

## Strategic Plan Method for Future Renewable Energy Technologies

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In transmitting towards secure, clean, and efficient energy, the world requires to develop the future renewable energy technologies that contribute to reducing energy consumption and carbon footprint and enabling near-zero CO<sub>2</sub> emissions. A number of complex factors such as performance limitations, innovation, industry rivalry, and competition can hasten technological change, and they must be watched closely to succeed in developing a vision for the new technology implementation. Numerous efforts have been focused on formulating a strategic plan for energy. However, there is limited consideration of the development of a strategic plan method for future renewable energy technologies. This study aimed to develop a strategic plan method to decide more appropriate and applicable renewable energy technologies. Development of the method for strategic planning requires an integrative approach taken from strategic management and planning concepts, technology innovation, as well as related knowledge in renewable energy technologies. Conceptual research methods are used to conduct the present study. The strategic plan method would assist the key decision-makers in developing a strategic plan to select more efficient, cost-competitive, and appropriate renewable energy technologies according to the real needs and desires of the community.

### 1. Introduction

Sustainability has become a progressively important topic in the global community due to increasing environmental and social problems (Chofreh et al., 2019). These problems are challenging as the solution requires a massive transformation in terms of policy, regulation, system, and technology in the community (Gaziulusoy and Brezet, 2015). In the case of societal challenges to provide secure, clean, and efficient energy, government and global institutions emphasise the community to change current energy technologies with more sustainable renewable energy technologies (Chofreh et al., 2018). However, the development of the next generation of renewable energy technologies is currently in the early stage of growth (European Commission, 2018). The world needs to develop new technologies that contribute to reducing energy consumption and carbon footprint and enabling near-zero CO<sub>2</sub> emissions (European Commission, 2014). It is enormous and multifaceted activities that require a strategic plan. Several complex factors hasten technological change. Limits on performance, breakthrough technology, market competition, manufacturing capability, economics, and changing needs of consumers all play a role and must be watched closely to succeed in developing a vision for the new technology implementations (Strong, 2007).

Strategic planning prepares an institution to anticipate, recognise, and adapt to change (Laamanen et al., 2018). It establishes who you are, where you are going, and how you plan to get there. Building technological change into the process makes it more of a strategic preparation model and thus better equipped to help institutions recognise, anticipate, and react to change (Yun et al., 2019). A number of studies have investigated the strategic planning process and used this concept in various fields of research. However, few studies focus on the development of a strategic plan methodology for the next generation of renewable energy technologies. In a

practical standpoint, the European Commission has developed a Strategic Energy Technology (SET) plan to identify and analyse new opportunities of research and innovation in the energy change towards renewable energy technologies by presenting relevant case studies across the 14 low-carbon energy technology sectors (European Commission, 2017). However, this plan only provides several components of strategic planning, such as internal scanning, targets, and milestones. Some other components that a strategic plan should consider are scanning the external and internal environment, analysing the opportunities and threats analysis, and analysing and monitoring the macro-environmental factors such as political, economic, social, and technological factors. The primary objective of the study is to develop a strategic planning method for the next generation of renewable energy technologies. It provides a procedure for forecasting future renewable energy technologies and their implementation priority. This study adopts a conceptual research method, which entails a review in three areas, including strategic planning, technological innovation, and renewable energy technology. The results show that the strategic plan includes three phases: strategic inputs, strategy formulation, and strategy implementation. Strategic inputs focus on analysing internal and external environments to determine resources, capabilities, and core competencies for developing the next generation of renewable energy resources. The outcome of the phase of the strategic input would be the input for the development of new vision and mission and formulation of the strategy of developing the new technologies.

The strategic plan would be a novel idea as it is designed by integrating various related concepts, such as strategic management, planning, analysis and assessment methods, technology innovation, and related concepts used in renewable energy technologies. This method would be beneficial for the international government and community as the results would provide a blueprint for achieving the vision of leveraging reliable and applicable forthcoming renewable energy technologies and information resources to support their mission. In addition, this plan would assist them in hastening technological change and avoiding the implementation of technologies that are not in accordance with the needs of the European industry and community.

## 2. Literature Review

Development of a method for planning new technologies requires an integrative approach taken from strategic management and planning concepts, technology innovation, as well as related knowledge in renewable energy technologies. A review of studies in the field of strategic planning and renewable energy technologies is provided in the following sub-sections to expose the research gap in the related area.

### 2.1 Related studies on strategic planning

Strategic planning research subject has been integrated into various sustainability studies, as given in Table 1. Rahman (2016) examined a plan for achieving urban sustainability in Bangladesh. He analysed social aspects of the current plan and found that the existing plan adopted strategic plan concept; however, this plan does not meet urban sustainability criteria. Barreto and Drummond (2017) evaluated strategic planning tools for managing protected areas in Brazil. They suggested improvement for the existing strategic plan to achieve better performance. Another study presented by Malekpour et al. (2017) that proposed a model that integrates short term and long term barriers into the strategic planning process for urban water. Pereverza et al. (2017) developed and applied a method for scenario development in strategic planning for sustainable heating systems. The method incorporates a morphological approach and scenario development principles to realise more sustainable heating systems in cities.

*Table 1: A review of strategic planning studies*

Reference	Research area
Rahman (2016)	Urban sustainability
Barreto and Drummond (2017)	Environmental management for protected areas
Malekpour et al. (2017)	Urban water
Pereverza et al. (2017)	Sustainable heating systems
Schwedes et al. (2017)	Sustainable transport
Löfgren et al. (2018)	Sustainable transport
Jaeckel (2019)	Deep seabed mining and marine environment
Krog and Sperling (2019)	Energy
Vecchiato (2019)	Energy
Villicaña-García and Ponce-Ortega (2019)	Energy

In the area of sustainable transport, Schwedes et al. (2017) recommended a concept transformation from project planning to strategic planning in the existing transport policy. Löfgren et al. (2018) found that the existing sustainable transport planning process does not perform strategic landscape assessments. They proposed a new integrative idea that incorporates strategic landscape assessment into the strategic planning process. Jaeckel (2019) investigated the International Seabed Authority's current strategic plan and revealed several gaps that can be included in the forthcoming environmental management strategy.

In energy research topic, Krog and Sperling (2019) proposed a framework for planning Danish energy transformation. The framework provides various dimensions to consider for designing the strategic energy plans. Vecchiato (2019) analysed Shell's scenarios planning for the Russian Federation energy market. He revealed that Shell's current scenarios planning consider strategic aspects of the external environment, and they assist top managers for decision making. However, the weakness of the scenarios is that it does not include the prediction of several main issues that have been emerged in the energy market. Villicaña-García and Ponce-Ortega (2019) developed a model for strategic planning the natural gas energy systems. The model adopted optimisation strategy to interlink sustainability dimensions.

There have been extensive studies that focused on strategic planning in sustainability areas, particularly in energy. However, little attention is given to investigate the strategic planning method for future renewable energy technologies. The present study attempts to address this research limitation by proposing a method for strategic planning to decide the appropriate renewable energy technologies.

## 2.2 Related studies on renewable energy technologies

Numerous studies have been conducted in the area of renewable energy technologies. Mohammed et al. (2017) analysed current renewable energy technologies in Nigeria and recommended further improvement of the technologies. They suggested that various renewable energy technologies should be based on autonomous energy systems and microgrid technologies. Taliotis et al. (2017) examined the impact of strategic energy decisions and proposed an optimisation strategy for Cyprus energy.

Pfeifer et al. (2018) proposed a model to integrate renewable energy sources and technology to provide energy storage. They found that the integration approach improved the energy supply and decreased the total extra energy production. Haas et al. (2019) performed similar research on energy storage technologies by developing a framework to plan effective and efficient energy storage systems. Matos et al. (2019) recommended several underground energy storage technologies and reservoirs to integrate renewable energies. Yang et al. (2018) analysed numerous drivers for adopting renewable heating technologies and used multi-criteria analysis to prioritise technology implementation.

In a general context, Ribeiro et al. (2018) offered a methodology for assessing public opinion and awareness concerning the implementation of renewable energy technologies. The results of the assessment assisted decision-makers in designing long-term strategic planning for technology implementation. Genc and Reynolds (2019) evaluated the impact of renewable energy technology diffusion and ownership on the energy markets. Rueda-Bayona et al. (2019) observed international activities that stimulate the implementation of offshore wind technology to diminish climate change problems. Vares et al. (2019) studied the impact of renewable energy technologies on energy building and greenhouse gas emissions. Renewable energy technologies have been vigorously observed to reduce energy consumption, carbon footprint, and enabling nearly zero CO<sub>2</sub> emissions. However, very few studies have considered the strategic planning method to predict the future generation of renewable energy technologies. Table 2 provides an overview of the existing studies in renewable energy technology.

*Table 2: A review of renewable energy technology studies*

Reference	Research area
Mohammed et al. (2017)	Combined generation systems
Taliotis et al. (2017)	Power supply optimisation
Pfeifer et al. (2018)	Energy storage and systems
Ribeiro et al. (2018)	General renewable energy technologies
Yang et al. (2018)	Home heating technology
Genc and Reynolds (2019)	Technology ownership
Haas et al. (2019)	Energy storage
Matos et al. (2019)	Energy storage
Rueda-Bayona et al. (2019)	Offshore wind technology
Vares et al. (2019)	Energy building

### 3. Research Methodology

This study applied conceptual research methods to develop the strategic planning method. This research approach has been adopted by numerous studies that proposed a theoretical framework (Chofreh et al., 2019). The conceptual research method engages an in-depth review of literature in the related area. This study examines two related areas of the topic, including strategic planning and renewable energy technologies to expose the research gap and assist this study in developing the strategic planning method. Figure 2 summarises the flow of the present study.

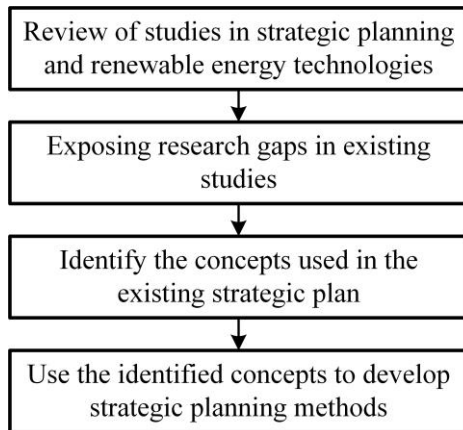


Figure 1: Research flow

### 4. Results and Discussion

A strategic plan method for the next generation of renewable energy technologies is a systematic process that would help the government and global institutions to predict and decide the appropriate new renewable energy technologies, and where and when it should be implemented. In addition, this method would assist the decision-makers to hasten technological change and avoid the implementation of technologies that are not by the needs of the industry and community.

The method focuses on strategies pivotal for creating a competitive advantage through the effective use of emerging technologies. It would be a novel idea as it is designed by integrating various related concepts, such as strategic management, planning, analysis and assessment methods, technology innovation, and related concepts used in renewable energy technologies. The strategic plan might be part of a competitive intelligence program, which involves various activities of defining, gathering, analysing, and distributing intelligence about new renewable energy technologies, customers, competitors, and any aspect of the environment needed to support executives, managers, and policymakers in strategic decision making. Figure 2 shows an overview of the strategic plan method for the next generation of renewable energy technologies.

The strategic planning method includes three phases: strategic inputs, strategy formulation, and strategy implementation. Strategic inputs focus on analysing internal and external environments to determine resources, capabilities, and core competencies for developing the next generation of renewable energy resources. The outcome of the phase of the strategic input would be the input for the development of new vision and mission and formulation of the strategy of developing the new technologies.

Strategy formulation is an analytical process to formulate a plan and develop a strategy to achieve sustainability goals and objectives. In this phase, the decision-makers require to design the business model and strategy to choose and implement the new renewable energy technologies. Development of resources plan is also necessary for the strategy formulation to identify the resources needed to implement the new technologies.

Action plan refers to sequence steps and activities that should be performed to implement the new technologies. To implement the strategy, the decision-makers should take actions toward achieving strategic competitiveness and above-average returns. Effective strategic actions that take place in the context of carefully integrated strategy formulation and implementation actions result in desired strategic outcomes. It is a dynamic process, as ever-changing markets and competitive structures are coordinated with the institution's continuously evolving strategic inputs.

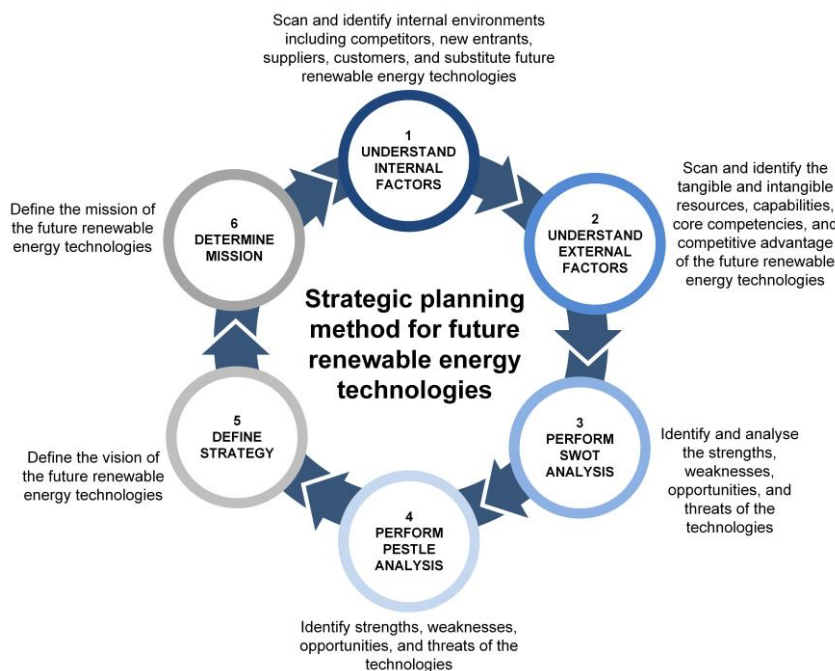


Figure 2: Strategic planning method for future renewable energy technologies

## 5. Conclusions

This study aimed to propose a strategic plan method for future renewable energy technologies. The developed strategic planning method includes three phases: strategic inputs, strategy formulation, and strategy implementation. The method shows some strategic aspects to consider in planning future renewable energy technologies. It considers external and internal factors including personal values, strengths and weaknesses, opportunities and threats, and expectations in competitive strategy formulation. The method can improve current renewable energy technologies within allocated resources. The strategic plan method also hopefully would assist the decision-makers to choose and implement more applicable and adequate technologies that are in line with the sustainability approach. European Commission (2019) stated that the application of strategic plan method for energy technology would help global institutions and government to diminish GHG emissions by at minimum 20 % and attain energy savings of 20 %.

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