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Small Nuclear Units에 의한 분산전원으로서의 전망(1)

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Small Nuclear Units and Distributed Resource Prospects(1)

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Abstract - This paper will be introduce a new paradigm and prospects for energy supply system in near future which produces electric and district heat cogeneration with dispersed power grid with small nuclear power units. Recently, in nuclear field, a lot of effort has been done in nuclear major countries to develop small and medium reactor for enhancement of nuclear peaceful use as like in district heating, electric power generation, seawater desalination or hydrogen generation. This paper presents a new way and prospects for power source in distribution system by using the distributed & remote cogeneration system using small reactor.

Index Terms-New paradigm and prospects for energy supply system, Small and medium reactor

1. Introduction

Efficient production and utilization of energy are crucial for our country's national security and economy, particularly since we have limited natural resources. Therefore, more stable, efficient and area-independent energy production and operation are necessary to replace large power generation by the national grid system or extreme dependence on foreign resources. Development of a cogeneration system with small power plants is necessary as a distributed power generation source, especially since our country is made up of islands, mountains and large cities with numerous apartment complexes. Furthermore, the demand for power in island areas is expected to greatly increase around maritime areas, such as waterfront ranching systems and physical distribution systems[1-5].

Our research institute seeks to develop a small-scale electric power system with an integrated development/transmission/distribution/load powered by an environmentally-friendly and maximally stable small nuclear reactor. We also seek to develop new basic technology to synthesize and apply region-specific district heating, freshwater, etc. We expect our research results to contribute to domestic technical independence as well as to overseas advancement in this field in the case that development of a power generation system with a small power reactor is actively being executed. In order to obtain effective research results, our research institute has engaged a number of electrical and atomic energy engineering professors, graduate students and industrial technicians, and is constructing with an industry organic system for the spread of research results. Moreover, our institute requests active interest and support from universities and industrial and governmental entities to earn a central role for scientific research and technical development in the fields of electric power engineering and energy[6-12].

2. Distribution System and Distributed Generation

Figure 1 shows the conceptual diagram of the distributed generations for a power distribution system with parent-lateral line and with sub-lateral line.

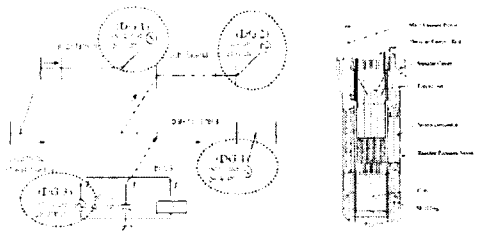

Fig. 1. Conceptual diagram for the distributed generations and Integral Reactor, SMART

3. Six Research Items for Small Nuclear Units and Distributed Resources [6-12]

Our institute requests active interest and support from universities and industrial and governmental entities to earn a central role for scientific research and technical development in the fields of electric power engineering and energy.

The Thermal Hydraulic System Analysis Division (THSAD) has the research development objectives to design a small-sized power reactor suitable for a distributed system and to develop particular stability according to the stability and natural current of the system. Stability of the small-sized power reactor must be secured during accidents that cause blackouts or loss of outside electric power. Therefore, the 1st circulation system is operated in a natural convection system without a pump and its stability must sufficiently be insured in both steady and transient states. Additionally, the design characteristics and feasibility of steam-gas pressurizers for small-sized

reactors should be investigated. Hence, this benchmarking experiment is essential for analysis of the thermal hydraulic system. The result will contribute to basic technological development for small-sized reactor unit designs.

The Radiation Protection Research Division (RPRD) is composed of the Kyunghee University Radiation Shield Team and the Seoul National University Environmental Radiation Team. It undertakes research for radiation protection and environmental safety of the regional energy system based on the small-sized reactor. The Radiation Shield Team investigates radiation shielding and the safety technology of the reactor. It will develop a simulation code to optimize radiation protection and perform actual calculations. The Environmental Radiation Team researches the radiation measurement and environmental radiation monitoring system to measure and monitor environmental radiation around the reactor and the surrounding area.

The Unmanned Remote Control Division (URCD) aims to develop instrumentation and control systems that enable unmanned remote monitoring, operation, and operation support for small modular distributed reactors. The small-sized reactors are controlled in optimal states irrespective of significant operational changes due to the ultra long fuel cycles. They operate autonomously by developing remote diagnostic, monitoring and fault-tolerant control algorithms. The URCD's results will reduce the operational cost of local energy systems using small-sized reactors and can overcome the difficulty of securing the operators in agricultural and fishery areas and islands.

The Power System Analysis and Control Division (PSACD) aims to develop new technologies for the next-generation Community Energy Systems (CES) that model and analyze power and load systems in CES. It operates and controls the various electrical components in CES. This division newly designs and models CES based on distributed generation and develops analysis and control methods for various system conditions. The real-time simulators for CES and the Web-based SCADA system are implemented for real-time testing and simulation of the developed technologies in this division.

The Micro-Grid Protection Research Division (MGPRD) develops optimal protection systems for microgrid-connected Distributed Generations (DG) based on IED (Intelligent Electronic Device) technologies. Asynchronous, synchronous, and inverter type DG models are used to consider the operational characteristics of DG systems and to simulate their interconnection and power islanding. The MGPRD will propose advanced protection schemes considering various faults and power islanding of DG. The advanced protection schemes developed by the MGPRD will enhance the performance of conventional protection systems for DG and could improve the operational reliability and stability of DG systems.

The Small Power Research Division (SPRD) has the objective to develop the fundamental technologies of other small power generation systems that can be applied to marine and space technology as well as micro local energy sources, rather than the small nuclear power system which the center aims to develop. Technology related to the marine reactor, micro gas-turbine, and new recycled energy can be researched by the SPRD. Currently, through a subcontract with Hyun-Dai Heavy Industry, research is being actively implemented to establish the requirements for manufacturing a nuclear power ship and to develop fundamental technology for the transfer of SMART-P to a maritime nuclear reactor.

2. Power System Map of 7 Island areas in Korea

4. Power system map of 7 island areas in South Korea

Figure 2 represents a power system map of 7 island areas in South Korea, and consists of Jeju island, Ulreung island, Paeknyong island, Heuksan island, Chuja island, Geomun island, Deokjeok island, etc.

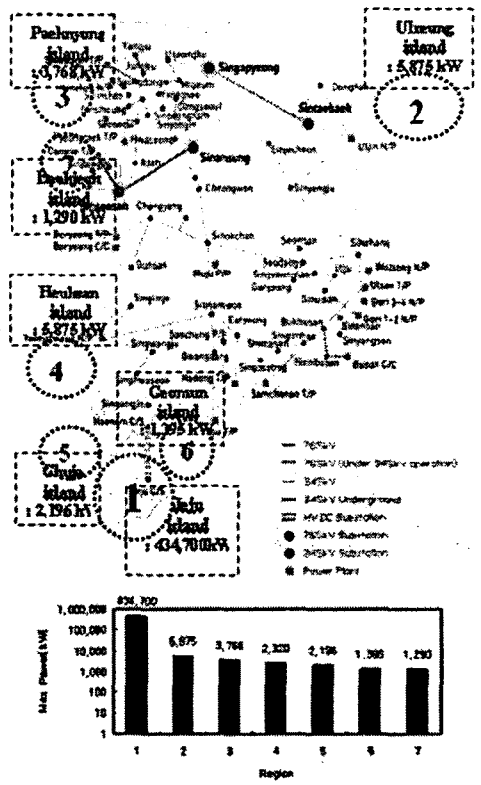

Fig. 2. Power system map of 7 island areas in South Korea and the maximum power bar graph of 7 island areas in South Korea

5. Conclusions

This paper introduced a new paradigm and prospects for energy supply system in near future which produces electric and district heat cogeneration with dispersed power grid with small nuclear power

units. Recently, in nuclear field, a lot of effort has been done in nuclear major countries to develop small and medium reactor for enhancement of nuclear peaceful use as follows:

- district heating
- local electric power generation
- island electric power generation
- seawater desalination
- hydrogen generation

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