



Bhutan Power Market Framework

Department of Energy

Ministry of Energy & Natural Resources

Royal Government of Bhutan

June 2026

1. Executive Summary

Bhutan's power sector is at a pivotal juncture. Driven by rising domestic consumption, increasing seasonal variability in hydropower generation, and the rapid evolution of regional electricity markets, the existing centralized, single-buyer model is increasingly constrained. While this model has successfully ensured affordability and universal access, it lacks mechanisms for transparent price discovery, dynamic system optimization, and competitive participation.

This Framework sets out the strategic and institutional arrangements for the phased development of a competitive and transparent electricity market in Bhutan, consistent with the National Energy Policy and applicable laws. The proposed framework represents a strategic evolution, not a replacement, of the current structure. It is designed to introduce market-based mechanisms in a phased and controlled manner, preserving the stability of long-term Power Purchase Agreements (PPAs) while unlocking the economic value of Bhutan's hydropower resources.

The framework is built on three core pillars:

- i. **A Centralized PPA Registry** to provide full visibility of contracted and available capacity.
- ii. **Day-Ahead and Real-Time Markets (DAM/RTM)** as the primary instruments for short-term trading and price discovery.
- iii. **Ancillary Services and Green Markets** to monetize system flexibility and environmental attributes.

Implementation will follow a three-phased roadmap: Foundation (2025-2027), Domestic Market Development (2027-2029), and Expansion & Regional Integration (2030-2040). This phased approach mitigates risks, ensures institutional readiness, and aligns with the development of regional markets. The successful implementation of this framework is expected to enhance export value, improve energy security, attract investment, and position Bhutan as a key player in the regional clean energy landscape.

2. Introduction

2.1. Background

Bhutan's power sector is fundamentally characterized by its nearly 100% hydropower-based generation. With an installed capacity of 3,576 MW, these assets serve as the backbone of the national economy, supplying both domestic demand and export markets. Historically, the sector has been managed through a centralized, regulated structure.

The current market structure follows a single-buyer model, wherein the state-owned Druk Green Power Corporation Limited (DGPC) generates power and supplies it to the Bhutan Power Corporation Limited (BPC). BPC is the single utility responsible for transmission, distribution, and retail supply to consumers under regulated tariffs approved by the Electricity Regulatory Authority (ERA). This model has been successful in providing near-universal electrification and system stability.

2.2. Rationale for Reform

While successful in its objectives, the existing model faces mounting structural and operational pressures that it cannot adequately address. These pressures necessitate a strategic evolution toward a more flexible and market-oriented system.

- i. **Growing Demand:** Domestic electricity consumption is rising sharply, driven by industrialization and economic growth.
- ii. **Seasonal Hydrological Variability:** The predominance of run-of-river hydropower plants results in generation surpluses during the monsoon and significant deficits in winter, requiring costly imports.
- iii. **Regional Market Evolution:** Electricity markets in the region, particularly in India, are rapidly evolving with the introduction of short-term, green, and ancillary markets. Bhutan must align to participate effectively in this changing landscape.

2.3. Policy and Strategic Direction

The Royal Government of Bhutan has acknowledged these challenges and outlined a clear strategic direction through the National Energy Policy (NEP) 2025. The NEP envisions a modernized, flexible, and market-aligned electricity sector, emphasizing diversification, private sector participation, and deeper

regional integration. This framework is designed to operationalize the policy direction set by the NEP and the proposed Energy Bill.

3. Objectives of the Framework

The objective of this Framework is to facilitate the gradual development of a competitive electricity market while maintaining system reliability, affordability, and energy security. The specific objectives are:

- i. **Efficient Resource Allocation:** Enable transparent price discovery and optimal utilization of hydropower through market-based mechanisms.
- ii. **Enhanced Energy Security:** Improve the management of seasonal imbalances and reduce reliance on expensive imports.
- iii. **Value Creation from Hydropower:** Monetize the inherent flexibility of hydropower assets through ancillary services and capture peak value in regional markets.
- iv. **Robust Digital Infrastructure:** Develop a scalable and secure digital platform for trading, scheduling, and settlement.
- v. **Institutional Strengthening:** Establish roles and responsibilities for market operations.
- vi. **Expand Regional Integration:** Facilitate enhanced cross-border electricity trade and integrate with regional markets.

4. Bhutan Power Market Framework

This chapter details the design, structure, and operational mechanics of the proposed Bhutan Power Market.

4.1. Guiding Design Principles

The framework is built on a set of core principles to ensure its relevance, feasibility, and success:

- i. **Phased Evolution:** A gradual transition from the regulated model to a hybrid and eventually a competitive market.
- ii. **Simplicity:** Initial market phases will operate as a single bidding zone with a uniform Market Clearing Price (MCP) to reduce complexity and ease participant onboarding.

- iii. **System Integration:** Market outcomes will be tightly integrated with the system operator's scheduling and dispatch functions to ensure grid reliability.
- iv. **Scalability:** The architecture and rules are designed to accommodate future expansion of participants, products, and regional integration.

4.2. Proposed Market Structure and Components

The Bhutan Power Market is envisioned as a modular, integrated ecosystem, providing a structured pathway from bilateral contracts to competitive and regionally connected markets.

Market Components:

- i. **Centralized PPA Registry:** A unified digital repository serving as the single source of truth for all PPAs. It will digitize contracts, map tied vs. untied capacity, and embed contractual constraints into market processes. This is the foundational module for the entire market transition.
- ii. **Day-Ahead Market (DAM):** A centralized auction platform where participants submit bids for next-day electricity delivery in 15-minute time blocks. The DAM will determine a transparent Market Clearing Price (MCP) and establish baseline schedules for the system.
- iii. **Real-Time Market (RTM):** A complementary intra-day mechanism for making adjustments closer to the time of delivery. The RTM allows participants to respond to forecast deviations and system contingencies, enabling effective short-term balancing.
- iv. **Ancillary Services Market:** A market for procuring grid stability services such as frequency regulation, operating reserves, and ramping support. This will unlock the value of Bhutan's flexible hydropower resources and strengthen system resilience.
- v. **Green Markets:** A framework for certifying and trading environmental attributes like Renewable Energy Certificates (RECs) and carbon credits. This will enable the monetization of Bhutan's carbon-negative renewable generation.
- vi. **Regional Integration Mechanisms:** The market structure will be designed to facilitate cross-border trade and eventual market coupling

with regional partners, optimizing exports based on real-time conditions.

4.3. The Hybrid Operating Model

The transition to a competitive market will follow a phased, hybrid model to ensure stability.

A. Stage 1: Regulated System (Current): The present structure of centralized allocation and regulated tariffs remains in place.

B. Stage 2: Hybrid Model: The existing PPA framework continues, but a limited volume of generation (untied capacity) and demand (marginal demand) is exposed to market-based trading. In this stage:

- **DGPC (and future IPPs)** are the primary sellers, declaring available capacity.
- **BPC** is the anchor buyer, aggregating national demand.
- **Energy Intensive Consumers** may participate in the market directly or indirectly through BPC.
- **Designated Trader (DGET)** sellers and buyers may participate in the market through the designated trader, DGET, who is also responsible for the cross-border trade of electricity.

C. Stage 3: Expanded Participation: Over time, as liquidity and market maturity increase, the volume of market trading expands, and new participants (like new traders, direct consumers and cross-border entities) are introduced, progressively exposing the system to competitive market forces and regional market integration.

4.4. Market Operation Cycle

The market will operate through a structured, time-bound workflow designed to ensure transparency and efficiency from bidding to settlement.

- a. Bid Submission:** Participants submit buy and sell bids for 15-minute blocks via the digital platform.
- b. Market Clearing:** The clearing engine matches bids using a uniform price auction. The Market Clearing Price (MCP) and traded volume are determined where the aggregate supply and demand curves intersect.

- c. Scheduling & Dispatch Integration:** Cleared volumes are converted into generation and demand schedules, validated by BPSO against system constraints, and finalized as dispatch instructions.
- d. Physical Delivery & Metering:** Electricity is delivered and measured using AMI/SCADA systems in 15-minute intervals.
- e. Deviation Management:** The system calculates deviations between actual and scheduled energy. A predefined mechanism (e.g., Grid Discipline Mechanism) applies charges or incentives to manage these imbalances.
- f. Settlement & Financial Clearing:** All transactions are converted into financial obligations, and the net position for each participant is computed. Settlement is structured on a T+1 (day after delivery) basis.

4.5. Market Participants

The market is designed around clearly defined roles to ensure operational clarity.

Stakeholder	Role in the Market
Generators (DGPC & IPPs)	Supply-side participants, offering available generation capacity to the market through price-based bids.
BPC	Acts as the primary demand aggregator, submitting demand bids and managing the interface between market outcomes and physical distribution.
Energy Intensive Consumers (EICs)	Represent a significant source of demand. They may participate directly or indirectly through BPC.
Bhutan Power System Operator (BPSO)	Responsible for ensuring grid stability by validating schedules, managing dispatch, and overseeing energy accounting.
Market Operator (BPMP)	Administers the market platform, manages the bidding, clearing, and settlement processes, and publishes market data.
Traders	Multiple traders may be introduced in later phases to support aggregation, improve liquidity, and enhance market participation.

5. Institutional and Governance Framework

A robust institutional and governance framework is essential for the market's credibility, transparency, and efficient operation.

5.1. Institutional Roles and Responsibilities

The framework establishes a clear separation of roles across the sector.

- i. **Department of Energy (DoE) – Policy Authority:** Defines the market vision, structure, guidelines, and reform roadmap, ensuring alignment with national priorities and cross-border strategy.
- ii. **Electricity Regulatory Authority (ERA) – Regulator:** Establishes market rules, issues licenses, monitors compliance, approves tariffs, and resolves disputes.
- iii. **Bhutan Power System Operator (BPSO) – System Operator:** Ensures grid security and reliability through scheduling, dispatch, balancing, and deviation management.
- iv. **Bhutan Power Market Platform (BPMP) – Market Operator:** Operates the technology platform, manages trading, clearing, settlement, and participant onboarding. It may initially be established within BPSO, with a pathway to becoming a functionally independent entity.

5.2. Market Operator (BPMP) Organizational Structure

The BPMP is envisioned to start with a lean, functional structure that can evolve as the market matures.

A. Stage I – Core Functions:

- o **Market Operations:** Manages DAM/RTM, bid processing, and trade confirmation.
- o **Information Technology:** Operates and secures the platform, manages systems integration.
- o **Finance, Risk & Compliance:** Manages settlement, collateral, and ensures regulatory compliance.
- o **Governance & Regulatory Interface:** Reports to ERA and manages audit and dispute processes.

B. Stage II – Expanded Functions (as market matures):

- **Market Development:** Focuses on onboarding participants, supporting liquidity, and managing stakeholder engagement.
- **Product Development:** Develops frameworks for new market segments like ancillary services and green products.

6. Technology and Digital Architecture

A secure, scalable digital platform is the operational backbone of the Bhutan Power Market.

6.1. Core Functional Modules

The platform is comprised of modular, interoperable components:

- i. **Centralized PPA Registry:** The authoritative source for contract data.
- ii. **Bid and Offer Submission Engine:** For structured entry of buy/sell bids.
- iii. **Market Clearing Engine:** Determines MCP and cleared volumes.
- iv. **Scheduling Integration Interface:** Facilitates the exchange of schedules with BPSO.
- v. **Meter Data Integration Layer:** Ingests and validates data from AMI/SCADA systems.
- vi. **Energy Accounting & Deviation Engine:** Calculates imbalances and charges.
- vii. **Automated Settlement System:** Computes final payables/receivables on a T+1 basis.
- viii. **Market Surveillance & Compliance Engine:** Monitors bidding behavior and price trends for regulatory oversight.
- ix. **Data Warehouse & Forecasting Engine:** Consolidates data for analytics, reporting, and forecasting.

6.2. High-Level Technical Architecture

The platform adopts a layered, API-first, and microservices-based architecture to ensure flexibility, scalability, and maintainability.

- i. **Experience Layer:** The user interface for participants (web portals), operators, and the public.
- ii. **Application Layer:** The core operational engine containing all market processing logic (bidding, clearing, settlement).
- iii. **Data Layer:** Manages data storage, separating transactional databases (OLTP) from reporting and analytics databases (OLAP).
- iv. **Integration Layer:** Enables secure, real-time data exchange with external systems like BPSO, metering, and financial systems.

6.3. Integration Framework

The market platform's effectiveness depends on seamless integration with existing power system infrastructure.

- i. **Enhanced System Operator Integration:** For validating schedules and coordinating dispatch.
- ii. **Metering Systems (AMI/SCADA):** For automated ingestion of 15-minute interval data.
- iii. **Financial Systems:** For automated settlement and payment processing.
- iv. **Regulatory Systems:** For compliance monitoring and data reporting.

6.4. Cybersecurity Framework

Given the market's critical role, cybersecurity is a foundational requirement.

- a. **Approach:** A defence-in-depth and zero-trust architecture is adopted, with principles of least privilege access and security-by-design.
- b. **Key Controls:** This encompasses robust identity and access management (RBAC, MFA), network segmentation, data encryption (at rest and in transit), continuous system monitoring, and a defined

incident response plan to protect market integrity, operational continuity, and financial transactions.

7. Implementation Roadmap

The transition to the Bhutan Power Market is structured as a phased, risk-managed evolution to ensure institutional readiness and system stability.

7.1. Phase I: Foundation (2025-2027)

This phase establishes the essential foundations for the market.

- a. Policy & Regulation:** Finalization of the National Energy Policy, enactment of the Energy Bill, adoption of power market guidelines, and notification of market rules by ERA.
- b. Institutional Setup:** Establishment of the Market Operator (BPMP) and clear definition of its roles.
- c. Digital Infrastructure:** Development and deployment of the Minimum Viable Product (MVP) for the market platform, including the Centralized PPA Registry and core integration capabilities.
- d. Readiness:** Execution of pilot and shadow market operations to validate processes and build participant capacity.

7.2. Phase II: Domestic Market Development (2027-2029)

This phase operationalizes the domestic market and introduces core trading mechanisms.

- a. Market Operations:** Launch and regular operations of the Day-Ahead Market (DAM) and introduction of the Real-Time Market (RTM).
- b. Participation:** Gradual increase in participants and the volume of electricity traded in the market.
- c. Market Extensions:** Implementation of initial frameworks for ancillary services and green markets.
- d. System & Oversight:** Strengthening of market monitoring, reporting, and compliance mechanisms to ensure market discipline.

7.3. Phase III: Expansion and Regional Integration (2030-2040)

This final phase focuses on scaling the market and deepening regional participation.

- a. Market Expansion:** Full implementation of ancillary services, scaled green market participation, and introduction of new market products.
- b. Regional Integration:** Development of cross-border participation mechanisms, alignment with regional frameworks (like those in India), and progression toward market coupling.
- c. Capability Enhancement:** Strengthening of settlement systems for multi-currency transactions, and advancement of analytics and forecasting capabilities.

8. Conclusion and Strategic Positioning

The Bhutan Power Market Framework presents a strategic and actionable pathway for the modernization of the country's most critical economic sector. It proposes a carefully calibrated transition that preserves the stability and security of the existing system while systematically unlocking the benefits of a market-driven framework.

By enabling transparent price discovery, improving operational flexibility, and facilitating the monetization of hydropower's full value, this framework will contribute to:

- i. Enhanced Economic Returns:** Capturing higher value from exports and optimizing domestic resource allocation.
- ii. Improved Energy Security:** Reducing reliance on imports through better seasonal balancing.
- iii. Increased Investment:** Providing clear signals for investment in storage, flexible generation, and demand response.

Strategically, this transition positions Bhutan as a regional leader in clean energy. Its nearly 100% hydropower-based profile and inherent operational flexibility make it an ideal partner for providing balancing and reserve services in a growing regional market. The successful execution of this framework, underpinned by strong institutional governance and a phased implementation approach, will secure Bhutan's energy future and solidify its role as a key player in the regional electricity ecosystem.