Impact of the Global Energy Crisis on Textile Manufacturing: A Strategic Roadmap

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Abstract
The textile manufacturing sector has experienced unprecedented energy-related challenges in recent years due to volatile fuel markets, geopolitical instability, and increasing electricity prices. These developments have significantly influenced production costs and operational efficiency, particularly in developing economies. This paper analyses these impacts on India's textile industry and proposes practical engineering strategies for improving energy resilience through renewable energy integration, process optimisation, digital energy management, and waste heat recovery.
India's textile industry, one of the world's largest employers, depends heavily on thermal and electrical energy for spinning, weaving, wet processing, garmenting, and finishing. Escalating energy costs have driven up production expenses, reduced global competitiveness, and affected export performance.

This paper examines the technical and economic impacts of the energy crisis on textile manufacturing in developing countries, with a special focus on India. It also presents a practical strategic roadmap centred on renewable energy adoption, open-access power procurement, energy-efficient technologies, digitalisation, waste heat recovery, and policy support. The study concludes that long-term resilience can only be built through integrated energy planning, technological modernisation, and sustainable manufacturing practices.

Keywords
Global energy crisis, textile industry, India, energy management, renewable energy, sustainability, strategic planning, industrial resilience

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1.0 Introduction:

The global energy crisis gained momentum after the COVID-19 pandemic, driven by geopolitical tensions, fuel supply disruptions, inflation, and surging energy demand. Conflicts such as the Russia-Ukraine war and instability in the Middle East caused sharp volatility in crude oil and natural gas prices, severely affecting manufacturing worldwide. Developing countries suffered even more due to heavy reliance on imported fossil fuels and weak energy infrastructure.

Textile manufacturing requires substantial quantities of both electrical and thermal energy because every stage of production, from fibre preparation to finishing, depends on energy-intensive equipment. Wet processing operations account for the highest thermal demand owing to repeated heating, washing, drying, and curing processes.In India, energy costs typically account for 15–20% of total textile production costs, making energy a critical factor for profitability.

India's textile sector plays a vital role in the economy, contributing significantly to GDP, exports, and employment. It directly employs over 45 million people and is concentrated in major clusters such as Bhiwandi, Malegaon, Ichalkaranji, Surat, Ahmedabad, Tirupur, and Ludhiana. However, rising electricity tariffs, fuel shortages, and price volatility are threatening the industry's sustainability and competitiveness.

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2. Global Energy Crisis: Background and Causes

2.1 Major Causes and Their Impact

Factor	Impact on Textile Industry
Geopolitical disturbances	Sharp rise in natural gas and crude oil prices
Supply chain disruptions	Delays in coal and fuel procurement
Inflation & currency issues	Higher cost of imported fuels
Power shortages	Frequent production interruptions
Rising industrial demand	Increased electricity tariffs
Climate regulations	Higher compliance costs

Global crude oil prices surged between 2022 and 2025, directly affecting transportation, synthetic fibre production, chemicals, and thermal energy generation. Textile units relying on diesel generators, furnace oil, coal, and natural gas faced severe cost increases. Many processing units in western India reported significant financial stress due to rising diesel and fuel prices.

3. Energy Consumption Pattern in Textile Manufacturing

Textile production is highly energy-intensive, with different stages requiring different forms of energy.

3.1 Energy Consumption by Process

Textile Process	Major Energy Source	Approximate Share
Spinning	Electricity	35–40%
Weaving / Knitting	Electricity	15–20%
Wet Processing	Steam + Electricity	30–35%
Garmenting	Electricity	5–8%
Utilities	Thermal + Electrical	10–15%

Source: https://www.mdpi.com/, https://textilelearner.net/, https://www.sciencedirect.com/,https://www.fibre2fashion.com/

Wet processing generally accounts for the highest thermal energy demand in textile manufacturing due to extensive heating and drying operations (Hasanbeigi et al., 2022).

"The textile industry is among India's major industrial consumers of coal, natural gas, biomass, furnace oil and electricity."

4. Impact of the Global Energy Crisis

4.1 Rising Production Costs

Escalating fuel and electricity prices have increased the operating cost of boilers, thermic fluid heaters, compressed-air systems, and process heating equipment. Consequently, manufacturers have experienced reduced operating margins, particularly in export-oriented textile clusters where energy constitutes a significant share of production costs.In many clusters, electricity tariff hikes have squeezed profit margins and weakened export competitiveness.

4.2 Production Disruptions

Power shortages and unstable fuel supply have led to machine downtime, reduced capacity utilisation, delayed shipments, and longer lead times. Several units in Gujarat and Maharashtra were forced to cut production during the peak crisis periods.

4.3 Decline in Export Competitiveness

Elevated energy costs have raised the prices of fabrics and garments, making Indian products less competitive compared to countries with subsidised power or lower energy costs.

4.4 Disproportionate Impact on MSMEs

Small and medium enterprises have suffered the most. Limited capital, outdated machinery, dependence on conventional energy, and poor energy efficiency have left them highly vulnerable.

5. Technical Analysis of Energy Consumption

Equipment	Energy Type	Key Efficiency Concern
Boiler	Thermal	Heat loss
Thermo-pack	Thermal	Combustion inefficiency
Stenter	Thermal + Electrical	Exhaust heat loss
Air Compressor	Electrical	Leakage losses
Dyeing Machine	Thermal	Steam wastage
Chiller	Electrical	High peak demand
Motors & Pumps	Electrical	Overloading

5.1 Major Energy-Consuming Equipment

5.2 Typical Energy Losses

- Steam leakage: 5–10%
- Condensate loss: 10–15%
- Improper insulation: 5–8%
- Compressed air leakage: 20–30%
- Inefficient motors: 8–12%

Well-planned energy audits and process optimisation can deliver substantial savings.

6. Strategic Roadmap for India

6.1 Renewable Energy Integration

Indian textile companies are gradually shifting towards solar power, biomass boilers, wind energy, group captive projects, and open-access renewable procurement. The share of renewables in the sector's power consumption rose from around 14% in FY2023 to nearly 18% in FY2025.

Recommended Renewable Strategy

- Rooftop Solar → Best suited for garmenting and spinning units
- Biomass Boilers → Ideal for wet processing
- Group Captive Solar → Suitable for integrated mills
- Wind Power → Large industrial clusters

6.2 Open Access Power Procurement

Open-access buying can cut power costs by 15–30%, reduce dependence on state utilities, and improve reliability. Clusters in Maharashtra and Gujarat are increasingly adopting captive and group-captive renewable models.

6.3 Energy Efficiency and Conservation

Measure	Potential Savings
VFD installation	10–20%
Waste heat recovery	15–25%
Condensate recovery	10–15%
LED lighting	5–8%
High-efficiency motors	5–12%
Heat pump technology	20–40%

Source: https://ingener.by/, https://www.sciencedirect.com/, https://www.researchgate.net/

6.4 Digital Energy Management

IoT-based monitoring, AI-driven predictive analytics, real-time dashboards, and smart load management can significantly improve efficiency.

6.5 Sustainable Wet Processing

Adopting low liquor ratio dyeing, cold pad batch processing, enzyme-based methods, heat recovery systems, and water recycling can reduce both energy use and environmental impact.

7. Policy Recommendations

The government should focus on:

- Higher subsidies for renewable energy adoption by MSMEs
- Simplified open-access regulations
- Mandatory periodic energy audits
- Low-interest green financing
- Incentives for carbon reduction and cleaner production

8. Proposed Strategic FrameworkIntegrated Energy Resilience Framework

Phase 1: **Assessment –** Energy audits, baseline mapping, and benchmarking

Phase 2: **Optimisation –** Utility modernisation and efficiency improvements

Phase3: **Renewable Integration –** Solar, biomass, and captive power projects

Phase 4:**Digital Transformation –** Smart monitoring and predictive maintenance

Phase 5: **Sustainability Compliance –** Carbon tracking, ESG reporting, and circular practices

9. Future Outlook

The textile industry of the future will rely on renewable energy, smart manufacturing, sustainable processing, energy-efficient machinery, and circular economy principles. Companies that act early will enjoy lower costs, stronger export competitiveness, better ESG performance, and long-term sustainability. Developing economies must move from reactive crisis management to proactive energy resilience planning.

10. Conclusion

The global energy crisis has clearly exposed the vulnerabilities of textile manufacturing in developing countries. In India, rising energy costs, operational instability, and growing sustainability demands present serious challenges. Yet, this crisis also offers a valuable opportunity to modernise the industry.

By adopting renewable energy, improving efficiency, embracing digital tools, and implementing supportive policies, India can build a more resilient and competitive textile sector. Sustainable energy planning is no longer optional — it has become essential for survival and future growth.

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