Chapter 18
From Smart Homes to Smart Cities:
How Smart Homes Contribute to the Sustainable Development Goals

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ABSTRACT

The United Nations has set the Sustainable Development Goals that guide a wide variety of programs to build a better and more sustainable future for all. The goals are not only universal but also connected with each other and indivisible. Since cities are hosting more than half of the world's population and held responsible for three-quarters of global energy consumption and GHG emissions, the Agenda 2030 includes city-related goals. Many countries have taken steps towards reducing greenhouse gases and increasing energy efficiency in cities. To achieve that, smart technology solutions have been developed and adapted to cities. Making cities smart should start from the home level because they have the biggest share in cities' energy consumption and GHG emissions. This chapter reveals the potential contribution of smart homes to smart city concepts in terms of energy efficiency and GHG emissions with the help of the bottom-up approach. In addition to presenting an extensive literature review to the reader, it also discusses how smart technologies contribute to citizen welfare.

INTRODUCTION

Global warming and climate change due to greenhouse gas emissions are becoming a serious challenge that the world has been facing. According to the Fifth Assessment Report (AR5) published by the Intergovernmental Panel on Climate Change (IPCC) in 2014, the urbanization rates in the world have been constantly increasing. As 13% of the world's population lived in cities in 1900, today more than half of the world's population lives in cities. By 2050, 64% - 69% of the world's population is expected to be

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in cities. In other words, every week the urban population in the world increases by about 1.3 million (IPCC, 2014). As cities are held responsible for approximately 44% of global greenhouse gas (GHG) emissions (IPCC, 2014), in Europe the rate is over 75% (Torres & Doubrava, 2010) due to high rates of urbanization. As long as the current urbanization trend in the world continues, it is estimated that the global GHG emissions rate of the cities will continue to increase over time (Rosenzweig et al., 2010). Countries have taken many measures to prevent this. One of the powerful measures is to set the Sustainable Development Goals (SDGs) adopted by all United Nations Member States in 2015. These 17 goals and 169 targets aim to achieve a set of important social priorities for people and the planet, now and into the future. They also help to promote global awareness of climate change and increasing GHG. Since urban activities are the main sources of greenhouse gas emissions, cities contribute significantly to climate change. Most of the greenhouse gas emissions are a direct result of energy usage in cities. According to Meyer et al. (2014), electricity and heat production accounts for 25% of total global greenhouse gas emissions, as one of the highest proportions. This emphasizes the urgent need for energy-efficient measures to reduce greenhouse gas emissions in cities.

As energy efficiency has been becoming the main target for city life, smart technologies have started to come to the fore in the energy efficiency literature (Faruqui et al., 2010; Gilbraith & Powers, 2013; Louis et al., 2014). With smart technologies, it is possible to make cities more sensitive to the environment in terms of energy consumption. In particular, the developments in the Internet of Things (IoT) and big data analytics in recent years along with complex computing infrastructures, have provided many new opportunities to ensure energy efficiency in cities and reduce GHG emissions (Batty, 2013; Khan et al., 2015; Kitchin, 2014; Rathore et al., 2016). This emerging global paradigm has been seen as one of the important areas in the solution of the problems caused by the ever-increasing urbanization. It has great potential to promote a massive social transformation by bringing together sustainable development and technological concepts (Bibri & Krogstie, 2020). In recent years, many alternative approaches based on IoT and big data technologies have been implemented regarding the energy efficiency of cities (Alkhayyat et al., 2019; B. Martinez et al., 2015; Hatamipour & Abedi, 2008; N. Javaid et al., 2017). These alternatives provided raw materials for both smart and sustainable cities to improve the energy consumption of cities against the increasing urbanization problem. So, in the energy efficiency literature, smart technologies have been paid great attention by researchers (Al Nuaimi et al., 2015; Angelidou et al., 2017; Batty, 2013; Bibri & Krogstie, 2020; Hashem et al., 2016; Perera et al., 1999). However, the situation is not the same for the approach that is starting from the residential level to make a city smart, although one of the most effective ways to really make cities smart is through making homes smart. Because, residential building is responsible for 30-40% of the global energy requirements (Huovila et al., 2007), while approximately 40% of total annual anthropogenic GHG emissions come from residential buildings (UNEP, 2019). According to UNEP (2019), in the absence of measures, energy demands for this sector could rise by 50 percent by 2060. Therefore, making cities smart should start from the residential level.

In the literature, two different approaches have come to the fore: top-down and bottom-up. The top-down approach discusses from the general to the specific. Particularly in energy efficiency literature, the approach treats the city as an energy sink. It does not distinguish individual end-uses. Unlike the top-down approach, the bottom-up approach starts at the specific and moves to the general. It extrapolates individual end-uses to the city level (Swan & Ugursal, 2009). Both approaches have advantages and disadvantages varying according to the areas implemented. Since macroeconomic indicators are predominantly used in top-down approaches, it is relatively easy to develop based on limited information. However, this approach does not use specialized knowledge presented in the lower echelons. This is important because