

1 **IEEE P3224™/D4.0**

2 **Draft Standard for Blockchain-based**  
3 **Green Power Identification Application**

4 Developed by the  
5  
6 **Blockchain and Distributed Ledgers**  
7 of the  
8 **IEEE Computer Society**  
9

10  
11 Approved date  
12  
13 **IEEE SA Standards Board**  
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1 **Abstract:** This standard specifies requirements and specifications for using blockchain for green  
2 power identification applications. It describes a technical framework for the planning, design,  
3 construction and operation of green power identification systems. The purpose is to improve the  
4 efficiency of system interactions, perform life cycle traceability management of green power  
5 identification applications, enhance the efficiency of multi-subject identity authentication for green  
6 power identification, and thereby improve business efficiency.

7  
8 **Keywords:** green power, green electricity certificate, blockchain, IEEE 3224  
9

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## 1 Introduction

2 This introduction is not part of P3224/D4.0, Draft Standard for Blockchain-based Green Power Identification  
3 Application .

4 This standard specifies requirements and specifications for using blockchain for green power identification  
5 applications. It describes a technical framework for the planning, design, construction and operation of green  
6 power identification systems. The purpose is to improve the efficiency of system interactions, perform life  
7 cycle traceability management of green power identification applications, enhance the efficiency of multi-  
8 subject identity authentication for green power identification, and thereby improve business efficiency.

9

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# 1 Draft Std. for Blockchain-based Green 2 Power Identification Application

## 3 1. Overview

4 This standard enables tracking, traceability and rights conformation throughout the life cycle, while avoiding  
5 repeated measurement and accounting. This standard helps to increase green power consumption  
6 on a society-wide scale and to further enable low-carbon energy transformation.

### 7 1.1 Scope

8 This standard defines an application model and technical framework for green power identification based on  
9 blockchain. This standard also specifies the technical and operation management requirements of green  
10 power identification based on blockchain.

### 11 1.2 Purpose

12 The standard enables tracking, traceability and rights conformation throughout the life cycle, while avoiding  
13 repeated measurement and accounting. Use of this standard supports increased green power consumption in  
14 society to further enable low-carbon energy transformation

### 15 1.3 Word usage

16 The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard  
17 and from which no deviation is permitted (*shall* equals *is required to*).<sup>1,2</sup>

18 The word *should* indicates that among several possibilities one is recommended as particularly suitable,  
19 without mentioning or excluding others; or that a certain course of action is preferred but not necessarily  
20 required (*should* equals *is recommended that*).

21 The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals  
22 *is permitted to*).

23 The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can*  
24 equals *is able to*).

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29 the referenced document (including any amendments or corrigenda) applies.

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<sup>1</sup> The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

<sup>2</sup> The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

## 1 3. Definitions, acronyms, and abbreviations

### 2 3.1 Definitions

3 For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary*  
4 *Online* should be consulted for terms not defined in this clause.<sup>3</sup>

5  
6 **green power:** electricity generated using specific power generation equipment, by converting renewable  
7 energy into electricity with zero or near-zero CO<sub>2</sub> emissions during its production.

8 Note: Specific power generation equipment includes wind turbines, photovoltaic generators, etc. According  
9 to the relevant policy requirements of the country or region to which they belong can be gradually expanded  
10 to other eligible power generators.

11 **green electricity certificate:** an electronic certificate with unique code identification issued to the renewable  
12 energy feed-in tariff of power generation enterprises, as the only certificate of green environmental rights  
13 and interests.

14 **green power product:** electricity supplied to the power grid and generated by renewable energy that  
15 meets the relevant policy requirements of the regions.

16 Note: Mainly refers to the online electricity consumption of wind and photovoltaic power generation  
17 enterprises, which can be gradually expanded to other eligible power sources according to regional laws,  
18 regulations and requirements.

19 **green power transaction:** the medium to long-term trading of electricity targeting green power products  
20 which meets the needs of power generation enterprises, power sales companies, and power users to sell and  
21 purchase green power products.

22 **green power consumption:** consumer behavior that paying for green environmental values by purchasing  
23 green power products, green electricity certificates, etc.

24 **green power identification:** the digital certificates that evaluate and certify the level of green power  
25 consumption behavior according to a unified methodology.

26

### 27 3.2 Acronyms and abbreviations

28 IPFS Inter Planetary File System

29 TCP/IP Transmission Control/Internet Protocol

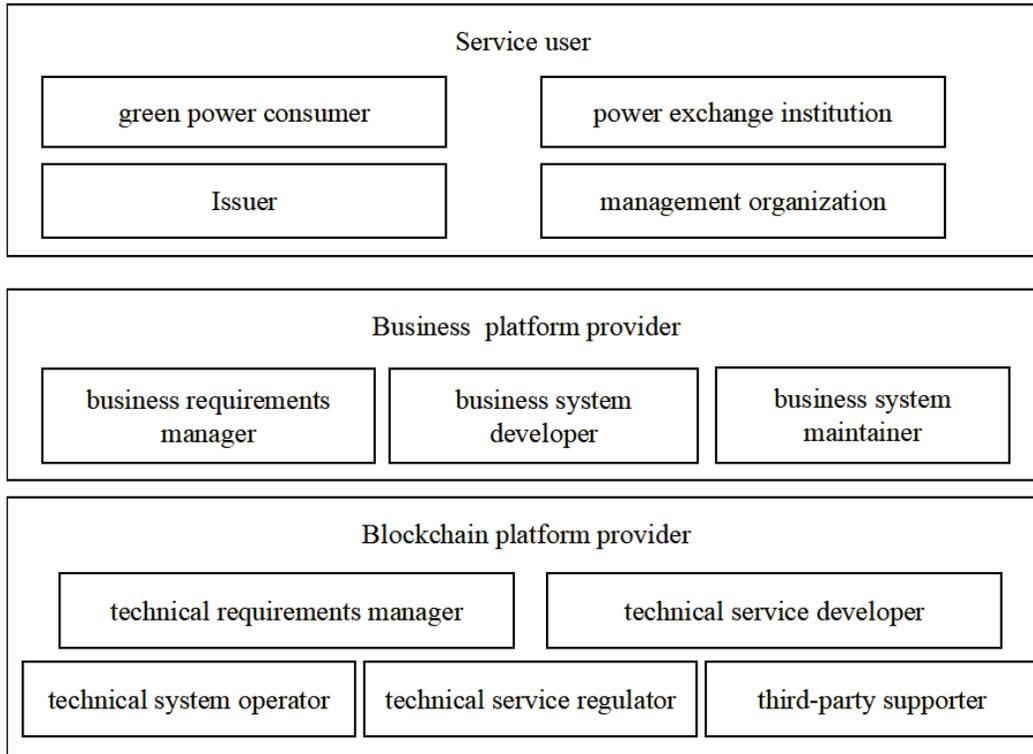
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1 **4. Stakeholder**

2 **4.1 General**

3 The Stakeholders of green power identification application refer to the relevant participants involved in the  
4 development, operation, service of green power identification application system, including service user,  
5 business platform provider, blockchain platform provider, as shown in Figure 1.  
6



7  
8 Figure 1- The stakeholder of blockchain green power identification

9 **4.2 Service user**

10 **4.2.1 Green power consumer**

11 Green power consumers are electricity consuming enterprises with green electricity consumption and  
12 certification needs, willing to pay for green environmental rights, mainly including users who directly  
13 participate in or are represented by power selling companies in transactions.  
14

15 **4.2.2 Power exchange institution**

16 An power exchange institution shall:

- 17 a) Organize green power transactions and provide relevant settlement basis;  
18 b) Summarize green power purchase and sales agreement, uniformly manage green power consumption data  
19 of green power consumers;

20 An power exchange institution shall :

- 21 a) Complete the issuance and transfer of green electricity certificates based on green power transaction  
22 information.

1 **4.2.3 Issuer**

2 An Issuer shall :

- 3 a) Be a legally recognized entity authorized by the government;
- 4 b) Responsible for distributing green electricity labels to green electricity users;
- 5 c) Carry out work under the guidance of rules.

6 An Issuer may:

- 7 a) Be any form of legally entity, including a government authority, non governmental organization, or
- 8 commercial enterprise.

9 **4.2.4 Management organization**

10 An management organization shall:

- 11 a) be an authorized department.

12 An management organization shall:

- 13 a) Be responsible for setting up a dedicated account for green power consumer to issue green power
- 14 identification
- 15 b) Be responsible for verifying the authenticity of relevant data and information.

16 **4.3 Business platform provider**

17 **4.3.1 Business requirements manager**

18 The business requirements manager shall be responsible for the requirements design and management of the  
19 green power identification business platform, revising and improving the requirements through multi-party  
20 coordination to form the final version.

21 The activities of the business requirements manager shall include, but are not limited to, the following:

- 22 a) Identify the core requirements of the system;
- 23 b) Identify the main functional modules and subdivided functional points;
- 24 c) Form the exploitable and maintainable requirement profiles.

25 **4.3.2 Business system developer**

26 The business system developer shall be responsible for sorting out and improving the business requirements  
27 of green power identification services, analyzing the rationality of system requirements and development  
28 difficulties. A business system developer also helps ensure the consistency between technical implementation  
29 and requirements. The activities of the business system developer shall include, but are not limited to, the  
30 following:

- 31 a) Design, develop and maintain the green power identification business service system;
- 32 b) Test and accept relevant functions of blockchain green power identification platform.

33 **4.3.3 Business system maintainer**

34 The business system maintainer is responsible for the maintenance process of the green power identification  
35 business platform. A business system maintainer helps ensure the availability of platform services, the  
36 correct usage of the platform by users, and the follow-up maintenance of the entire process of the platform.

37 The activities of the business system maintainer shall include the following:

- 38 a) Initialize the environment and process;
- 39 b) Define the operation methods and operation manual;
- 40 c) Maintain the normal operation of the system.

## 1 **4.4 Blockchain platform provider**

### 2 **4.4.1 Technical requirements manager**

3 The technical requirements manager is responsible for the requirements design and management of  
4 blockchain technology that is corresponded to the green power identification service so as to support  
5 blockchain the technology provider in subsequent technology development and maintenance.

6 The activities of the technical requirements manager shall include, but are not limited to, the following:

- 7 a) Identify the relevant requirements of blockchain technology;
- 8 b) Design a reasonable and complete blockchain technology requirement scheme.

### 9 **4.4.2 Technical service developer**

10 The technical service developer is responsible for evaluating the rationality and feasibility of blockchain  
11 technology requirements and designs. Technical service developer develops and implements technology  
12 according to the requirements, ensuring the consistency technical implementation and requirements.

13 The activities of the technical service developer shall include, but are not limited to, the following:

- 14 a) Design, develop and maintain service components or smart contracts in the blockchain system;
- 15 b) Test and accept relevant functions in the blockchain system.

### 16 **4.4.3 Technical system operator**

17 The technical system operator is responsible for the operation and maintenance process of the blockchain  
18 technology service. The technical system operator works to help ensure that the blockchain technology  
19 service and infrastructure meet the operational objectives, such as data on chain storage and smart contract  
20 execution.

21 The activities of the technical system operator shall include, but are not limited to, the following:

- 22 a) Plan the proper implementation and deployment of blockchain services;
- 23 b) Provide the whole-process maintenance services of system.

### 24 **4.4.4 Technical service regulator**

25 The technical service regulator is responsible for supervising and managing other technology providers,  
26 ensuring the legal and reasonable operation of blockchain services, and maintaining trusted blockchain  
27 services.

28 The activities of the technical service regulator shall include, but are not limited to, the following:

- 29 a) Monitor and analyze relevant data;
- 30 b) Set regulatory rules, examine and regulate blockchain services;
- 31 c) Provide emergency management services.

### 32 **4.4.5 Third-party supporter**

33 Third-party supporter is responsible for improving the external third-party support services of the green  
34 power identification service application system (such as network timing service, certificate authentication  
35 service, identity authentication service, etc.) so as to help strengthen the system and improve its functions.

## 36 **5. Technical framework**

37 The green power identification business system based on blockchain is mainly composed of infrastructure  
38 layer, platform layer, data layer, application service layer and cross-layer service layer. The business system  
39 framework is shown in Figure 2.

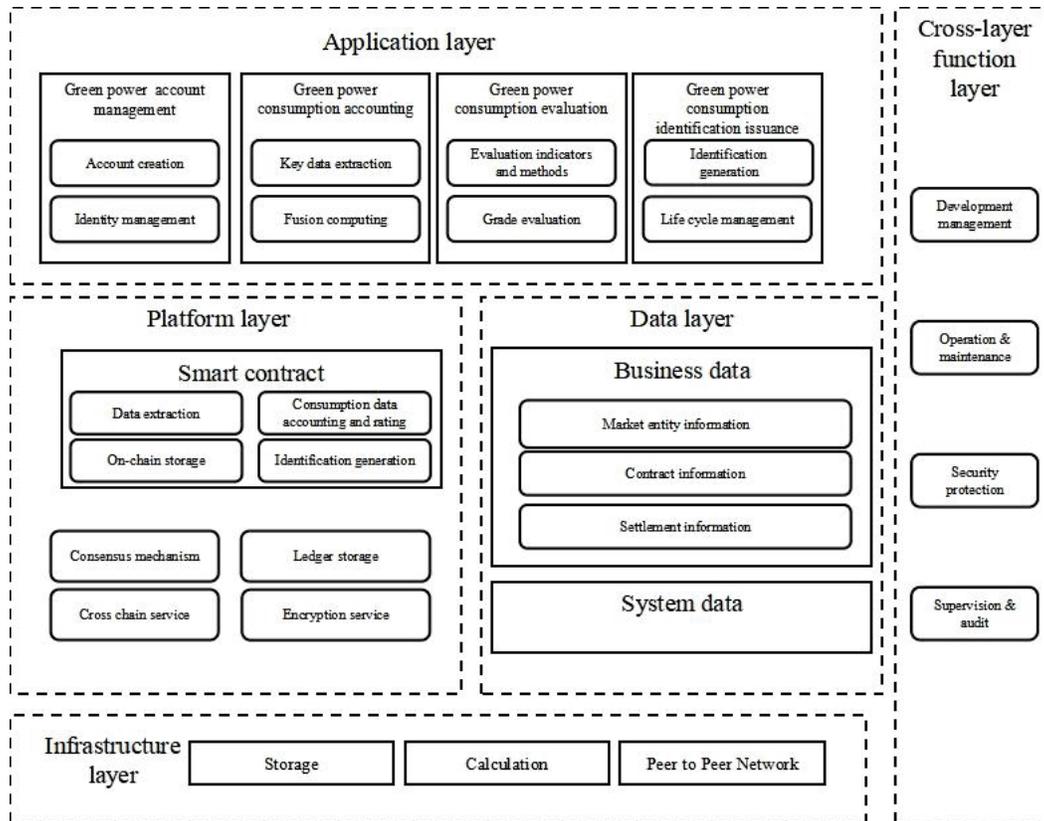


Figure 2- Framework for green power identification application system

### 5.1 Infrastructure layer

Infrastructure layer is the basis of blockchain green power identification application system. It provides the required basic environment and components for the data layer, platform layer and application layer. The infrastructure layer includes storage, calculation, peer to peer network.

#### 5.1.1 Storage

The storage function component realizes the storage of various types of data generated during the operation of blockchain. Its functions include improving data reliability through distributed storage of data.

#### 5.1.2 Calculation

The computing function component provides the computing power for the operation of blockchain systems. Its functions shall include:

- a) Provide operational support for blockchain systems;
- b) Can be adopted by every node in a peer-to-peer network.

#### 5.1.3 Peer to Peer Network

The blockchain system uses distributed peer-to-peer network protocols to organize various network nodes in the blockchain. Its functions shall include:

- a) Provide efficient and secure peer-to-peer communication;
- b) Provide multicast capabilities based on peer-to-peer communication.

## 1 **5.2 Data layer**

2 Data layer includes system data and business data, The business data in the system are as follows.

### 3 **5.2.1 Market entity information**

4 Market entity information shall include but not limited to as follows:

- 5 a) Company name;
- 6 b) Company Unified Social Credit Code;
- 7 c) Name and ID number of the company's legal representative.

### 8 **5.2.2 Contract information**

9 Contract information shall include but not limited to as follows:

- 10 a) Contract number, contract name, contract type, contract electricity amount, contract start time, contract
  - 11 end time, contract electricity price, and electricity type;
  - 12 b) Seller code, seller name, seller power generation type, and seller province;
  - 13 c) Buyer code, buyer name, buyer province, and electricity price;
  - 14 d) Transmission code, transmission name, transmission province, transmission electricity amount,
  - 15 transmission electricity price, electricity transmission loss rate, and transmission loss discount;
  - 16 e) Transaction sequence code and transaction sequence name.
- 17 Note: If there is an agent, the contract information shall also include agent code, agent name, agent province,
- 18 and agent electricity price.

### 19 **5.2.3 Settlement information**

20 Settlement information shall include but not limited to as follows:

- 21 a) Settlement period, settlement electricity type, settlement number, power market code;
- 22 b) Settlement electricity quantity, settlement electricity price, settlement electricity charge;
- 23 c) Corresponding contract number;
- 24 d) Related green certificate number.

## 25 **5.3 Platform layer**

26 Platform layer realizes the consensus mechanism, smart contract, security mechanism, authority management,  
27 encryption service, ledger storage and cross chain service of the blockchain based on infrastructure layer and  
28 the data layer. It supports the services for the upper-layer application of blockchain. Among them, the smart  
29 contract function module performs.

### 30 **5.3.1 Consensus mechanism**

31 The consensus mechanism functional component completes the consensus process of blockchain network  
32 nodes through specific consensus algorithms. Its functions shall include:

- 33 a) Support multiple nodes to participate in consensus and validation;
- 34 b) Support independent nodes to verify the effectiveness of relevant information submitted by blockchain  
35 networks;
- 36 c) Support the identification and rejection of new or modified information that has not been confirmed by  
37 consensus;
- 38 d) Have fault tolerance , including non malicious errors such as physical or network failures, malicious errors  
39 such as nodes being illegally controlled, and uncontrollable errors such as nodes generating uncertain  
40 behavior.

### 1 **5.3.2 Ledger storage**

2 The ledger storage function component enables the storage of distributed data in blockchain. Its functions  
3 shall include:

- 4 a) Support persistent storage of ledger data;
- 5 b) Support multiple nodes to have delayed complete data;
- 6 c) Support providing authorized data to nodes.

### 7 **5.3.3 Cross chain service**

8 Cross chain service management functional components shall achieve cross chain functionality with other  
9 chain groups. Its functions shall include:

- 10 a) Establish connections between blockchain service providers and cross chain service providers based on  
11 requests;
- 12 b) Support the exchange of identity and authentication information between both parties.

### 13 **5.3.4 Encryption service**

14 The encryption service functional component shall provide encryption algorithms and key security  
15 management. Its functions shall include:

- 16 a) Support symmetric, asymmetric, abstract, hash algorithms, etc;
- 17 b) Having a clear key management scheme to ensure the normal operation of the underlying security  
18 mechanism of the blockchain.

### 19 **5.3.5 Smart contracts**

20 The smart contract function component supports generating specific results based on specific inputs under  
21 preset rules. Its functions shall include:

- 22 a) Develop smart contracts that support green power identification application includes:
  - 23 1) Data extraction;
  - 24 2) On- chain storage;
  - 25 3) Accounting and evaluation of consumption data;
  - 26 4) Identification generation.
- 27 b) Support static and dynamic inspection of contract content;
- 28 c) Provide support for operational carriers, such as virtual machines;
- 29 d) For smart contracts that interact with external data of the blockchain system, the scope of influence of  
30 external data sources shall be limited to the scope of the smart contract and shall not affect the overall  
31 operation of the blockchain system.

## 32 **5.4 Application layer**

33 Application layer is integrated with green power identification related business, and is the specific application  
34 of blockchain technology in green power identification. Relevant function includes:

- 35 a) Green power account management;
- 36 b) Green power consumption accounting;
- 37 c) Green power consumption evaluation;
- 38 d) Green power consumption identification issuance.

## 39 **5.5 Cross-layer function layer**

40 Cross-layer service layer contains functional components that span multiple functional layers to help ensure  
41 accurate business management, such as development management, operation maintenance, security  
42 protection, supervision and adult.

- 43 a) Development Management

1 It shall have a combination of service tools for providing development, debugging, and deployment of smart  
2 contracts, distributed accounting technology, and related applications, building management functional  
3 components, and testing management functional components.

4 b) Operations and Maintenance

5 It shall have service catalog, policy management, exception and problem management, delivery management,  
6 cross chain service management, ledger management, member management and other components.

7 c) Security protection

8 It shall be equipped with authentication and identity management, authorization and security policy  
9 management, privacy protection, ledger protection, availability management and other components.

10 d) Supervision & audit

11 It shall support governance functional components that support blockchain systems to meet the requirements  
12 of governance institutions for blockchain services, as well as audit support functional components that meet  
13 the requirements of responsibility identification and event tracing.

14 **6. Application model**

15 The application model of the green power evaluation system is shown in Figure 3. It includes four functional  
16 modules:

17 a) Account registration module

18 A green power consumer submits an account establishment application to the management agency for all  
19 business operations related to the application for green power identification, including storing the green  
20 power consumption data and storing the issued green power identification.

21 b) Data extraction and on chain authentication module

22 The original data for green power consumption evaluation is extracted from power trading institutions,  
23 including green power trading volume and green certificate trading volume.

24 c) Accounting for green power consumption data and evaluation of green power consumption behaviour  
25 module

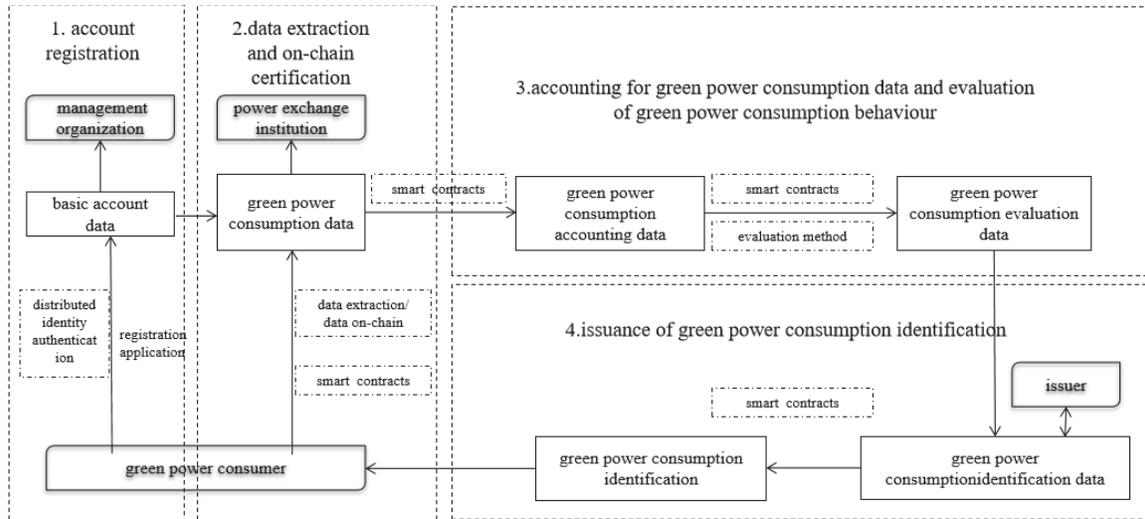
26 Calculate and summarize all green power consumption data in the user's green power account during the  
27 evaluation period, then, evaluate the total green power consumption data of users during the evaluation period  
28 through smart contracts based on the given evaluation algorithm.

29 d) Issuance of green power consumption identification module

30 Issue corresponding green power consumption identification to green power consumption users based on  
31 their corresponding evaluation levels by smart contracts .

32

33



1 Note: [Stakeholder] :stakeholder [Data] :data [Blockchain function] :blockchain function

2 Figure 3- Application model of the blockchain platform for green power identification application

## 4 7. Key process

### 5 7.1 Account registration

6 The registration process is as follows:

- 7 a) The user initiates a registration application to the management organization through the node terminal
- 8 application, and the management organization reviews the user's identity information and sends the relevant
- 9 policies for this registration back to the user;
- 10 b) The user terminal node generates a pair of new public and private keys, which are unique to the user, third-
- 11 party service providers, and blockchain;
- 12 c) The blockchain system receives a user's public key and initiates a registration application with a third-
- 13 party digital certificate service provider;
- 14 d) The third-party service provider registration system pushes account information to the upper level business
- 15 system of the blockchain, and the business system automatically generates accounts to complete account
- 16 opening;
- 17 e) Save user public key and associated user account information;
- 18 f) Response to user registration success information.

### 19 7.2 Data extraction and on-chain certification

#### 20 7.2.1 Data extraction requirements

21 The green power consumption data include off-chain data, on-chain data, and data stored on IPFS.

- 22 a) For off-chain data, the process for data extracting shall be:
  - 23 1) The on-chain smart contract sends a request to the oracle smart contract, and receive feedback from the
  - 24 oracle. The information is stored on the blockchain after consensus is reached;
  - 25 2) After receiving the request from the on-chain smart contract, the oracle smart contract sends a data
  - 26 retrieval request to the off-chain data source;
  - 27 3) The off-chain data source uploads the required data while the oracle smart contract verifies the node.
  - 28 If the node fails verification, the data is requested again.

- 1 b) For on-chain data sources, the process for data extracting shall be:
  - 2 1) The on-chain smart contract sends a request to the data storage chain smart contract interface;
  - 3 2) The data storage chain smart contract sends the required data to the outside;
  - 4 3) After receiving the data, the identification evaluation smart contract performs on-chain processing.
- 5 c) For data stored on IPFS, the process for extracting green power consumption data shall be:
  - 6 1) At the beginning of each evaluation cycle, the on-chain smart contract sends a data request to the IPFS
  - 7 system;
  - 8 2) By indexing with keywords, the structure of the Merkle DAG of the data is retrieved. The structure of
  - 9 the Merkle DAG is then replaced with the content of the original file to obtain the complete file. The data
  - 10 fields in the file are parsed and processed on-chain.

## 11 7.2.2 Technical requirements for evidence preservation

12 The requirements for evidence preservation shall include but not limited to as follows:

- 13 a) The system shall support verifying the legality of the on-chain data by calling smart contracts, and once
- 14 the verification passes, the information shall be stored on the chain for preservation;
- 15 b) The evidence preservation period shall be consistent with the business cycle of the information pushed by
- 16 the power trading platform;
- 17 c) The preservation process shall be completed within one minute after the business is triggered;
- 18 d) The preservation method shall be content-based.

## 19 7.3 Green power consumption accounting and evaluation

20 After uploading the green power consumption data to the blockchain, it is necessary to summarize and

21 calculate the uploaded green power consumption data with a fixed structure, and generate specific calculation

22 values as green power consumption evaluation data.

23 The requirements for green power consumption accounting and evaluation are as follows:

- 24 a) Generate specific values as the green power consumption evaluation score of the company according to
- 25 the green power consumption certification evaluation formula to .
- 26 b) In the blockchain system, data calculation shall be performed through a smart contract, solidity language
- 27 is recommended to be used for smart contract programming.
- 28 d) The evaluation indicators for green power consumption data shall at least include the proportion of green
- 29 power consumption, and a reasonable value shall be determined as a threshold to rate users' green power
- 30 consumption.

31 Note: For different industries, different thresholds can also be set by the regulatory authorities based on

32 industry characteristics.

- 33 c) Indicators such as green power trading prices and stability of green power consumption may be
- 34 considered, for evaluation models with multiple evaluation indicators, a weighted calculation method shall be
- 35 used. For each indicator, the green power consumption evaluation shall be summarized and calculated using
- 36 the following formula for accounting:

37 Company  $j$ 's green power consumption data  $Y_j$  is shown in the formula,

$$38 Y_j = \sum_{i=1}^n \alpha_i X_{ji}$$

39 where  $\alpha_i$  represents  $X_{ji}$ 's corresponding weight value, which satisfies  $\sum_{i=1}^n \alpha_i = 1$ ;  $X_{ji}$  represents the green

40 power consumption index  $X_i$  of the company  $j$ .

## 41 7.4 Green power identification issuance requirement

42 The requirements for generating green power identification are as follows:

- 43 a) Carry out on a yearly cycle, i.e., conduct green power consumption assessment, certification, and issuance
- 44 once a year, and generate a green power consumption identification;

- 1 b) The green power identification shall include at least the following information:
- 2     1) Basic information of green power consumer;
- 3     2) Total green power trading volume;
- 4     3) Total green certificate trading volume;
- 5     4) Total power consumption;
- 6     5) Green power proportion;
- 7     6) Effective period.
- 8 c) Each identifier is valid for one year, i.e., the identifier is valid from the date of generation until the day
- 9 before the generation date of the next identifier;
- 10 d) After each generation of digital identifiers, the previous batch of generated NFT digital identifiers shall be
- 11 recycled;
- 12 e) When constructing NFT structures, it is recommended to follow standards such as ERC-721, ERC-1155,
- 13 NEP-11, etc.