

## Principal Research Results

# Development of Operation Control Technique for Autonomous Demand Area Power System

## – Demonstration of Isolated Operation Methods in Non-fault Section in the event of Grid Failure –

### Background

We are promoting a study of the Autonomous Demand Area Power System (ADAPS)\*<sup>1</sup>. The purpose of the ADAPS is to establish smooth introduction and effective use of the distributed power generation (DG) while preventing the grid interconnection problems such as influence on power quality and safety. As for utilization technique of DG, isolated operation method of non-fault section in the event of the grid failure or outage is being developed. To date, an uninterrupted power supply method of high voltage non-fault section using the Loop Power Controller (LPC) has been proposed, targeting high voltage distribution line. Additionally, a method to avoid outage of low voltage customer by isolated operation of the customer owned DG using the Supply and Demand Interface (SDI) in the event of outage of high voltage distribution line has been developed and demonstrated. As for the latter method, it is desirable to establish the technique to expand non-outage area into whole area of low voltage distribution line including the customers not having DG.

### Objectives

To demonstrate uninterrupted power supply method by isolated operation in high voltage non-fault section using LPC. And to develop and demonstrate the isolated operation method in low voltage distribution using DG, storage battery and the technique of cutting off selected load of customer.

### Results

#### 1. Demonstration of autonomous distributed protection system in high voltage distribution line

The proposed method shown in Fig.1, which consists of sectioning switches, operation control subsystem and LPC, is demonstrated by a ground fault test of high voltage distribution line using the ADAPS hybrid experimental facility of CRIEPI. As the result, it is clear that both an autonomous parallel control method in each section for fast operation and change of the LPC operation mode for isolated operation are properly achieved as our design. As a result, it is demonstrated that both outage in fault section within required time and uninterrupted power supply in neighboring non-fault section can be realized. (Fig.1)

#### 2. Development and demonstration of isolated operation method for low voltage distribution line

An isolated operation method for low voltage distribution line shown in Fig.2 is developed. The validity of the method is demonstrated using a pilot facility of SDI. The following methods are adopted for the maximum term of uninterrupted power supply operation with limited PV power output. [1] A customer having PV (#1 in Fig.2) adjusts power balance between supply and demand in whole low voltage distribution line by storage battery. [2] The central management system of low voltage distribution line calculates overall surplus power of PV in the low voltage distribution line including other customers having PV (#2 and #3 in Fig.2). According to the information of the surplus power, if necessary, the customer not having PV (#4 in Fig.2) cuts off selected loads.

As the result of demonstration test, it is confirmed that isolated operation of whole low voltage distribution line can be continued by the effective use of PV surplus power as our design. As a result, it is demonstrated that more customers can avoid outage by the designed method.

### Future works

We will establish the operation control technique of ADAPS by way of overall demonstration and evaluation including control method of LPC and DG for maintaining proper voltage and minimizing power loss of distribution line in normal situation.

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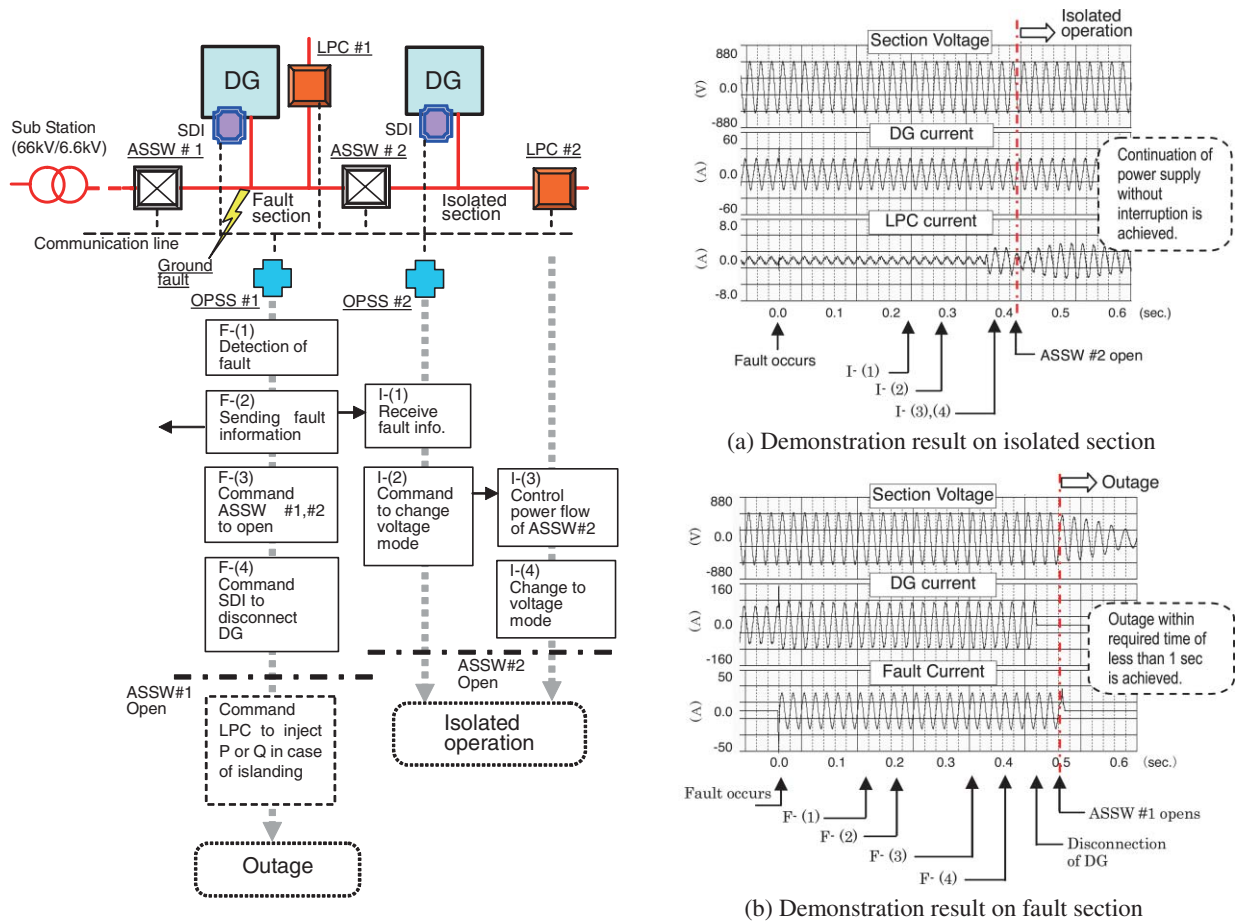
### References:

Hiromu Kobayashi, 2006 “Demonstration Test of Fast Separation of Fault Section and Uninterruptible Isolated Operation of Normal Section in ADAPS”, CRIEPI Report R05027 (in Japanese)  
Masahiro Asari and Hiromu Kobayashi, 2006 “Development of Low Voltage Demand Supply Interface - Selective Load Management and Low Voltage Network - ”, CRIEPI Report R05029 (in Japanese)

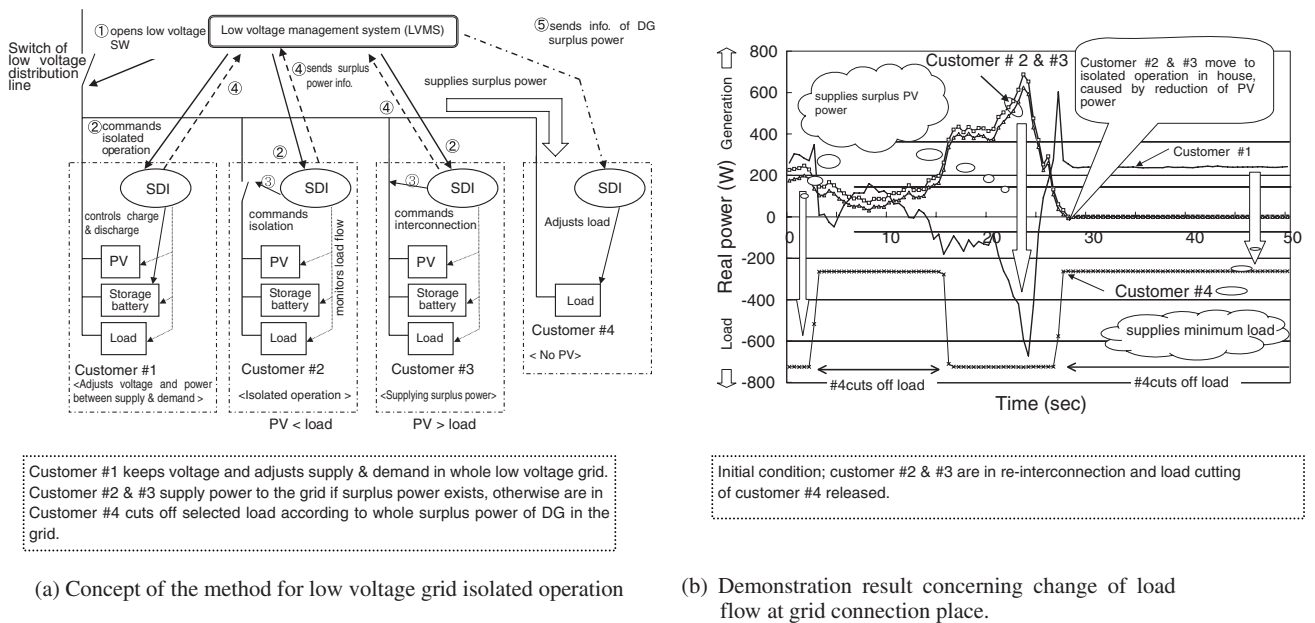
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\* 1 : Loop shaped distribution line is adopted for basic system configuration. Loop power controllers (LPC), controlling line power flow and voltage actively, are installed at each looping point. Supply and demand interface (SDI) is installed in each customer. The SDI controls DG autonomously taking account of energy saving and load leveling, based on information from both the utility side and customer side. A central operation control system is installed for the purpose of unifying the whole system. Operation control sub-system is also installed in each section for the purpose of rapid and reliable operation in case of line fault. As a communication method for co-operation between all devices, the Mobile Agent and the Ethernet network are being investigated. Those measures may be able to cope with frequent changes of system configuration and of system management control functions including fault operation flexibly with low cost.

## B. Creation of integrated energy service



**Fig.1** Demonstration result of proposed method for protection and isolated operation in grid failure



(a) Concept of the method for low voltage grid isolated operation

(b) Demonstration result concerning change of load flow at grid connection place.

**Fig.2** Concept of the method for low voltage grid isolated operation and demonstration result