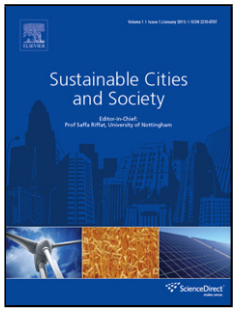


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# An Interval Type-2 Fuzzy Analysis towards Electric Vehicle Charging Station Allocation from A Sustainable Perspective

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**Abstract**

Electric vehicles (EVs), as an efficient and environmentally friendly method for reducing fossil fuel use and air pollution, are becoming more popular as governments seek to implement sustainable development. Initial concerns about the high cost and limited travel range of EVs have now been mitigated through the convenient and efficient deployment of electric vehicle charging stations (EVCSs). The State Grid Sichuan Electric Power Company intends to construct six EVCSs in Tianfu New district, which is expected to play a significant role in the sustainable development of western China. As proper siting is the foundation for EVCS construction, in this paper, a multi-criteria group decision making (MCGDM) framework with linguistic information is proposed to deal with the EVCS siting in Tianfu New district. Thirteen criteria from four influencing aspects are identified to estimate the impact of EVCS construction. To address imprecise information and vague concepts in human language, interval type-2 fuzzy numbers (IT2 FNs), which can effectively reduce information leakage, are applied to model the linguistic terms. The entropy weight method and a rough consensus reaching process are introduced to ensure the rationality of final decision. The results show that the proposed MCGDM is feasible and efficient for EVCS site selection.

*Keywords:* Decision support systems, Electric vehicles, Fuzzy sets, infrastructure planning, Sustainable development

## 1. Introduction

Energy has been the main driver of economic development, with fossil fuel having played a major role in the past. Because of an over-reliance on fossil fuel, the health of the earth is now faced with many challenges, and many hot words appear, such as over-exploitation of natural resources [11], excessive carbon emissions, and the need for sustainable development [55]. Sustainable development has become more important because of predicted energy shortages based on a rapid consumption of fossil fuels. According to the report of IEA [47], China has taken a proportion of 20.4% in 2015 world final total consumption, compared with 19.72% for America, and become the largest energy consumer in the world due to a high-speed economic growth and large scale urbanization. The consequent rise of the middle class in China along with speedy urbanization has triggered a vesuvian demand for automobiles, which has further stimulated energy consumption and increased carbon emissions. China Transportation reported that 7% of total carbon emissions and 21% of total energy consumption could be directly attributed to the use of vehicles with internal combustion engine [27]. As a result, there has been a renewed focus on clean energy transportation such as Electric Vehicles (EVs), which are powered with additionally installed renewable energy capacities. Since the use of EVs significantly reduces crude oil dependency and minimize the emission of transportation-related carbon dioxide and other pollutants, such as noise pollution and nitrogen oxide emission, , EVs have been seen as one of the premium solutions for land transportation systems [18, 21, 23, 43].

In this paper, we shall focus on EVs, including plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs), because of their high energy efficiency, the ability to substitute electricity for petroleum and the potential to reduce the carbon footprint. However, there are several obstacles to an immediate large scale EVs adoption, one of

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