

Smart Energy: A Primer

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Abstract : *Energy is indispensable in our modern society. It is crucial to tackling the most important issues such as climate change, sustainable development, health, global food security, and environmental protection. Smart energy refers to an approach in which smart electricity, thermal and gas grids are combined. It is a radical, holistic, and universal approach as opposed to a single sector approach. This paper presents a brief introduction to smart energy.*

Key words: smart energy, smart energy systems, smart meters

Introduction

The modern economy depends heavily on energy. The ever-increasing cost and ever-growing demand of energy have led governments around the world to seek smart ways for generating, controlling, supplying, and saving energy. For example, using energy efficiently in smart homes saves money and reduces carbon footprint.

Traditional renewable energy sources such as photovoltaic, hydroelectricity, wind power, tidal energy, and geothermal energy have greatly advanced recently. However, they cannot respond to environmental changes. Developing smart and economical generators is crucial to meet energy needs of the modern world [1]. Smart energy supply is essential for our industrial growth. It addresses the environmental impacts of the energy and transport sectors.

Recently, the terms “smart energy” and “smart energy systems” have been used to expand the concept of “smart grid”. While smart grids focuses mainly on the electricity sector, smart energy systems (or smart energy grids) include other sectors such heating, cooling, industry, buildings, and transportation [2]. Smart energy regions refer to regions that offer maximal quality of living to their inhabitants with a minimal consumption of energy by combining infrastructures (energy, mobility, transport, communication, etc.). Realizing this may require a robust communications infrastructure for ubiquitous and reliable information exchange among sensors and actuators.

Smart Energy Management

Smart energy management has two major components: the smart energy system and smart meters.

1. *Smart Energy System:* A smart energy system is affordable, **100% renewable** energy, and consumes a **sustainable level of bioenergy**. It is based on three grid infrastructures [3]: Smart Electricity Grids to connect flexible electricity demands such as heat pumps and electric vehicles to the intermittent renewable resources such as wind and solar power. Smart Thermal Grids to connect the electricity and heating sectors. Smart Gas Grids to connect the electricity, heating, and transport sectors.

Smart energy grids can provide efficient bidirectional energy supply and enhance the operational efficiency of energy supply with reduced greenhouse gas emissions. They allow for intelligent monitoring and distributed energy generation capabilities within the multi-energy systems (thermal, electricity, and gas, water). They facilitate the integration of diverse technologies such as renewable energy, electrical vehicles, and smart homes.

The major expectations from smart energy systems are presented in Figure 1 [4]. An energy system is considered smart if it uses technologies and resources that are adequate, affordable, clean, and reliable. Therefore, smart energy systems are evaluated based on their efficiencies and environmental performance. The successful functioning of smart energy systems necessitates strong minded and direct action.

2. *Smart meters:* These are electronic devices that are used in a home or business to measure how much energy is consumed. They are the most basic components in the intelligent energy networks. Although smart metering technologies have so far been mainly used electric smart grids, recent development has enabled auto reading and two-way communications of heat and gas meters [4]. Smart meters bring an end to home visits from meter readers because they can remotely record and report utility consumption (energy, gas or water). They provide real-time information necessary to prevent malfunctions and damages to utilities.

Other technologies involved in smart energy management include Internet of things (IoT) and RFID.

Applications

Smart energy is used in smart homes, smart cities, commercial buildings, electric vehicles, smart irrigation, and wherever energy is used. For example, cities are the fastest growing form of settlement worldwide and they need energy to sustain them. Buildings consume a lot of energy and are responsible for the largest carbon dioxide (CO₂) producers. Therefore, making efficient use of energy at smart homes, smart cities, and buildings is crucial for conservation and reduction in greenhouse effects.

Benefits and Challenges

Smart energy has the potential to reduce energy bills of households and businesses. It also reduces the demand for oil and gas and creates new green jobs. While smart energy technology has positive impacts on global warming, health, and cost, it has negative effects on security and privacy [5].

Data security and privacy become important when IoT technologies are employed for smart energy applications. Smart meter invites intended or unintended privacy breaching activities such as in-house activity detection. Careful planning is required to ensure that all possible measures are taken to

prevent compromise. Energy security is also important for the advancement and improvement of all societies [4].

Smart energy grids present huge technical challenges in their design, operation, and maintenance. They also present challenges for communication networks and information technologies.

Conclusion

Governments all over the world are investing in smart energy grids to ensure optimum energy supply and use. This will facilitate the integration of heterogeneous technologies, such as renewable energy systems, electrical vehicle networks, and smart homes. Smart energy focuses more on residential and industrial issues and less on transportation and commercial [6].

As nations become more conscious of reducing their carbon footprint, solar energy and wind energy are given more priority. Smart energy will eventually transform the existing supply and use of energy.

More information about smart energy can be found in [7,8] and other books on the subject available in Amazon.com. One may also consult journals devoted exclusively on energy issues. These include *Joule*, *Energy*, *Applied Energy*, and *Energy Technology & Policy*.

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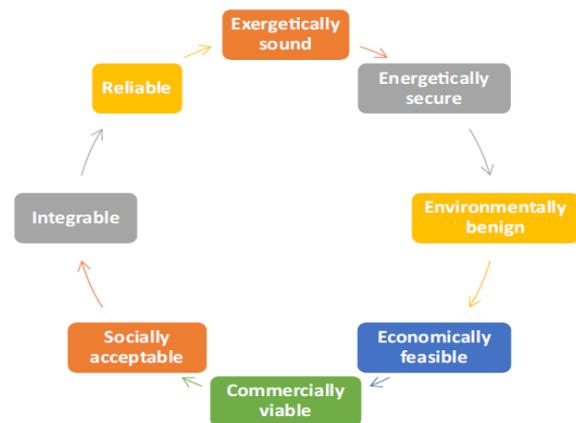


Figure 1 Major expectations from smart energy systems [4].