

Energy Internet Platform Architecture



Overview

In this paper, a holistic review of the energy Internet evolution in terms of the architecture, types of ERs, and the benefits and challenges of its implementation is presented.

Key Takeaways

Energy Internet architecture integrates distributed energy resources, smart grids, and communication networks into a multi-layered, flexible, and interactive energy system.

Overview

The Energy Internet (EI) is a dynamic, distributed network that combines traditional power systems with distributed renewable energy resources (DRERs), energy storage devices, and controllable loads, enabling real-time energy transactions and management through Internet-enabled communication technologies. It transforms energy production, storage, and distribution into an interactive, Internet-like system where households and businesses can act as prosumers, both consuming and producing energy.

Core Components



Distributed Energy Resources (DERs): Small-scale renewable energy systems such as solar panels, wind turbines, and biomass units that feed energy into the network.

Distributed Energy Storage Devices (DESDs): Batteries and other storage systems that balance supply and demand, enabling peak load management and energy trading.

Energy Routers (ERs): Analogous to communication routers, ERs manage the flow of energy packets across the network, ensuring efficient routing and integration of AC/DC supplies.

Controllable Loads and IoT

Smart Devices: Smart appliances and electric vehicle chargers that can adjust consumption patterns based on real-time pricing and grid conditions.

Communication and Information Systems: Internet-based protocols and ICT infrastructure that enable real-time monitoring, data exchange, and secure energy transactions.

Layered Architecture

The Energy Internet is typically structured into six layers:

- Business Layer:** Defines market roles, energy trading mechanisms, and economic interactions among participants.
- Use Case Layer:** Specifies operational scenarios, such as demand response, energy sharing, and microgrid management.
- Operation Layer:** Handles real-time energy management, scheduling, and control of distributed resources.

- Communication Layer:** Provides the ICT backbone for data exchange, monitoring, and coordination.
- Interface Layer:** Connects physical devices to the network, enabling interoperability between appliances, ERs, and control systems.
- Appliance Layer:** Includes end-user devices and energy-consuming or producing equipment that interact with the network.

Data flows from the Business Layer down to the Interface Layer, while appliances communicate with the network through standardized interfaces, ensuring seamless integration and coordination.

Operational Principles

Bidirectional Energy Flow: Energy and information flow in both directions, allowing prosumers to sell excess energy and participate in local energy markets.

Plug-and-

Play Integration: New energy resources and devices can be added without disrupting the network, supporting scalability and flexibility.

Real-

Time Monitoring and Control: Continuous data collection enables dynamic load balancing, peak shaving, and demand-side management.

Security and Reliability: ICT protocols ensure secure communication, prevent cyber threats, and maintain system stability.

Applications and Benefits

Supports smart cities and buildings by integrating renewable energy and storage systems. Enables energy trading among households and microgrids. Enhances energy efficiency, reliability, and sustainability.

Facilitates AC/DC hybrid networks for diverse energy applications, including electric vehicles and nano-grids. The Energy Internet represents the next evolution of the smart grid, combining distributed energy, ICT, and market mechanisms to create a flexible, secure, and interactive energy ecosystem.

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