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Constraints and Barriers to Deployment of Distributed Energy Systems and Micro Grids in Southern China

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Abstract

Distributed Energy Systems (DES) have a comparative advantage of meeting electricity, heating and cooling demand of urban communities in Southern China. The DES Systems facilitate the integration of distributed renewable energy sources, minimize transmission & distribution losses and maximize the use of waste energy from distributed thermal power sources for providing heating and cooling services. However, there are several institutional, regulatory and policy barriers to deployment of DES systems in China. The paper analyses these barriers based on a case study of a DES System for Ningbo High Tech Park in China and proposes recommendations on how to overcome them.

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Keywords : Distributed Energy System; Energy Management System; Distributed Combined Heat and Power Plants; Absorption Chillers

1. Introduction

China has experienced an unprecedented rate of urbanization since 1990s and this has resulted in increased demand for energy to meet the electricity, heating and cooling demand of recently established urban communities. As Southern China (i.e. South of Yangtze River which includes large urban centers such as Shanghai, Guangzhou) is not provided with centralized district heating due to a policy decision taken in 1950s, the urban residents in Southern Chinese depend on electricity for heating during the winter and cooling (air-condition) during the summer. The electricity is mostly generated in large coal fired power plants resulting in energy losses at the point of generation (i.e. waste heat) as well as in transmission and distribution.

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A more efficient way to provide energy to urban communities in Southern China is through Distributed Energy Systems (DES), which include micro grid for supplying electricity within a designated area, Energy Management System (EMS), Distributed Combined Heat and Power Plants (DCHP), heat exchanges, absorption chillers and other distributed energy sources.

The advantages of DES systems compared to centralized energy systems consist of:

- Enable the extraction of thermal energy from DCHP plants at the optimum temperature and pressure to maximize the thermal efficiency of DCHP plants and meet the heating and cooling demand
- Minimize the investment requirement for bulk power transmission and heating pipelines associated with centralized electricity networks and heat supply systems.
- Minimize electricity losses in power transmission and heat losses in long distance heat transfers.
- Reduce the seasonal and daily variations in electricity demand and demand for natural gas by using the DCHP plants to meet the peak electricity demand.
- Improve the reliability of electricity supply as there is less dependence on long distance electricity transmission network.
- Facilitate the integration of distributed renewable energy sources and facilitate the reduction of intermittency of distributed renewable energy by coupling them with DCHP units.
- Together with appropriate smart grid applications, demand response can be used to balance the demand –supply balance in the region covered by the DES system.

In spite of these obvious advantages, the development of DES in Southern China is still at a pilot stage. Since 2000, 23 projects with installed capacity of 18 MW have been completed and further 16 projects with a capacity of 84 MW are under construction. However, some of the early projects have been discontinued to poor financial returns and less than anticipated demand for heating and cooling. Given the economic merit and potential demand in Southern China, this level of deployment of DES is not satisfactory and this paper attempts to address the institutional, regulatory and policy issues preventing the mainstreaming of DES.

2. What is Distributed Energy Systems (DES)?

A DES system essentially consists of a group of interconnected distributed energy sources to meet the electricity, heating and cooling demand of residential and commercial consumers in a designated geographical zone. Although the distributed energy systems are connected to the main electricity grid for reliability purposes, most of the energy used within the distributed energy system is produced using the embedded energy sources within DES. These may include natural gas based DCHP units and solar PV units. In addition, waste to energy, shallow ground geo thermal energy and solar thermal energy can be used to complement the thermal energy provided by DCHP units.

Heating and cooling units consisting of Lithium Bromide Absorption Chillers are installed within the DES system to provide cooling to residential and commercial buildings using the thermal energy supplied from DCHP units. The distributed energy sources, energy conversion units and consumers are connected to an Energy Management System (EMS) with two-way data communication capability to optimize the operation of the DES. The EMS enables the DES to be operated under different operating regimes to achieve certain objectives by the regulators. These could be;

- Minimize the cost of electricity and/or cost of thermal energy
- Maximize the energy production by distributed sources and minimizing grid purchases
- Minimize the greenhouse gas (GHG) emissions.
- Integration of energy storage capacity installed at customer premises (i.e. batteries and electric vehicles) and real time demand response.