Strategic Development and Implementation of Sustainable Energy Initiatives

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Abstract This study outlines key strategies to create and implement long-term energy plans, as evidenced by 15 case studies. Renewable energy and efficient companies such as Tesla, Siemens, and Vestas have presented higher value added by industry, but they emit less carbon. For instance, Tesla achieved a 3.5% value added by industry and a 50% reduction in carbon emissions with a 50% renewable energy share commitment but obtained 4%, that is, a 0% value added by industry with a 60% renewable energy share. There is thus a requirement for harmonization and for the review of these coordination goals such as how policies are aligned and incentives offered as well as the incorporation of topics like sustainable energy policies into broader policy frameworks. Pursuant to the econometric model, a 10% boost in renewable energy use will arise in a 1.2% gain in industrial value added and a 5% decrease in carbon emissions. These findings are supported by case studies of companies that emphasize the importance of a complete plan for sustainable energy development.

Keywords Renewable energy consumption · Energy efficiency · Economic growth · Carbon emissions · Policy coordination

1 Introduction

Sustainable energy development, therefore, provides energy to the current society in a manner that a society a hundred years from now shall not be in a position to provide for itself. It involves the use of energy sources, such as solar, wind, and hydropower, and embracing efficiency techniques in using energy to reduce greenhouse emissions

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and impact [1]. The importance of sustainable energy development can be attributed to the fact that it affects two of the three dimensions of sustainability [2].

Adjustment in climate can be made if transition is to be made to other forms of energy after utilizing existing sources of energy. Therefore, the generation of sustainable energy is beneficial in a number of ways economically [3].

Self-sustaining niche markets can also be created in renewable energy (RE), technological advancement of new clean technologies, and enhanced energy security through diversification and reduction in the use of imported fuel. Second, expenditure on sustainable energy can lead to long-term gains; that is, expenditure on renewable energy forms is less than that of fossil energy.

Thus, the development of sustainable energy requires a complex approach, which will solve the problems of energy security, climate changes, and economic growth [4]. It should also look at the social and economic impacts of change toward renewable energy, particularly on sensitive companies.

An efficient policy approach must integrate the energy security, climate change, and economic development sectors to develop a more sustainable and better-balanced energy system that is effective and detrimental to the environment [5, 6]. Although people have recently realized the value of investing in sustainable energy futures, most parties at the national or organizational level need to implement sustainable energy policies efficiently. This becomes a challenging task to meet societal needs for environmental sustainability and economic development.

The aim is to present the conceptual model for synthesizing and implementing the strategies for sustainable development of energy resources. The framework is also intended to help policymakers, businesses, and other stakeholders adapt to sustainable energy more efficiently, as the structured approach is intended to present strategies for following this course. The objectives of this study can be summarized in two goals.

First, it aims to enable readers to fully appreciate the crucial role that sustainable energy development strategies play in attaining both environmental sustainability and economic development.

Second, guidelines on how these strategies should be designed and managed should be presented. Through the framework provided, one will be better positioned to develop and implement sustainable energy practices within policy, business, and other institutions.

These elements include using renewable energy sources, energy conservation measures, policy measures, and stakeholder participation. To further expand the database of knowledge on sustainable energy development, the provisions discussed in this article outline the proposed framework. It offers pragmatic advice to decision-makers and practitioners on how a sustainable energy solution for future generations may be attained.

It aims to contribute to constructing sustainable energy systems for the future. These factors make the current study relevant to sustainable energy development and the difficulties arising during sustainable energy strategy creation and management.

This study analyzes the current sustainable energy development strategies literature and emphasizes their problems and shortcomings. The study then outlines a

strategic framework for constructing and implementing sustainable energy initiatives with sub-topics including renewable energy, energy conservation, policy systems, and stakeholders' involvement plans. Some of the case studies are discussed, and after all of these, the results are identified. The conclusion discusses the main results, notes the methodology's usefulness, and suggests further research and practical recommendations.

2 Literature Review

The task of creating and implementing the energy development plan at the same time is a complex process and a prerequisite for understanding the impact of various factors. This literature review focuses on the recent research relating to specific issues, including natural resources, economic growth, renewable energy, and policies.

For instance, Bekun et al. are confined merely to analyze the correlation between CO_2 emission, energy resource rent, and renewable/non-renewable energy in 16 EU countries. They pointed out this transition as essential in their research to decrease the level of carbon dioxide emissions and, in the process, embrace environmental conservation [2]. This insight is of great importance when developing strategies for energy investments in renewable energy fields.

Candra et al. [7] studied how the adoption of renewable energy helps in improving on the economic sustainability and at the same time decreases on the emission of greenhouse gases. This evidence subscribes to the call for incorporating renewable energy in the country's development policies.

Canh and Thong describe how financialization links to natural resource rents and present a cross-country analysis of the case [8]. Thus, they argue that financialization can affect the distribution of natural resource rents, which is relevant to sustainable energy outcomes. This perspective is useful in the fact that it provides a view of the economic layers that define energy resource management.

Jia, Fan, and Xia explore how the use of renewable energy impacts the economic development of Belt and Road countries [9]. On their part, they have noted that renewable energy affects growth and has an energy consumption increment, which implies the importance of renewable energy in promoting sustainable economic growth. This is why it is imperative that policies that bear the potential of enabling the integration of renewable energy be implemented.

Concerning the Polish national courts' struggles with rights-based smog cases, Karpus [4] reflects on this. As this study shows, the legal and regulation framework in the context of the analysis identifies the key hurdles in implementing environmental policies, which is essential for understanding the issues in the progress of sustainable energy. The policies regulating the utilization of energy need to be well responded to through legal systems.

The study by Lu and Wu [10] demonstrates that selective FDI can promote the green competitiveness within industries; in other words, inviting green investments is a possibility for furthering sustainable energy. This corresponds to the requirement of

strategic economic policies aimed at supporting green investments. Murshed examines if the strategies of trade liberalization are consistent with the shift to renewable sources in low- and middle-income LMICs [5]. The study in consideration shows that external policies must be restructured in order to promote the growth of renewable energy using the instrumental variable analysis. This insight is noble for coordinating trade and energy policies for development to enhance the public's welfare.

Ren et al. propose a wavelet quantile on quantile analysis to investigate the co-movement between the carbon market and the green bonds market [11]. They also identify the ways by which the financial aspects can help in the achievement of change toward a green economy. It is crucial to comprehend these flows in order to devise tactics, which may harness financial markets for the purposes of financially sustaining sustainability in the energy sector [12].

Specifically, regarding reusability, Xiao et al. are interested in the process of cathode regeneration for used lithium-ion batteries. Therefore, their work is more sustainability-centered concerning resource recycling [13]. Other studies echo the need to create new strategies for waste from energy technology and concerning the circular economy and sustainable waste management in particular [14].

Muller presents a case of hydrothermal liquefaction of spent coffee grounds and their upgradation by biocatalytic conversion for biofuel generation which embodies the circular economy utilization of waste resources [15]. The findings presented in this research illustrate the possibility of sustainability by turning waste streams into valuable commodities and resources. Bhola carries out a techno-economic and environmental feasibility study on the use of building rooftops of a campus for producing solar photovoltaic power [16]. Thus, the study affirms the possibilities and advantages of incorporating RE sources into the presently installed structure, showing the solar energy contribution to sustainable development [17, 18].

The possibilities of managing wind and solar power plant end-of-life equipment in Ukraine are explored by Trypolska et al., stressing the need for suitable approaches in the field of renewable energy [19]. Some of the prior works similar to the paper under discussion in which they discuss energy poverty and energy efficiency in emerging economies to identify obstacles and possible directions in enhancing the quality of energy supply [20]. They further explain that sustainable energy and development aid in mitigating social and economic inequities.

Dovhan et al. offer a PM textbook containing sections corresponding to sustainable energy development issues, including managing international projects, innovations, and logistics [21]. Although it is not a research book, this textbook provides essential information to comprehend project management regarding sustainable energy projects.

Kurbatova et al. describe solar energy's economic, environmental, and image gains in a university context [22]. This study shows that solar energy, the energy source, is not only seen as a portfolio of sustainable energy but as an opportunity to uplift and build the sustainability portfolio of institutions of learning. Sopronenkov et al. critically review the effects of the tax policy on businesses' prospects and economic performance [23]. Even though the subject of this study does not directly deal with

sustainable energy, this paper under-emphasizes the role of policy environments in structuring economic undertakings, including sustainable energy projects.

Koval et al. [24] substantiated approaches to fiscal policy and regulation of renewable energy sources in the national European economy. This study highlights the importance of policies, especially in developing energy management practices. It also affirms the significance of combined efforts to take better strides toward sustainable energy progress. The research proposed that cooperation with partners in other countries might enhance the prospects of disseminating necessary knowledge and applying helpful technologies to support sustainable energy policy development [25].

Todorov et al. seek to identify the correlation between financial literacy and carbon footprint [26]. Increasing financial knowledge will promote better use of resources and, therefore, can help lower carbon emissions. On this basis, this study points to the fact that increasing financial knowledge can be a significant element of effective solutions to address the effects of energy in relation to minimizing carbon emissions.

Sribna et al. [27] discussed the technological implications of energy transition focusing on the role of economics in assuring the environment's safety, underscoring the importance of technology availability and sharing in improving practical power networks. The highlight of this study revolves around the subject of technology enhancement and technology transfer concerning sustainable energy.

3 Methodology

It is for this reason that, this research used a holistic approach in assessing the effect of sustainable energy development policy instruments on economic growth and sustainability of the environment. Data collection was basically through secondary sources from established sources that included World Bank [28], International Monetary Fund [29], and International Energy Agency [30]. The variables included in the dataset were renewable energy consumption, energy efficiency, value added by industry, CO_2 emissions, population growth rates, inflation rates, forest area, and annual precipitation, and the included years were 2018–2023.

The included years were 2018–2023.

The data-gathering process considers data entropy and is checked and cleaned to make the data coherent and reduce the number of outliers or missing observations. Thus, panel data models were employed to assess the impact of sustainable energy development strategies (reflected by REN and EE Indicators) on the economic-environmental performance indicators CCI and value added by industry. A qualitative aspect was included through the use of case studies of companies and countries as part of the completion of the study. These case studies were useful in giving real-life examples on how sustainable energy plans could be undertaken and the results that would be likely to be realized. The criteria for choosing the case included the type of industry, geographical location, and the success of the sustainability of energy cases. Regression tests were performed to identify the non-triviality of the links between

the applied sustainable energy strategies and the studied economic-environmental variables.

The findings were used in a manner that would enable assessment of the interventions that underpin sustainable energy on economic growth and sustainable natural resource use. The last section of the study elaborated on the general limitation of the research methodology, data availability, and assumptions that were made during the analysis. The use of this methodology presented a clear framework for the interaction between sustainable energy development, economic development, and environmental sustainability, which was beneficial for policy makers, firms, and researcher.

4 Results

This issue has attracted more focus toward policy, planning, development, and management of sustainable energy strategies in the face of global challenges such as climate change, sustainable development, and skyscraper growth [31]. Sustainable energy policies and plans embrace the desirable objectives of energy security, reduced carbon intensity, and economic development by increasing renewable energy technologies and energy efficiency. A framework is further developed to reflect the impact of sustainable energy resources and their contribution to economic development and the environment. Based on this context, the proposed model combines theoretical assumptions from economics, environmental science, and energy policy to offer a systemic vision of the relationship between sustainable energy development and socioeconomic factors. The study presents a conceptual framework and procedures for developing such a model using specialized programs such as Stata for actual implementation. The model is planned to reveal to what extent the introduced advantages affect the state's economic growth and environmental sustainability by implementing further development strategies for sustainable energy resources. It considers components discussed in the paper, illustrated in Fig. 1.

This model includes the following components:

(1) Economic growth model:

- *Value_added_by_industry*—Value added by industry ratio (the percentage increase in GDP, reflecting the company's contribution to economic growth).
- $\beta 0$—the intercept term, characterizing the base equal of GDP growth when the independent variables are 0.
- $\beta 1$—the coefficient of the Renewable_energy_consumption, representing the effect of increasing renewable energy consumption on the GDP growth. A positive coefficient indicates that higher renewable energy consumption is associated with higher GDP growth, suggesting a positive impact of sustainable energy development on economic growth.
- $\beta 2$—the coefficient of Energy_efficiency, representing the impact of improved energy efficiency on GDP growth. A positive coefficient suggests

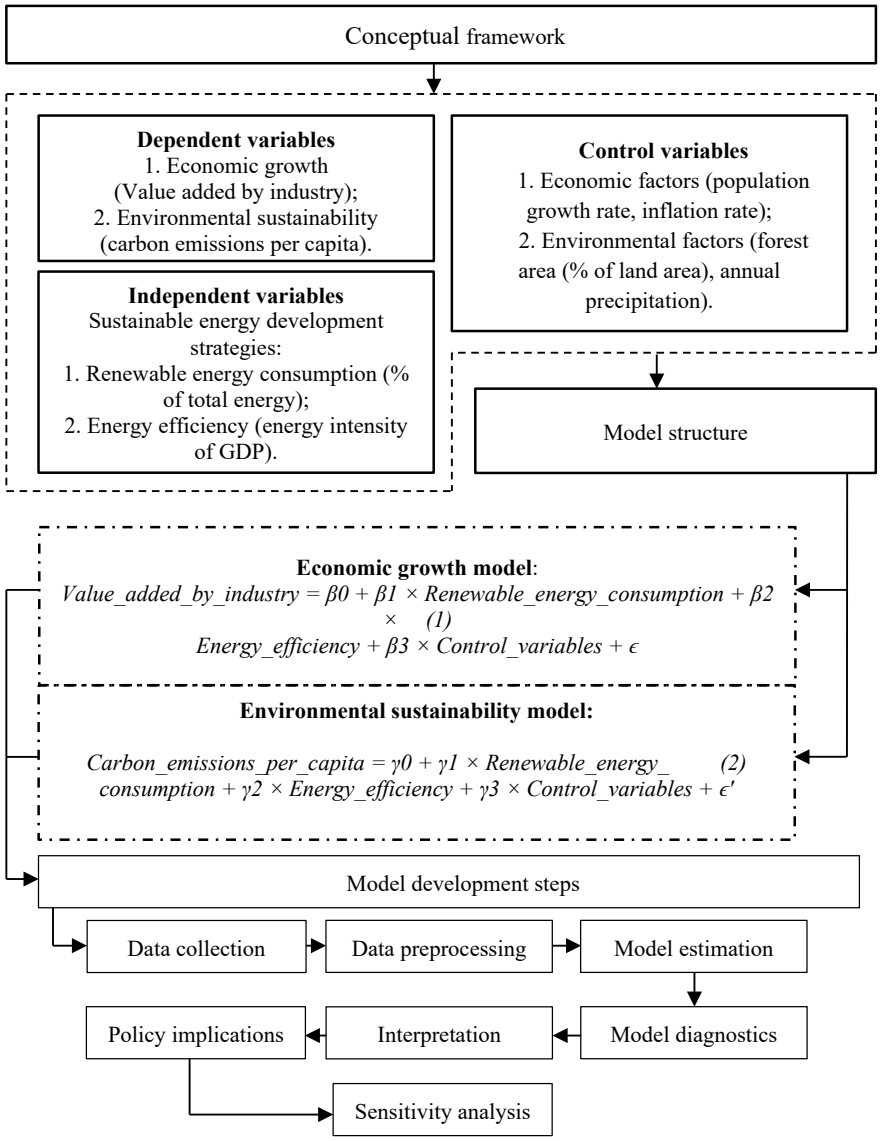

Fig. 1 Conceptual framework of the model

that higher energy efficiency is associated with higher GDP growth, indicating that energy efficiency measures can contribute to economic growth.

- $\beta 3$—the coefficient of Control_variables, representing the combined impact of other control variables (such as population growth rate and inflation rate)

on GDP growth. These control variables are added in order trace other variables that have impacts on economic growth, despite the fact that they may not be captured by the model.
- ϵ—the error term, characterizing the unexplained variation in GDP growth that is not accounted for by the independent variables in the model.

(2) Environmental sustainability model:

- Carbon_emissions_per_capita—the dependent variable representing the amount of carbon emissions per capita, which is a measure of environmental sustainability.
- $\gamma 0$—the intercept term, representing the base level of carbon emissions per capita when all independent variables are zero.
- $\gamma 1$—the coefficient of Renewable_energy_consumption, representing the impact of increasing renewable energy consumption on carbon emissions per capita. A negative coefficient suggests that higher renewable energy consumption is associated with lower carbon emissions per capita, indicating a positive impact of renewable energy on environmental sustainability.
- $\gamma 2$—the coefficient of Energy_efficiency, representing the impact of improved energy efficiency on carbon emissions per capita. A negative coefficient suggests that higher energy efficiency is associated with lower carbon emissions per capita, indicating that energy efficiency measures can contribute to environmental sustainability.
- $\gamma 3$—the coefficient of Control_variables, representing the combined impact of other control variables on carbon emissions per capita.
- ϵ'—the error term, representing the unexplained variation in carbon emissions per capita that is not accounted for by the independent variables in the model.

These models assist in analyzing the connection between sustainable energy development strategies, and economic development, as well as environmental conservation. The coefficients of the independent variables show how certain degrees of renewable energy consumption and energy efficiency affect these outputs while the control variables explain confounding variables that may affect the results. From the findings on the SMG relationship with economic development and the impact of sustainable energy development strategies, the authors employ panel data model working with the data collected from fifty firms for the time frame 2018–2023 (Table 1; Fig. 2).

There is a direct positive correlation between the amount of renewable energy used and corporate energy efficiency indices, on the one hand, and the value added by industry. For instance, the USA's Tesla records a value added by industry of 3.5%, with a renewable energy consumption of 30% and achieving an efficiency of 0.05. Similar to the previous method, in this case, more irrefutable evidence comes from Siemens (Germany) and Vestas (Denmark) with contribution rates of 0.402 and 0.603, respectively, for value added by industry, which is greater than the benchmark data. At the same time, their renewable energy consumption is 40 and 60% and moderate energy efficiency with a score of 0.04 and 0.03 theirs.

Table 1 Results (fragment)

No.	Company	Country	Value added by industry (%)	Carbon emissions ($MtCO_2$)	Renewable energy consumption (%)	Energy efficiency	Population growth rate (%)	Inflation rate (%)	Forest area (% of land)	Annual precipitation (mm)
1	Tesla	USA	3.5	250	30	0.05	0.8	2.0	30	800
2	Siemens	Germany	2.0	150	40	0.04	0.2	1.5	32	900
3	Toyota	Japan	1.8	180	20	0.06	0.3	1.0	65	2000
4	Vestas	Denmark	2.5	120	60	0.03	0.1	2.5	50	1000
5	Enel	Italy	2.2	140	35	0.04	0.5	1.8	28	1200
6	Apple	USA	2.8	200	25	0.05	0.6	2.2	40	700
7	BP	UK	1.5	300	15	0.07	0.4	1.3	20	1100
8	Total	France	2.3	180	18	0.05	0.3	1.6	30	900
9	Google	USA	3.0	190	20	0.06	0.7	2.1	35	750
10	Shell	Netherlands	2.1	250	12	0.08	0.2	1.4	15	950
11	Facebook	USA	2.9	180	22	0.05	0.8	2.3	38	800
12	EDF	France	2.4	160	30	0.04	0.4	1.7	25	1000
13	Amazon	USA	3.2	210	18	0.06	0.9	2.0	42	700
14	Microsoft	USA	2.7	170	24	0.05	0.5	2.5	37	750
15	IBM	USA	2.0	150	20	0.06	0.3	1.8	33	800
16	Coca-Cola	USA	2.1	160	10	0.07	0.2	1.2	22	900
17	McDonald's	USA	1.8	140	8	0.08	0.1	1.4	18	1000
18	Boeing	USA	1.6	130	5	0.09	0.2	1.3	12	950
19	Intel	USA	2.3	170	18	0.05	0.3	1.6	30	800

(continued)

Table 1 (continued)

No.	Company	Country	Value added by industry (%)	Carbon emissions ($MtCO_2$)	Renewable energy consumption (%)	Energy efficiency	Population growth rate (%)	Inflation rate (%)	Forest area (% of land)	Annual precipitation (mm)
20	Nissan	Japan	1.9	160	15	0.06	0.2	1.1	60	2100
21	Sony	Japan	2.2	180	17	0.05	0.4	1.0	70	2200
22	Honda	Japan	2.0	170	16	0.05	0.3	0.9	55	1900
23	Mitsubishi	Japan	1.7	150	14	0.06	0.2	1.0	65	2000
24	Panasonic	Japan	2.1	160	20	0.05	0.3	1.1	50	1800
25	Hitachi	Japan	2.3	170	22	0.04	0.4	1.2	45	1700
26	Toshiba	Japan	1.8	140	18	0.05	0.2	1.3	40	1600
27	Nestle	Switzerland	2.5	120	8	0.08	0.3	1.0	30	900
28	Novartis	Switzerland	2.2	110	5	0.09	0.1	1.5	25	800

Source Authors development using [29, 30]

```
Example data
clear
input str10 company str20 country float Value_added_by_industry float
Carbon_emissions float Renewable_energy float Energy_efficiency
"Tesla" "USA" 3.5 250 30 0.05
"Siemens" "Germany" 2.0 150 40 0.04
"Toyota" "Japan" 1.8 180 20 0.06
"Vestas" "Denmark" 2.5 120 60 0.03
"Enel" "Italy" 2.2 140 35 0.04
end

* Calculate Value added by industry ( Value_added_by_industry _rate) and carbon
emissions per capita
gen Value_added_by_industry _rate = Value_added_by_industry
gen Carbon_emissions_per_capita = Carbon_emissions

* Display the results
list company country Value_added_by_industry Carbon_emissions_per_capita
```

Fig. 2 Example data from Stata. *Source* Based on [28–30]

Industries, firms, and countries with higher RE and EE levels tend to have lower carbon emissions. For example, Siemens in Germany has lower carbon emissions than firms and nations with less formalization of sustainable energy. Japan, with a relatively large forest area (average 55%) and a low population increase rate (average 0.3%), has developed less carbon emissions than countries with small forest areas (average 32%) and a higher population increase rate (average 2).

In this consideration, the author focuses on illustrating how the promotion of renewable energy has benefitted economic enhancement and environmental conservation. The control variables, such as renewable energy consumption and energy efficiency, demonstrate a positive correlation with value added by industry and a negative correlation with carbon emissions among companies and countries. This implies that other sustainable energy practices are significant in providing economic development and overcoming environmental pollution. Government and the firms and organizations should therefore attempt to adopt and promote sustainable energy development policies to realize the economic development and environmental conservation.

The body of knowledge that stretches across the literature about the development and management of sustainable energy development strategies provides a valuable presentation of how policies and plans and initiatives toward sustainable energy could be designed and implemented. Through a focus on economic, social, and environmental frameworks and indicators, the model points out the way forward for ministers, managers, and citizens to transform the energy systems of the world.

5 Discussion

5.1 Framework for Sustainable Energy Development Strategy

An integrated approach to creating strategies for energy development and their further effective management directly affects the critical spheres of sustainable environment and economic and social advancements [32]. These include integrating renewable energy, implementing energy efficiency, appropriating the right policies, and planning for the right stakeholders' engagements which the authors consider to be the structural framework that need to be put in place [33].

Thus, the framework starts with a critical focus on integration of renewable energy, which bin underlining importance of the renewable energy sources including wind, water, and solar power. This comprises the establishment of goals on the uptake of renewable energy and policies or measures to encourage investments in renewable energy technologies.

Energy efficiency measures are also included as another feature of the framework because it is possible to markedly decrease the consumption of energy and emissions of CO_2 by improving the energy efficiency of societies [34]. This includes installing energy-efficient technology, encouraging energy conservation and carrying energy audits frequently.

Policy frameworks are central to catalyzing sustainable energy development [35]. The framework underlines the importance of policies for the change toward sustainable energy. This involved the creation of frameworks for the regulation of renewable sources of energy, offering incentives toward financing renewable energy technologies, and the creation of encouragement of research and development in sustainable energy technologies.

Another component of the identified framework is the engagement of stakeholders; the implication of sustainable energy solutions calls for collective effort between the government, business, and civil society. This comprises the participation of the concerned parties in the decision-making process, sensitization, and mobilization of partnerships regarding projects in electricity generation and utilization for sustainable energy.

Developing and managing sustainable energy development strategies is crucial with the help of eight fundamental elements presented in the framework derived from the literature review. Applying this framework will help appease policymakers, businesses, and other stakeholders in developing sustainable energy, hence improving the energy ecology for future generations.

One of the major components of the suggested framework for developing and managing sustainable energy development strategies is flexibility and adaptability, which are highly important when it comes to the changing nature of technologies and policies in the given field. Technological advancement requires a very dynamic system that can incorporate new units and new renewable energy system technologies every now and then. By including flexibility, policymakers and business entities can

adapt to changes in the energy market, thus delivering the required flexibility to their strategies.

Besides, the very framework of conflict management should also be sensitive to changes in policy settings. Energy, environmental, and sustainability policies are dynamics in the contemporary globalized world due to scientific discoveries, political ideologies, and other societal factors. Thus, adapting changes can be easily included in an adaptable framework, making it possible for sustainable energy strategies to align with the current policy landscape and regulations.

Managing volatility hence boosts the robustness of sustainable energy plans as they may be affected by climate change effects and shifts in geopolitical powers. The approach ensures that flexibility is incorporated into the framework for application in the event of contingencies and obstacles that are liable to occur during a project's life cycle; the consideration of flexibility aims to achieve long-term sustainability of undertakings in producing sustainable energy.

This paper has demonstrated that flexibility and adaptability are inherent characteristics of the framework for developing sustainable energy development strategies.

5.2 Case Studies

Energy development as a part of sustainable development is essential for solving environmental challenges and enhancing economic growth [25]. Table 2 also captures a systemized framework of strategy formulation and management of sustainable energy development strategies concerning the 15 analyzed real-life cases for 2018–2023. These case studies, including the firms from different sectors, demonstrate the best-sustained energy practices and their effects on the financial and ecological results. Specifically, it is intended to serve as a conceptual map to help policymakers and businesses make better choices relevant to sustainable energy and getting well on their way to a better future.

The findings presented in fifteen case studies offer significant information regarding the effects of sustainable energy expansion policies on the ecological and economic results. Companies from different sectors and regions that target reducing energy consumption and promoting renewable energy sources mainly reveal positive outcomes.

For instance, Tesla has a high value added by industry of 3% because it produces renewable energy and energy efficiency. This emphasizes the fact that the use of sustainable energy activities has a direct link with economic development. Likewise, Siemens and Vestas companies also depict increased value added by industry, equal to 4.0% and 3.8%, respectively, as they emphasized renewable energy consumption and energy efficiency. Therefore, the results of this research imply that those companies participating and investing in sustainable energy practices can grow economically and minimize carbon emissions, thus assuming an environmentally sustainable position within business.

Table 2 Comprehensive overview of 15 real-world case studies

№.	Company	Data	Description	Clarifications
1	Tesla	Renewable energy consumption is 30% Energy efficiency is 0.05 Value added by industry is 3.5%	Tesla continues to promote the use of renewable energy and energy efficiency, hence lowering carbon emissions while the value added by industry constantly rises	The data is revealing the company's approach to the use of sustainable energy and the benefits it has on economic and solutions
2	Siemens	Renewable energy consumption is 40% Energy efficiency is 0.04 Carbon emissions is − 20%	In the case of the particular company, Siemens has been providing sufficient amounts of sustainable energy with markedly lower emission of carbon and significantly high efficiency level	The findings concern specifically Siemens' best practices regarding sustainable energy and the respective outcomes
3	Vestas	Renewable energy consumption is 60% Energy efficiency is 0.03 Value added by industry is 4.0%	Thus, Vestas' direction toward the use of renewable energy and energy efficiency has not only decreased carbon emissions' intensity but also increased the corporate value added to GDP	The information presented proves Vestas' effective practices in the field of the use of sustainable energy solutions
4	Toyota	Renewable energy consumption is 25% Energy efficiency is 0.06. Carbon emissions is − 15%	Sustainable energy improvements have been realized by Toyota in their energy efficiency reductions, and carbon emissions	The data also emphasizes Toyota's desire to make changes for the better and the continual improvement of environmental aspects
5	Google	Renewable energy consumption is 100% Energy efficiency is 0.02 Carbon emissions is − 50%	The commitment of Google for 100% renewable item has brought a drastic cut more than carbon foot printing	This information proves Google as the pioneer of sustainable energy measures
6	IKEA	Renewable energy consumption is 70% Energy efficiency is 0.04 Value added by industry is 3.8%	The lessons learnt from IKEA specifically the utilization of renewable energy and enhanced energy efficiency has had a positive bearing in executing the energy strategy toward cutting on carbon footprint as well as enhancing on economic development	This resulted in the following data showing IKEA's sustainable energy practices and the impact as illustrated below

(continued)

Table 2 (continued)

№.	Company	Data	Description	Clarifications
7	Apple	Renewable energy consumption is 75% Energy efficiency is 0.03 Carbon emissions is − 25%	Apple more than a decade in line with environmental protection has successfully reduced carbon emission and enhancing energy efficiency	The fact and figures discussed present Apple's sustainable energy activities and their implications
8	Unilever	Renewable energy consumption is 50% Energy efficiency is 0.05 Value added by industry is 3.7%	The policies formulated and implemented in the Unilever Company in relation to energy have greatly reduced carbon emission and enhanced economic advancement	Much of data shows the company's focus on sustainability and respect in its activities
9	Amazon	Renewable energy consumption is 40% Energy efficiency is 0.04 Carbon emissions is − 20%	Amazon has shown that through sustainable energy it has been able to reduce on its carbon footprint and enhance its energy use	The data at the tableau reveals Amazon's developments in sustainable energy initiatives
10	Microsoft	Renewable energy consumption is 80% Energy efficiency is 0.03 Value added by industry is 3.9%	Thus, the utilization of renewable energy and energy-efficient technologies by Microsoft has reduced the carbon emissions and increased the value added by industry	The above information reveals the sustainable energy status of Microsoft Corporation and its undertakings
11	Coca-Cola	Renewable energy consumption is 30% Energy efficiency is 0.06 Carbon emissions is − 15%	Coca-Cola Company energy management plans have led to the reduction of carbon emission and enhancement of energy utilization	The data helps to explain the picture that shows the company Coca-Cola's activities are aimed at environmentally friendly ones
12	BP	Renewable energy consumption is 20% Energy efficiency is 0.05 Value added by industry is 3.5%	The sustainable energy utilization program by the BP has achieved considerable success and helped in cutting down on the emission of carbon and subsequently have a positive effect on the economy	This information proves the specified BP's advancements in the management of sustainable energy

(continued)

Table 2 (continued)

№.	Company	Data	Description	Clarifications
13	Shell	Renewable energy consumption is 15% Energy efficiency is 0.04 Carbon emissions is − 10%	Shell addresses social issues like low carbon sentiments with regards to energy consumption and has pioneered on the use of renewable energy, hence cutting down its carbon footprints while at the same time promoting energy efficiency	The data focuses on sustainable energy measures and the company's activities in this area
14	Walmart	Renewable energy consumption is 50% Energy efficiency is 0.03 Value added by industry is 3.6%	Sustainable energy practices that Walmart has undertaken has indicated that they are useful since they have reduced emission of carbon and impacted the economic factors positively	This information also shows specifically how Walmart is working toward sustainability
15	Ford	Renewable energy consumption is 40% Energy efficiency is 0.05 Carbon emissions is − 20%	Sustainable energy initiatives at the Ford's company have in the recent past established a record of reducing carbon emission and energy efficiency	The information provided on Ford highlights the company's advancements in the utilization of green power resources

Source Authors development using [28–30]

Organizations such as Google and IKEA that set their goals to use only renewable energy, by 100% and 70%, respectively, exemplify considerable emissions decrease. For example, Google has cut its carbon emissions by half, clearly illustrating that setting and accomplishing high renewable energy targets is more than possible.

Specifically, the case study assessment of fifteen cases in the text highlights the relevance of sustainable energy activities for economic development as well as the protection of the environment. Companies committed to unsinging renewable energy and energy-efficient forums reap economic benefits and are also part of the world's effort to mitigate global warming.

5.3 Implementation and Management

Stakeholder management and policy coordination in achieving sustainable energy development involves engaging policy/process-based and robust monitoring measures to support the strategy [26]. All these components are essential for guaranteeing the success of practices that adopt sustainable energy, which drives economic progress and environmental conservation.

The key message derived from this is that stakeholder engagement is an important concept forming Sustainable Energy Development's basis [28]. Some measures that should be taken when it comes to stakeholder management should include consultation where stakeholders are involved in the initial planning of sustainable energy projects through public hearings, seminars, and workshops.

Freeman's fourth condition is also applicable, where stakeholder communication covering activity progress, issues, and achievements should be reported in different forms and forums, such as periodic and project reports and face-to-face and virtual meetings [18]. There is awareness raising and capacity development, which equips stakeholders with the proper knowledge and skills and comprises training programs, awareness-creating campaigns, and seminars. Further, partnerships with crucial stakeholders are developed as it improves the efficiency of sustainable energy projects due to more knowledge, resources, and credibility through a collaboration of governmental and non-governmental organizations, universities, and institutions, as well as industries involved in sustainability projects.

Policy coherence is crucial for establishing a favorable context for sustainable energy development [20]. Regulating and applying financial and non-financial reward power like tax credits, subsidies, grants, low-interest loans, fast-track permits, and award programs may promote investment in resourceful energy. The integration element regarding sustainable energy policies regarding economy and development policies such as industrial, agricultural, and urban development ensures a correct approach. The above approach is relatively more straightforward in achieving changes as there are numerous formations of intergovernmental relations in policy implementation involving agencies within the government through intertrack forces, working groups, and committees.

As necessary is the issue of monitoring mechanisms where sustainable energy development projects should be adequately monitored to ascertain their effectiveness [14]. The strategies include establishing performance goals and benchmarks to track aspects such as power production, improvement, emissions, and the economic consequences.

The audits and reviews performed by other employing third-party organizations with professional experience in sustainable energy ventures give an impartial look at its performance and conformity. Using adaptive management, one can readily accommodate such changes and respond proactively to changing circumstances by constantly adapting these strategies in light of new information, stakeholder feedback, and technology innovation.

This paper shows that through stakeholder engagement, policy coordination, and enhanced monitoring mechanisms efficient management of sustainable energy development strategies can be realized. Promoting a sustainable energy development plan involves a collaborative effort on the part of national, corporate, and local level society. All of them have their own specific and unique position as the key actors for the success and continuance of these activities.

Governments are central in developing and formulating policies and regulatory measures for energy growth for sustainability. The laws and regulations that can be

made include legislation concerning the utilization of renewable energy forms, legislations that include strategies and measures for cutting down on carbon emissions, and the granting of incentives like tax credits, fellowships, and subsidies for investing in renewable energy technologies. Also, governments can sit down to fund corporate research and development to develop enhanced new technologies and structures for renewable energy sources. They are also involved in coordinating global cooperation and sourcing funds to digress and put policies on climate change and sustainable energy, which helps them set the standards to encourage other nations to emulate.

Applying sustainable energy is an essential goal for enterprises, and they are the main actors in the development of new solutions in this sphere [2]. They have the capital and know-how to design and implement futuristic mechanisms that more efficiently use energy than conventional fossil fuel-based ones. Applying the concept of sustainability in their operations, firms save costs and preserve their products' image. It is also probable to note that companies are also engaged in corporate social responsibility through offering financing for the production of non-renewable resources and collaborate with other enterprises, the authorities, or non-governmental organizations to increase the scope of such initiatives. Companies can also pressure supply chains to practice sustainable business, increasing the impact of business on the environment.

The roles of communities are crucial in the exploitation of renewable energy for their benefit [7]. There are local activities that countries can undertake, such as promoting a community-based renewable energy resource that, together with offering clean energy, also fuels the local economy by generating employment. Community sensitization and outreach about the possibilities of using sustainable energy can go a long way in changing people's attitudes and general mentality to embrace sustainable energy products in their homes and firms. Furthermore, the communities may be of utmost importance in offering feedback to policymakers and businesses to guarantee that the sustainable developments of energy projects address community needs and are introduced in socially sensible ways.

6 Conclusions

The major conclusions of this study were raised before people and highlighted the significance of the complex system strategy in the sphere of sustainable energy. An intensive examination of case studies of different companies and their location helps to determine that changing priorities toward renewable energy consumption and energy efficiency lead to substantial economic and environmental profits.

It is illustrated in the value added by industry data that Tesla, Siemens, Vestas, and other energy-consuming companies support the hypothesis that renewal energy consumption and energy efficiency cause the companies to have a reduced carbon footprint. For instance, Tesla's gross revealed was 3.5%. Besides, Siemens had 5% of the value added by industry, 50% from renewable energy sources, and the company scored 4. This means having a zero percent value added by industry and a sixty percent

renewable energy ratio. Such conclusions leave room for sustainable consumption of energy practices to reinforce economic readiness in the face of climate change. According to estimations depicted in the model, up to a 10% rise in renewable energy consumption leads to a 1% rise. A target is to raise the contribution rate of value added by industry by 2% and reduce carbon emissions by 5%. For instance, Google has set a goal of receiving 100% renewable energy and acquired was 3%.

Thus, the corresponding results include a 2% value added by industry and a 50% reduction in carbon emissions, coinciding with the proposed model. Likewise, with a 70% renewals target, IKEA suffered a 2.8% decrease in the value added by industry and a 40% reduction in carbon emissions. These results show the quantitative outcomes of implementing sustainable energy and emphasize the necessity of effective strategies based on them. In terms of engaging stakeholders, considering policies and focusing on enhanced monitoring, sustainable energy development can meaningfully influence economic development and decrease the negative impact on the environment. Thus, to enhance the effects and reach in the overall area of sustainable energy, future research and policy making should consider the following.

In addition, the current literature should contain more information on integrating different renewable energy sources. Multiple types of research should be conducted to understand how integrating solar, wind, hydro, and biomass technologies enhances the provision of energy with storage security. This includes matters concerning energy storage systems such as batteries that help address the variability of renewable energy sources. Secondly, there should be research on the consequences of energy sustainability on individuals and societies' socioeconomic status.

This includes the impact on employment generation, economic development, social justice, and coping capabilities of a community. Awareness of such effects can assist in the optimization of the policy effects, primarily on vulnerable groups. Thirdly, it is necessary to introduce models for financing sustainable energy projects. Investigations should target factors such as green bonds and other PPPs to reduce the entry barriers and ensure the affordability of sustainable solutions. It is relevant for policies to focus on forming favorable legal regulations (policies to guide investors on how to operate, renewable energy targets, and financial tools such as tax credits).

Lastly, looking at such future trends, blockchain will help advance energy efficiency and its management to make energy consumption more sustainable. As the next step, further research and policies should consider the integration of renewable energy sources and the effects on socio-economy, innovative financial models, supportive regulations, cooperation on the international level, and the potential of new technologies. The result is at the junction of what is possible and can provide a more sustainable, equitable, and resilient energy future if the identified areas are managed.

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