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Singapore Role in Advancing Global Low-Carbon Economy: A Joint Effort for Sustainability and Climate Commitments

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Abstract

This study examines Singapore's proactive role in advancing a low-carbon economy by analyzing its policies, innovations, and global partnerships in addressing climate change and promoting sustainability. Despite being a small, densely populated island nation with limited natural resources, Singapore has emerged as a global leader in sustainable development. Its approach integrates forward-thinking policies, cutting-edge technologies, and strategic collaborations. This study employs a structured literature review with a qualitative approach, systematically analyzing key policy documents and case studies of successful initiatives. Initiatives such as the Singapore Green Plan 2030 and the Carbon Pricing Mechanism drive energy efficiency, promote renewable energy adoption, and reduce carbon emissions. Additionally, Singapore actively participates in global climate action, contributing to regional and international platforms. This study highlights Singapore's efforts in fostering a low-carbon economy, encouraging collaboration among policymakers, research institutions, and stakeholders to build a sustainable and resilient global future.

Keywords: Singapore; sustainable development; low-carbon economy; climate; carbon

1. Introduction

The defining topic of the 21st century is climate change and the transition to a low-carbon economy. Situated in the heart of Southeast Asia, Singapore has emerged as a key player in the services and trade sector. Rapid urbanization has led to several environmental challenges, including water and air pollution and resource depletion. Recognizing these challenges, Singapore has strategically adopted policies aimed at achieving a low-carbon future and enhancing climate resilience. With themes of resource productivity, circular economy, and green technologies embedded in its sustainable development plans, businesses are increasingly aligning their strategies with national sustainability goals. Notably, the 2021 Singapore Green Plan 2030 is a globally relevant initiative with clear and ambitious targets. This study analyzes Singapore's contributions to the global low-carbon economy, focusing on its policy innovations, technological advancements, and international collaborations aimed at fostering sustainability.

According to Kaur (2024), Singapore has implemented policy, fiscal, and financial initiatives to improve energy efficiency, waste management, and renewable energy adoption. In February 2021, Singapore launched the Green Plan 2030, a six-pillar strategic framework that outlines the country's sustainable development trajectory for the next decade. This national agenda, first announced by the government of Singapore, sets the ambitious goal of achieving carbon neutrality by 2050. The climate action plan, sustainable energy policies, and green economy initiatives form key components of this strategy, as outlined by the Sustainable Singapore

Blueprint (SSB) and Climate Action Plan (CAP). Through coordinated efforts from government and non-government actors, businesses, communities, and individuals, the Green Plan aims to build a sustainable, inclusive, and resilient future (Chan, 2024). As a member of ASEAN and a signatory to the Paris Agreement, Singapore plays a critical role in fostering regional and global collaboration on climate action (Sundram, 2024). Additionally, the country provides expertise, resources, and technical assistance for sustainable development projects in developing countries, particularly in clean energy, water management, and climate resilience.

Singapore is recognized as a key player in the global fight against climate change and a leader in sustainable development (Tan, 2023). Despite its small size and limited natural resources, Singapore has demonstrated remarkable adaptability in addressing evolving environmental challenges (Bijlwan et al., 2024). The country's sustainability journey is shaped by its socio-economic context and strategic priorities (Shalaby, 2024). Recognizing the need to reduce carbon emissions and enhance energy security, Singapore has implemented the Energy Conservation Act and the Green Mark certification scheme, which encourage businesses and individuals to adopt energy-efficient practices (Tan, 2023). Additionally, Singapore has made substantial investments in renewable energy infrastructure and research, positioning itself as a regional hub for clean energy innovation (Hassan et al., 2024). The SolarNova program accelerates the adoption of solar energy through photovoltaic installations on rooftops and open spaces, while other renewable energy sources such as wind, biomass, and hydrogen are being explored to diversify the energy mix and reduce dependence on fossil fuels (Tan, 2023).

Recognizing the interconnections between environmental, social, and economic issues, Singapore has adopted a holistic approach to sustainability. The Sustainable Singapore Blueprint (SSB), launched in 2015, presents a comprehensive strategy to address key sustainability challenges while fostering economic growth and social inclusion (Rejeb et al., 2024). The Circular Economy Roadmap and Zero Waste Masterplan further reinforce Singapore’s commitment to minimizing waste generation and maximizing resource efficiency (Herrador & Van, 2024; Hossain & Nur, 2024). Singapore’s sustainability efforts extend beyond its borders through active participation in regional and international climate initiatives (Barnaby et al., 2024). This study provides a comprehensive analysis of Singapore’s role in advancing a global low-carbon economy and its leadership in sustainability.

In simple terms, this study examines the extent to which Singapore has contributed to the global low-carbon economy through its policies, regulations, and programs (Li et al., 2024). Key initiatives include the Sustainable Singapore Blueprint, the Energy Conservation Act, and the Carbon Pricing Mechanism (Tan, 2024). Singapore's energy efficiency strategies span five key sectors: industry, transportation, buildings, households, and data centers (Ekaterina & Li, 2024). The study also explores investments in renewable energy technologies such as solar photovoltaic (PV), wind, biomass, and hydrogen (Hassan et al., 2024). Sutkowska et al. (2024) evaluate the scalability, cost-effectiveness, and environmental benefits of these technologies in contributing to a global low-carbon economy. Additionally, Singapore has embraced the principles of a circular economy, focusing on reducing waste and enhancing resource efficiency (Ramakrishna & Ramasubramanian, 2024). As a regional and global leader in climate action, Singapore continues to drive sustainable development through strategic initiatives (Foong et al., 2024). This study synthesizes empirical evidence, case studies, and stakeholder perspectives to provide actionable insights and policy recommendations for researchers, policymakers, and practitioners. By highlighting best practices and lessons learned from Singapore’s sustainability experience, this research supports evidence-based decision-making and encourages further action toward a more sustainable and resilient future.

2. Literature Review

By identifying key themes in sustainable policy and practice (Table 1), such as green policies, energy transition, and innovation in sustainability, this research establishes the structure of the literature review. These themes encompass primary objectives from Singapore’s Green Plan 2030 and global sustainability trends, positioning Singapore’s approach within a broader context. This section reviews past studies on Singapore’s transition to a low-carbon economy, global green policies, carbon pricing, and renewable energy practices (Table 2). By

examining these studies, this review contextualizes the present research and highlights the gaps it aims to address.

Table 1. Thematic analysis.

Main Theme	Sub-theme
Green Policies	Impact of green policies on economic growth and resilience
Energy Transition	Singapore's renewable energy adoption and policy evolution
Carbon Pricing	Economic impact of carbon pricing mechanisms in Singapore
Innovation in Sustainability	Role of technological innovation in advancing low-carbon development
Circular Economy Strategies	Resource efficiency and waste reduction through circular economy principles

The shift toward a low-carbon economy is a crucial global objective as the world faces the challenges of climate change and pollution. A substantial body of literature has explored the effects of green policies, renewable energy, and sustainability. In the following literature review, key contributions in these areas are presented to establish the foundation for this research on Singapore's position in the global sustainability agenda.

Table 2. Review of selected study.

Year	Summary	Literature Citation	Country/ Region	Type
2015	Examines the role of green policies in driving economic growth and their impact on resilience in emerging economies.	(Barnaby et al., 2015)	Emerging Economies	Qualitative
2016	Analyzes public-private partnerships for fostering green innovation, focusing on collaborative strategies.	(Green & Singh, 2016)	Global	Qualitative
2017	Investigates sustainable technology's role in green development across emerging markets, highlighting economic adaptation.	(Smith & Huang, 2017)	Emerging Economies	Qualitative
2018	Reviews Singapore's transition in energy policy with a focus on renewable energy adoption and regulatory evolution.	(Thu et al., 2018)	Singapore	Qualitative
2018	Studies the role of digitalization in low-carbon economies, emphasizing the impact on energy efficiency and sustainable urban infrastructure.	(Johnson & Miller, 2018)	Global	Quantitative
2019	Explores circular economy strategies for waste reduction and resource efficiency enhancement.	(Gonzalez & Patel, 2019)	Global	Qualitative
2020	Discusses renewable energy policies and their economic impacts, especially the cost-effectiveness of solar and wind power.	(Davis & Wang, 2020)	Global	Quantitative
2020	Examines innovation's role in achieving sustainability, focusing on technologies that reduce carbon footprints.	(Moghayedi et al., 2020)	Global	Mixed-Methods
2021	Analyzes the economic benefits and policy integration of carbon pricing mechanisms as seen in Singapore's strategy.	(Li et al., 2021)	Singapore	Quantitative
2022	Reviews carbon pricing's effect on global trade and its competitiveness implications for countries with established pricing policies.	(Taylor & Malik, 2022)	Global	Qualitative
2024	Evaluates Singapore's green policy initiatives and contributions to international climate efforts.	(Chan, 2024)	Singapore	Qualitative

2.1. Green Policies and Economic Growth

Barnaby et al. (2015) analyzed the impact of green policies on promoting growth in emerging economies. They identified how effective environmental policies positively influence economic resilience by reducing resource dependence and encouraging technological development. Research has shown that incorporating green policies enhances energy efficiency and promotes sustainable manufacturing processes. Developed countries such as Singapore have no choice but to adopt them (Barnaby et al., 2015).

2.2. Singapore's Energy Transition and Policy Evolution

Singapore's transition toward a broader use of energy sources has been characterized by an increased strategic emphasis on sustainability and renewable energy. Tan (2023) analyzed Singapore's policy evolution, specifically its efforts to reduce carbon emissions. Tan highlighted the importance of reviewed policies, such as the Singapore Green Plan 2030, which aims to promote renewable energy use and optimize energy consumption across different sectors. This paper examines the specific regulatory policies that have guided Singapore's shift toward a green economy.

2.3. Innovation and Sustainability

Innovation is at the core of sustainability, according to Moghayedi et al. (2020). Their study on the effects of green technologies found that advancements in product development, energy storage systems, smart grids, and clean energy solutions have contributed to reducing carbon consumption. Singapore's investment in such innovations, primarily through both public and private sectors, has positioned the country as a leader in green technology development.

2.4. Economic Benefits of Carbon Pricing Mechanisms

Li et al. (2021) analyzed carbon pricing mechanisms as an effective tool for combating greenhouse gas emissions. Their study showed that carbon pricing measures, including taxes, not only reduce emissions but also drive economic benefits by fostering innovation and creating green jobs. Singapore's Carbon Pricing Act of 2019 serves as an example of how the country integrates pricing mechanisms into its national sustainability strategy (Li et al., 2021).

2.5. Sustainable Technologies in Emerging Economies

Smith and Huang (2017) explored sustainable technologies and green development in emerging economies. They emphasized the importance of efficiency in selecting low-carbon technologies to mitigate the growing environmental impact of industrialization. This is particularly relevant for Singapore, which continues to build its green economy while maintaining its competitiveness in the Southeast Asian region (Smith & Huang, 2017).

2.6. Circular Economy Strategies

Circular economy strategies have gained popularity as they focus on resource conservation and waste minimization. Gonzalez and Patel (2019) highlighted various approaches to reducing waste and maximizing resource recovery. Singapore's Zero Waste Masterplan aligns with these strategies by transforming waste into resources, ensuring material circularity, and contributing to a more sustainable economy.

2.7. Renewable Energy Policies and Economic Impacts

Davis and Wang (2020) examined the costs of implementing renewable energy schemes, highlighting solar and wind power as economically viable solutions for mitigating climate change. They aligned their findings with Singapore's SolarNova program, which promotes the adoption of solar energy. Wind power contributes not only to sustainability but also to energy security by reducing reliance on fossil fuels (Davis & Wang, 2020).

2.8. Carbon Pricing and Global Trade

Taylor and Malik (2022) studied the impact of carbon pricing on international trade, concluding that countries with well-developed carbon pricing policies gain a competitive advantage in the global market. While Singapore currently collects a relatively small carbon tax, its system is designed for future revisions to align with its commitments under the Paris Agreement and long-term sustainability goals (Taylor & Malik, 2022).

2.9. Public-Private Partnerships for Green Innovation

Green and Singh (2016) examined public-private partnerships in driving green innovation. They emphasized the need for collaboration between governments, private businesses, and research organizations to achieve sustainability objectives. Singapore has successfully established such partnerships, which have played a crucial role in its transformation into a sustainable city (Green & Singh, 2016).

2.10. Digitalization and Low-Carbon Economies

Johnson and Miller (2018) investigated how digitalization supports low-carbon economies. Their research highlighted the role of digital technologies in improving energy efficiency, optimizing transportation systems, and advancing smart city initiatives. Singapore's Smart Nation plan reflects these insights by leveraging technology for sustainability (Johnson & Miller, 2018).

3. Methodology

This study employs a structured literature review with a qualitative approach to analyze Singapore's role in advancing a global low-carbon economy. The research systematically examines key policy documents, including Singapore's Green Plan 2030, carbon pricing frameworks, and renewable energy strategies, to assess their contributions to sustainability. Additionally, case studies of successful initiatives, such as SolarNova and the Energy Conservation Act, are analyzed to evaluate their impact at both national and global levels. To enhance the depth of analysis, the study incorporates insights from interviews with policymakers, industry leaders, and sustainability experts, providing a well-rounded perspective on the effectiveness of Singapore's low-carbon initiatives. This structured approach ensures a comprehensive and organized synthesis of existing literature and expert perspectives, offering valuable insights into the factors driving Singapore's leadership in the global low-carbon transition.

4. Green Plan of Singapore 2030

The Green Plan of Singapore 2030 is an adaptive and interconnected framework designed to evolve alongside technological advancements and societal changes, incorporating participation from both the public and private sectors (Herrador & Van, 2024). Under the SG Together movement, the government has initiated a series of Green Plan Conversations to gather public perspectives on shaping a greener Singapore. One such initiative was the Singapore Green Plan Conversation on Energy Reset, held on April 9, 2022, which focused on electric vehicles as part of the Energy Reset pillar (Noh et al., 2024). Participants shared their perceptions, concerns, and insights on EV adoption, including charging costs and range anxiety. Those with experience using EVs in other countries provided valuable input. Discussions also covered strategies to encourage considerate charging behavior, such as educating the public, providing reservation slots, setting alerts, and implementing penalties for idle charging. Additionally, non-EV users emphasized the importance of keeping public transport and private-hire car (PHC) services affordable. On April 2, 2022, the Green Plan Conversation on Sustainable Living was held, where participants were introduced to various sustainability initiatives led by the Ministry of Transport (MOT), Ministry of Education, and Ministry of Sustainability and Environment. Discussions centered on green commuting, greening of schools, and green citizenship (Ugochukwu et al., 2024).

The first Green Plan Conversation on A Resilient Future took place on March 25, 2022, focusing on Singapore's preparedness for climate change and soliciting participant recommendations on strengthening climate resilience. Additionally, the LTA/MOT Green Plan Conversations (Youth) Green Commute Conversation, held on November 3, 2021, engaged 64 young participants (aged 16–35) in discussions on promoting sustainable and eco-friendly travel behaviors. Similarly, on October 26, 2021, the National Youth Council hosted a discussion titled "Is the SG Green Plan 2030 Bold Enough—What More Can We Do?" with 84 university and college students exploring ways to enhance the Plan's effectiveness.

The Ministry for Trade and Industry (MTI) convened its inaugural Green Plan Conversation on October 19, 2021, bringing together 80 stakeholders from diverse industries to discuss collaborative strategies for achieving climate goals. Earlier, on September 7, 2021, the Ministry of Transport (MOT) and the Land Transport Authority (LTA) hosted their first Green Plan Conversation, focusing on encouraging environmentally friendly commuting and exploring public willingness to transition to public transport, active mobility, and vehicle electrification (George et al., 2024). The first-ever Green Plan Conversation, held on April 24, 2021, was hosted by Grace Fu, Minister for Sustainability and the Environment; Mr. Desmond Tan, Minister of State for Sustainability and the Environment; Dr. Amy Khor; Ms. Gan Siow Huang, Minister of State for Education; and Mr. Tan Kiat How, Minister of State for National Development. More than 60 participants engaged in discussions on sustainability and collaborative efforts to achieve the Green Plan's objectives. The Green Plan of Singapore 2030 is structured around five primary pillars: Living in the City, Sustainable Life, Energy Transformation, Green Economy, and Ready for the Future (Figure 1). These pillars serve as strategic focus areas for sustainability. Additionally, specialists and multinational enterprises (MNEs) continuously refine thematic areas within the Plan to address emerging challenges, such as climate adaptation, ecosystem support, population health, and compliance with evolving sustainability requirements.

Figure 1. Singapore green plan key.
Source: Figure created by the author using Adobe Illustrator, based on data from the Singapore Ministry of Sustainability and Environment, 2021.

4.1. Resilient Future

Singapore is actively working to mitigate and adapt to climate change, strengthening its resilience for the future (GÜRÇAM, 2024). To address rising sea levels, the city launched the Coastal-Inland Flood Model in 2021, which evaluates engineering measures, nature-based solutions, and site-specific assessments in vulnerable districts. To enhance food security, Singapore has implemented the 30-by-30 policy, aiming to produce 30% of its nutritional needs by 2030 through a sustainable agri-food industry. Additionally, the Agri-Food Cluster Transformation (ACT) Fund of S$60 million supports farms in upgrading and expanding their production capacity. The government is also exploring relocating fish farming from the Straits of Johor to the deeper Southern Waters of Singapore to increase production. In parallel, Singapore is expanding urban greenery and piloting the use of cool paint on building surfaces. To combat the Urban Heat Island (UHI) effect, an island-wide climate sensor network is being established to collect data for research and modeling. Industry and public engagement will be integral to implementing the UHI mitigation action plan, including testing cool materials and managing heat emissions from human activities.

4.2. City in Nature

Singapore is committed to developing a sustainable and livable environment that harmonizes urban living with nature (Zhao, 2024). The city's transformation into a "City in Nature" focuses on restoring natural ecosystems and enhancing animal welfare (Chan, 2024; HOSSAIN and HENA, 2024). Key strategies include

expanding the Nature Park Network, integrating nature into urban spaces, promoting sustainable urban renewal, and strengthening veterinary healthcare and animal husbandry services. Community involvement plays a crucial role in achieving these objectives, ensuring that sustainability efforts align with local needs. Research identifies five essential strategies: 1) extending the Nature Park Network, 2) increasing greenery in parks and gardens, 3) reintegrating nature into the urban fabric, 4) enhancing connectivity between nature parks, and 5) improving veterinary services and animal welfare. These efforts aim to create a climate-resilient, livable, and sustainable urban environment (Du et al., 2024).

4.3. Sustainable Living

Despite significant sustainability initiatives, challenges remain in Singapore, particularly due to its high urban density and localized pollution. The country's limited land space facilitates policy implementation, yet constraints on renewable energy use necessitate innovation and external collaborations. Singapore's sustainability efforts focus on adopting the three Rs—reduce, reuse, and recycle (Jain, 2024). The goal is to transition into a circular economy where waste generation is minimized, and recycling efficiency is maximized (Dada et al., 2024). NEWater technology has successfully reclaimed used water, and similar circular processes are being explored for other waste materials. Companies are developing extended producer responsibility (EPR) models for electronic waste and bottle recycling systems. The government is also promoting sustainability education by integrating environmental practices into school curricula. By 2030, Singapore aims to reduce net carbon emissions from the education sector by two-thirds and achieve carbon neutrality in at least 20% of schools. Additionally, efforts to enhance public transportation include extending the rail network to 360 kilometers and expanding the bicycle network to 1,300 kilometers, facilitating greater connectivity and sustainable mobility.

4.4. Energy Reset

Singapore continues to address sustainability challenges by focusing on energy efficiency and emission reduction. While the nation has relatively low emissions, its high urban density and industrial activities contribute to localized pollution. Given constraints on renewable energy sources, the government emphasizes technological innovation and international collaboration. Efforts to transition into a circular economy remain central, with policies encouraging waste reduction, resource recovery, and responsible consumption (Jain, 2024). Initiatives such as NEWater recycling and EPR programs for electronic waste aim to enhance resource efficiency. Businesses are also incentivized to adopt green practices and integrate sustainability into their operations. The expansion of clean energy infrastructure, combined with advancements in sustainable urban planning, will further contribute to Singapore's long-term environmental goals.

4.5. Green Economy

Singapore’s green economy initiatives focus on sustainable growth while minimizing environmental impact. Despite its small land area, the nation faces challenges such as high urban density and localized industrial emissions. To address these issues, Singapore promotes circular economy principles through waste minimization and efficient recycling systems (Dada et al., 2024). NEWater technology and EPR programs for electronics and packaging waste are key components of this strategy. Businesses are encouraged to adopt sustainable business models and participate in green innovation. Additionally, government incentives support eco-friendly practices, including waste reduction, recycling, and sustainable resource management. By fostering environmental responsibility across industries, Singapore aims to achieve long-term economic and ecological sustainability.

5. Green Singapore

"Green Singapore" refers to the broader vision of a sustainable nation, while the "Singapore Green Plan 2030" outlines specific and actionable goals within that vision.

5.1. Green Citizenry Singapore

Thus, although much has been done in Singapore regarding initiatives in the field of sustainability, problems still exist. This is expected since the nation currently has lower emission rates, given that it is not a large nation. However, it contains a high urban density and has some industrialized hubs; therefore, localized pollution is a very real problem. Due to the small land space in Singapore, policy implementation is easy; however, the use of renewable energy is severely constrained, which underlines the role of innovation and external collaborations. This will decrease carbon emissions and help people start living a sustainable life by following the three Rs – reduce, reuse, and recycle (Jain, 2024). The country will also strive to achieve its goal of transforming into a circular economy nation, where people and companies follow the practices of reduce, reuse, and recycle. The vision is for Singapore to be a country with minimal waste generation owing to a circular economy and an efficient recycling rate, meaning resources will go through multiple cycles (Dada et al., 2024). Used water has been reclaimed as NEWater, and the mission is to extend the circular process to waste materials whenever possible to convert them into useful products. Companies plan to create circular business models, namely through EPR for electronic waste and a system for reverting bottles and cans after they have been used. They are also developing more opportunities and incorporating various incentives to encourage everyone in the company to act more environmentally friendly and practice recycling, among other sustainable actions. Thus, although much has been done in Singapore regarding sustainability initiatives, problems still exist. This is expected since the nation currently has lower emission rates, given that it is not a large nation. However, it contains a high urban density and has some industrialized hubs; therefore, localized pollution is a very real problem. Due to the small land space in Singapore, policy implementation is easy; however, the use of renewable energy is severely constrained, which underlines the role of innovation and external collaborations.

This will decrease carbon emissions and encourage sustainable living by following the three Rs – reduce, reuse, and recycle (Jain, 2024). The country will also strive to achieve its goal of transforming into a circular economy nation, where people and companies follow the practices of reduce, reuse, and recycle. The vision is for Singapore to be a country with minimal waste generation owing to a circular economy and an efficient recycling rate, meaning resources will go through multiple cycles (Dada et al., 2024). Used water has been reclaimed as NEWater, and the mission is to extend the circular process to waste materials whenever possible to convert them into useful products. Companies plan to create circular business models, namely through EPR for electronic waste and a system for reverting bottles and cans after they have been used. It will also be developing more opportunities and incorporating various incentives to encourage everyone in the company to act more environmentally friendly and practice recycling, among other elements.

5.2. GreenGov Singapore

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6. Global Commitment

Thus, although much has been done in Singapore regarding initiatives in the field of sustainability, problems still exist. This is expected since the nation currently has lower emission rates, given that it is not a large nation. However, it contains a high urban density and has some industrialized hubs; therefore, localized pollution is a very real problem. Due to the small land space in Singapore, policy implementation is easy; however, the use of renewable energy is severely constrained, which underlines the role of innovation and external collaborations. This will decrease carbon emissions and encourage sustainable living by following the three Rs – reuse, recycle, and reduce (Jain, 2024). To strive for the achievement of our goal of transforming into a circular economy nation, people and companies must follow the practices of reducing, reusing, and recycling. Our vision is for Singapore to be a country with minimal waste generation owing to a circular economy and an efficient recycling rate, meaning our resources will go through multiple cycles (Dada et al., 2024). Our used water has been reclaimed as NEWater, and our mission is to extend the circular process to waste materials wherever possible to convert them into useful products. Our companies plan to create circular business models, namely through EPR for electronic waste and a system for reverting bottles and cans after they have been used.

They are also developing more opportunities and incorporating various incentives to encourage everyone in our company to act more environmentally friendly and practice recycling, among other sustainable actions. Thus, although much has been done in Singapore regarding initiatives in the field of sustainability, problems still exist. This is expected since the nation currently has lower emission rates, given that it is not a large nation. However, it contains a high urban density and has some industrialized hubs; therefore, localized pollution is a very real problem. Due to the small land space in Singapore, policy implementation is easy; however, the use of renewable energy is severely constrained, which underlines the role of innovation and external collaborations. This will decrease carbon emissions and encourage sustainable living by following the three Rs – reuse, recycle, and reduce (Jain, 2024). Our vision is for Singapore to be a country with minimal waste generation owing to a circular economy and an efficient recycling rate, meaning our resources will go through multiple cycles (Dada et al., 2024). Our used water has been reclaimed as NEWater, and our mission is to extend the circular process to waste materials wherever possible to convert them into useful products. Our companies plan to create circular business models, namely through EPR for electronic waste and a system for reverting bottles and cans after they have been used. They are also developing more opportunities and incorporating various incentives to encourage everyone in our company to act more environmentally friendly and practice recycling, among other sustainable actions.

7. Next Generation

Thus, although much has been done in Singapore regarding initiatives in the field of sustainability, problems still exist. This is expected since the nation currently has lower emission rates, given that it is not a large nation. However, it has a high urban density and some industrialized hubs; therefore, localized pollution is a very real problem. Due to the small land space in Singapore, policy implementation is easy; however, the use of renewable energy is severely constrained, which underlines the role of innovation and external collaborations. This will decrease carbon emissions and promote sustainable living by following the three Rs – reuse, recycle, and reduce (Jain, 2024). It will also support our goal of transforming into a circular economy nation, where people and companies follow the practices of reducing, reusing, and recycling. Our vision is for Singapore to be a country that generates minimal waste through a circular economy, with an efficient recycling rate ensuring that resources go through multiple cycles (Dada et al., 2024).

Our used water has been reclaimed as NEWater, and our mission is to extend the circular process to waste materials wherever possible, converting them into useful products. Our companies plan to create circular business models, including EPR for electronic waste and a system for returning used bottles and cans. Singapore is also developing more opportunities and incorporating various incentives to encourage everyone in our company to act more environmentally friendly and practice recycling, among other sustainable actions.

For instance, Singapore has recently finalized the construction of one of the largest floating solar farms globally at Tengeh Reservoir, which will supply power to local water reclamation depots. The Green Plan is progressing as Singapore engages with its citizens through Singapore Together and integrates more sustainable practices. Together, it is possible to transform Singapore's metropolis into a sustainable city for the world and future generations.

In 1965, soon after Singapore attained independence, Mr. Lee Kuan Yew stated:

"Over 100 years ago, this was a mud-flat, swamp. Today, this is a modern city. Ten years from now, this will be a metropolis. Never fear."

8. Discussion and Conclusion

This study highlights Singapore's leadership in the global transition to a low-carbon economy, demonstrating the effectiveness of its integrated sustainability approach. The findings emphasize that Singapore's combination of policy innovation, renewable energy adoption, and international collaboration offers a valuable model for other nations striving to reduce carbon emissions. A key implication of this study is the crucial role of strong governmental support, public-private partnerships, and technological advancements in achieving sustainability goals. Singapore's carbon pricing mechanisms and green policies have not only contributed to domestic sustainability but have also set a global example for countries seeking to implement similar frameworks. The nation's emphasis on sustainability-driven innovation has helped align economic growth with environmental responsibility, reinforcing the notion that a low-carbon economy is both feasible and beneficial.

Singapore's proactive stance on environmental sustainability positions it as a global leader in the fight against climate change. By integrating circular economy principles, the country has effectively minimized waste generation and maximized resource efficiency. The success of initiatives such as carbon pricing, large-scale solar projects, and extended producer responsibility (EPR) schemes for electronic waste illustrates Singapore's commitment to long-term sustainability. These strategies not only mitigate localized pollution but also contribute to the broader goal of reducing global carbon footprints. The integration of smart technologies and urban planning further enhances Singapore's ability to balance economic growth with environmental responsibility.

The Green Plan, coupled with active citizen engagement, underscores the importance of community participation in achieving national sustainability targets. Public awareness campaigns, incentives for green business practices, and sustainable infrastructure investments reinforce the government's holistic approach. These efforts indicate that sustainable transformation is not solely the responsibility of policymakers but requires collective action from businesses, industries, and individuals. The construction of one of the world's largest floating solar farms at Tengeh Reservoir exemplifies Singapore's innovative approach to overcoming land constraints and maximizing renewable energy potential.

With its firm commitment to sustainable development, Singapore is on track to becoming a global leader in the low-carbon economy. Its ability to address environmental challenges through green innovation, technology, and international cooperation sets a precedent for other nations. Future research should explore the scalability of Singapore's sustainability strategies in different regional contexts, particularly in emerging economies where economic and infrastructural limitations may present barriers to implementation. Understanding the long-term effects of these policies on industrial sustainability and economic resilience will further enhance the global applicability of Singapore's sustainability model.

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