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Editorial

Global Trends and Advances Towards a Smarter Grid and Smart Cities

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Abstract: Taking advantage of new developing technologies, power systems are being developed into smarter grids with the vision of becoming the next-generation electric grid for smart cities. Some of the emerging issues and challenges associated with the development of technologies for smarter grids and smart cities are highlighted in this special issue of the *Future Internet* journal.

Keywords: smarter grids; smart cities; distributed generation; integration; security; protection; optimization

1. Introduction

Taking advantage of the new developing technologies, one main thrust in research and development in electric power systems at the academic, industry, business and government levels in the past few years has been to make power systems smarter. The vision of a smarter grid is to become the next-generation electric grid for smart cities. Automatic monitoring of energy flows in smart energy networks will enable them to adjust to changes in energy supply and demand. When coupled with smart metering systems, such grids connect consumers/prosumers with suppliers while providing information on real-time consumption. This ensures effective matching of supply and demand by utilizing data that optimizes efficiency and enables the use of environmentally friendly power generation and storage.

It will enable the smart integration of conventional electric power generation, renewable generation, distributed generation, energy storage, transmission, distribution and demand management to ensure a dependable and sustainable supply of electricity. The benefits of such a grid, integrated at all levels, are expected to include enhanced reliability and resilience, optimized operation and control, higher intelligence for decentralized operation, higher efficiency, more efficient demand-side management and better power quality. However, all these prospective transformations will also bring with them their own numerous challenges and opportunities.

2. Contributions

The papers in this Special Issue of the *Future Internet* journal highlight some of the emerging issues and challenges associated with the development of technologies for smarter grids and smart cities of the future.

The automatic generation control (AGC) mechanism in power systems, which comes into operation whenever an over-supply or under-supply of energy occurs in a power system, is vulnerable to load altering attacks that can disrupt AGC mechanism. An attack thwarting system using a transactive energy framework for countering load attacking cyber-attacks based on establishing coordination between the flexible loads and the power grid operator is proposed in the first paper [1]. It provokes real-time adjustment in power consumption of the flexible loads in response to the frequency disturbances caused by load altering attacks.

The traditional overcurrent protection and control systems used in power distribution systems have a no-fault location function. It may thus take several minutes or even hours to manually locate a fault and restore power. The adaptive current differential protection and fast auto-reclosing system for 10 kV distribution networks proposed in the second paper [2] can locate and isolate a fault within 900 ms (based on load switch operating time of 700 ms) and can thus restore power supply in less than one second after the fault is cleared.

In some countries, weather conditions can lead to uncomfortable conditions in bus stops for commuters. A smart IoT-based environmentally friendly design for bus stop services is proposed in the third paper [3] with the objective of optimizing energy consumption through estimating bus stop occupancy, remote monitoring of air conditioning and lights, automatic reporting of utility breakdown and measurement of air pollution. The advent of smart sensors, single system-on-chip computing devices, Internet of Things (IoT) and cloud computing is facilitating the design and development of smart devices and services. Bus stops are equipped with a WiFi-based standalone microcontroller connected by sensors and actuators to notify the operators and maintenance personnel in the case of abnormal conditions.

Operation scheduling is a practical optimization problem for managing the electric power supply and demand in micro-grids efficiently, but no established solution to the problem seems yet to exist. A framework for this complicated mixed-integer programming problem which has multiple optimization variables and an effective solution to obtain an operation schedule of the micro-grid components is proposed in the fourth paper [4]. Trading electricity with traditional main power grids is included in the optimization target in addition to considering the uncertainty originating from variable renewable energy sources.

The integration of variable renewable energy resources requires the right approach to design and operational planning to cope with the fluctuating output. The technical and economic prospects of scheduling flexible demand resources in optimal configuration planning of variable renewable resources-based micro-grids are investigated in the fifth paper [5] with the objective of determining the optimal size of battery energy storage, photovoltaic and wind systems at minimum total investment cost. Studies show that the application of flexible demand resource scheduling can result in significant cost-savings of the investment cost.

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