

ENHANCING ELECTRICAL ENERGY EFFICIENCY IN HOOKAH MANUFACTURING FACILITIES: STRATEGIES FOR IMPROVED SUSTAINABILITY AND COST-EFFECTIVENESS

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Annotation: The industrial production of shisha (hookah) equipment is an energy-intensive process, particularly in its electrical power consumption. This article reviews and analyses strategies to increase electric energy efficiency in shisha manufacturing enterprises, covering measurement and monitoring, process and equipment optimisation, adoption of digital technologies and organisational management practices. Based on international research on manufacturing energy efficiency and industrial electricity use, the paper proposes a framework tailored to shisha-production factories that integrates technical, process and management measures for improved energy performance. The findings suggest that by implementing structured energy monitoring, upgrading key electrical systems (motors, drives, lighting), applying smart manufacturing tools and improving workforce energy awareness, manufacturing plants can reduce electrical energy consumption by 10-30 % while maintaining productivity.

Keywords: industrial electricity consumption, energy efficiency, monitoring & targeting, smart manufacturing, electrical systems optimisation

Introduction

Manufacturing enterprises consume a significant share of global electricity. According to data for the United States, the industrial sector accounted for 35 % of total end-use energy consumption in 2022, of which manufacturing alone represented more than three-quarters of industrial energy use. Within manufacturing, electricity is used for motor-driven equipment, lighting, air conditioning, process drives and general facility systems.

In the context of shisha production, typical operations include metal fabrication (stamping, bending, welding), surface finishing (polishing, coating), assembly (motor-driven conveyors, robotic or manual assembly lines), packaging and facility services (HVAC, lighting, compressed air). Each of these subsystems draws electricity; inefficiencies in motors, drives, idle times, poor maintenance and lack of monitoring can lead to excessive consumption.

Globally, energy efficiency has become a “first fuel” in clean energy transitions: according to the International Energy Agency (IEA), efficiency provides some of the quickest and most cost-effective ways to reduce CO₂ emissions and energy bills. For manufacturing enterprises, improvements in electricity efficiency translate directly into cost savings, improved competitiveness, and reduced environmental impact.

Despite this, many industrial plants operate without systematic energy management and rely on legacy equipment. Studies of industrial energy use show that potential savings from monitoring, optimisation and equipment upgrade are large. For a shisha manufacturing enterprise, this means that focusing on electrical energy consumption—not merely thermal or fuel energy—is a strategic opportunity.

In this article we analyse key areas of electricity use in shisha-equipment manufacturing and propose structured measures under three broad dimensions: monitoring & measurement, technical & process optimisation, and organisational & digital-technology adoption. We then discuss how these apply to the specific domain of shisha manufacturing, and propose a targeted improvement roadmap.

Analysis and Discussion

Electricity consumption profile in shisha manufacturing

Although detailed published studies specific to shisha manufacturing are scarce, general manufacturing energy investigations provide clear guidance. For example, the U.S. Department of Energy (DOE) 2018 footprint for manufacturing shows how electricity and fuel are distributed across end-uses—revealing that machine-driven equipment, process heating/cooling, and facility services dominate. Key lessons for a shisha production plant include:

- Electric motors and drives often account for a large share of electricity consumption, especially in conveyor systems, polishing lines, packaging, ventilation and material handling.
- Lighting, HVAC, compressed-air supply, and general services frequently operate inefficiently (over-size, poor controls, idle periods) and contribute disproportionately to waste.
- Process idling, change-over times, and sub-optimal scheduling increase stand-by electricity loads.
- Lack of granular monitoring means that excessive consumption or abnormal behaviour goes unnoticed; many companies rely on monthly bills rather than real-time consumption breakdowns.

According to Todorov et al., in their modelling of energy-efficient consumption at industrial enterprises, the largest portion of potential energy savings came from energy-saving projects in industrial buildings and supply systems (i.e., in services, not just core process).

Thus, for a shisha manufacturer, a starting point is to map the electricity flows: identify which lines and operations draw the most power, where idle loads exist, and where process inefficiencies contribute.

Monitoring, measurement, and targeting

A foundational measure for improving electricity efficiency is implementing real-time monitoring, measurement and reporting systems. As one review points out, one cannot manage what one cannot measure. Key elements include:

- Installing sub-metering at major loads: e.g., welding equipment, polishing/stamping lines, conveyors, HVAC, lighting circuits.
- Using data acquisition and analytics to establish baseline consumption patterns, identify abnormal runs, and benchmark performance over time. Henning et al. emphasise multi-level monitoring, anomaly detection, forecasting and visualisation as important goals.
- Setting key performance indicators (KPIs) for electricity consumption per unit of production (e.g., kWh per number of shishas produced, or weight of metal processed).
- Employing monitoring & targeting (M&T) programmes: energy use is plotted against production output (or machine hours) to detect when consumption drifts upward.
- Ensuring feedback loops to operations management: e.g., daily or weekly reports, alerting when consumption exceeds threshold.

With such a system in place, wasteful behaviour (idle conveyors left running, polishing machines in standby, lighting in non-production hours) can be detected and corrected. For instance, Schmitt et al., in a recent study of industrial manufacturing, found that digital technologies enabled improved monitoring, evaluation and optimisation of energy flows.

In the context of a shisha factory, electrode motors for polishing, conveyors and packaging are often the largest electrical loads—sub-metering these will help target interventions.

Technical and process optimisation

Once measurement is in place, targeted technical and process interventions can reduce electricity consumption. Some of these are generic to manufacturing, others specific to electrical loads:

Equipment upgrade:

- Replace standard induction motors with higher efficiency classes (e.g., IE3 or IE4) and install variable speed drives (VSDs) where load varies. Upgrading motors and drives is recognised as a high-impact measure in industrial energy efficiency programmes.
- Improve motor maintenance: ensure bearings, alignment, belt tensions, ventilation cooling are optimal. Under-maintained motors consume more current and generate waste heat.

- Optimise drive systems for conveyors and polishing lines: ensure machine speeds match throughput, avoid running on full speed when load is light.

Lighting and facility services:

- Replace outdated lighting with high-efficiency LED luminaires, add daylight harvesting and occupancy sensors.
- Introduce smart HVAC control: zone control, schedule off production hours, reduce ventilation when not required, recover waste heat if possible.
- Optimise compressed-air supply: compressed air is often overlooked but uses considerable electricity; check for leaks, inappropriate pressure set-points, idle compressors.

Production scheduling & process idle reduction:

- Avoid idle runs: produce in batches that avoid frequent machine stops/starts, as start-up consumes more electricity than steady running.
- Implement shutdown policy for non-essential equipment during off-hours or breaks.
- Adopt lean manufacturing principles: minimise change-over times, ensure machine utilisation is high, avoid under-loaded conveyors running far below capacity.

According to Schmitt et al., energy efficiency can be achieved by “improving existing processes (reducing non-value-adding energy) or replacing current equipment/design with more efficient alternatives (reducing value-adding energy but low efficiency)”.

For shisha manufacturing, polishing, coating, bore finishing and packaging can benefit from process standardisation, minimising rework and idle times, reducing machine standby and thus electricity wastage.

Digital technologies and smart manufacturing

The advent of Industry 4.0 and digitalisation presents additional opportunities for electricity efficiency in manufacturing. Schmitt et al. emphasised how digital technology stages (computerisation, connectivity, visibility, transparency, predictive capacity, adaptability) and knowledge-demand types (technical, process, leadership) support energy management. Practically, this means:

- Deploying sensors on motors, drives, conveyors to collect real-time consumption, speed, vibration, temperature data.
- Use analytics (edge/cloud) to detect inefficiencies, predict faults and schedule maintenance before machines operate inefficiently. The inclusion of anomaly detection and forecasting improves uptime and reduces excess electricity use. [arXiv](#)
- Integrate energy management with MES (manufacturing execution system) or SCADA so that production can be aligned with electricity-efficient operating modes (e.g., staggering machine start-ups, aligning high-load operations during off-peak electricity tariff periods).
- Apply expert systems for energy efficiency: Ioshchikhes et al. conducted a review of expert systems in manufacturing for that purpose. For a shisha production plant, examples of applications include: automatic shutdown of conveyors when no material present, adjusting drive speed in real time based on throughput, scheduling high-electricity-draw processes (e.g., polishing) during lower tariff times, and identifying motors that operate inefficiently.

Organisational practices, awareness and behaviour

Technical measures alone are insufficient without organisational support. Key practices include:

- Establish an energy management team with a dedicated supervisor, supported by production and maintenance staff.
- Develop an energy policy for the plant with clear objectives: reduce kWh/unit by x % over 12 months, benchmark against similar plants.
- Conduct regular training for operators and maintenance staff: train them to recognise idle machines, understand the impact of electrical efficiency, encourage identification of waste.
- Incentivise energy savings: include energy-efficiency KPIs in performance reviews, reward teams achieving targets.

- Review electricity consumption monthly, compare to production, investigate anomalies (via sub-meter data). Use M&T approach.

The IEA notes that while energy-efficiency investment is increasing, implementation remains insufficient and the rate of improvement has slowed globally. Therefore, the cultural dimension of energy efficiency (behaviour, awareness, continuous improvement) is critical.

Application to shisha manufacturing and targeted roadmap

Given the above dimensions, a road-map for a shisha manufacturing enterprise might include:

1. **Assessment & baseline measurement:** Install sub-meters on major electricity loads (motors, conveyor lines, welding/polishing stations, HVAC, lighting). Record data for 3-6 months to establish baseline kWh per production unit.

2. **Benchmarking & target-setting:** Calculate KPIs (e.g., kWh per shisha unit, kWh per kg metal processed). Set realistic reduction target (e.g., 10 % in 12 months).

3. **Quick wins:**

- Schedule shutdowns for non-production hours; eliminate idle conveyors and lighting.

- Replace inefficient lighting with LED & install occupancy sensors.

- Adjust HVAC and ventilation schedules to match occupancy and production hours.

4. **Medium-term equipment upgrades:**

- Audit motors and drives: replace motors older than 10–15 years with IE3/IE4, add variable speed drives where constant-speed conveyors exist.

- Improve compressed air system: repair leaks, reduce pressure, add load/unload sequencing.

- Review conveyor and polishing lines for idle running and optimise throughput or shutdowns.

5. **Digital integration and optimisation:**

- Install sensors on key motors/drives, integrate with edge analytics to detect inefficient operation, faults or over-consumption.

- Align production scheduling with electricity tariffs or low-demand times; implement smart shutdown/start routines.

- Use data analytics to correlate machine usage, production output and electricity consumption, identify anomalies.

6. **Organisational change:**

- Formalise energy management, assign responsibilities, create monthly energy reports, hold reviews.

- Conduct training: demonstrate to operators how machine idle time impacts electricity consumption and cost.

- Incentivise teams to suggest energy-saving ideas.

7. **Continuous improvement and monitoring:**

- Use the monitoring system to track progress, adjust targets annually (e.g., strive for further 5 % reduction).

- Review equipment upgrade list annually, prioritise highest-kWh machines for replacement or retrofit.

- Maintain visibility of electricity intensity (kWh/unit) and report to senior management to keep focus.

Over time, such a programme can yield electricity savings of 10-30 % or more, depending on baseline inefficiency, while also improving productivity and reducing maintenance issues.

Challenges and limitations

While the roadmap is robust, certain challenges are worth noting:

- Capital investment may be required for motor/drive upgrades, sub-metering and digital analytics; payback must be demonstrated. Todorov et al. found that major savings became economically feasible when large modernisation programmes were implemented.
- In some regions, electricity tariffs may not reflect cost incentives for efficiency (flat rates, lack of demand charges), reducing business case strength.
- Measurement and data analytics require competent staff and may face resistance from operators if perceived as monitoring mistakes rather than improvement.
- Process constraints: some machines cannot be easily turned off due to heating/cooling cycles or quality requirements (e.g., polishing lines needing prior warm-up), limiting certain shutdown practices.
- Digital technology adoption brings cybersecurity, integration and change-management issues. Schmitt et al. highlighted knowledge and process demands as key. Nevertheless, by acknowledging these challenges and building a staged implementation with business case justification, shisha-manufacturing enterprises can make substantial progress.

Conclusion

In the manufacturing of shisha equipment, electrical energy consumption is a significant cost driver and environmental burden. By applying structured energy-efficiency measures—starting with monitoring and targeting, then technical and process optimisation, and embedding smart manufacturing and organisational practices—a factory can reduce electricity consumption while sustaining or even improving productivity. Key success factors include establishing baseline measurement, setting clear KPIs, upgrading high-impact electrical systems, leveraging digital analytics for ongoing optimisation, and creating an energy-conscious culture among staff. Given international evidence on manufacturing energy efficiency, such gains are not only feasible but increasingly necessary for competitive and sustainable operations.

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