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The Role of Intelligent Energy Supply Systems in Enhancing the Resilience and Digital Commercialization of Uzbekistan's Handicraft Sector

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Abstract. This paper examines how intelligent energy supply systems enhance the resilience of Uzbekistan's handicraft sector and enable digital commercialization of craft products and services. Using national energy indicators (annual generation ≈70 billion kWh; transmission and distribution losses 15–20%; businesses face 24–29 days of outages annually; renewables share ≈6.6%; demand projected to 109–123 by 2030),[1] we quantify potential gains from Smart Grid technologies, distributed renewables and advanced metering infrastructure. Policy, technical and financing recommendations for phased implementation are provided.

INTRODUCTION

Handicraft production represents a significant segment of Uzbekistan's local economy, generating employment, preserving cultural traditions, and forming a potential base for export-oriented development. However, limited energy-supply reliability and the high proportion of network losses reduce productivity and make the transition toward digital commerce both costly and risky[2]. The aim of this study is to demonstrate how intelligent energy supply systems (hereafter, IESS) mitigate operational risks for artisans, enhance access to digital sales channels, and reduce associated costs.

LITERATURE REVIEW

Key sources on Smart Grid technologies, distributed generation, and the impact of energy-supply quality on small-scale production include reports by the International Energy Agency (IEA)[3] and the World Bank on Uzbekistan, as well as demand-forecasting analytical models developed by the German Economic Team. Empirical data on system losses and reliability consistently confirm the presence of substantial untapped potential for optimization[4].

METODOLOGY

The study combines several methodological approaches: an analysis of official statistical sources and reports issued by international organizations; [5]a modeling framework assessing how reductions in energy losses and

[1] German Economic Team (GET), *Uzbekistan electricity demand forecast to 2035*, 2024/2025. [Online]
[2] World Bank, *Uzbekistan Electricity Sector Transformation and Resilient Transmission Project*, 2023. [Online].
[3] https://www.iea.org/reports/uzbekistan-energy-profile/energy-security
[4] World Bank, internal data, *Growth Diagnostics for Uzbekistan*
[5] https://www.iea.org/reports/uzbekistan-energy-profile/energy-security

improvements in supply reliability influence the productivity of handicraft workshops;[6] and a techno-economic evaluation of three implementation scenarios, namely localized energy islands, micro-/distributed grids with the capability to sell surplus electricity, and the digital integration of energy data with commercial trading platforms. For the quantitative component, the model relies on baseline indicators including an annual electricity generation of approximately 70 billion kWh and a projected demand of 109–123 TWh by 2030.[7]

RESULTS

The study yields several key findings. First, regarding reliability, the current level of network losses (15–20 percent) and the frequency of power outages (24–29 days per year for enterprises,[8] according to World Bank estimates)[9] have a substantial impact on productivity. The transition to intelligent energy supply systems equipped with automatic diagnostics, remote control, and AI-based predictive maintenance—both in pilot projects and in international practice—reduces outage duration and facilitates faster localization of faults. Second, the development of micro-hubs with partial energy autonomy demonstrates significant potential. Establishing handicraft hubs equipped with solar panels and storage systems ensures continuity of critical operations, including resilience during peak-load periods, uninterrupted functioning of online sales channels, and the preservation of materials and finished products during disruptions in centralized supply.

Third, the economic impact is considerable. Reducing downtime and lowering energy expenditures (with average retail tariffs of approximately USD 0.045/kWh for households and USD 0.076/kWh for businesses as of 2025) increases the profitability of artisanal production. Peak-load management and dynamic pricing can reduce energy costs by 20–35 percent under comprehensive implementation of efficiency measures and local generation.

Fourth, stable energy supply enables digital commercialization. Reliable electricity ensures continuous operation of online sales, order-management systems, and logistics platforms. When combined with digital-skills training and integration into online marketplaces, artisans experience tangible sales growth and expanded access to export channels.

The quantitative analysis further shows that the current structure of Uzbekistan's energy system leads to significant economic losses and constrains the commercial resilience of the handicraft sector. With annual electricity generation of approximately 70,000,000,000 kWh and network losses of 15–20 percent, the absolute amount of energy lost ranges from 10,500,000,000 kWh (at 15 percent) to 14,000,000,000 kWh (at 20 percent). At an estimated average retail price of USD 0.045/kWh for households, the notional monetary value of these losses is between USD 472,500,000 and USD 630,000,000 per year. [10]These estimates illustrate that even a several-percentage-point reduction in losses is far from a minor academic refinement; it reflects hundreds of millions of dollars in resources that could be redirected to investments in micro-energy solutions for handicraft hubs, training, and logistics.

The transition to intelligent energy supply systems—consisting of advanced metering infrastructure (AMI), digital dispatching, predictive maintenance of lines and transformers, and integration of distributed generation and storage—produces substantial reductions in both losses and outages, as demonstrated by international benchmarks. In the scenario models applied in this study, a realistic implementation pathway reduces effective network losses by roughly half (from 15–20 percent to 7.5–10 percent), equivalent to savings of 5,250,000,000–7,000,000,000 kWh. At the same retail price of USD 0.045/kWh, this corresponds to annual monetary savings of approximately USD 236,250,000–315,000,000. When the value of avoided downtime for workshops is considered—not merely the monetary value of energy—the effect is even more pronounced. Reduced losses and improved grid controllability directly decrease the duration of long outages.

The practical implications for a small workshop are clear. Suppose a typical workshop consumes 10,000 kWh per year—an illustrative, transparent assumption suitable for demonstration and to be refined through local survey data. At the business tariff of approximately USD 0.076/kWh, annual electricity costs amount to 10,000 × 0.076 = 760 USD. If the combination of local solar installation and load-management measures yields a 30 percent cost reduction, annual savings reach 228 USD per workshop. For a cooperative of 20 workshops, this totals 4,560 USD per year—

[6] World Bank, internal data, *Growth Diagnostics for Uzbekistan*
[7] https://www.german-economic-team.com/en/newsletter/get-forecast-electricity-demand-to-grow-strongly-by-2035
[8] Available: https://documents1.worldbank.org/curated/en/184411624932251299/pdf/Uzbekistan-Electricity-Sector-Transformation-and-Resilient-Transmission-Project.pdf
[9] World Bank, 2023
[10] https://www.iea.org/reports/uzbekistan-energy-profile/energy-security

enough to finance a digital-marketing manager or partially lease storage infrastructure. These simple figures show how energy-related savings directly transform into resources for digital commercial development.

With respect to reliability, enterprises currently experience 24–29 days of outages annually. In Smart Grid and microgrid pilot projects, outage duration decreases by 50–80 percent depending on the available redundancy and responsiveness of grid control. Under a conservative scenario (50 percent reduction), 24–29 days fall to 12–14.5 days; under a more ambitious scenario (75 percent reduction), to 6–7.25 days. Reduced downtime directly increases production volume and lowers the defect rate: if current losses due to outages amount to 12–18 percent of annual output for a typical workshop, the reduction in downtime can decrease losses to 2–4 percent.[11] For an entrepreneur, this means not only saving on electricity but also increasing revenue, since uninterrupted operations translate into proportional growth in output, assuming steady demand.

Additional Quantitative Effects. Another numerical effect relates to projected electricity demand and the resulting pressure on the grid. If current consumption is close to 70 TWh and forecasts indicate 109–123 TWh by 2030, this implies an increase in load of approximately 39 to 53 TWh (109 − 70 = 39; 123 − 70 = 53). An increase of this magnitude, if not accompanied by network modernization, will inevitably intensify the frequency of system failures and overloads, particularly under conditions of uneven demand distribution. Integrating intelligent energy systems and distributed renewable energy sources reduces peak loads and lowers the need for capital investment in the transmission network because part of the demand is met by localized generation. This approach cuts expenditures for distribution companies and decreases the risk of operational disruptions for small producers. The calculations at the national level and their implications for the handicraft sector yield several illustrative conclusions. If intelligent energy systems reduce system losses by 5 percentage points (for example, from 15 percent to 10 percent), the amount of saved energy would equal 0.05 × 70,000,000,000 = 3,500,000,000 kWh.

At a price of USD 0.045/kWh, this corresponds to USD 157,500,000 saved annually[12]. These funds could be partially directed toward support programs for artisans and partially toward subsidizing local generation installations. Such recalculations demonstrate the mechanisms of benefit redistribution: technical optimization of the grid translates into real financial flows for the sector.

The study also models the direct contribution of intelligent energy systems to digital commercialization. Given the current level of digital engagement among artisans, estimated at 25–30 percent, and the average potential increase in sales through online marketplaces of 35–60 percent following the stabilization of energy supply and digital-skills training, even a conservative scenario indicates significant growth in annual revenue. For example, if a workshop currently earns USD 5,000 per year from sales and digital transformation raises sales by 35 percent, the additional income amounts to USD 1,750. Considering the regional employment multiplier and the role of household labor (each workshop typically supports 2–3 jobs), the effect on the local economy becomes substantial.

It is important to emphasize that all numerical estimates in this section are illustrative and based on aggregated national indicators and established Smart Grid implementation practices. For local precision, primary data should be collected, including actual workshop energy-consumption measurements, documented product-loss rates due to outages, surveys on revenue loss during power cuts, and economic metrics of sales before and after digitalization. Nevertheless, even conservative estimates confirm that the adoption of intelligent energy systems can convert a significant share of systemic losses into development capital for the handicraft economy.

Finally, the quantitative analysis supports several key conclusions relevant for practical policymaking. First, the economic rationale for intelligent energy systems is robust: reducing losses and decreasing outage frequency generates direct monetary benefits—amounting to hundreds of millions of dollars at the national level and hundreds of dollars per workshop—which can finance digital commercialization. Second, investments in intelligent energy systems exhibit a multiplier effect: beyond direct savings, they enhance internet reliability and support the functioning of payment gateways, both of which are critical for e-commerce in handicraft products. Third, pilot projects with transparent monitoring of energy consumption, clear accounting of economic effects, and accompanying training programs produce rapid feedback and create a strong justification for scaling up national initiatives.

[11] World Bank, internal data, *Growth Diagnostics for Uzbekistan* (data on enterprise outage days

[12] Available: https://www.globalpetrolprices.com/Uzbekistan/electricity_prices/

Table 1. Comparison of Key Indicators: Traditional vs. Intelligent Energy Supply Systems.

Indicator	Traditional System	Intelligent System (after implementation)
Average Number of Outages per Month	6–8	1–2
Production Losses Due to Downtime	12–18%	2–4%
Energy Expenses	High	Decreased to 20–35%
Potential for Integration of Renewable Energy Sources (RES)	Limited	High

Table 2. Impact of Intelligent Energy Systems on the Digital Commercialization of the Handicraft Sector

Parameter	Before Implementation	After Implementation
Availability of Online Sales	Low	High
Equipment Operational Stability	Medium	High
Level of Digital Activity of Artisans	25–30%	60–75%
Average Sales Volume via Marketplaces	Baseline	+35–60%

Scenario A: Handicraft energy hubs based on solar panels and storage systems. Assessment: low entry threshold for cooperatives, rapid impact on reliability and ability to sustain digital sales.

Scenario B: Connection to micro/distributed networks with the possibility of selling energy on the local market. Assessment: requires institutional support and accessible financing, but generates additional revenue.

Scenario C: Full digital integration of energy data with order management, payment systems, and logistics. Assessment: maximal effect for commercialization, requires broad digital literacy and stable internet access.

Economic and Institutional Recommendations: It is necessary to implement pilot projects involving artisan cooperatives and local authorities, include elements of grants and concessional financing for solar systems and storage, and develop PPP mechanisms and “energy as a service” schemes. Educational programs should combine technical training (operation of micro-energy systems) and digital skills (online sales, marketing).

Key Barriers: access to capital, limited technical skills, need for network modernization, cybersecurity risks in IT-energy integration. It is recommended to develop regulations on energy data exchange, privacy protection, and safeguarding critical infrastructure.

Methodological Notes: This article uses aggregated national indicators and forecasts presented in reports by the IEA, World Bank, and German Economic Team; local economic impact estimates are modeled based on international Smart Grid implementation practices and pilot projects for renewable energy integration in production hubs.

CONCLUSIONS

Intelligent energy systems provide practical and measurable benefits for the handicraft sector: reducing losses, minimizing downtime, improving efficiency, and creating a platform for digital commercialization. In Uzbekistan, where energy consumption is growing rapidly and network losses are significant, the priority is to combine infrastructure modernization with support for small-scale production.

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