufacturers/ suppliers	• Maintaining appliance inventory • On-site verification of consumer • Supplying consumers with the appliance at the required location • Collection of beneficiary details • Collection of payments towards appliance cost from consumers (upfront or EMI) • After-sales services • Transportation of replaced appliance to scrapyard

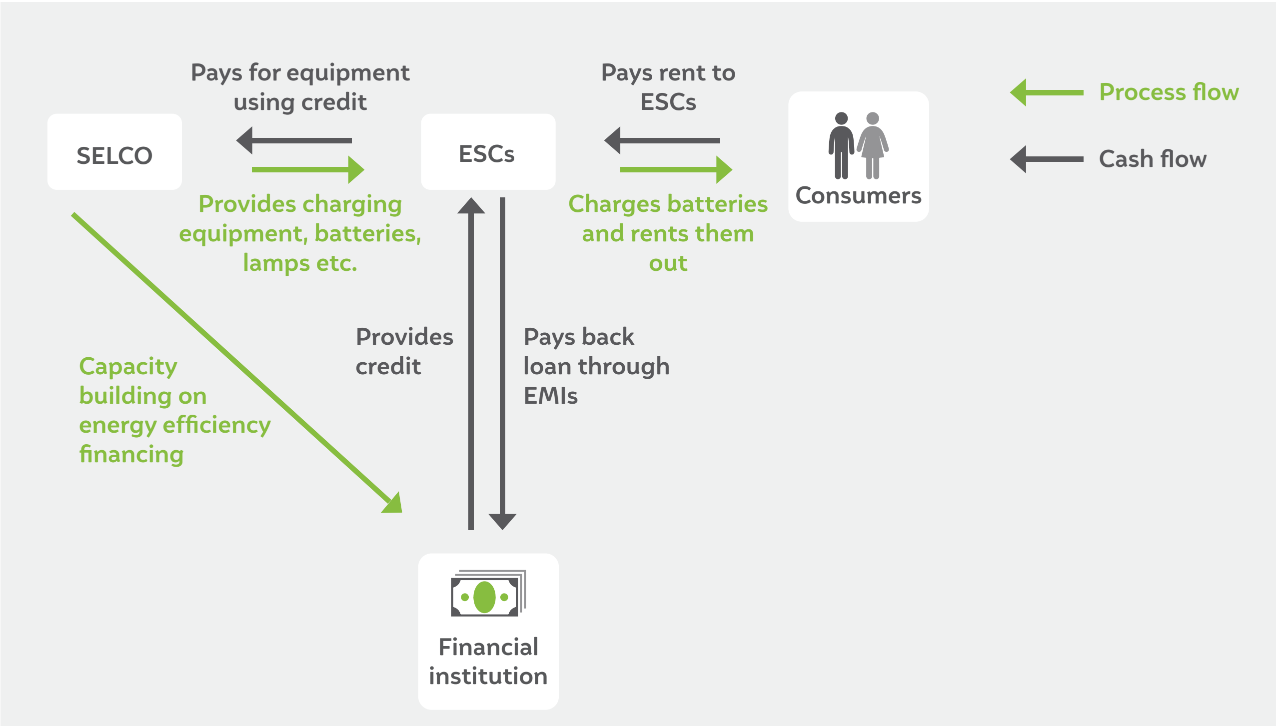
Cash for Coolers shows how the government can encourage retailer participation and address the lack of consumer access to finance.

A2.4 SELCO's direct-to-consumer model

SELCO was founded as a company promoting solar energy lighting through innovative technology and business model solutions for low-income households. For providing households with solar home systems, SELCO bears the upfront cost of the installed system, and consumers pay back from regular savings. The business model for increasing uptake of solar lighting relies heavily upon partnerships with local entrepreneurs in the target geography, called 'energy service centres' (ESCs). The company provides ESC operators with batteries and/or electric lamps and charging equipment, often on credit from financial institutions, which they can rent out to consumers (Figure A5). In this manner, the model aims to mitigate the risks of operating a centralised supply chain in remote rural areas by spreading it out among stakeholders (SELCO, ESC, financial institutions).

SELCO's entrepreneur model is an example of how private financial institutions can participate in energy-efficiency schemes. Table A8 lists out the functions of each stakeholder.

Figure A5 SELCO's direct-to-consumer model



Source: Authors' analysis

Stakeholder	Functions
SELCO	• Provides ESCs with charging equipment, batteries, lamps, etc. on upfront payment • Engages with financial institutions for extending credit to ESCs and consumers
ESCs	• Procures equipment from SELCO, is the owner of the equipment • Pays back SELCO for equipment using credit from a financial institution • Rents out batteries, lamps to consumers • Pays back the financial institution through EMIs • Sales, marketing, and after-sales service
Financial institution	• Extends credit to ESCs on favourable terms

Table A8 Functions of stakeholders under SELCO's direct-to-consumer model

Source: Authors' analysis

Annexure 3 List of stakeholders consulted

Figure A9 Stakeholders consulted for this study

S. No.	Name of organisation	Nature of organisation
1	Energy Efficiency Services Limited (EESL)	State-owned energy service company (ESCO)
2	Collaborative Labelling and Appliance Standards Programme (CLASP)	Research think tank
3	Centre for Strategic & International Studies (CSIS)	
4	Feedback Energy Distribution Co. Ltd. (FEDCO)	Distribution Franchisee, Odisha
5	Tata Power Delhi Distribution Limited (TPDDL)	Discom, Delhi
6	BSES Yamuna Power Limited (BYPL)	
7	BSES Rajdhani Power Limited (BRPL)	
8	Purvanchal Vidyut Vitaran Nigam Limited (PuVVNL)	Discom, Uttar Pradesh
9	Atomberg Technologies	Original Equipment Manufacturer (OEM)/OEM association
10	Virtual Forest	
11	Crompton Greaves	
12	Ram Ratna Electricals	
13	International Copper Association	
14	SNK Trading Company	Appliance distributor
15	Amazon	Online retail platform
16	SARALA	Microfinance institution (MFI)
17	Sa-Dhan	MFI association
18	Sunny Store (Ranchi, Chhattisgarh)	Appliance retailers
19	Perfect Electricals (Ahmedabad, Gujarat)	
20	M.K. Electric Sales (Lucknow, Uttar Pradesh)	
21	Kasliwal Electricals (Jaipur, Rajasthan)	
22	K.K. Electricals (Indore, Madhya Pradesh)	
23	Shree Balaji Distributors (Bhubaneswar, Odisha)	

Source: Authors' analysis

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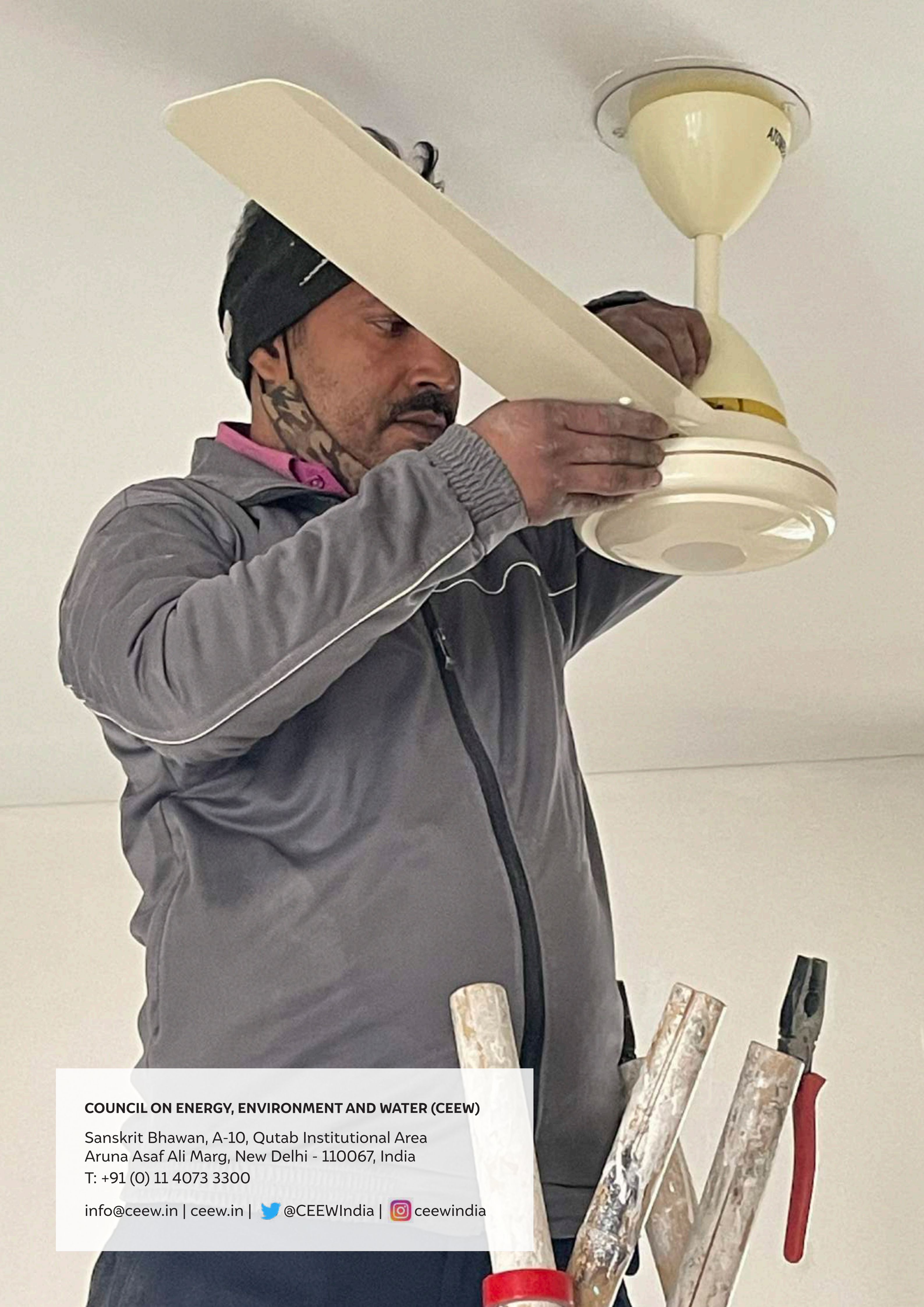
Super-efficient appliances can help extend critical services such as lighting and cooling to consumers who cannot afford these basic amenities.

Image: iStock



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