Research on Multi-Source Fusion Energy Management and Control System for Regional Energy Internet

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ABSTRACT

With the energy transformation, the traditional independent energy supply and consumption patterns can not fully meet the actual needs. In response to this situation and research needs, a multi-source fusion energy management and control system of multiple energy sources for regional energy internet is proposes and the system architecture, function design, and summarizes the key technologies involved in the system are Introduced in this paper. The system can realize various energy fusion and "source-grid-load" interaction in order to optimal scheduling management to various energy sources and the user.

Keywords: energy internet; multi-energy fusion; "source-grid-load" interaction; energy management system

Preface

At this stage, a single clean energy alternative to traditional energy has not fully met the actual needs. It should be achieved that a variety of low-carbon energy consisted of solar thermal, photovoltaic, water, ground source heat pump, air source heat pump, gas boiler, biomass, wind power and other low-carbon energy are managed in a unified way based on the concept of "multi energy complementary". This will be one of the most effective ways to reduce energy consumption and carbon emissions in the coming period.

In order to promote the modern transformation of energy and promote the application of renewable energy development, it is the urgent need for a multi-source fusion energy management and control system for regional energy internet to
achieve "source-grid-load" interaction and the coordination management of multi-energy flow. It realizes the complementary joint operation analysis, control and coordination interaction of multi energy flow to improve energy efficiency and enhance energy system stability.

**Overall architecture**

The multi-source fusion energy management and control system covers the micro grid, industrial and commercial users, urban residents, urban lighting, urban transportation and other user side energy links. On the one hand, a holographic multi energy internet of things will be built to achieve a wide range of energy services terminal access, the energy information exchange and energy service information network will be built to comprehensive support two-way interaction demand with the help of advanced communication network technology and big data technology, cloud computing technology.

On the other hand, the interoperability between service center and the service object is achieved to provide a unified sharing service for the operation and maintenance management, production control and marketing transactions. And it can also achieved to provide the different service objects the services such as energy efficiency management, energy trading and query interaction etc.
Functional module

The main function of the multi-source fusion energy management and control system is to achieve the coordination and comprehensive utilization of cold, heat, electricity and gas to realize ecological, economical and biochemical development and utilization and enhance the utilization of renewable energy and clean energy, improve the energy use ratio of renewable energy and clean optimization. The main functions are as follows:

Design of integrated energy data acquisition modular.

Aiming at the energy centralized monitoring function, this system realize real-time monitoring and accurate measurement of the integrated energy with a variety of energy metering equipment and monitoring equipment, adopting advanced and mature wireless, wired, carrier and other communication methods.

Design of the "source-grid-load-storage" operation and control system

Using a variety of energy conversion technology and information flow and energy flow interaction technology, this system realizes the information exchange and the coordination control of a variety of energy resources and a new integrated energy management mechanisms and models to achieve the "source-grid-load-storage" operation and control system to ensure the safety, reliability and economy of the integrated energy operation system, which is characterized by the multi-energy complementary, intensive and efficient use, clean and intelligence, and the coordination response between supply and demand side, as shown in Figure 2.

![Figure 2. Framework of "source-grid-load" interaction and multi-energy fusion system.](image)

In the aspect of the coordination between grid and source, using the advanced multi-flow scheduling and control technology, the energy supply optimization model combining distributed self control with centralized control is established to reduce energy network congestion and security risk and to enhance flexibility and reliability of the integrated energy management system.
In the aspect of the response demand, on the overall demand for energy resources, the reasonable response demand mode is formulated to guide the demand side active tracking output fluctuation of renewable energy and to realizing orderly charge and discharge of the storage resources, enhancing the accept ability of the new energy to the system.

**Design of “cooling-heat-gas-electric” multi-energy fusion control system**

In the aspect of multi-energy complementary, this system builds the energy integration control platform with multi energy interconnection, integration and complementary function. With the coordinated control model of multi-energy accumulation, coordination and complementary by monitoring and coordination control of multiple types of energy resources, this platform overcome the impact of the environment, weather, transportation channel and other factors to energy supply and ensure the safe and efficient of system and improve the comprehensive utilization of energy efficiency and renewable energy consumptive capacity.

**Design of intelligent home energy efficiency management module**

By the establishment of a modern family service system and the deployment of smart home energy center, the intelligent management and interaction of the home energy internet is achieved to provide efficient quality service.

On the one hand by the establishment of user family energy consumption model, this module calculates the comprehensive energy consumption optimization index and provides energy efficiency optimization strategy of service, at the same time according to the real-time price and new energy generation, establishing family demand response strategy to meet the grid peak demand.

On the other hand, the modular can analysis the data of electrical applications safety according to the load characteristics of household, and provide the hidden power warning information such as electric leakage, heavy load and overload information to prevent accidents from spreading and expanding in time and to achieve active safety management of power use.

**Design of energy purchase, sale and transaction service module**

This system also contains a information support platform for energy purchase and sale business to provide the new mode of integrated energy service such as customer service, calculation and settlement of energy purchase and sale, value-added services, energy trading services.

And by the way of integration of settlement entrance of gas, electricity, water, heat and other energy, the online energy usage tracking, query and settlement of the enterprise users and home users can be realized on the concept of “Internet plus Energy services”.

**Key technologies**

**Regional energy router**

The regional energy router is the key of the regional multi-energy fusion management and control system to realize the energy flow management, mutual
transformation and coordinated control. The principle structure is shown in figure 5. As the center of energy conversion system, it is connected with AC power, DC power supply, power grid photovoltaic power, user load, energy storage equipment and gas, heating and cooling pipes, and each channel is equipped with a corresponding control switch to control the path on or off according to the needs and the corresponding selection rules.

The AC and DC double buses are set. The AC and DC power of the distribution network are respectively connected to each bus directly, and the AC and DC double buses are converted into each other through the inverter. The regional distributed PV generator is connected with AC bus through inverter. For alternating current users, AC bus directly provides AC power supply. For electric vehicles and other DC users, the device can be directly connected with the DC bus. The current energy storage equipment is mainly battery, which uses direct current to charge and discharge and is directly connected with the DC bus. So by focusing on various forms of energy resources docking, the various power coordinate transformation and interaction with the power grid and intelligent user can be realized to support the implementation of the grid fast load control and automatic demand response.

**Energy information interaction technology**

System control and energy management services is based on the information timeliness and comprehensiveness, the energy information network covers the micro grid, industrial and commercial users, city residents, city lighting, city traffic and other fields. The energy management and control decisions depend on these state information. In order to meet the real-time demand of each user, the higher requirements for transmission delay and interactive reliability are put forward.

Therefore, the panoramic holographic internet of things of multi-energy real-time access constructed can achieve a variety of energy service terminal wide coverage and full access. And the interoperability between service center and the service object is achieved to provide a unified sharing service network for the operation and maintenance management, production control, marketing transactions and to provide the services such as energy efficiency management, energy trading, inquiry, interaction and other services by the internet terminal, mobile phone terminal.

**Conclusion**

Based on the analysis of the actual needs of the energy internet, this paper put forward a design scheme of regional multi-energy fusion management and control system, and gives the system architecture, function module design and related key technologies. The system realizes source-grid-load coordinated operation analysis and control, and builds a comprehensive utilization system of cold, heat, electricity, gas to achieve the multi-energy complementary and the integrated management and coordinated interaction with electric power as the core. This system increases the proportion of high-quality energy applications and has a positive significance to realize the ecological, economical and biochemical development and utilization of regional energy resources.
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