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A Sustainable Electricity Supply Chain Based on Distributed Renewable Energy

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Extended Abstract

Electricity generation from fossil fuels has contributed to a majority of global warming emissions so that the use of renewable energy sources such as wind and solar energy has been increasing in many countries. A growing number of firms have installed onsite wind turbines, solar panels and biogas generators to power their energy-intensive facilities; meanwhile, many residential houses, large commercial buildings and remote farms have started to rely on solar photovoltaics for the generation of electric power. The share of renewable energy in gross final energy consumption in the EU was 16 percent in 2014, and the EU aims at increasing this ratio to 20 percent by 2020.

This research is to investigate a distributed value chain system for low-carbon electricity that is produced by end-consumers' on-site power units using renewable energy resources and distributed through smart grids. An end-consumer in such distributed electricity value chain system will act as both a consumer and a supplier. In the distributed electricity value system, conventional electricity supply chain still exists as an important backbone, but is augmented by bi-directional flows of information and products/services (i.e., electricity). Compared with bulk electricity supplied by conventional utilities, electricity in a distributed value chain system is produced by a large number of small modular energy conversion units, which are located close to the point of end use [1].

Many countries have recently implemented and further heavily invested in smart grids with small on-site renewable energy generators such as photovoltaic systems and medium and small wind turbines, due to climate change and environmental and health concerns. Also, the technological innovations and a changing landscape of economics and regulatory policy could accelerate the new trend of using small on-site electricity generation with renewable energy resources. Bas [2] addressed that an electricity supply chain is a significant value chain incorporating the processes from the primary resource sourcing to electricity consumption. He also emphasized that since electricity is a highly perishable commodity, a holistic view of processes with proper supply chain design becomes particularly invaluable to avoid any energy losses and shortage. Thus, an efficient electricity supply chain network system should be well designed with security and operated to manage bi-directional power flow, adequate voltage control, quality of electric power, a DC-AC interface, and standby generation capacity. In consideration of regulations, finance, and information flows involved in the electricity supply chain network system, a holistic view of the electricity power supply chain, including all relevant stake holders including generators, transmission and distribution companies, end-users and market regulators, is critical for attaining the sustainability goal of using on-site renewable energy.

Therefore, this research presents the current progress of changes in the regulatory policies in some countries, the development and the use of on-site renewable energy generators, the implementation of smart-grid electricity supply chain systems, and operation and management of such type of low-carbon power system. Data for this research were collected from reports published by government agencies and research institutes in some countries, research papers in the literature, and interviews with renewable energy professionals.

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