

# Renewable Energy and Sustainability Convergence: Construction, Commissioning and Occupancy of Senior Citizens Homes

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## Abstract

The change to renewable energy in the development of senior citizens homes is crucial as professionals in the built environment and organizations are getting more conscious of environmental conservation. The need to cut energy billing costs, raising energy efficiency, and emit little or no greenhouse gases known to be dangerous to human living makes this very imperative. Solar, wind, and geothermal energy sources are gaining ground. This study seeks to examine the benefits of incorporating renewable energy in housing facilities that accommodate senior citizens. The survey research design, employing qualitative and quantitative data from respondents, was analyzed using descriptive statistics and inferential analysis. The study revealed that structures integrated with solar photovoltaic (PV) systems, solar panels and wind power can reduce dependence on conventional power systems, having a notable positive influence on the greenhouse effect through a reduction in the emission of greenhouse gases, providing satisfactory indoor conditions to have a positive impact on elderly health. Favourable government policies and regulations in terms of subsidies, grants and regulation enforcement of regulations would help greatly. The research concluded that in addition to improving the quality of care for elderly residents, the generation of renewable energy promotes the concept of sustainability.

**Keywords:** Renewable Energy, Senior Citizens Homes, Solar Energy, Wind Energy, Sustainability.

## Introduction

Renewable energy sources, which include solar, wind and geothermal are readily available and in most cases cheaper than coal, oil or gas, are known to emit little or no greenhouse gases. Fossil fuels are by far the largest contributor to global climate change, accounting for over 75 percent of global greenhouse gas emissions and nearly 90 percent of all carbon dioxide emissions. With the threat of dwindling non-renewable resources and unpredictable climate change (Aluko *et al.*, 2020), building practices meant to preserve environmental value and scarce resources (Saidu and Yeom, 2020), are gaining momentum around the world. Meanwhile, cleaner sources of energy are gaining ground, being the pathway to a healthy, livable planet even for generations to come. Not only are renewable energy sources all around, they are cheaper, healthier, make economic sense and even create jobs. The escalation in the worldwide consciousness of sustainable development and energy because of the above, has boosted the use of renewable energy in the construction

of structures especially the senior citizens building. It refers to the fact that those buildings are purpose-built for seniors as people in that age group might need special environments that will boost their health, comfort, and safety. It is suggested that the critical opportunities to develop energy efficient and eco-friendly buildings can be provided by renewable energy resources like solar and the wind.

The utilization of renewable energy sources in construction leads to reduced operational cost, reduced emission of greenhouse gasses, and enhanced indoor air quality in buildings (Asif *et al.*, 2019). Regarding vulnerable groups, one could start with 'employers and employees who spend most of the time in open spaces,' moving further to 'children, pregnant women, senior citizens' given the risk of 'sometimes fatal,' diseases as a result of poor air quality and extreme temperatures for the latter. Applying solar panels, solar tanks, and windmills as extra sources of power can be effective, secure, and sustainable, hence sparing the use of the non-renewable energy (Green, *et al.*, 2021).

Concerning the challenges associated with the design and implementation of renewable energy systems in senior citizens' buildings, the following are worthy of consideration; These are high fixed costs, specific necessity in maintenance, and possible technological factors. Though, with the help of technological developments and favorable policies, the challenges can be well handled ultimately leading to improved long-term outcome (Bilardo *et al.*, 2020; Karimi *et al.*, 2023).

This article discussed how wind and solar power could be used more in developing houses for elderly persons, then showed benefits, where problems lie, and what one should do to succeed. It took a cursory look at everything from past works to procedures used to give an idea on how the aged-friendly structures' durability could be upgraded through renewable sources.

## **Problem Statement**

The problem statement delves into the critical issues surrounding the convergence of renewable energy and sustainability in the construction, commissioning, and occupancy of senior citizens' homes. This predicament is paramount as it directly impacts the environmental footprint, energy efficiency, and overall well-being of elderly residents in these facilities. Achieving a harmonious integration of renewable energy sources, sustainable construction practices, and efficient building commissioning processes is essential to minimize negative environmental impacts, promote resource efficiency, and enhance occupant comfort and health. Failure to address these challenges can lead to increased energy consumption, higher operational costs, and reduced quality of life for senior citizens. Hence, the problem statement emphasizes the importance of developing strategies and technologies to ensure the sustainable construction, commissioning, and occupancy of senior citizens' homes, ultimately creating environmentally friendly and comfortable living spaces for the elderly population.

### Aim and Objectives

The aim of this topic is to explore how renewable energy and sustainability can be effectively integrated into the construction, commissioning, and occupancy of senior citizens' homes to create environmentally friendly and comfortable living spaces for the elderly population.

The objectives include;

- a. identifying renewable energy sources suitable for senior homes;
- b. implementing sustainable construction practices;
- c. optimizing building commissioning processes for energy efficiency, ensuring occupant comfort and health, and minimizing negative environmental impacts throughout the lifecycle of the senior citizens' homes.

### Literature Review

Design and development pattern has seen shifts and transitions from industrialization to mechanism. This is a trend that has recently been labeled as environmentally unfriendly. Since buildings should also be seen as a part of the earth in ecological architecture, solutions to environmental load should be viewed from passive angle that focuses less on automation. Agyabeng *et al.*, (2022), posited that living spaces have become one of the basic and essential conditions that further enhances the ultimate quality of life and the welfare of most people in different places. Renewable energy in senior living homes has some awesome environmental benefits. These homes can greatly reduce their carbon footprint by using clean and sustainable energy sources like solar or wind power.

### Benefits of Renewable Energy in Senior Citizens' Homes

The major concerns of the proponents of sustainable architecture are reduction in global carbon emission and reduction in energy consumed by building occupants, coupled with the fact that climate change and diminution of natural resources are the major tasks that we have had to confront in this 21<sup>st</sup> century, according to Abubakar and Aina (2021). Renewable energy has positive impacts on the health and well-being of senior citizens in living in homes. Such benefits include the followings:

**1. Energy Efficiency and Cost Savings:** Solar photovoltaic systems plus wind turbines are uptake renewable energy technologies that have greatly diminished the conventional sources of energy. It has been established that structures and premises that adopt solar PV systems can bring up to a 50 percent cut in energy consumption, and considerable cost savings in the long run (Bilardo *et al.* 2020). In the same regard, utilization of solar thermal systems to warm water and space can also help in reducing energy expenses (Asif *et al.* 2019). Incorporating energy-efficient appliances, designed to consume less energy while still providing the necessary functionality, helps in no small measure.

**2. Environmental Impact:** A renewable energy system helps in the reduction of greenhouse gasses hence making a positive impact on climate change. Integrating solar and wind energy in building construction complies with national environmental policies and international environmental objectives. The integration of these systems will go a long way in minimizing the emission of carbon dioxide into the atmosphere hence making the buildings green (Green *et al.*, 2021). Renewable energy systems, such as solar panels or wind turbines, operate quietly compared to conventional energy sources like generators or fossil fuel power plants. This can create a more peaceful and serene environment for senior citizens, thereby promoting better sleep and overall well-being.

**3. Health and Comfort:** Reduced carbon emissions and air pollution from energy production helps to promote health and comfort. This is especially important to senior citizens and that is why it is necessary to be able to control the temperature in your house. It should be noted that renewable energy systems like solar thermal and passive solar heating and cooling systems facilitate provision of thermal comfort and indoor air quality. Higher quality of air is a necessity more to the senior citizens given that they have high vulnerability to cardiorespiratory diseases (Karimi *et al.* 2023). On the same note, the employment of renewable energy also minimizes the utilization of fossil energy sources known to cause indoor air pollution. Implementing smart energy management systems can optimize energy usage in senior citizens' homes. These systems can automatically adjust lighting, temperature and other energy consuming devices based on occupancy and time of day, ensuring energy efficiency.

**4. Psychological benefits:** Living in an environment that gives priority to sustainability and renewable energy can have positive psychological effects on senior citizens in homes providing a more tranquil and healthier living environment and this has been linked to reduced stress, better sleep, and overall improved mental health. This can also create a sense of pride and a feeling of contributing to a better future especially where the wider community is involved. This sense of purpose and connection enhances well-being and overall happiness of the senior citizens, thereby creating a healthier, more comfortable and engaging environment that boosts social connections and foster a sense of community among the senior residents, staff and the wider community.

### **Challenges in Implementing Renewable Energy**

Implementing renewable energy systems in any environment comes with some challenges and that being installed in senior citizens' homes cannot be different. The study showed the following challenges:

**1. Initial Costs and Economic Feasibility:** A challenge or a factor that has been cited often as a hindering factor to the adoption of systems with renewable energy, is the relatively high capital costs needed at the onset. Although the economic savings, social benefits and life cycle cost savings are significant, the initial investment costs on renewable energy technologies like solar panels, wind turbines, among others, are initially very high (Zhang *et al.*, 2023). Government's subsidies, rebates and grants from are significant when it comes to affordability of such systems. The initial high costs of installing solar panels or other renewable energy systems can be offset by these financial incentives, making the transition more financially feasible.

**2. Technological Barriers and Maintenance:** The proven utilization of renewable energy systems demands implementation by ways of sophisticated technology besides proper maintenance. Systems such as photovoltaic systems require cleaning and inspection to ensure that they are operating optimally. Wind turbines also need moderate maintenance from time to time to give the best performance (Kwok *et al.*, 2023). This is a requirement that should demand training and resources on the part of the facility managers.

**3. Regulatory and Policy Support:** In the case of the connection of renewable energy to senior citizens' building integration, supportive policies and regulations play a crucial role in the enhancement of the process. National and local authorities should give proper guidance, as well as a stimulus and backing to promote the application of renewable energy systems (Vassiliades *et al.*, 2022). Measures referring to the energy efficiency codes and the inclusion of renewable energy can play a major role in encouraging sustainability in the construction industry.

Government's introduction of energy rebate programs could enhance the introduction of renewable energy equipment. Sustainably-designed buildings would cost less to operate and have excellent energy performance. With 128 respondents, this research confirmed that government's introduction of direct grants by way of subsidizing costs of renewable energy equipment was ranked as first highest incentive, followed by special loans to encourage developers and contractors and government's rebates taking the third place.

**Table 1:** Government’s Incentives on Introduction of Renewable energy equipment

Incentives of Application of Passive Design	Yes	No	Undecided	Rank	Mean
Do you agree that government’s introduction of direct grants by way of subsidizing costs of Renewable energy equipment in building projects would support innovative and cutting-edge ideas that reduce energy use and greenhouse gas emissions significantly?	121 (94.5%)	2 (1.6%)	5 (3.9%)	1	2.93
Do you agree that government’s recognition and awards to building owners and developers who have demonstrated exemplary building practices will further encourage high level of introduction of Renewable energy equipment?	93 (72.7%)	14 (10.9%)	21 (16.4%)	6	2.62
Do you agree that eco-labelling by way of providing accurate information about environmental functionality of sustainable projects and features generate valued premium for Renewable energy equipment?	91 (71.1%)	16 (12.5%)	21 (16.4%)	7	2.59
Do you agree that expedited permitting and plan reviews of building project proposals can be influential in promoting introduction of Renewable energy equipment?	98 (76.6%)	5 (3.9%)	25 (19.5%)	5	2.73
Do you believe that technical assistance would encourage potential owners and developers at the delivery of Renewable energy equipment?	108 (84.4%)	5 (3.9%)	15 (11.7%)	4	2.80
Do you believe that availability of special loans will encourage developers and contractors to set Renewable energy standards?	114 (89.1%)	2 (1.6%)	12 (9.4%)	2	2.88
Do you agree that government’s rebates can promote introduction of Renewable energy equipment in building practice?	109 (85.2%)	4 (3.1%)	15 (11.7%)	3	2.82

Source: Field Survey, (2023). Analysis with SPSS 26.0

**Case Studies and Practical Applications**

Several case studies illustrate the successful implementation of renewable energy systems in senior citizens' buildings. A couple of case studies and success stories on successfully implemented renewable energy systems in senior living homes include:

**1. The Green-spring Retirement Community in Virginia, USA.**

This implemented a solar energy system on their campus. They installed solar panels on the rooftops of their buildings, generating clean energy and reducing their reliance on the grid.

This initiative not only reduced their carbon footprint but also resulted in significant energy cost savings for the community.



Plate 1: Greenspring Village, VA

**2. The St. Louis Senior Center in Missouri, USA.**

This implemented a geothermal heating and cooling system. By utilizing the stable temperature of the earth, they were able to efficiently heat and cool their facility. This renewable energy system not only provided a comfortable environment for the residents but also reduced their energy consumption and costs.

The above two case studies demonstrate the practical benefits and feasibility of incorporating renewable energy in the construction and operation of senior citizens' buildings. They also highlight the importance of tailored design and strategic planning to address the unique needs of older adults while achieving sustainability goals.



Plate 2: St Louis Activity Center, Missouri.



## Methodologies

The data collection and analysis for this research involved a combination of quantitative and qualitative research methods with the aim of investigating the use of renewable energy forms among the senior citizens' buildings. Firstly, a bibliographic search was performed to gather published research articles, papers, government and industrial reports, and articles from peer-reviewed journals, conference proceedings, and newspapers available on google scholar and Science direct. Some chosen papers were discussed to compare trends, advantages, drawbacks, and the application of renewable energy systems in buildings for these categories of inhabitants.

The case study assessment was performed through identifying samples of seniors' buildings that embrace renewable energy systems. Only cases that have proven records as to the amount of energy saved, the changes that have occurred in the environment and, in general, as to the success in retrofitting existing buildings for making them more sustainable, were selected for this research. Data on the design, initiatives and efficacy of the renewable energy systems were acquired from project documents, peer reviewed journal papers and interviews with project leaders. The assessment involved analyzing the renewable energy systems, conducting cost analysis and benefits, and investigating IAQ and occupants' comfort.

There were surveys with the consultants in the field of renewable energy, constructing sustainable buildings for seniors and other similar specialized fields. Respondents were professionals purposely selected in the built-up environment and policy-makers. Semi-structured interviews allowed studying actual difficulties and effective implementation of solutions regarding the use of renewable energy in the senior citizens' buildings. Interviews were transcribed and thematic analysis made, which made the identification of major themes and factors important for the topic at hand possible, along with practical implications. This kept a balanced and detailed perspective about the effort that renewable energies can bring to improve the sustainability and the habitability of structures designed for senior people.

## Results

The results of this study showed several key findings regarding the implementation of renewable energy systems for senior citizens' buildings.

### Energy Efficiency and Cost Savings

The evaluation proves that structures integrated with solar photovoltaic (PV) systems and wind power can lessen the dependence on conventional power systems. For example, a senior living facility in California which had installed the solar PV panel reportedly reduced energy cost by 40% as well as attained better energy performance (Davis *et al.*, 2021). One more similar case in Germany showed that application of passive solar elements in the



construction of a house for seniors decreased the demand for heating by 30 % (Smith *et al.*, 2019).

### **Environmental Impact**

Thus, renewable energy systems are not only important in the discovery of fresh ways of generating electrical power but they too have a notable positive influence on the greenhouse effect through the emission reduction on greenhouse gasses. The utilization of solar and wind energy in the construction of buildings that have senior citizens also fit into universal sustainable measures. For instance, an implementation of Solar and wind energy project claimed the building carbon emission rate to have reduced, which helps in creating a greener structure (Green *et al.*, 2021).

### **Health and Comfort**

Solar thermal collecting systems, together with thermal and passive techniques, already augments thermal comfort, and reduces indoor air pollution, important to the elderly. Increased value of better air quality is accrued through aged people since they are vulnerable to problems in breathing. According to researchers, renewable energy systems provide satisfactory indoor conditions so as to have a positive impact on elderly's health (Karimi Kyooni *et al.*, 2023).

### **Challenges and Solutions**

However, a major disadvantage consists in the relatively high costs that are required to start such a process and the technological difficulties that soon appear. Renewable energy technologies like solar panels, wind turbines among others require a very huge capital investment at the initial stage of the installation process. But these costs are often manageable through ways such as offering bonuses and expenses covered by the government. For example, the research of the projects supported by the government's subsidy indicated that there are more realistic implementations and the speed of obtaining more investment returns quicker (Zhang *et al.*, 2023).

As in other components, technological challenges could also be identified; these involved such aspects as the necessity of unique equipment maintenance. This initiative suggests that renewable energy systems need maintenance for them to be effective at their functionality. Some of the ways through which these challenges could be surmounted include training of facility managers and provision of resources on maintenance among others (Kwok *et al.*, 2023).

### **Policy and Regulatory Support**

Therefore, based on the indexes, the application of renewable energy in buildings for senior citizens can only be successful when the government supports them with favorable policies

and regulations. National governmental regulations and local state bodies should give significant attention to the implementation of renewable energy systems. Institutional changes that set rules and encouragement and supply arrangements favorable to the utilization of renewable energy are crucial in charting out the change towards a sustainable building environment (Vassiliades *et al.*, 2022).

## Conclusion

This study established that incorporating renewable energy into constructions of the buildings intended for the senior citizens is essential to work towards sustainability, and improve their living standards. Educating the wider community about renewable energy fosters a sense of collective responsibility and encourages community engagement. This can lead to collaborative efforts in implementing renewable energy projects and creating a more sustainable future. This is vital for raising awareness, promoting environmental sustainability, highlighting cost-saving opportunities and fostering community engagement. People are therefore empowered to make informed choices and contribute to a greener world and hence mitigate against climate change. Though issues like high initial costs, cost of maintenance, and technology require more attention in the form of policies and innovative design to address the existing gaps, further studies and analysis of such a field will require a lot of emphasis to fully unlock the potential of renewable energy for improved and comfortable living standards for the elderly.

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