Energy Profile

Greater Kolkata Fan Cluster

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Creating Innovative Solutions for a Sustainable Future

Promoting Energy Efficiency in SMEs
SAMEEEKSHA

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Contents

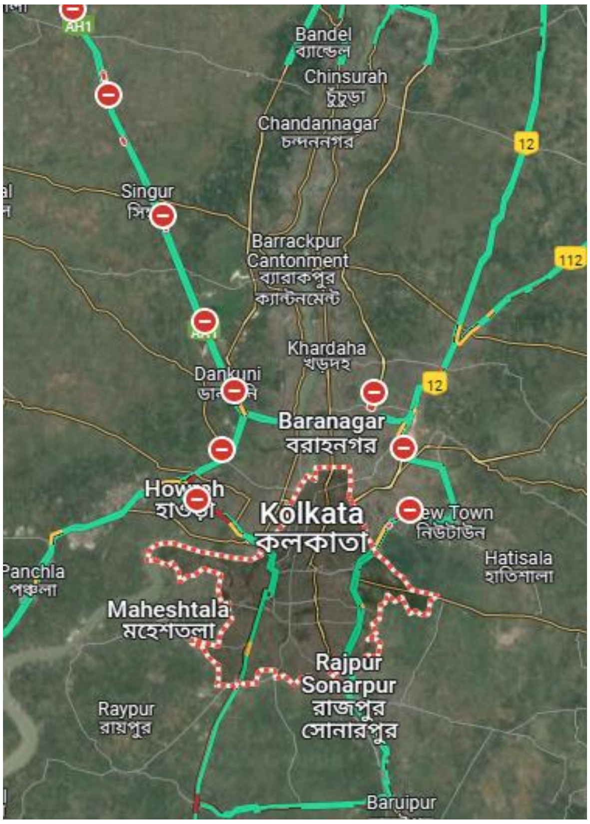
Abbreviations

APFC	Automatic Power Factor Controller
CNC	Computer Numerical Control
CO_2	Carbon Dioxide
GHG	Greenhouse Gas
IE	International efficiency
ISI	Indian Standards Institution
kVA	kilo volt ampere
kVAh	kilo volt ampere hour
kW	kilo watt
kWh	kilo watt hour
LPG	Liquified Petroleum Gas
million Rs.	Million rupees
MSME	Micro Small and Medium Enterprise
PF	Power Factor
PMSM	Permanent Magnet Synchronous Motor
RPM	Rotation Per Minute
ROI	Return on investment
SEC	Specific energy consumption
TERI	The Energy and Resources Institute
t-CO2	Tonnes of carbon dioxide
toe	Tonne of Oil Equivalent
tpd	Tonnes per day
VFD	Variable Frequency Drive

Greater Kolkata Fan Cluster

1.0 Overview of the cluster

The district of Kolkata is situated on the banks of the Hooghly River and covers a geographical area of about 206 sq. km. It is bounded by North 24-Parganas in the North, on the South by 24-Parganas, on the East by North and South 24-Parganas and on the West by river Hooghly.



The district hosts a large number of registered industrial units, with the majority falling under the Micro, Small, and Medium Enterprises (MSME) sector. Among its diverse industrial base, Kolkata holds historical significance in the fan manufacturing industry. The establishment of USHA Fans in the 1960s marked the beginning of this legacy. Over time, several skilled workers and engineers associated with USHA ventured into entrepreneurship, leading to the proliferation of fan manufacturing units across the region.

Approximately 20 units located across Kolkata and its suburban regions are engaged in fan assembly, utilizing ancillary components sourced from the Bansdroni cluster and other parts of India. This cluster manufactures a diverse range of ceiling, table, and exhaust fans, serving both domestic and national markets.

Prominent brands associated with this cluster include USHA, Toofan, Barsha, among others.

2.0 Product, market and production capacities

A fan is composed of various components, the main components being electric motor, blades, fan covers, downrod tube, bearings, capacitor, canopy and speed regulator.

The stator and rotor are the main components of an electric motor. The stator consists of the inner windings or magnets and is stationary. The rotor is the outer core and makes the fan rotate. The stator creates a rotating magnetic field as the polarity fluctuates. This magnetic field induces a current in the rotor's laminations, causing it to spin around the stationary stator.

The other major components of a ceiling fan are the following:

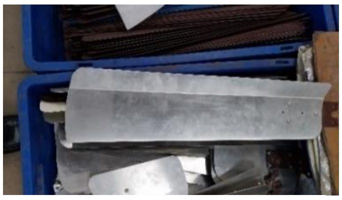
- Blades, made from metallic plates (mild steel (MS)/aluminium);
- Top and bottom fan cover (cast iron, aluminium die castings, MS);
- Downrod tube (MS);
- Bearings;
- Capacitor/condenser;
- Speed regulator;
- Canopies (plastic moulding).

The major components of an induction motor fan are shown below.

Stator stack	Rotor	Enamelled winding wires	Blades	Conductor rings
Top & bottom cover	Downrod	Bearings	Regulator	Condenser

Fan rotor

Fan covers



Fan blade

Fan stator

There are about 70 units in this cluster which manufacture 9 million fans per year. The units operate around 10-12 hours per day. Based on production capacity, the units are classified into 3 categories as shown in Table 1.

Table 1: Categorisation of fan units

Category	Number of units	Annual Production, million
Medium	5	4.1
Small	20	3.3
Micro	45	1.5
Total	**70**	**8.9**

3.0 Production process

The manufacturing of electric fans involves a sequence of systematic steps, beginning with the procurement of raw materials and culminating in the dispatch of fully assembled, tested, and packaged fans.

3.1 Procurement of Raw Materials and Components

The manufacturing units need to procure a wide range of components such as :

- **Electrical Components**: Motors, stators, rotors, capacitors, wiring harnesses, and control switches
- **Mechanical Components**: Fan blades (aluminum or plastic), motor housings (cast or sheet metal), pedestal stands (for pedestal/table fans), height adjustment mechanisms, protective front and rear guards, bearings, and bushings
- **Hardware and Fasteners**: Screws, rivets, washers, and clamps used during sub-assembly and final assembly

Procurement emphasizes quality, compatibility, and compliance with ISI standards or equivalent specifications.

3.2 Quality Inspection of Incoming Materials

Before production, all incoming materials undergo a stringent quality check at the inspection bay:

- **Dimensional Verification**: Using callipers, micrometers, and gauges to ensure accuracy.
- **Visual Inspection**: To detect surface defects such as cracks, rust, burrs, or deformation.
- **Electrical Compliance Check**: For components like capacitors, motors, and switches—ensuring voltage, resistance, and current parameters meet specifications.

Materials failing inspection are rejected or returned to vendors.

3.3 Stator & Rotor Assembly

This is the core step in motor preparation:

- **Stator Winding**: Copper wire is wound around the stator core using automated or semi-automated winding machines. Wound stators are then varnished and dried to prevent short-circuiting.
- **Rotor Fitting**: The rotor (typically squirrel cage type) is carefully inserted and aligned with the stator inside the motor housing.
- **Balancing**: Dynamic balancing is performed on rotors to reduce vibration during operation.
- **Bearing/Bushing Installation**: Bearings or bronze bushings are pressed into the end shields to ensure smooth, frictionless rotation of the rotor.

3.4 Motor Housing & Electrical Wiring

Once the electromechanical core is ready:

- **Housing Assembly**: The stator-rotor assembly is enclosed in the motor casing, which may be die-cast aluminum or mild steel, depending on design.
- **Internal Wiring**: Wires from stator to capacitor, control switch, and terminals are routed neatly and secured using clamps or grommets to prevent chafing.
- **Capacitor and Switch Fitting**: Capacitors are mounted securely within the housing. Switches (rotary or push-button type) are wired for speed control and ON/OFF operation.
- **Insulation & Earthing**: Ensures electrical safety and compliance with IS standards.

3.5 Blade & Guard Assembly

Following motor wiring:

- **Blade Mounting**: Fan blades (usually 3 or 4) are mounted onto the rotor shaft or hub. Alignment is checked to avoid wobble or imbalance.
- **Guard Fitting**: Protective guards are installed on the front and rear to shield the blades, following safety norms. The guards are spot-welded or bolted, depending on design.
- **Aesthetic Check**: Ensures proper alignment and visual appeal.

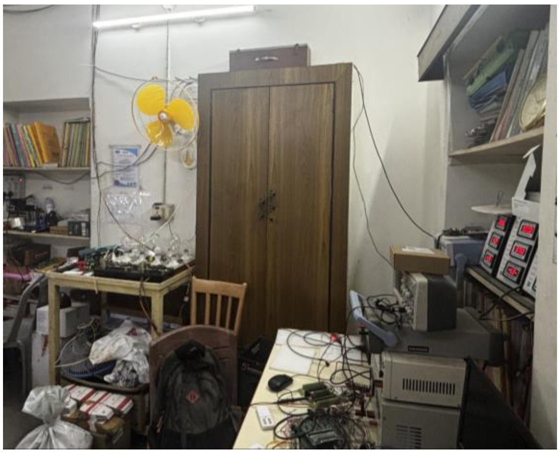
3.6 Pedestal Stand and Height Adjustment Mechanism Assembly

For pedestal/table fans:

- **Base Assembly**: The weighted base is fitted with anti-skid rubber grips.
- **Height Rod and Tilting Mechanism**: The height adjustment pipe, locking mechanism, and oscillation gear assembly are installed.
- **Neck Tilting System**: Allows vertical angle adjustment of airflow.

3.7 Testing and Quality control

All assembled fans undergo thorough testing:



- **Electrical Testing**: Verification of insulation resistance, high-voltage breakdown (Hi-pot), current leakage, and grounding.
- **Noise Testing**: Sound level meters measure operational noise to ensure within permissible decibel range.
- **Vibration Analysis**: Fans are run at maximum speed to detect abnormal vibrations or rotor misalignment.

- **Performance Testing**:
  - RPM of motor
  - Air delivery (measured using anemometers)
  - Motor temperature rise over time
  - Power consumption under load

Only units passing all tests are cleared for packaging.

3.8 Packaging & Dispatch

After final approval:

- **Packaging**:
  - Fans are disassembled (where needed) and packed with blade, guard, stand, and motor sections separately.
  - Thermocol sheets or moulded trays are used for cushioning.
  - Instruction manuals and warranty cards are added.
  - Boxes are labelled with brand name, model number, technical specifications, ISI mark (if applicable), and batch number.
- **Storage & Dispatch**:
  - Packed boxes are stored in finished goods inventory and dispatched as per customer orders or distribution schedules.

4.0 Technologies employed

Some major process equipment used in this cluster are described below.

4.1 Heating Ovens

In units equipped with painting facilities, heating ovens are used for curing powder coatings or drying liquid paint. Among these, LPG-fired ovens are the most commonly adopted due to their efficiency and availability. While most units carry out painting as part of their in-house product finishing processes, some also provide it as a standalone service. These services include both powder coating and liquid spray-painting techniques. After the application of paint, components are batch-loaded into the oven, with curing or drying cycles typically ranging from 25 to 45 minutes, depending on the shape and size of the items.

4.2 Machining

The majority of units in machining rely on conventional lathe machines (grinding machines, turning machines) while a few opt for CNC lathe machines for precise work quality. In addition to lathe machines, these units utilize drill machines, cutters, balancing machines (a variant of drill machines), punching machines etc. Typically, these machines feature motor capacities ranging from 0.75 kW to 3.7 kW.

4.3 Air compressor

Compressed air is used in units having painting facilities for spraying powder colour or liquid paint. All compressors are of reciprocating type and have rated power ranging from 5.5 to 11 kW. The pressure requirement for painting is 5.5 to 6 kg/cm^2, but to offset the pressure drop due to leakages cut off pressure is maintained at 8-10 kg/cm^2.

4.4 Air blowers

Air blowers are used to supply combustion air to the aluminium melting furnaces. The air blowers associated with such furnaces have been observed to have a rated capacity of 3.7 kW. Fans are also used to carry out the combustion gas from the LPG fired heating ovens.

4.5 Coil winding machine

The machines utilized for stator winding in fan production wind copper wire onto a rotating coil body. Despite their minimal power consumption, these machines play a crucial role in producing an essential component of the fan. They are available in semi-automatic and automatic variants. A typical coil winding machine consumes between 0.75 to 3 kW of power.

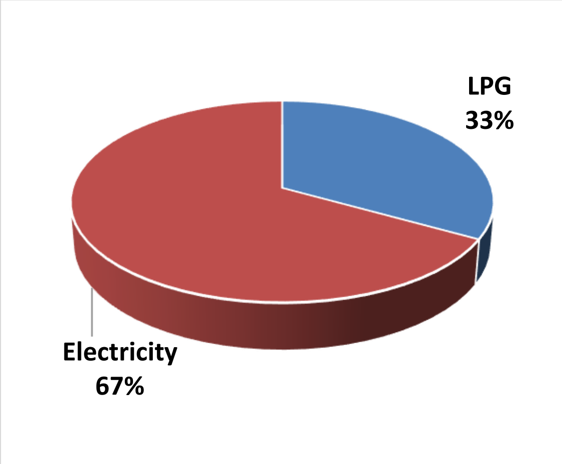
5.0 Energy scenario in cluster

The fan units mainly use LPG for the heaters. Electricity, sourced from girds, is used for operating the electrical loads. Grid electricity is supplied by West Bengal State Electricity Distribution Company Limited (WBSEDCL). The details of the major energy sources and tariffs are shown in Table 2.

Table 2: Energy consumption in cluster

Sl.	Energy source	Availability	Tariff details
1.	Electricity	West Bengal State Electricity Distribution Corporation Limited (WBSEDCL)	Tariff category: B (I-DIT) • Demand charge: INR 270 per kVA per month • Energy charges (in INR/kWh): 06:00 hrs-17:00 hrs: 6.83 17:00 hrs-23:00 hrs: 8.2 23:00 hrs-06:00 hrs: 5.12
2.	LPG	From local market	INR 59 per kg (price subjected to market fluctuations)

5.1 Energy consumption



The major energy sources utilized in the Kolkata fan cluster by the various units are LPG for thermal energy source and electricity. Grid electricity is used to power various motive loads across processing sections.

(i) Unit level consumption

The major energy in the unit level is consumed in the form of electricity. Fuels are used in the heat chambers. The typical energy consumption of different capacities of units are shown in Table 3.

Table 3: Typical annual energy consumption of fan units

Type of unit	LPG (t)	Electricity (kWh)	Total energy (toe)
Medium	13.9	271,122	37.2
Small	4.9	135,561	16.5
Micro	2.4	54,224	7.1

(ii) Cluster level consumption

The annual consumption of the cluster is estimated to be 836 toe per year leading to an estimated bill of Rs. 67 million. The estimated 'greenhouse gas' emissions from the cluster are 5,371 tonnes of CO_2 per annum. A breakup of the energy consumption of the cluster is shown in Table 4.

Table 4: Energy consumption, CO_2 emissions and energy bill

Energy Type	Annual consumption	Equivalent energy (toe)	Equivalent CO_2 emission (tCO^2)	Annual energy bill (million Rs)
LPG	245 tonne	276.6	732.1	14
Electricity	6.51 million kWh	559.6	4,639.4	52
	Total	**836.2**	**5,371.6**	**67**

6.0 Potential energy efficient technologies

Fan units offer significant scope for energy-efficiency improvements in both thermal and electrical areas. These options are discussed below.

6.1 Power factor Improvement

Effective power factor (PF) management offers a strategic opportunity for energy cost savings through utility rebates and improved electrical efficiency. Analysis of power factor performance in several industrial units indicates that many operate within a suboptimal range—typically between 0.87 and 0.94—falling short of the ideal benchmark of 0.99.

Maintaining a higher power factor not only reduces reactive power demand but also enables industries to qualify for greater incentives or rebates from electricity distribution companies. In one such case, a unit received a nominal rebate for maintaining average power factor; however, it missed out on a significant rebate opportunity by not optimizing to the target range.

To address this, it is recommended that units consider the installation of Automatic Power Factor Controllers (APFC) in combination with appropriately sized capacitor banks. This upgrade typically results in better voltage regulation, reduced losses in the distribution system, and direct monetary savings through enhanced utility rebates.

6.2 Compressed air system

Compressed air systems present considerable potential for energy savings—up to 40% in some cases—through improvements on both the supply and demand sides. On the supply side, energy efficiency can be enhanced by upgrading or optimizing equipment and lowering system pressure. On the demand side, reductions can be achieved by improving end-use efficiency and repairing leaks. Key opportunities within compressed air systems include:

(a) Arresting compressed air leakage- Compressed air is one of the most energy-intensive utilities in a plant, yet leakages—often exceeding 20%—are common and frequently overlooked. By identifying and sealing leaks at joints, valves, and connectors, leakage can be reduced to below 5%. This typically requires minimal or no investment and yields substantial energy savings.

(b) Optimizing compressor pressure settings- In many cases, the pressure setpoint of air compressors exceeds the actual requirement at the point of use. Lowering the generation pressure by just 1 bar can result in energy savings of approximately 7–10%. Optimizing pressure settings ensures efficient operation and minimizes unnecessary energy consumption.

(c) Replacing Conventional Compressors with PMSM-Based (Permanent Magnet Synchronous Motor) Models- Traditional screw or reciprocating compressors often suffer from lower motor efficiencies and energy losses during part-load operation or frequent start-stop cycles. PMSM compressors offer improved efficiency due to their advanced motor design, lower thermal losses, and ability to maintain high performance across varying loads. Replacing conventional compressors with PMSM models can yield energy savings of 15–30%, particularly in facilities with fluctuating compressed air demand.

6.3 Upgrading furnace insulation to reduce heat losses

In fan units, furnaces are used for heat treatment, paint drying processes often operate at moderate temperatures but for prolonged durations. Poor insulation leads to significant heat losses and higher energy consumption. Upgrading the furnace insulation will reduce the heat losses.

6.4 LPG Furnace to electric furnace

Within the cluster, a number of units currently rely on LPG-fired furnaces for heating applications such as curing, drying, or powder coating. While LPG furnaces are prevalent due to their ease of installation and operation, assessments indicate substantial scope for improvement in terms of energy efficiency, cost reduction, and process control.

LPG-fired systems often suffer from heat loss, inconsistent temperature control, and higher operating costs, particularly in light of fluctuating LPG prices. In contrast, electric furnaces offer more precise thermal regulation, cleaner operation with no on-site emissions, and improved compatibility with automation and control systems.

Based on energy audit findings across the cluster, it is observed that replacing LPG-fired furnaces with electric alternatives can result in 20–30% energy cost savings, along with enhanced product quality due to better temperature consistency. Furthermore, electric systems eliminate the need for fuel storage and reduce risks associated with handling combustible gases.

Given these benefits, it is strongly recommended that units within the cluster explore the feasibility of transitioning to electric furnaces, particularly for operations requiring controlled and uniform heating. Adoption of electric furnaces can contribute significantly to the overall energy efficiency and sustainability of the cluster.

6.5 Energy efficient IE3/ IE4 standard motors

The electricity consumption in the units takes place mainly in motors associated with fans and blowers. The motor ratings range from 1 HP to 25 HP, depending on their application and operational requirements.

A significant portion of the motors in the cluster are standard efficiency models, with many having undergone multiple rewinds, leading to efficiency losses of 5% to 10%. Considerable energy savings can be achieved by replacing standard motors with premium efficiency class (IE3/IE4) motors and implementing system-level improvements. Upgrading to higher-efficiency motors can lead to an estimated efficiency gain of 5-10%, while integrating technologies such as variable frequency drives (VFDs), soft starters and optimized gear assemblies can enhance system performance by 10–15%, offering a high return on investment (ROI).