A Guide to Industrial Electricity Costs and Grid Stability in Costa Rica

A Factual Guide for Manufacturing Investors

Content Partner: J. v. G. technology GmbH

Turnkey solar module production lines — since 1997

www.jvg-thoma.com

Technical Overview: Industrial Electricity Costs and Grid Stability in Costa Rica

Created as part of the PVKnowHow Knowledge Network

Prepared by J.v.G. Technology GmbH

European specialists in turnkey solar module production lines

Costa Rica: Renewable Energy Profile

Energy Mix (2023 Reference)

- ~95% of electricity from renewable sources in 2023
- Hydropower: ~74% of total generation
- Geothermal: ~13% | Wind: ~12.5%
- Solar & biomass: <1% combined
- Backup thermal (diesel/bunker): remainder

Institutional Context

- Grid managed by Instituto Costarricense de Electricidad (ICE)
- State-owned, vertically integrated utility
- 99.4% national electricity coverage
- National Energy Plan 2015–2030 targets diversification
- Ranks 3rd in Latin America on energy transition index (WEF)

Source: Trade Commissioner of Canada / ICE / World Economic Forum (2023). Renewable share varies year-to-year based on hydrology.

Opportunity: Green Manufacturing Positioning

Low-Carbon Supply Chain

- ~95%+ renewable-sourced electricity enables credible low-carbon product claims
- Relevant for ESG reporting and EU market access
- Increasingly valued by OEM buyers and downstream investors

Brand & Market Differentiation

- Green manufacturing positioning supports premium positioning in regulated markets
- Aligns with European and North American procurement criteria
- Reduces Scope 2 emissions without costly offsets

Policy Alignment

- Costa Rica's National Decarbonization Plan targets 100% renewable electricity by 2030
- Stable long-term policy direction reduces regulatory risk for investors
- State utility structure provides consistent tariff governance

Risk: Hydropower Seasonality

The Structural Vulnerability

- Hydropower accounts for ~70–74% of national generation
- Output is directly dependent on rainfall and reservoir levels
- Dry season (Dec–Apr) reduces hydro output significantly
- El Niño events can cause prolonged drought conditions
- In 2024, El Niño reduced rainfall — renewable share fell to ~86%

Observed Consequences

- Hydropower reservoir inflows fell ~16% during 2023/24 drought
- Thermal backup (diesel/bunker) activated — rising to ~25% of mix in peak months
- ICE announced potential rationing in May 2024 (not implemented)
- Grid dispatchers may prioritize residential supply over industrial loads
- Tariff implications: fossil backup increases system costs

⚠ Investors should not rely solely on national renewable averages. Seasonal and drought-year scenarios must be factored into energy cost and continuity planning.

Industrial Electricity Cost Range in Costa Rica

$0.15

Lower Bound

Off-peak, favorable tariff period; large industrial consumer classification

$0.20

Upper Bound

Per kWh — peak-period consumption; demand charge components included

~$0.19

Blended Average

Approximate effective rate for a continuous industrial operation (reference estimate)

Tariffs are set by ICE and subject to regulatory review. The $0.15–$0.20/kWh range is a reference benchmark for industrial planning. Actual rates depend on voltage level, contracted demand, and consumption profile. Source: PVKnowHow reference framework.

Demand Charges Explained

What Is a Demand Charge?

- A separate billing component based on peak power draw (kW), not energy consumed (kWh)
- Measured as the highest 15- or 30-minute average power demand in the billing period
- Charged regardless of how briefly the peak occurs
- Designed to recover utility infrastructure costs for sizing capacity to peak load

Impact on Manufacturing Operations

- Start-up surges from large motors, ovens, or laminators create peaks
- A single brief spike can set the demand charge for the entire month
- For energy-intensive processes, demand charges can represent 30–50% of total bill
- Staggering equipment start-ups can significantly reduce peak demand
- Load management and scheduling are primary levers to control this cost

Time-of-Use Tariffs: Peak vs. Off-Peak

Peak Hours (Higher Rate)

- Typically morning and evening demand peaks
- Rates are materially higher than base tariff
- Energy-intensive processes run during this period drive up costs significantly
- Grid stress is highest — voltage fluctuation risk elevated

Off-Peak Hours (Lower Rate)

- Typically midday and overnight windows
- Most cost-effective period for high-energy process steps
- Grid is generally more stable during off-peak periods
- Scheduling flexibility is a direct operational cost lever

Weekend & Holiday Rates

- Reduced rates may apply on weekends and public holidays
- Continuous 24/7 production lines benefit from averaging across all periods
- Weekend batch processing can be aligned to minimize peak-period exposure

Exact time-of-use windows and rate differentials are defined by ICE tariff schedules applicable to the industrial consumer's voltage category. These should be confirmed during site-specific due diligence.

Cost Optimization via Production Scheduling

1

Step 1 — Map Energy Load Profile

Identify which process steps draw the highest power (e.g., heating, lamination, soldering)

Quantify peak demand events and their timing

2

Step 2 — Align Scheduling to Tariff Windows

Shift high-energy steps to off-peak and weekend periods where operationally feasible

Avoid stacking equipment start-ups to suppress demand peaks

3

Step 3 — Implement Demand Management Controls

Install energy monitoring systems with real-time demand tracking

Set automated load shedding thresholds to prevent peak demand spikes

4

Step 4 — Quantify Savings vs. Baseline

Model effective blended rate under optimized vs. unoptimized schedule

Factor savings into project financial model and payback calculations

Grid Stability Risks: Understanding SAIDI & SAIFI

Key Reliability Metrics

- **SAIDI** — System Average Interruption Duration Index: average total outage duration per customer per year (measured in minutes or hours)
- **SAIFI** — System Average Interruption Frequency Index: average number of outages per customer per year
- Lower values indicate a more reliable grid
- IEEE benchmark: median North American SAIDI ~1.5 hours/year

Costa Rica Context

- National averages may not reflect local distribution reliability at a specific site
- Factors: severe weather, local line faults, regional demand spikes
- Dry-season grid stress can elevate both SAIDI and SAIFI temporarily
- Industrial zones vary significantly — site-level assessment is essential
- Assessing local grid reliability is a critical due diligence step before committing to a site

Downtime Impact on Solar Module Manufacturing

Direct Production Loss

- A single hour of unplanned downtime on a ~50 MW reference line represents significant lost output
- Automated lines cannot simply pause and resume — in-process material may be scrapped
- Throughput loss compounds over a multi-shift production schedule

Process-Critical Risk Points

- Power loss during lamination can damage modules in-chamber (temperature, vacuum loss)
- Soldering and tabbing steps are equally sensitive to power interruptions
- Restart cycles consume additional energy and extend cycle time

Financial Exposure

- Lost production + scrap material + restart labor + potential equipment repair
- Warranty exposure if quality is compromised by interrupted processes
- Downstream delivery commitments may be affected

⚠ Source reference: Based on turnkey project experience (PVKnowHow / J.v.G. Technology GmbH). Actual financial exposure depends on line configuration, product mix, and contract terms.

Mitigation: UPS Systems & Backup Generation

Uninterruptible Power Supply (UPS)

- Provides instantaneous bridging during grid interruptions (typically seconds to minutes)
- Protects sensitive process equipment from voltage transients and micro-interruptions
- Essential for PLC-controlled production equipment — preserves process state
- Must be sized to cover critical loads during transfer to backup generation

Diesel / HFO Backup Generators

- Provide sustained power during extended grid outages (minutes to hours)
- Sized to cover full production load or critical process-only load
- Transfer time (UPS bridge → generator) is a key design parameter
- Fuel storage capacity determines autonomy — typically 24–72 hours on-site

Design Considerations

- UPS + generator combination is standard for precision industrial applications
- Capital cost and maintenance must be included in total project budget
- Sizing should be based on actual load profile, not theoretical maximum
- Automatic transfer switching (ATS) ensures seamless operation without manual intervention

Mitigation: Operational Scheduling

1

Grid Monitoring Integration

Real-time monitoring of grid voltage, frequency, and demand; automated alerts trigger load management responses before equipment is affected

2

Peak Demand Avoidance

Scheduling energy-intensive steps outside peak tariff windows reduces both cost and grid-side risk; staggered start-up protocols suppress demand spikes

3

Maintenance Alignment

Planned maintenance windows aligned with grid stress periods (dry season peaks) reduce exposure; predictive maintenance reduces unplanned downtime further

Operational scheduling is a zero-capex mitigation measure that directly reduces both electricity cost and process disruption risk. It should be embedded in the factory operating procedure from Day 1.

On-Site Solar as a Strategic Advantage

Why On-Site Solar Makes Sense in Costa Rica

- Costa Rica has strong solar irradiation — particularly complementary during the dry season when hydro output declines
- Solar generation peaks during midday off-peak tariff windows → natural cost alignment
- Reduces dependency on grid during dry-season stress periods
- Supports credible Scope 2 emissions reduction for ESG reporting

Considerations for Industrial Implementation

- Roof or land area at factory site determines system scale
- Grid-tied systems reduce net consumption but do not provide backup during outages (without battery storage)
- Battery storage adds cost but enables resilience — sizing is site-specific
- Costa Rica's Law 22.009 (2021) enables distributed renewable generation and net metering
- ICE is actively expanding solar procurement from private generators

Key Project Data

~50 MW

Reference Scale

Industrial solar module production line — reference benchmark for this analysis

<18 mo

Typical Ramp-Up

Target: <12–18 months from site readiness to production ramp — industry benchmark for turnkey lines

98.6%

Renewable Share

Costa Rica renewable electricity generation in 2025 — rebounded from ~86% in drought year 2024

~95%

Long-Run Average

Approximate renewable generation share in non-drought years (2023 reference: 95%)

Line type: Automated solar module production · **Investment:** Configuration-dependent (not specified — project-specific) · **Region:** Costa Rica · **Source:** PVKnowHow / J.v.G. Technology GmbH · ICE / Tico Times (2026)

Conclusion: Infrastructure as a Critical Success Factor

Energy Cost Is Not Fixed

- The $0.15–$0.20/kWh range is a planning benchmark — actual cost depends on load profile, scheduling, and tariff category
- Demand charges and time-of-use rates are manageable levers, not fixed costs

Grid Reliability Requires Site-Level Due Diligence

- National renewable percentages do not reflect local distribution reliability
- Hydropower seasonality and drought risk must be explicitly modeled
- UPS and backup generation are not optional for precision manufacturing

Green Positioning Is a Real Advantage — With Caveats

- Costa Rica's renewable profile supports credible green manufacturing claims in normal hydrology years
- Drought-year variability (e.g., 2024: ~86% renewable) must be disclosed transparently
- On-site solar strengthens the position and reduces grid dependency simultaneously

ⓘ Infrastructure planning — electricity cost, grid stability, and backup systems — should be treated as a core component of the investment case, not an afterthought. Source: PVKnowHow / J.v.G. Technology GmbH

About the Content Partner

J. v. G. technology GmbH — The DESERT Company

Founded in 1997 in Bavaria, Germany. Family-owned engineering company specializing in turnkey solar module production lines.

More than 90 factory projects delivered worldwide.
On-site team training included — no prior manufacturing experience required.

Key areas:

Turnkey PV manufacturing lines | DESERT Technology® | TÜV-certified module designs | Factory planning to production

www.jvg-thoma.com

Contact

J.v.G. Technology GmbH

Möningerberg 1a, 92342 Freystadt, Germany

info@jvg-thoma.de | www.jvg-thoma.com

Source: https://www.pvknowhow.com/countries/costa-rica/industrial-electricity-costs-grid-stability-costa-rica/

Created with the support of JvGLabs — specialist for AI systems and AI-driven visibility. www.jvglabs.com