

CURRENT DEVELOPMENT AND FUTURE PLAN FOR SMART DISTRIBUTION GRID IN KOREA

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ABSTRACT

Since 1998, Korea Electric Power Corporation (KEPCO) 's distribution automation system (DAS) has been deployed and now operated in whole 190 branch offices in KEPCO. From 2005, research project has been carried on, which titled with "Development of Intelligent Distribution Automation System (IDAS)" to give DAS more intelligence. The project is consisted of 4 sub projects in which high level master station for IDAS, intelligent multi-functional remote terminal unit, sensor and intelligent distribution facilities with diagnosis are being developed to improve the power quality and reliability of the distribution networks and test bed for distribution generation is being established. The high level management systems and intelligent RTUs and distribution facilities has already developed and will be integrated and tested in the field next year.

From 2008, KEPCO will launch new research project for Smart Distribution Grid. In this project, distribution automation system will be transformed into the smart multi-agent, self diagnostic and fault anticipatable system with fully integrated with Distributed Energy Resources and with conformance to IEC 61850. And new DC (direct current) power distribution network configuration and operating technology will also be developed using DC microgrid and customer storage system. After completion of this future projects, the power distribution architecture for next grid will be developed, through products of that revolutionary improvement for power network in terms of integrated operation, reliability and utilization will be accomplished.

INTRODUCTION

KEPCO's effort for more efficient operation was started with distribution automation. KEPCO has researched and developed distribution system since 1993 and distribution automation system has been operated since 1998. Now days KEPCO's distribution automation system has been installed and operated in all 190 branch office. And around 35 percent of total 126,854 line switches have been automated in 2006. As communication media for distribution automation, several types of media such as optical fiber, telephone wire, TRS, Mobile Data and CDMA is used.

media	fiber	wire		Data	
Share (%)	68	15	8	8	1

Figure1 shows the typical configuration of KEPCO's distribution automation system. Distribution automation system has advanced application program such as FLISR (fault location, isolation and restoration), Load balancing and loss minimization, Relay coordination, etc.

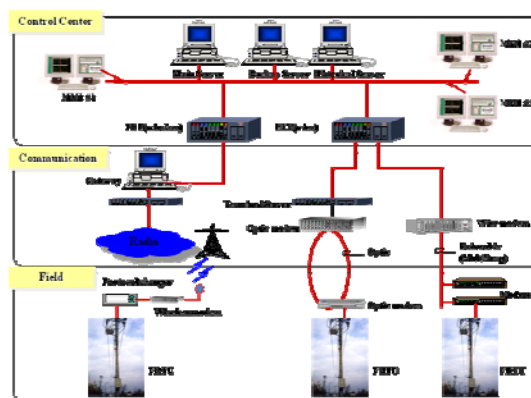


Figure 1 Configuration of DAS in KEPCO

In 2006, KEPCO had determined to cluster total 190 branch office into 2~10 and construct total 41 distribution control center until 2009 for establishing center based large scale direct operation system and advanced distribution operation environment. Also, 41 main control centers will be renewed using new IT technologies. Figure 2 shows the new type distribution control center using DLP multi-cubes and other IT technologies.



Figure 2 New Distribution Control Center

Table 1 Communication Media

Comm.	Optical	Tel.	TRS	Mobile	CDMA

CURRENT PROGRAM ON SMART DISTRIBUTION GRID

To make digital, intelligent and power system digital and create new growth engine of Korea using information and communication technologies, POWER IT program launched in 2005. Power IT research program consists of 10 research projects such as Korean EMS, FACTS, Intelligent Transmission network, IEC 61850 based substation automation, Intelligent Distribution automation, MicroGrid, BPL, power semiconductor and Integrated management of Customer's energy resources. Intelligent distribution automation is included in distribution area in Power IT program.

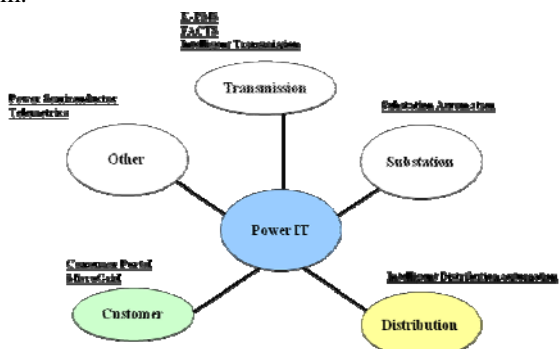


Figure 3 Power IT Research Program

Intelligent Distribution Automation System (IDAS)

The research project that titled “Intelligent Distribution Automation systems” launched in 2005 and carried on by 2010 for 5 years. The final goal of this project is to develop the integrated and intelligent distribution automation system. The project is divided into four sub projects, which are the development of IDAS master station (SP1), development of intelligent feeder remote terminal unit and high speed data processing unit (SP2), development of intelligent distribution equipments (SP3) and DG interconnection technology and devices (SP4).

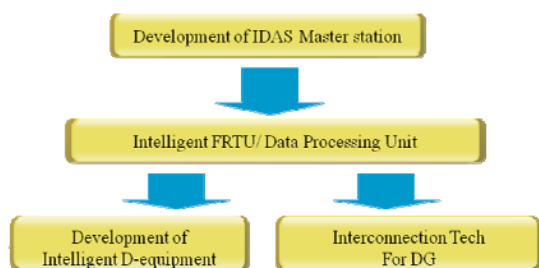


Figure 4 Project structure of IDAS

The product of IDAS will be integrated and tested in 2008 and 2009.

Development of IDAS master station

In SP1, the integrated distribution automation system is going to be developed covering from substation SCADA to monitoring DG. In master station, there are several server

s for DAS, SCADA and GIS. Each server exchanges operation information using middleware. And many application programs such as distribution load flow, load forecasting, reliability management and power quality monitoring is developing.

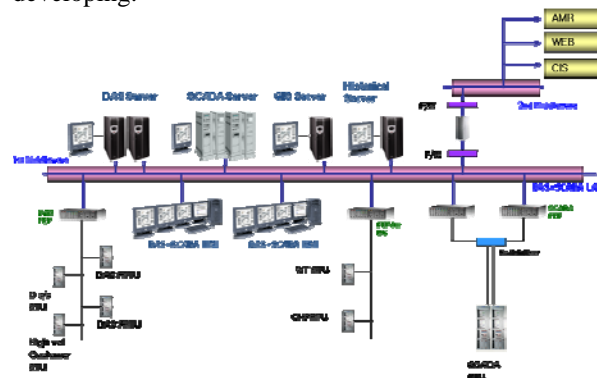


Figure 5 Configuration of Master Station

The master station will be tested in Gochang Test center in Korea 2008 and will be installed and tested in Vietnam and China.

Development of intelligent FRTU

In SP2 (development of intelligent FRTU), three types of FRTU is developing. The first is Intelligent FRTU for overhead and underground distribution switch/recloser, the second is FRTU for distribution substation, and the third is FRTU for monitoring distributed generation. Intelligent FRTU has the 0.5% accuracy and 128 sampling rate. It can monitor power quality status such as sag, swell, interruption, harmonics, etc. Fault waveform can also be captured and transferred to master station. The communication protocol that is used in intelligent FRTU is DNP3 and IEC 60870-5-

101. Firmware can be updated remotely and have the self diagnostic function.



Figure 6 Intelligent FRTU

Development of Intelligent Distribution Equipment

In SP3 (development of intelligent distribution equipment), high accuracy sensor and 15 types of distribution equipments is being developed. Intelligence means that the equipment embeds the sensor can detect the aging status and communicate the diagnostic information with master station. The sensors for measuring current and voltage with high accuracy and for measuring partial discharge is already

y developed and is used in intelligent distribution equipments. The developing intelligent distribution equipments includes compact substation, automated capacitor bank, switches with diagnostic function.

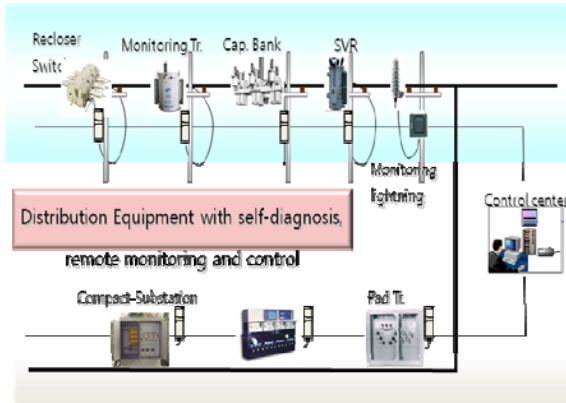


Figure 7 Development of intelligent dist. equipments

Interconnection Technology for distributed resources

In SP4, development of interconnection technology for DG, establishment of DG test center, development of several DG interconnection devices and interconnection technology is included. Figure 8 shows the network and DG configuration of DG Test center.

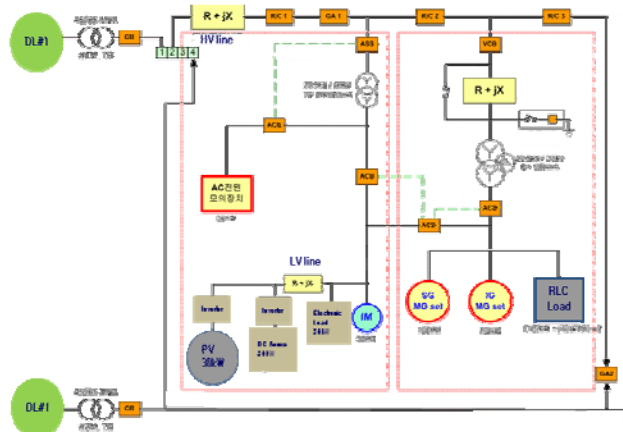


Figure 8 network configuration of DG Test Center

Total 30kW photovoltaic generation is installed, which is 6 units for 3kW, 1unit for 12kW and can be tested the interference between PVs. The wind turbine and Combined Heat and Power (CHP) can be simulated by using motor-generator sets.

Bidirectional recloser and integrated protection unit for interconnection of DG are also developed. Bidirectional recloser is the upgraded type of general recloser to consider two way power flows by DG and solve that problem caused by DG. This equipment have protection component of CR, OCGR, DGR, OVGR, UVR, RPR. And the integrated protection unit for interconnection of DG has the relay function of OCGR, DGR, OVGR, OCR, DOCG, NSO

CR, RPR, OPR, UPR, OVR, UVR, OFR, UFR, NSOVR, df/df, SGR.

FUTURE PLAN FOR SMART DISTRIBUTION GRID

Following Power IT program, the new research programs are planned for implementing smart grid. To cope with situation of high oil price and energy crisis and Bali roadmap to reduce CO2 emission, innovation of electric grid as energy platform through energy awareness and ICT technologies is needed.

In Korea, especially in distribution area, the new two projects are 'development of smart distribution system' and 'establishment of integrated test bed'.

Development of Smart Distribution System

The research goal of 'development of smart distribution system' is to develop open standard architecture and integrated operation system for smart distribution grid. This project has 3 sub project (SP), which are development of architecture and optimal operation technology for smart distribution system, integrated smart distribution operation systems, and DC (direct current) distribution technology.

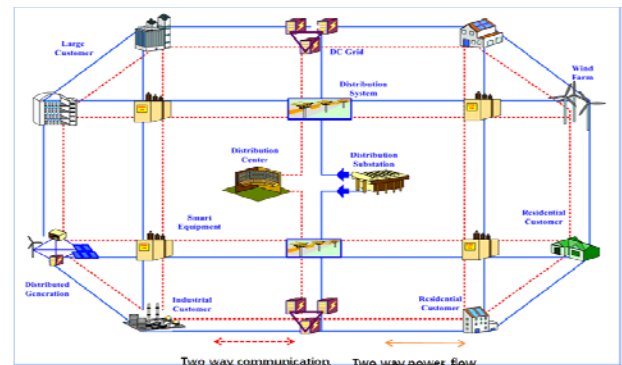


Figure 9 Smart distribution grid

In SP1, the integrated open architecture for interoperability will be defined and coordinated the product of Power IT program. In SP2, new smart distribution operation systems, which evolves from the intelligent distribution automation system. Transforming from the serial communication to LAN based, the new smart distribution operation system will be kind of energy management system (EMS) to integrate high penetration of DG and new smart distribution equipment to be implemented using plug and play and peer to peer communication with conformance to CIM and IEC 61850. In SP3, DC (direct current) distribution technology, including the interconnection technology between DC and AC grid, multi modal power network technology, and customer energy management systems using battery.

Establishment of Test bed for Smart Distribution

In 'Establishment of Test bed for smart distribution', the i

ntegrated testing environment and site will be established. And in that test bed, the test, evaluation and development of certificate standard and process for power IT product will be carried on. Also, the product of smart distribution systems will be tested and evaluated. By this research project, the product and solution developed in Power IT program and development of smart distribution system project will be supported to conform the global standards and provided the reference and operation experiences.

CONCLUSION

Since 1998, KEPCO's distribution automation system was developed and deployed in all branch office. In 2006, new distribution control center was designed for large scale direct operation and advanced distribution operation environment. To put the more intelligence in this distribution automation system, new intelligent distribution automation system (IDAS) was launched as one of Power IT program in 2005.

Now in 2008, new transformation in distribution system is planned, and the project is on smart distribution system. Through these projects, the open architecture and operation system for next distribution grid will be developed and revolutionary improvement for power network in terms of integrated operation, reliability and utilization will be accomplished. Moreover, KEPCO and Korean manufacturers will be expected to obtain the strong competency for global market. .

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