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An Overview of Smart Local Energy Systems

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ABSTRACT

The rapid advancement of Information and Communication Technologies in the last decade has revealed the trend of getting smarter to everyday objects. The rise of these technologies has also affected new areas such as smart cities and smart local energy systems. The smart cities paradigm focuses on evaluating industry and urban planning from an environmental and sustainable perspective, while ensuring people's well-being and rights. However, this transformation has obstacles. Energy management in sustainable smart cities aims to achieve environmental benefits, efficiency increase and cost reduction by providing significant improvements in clean energy processes. Smart local energy systems (SLES) integrate smart cities concepts to local and neighbourhood levels. In this study, while smart local energy projects examine the change in urban energy systems, the suitability of renewable energy technologies, production, distribution and energy management systems and the transitions in these systems are examined by considering a systematic change in local energy infrastructures. The concept of smart energy cities is an important step towards the future of cities, and future perspectives on the adoption of this model by other cities are also examined. The aim of the study is analysing the findings of SLES projects by literature review. In this study, after discussing the place of SLES in urban infrastructure and their importance for the future of cities, the basic issues and developments of the field are discussed through publications prepared in this field. SLES is a new concept and projects findings are brand new so the motivation of this study is to make a literature contribution on this area.

1. INTRODUCTION

THE regular functioning of the urban system depends on a well-planned urban infrastructure. Urban infrastructure brings together a wide range of issues and integrated municipal services such as new technologies, urban planning, local governance, information communication infrastructure, energy systems planning, economic growth, climate change and waste management, and engineering services [1]. Urban infrastructure is a part of the governance process as a network system involving local authorities, governments and citizens, and the private sector in most countries [2]. Planning the infrastructure systems of cities depends on financial investments that involve extensive coordination processes. "Cities often use multi-stakeholder participation models such as commissions, authorities, and quasi-public companies to implement infrastructure projects" [3]. As the population of cities increases, the need for resource transfer and a qualified labour force to renew their infrastructure increases [4,5]. A qualified workforce gives cities an advantage in the development of cities and innovative infrastructure systems. The development of cities and their role in global competition are closely related to infrastructure investments along with a qualified workforce [6-8]. The uninterrupted and regular operation of local governments and urban infrastructure systems depends on successful energy management. Energy management of cities is closely related to issues such as smart cities and Smart Grids. Developing smart systems for sustainability and self-sufficiency in energy distribution is one of the policy tools of local administrators [9]. Energy supply, demand, and adaptation are among the government's priority issues of climate change planning [10,11]. In particular, affordable and clean energy (SDG7), which is among the United Nations 2030 development goals, encourages governments to take effective strategies on renewable energy and energy justice [12,13]. Combating global climate change and future resource problems creates a tendency for countries to act together when making energy planning. The effective use of renewable energy resources is an important breakthrough for the assurance of a sustainable future and the self-sufficiency of countries. Bringing together the fields of energy management, climate relations, policy, and finance, the Smart Grid concept offers a solution to one of the most complex and challenging problems faced by modern societies.

Interactions in these areas are of great importance for the sustainability of energy systems, combating climate change, policy-making processes and financial sustainability. In addition, this process is one of the first stages of transition to a low carbon economy [14,15].

Although energy policies are shaped according to the natural energy resource potential of countries, the decisions taken by countries regarding energy create global consequences that affect each other. Natural resource wealth does not always create advantages for countries. When the richness of countries' energy resources is not supported by innovative governance systems, a phenomenon called the resource curse may arise. The resource curse is a concept that describes the economic impasse and vicious circle that countries rich in natural resources fall into as a result of increasingly directing their economies to these resources [16]. In this way, countries with natural resources, expressed as fossil fuels, invest in renewable and alternative energy sources and different innovation areas along with these energy resources, creating effects that save them from this resource curse. In addition, it is critical for countries that cannot be self-sufficient with natural energy resources to invest in renewable and alternative energy sources, to investigate local renewable energy resource potentials, and to become self-sufficient and resilient when affected by sudden crises and natural disasters in the world. Smart cities offer successful examples of planning cities with low carbon and reduced energy dependency when compatible with smart energy systems [17]. When viewed from these aspects, investing in this field by following the technology and innovations in SLES, the foundations of which were laid in England, for success in city management increases the city's competitive power on a global scale.

Energy planning deals with issues such as power consumption, energy supply, and networks between suppliers and users [18]. Whether countries provide energy to citizens through privatization or state support depends on existing and potential fossil-based energy resources and policies. Viewed from this perspective, urban infrastructure and energy have socio-political significance that focuses on institutional relations and historical concentrations of control, power, and access [19]. Obtaining local energy systems from clean, renewable energy sources can also create the opportunity for political autonomy by enabling a certain region or city to be self-sufficient to a certain extent. In this respect, dependence on foreign energy or the ability to obtain energy from local sources has significant effects on the democratic rights and quality of life of citizens as well as the development level of countries. Ensuring energy distribution based on equality is related to energy justice. "Energy justice is an issue that affects energy policies as an area of determining the sources of injustice in energy production and consumption processes and establishing a balance in the fields of climate change and social justice" [20,21]. 2050 net-zero carbon target is also the main goal in this sustainability policy area.

There will be a balance between the technical features of smart local energy systems and their social-political aspects during the evaluation of this study. In this respect, the scope of the study was narrowed by defining smart local energy systems and systematically reviewing innovative articles in this field. Therefore, the motivation of the study is to bring up the subject of SLES, which is new in current and academic literature, and to conduct a comprehensive examination of the subject in the field of technical and social sciences.

SLES are a set of approaches that support local economies and balance the supply and demand of a region's energy services. The ability of cities to create local energy systems is linked to analyzing the potential of renewable energy sources and integrating these systems into urban planning and architectural designs of public buildings. Smart systems include technologies that contribute to energy saving in the field of energy. Tools supported by local governments, such as microgrids, active distribution networks, energy communities, virtual power plants (VPP), and multiple energy centers (EH), are used in realizing this approach [22]. The active distribution network consists of energy storage, loads, various distribution systems, energy conversion, monitoring, and protection devices. This system is linked to Active Network Management. Active Network Management includes the operation of distribution networks with energy storage and flexible demand technologies [23]. A microgrid is a defined, single, and controllable local power grid that is grid-connected and can operate in islanded mode. "By improving power quality, microgrid provides a new technical pathway for large-scale implementation of grid-connected renewable energy production" [24]. "MS/Local Production of micro sources is optimized for power exchange with the best utility provider and the best market participation" [25]. Microgrids are divided into two groups: single-carrier and multi-carrier. Various multi-energy carriers are utilized to form energy hubs [26]. With its transformative function in sustainable energy systems, Energy Hub (EH) is an important component of local energy systems. "EH/Energy Hub concept was presented by a research team at Power Systems and High Voltage Laboratory at ETH Zurich within the framework of the project called "a vision of future energy networks" [27]. Virtual Power Plants (VPP) are networks of small energy-producing or storage devices, such as batteries and solar panels, grouped together to serve the electrical grid. "VPP is an effective technology in providing clean energy for sustainable cities" [28]. When the technical concepts related to energy components with brief explanations are examined in this section, it is seen how various new technologies are used for SLES.

European Union Energy communities enable local communities to invest in clean, renewable energy. The Clean Energy for All Europeans legislative package develops energy policies that support communities [29-31]. Benefits such as social welfare and affordability of energy from local sources are discussed in terms of the socio-political contributions of the SLES issue [32]. There is a trend towards the creation of energy communities around the world [33]. The reason for this is the greater understanding of the critical importance of countries and regions being self-sufficient in terms of energy in case of sudden and unexpected situations such as the Russia-Ukraine war, pandemics, and natural disasters.

So far, definitions have been made on the components of urban infrastructure and energy systems and their relationship with SLES. Brief information has been provided on the system components used to integrate various clean and renewable energy systems by local requirements and energy sources by taking advantage of technological innovations. In this process, energy communities have added a social dimension to the technical issue by integrating technological developments and urban administrative systems. At the same time, SLES projects developed by the UK and policies on the 2030 sustainable development goals, the 2050 net-zero carbon target, and energy justice are discussed in this section. In this study, a literature review was conducted on articles on SLES published between 2020 and 2023 and scanned in Web of Science. With this approach, current issues in the field, the most discussed application experiences and developments on the subject will be examined.

The decentralization of urban energy systems, how these technologies affect local governments and energy policies, and how the technical and social dynamics in SLES evolve together are presented with a comprehensive evaluation. Specifically focusing on topics such as Distributed Energy Systems (DES), Micrognids (MG), and Smart Microgrids (SMG), this research has offered insights for the integration of these technologies in urban planning and policies for climate change mitigation and adaptation planning.

2. SMART LOCAL ENERGY SYSTEMS

A number of strategies have been determined in the UK to achieve the net-zero carbon target by 2050. SLES initiative has been developed in the UK as a key component of this approach [34]. SLES is a decentralized energy system based on the integration between local and renewable energy systems [35]. “SLES originated in the UK Government's PFER/Prospering from Energy Revolution in 2018. Smart cities, smart grids, and smart energy systems are among the main components of this concept” [32]. Bray et al. [36] mentioned that in the transition to the SLES system, the use of new smart systems provides flexibility and network balancing, and automation is achieved through artificial intelligence and machine learning. The network relations between SLES components and the city are seen in Fig. 1.

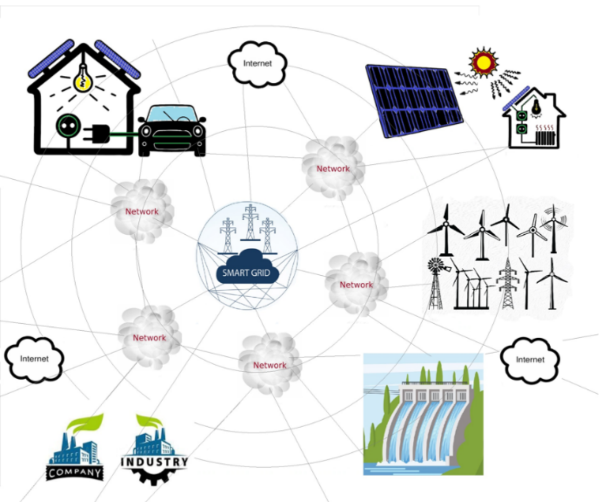

Fig. 1. The schematic explanation of smart local energy systems.

As seen in Figure 1, energy transmission and distribution is one of the most fundamental elements of smart energy systems, and developments in this area provide significant advantages such as increasing energy efficiency and ensuring grid stability. With the integration of information and communication technology (ICT) and control systems, Smart Grid facilitates optimal grid control, efficient use of equipment, and improves the quality and reliability of power supply, as well as the integration of renewable energy sources and optimal planning of distribution systems. Energy storage systems here improve energy efficiency and ensure grid stability by storing energy during periods of low demand and making it available during periods of high demand [37]. These systems include various technologies such as supercapacitors, hydrogen storage, and battery storage. Furthermore, smart energy storage systems include an intelligent controller that monitors energy production, consumption, and storage and performs important functions such as energy efficiency optimization and energy trading, and flexibility. Energy transmission and communication include components such as high-voltage transmission lines, low-voltage distribution lines, fiber optic communication networks, and smart meters, which perform key functions such as data transmission, control, and management of consumption information. And Fig. 1 illustrates these functions semantically.

In the UK, ownership of local energy development companies has been established through various participatory initiatives such as municipalities, communities, universities, and private companies [34]. From this perspective, SLES provides environmental, economic, financial and social benefits [38]. At the same time, the development of SLES in the UK is part of the energy transition, contributing to achieving the Sustainable Development Goals (SDGs) [39].

Stakeholders, approaches, goals, and resources of each SLES project vary. Wu et al. [34] grouped some SLES projects in the UK as follows;

- Local Energy Oxfordshire
- GreenSCIES and GreenSCIES
- Greater Manchester Local
- Energy Superhub Oxford
- Energy Market
- Girona
- Zero Carbon Rugeley
- ReFLEX Orkney

Each country has energy policies depending on its dynamics and resources, and local governments are among the administrative parties in the implementation of these policies [40]. With its environmental, economic, and social benefits, SLES provides local governments with a participatory and fair energy planning opportunity, while the actors and infrastructure in local energy planning affect local system goals [41]. Microgrids and customer, government, and utility relations are the main determinants of the success of the local distribution process [42]. When the SLES administrative structure is examined, the system in Fig 2 can be seen.

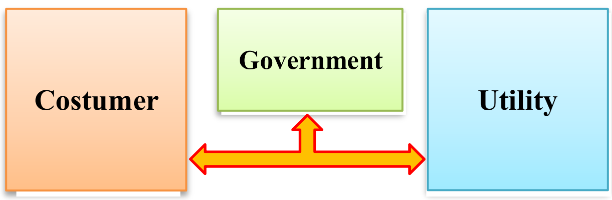

Fig. 2. The relationship between customers, government and service providers

As shown in the figure, there are both bilateral and tripartite reciprocal relationships between customers, the government, and service providers. Here, customer factors emphasize the need for a stable and uninterrupted supply for energy consumption. Customers want to access electricity around the clock, avoid power outages, and receive fast and efficient support services when needed. It is also intended to encourage customers who wish to self-supply part of their energy consumption and ensure that they can easily pay their bills. For government factors, it can be defined as ensuring public satisfaction and trust and ensuring the sustainability and financial stability of electricity services. It also aims to support environmental and economic sustainability through policies and regulations such as promoting innovation and modernization in the energy sector, reducing emission intensity and encouraging the use of environmentally friendly energy sources. Service provider factors focus on ensuring the efficient and reliable operation of the energy grid. This includes reducing energy losses, managing peak loads, minimizing outages and optimizing asset management. It also includes efforts to increase network visibility, build self-healing networks and integrate renewable energy sources to improve grid performance and reliability. These factors are based on customer demands and government regulation.

3. METHODOLOGY

Since SLES is a topic dependent on current and technological innovations, the first publications scanned in Web of Science in this field were made in 2020. When the articles were scanned on the web of science with the combined keywords "Smart Local Energy Systems" between 2020 and 2023, 37 publications were found, and among these publications, 33 publications were found suitable for evaluation in terms of content. The reason why 4 publications were not evaluated is that they were publications that barely touched upon the subject of SLES. Table 1 includes the methods and purposes used in these publications.

TABLE I
ARTICLES WITH THE KEYWORDS "SMART LOCAL ENERGY SYSTEMS/SLES" SCANNED IN WEB OF SCIENCE BETWEEN 2020-2023.

Researches	Aim/Approach	Main Findings
Gillham et al. [43]	This study is aimed to investigate strategic approaches to SLES through the concept of energy service. Content analysis and methods supporting content analysis have used.	The effectiveness of domestic energy service provision in reducing carbon emissions has been determined.
Arueyingho et al. [44]	This study is aimed to examine the careers of professionals working on smart local energy systems in this new sector. Interview was used as the method.	Since SLES is a new and dynamic sector, it has been determined that professionals in this sector are open to innovations and have flexible skill profiles.
Couraud et al. [45]	This study aimed to provide a comprehensive review of the SLES project called Responsive FLEXibility (ReFLEX) in the UK. Case study was used as the method.	Various evaluations have been made on future technologies through the FLEXibility (ReFLEX) project.
Smith et al. [46]	This study is aimed to conduct an empirical research on smart local energy systems in the UK. Expert interviews and field research were conducted.	The study, which examined various social justice approaches to SLES, found that there are differences in approach in the social dimensions of the issue.
Gooding et al. [47]	Case study research of three SLES projects funded under the UK government program was conducted in this study.	The features of SLES that support local community awareness and provide opportunities for social participation in the context of the environmental and climate emergency have been observed from relevant projects.
Fell et al. [32]	The subject of SLES, how the relationships are developed is examined as a theory of change for a social project. A variety of participatory social science methods were used, including the stakeholder workshop.	It has been concluded that a deficiency in the correct analysis of multiple sector structures in SLES projects and in ensuring compliance conditions will prevent the healthy functioning of the process.
Byk et al. [48]	It is aimed to analyze the economic benefits of SLES projects. A mixed method have used, including analysis of implemented projects.	As a result of the research, it was determined that SLES projects are attractive to investment companies.
Ahangar et al. [49]	In this study, research was conducted on the design of green hydrogen in electric vehicles based on multi-vector smart local energy systems.	This study demonstrated the importance of understanding local demand within a multi-vector optimization framework to provide durable energy services, and viable.
Wu et al. [34]	The study involves a systematic analysis of local energy systems practices in the UK. The method has been evaluated based on secondary data.	The study has been determined that SLES will create significant impacts in innovative areas such as future net zero power systems and electric heat.
Turnell et al. [50]	Techniques for utilizing waste heat from industry are being researched by examining projects in the UK through SLES. Case study method was used.	The study draws attention to the importance of relations between local governments, investors and researchers for SLES projects.

Li et al. [51]	The study investigates the problems and opportunities that may be experienced in scaling up SLES projects. Data modeling method was used.	It has been established that in order to scale up SLES, it is necessary to understand the strategic decision-making processes of local investors and governance institutions and their resulting impact on emissions, costs and stability of the national electricity system.
Soutar et al. [52]	In the study, research was conducted on investor user and community groups within the scope of 12 SLES projects in the UK. Interview technique was used as the method.	While the study examines the experiences of stakeholders in the process, it emphasizes the importance of participation in the success of SLES projects.
Bray et al. [36]	The approaches of 38 English Local Enterprise Partnerships to SLES projects were examined. As a method, a systematic literature review was conducted.	The study opens a discussion from a critical perspective on how a more equitable system should be handled in the transition to the net zero carbon target in the SLES system.
Fan et al. [53]	The study produced AL-based smart algorithms for the control and management of SLES projects. Engineering modelling method was used.	With the model approach and living lab application developed in the study, opportunities for demonstration of SLES were found.
Vedantham et al. [38]	The study provides an examination of the information and communications technology (ICT) infrastructure of the SLES project.	It is important that ICT infrastructures for SLES are categorized and summarized according to their purposes and technologies as a basis for future projects.
Francis et al. [34]	This study evaluates SLES projects, monitoring system performance, and monitoring benefit realizations with the Multi-Criteria Evaluation (MCA) tool. The method was developed through online surveys.	The research provided insight into the priority weighting of the criteria to be used in the multi-criteria evaluation tool being developed for SLES.
McGarry et al. [54]	This study developed a multi-functional battery control strategy combining carbon intensity-based control dispatch to support the decarbonisation of rural distribution networks in Scotland. Case study method was used.	The findings of the study indicate that carbon-neutral local distribution networks for SLES projects can be realized in the short term.
Williams et al. [55]	This article provides an overview of a systematic approach to SLES performance optimization using central London, UK as a case study.	The study focused on the Aquifer Thermal Energy Stores (ATES) system and made various evaluations on the subject.
Dunham and Jones [56]	This article explores the opportunities and challenges for implementing SLES in cities and towns through two very different case studies. Case study method was used.	The study evaluated heat recovery from industrial processes and inter-seasonal thermal storage, and evaluated the opportunity to add electric vehicle charging points along the network route.
Ford et al. [57]	The aim of the study is to examine the differences between central supply systems and SLES regimes in the field of energy. Meta-narrative literature review and expert interviews were used as methods.	SLES regimes have been found to enable smarter decision-making and planning, new forms of localized operations and optimization by new actors.
González et al. [58]	Local energy business sector characterization was made in connection with smart local energy systems and data base construction method is used in the study.	The study showed the necessity of investing more in locality and intelligence in management processes in the energy sector.
Revesz et al. [59]	This article introduces the SLES project called GreenSCIES, which provides carbon savings for schools, businesses and local residents.	This study demonstrates the benefits of integrated SLES through a focused scheme design called New River.
Savelli and Morstyn [60]	In the article that deals with the social relationship dimension of smart local energy systems and the concepts of energy justice, a schematic model proposal has been developed on the subject.	This research brings into question the role that smart energy neighborhoods can play in future energy systems.
Walker et al. [61]	How 'local' is constructed in early stage 3 SLES demonstrations in the United Kingdom is examined through secondary data within the scope of the study.	The study found that it provides a useful framework for revealing the 'local' complexities of early-stage decentralized energy projects and highlighting the intersections of space, in later stages of project implementation.

Mullen et al. [62]	SmartHubs Smart Local Energy Systems project is examined within the scope of the study. Case study was used as the method.	Taking into account the different needs of various stakeholders, the study modeled the operation of the SmartHubs demonstration project in the specific context of a publicly funded project and made various predictions on the future of the project.
Wang and Wade [63]	The study was organized as preliminary research for evaluation and improvements in the SLES transition process.	Processes that can be developed for real-time control of SLES projects are discussed in the study.
Knox et al. [64]	The issue of justice was researched through articles discussing energy justice in smart local energy systems. A systematic literature review was used as a method.	This research investigating community innovation and entrepreneurial behavior of SLES initiatives has been determined to advance understanding of how socially equitable SLES can spread, develop, and grow.
Wardle et al. [65]	The study proposes a method to apply engineering design principles to a type of energy system called a smart local energy system.	For SLES, axiomatic design theory was used within the scope of the study.
Yew and Flynn [66]	This study examines how SLES can support the optimization of benefits between prosumers and consumers in local communities and its impacts on the wider electricity network.	Findings from the simulation in the study suggest that there is an optimal ratio of prosumers to consumers.
Vigurs et al. [67]	The study investigates how SLES providers can minimize both user concerns and causes for privacy concerns.	The study finds that SLES projects can be passively resisted by citizens refusing to install data collection technologies or not participating in the adaptation of their energy use behavior.
Morstyn et al. [22]	The study investigates the control modeling and simulation possibilities of OPEN, an open source software platform, for SLES.	The study has presented OPEN/Open Platform for Energy Networks an open-source Python platform for developing smart local energy system applications.
Rae et al. [68]	The study aimed to identify the main technical barriers facing SLES in the UK. Literature scanning was used as a method.	As a result of the research, three main challenges with SLES projects emerged: uncertainty, diversity and integration.
Devine-Wright [69]	Pattern-IT examined the involvement of project partners with communities involved in the implementation of SLES. Focus group discussions were held with this approach.	Pattern-IT evaluated the relationships between SLES stakeholders by allowing quantitative or qualitative analysis.

As can be seen in Table 1, along with various engineering solutions, applications, and simulations, it can be seen that studies on SLES are highly concentrated in the field of social science with contents such as social dimensions, local governments, energy justice, local investments, citizen participation, stakeholder characteristics, and companies. Again, the fact that the studies are on projects carried out in the UK and have not yet been implemented widely limits the study's ability to make predictions about the future of SLES. It is seen that the studies are generally carried out with social science research methods, and some of them are compilations. However, various engineering applications and simulation techniques were used in some of the studies. It should be noted that literature review results show that disagreements between key actors, such as citizens, investors, and the government, can put the future of projects at risk. As an important observation, Rae et al. [68] stated that the three main difficulties experienced in SLES processes are diversity, uncertainty, and integration. Research data generally focused on existing projects and technical processes, and it was determined that critical studies in the field should increase.

4. DISCUSSION

Energy crisis worldwide is among the biggest threats to a sustainable future. Governments and local governments put forward various policy tools to ensure the correct and effective use of renewable energy resources for a sustainable future and to address global climate change. In particular, the transition to renewable and clean energy sources and enabling cities to produce renewable energy in a self-sufficient manner are among the main policy tools in achieving the net-zero carbon target, which is a goal set by the United Nations' Paris climate agreement [70,71]. Today, new concepts such as energy communities and energy justice lead governments and local governments to seek solutions to meet the energy needs of citizens in their social policies [21,72]. In this respect, the SLES discussed within the scope of the study offers a model for the sustainable cities of the future and the net-zero carbon target of countries. It seems that this model, developed in the UK, will become widespread in European countries. In the future, the experiences of projects in this field will be guiding for governments and local governments.

If categorization is needed for SLES issue, it would be appropriate to position it as a micro-city scale model proposal regarding the energy policies implemented by the UK for the zero carbon target. Energy policies have a profound impact on society's energy use and its environmental impacts. Smart grid policies linked to SLES are important to promote the modernization of energy systems, support renewable energy investments, and regulate energy markets. At the same time, policies to combat climate change are closely related to energy policy and aim to reduce the environmental impacts of energy production and consumption. Table 2 shows the relationship between energy management and SLES.

TABLE II
INTERCONNECTION OF SLES AND ENERGY MANAGEMENT, CLIMATE RELATIONS, POLICY, AND FINANCE.

Field	Characteristics
Energy Management	Establishment and operation of efficient and sustainable energy systems for local areas Integration of renewable energy sources Demand management
Climate Relations	Impact of energy production and consumption on climate change Reduction of carbon emissions with zero carbon emission target Promotion of renewable energy sources to the citizens
Policy	Encouraging the modernization of energy systems Supporting investments in renewable energy Regulation of energy markets Enabling participatory processes such as energy communities
Finance	Provision of financial resources for SLES Construction of renewable energy infrastructure Implementation of financial incentives and policies

Changes and technological progress in energy systems require the public to be more informed in this field and to be a stakeholder in the energy management process [73]. In this process, SLES can be defined as a participatory energy management system in which local energy potentials are developed through the interaction of local administrators, entrepreneurs, and citizens. SLES delivers local value for energy management [74].

SLES achievements will enable the development of models in this field in the future. Future studies will be developed with more comprehensive methods and econometric studies examining different country practices and broader application areas in this field. There is a need for innovative research, especially on the energy gains and costs of projects [57,75].

When the relevant literature is examined within the scope of the study, it is seen that academic research on SLES is similar to each other, but more studies and diversity are needed, especially in terms of research methods and approaches. However, there is a need for more critical studies on the subject, especially on the issues of social justice and the accessibility of energy for every citizen within the community.

5. CONCLUSIONS

This study emphasizes that the smart grid that enables SLES systems is not a monolithic system, but rather a fundamental part of smart control to increase the utilization of assets, combining many renewable energy sources and effective technologies. The dynamic features of the smart grid update traditional system requirements to continuously provide energy with the intermittent nature of renewable energy production. Communication networks and control systems that enable distributed generation to be hosted are critical technologies for centralized or distributed monitoring, protection and operation of the smart grid.

SLES is a participatory multi-actor energy management system based on community expectations and energy justice of local energy systems. Making this energy system, which does not come from a central source but from local potentials, become applicable and widespread, increases the resilience of cities against crises. The academic literature examined shows that it is still early to make determinations on the publication process and project achievements in this field, expanding to an urban scale. However, research shows that as the projects increase and become widespread, significant gains can be achieved in the fields of the future of energy, zero carbon target, sustainable future, combating the climate crisis and energy justice. In terms of content, SLES draws attention as a project approach that supports technology and citizen participation and is a cross-section between social sciences and engineering sciences.

This study discusses the political, economic and social importance of SLES initiatives. Problems related to climate change and ever-increasing energy demand show that cities and countries need to develop policies on electricity consumption as they advance technologically, and SLES projects are among the solution tools for these problems.

SLES projects, initiated by the UK to achieve the net-zero carbon target by 2050, have provided an experience laboratory for the development and integration of new technologies of renewable energy. When the publication scans Table 1 of the research on SLES are examined, it is shown that they are interdisciplinary in nature and that studies containing the examination and analysis of UK projects are predominant. Since this field is quite new, the motivation for the study is to review the diversity of studies that have been done in this field so far. At the same time, it is seen in the literature research that the technical subject has very close ties with social sciences and public administration. Future studies can be conducted on the applications of these experiences in different countries.

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