A concept of hydrogen energy community balanced supply with demand internetworking electric power, hydrogen and hot water

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The authors have designed the hydrogen energy community (HEC) interconnecting stationary fuel cells (FCs) as distributed energy resources (DERs) and internetworking electric power, hydrogen and hot water in residential areas.[1] The demonstration project of HEC has been performed from April 2007 to March 2009 for two years, and the results indicated the way to conduct hydrogen economy in Japanese residential areas.[2] After the demonstration, there have been changed the circumstances of DERs in Japan, they were caused by the regulations for residential photovoltaics (PV), net metering, performed in Nov. 2009 and by the 2011 earthquake of Tohoku and the Fukushima Daiichi nuclear disaster on 11 March 2011 (3.11 Disaster).

In this paper, the HEC interconnecting stationary FCs as DERs is redefined from the viewpoints of energy network configuration and its objective functions. Considering the damage of 3.11 Disaster to energy supply systems, some structural and functional problems on the HEC as to system resilience are pointed out. As a new framework of energy network installed system resilience in residential areas, the authors propose a concept of HEC balanced supply with demand internetworking electric power, hydrogen and hot water (HEC with Resilience). This concept illustrates the basic design model including a PV system and damage estimation, and shows the energy network topology of HEC with Resilience (Fig. 1). This study specifies the evaluation indexes, which consist of energy security, resilient power (RePower) and nagawatt demand (Negawatt), and proposes the objective function with the constraint condition on the HEC with Resilience (Eq. 1, Eq. 2).

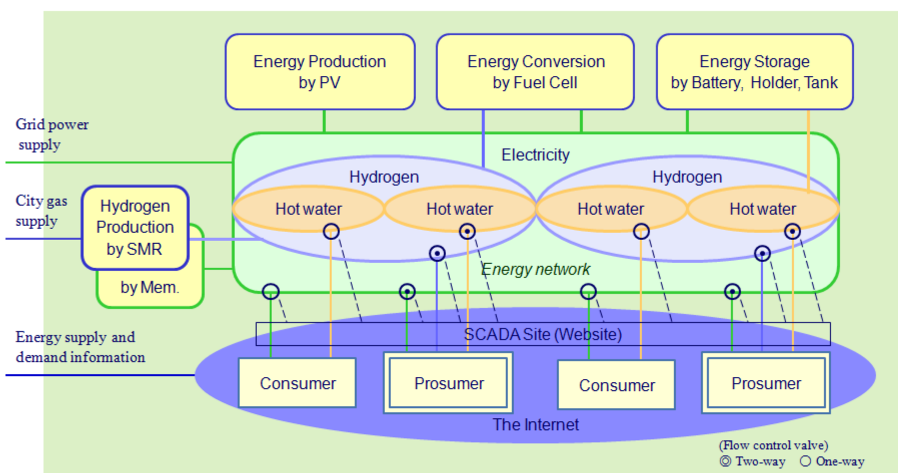

Fig. 1 Energy network topology of Hydrogen Energy Community balanced supply with demand

$$RePower \geqq \sum_{n} Negawatt(n) \quad \text{(kW)} \tag{1}$$

$$\int_{t=0}^{t=T} RePower\,dt = \int_{t=0}^{t=T} \sum_{n} Negawatt(n)\,dt, \quad T \to Maximum \quad \text{(kWh)} \tag{2}$$

Keywords: energy network; hydrogen energy community; system resilience ; stationary fuel cell

References

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