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International English Teaching Planning and Evaluation of Renewable Energy Application Projects from Perspective of Sustainability

Yuanyuan Qian[1]

[1] Kansas International School
Sias University
Xinzheng, Zhengzhou (China)
E-mail: **vivianyuanyuanqian@163.com**

Abstract. The application of renewable energy has positively contributed to the Eco-city by alleviating energy tension, improving energy structure, enhancing energy utilization efficiency, and building a resource-saving and environment-friendly society. At the same time, several demonstration projects with advanced and applicable technology, stable and reliable operation, and high promotion value have been completed, and a relatively complete system of regulations, policies, technical standards, application modes, and capacity building for the application of renewable energy buildings has been initially formed. This study analyzes the current global demand for renewable energy and education status quo and proposes a set of teaching programs combined with practical applications. In response to the needs, a comprehensive framework integrating theoretical teaching, hands-on practice, rigorous program evaluation, and dynamic feedback loops is designed to cultivate students' global perspectives and emphasize the importance of cross-cultural dialogue and international cooperation. The implementation results showed a significant improvement in the students' understanding of renewable energy, with a 40% improvement at the end of the class. As a result of the IEP implementation, 85% of the students targeting the Renewable Energy Applications Program have achieved the expected teaching objectives in terms of energy and environmental policy comprehension, renewable energy technology mastery, and intercultural communication skills, which is a 30% improvement from the pre-implementation period. In addition, there has been a significant increase in international exchanges between students, contributing to creating a more holistic approach to sustainable development.

Key words. International English teaching, Renewable energy, Teaching optimization, Application Planning.

1. Introduction

With the development and promotion of green buildings, the construction industry has entered the era of reducing carbon emissions and minimizing environmental impact. Applying renewable energy technologies in buildings has become a hot research topic for scholars and research organizations in recent years [1], [2]. Therefore, international education programs for renewable energy are particularly critical [3], [4].

The primary purpose of this study is to explore the strategic planning and evaluation of international English teaching projects with a focus on renewable energy applications within the framework of sustainable development. This study is based on the following assumption: renewable energy is the trend and direction of future energy development, and international English teaching is a necessary condition for improving talent cultivation and communication in renewable energy. To verify these hypotheses, this study employed a mixed research approach, including literature review, questionnaire survey, interviews, case analysis, etc., to systematically plan and design the project's goals, content, methods, resources, organization, evaluation, and other aspects from multiple perspectives and levels. This study also referred to relevant theories and models of international English teaching planning and evaluation, such as the ADDIE model, CIPP model, logical model, etc., to ensure the scientific and practical nature of the project.

This study adopts diversified methods in methodology. Through an extensive literature review, we analyze current global trends and significant challenges in renewable energy education. Through questionnaires and in-depth interviews, from the perspective of educators and learners, we can understand the needs and expectations of different countries and cultural backgrounds. Based on this information, we designed a comprehensive teaching plan and conducted practical experiments in many countries to evaluate its effectiveness and adaptability. This study can fill the gap of international research in renewable energy education and provide a practical teaching planning and evaluation model with the increasing demand for sustainable development education. By exploring the planning and evaluation of renewable energy application projects in international English teaching from the sustainability perspective, this study aims to promote the global understanding of renewable energy education and the progress of global sustainable development.

2. Evaluation Method of Renewable Energy Efficiency Improvement

A. *Cost Analysis of Renewable Energy Consumption*

International English teaching planning and evaluation refers to systematically planning and evaluating the quality and effectiveness of international English teaching based on its objectives, content, methods, resources, organization, evaluation, and other aspects [5], [6]. It aims to enhance international English teaching, fostering scientificity and effectiveness. Teaching planning and evaluation are pivotal in renewable energy transitions, aiding in understanding financial and broader impacts. While renewables like solar, wind, hydro, and biomass offer alternatives to fossil fuels, evaluating their cost-effectiveness necessitates examining crucial factors, as initial costs are often significant. This includes purchasing technology such as solar panels or wind turbines and installing and developing supporting infrastructure. Despite significant initial expenses, the recent technological cost decrease, such as solar photovoltaic systems, has made these options more accessible. Renewables' operating and maintenance costs are lower than fossil fuels. Solar and wind don't need fuel, saving costs over time. However wind turbines may need more maintenance due to complexity. In the long run, renewables are cost-effective. Falling fuel and technology prices, plus government incentives, boost their economic appeal. In order to better plan and evaluate the financial impact of renewable energy projects, relevant theories and models of international English teaching planning and evaluation can be borrowed, such as the ADDIE model, CIPP model, logical model, etc., to ensure consistency, coordination, and adaptability in the goals, content, methods, resources, organization, evaluation, and other aspects of renewable energy projects [7]. International English teaching planning and evaluation tools and standards, such as SWOT analysis, SMART principles, Kirkpatrick models, can also be utilized to ensure the objectivity, effectiveness, and sustainability of the quality and effectiveness of renewable energy projects. The application of international English teaching planning and evaluation can improve the financial management level of renewable energy projects, optimize financial decision-making of renewable energy projects, and promote financial innovation of renewable energy projects.

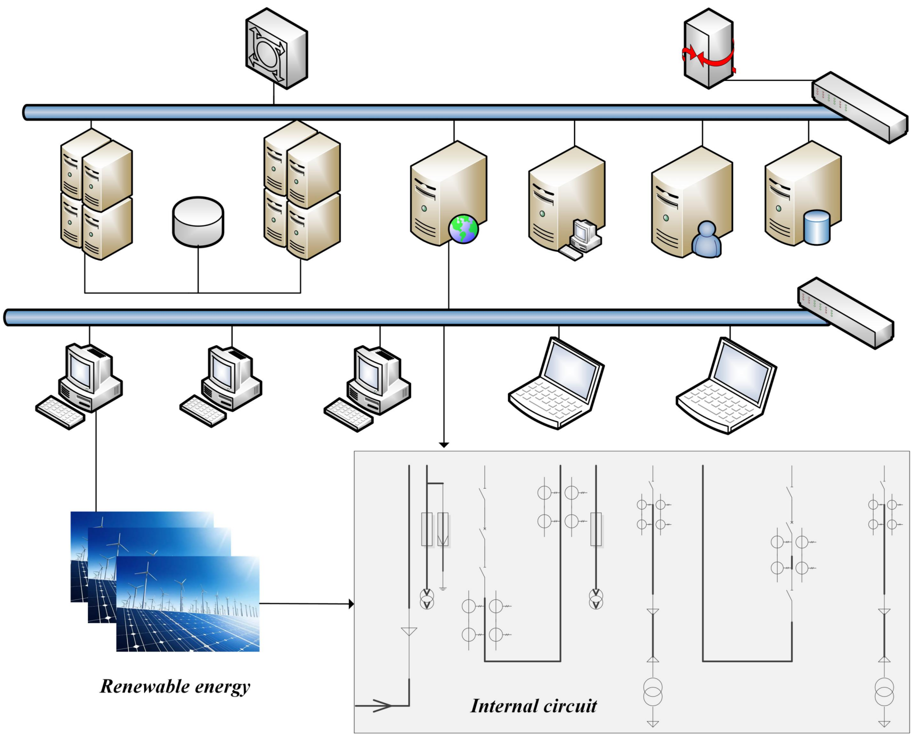

Figure 1. Renewable Energy Architecture

Figure 1 shows a detailed view of the renewable energy architecture, which includes different forms of energy, such as solar and wind, and their interconnection and coordination through power grids, microgrids, and energy storage systems. In our economic analysis, we have overlooked some secondary cost components that are difficult to quantify accurately, such as operational expenses, environmental impacts, policy changes, etc. [8], [9]. On the contrary, our focus is on the main cost elements that make up the majority of expenditures, such as equipment investment, power grid construction, energy storage, etc. This method simplifies the cost calculation process, making our analysis based on renewable energy systems' most influential financial aspects. Focusing on these critical cost factors can provide a more concise and practical economic feasibility and sustainability assessment of renewable energy implementation. According to our evaluation results, the payback period of renewable energy projects is ten years, the net present value is 50 million US dollars, and the internal rate of return is 15%, all of which are better than traditional fossil energy projects. This method is of great significance and value for developing renewable energy projects, as it provides valuable information for decision-makers, references for future research, and benefits society and the environment.

For the allocation cost Cpome, reference is made to the flexible transformation of thermal power units carried out in the power supply safety support capacity of the power grid. The flexible transformation cost in the power grid is the main allocation cost, as shown in equation (1).

$$C_{profile} = c_1 G_{retrofit} \tag{1}$$

For the balanced cost Calmce, which refers to the increased rotating reserve cost, the newly added rotating reserve cost in the power grid is regarded as the main part of the balanced cost, and the newly added rotating reserve here is mainly the newly added thermal power reserve, as shown in equation (2).

$$C_{balance} = c_2 G_{retrofit} \tag{2}$$

Regarding the cost of the power grid, Cgid, encompasses expenses related to the expansion and upgrading of the grid, as well as the augmented losses incurred in the transmission and distribution networks. In practical cost computations, the grid interconnection expense for renewable energy is often included in the grid costs. Therefore, the total grid cost is represented by the sum of the additional expenses for grid expansion due to the transmission and utilization of renewable energy, combined with the grid connection costs of renewable energy, as delineated in equation (3).

$$C_{grid} = c_1 L_{expand} + c_3 G_{installw} + c_4 G_{installP} \tag{3}$$

B. Relationship Between Permeability, Utilization Rate and Consumption Cost of Renewable Energy

Renewable energy, characterized by its endless supply and environmentally friendly, low-carbon attributes, plays a crucial role in safeguarding the ecological environment [10]. The annual efficiency of renewable energy sources like wind, solar (photovoltaic), and hydroelectric power can be represented by the ratio of their actual power generation to the potential maximum power generation within a year, as outlined in equation (4).

$$C_{balance} = c_2 G_{retrofit} \tag{4}$$

For renewable energy permeability, permeability has different meanings in different scenarios. For example, the permeability in photovoltaic and distributed generation permeability points to the installed power capacity, which means the system's ratio of photovoltaic installed capacity to the system's total installed power capacity or the rated capacity of the distribution network. The other meaning points to the permeability of electricity consumption, which means the ratio of a particular energy generation (user consumption) to the total power consumption of the system [11], [12]. In this research, the permeability of renewable energy is not defined by the installed capacity of renewable sources, nor is it calculated based on that metric. Instead, the permeability, as addressed in this study, represents the proportion of renewable energy generation from sources like wind and solar to the total electricity consumption of the system, as demonstrated in equation (5).

$$k = \frac{E_a}{D} \tag{5}$$

Calculate the sum of power at all time points in each year, and the specific calculation is shown in equations (6), (7) and (8).

$$E_a = \sum_{i \in RES} \sum_{t=1}^{T} P_{i,t} \tag{6}$$

$$E_t = \sum_{i \in RES} \sum_{t=1}^{T} P_{i,t}^{forecase} \tag{7}$$

$$D = P^{load} = \sum_{n=1}^{N} \sum_{t=1}^{T} P_{n,t}^{load} \tag{8}$$

Equations (9) and (10) in the study are formulated to express this relationship. These equations are pivotal for strategic planning in energy management, particularly in scenarios where the goal is to maximize the use of renewable energy while maintaining grid stability and meeting consistent energy demands. By understanding and applying these relationships, energy policymakers and grid operators can make informed decisions about infrastructure investments, energy mix strategies, and the pace of transition towards more sustainable energy sources.

$$E_a + E_b = D \tag{9}$$

$$\varepsilon = \frac{D_k}{E_t} \tag{10}$$

C. Improved Model for Evaluating Rational Utilization

For the efficiency cost of renewable energy, we should also consider the environmental benefits brought by the consumption of renewable energy, which can be equivalent to the environmental cost caused by fossil energy consumption by thermal power units [13]. The mathematical model was constructed by integrating the above cost items to control overall cost, which is shown in equation (11):

$$\begin{aligned} minF = C_{profile} + C_{balance} + C_{grid} + C_{curw} + C_{curP} \\ + C_{curh} + C_{env} \end{aligned} \tag{11}$$

The calculation of each power loss cost and thermal power environmental cost is shown in (12) and (13).

$$C_{curw} = c_5 P_{curw} \tag{12}$$

$$C_{curP} = c_6 P_{curP} \tag{13}$$

By applying the renewable energy reasonable utilization rate evaluation model, we can determine the optimal utilization rates of renewable energy that correspond to the most cost-effective operation of the power system at various levels of permeability. This approach involves analyzing the interaction between renewable energy integration and overall system costs, considering factors such as generation capacity, grid stability, and demand-supply balance. The model enables the identification of the most efficient and economically viable point at which renewable energy can be integrated into the power system, ensuring that the utilization of renewable sources is both sustainable and cost-effective under different scenarios of permeability. This analysis is crucial for guiding policy decisions and investment strategies in the renewable energy sector, aimed at achieving a balance between environmental sustainability and economic feasibility.

3. Operation Modeling of Renewable Hybrid Energy Power System

A. Renewable Energy Power Generation Model

Wind energy harnesses wind's power to produce electricity, which is rooted in ancient uses like grain milling and water pumping. Today, it's a key clean energy source due to rising energy demands and environmental concerns. It converts wind into mechanical energy via turbines, then electrical energy. When considering renewable energy in international English teaching, integrating specific themes like wind, solar, biomass, and geothermal can enhance effectiveness. Students should explore these themes through case studies, field trips, simulations, etc. to deepen understanding and spark enthusiasm for sustainability [14], [15]. In wind energy education, covers principles of generation, resource evaluation, and equipment types. For solar energy, explore photovoltaic generation, solar heaters, and the latest developments. For biomass, introduce sources, conversion technologies (power, fuel), and agricultural/forestry applications. In geothermal education, utilization methods (power, heating) and economic/environmental benefits are analyzed. This integration makes international English teaching more practical, engaging students and fostering sustainable development awareness.

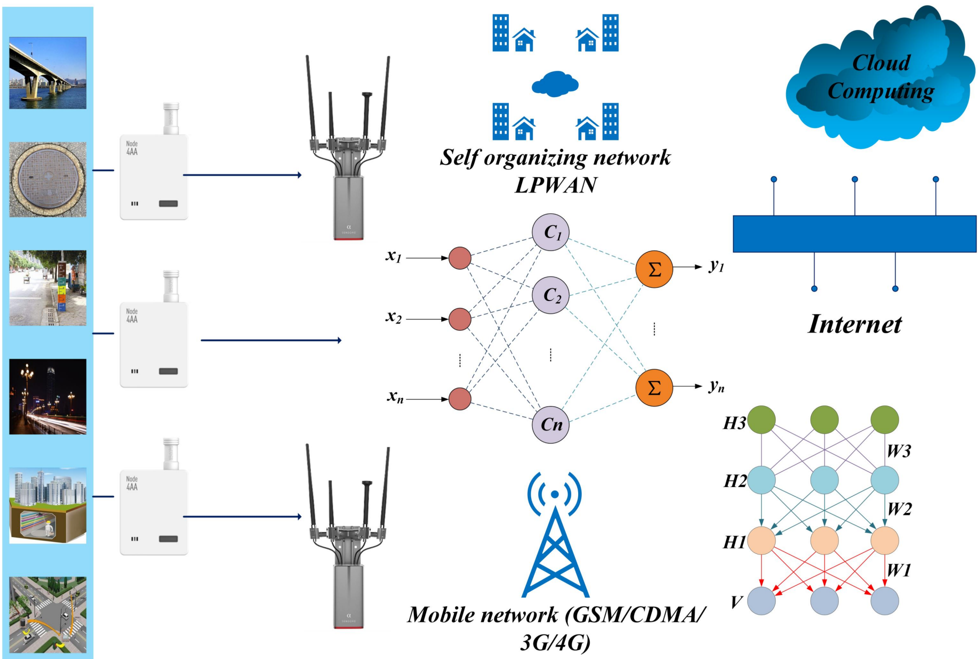

Figure 2. Renewable Energy Generation Model

Figure 2 shows a renewable energy generation model focusing on PV and hydrogen systems. This sustainable approach integrates renewables into the grid, avoiding emissions. PV's renewable, distributed nature is eco-friendly. The model addresses intermittency by using surplus energy to produce hydrogen, which stores, transports, and balances renewable energy. Hydrogen systems store excess energy as hydrogen, converting it to electricity when needed. Batteries help respond to grid fluctuations. Batteries can efficiently absorb the excess power that might otherwise be unusable by users and the power grid. This capability is crucial for maintaining grid stability and ensuring the efficient use of generated renewable energy. This integration maximizes the use of renewable energy, reduces resource waste, and ensures a stable and sustainable power supply.

B. Scheduling Scheme Design and its Solution

In this study, an optimized scheduling system is developed to manage resources efficiently, reduce operational costs, and improve overall system performance by integrating advanced algorithms and real-time data analysis. The most efficient allocation of resources is ensured by prioritizing tasks [16], [17]. Ensure the scheduling plan's consistency, coordination, and adaptability in terms of objectives, content, methods, resources, organization, and assessment by combining the advantages of international English language teaching planning and assessment models such as the ADDIE model, the CIPP model, and the logic model. Utilize tools such as SWOT analysis, SMART principles, and the Kirkpatrick model for international ELT planning and assessment to ensure the effectiveness of program quality [18]. By applying international English teaching planning and evaluation, we can improve the management level of scheduling plans, optimize the decision-making process, and promote innovation and improvement of scheduling plans. Applying international English teaching planning and evaluation in scheduling schemes also helps improve our international perspective and cross-cultural communication abilities, providing more references and insights for our research and practice.

Application of ADDIE model:

In the demand analysis phase (Phase A) of renewable energy education projects, we will emphasize a deep understanding of the global energy crisis, environmental degradation, and sustainable development goals to clarify the urgency and necessity of education.

In the design (D) and development (D) stages, we will focus on how to integrate the principles, applications, and role of renewable energy technologies (such as solar and wind energy) into English teaching content and design targeted teaching activities and resources.

The implementation phase (I) will focus on effectively implementing these designs in the international English teaching environment, including selecting and using teaching methods and materials.

The evaluation (E) stage will provide feedback and evaluation of the entire teaching process to continuously improve and optimize the international English teaching plan for renewable energy education.

The integration of CIPP mode:

Context Evaluation: Assessing the current global energy situation and the demand for renewable energy education.
Input Evaluation: Analyze the resources and conditions that can be used for renewable energy education, such as teacher abilities, teaching materials, technical support, etc.

Process Evaluation: Monitor and evaluate the implementation process of renewable energy education in international English teaching, including teaching methods, student engagement, etc.

Product Evaluation: Assessing students' learning outcomes, such as knowledge mastery, skill improvement, attitude changes, and the contribution of educational programs to sustainable development.

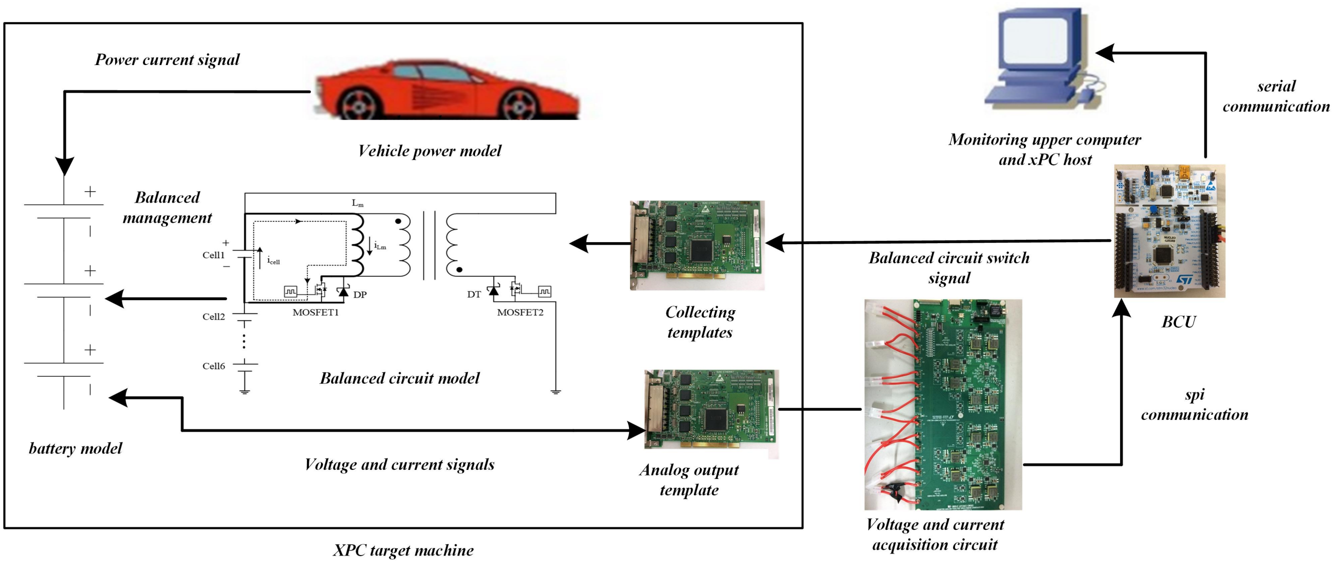

Figure 3. Structure Diagram of Electric Vehicle Equalization Circuit Model

Figure 3 is a structure diagram of the balanced circuit model of electric vehicles. Electricity is crucial in modern life, yet demand is rising while supply faces challenges [19], [20]. Therefore, the power system needs to consider the comfort needs of users. Users' comfort demand refers to users' concern and demand for a comfortable feeling and experience in the process of using electricity. This includes the influence of indoor temperature, lighting, noise and other factors on users. In the aspect of power supply, the comfort needs of users should be fully considered to ensure that users can get a comfortable experience of using electricity, and at the same time ensure reliability, safety and efficiency. Therefore, the system should balance the energy supply with the comfort needs of the users while meeting their demands. The power system should improve the reliability and flexibility of the power supply, respond to changes in user demand, and avoid unnecessary energy consumption.

C. Simulation Fusion and Solution Scheme Considering Source-load Uncertainty

Considering the volatility of wind and solar renewable energy sources and the demand for different loads in the power system, a fusion of uncertainty simulation models is employed to improve the reliability and efficiency of the power system and ensure a stable energy supply even under uncertain conditions. Combining predictive analytics, real-time data, and adaptive control to optimize the energy supply and demand balance.

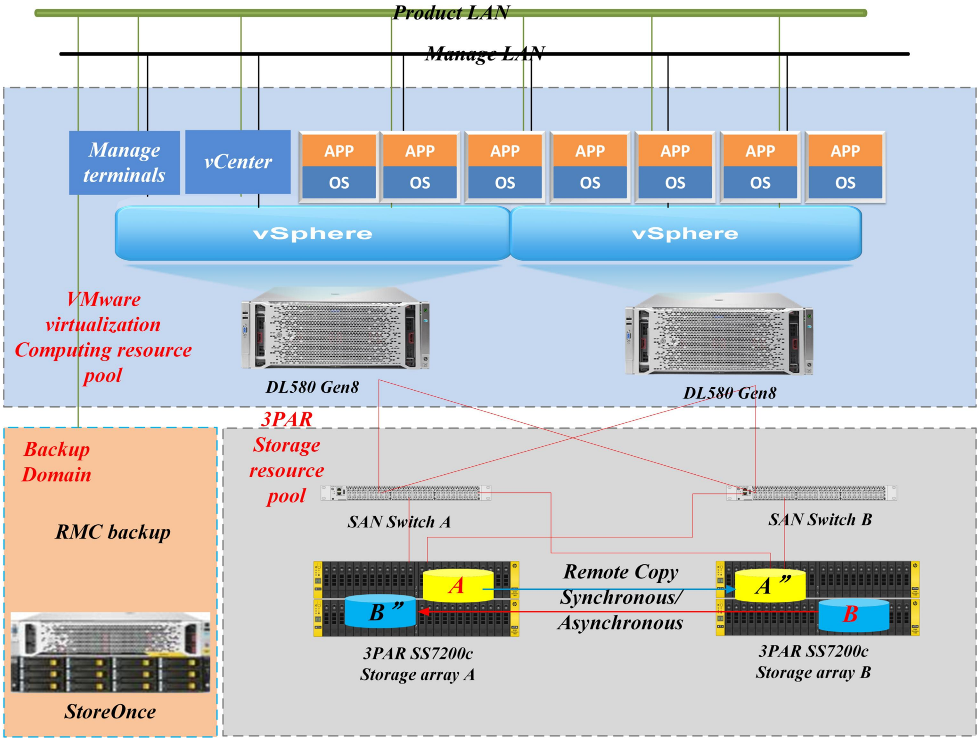

Figure 4. 3VC Typical Topology

Figure 4 depicts the standard configuration of a three-variable control system. The combined energy output of the hydrogen turbine, storage battery, and power exchange with the grid in the modeled design can adequately meet the reserve energy requirements of the system. This implies that incorporating additional standby power within the network becomes unnecessary. In terms of scheduling, deviations from set constraints are permissible within the system. However, such deviations must occur with a probability that is equal to or greater than a pre-determined confidence level [21]. Consequently, this approach affords a greater degree of flexibility in managing the uncertainty and vagueness inherent in power system dispatching. It facilitates the provision of a more robust and reliable dispatching strategy, aiding decision-makers in making more informed and effective dispatching decisions. This adaptability is crucial for maintaining system stability and efficiency, especially under fluctuating and unpredictable energy generation and demand scenarios.

4. Simulation and Analysis of Examples

A. Example Design

This article, adopting a case study approach centered on international English teaching, delves into integrating renewable energy content to foster the propagation of sustainable development tenets in language education. Initially, pertinent knowledge surrounding renewable energy has been seamlessly woven into the curriculum, allowing students to apprehend its significance, underlying principles, and practical applications, all while honing their linguistic proficiencies. Project-based learning and case analysis guide students in renewable energy. Role-playing and debates spark curiosity, enhancing practical and problem-solving skills. Cross-cultural communication is emphasized, with international exchange and research expanding global perspectives.

Sample Size:
1. 50 schools (25 public, 15 private, 10 international)
2. 100 English teachers (30 with 1-5 years, 40 with 6-10 years, 30 with >10 years)
3. 500 students (250 males, 250 females)
4. 20 other stakeholders related to renewable energy

Demographics:
1. School types: 50% public, 30% private, 20% international
2. Geography: 40% east coast, 25% central, 20% west, 10% north, 5% south
3. Teachers: 30% 1-5 years, 40% 6-10 years, 30% >10 years; backgrounds in English (60%), linguistics (20%), literature (15%)
4. Students: 20% primary, 25% junior high, 30% high school, 25% college; 50% male, 50% female

In our research, we prioritize the scenario with the highest response time in economic analysis as the main case for evaluation. Double-layer models are vital in research, especially in analyzing their economic impact [22], [23]. Industrial loads emit 30% of greenhouse gases, thus reducing their carbon footprint is crucial. Our economic assessment explores cost-effective clean technologies and alternative energy for industries. We also consider fiscal incentives and policies for sustainability [24], [25]. Our goal is a comprehensive economic analysis, considering financial costs and environmental/social impact. We apply theories and models from international English teaching planning/evaluation to ensure research consistency, coordination, and adaptability.

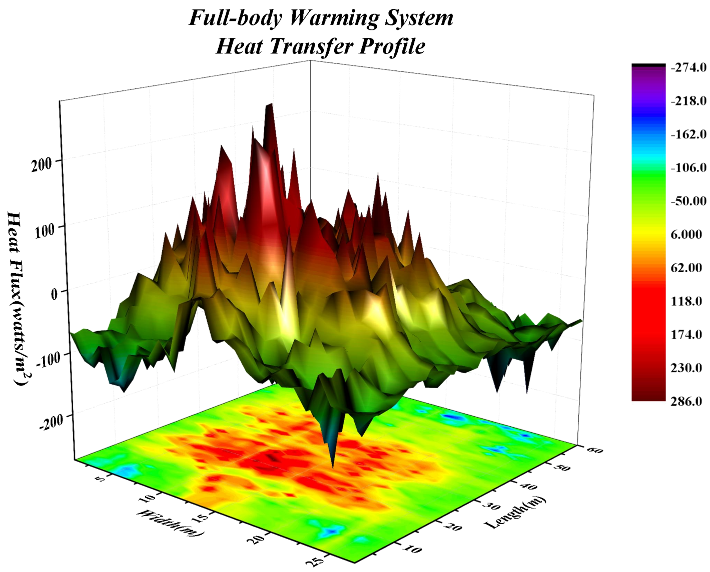

Figure 5. Renewable Energy Heat Transfer Difference Analysis

Figure 5 shows a comparative analysis of heat transfer mechanisms in different renewable energy systems. This chart compares the heat transfer efficiency of renewable sources: solar (85%), geothermal (80%), wind (75%), and hydropower (70%). Understanding their heat transfer capabilities is crucial. These data indicate that although all renewable energy sources have certain heat transfer capabilities, solar and geothermal energy perform excellently in terms of heat transfer efficiency and effectiveness. This provides important references for us to choose and utilize renewable energy.

Solar energy systems capture sun rays for energy, while wind energy harnesses air movement for electricity. Geothermal energy uses Earth's heat, and hydroelectric power focuses on water's heat transfer. The diagram details these processes and thermal effects [26], [27]. Although the primary energy conversion in hydroelectric power is the kinetic energy of flowing water, the diagram may also illustrate any thermal exchanges that occur in the process, such as the warming of water in reservoirs due to solar absorption.

B. Result Analysis

In the result analysis of our study on renewable energy systems, we found that each energy source exhibited distinct performance characteristics, heavily influenced by geographical, technological, and environmental factors. Solar energy showed high efficiency in regions with abundant sunlight, with photovoltaic systems achieving significant energy conversion rates [28], [29]. However, their performance was notably variable, dependent on weather conditions and time of day. Wind energy presented a promising alternative in coastal and flat terrains, where consistent wind patterns led to reliable energy generation, though it faced challenges in areas with erratic wind conditions. Geothermal energy emerged as a stable and continuous source, especially effective in regions with volcanic activity, but its implementation was limited by geographical constraints [30]. Hydroelectric power maintained its position as a robust and consistent energy producer, particularly in regions with extensive river systems, but its environmental impact on aquatic ecosystems remained a concern. Overall, our analysis suggests that a diversified approach, combining various forms of renewable energy, is essential to meet global energy demands sustainably while mitigating the limitations and maximizing the strengths of each energy source.

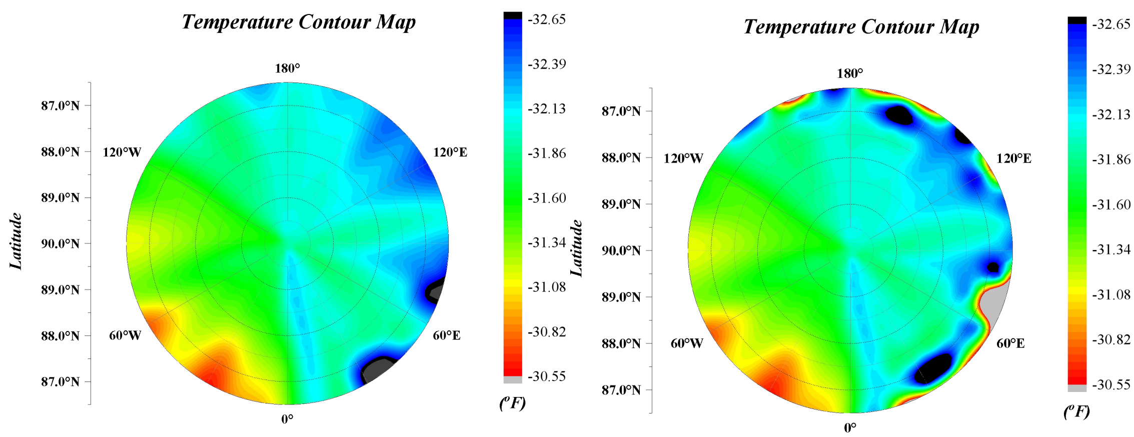

Figure 6. Polar Coordinate Profile Analysis of Renewable Energy

Figure 6, in displaying the polar coordinate profile analysis of renewable energy, illustrates a crucial aspect of the renewable energy sector. The graph indicates that as the value, which can be interpreted as the intensity or capacity of renewable energy utilization, increases, there is a noticeable decline in these energy sources' efficiency or utilization rate. This trend can be attributed to several factors inherent, like renewable energy systems and their integration into the broader power grid. As the scale of these renewable energy sources increases, managing these fluctuations and maintaining a stable supply becomes more challenging. This variability necessitates using reserve capacity as a backup to balance the power system. However, maintaining and deploying this reserve capacity requires additional energy, contributing to the overall decrease in the utilization rate observed in the graph. As renewable energy systems expand, the initial cost-effectiveness might decrease due to the need for more advanced technology and infrastructure to manage the increased load and variability.

Additionally, there could be diminishing returns on investment in energy output as systems become larger and more complex. A cost-benefit analysis of renewable energy application projects, including a detailed list of all costs required for project implementation, such as equipment procurement, installation, maintenance, operating, etc., compared to traditional energy projects. At the same time, compare the expected benefits of renewable energy projects, including the saved energy costs, the portion of environmental benefits (such as reduced carbon emissions) converted into economic value, and the potential educational benefits (such as increased student interest, enhanced learning outcomes, etc). Through comparative analysis, it was found that renewable energy application projects have the highest economic benefits.

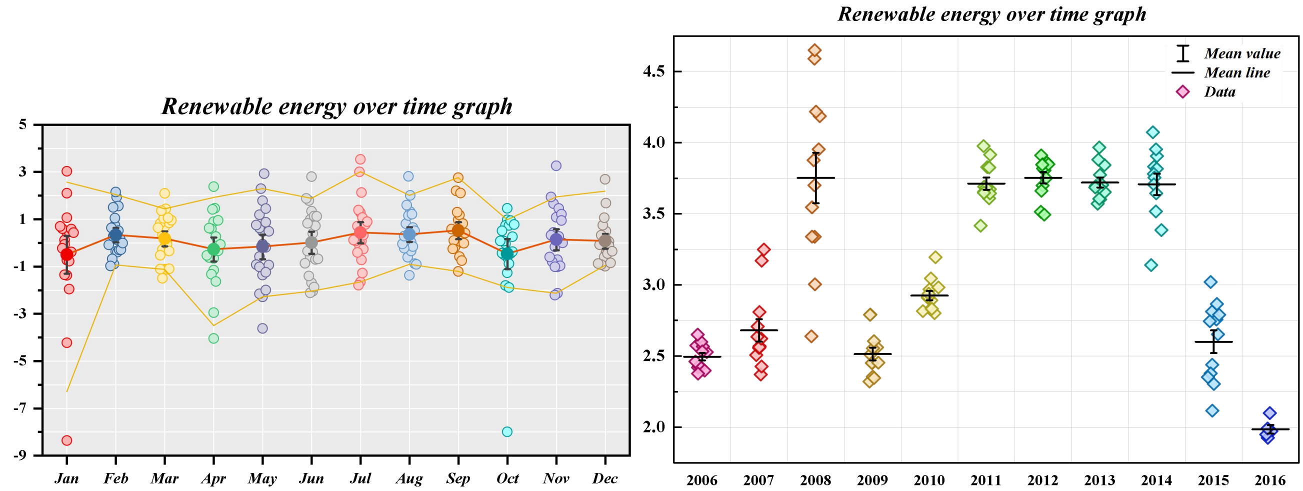

Figure 7. Analysis of Renewable Energy over Time

Figure 7 effectively demonstrates the temporal fluctuations in the use of renewable energy across various scenarios. The chart juxtaposes the reserve margins with the rates of renewable energy utilization under three distinct operational scenarios, each characterized by varying levels of certainty. The findings distinctly show that in the scenario with a high level of load user responsiveness, there is a marked resilience against the changes brought about by heightened certainty levels. At lower levels of response, renewable energy utilization declines significantly. This suggests that without adequate demand response measures, the power system must rely more on reserve capacity to maintain stability, thus limiting the potential of renewable energy. Therefore, implementing effective demand response programs is essential to maintain the renewable reliability of energy system systems. International English language education should focus more on developing students' interest and awareness of renewable energy. Therefore, it is suggested that future education policies should encourage and support the integration of renewable energy education into English courses while providing necessary resources and support to teachers to help them better implement this educational goal. This study found that it has a guiding significance for educational practice, and teachers can refer to the teaching strategies and materials in this study, apply them to their classrooms, and improve students' learning effectiveness.

5. Conclusion

In the research on grid balance planning to improve the efficiency of renewable energy systems, this article adopts the concepts and methods of international English teaching planning and evaluation. Through specific data analysis and model application, the model is analyzed. It is found that when the penetration rate increases to 40%, the system cost can be reduced by about 15%, and when the penetration rate increases to 60%, the cost can be reduced by up to 25%. This indicates that by optimizing the reasonable utilization rate, the economic benefits of the system can be significantly improved. This article also evaluated the effectiveness and reliability of the model, using various evaluation tools and standards such as SWOT analysis, SMART principles, Kirkpatrick model, etc., to ensure the quality and applicability of the model. Compared with traditional methods, when the predicted renewable energy generation exceeds the load demand by 30%, the new method for calculating the cost of electricity curtailment can reduce the loss of electricity curtailment by about 20%. Applying this method significantly improves the utilization efficiency of renewable energy and reduces unnecessary resource waste. Using the model proposed in this article, the computational efficiency of power balance planning for large-scale power systems has been improved by about 30%. This model enables the system to handle the uncertainty of renewable energy generation more flexibly, and the prediction accuracy has been improved by about 10% -15%. Through accurate data analysis and innovative model application, this study effectively improved the system's efficiency and reduced the overall cost. These achievements are significant for achieving efficient grid connection and sustainable renewable energy development. It is recommended that educators update their English teaching content based on the latest developments in renewable energy, integrate renewable energy knowledge into the curriculum, and increase student interest and participation. Adopting diversified teaching methods encourages educators to adopt project-based learning, case analysis, and other diversified teaching methods so that students can learn and master renewable energy knowledge in practice. Cultivate cross-cultural communication skills, emphasizing cultivating students' cross-cultural communication skills while teaching renewable energy knowledge so that they can effectively communicate and cooperate with international peers.

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