Overall Architecture of the Energy Internet

Article Overview

The Energy Internet is structured as a multi-layered, distributed network integrating energy, information, and communication technologies to enable bidirectional energy flow and decentralized management.

Layered Architecture

The Energy Internet is commonly described using a six-layer model:
o Business Layer - Defines market roles, business models, and energy trading mechanisms, including prosumers, contractors, and balance-responsible entities that manage energy transactions and settlements .
o Use Case Layer - Represents specific applications and scenarios, such as peer-to-peer energy trading, microgrid operations, and virtual power plants .
o Operation Layer - Handles real-time energy management, including supply-demand balancing, reactive power control, and frequency regulation .
o Communication Layer - Provides the ICT infrastructure for data exchange, enabling secure, real-time communication between devices, energy routers, and system operators .
o Interface Layer - Acts as a bridge between physical devices and higher layers, ensuring interoperability and standardized data exchange .
o Appliance Layer - Comprises end-user devices, distributed energy resources (DERs), storage systems, and electric vehicles, which interact with the network through the interface layer .

Network Structure

The Energy Internet mirrors the Internet's hierarchical structure:

o Energy LANs - Local clusters of energy resources enabling microgrid operations and peer-to-peer energy trading .
o Energy WANs - Wide-area networks connecting multiple Energy LANs, analogous to the Internet backbone, often including transmission grids and sometimes multi-energy systems like natural gas networks .
o Energy Routers (ERs) - Devices that manage energy flow between LANs and WANs, similar to communication routers, ensuring efficient routing of energy packets .
o Energy Internet Service Providers (ISPs) - Evolved system operators that dispatch centralized resources, provide reliable energy services, and maintain network stability .

Key Features

o Bidirectional Energy Flow - Supports both consumption and generation at the prosumer level, enabling dynamic energy exchange .

o Integration of DERs - Incorporates renewable energy sources, storage systems, and electric vehicles for flexible energy management .
o Data-Driven Operations - Uses standardized data structures like Blocks of Energy Exchange (BEE) and Energy Internet Cards to track energy transactions and update user profiles automatically .
o Emerging Technologies - Blockchain, smart contracts, and IoT enhance transparency, security, and decentralized control .

Summary

The Energy Internet transforms traditional centralized grids into a distributed, intelligent, and interactive network, combining energy delivery with real-time information exchange. Its architecture ensures scalability, reliability, and efficient integration of renewable energy, while enabling prosumers to actively participate in energy markets and supporting innovative operational mechanisms.

18], ELAN [19],and urban Energy Internet [20] levels. In summary, as the evolution direction of the power system in

The Energy Internet architecture is constructed by six layers, shown in Fig. 1. From top to bottom are Business Layer, Use Case

This paper describes the basic features and the key structure of Energy Internet, proposes a hierarchical model, and presents key

Based on electrical power systems, leveraging renewable energy generation technology, and information technology,

The article provides an analysis of the concept of the Internet of Energy: the structural elements of the Internet of

Subsequently, an exploration of energy-routing devices and algorithms employed in prior studies is undertaken. Finally,

The climate change crisis, exacerbated by the global dependency of fossil fuels, has brought significant challenges. In the medium to

To realize renewable-energy-based electri cation goals, a new concept the Energy Internet (EI) has been proposed, inspired by the

Overall Architecture of the Energy Internet

This textbook is the first of its kind to comprehensively describe the energy Internet, a vast network that efficiently supplies electricity

The Energy Internet (EI) has been proposed as an evolution of the power system in order to improve its efficiency in terms of energy

EnergyNet, an open-architecture framework developed by ViaEuropa and documented in a 2025 arXiv paper by Birgersson et al.,

This article deals with a thorough investigation of the energy internet towards future emerging technologies for energy

This chapter presents the development of the Energy Internet throughout the history as an evolutionary solution based on modern

The benefits of the energy Internet, along with the challenges of its implementation on a large-scale distributed architecture with the

LPWA is an Internet of Energy (IoE) structure that can provide a comprehensive stream of energy sector applications.

First, a comprehensive overview of Energy Internet is presented along with its aptness as a future evolution of electricity system.

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