

Annex 3 YGEN energy efficiency/VFD report

ENERGY EFFICIENCY IMPROVEMENT & ELECTRICAL COST REDUCTION

Client

[Factory XX]

Location

Savar, Bangladesh

Assessment Year

2025

1. EXECUTIVE SUMMARY

An energy efficiency assessment was conducted at Factory XX to identify opportunities for reducing electrical energy consumption, minimizing operating costs, and improving overall plant efficiency.

The factory's annual electricity consumption during 2025 was:

Parameter	Value
Annual Energy Consumption	989,258.71 kWh
Annual Electricity Cost	11,293,267.96 BDT (USD 91746.51)
Average Monthly Consumption	82,438 kWh
Average Monthly Cost	941,105 BDT
Average Energy Tariff	11.42 BDT/kWh

The assessment identified that the major energy consumers are:

- Sewing Machine Motors
- Ventilation Fans
- Air Compressors
- Water Pumps

Potential energy savings of 20–30% can be achieved through motor technology upgrades, VFD implementation, compressed air optimization, and fan modernization.

2. EXISTING ELECTRICAL LOAD INVENTORY

Sewing Machine Motors

Motor Type	Quantity	Rating
Clutch Motor	381	400 W
Induction Motor	34	300 W
Servo Motor	42	650 W
Servo Motor	17	550 W

Connected Load Calculation

Clutch Motors : $381 \times 0.4 = 152.4$ Kw

Induction Motors : $34 \times 0.3 = 10.2$ kW

Servo Motors : $42 \times 0.65 = 27.3$ kW

Servo Motors : $17 \times 0.55 = 9.35$ kW

Total Sewing Motor Connected Load : 199.25 kW

3. FAN SYSTEM ANALYSIS

Factory Ventilation Fans : 626 Nos

Assumed Average Fan Rating : 75 W

Connected Load : $626 \times 75 = 46.95$ kW

Current Fan Technology:

- Conventional AC Induction Motors
- Fixed Speed Operation
- No Occupancy-Based Control

Major Loss Sources:

- Rotor Copper Losses
- Iron Core Losses
- Mechanical Friction Losses
- Continuous Full-Speed Operation

4. AIR COMPRESSOR SYSTEM ANALYSIS

Air Compressor-1

Parameter	Value
Rated Power	22 kW
Voltage	380 V
Frequency	50 Hz
Connection	DOL
Current	48A / 36A / 46A

Current Imbalance

Average Current : 43.3 A
 Maximum deviation : 7.3 A
 Current Unbalance : 16.9%
 Recommended Limit : < 5%

Observation:

Motor current imbalance indicates:

- Unequal phase loading
- Possible voltage imbalance
- Increased copper losses
- Reduced motor efficiency

Air Compressor-2

Parameter	Value
Rated Power	37 kW
Frequency	155 Hz
VFD Controlled	Yes
Efficiency	94.5%
Current	79A / 76A / 60A

Observation:

Already operating under VFD control. This compressor demonstrates the energy-saving benefit achievable by applying VFD technology to Compressor-1.

5. WATER PUMP ANALYSIS

Water Pump-1

5.5 kW

Current : 10 A

Direct Online Operation

Water Pump-2

4.5 kW

391 V

Current : 6 A

Direct Online Operation

Combined Load : 10 kW

Both pumps operate at constant speed irrespective of demand.

6. MOTOR TECHNOLOGY ANALYSIS

Clutch Motor Technology

Current Installation : 381 Motors

Total Connected Load : 152.4 kW

Operating Principle

Clutch motors run continuously whenever power is available.

Even when the sewing machine is idle:

- Motor rotates at full speed.
- Electrical energy continues to be consumed.
- Energy is dissipated as heat.

Typical Efficiency : 70–75%

Servo Motor Technology

Servo motors consume energy only when sewing operation occurs.

Typical Efficiency : 85–92%

Energy Reduction Compared to Clutch Motor : 40–70%

Industry Average Saving : 60%

7. ENERGY SAVING OPPORTUNITY ASSESSMENT

Opportunity 1

Replace 381 Clutch Motors with Servo Motors
 Existing Connected Load : 152.4 kW
 Expected Reduction : 60%
 Power Saving : 91.44 kW
 Annual Saving : $91.44 \times 10 \times 300 = 274,320$ kWh/year
 Cost Saving : $274,320 \times 11.42 = 3,132,734$ BDT/year

Opportunity 2

Install VFD on Air Compressor-1

Current Compressor: 22 kW
 Energy Saving Mechanism: The compressor currently operates at fixed speed. When air demand decreases, the compressor still consumes high power. VFD allows compressor speed adjustment according to air demand.
 Affinity Law: $P \propto N^3$
 Expected Saving: 25%
 Power Saving: 5.5 kW
 Annual Saving: 33,000 kWh
 Cost Saving: 376,860 BDT/year

Opportunity 3

Install VFD on Water Pumps

Combined Pump Load:
 10 kW
 Pump Affinity Law: $P \propto N^3$
 Expected Saving: 20%
 Power Reduction: 2 kW
 Annual Saving: 17,520 kWh
 Annual Cost Reduction: 200,678 BDT/year

Opportunity 4

Upgrade Fan System to BLDC Technology

Existing Fan Load: 46.95 kW
 BLDC Fan Efficiency: 85–92%
 Conventional Fan Efficiency: 60–70%
 Expected Saving: 30%
 Power Reduction: 14.08 kW

 Annual Saving: 50,688 kWh
 Cost Saving: 578,857 BDT/year

Opportunity 5

Compressed Air Leakage Reduction Program

Industry Benchmark: 15–30% compressed air loss through leakage.

Leak Sources:

- Hose Connections
- Pneumatic Valves
- Pipe Joints
- Quick Couplings
- FRL Units

A 3 mm leak at 7 bar pressure can waste approximately : 21,900 kWh/year

Cost Impact: $\approx$ 250,000 BDT/year

Recommended Actions:

- Ultrasonic Leak Survey
- Pressure Optimization
- Leak Tagging System
- Monthly Verification Program

Expected Saving : 150,000–250,000 BDT/year

8. CARBON EMISSION REDUCTION

Bangladesh Grid Emission Factor : 0.67 kg CO₂/kWh

Total Energy Saving Potential : 375,528 kWh/year

Annual CO₂ Reduction: $375,528 \times 0.67 = 251,604$ kg CO₂/year

9. FINANCIAL IMPACT ANALYSIS

Measure	Annual Saving (BDT)
Servo Motor Conversion	3,132,734
Compressor VFD	376,860
Pump VFD	200,678
BLDC Fan Upgrade	578,857
Air Leakage Reduction	200,000

Total Estimated Annual Saving = 4,489,129 BDT/year

10. OVERALL IMPROVEMENT

Parameter	Existing	After Improvement
Annual Consumption	989,259 kWh	613,731 kWh
Annual Cost	11.29 m. BDT	6.80 m. BDT
Annual Saving	-	4.49 m. BDT
CO ₂ Reduction	-	251.6 Tons/year

11. IMPLEMENTATION PRIORITY

Phase-1 (0–3 Months)

1. Compressed Air Leak Audit
2. Power Quality Analysis using Yokogawa PQ Analyzer
3. Compressor Load Study
4. Load Balancing

Phase-2 (3–6 Months)

1. Install VFD on Compressor-1
2. Install VFD on Water Pumps
3. Energy Monitoring System

Phase-3 (6–12 Months)

1. Replace 381 Clutch Motors with Servo Motors
2. Replace Conventional Fans with BLDC Fans
3. Establish Energy Management Program (ISO 50001 Framework)

Financial Summary (ROI)

Opportunity	Approximate Investment (BDT)	Annual Saving (BDT)	ROI	Payback
Air Compressor-1 VFD	290,000	376,860	70%	12.9 Months
Water Pump VFDs	150,000	200,678	80%	12.4 Months
BLDC Fan Replacement	3,067,000	578,857	18.9%	5.3 Years
Compressed Air Leak Management	100,000	95,928–200,000	96–200%	6–12 Months

Conclusion

The largest energy-saving opportunity at Factory XX is the replacement of 381 clutch sewing motors with high-efficiency servo motors, contributing nearly 70% of the total energy-saving potential. Combined with VFD implementation, fan modernization, and compressed-air system optimization, the factory can reduce its annual electricity expenditure by approximately **BDT 4.5 million per year**, corresponding to an overall energy reduction of **20–25%**. Based on the estimated investment, the proposed energy conservation measures are expected to achieve an **annual Return on Investment (ROI) of approximately 60–80%**, with an overall **simple payback (investment recovery) period of approximately 1.8–1.9 years**. In addition to significant financial savings, these improvements will enhance production efficiency, equipment reliability, operational flexibility, and environmental sustainability while reducing the plant's overall carbon footprint.