Government Blockchain Association

Energy Working Group

Blockchain Maturity Model

Energy Supplement

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Approval

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Contents

1 Introduction

This document describes the criteria that supplements the Blockchain Maturity Model (BMM) requirements to determine if a blockchain-based energy solution can be considered a trusted blockchain solution.

1.1 Scope

Solutions in-scope for this supplement use blockchain technology to facilitate the decentralized generation, storage, distribution, and management for all types of energy.

1.2 Purpose

This document is used as a supplement to the Blockchain Maturity Model (BMM) and is used to assess solutions, using blockchain technology to facilitate decentralized generation, storage, distribution, and management for all types of energy.

1.3 Use

The full set of requirements defined in this document may exceed the scope of a solution being assessed. For example, a solution may address the generation of energy but not the distribution of energy. In that case, the requirements would be non-applicable. Consequently, using this document is a two-step process. First, select the features of the solution that are related to this supplement. Then compare the solution to the applicable requirements described in paragraph 2 (Requirements) of this document.

1.4 Key Terms & Phrases

Record to an immutable ledger	When this phrase is used it sets the expectation that the data is explicitly listed on an immutable ledger or summary data is listed. The driving principle is that the data may not be altered without notice of the data stakeholders.
Solution	The solution includes the blockchain and all physical, electronic, information and materials that when combined perform a function related to sourcing, generating, storage, distribution, or administration of energy.

2 Requirements

The blockchain solutions in the energy industry perform one or more of the following functions:

- Sourcing
- Generation
- Storage
- Transmission
- Distribution
- Administration

2.1 Life Cycle Requirements

2.1.1 Sourcing

Sourcing includes the acquisition of energy raw materials including material that is mined or other feed stock. Feed stock may include waste products or other renewable sources that can be converted into energy.

Solutions that support the mining or collecting of raw materials, equipment, and resources to enable power generation shall record the following information on an immutable ledger:

- Origin of raw materials including the identity, condition, location, quantity, date/time stamp, entities, process, and reference agreements related to receipt of raw materials.
- Chain of custody including the entities, persons, conditions, date/time stamps, inspections, certifications and movement of raw materials.
- Compliance related information related to required Environmental, Social, and Governance (ESG) standards.

Notes:

1. ESG data may include tracking labor practices, environmental impact, and sourcing conditions.
2. Carbon credit information may be required.

2.1.2 Generation

Solutions that use blockchain technology to support the generation of energy shall record the:

- Assumptions, and criteria used to estimate energy demands
- Capacity for storage and distribution of energy
- Relationship between energy generation and consumption/demand
- Log of events, stakeholders, processes, and results of energy generation activities.

- Automated reporting and alerts to managerial, compliance, and regulatory authorities of anomalies and activities that may impact health, safety, and environmental conditions.

2.1.3 Storage

Storage is the capture and holding of energy for use later, allowing supply and demand to be balanced more effectively across the energy system. It typically involves technologies that store electricity or other forms of energy. This includes batteries (e.g., lithium-ion or flow batteries), pumped hydroelectric storage, compressed air energy storage, or thermal storage. This is done so energy generated at one time (during periods of high solar or wind output) can be used later when demand is higher or renewable sources are unavailable. Storage improves grid reliability, supports renewable integration, reduces peak load pressure, and enhances energy resilience.

Solutions that use blockchain to record data about energy storage and manage the storage of energy shall record the following data to an immutable ledger:

- Identification
- Location
- Date/Time materials entered storage
- Date/time materials exited storage
- Condition of the stored materials
- Environmental conditions that may have an impact on the materials stored
- Automated reporting and alerts to managerial, compliance, and regulatory authorities of leakage, contamination, or other anomalies and activities that impact health, safety, and environmental conditions.

2.1.3.1 Tanks

Tanks are used for liquid or gas storage, pose risks like leaks, corrosion, or overpressure, requiring structural integrity checks and containment systems. While batteries focus on efficiency and lifecycles, coal and tanks primarily involve bulk material handling and containment.

Solutions that use tanks to store anergy shall record the following information to an immutable ledger.

- Inspection of tank integrity (e.g., corrosion, structural stability).
- Pressure regulation systems and safety valves.
- Emergency response plans for leaks or overpressure events.
- Monitoring for flammable/explosive hazards and gas detection systems.

2.1.3.2 Coal Storage

Coal Storage is the handling and temporary holding of coal before it is used for power generation or industrial processes. Coal is typically stored in large stockpiles or silos at mining sites, transport hubs, or power plants to ensure a steady, reliable supply. Proper coal storage is essential to protect the fuel from moisture, spontaneous combustion, dust emissions, and environmental contamination. It often involves measures such as covering stockpiles, controlling runoff, implementing fire suppression systems, and monitoring temperature and gas levels. Effective coal storage ensures operational continuity, fuel quality, and safety while minimizing environmental and regulatory risks.

Solutions that use coal to store anergy shall record the following information to an immutable ledger.

- Dust suppression systems (e.g., water sprays, enclosures) to prevent respiratory risks.
- Fire and explosion prevention measures (e.g., inert gas blanketing, temperature monitoring).
- Safe access to storage areas (e.g., proper lighting, fall protection).

2.1.3.3 Batteries

Battery storage refers to the use of rechargeable batteries—such as lithium-ion, flow, lead-acid, or emerging solid-state technologies to store electrical energy for later use. Batteries play a critical role in balancing supply and demand, especially in systems that incorporate intermittent renewable sources like solar and wind. They enable energy to be stored during periods of low demand or excess generation and discharged when demand rises, or generation drops. Battery storage improves grid stability, supports frequency regulation, provides backup power during outages, and allows for peak shaving and load shifting. Utility-scale battery systems are increasingly used in both centralized grids and decentralized energy solutions.

For solutions that use batteries to store energy, the following information shall be recorded on an immutable ledger:

- Battery Identification and Provenance
- Performance Data Over Time
- Energy Transactions
- Maintenance and Service Logs
- Ownership and Custody Transfers

Notes:

For more information about the types of data that may be recorded see the list below.

- Battery identification and provenance data may include serial number, manufacturer, model, and production date to ensure traceability and prevent counterfeiting.
- Performance data over time may include charge/discharge cycles, efficiency, and capacity degradation to verify system health and support warranty or resale.
- Energy transactions could include details of energy stored, discharged, and exchanged (including timestamps) to support auditing, billing, and grid service validation.
- Maintenance and service logs typically include records of inspections, repairs, and technician activities to establish accountability and support predictive maintenance.
- Ownership and custody transfers involves the current and past ownership to ensure legal clarity and facilitate leasing, resale, or regulatory reporting.

2.1.4 Transmission

Energy transmission refers to the high-voltage transfer of electricity from power generation facilities to substations closer to populated areas or industrial centers. This stage bridges the gap between generation and distribution. Transmission systems use extensive networks of high-voltage power lines, transformers, and substations designed to move large volumes of electricity efficiently over long distances with minimal loss. Transmission is managed by regional or national grid operators who balance supply and demand in real time, maintain grid stability, and coordinate cross-border or interregional energy flows. Reliable transmission is essential for ensuring a resilient and responsive energy grid.

Note: Examples of power generation facilities include power plants, wind farms, or solar arrays.

For solutions that involve the transmission of energy, the following information shall be recorded on an immutable ledger:

- Transmission Line Metadata
- Real-Time and Historical Load Data
- Outage and Fault Records

- Maintenance and Inspection Logs
- Energy Source Traceability

> **Notes:**
>
> For more information about the types of transmission data that may be recorded see the list below.
>
> - Transmission Line Metadata includes unique identifiers, technical specifications (voltage level, capacity), installation date, and geographic routing.
> - Real-time and historical load data typically includes power flow, frequency, voltage levels, and congestion status to support grid balancing, market settlement, and auditability.
> - Outage and fault records describe time and description of events, causes of disruptions (e.g., weather, equipment failure), and response actions to ensure accountability and improve resilience.
> - Maintenance and inspection logs include scheduled maintenance, repairs, and technician credentials to track asset integrity and regulatory compliance.
> - Energy source traceability includes the origin of transmitted electricity (e.g., renewable vs. fossil fuel) to support carbon accounting, ESG reporting, and clean energy certification.

2.1.5 Distribution

Energy distribution focuses on the final stage of delivering electricity, gas, or fuels from transmission networks to homes, businesses, and industries through substations, transformers, pipelines, and distribution lines. It involves load balancing, real-time monitoring, outage management, and maintaining grid infrastructure.

For solutions that involve energy distribution, the following information shall be recorded on an immutable ledger:

- Asset Registry
- Energy Delivery Records
- Load Balancing and Grid Events
- Maintenance and Service Records
- Outage and Incident Logs

- Proof of origin for renewable energy certification (e.g., solar, wind).
- Real-time recording of energy generation, distribution, and consumption
- Verification of energy quality (e.g., voltage, frequency) to ensure compliance.

Notes:

For more information about the types of distribution data that may be recorded see the list below.

- Asset Registry may include unique IDs, locations, specifications, and commissioning dates of distribution infrastructure such as substations, transformers, meters, and pipelines.
- Energy delivery records are timestamped data on energy volumes delivered to end users, by location and type (e.g., electricity, gas), supporting billing and usage audits.
- Outage and Incident Logs are real-time and historical records of outages, causes, duration, and response actions to improve accountability and grid resilience.
- Maintenance and Service Records are logs of inspections, repairs, replacements, and responsible personnel to ensure safety, compliance, and traceable asset management.
- Load balancing and grid events includes data about local grid loads, voltage fluctuations, and demand response activities to enhance operational transparency and market coordination.

2.2 Administration

Administrative requirements are expected to be met by all solutions that are involved in sourcing, generating, storage, transmission, and distribution of energy.

2.2.1 Health & Safety

Health and safety are critical in the energy industry due to the inherent risks associated with generating, storing, transmitting, and distributing energy. From high-voltage equipment and combustible fuels to hazardous chemicals in battery systems, energy infrastructure presents significant potential for injury, environmental harm, and operational disruption if not properly managed. Ensuring the safety of workers, the public, and surrounding ecosystems requires robust policies, real-time monitoring, and strict compliance with regulatory standards. Blockchain technology can enhance these efforts by ensuring transparent, immutable records of safety procedures, incidents, maintenance activities, and environmental data.

To meet health and safety expectations, a blockchain-based energy solution shall:

1. Have a mechanism to record all safety incidents, inspections, and mitigations on an immutable distributed ledger.
2. Include clear, tested emergency response protocols with remote and automated response capabilities.
3. Demonstrate compliance with applicable health, safety, and environmental regulations, including supporting documentation and certifications.
4. Record the training, qualifications, and certifications of personnel that are trained and qualified for the specific safety risks mitigations and contingencies; and
5. Have a mechanism to monitor, notify/alert and record relevant environmental health and safety data (e.g., emissions, leaks, noise) in real time on an immutable ledger.

2.2.2 Inspections & Certifications

Inspections and certifications is the processes used to verify that energy infrastructure, equipment, and operations meet established safety, quality, and regulatory standards. Inspections are typically conducted by authorized personnel or third-party auditors who examine physical assets such as pipelines, power plants, transmission lines, or renewable energy installations to ensure they are functioning properly, safely, and in compliance with applicable laws and technical specifications. Certifications are formal attestations, often issued by regulatory agencies or accredited organizations that confirm a system, component, or operator meets recognized standards or has passed required testing.

Solutions that require inspection & certification shall record the following information on an immutable ledger:

- Inspection/certification ID
- Type and scope of inspection
- Inspector credentials and organization
- Findings, compliance status, and recommendations
- Issue date, expiration date, and renewal requirements
- Evidence or documentation of inspection (e.g., photos, reports)

2.2.3 Licensing & Permits

Licensing and permitting are the formal processes required by government authorities to ensure that energy projects comply with legal, environmental, safety, and operational standards before development or operation can begin. Licensing grants approval to engage in specific energy-related activities such as generating, transmitting, or distributing electricity, or extracting and transporting natural resources, and is typically issued by a regulatory body with conditions attached. Permitting involves securing specific legal permissions, often related to environmental protection, construction, zoning, or land use and may require input from multiple agencies and stakeholders, especially when projects could impact communities or natural resources.

Solutions that require licensing and permitting shall record the following information on an immutable ledger:

- License/permit ID and type
- Issuing authority and jurisdiction
- Validity period (start and expiry dates)
- Associated conditions or restrictions
- Verification status and timestamps of issuance

2.2.4 Provisioning & Calibrations

Provisioning and calibrations are the preparation and fine-tuning of equipment and systems to ensure accurate, reliable, and efficient performance. Provisioning involves the setup and configuration of energy infrastructure or devices. This includes meters, sensors, control systems, or communication networks so they are ready for deployment and integrated properly into the broader system. Calibrations refer to the precise adjustment and verification of measurement instruments to ensure they produce accurate readings, which is critical for monitoring energy usage, ensuring safety, and maintaining regulatory compliance.

Solutions that require provisioning & calibrations shall record the following information on an immutable ledger:

- Equipment/device ID and specifications
- Provisioning dates and responsible parties
- Calibration dates, parameters, and results
- Calibration standards or benchmarks used
- Certification of calibration and associated approvals

2.2.5 On-going Maintenance

Ongoing maintenance in an energy solution typically requires a structured program that includes regular inspections, performance monitoring, equipment servicing, and timely repairs to ensure safety, reliability, and efficiency. This may involve cleaning and testing components like turbines, batteries, transformers, and circuit breakers; updating software and firmware in control systems; replacing worn parts; managing vegetation near power lines; and ensuring compliance with regulatory and environmental standards. It also includes maintaining cybersecurity, monitoring grid stability, and conducting preventive and predictive maintenance using data analytics and sensors to minimize unplanned outages and extend asset life.

Solutions that involve on-going maintenance shall record the following information on an immutable ledger:

- Maintenance request ID and type
- Description of maintenance tasks
- Date, time, and duration of maintenance
- Responsible technicians and organizations
- Parts used and work performed
- Outcomes and performance post-maintenance

Appendix A: Definitions

The following terms and phrases are used in this document and have a specific meaning related to this energy supplement.

Record to an immutable ledger	When this phrase is used it sets the expectation that the data is explicitly listed on an immutable ledger or summary data is listed. The driving principle is that the data may not be altered without notice of the data stakeholders.
Solution	The solution includes the blockchain and all physical, electronic, information and materials that when combined perform a function related to the sourcing, generating, storage, distribution, or administration of energy.

Appendix B: Energy Data Standards

Category	Attributes	Description	Format

Appendix C Blockchain Energy Use Cases

This appendix includes blockchain use cases applicable to the Energy Industry. They include:

Billing and Settlement

In traditional energy markets, billing and settlement processes are often slow, error-prone, and subject to disputes. Blockchain enables smart contracts—self-executing agreements with terms directly written into code—that can automatically handle billing, settlements, and financial reconciliation between energy producers, distributors, and consumers. These automated processes reduce administrative overhead, minimize delays, and ensure that payments are made only when agreed conditions are met.

Tokenized Energy Assets

Beyond operational efficiencies, blockchain enables new financial models through tokenization. Energy assets such as solar panels, battery storage units, or even future energy production can be divided into digital tokens, allowing for fractional ownership and broader participation in energy investment. This democratization of asset ownership can attract new sources of capital, facilitate community energy projects, and support more resilient, distributed energy infrastructure.

Energy Credits

Blockchain also plays a vital role in the management of renewable energy credits (RECs), carbon credits, and government subsidies. These instruments are crucial for incentivizing clean energy but are often undermined by fraud or double-counting. Blockchain's transparent and tamper-resistant recordkeeping ensures that credits and subsidies are issued, traded, and retired with full traceability, bolstering confidence in sustainability programs.

Decentralized Energy Markets

Furthermore, blockchain can support decentralized energy markets where individuals, businesses, and microgrids engage in peer-to-peer energy trading. In such markets, financial transactions are recorded and settled on-chain, eliminating the need for intermediaries and ensuring accurate pricing and payment flows. This model empowers consumers and increases market competition while maintaining regulatory oversight.

By enabling real-time, auditable, and secure financial operations, blockchain provides a foundation for more trustworthy and efficient energy markets. Its application in financial management supports the broader goals of energy equity, sustainability, and innovation across the entire energy value chain.

Appendix D: References

Several internationally recognized standards provide guidance on health and safety best practices in the energy industry. These standards help organizations design, implement, and monitor effective safety management systems across various energy sectors, including fossil fuels, renewables, transmission, and storage. Key standards include:

API Standards (American Petroleum Institute)	Used globally in oil and gas, these standards—such as API RP 500 (hazardous area classification) and API RP 75 (safety and environmental management systems)—guide best practices for upstream and downstream safety.
BS EN 50522 – Earthing of Power Installations Exceeding 1 kV AC	This European standard is critical for ensuring electrical safety in power transmission and distribution infrastructure.
GDPR	Data protection regulation, ensuring that personal and safety data stored on the blockchain complies with privacy laws.
IEC 61508 – Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems	Applicable to systems where electrical and electronic components are involved (common in energy control systems), this standard ensures systems perform safely and predictably under all conditions.
ILO Guidelines on Occupational Safety and Health Management Systems (ILO-OSH 2001)	Published by the International Labour Organization, these guidelines provide a global benchmark for integrating OSH (Occupational Safety and Health) into business processes.
ISO 14001:2015 – Environmental Management Systems	Although focused on environmental impacts, this standard intersects with health and safety by helping manage risks related to spills, emissions, and hazardous waste.
ISO 45001:2018 Occupational Health and Safety Management Systems	This is the leading international standard for creating safe and healthy workplaces. It provides a framework for managing risks, ensuring compliance, and improving overall health and safety performance.
ISO 50001	Energy management systems, for aligning blockchain-

	based solutions with energy efficiency and sustainability goals.
ISO/IEC 2700	Information security management, essential for securing blockchain infrastructure.
NFPA 70E – Standard for Electrical Safety in the Workplace	Developed by the National Fire Protection Association (widely used globally), this standard addresses electrical safety practices to prevent arc flash incidents, electric shock, and fires.
NIST Cybersecurity Framework	To guide security and risk management practices in blockchain implementations.
OSHA Regulations (U.S.) EU Directives (Europe)	While region-specific, these legal frameworks (e.g., EU's Directive 2009/104/EC) are widely recognized and often referenced in international contracts and audits, particularly for physical and environmental safety compliance.