Nile Journal of Communication & Computer Science

Volume 6, December 2023

Journal Webpage: https://njccs.journals.ekb.eg

Nile Journal of Communication & Computer Science
NJ Nile Journals
Print ISSN: 2805-2366
Online ISSN: 2805-2374

Renewable Energy Sources Applications in Currently Occupied Structures

Magda I. El Afifi[1], Walaa A. Abdelrazik[2]
[1]Assistant Professor- ECE department-Nile Higher Institute for Engineering and Technology
[2]Assistant Lecture- Architecture department-Nile Higher Institute for Engineering and Technology

Abstract

It is made easier to incorporate renewable energy technology into the design and operation of buildings by the technological possibilities, techniques, and approaches that are addressed in this article. These building technologies include solar, wind, and geothermal systems. This article's goal is to provide a comprehensive study of the multiple technologies and alternative sources of energy that have been successfully adopted in order to reduce the amount of electrical and thermal energy that is required by buildings. These technologies and sources of energy include solar energy, wind energy, geothermal energy, bioenergy, and more. In this study, the methods that are applied for the integration of these technologies inside the structures of buildings are explored. Additionally, the importance of increasing the energy efficiency of buildings is discussed in this research. In addition, this article provides tips on how to properly implement programs that make use of alternative or renewable forms of energy.

Keyword- Renewable energy, Architecture, electrical demand, Sources Applications

1. Introduction

WBCSD 2009 estimates that buildings account for 40% of the world's annual energy usage. In 2007, buildings consumed about 20% of the world's total energy consumption, or 198 quadrillion British thermal units (Btu). According to projections made by the Energy Information Administration (EIA), worldwide energy consumption would increase by 1.4% each year until 2035 [1], [2], which means that building usage will reach 296 quadrillion Btu.

Because of their high energy consumption, buildings are a major contributor to the production of greenhouse gases (GHGs) and carbon emissions, and fossil fuels supply the vast majority of the world's energy needs. It is now generally accepted that increased building energy efficiency has the potential to reduce both fossil fuel use and the emissions of greenhouse gases. Lower building operational energy costs are one of the many benefits that have piqued the interest of policymakers, the technical community, and the general public in addressing building energy challenges and exploring strategies for lowering building energy use.

While new buildings are being built with energy efficiency in mind, existing structures will make up the bulk of the building stock for the foreseeable future. Seventy-five to eighty percent of the buildings that will be standing in 2030 already exist now, as stated by Gordon Holness, president of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers. According to these findings, cutting energy use in already-built structures could reduce the building sector's impact on global energy consumption.

Reducing energy consumption by employing energy efficiency measures and offsetting the remainder of the building's energy requirements with renewable energy sources are two complementing ways for decreasing energy consumption in existing buildings (Fig. 1).

Cost-effective building energy efficiency measures should be considered before those that generate renewable energy to offset the initial investment [3]. It is recommended that all energy efficiency possibilities be explored, and as many as are practicable realize, prior to or in conjunction with renewable energy initiatives for existing buildings. It is important to note that this research solely addresses the benefits and drawbacks of implementing renewable energy projects in preexisting structures.

There are rules in place in both developed and developing countries that mandate greater use of renewable energy sources. In the European Union, for instance, the Renewable Energy Sources (RES) Directive 2009/28/EC requires that by 2020, up from 2010 levels, 20% of the energy generated must come from such systems. Building energy labels are required by the European Union's 2002/91/ED Energy Conservation in Buildings Directive, which also sets standards for energy performance and encourages the use of renewable energy sources.

Such actions not only remove legislative barriers but also provide financial incentives for the installation of renewable energy installations. The use of renewable energy systems is becoming increasingly popular as a means to meet the energy needs of buildings, demonstrate environmental leadership, improve the reliability of on-site electrical and thermal energy sources, solve problems with energy security, and reap other benefits. These programs urge decision-makers involved in the refurbishment of older structures to consider ways in which renewable energy sources might be included into the renovations. To further reduce utility costs and, in many cases, the building's carbon footprint, these measures also urge those who foot the bill for the building's energy consumption to look into installing renewable energy systems.

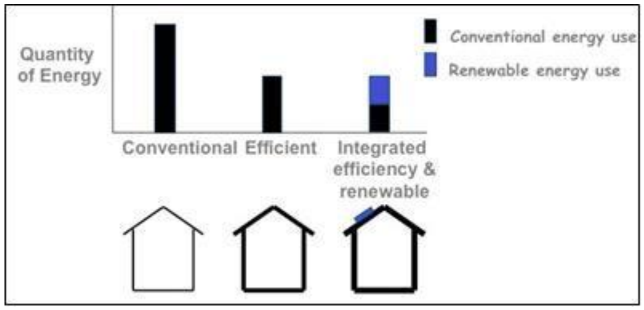

Fig. 1. Exhibit how total conventional energy use in a building may be drastically cut by adopting both energy efficiency and renewable energy measures**.**

2. Technologies and Sources of Renewable Energy

Common renewable energy sources used in construction include Biomass, wind, geothermal, and solar. There are a lot of considerations to make before settling on a specific renewable energy technology for an existing building retrofit project. These include: the cost of energy purchased from the building's energy provider; the cost of space for siting the renewable energy technology; the availability of incentives to offset the cost of installing the renewable energy system; and local regulations affecting renewable energy systems.

- Preference for avoiding the alteration of already-existing structures
- Energy consumption patterns that the renewable energy system will help reduce.

The Global Energy Network Institute is one such group that makes available information on Europe's renewable energy resources. Using a map of available renewable energy sources, a potential construction site can be evaluated for its suitability. Even if the resource in issue is subpar, the installation of renewable energy systems is often still cost-effective due to other considerations including the cost of other energy sources and the availability of local subsidies for renewable energy installations. For example, in 2008, Germany had more solar electric systems installed than the rest of Europe combined (5,351,000 MWp), despite the fact that most of the country has a very low annual average solar resource (less than 1,000 kWh/m2). In contrast, Italy has 317,500 MWp of installed solar electric capacity as of 2008 (EurOberv'ER, 2009) and modest to outstanding solar resources (between 900 and 1,800 kWh/m2). Fig. 2 compares Germany and Italy in terms of their solar potential. This case shows how non-renewable energy resource considerations can influence solar electric system installation preferences [4].

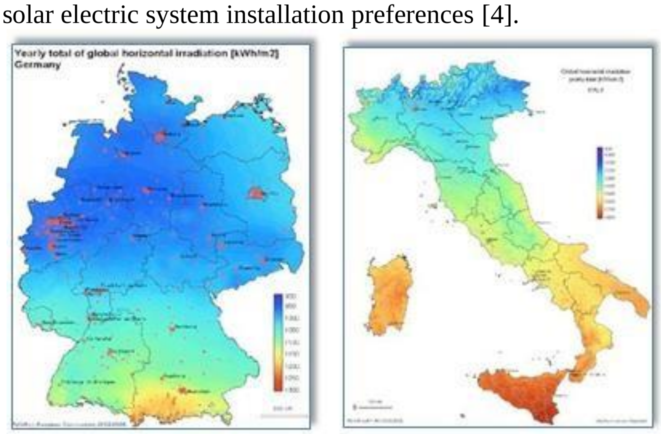

Fig. 2. Germany and Italy solar resource maps [3]

Energy systems in buildings can benefit from the incorporation of a wide range of renewable energy technology. Several prominent cases include:

- Photovoltaic (PV) systems, also known as solar electric systems.
- Solar thermal technologies include a wide range of uses, from preheating ventilation air to heating domestic water and spaces using solar hot water systems.
- Geothermal heat pumps are a technology that can be used to heat and cool buildings by harnessing the Earth's internal heat.
- Wind turbines are machines that harness the wind's kinetic energy and transform it into mechanical energy, which is subsequently utilized to power generators.
- The term "biomass systems" is used to describe the generation of power or fuel from organic material.

In the parts that follow, we'll go into greater depth about each technique.

2.1 Photovoltaic (PV) Systems

In order to harness the power of the sun, PV arrays can be set up. Arrays of modules make up a system, which can be mounted on or near a building or other structure (see Fig. 3). The system's direct current output is transformed into grid-ready, high-quality alternating current by a power inverter.

The most efficient solar cells have often been those made of silicon, and they have taken the form of flat-plate, single-crystal devices that convert sunlight directly into direct current power. Comparable but slightly less efficient technology is multi-crystal solar cells. Amorphous silicon and other non-silicon materials, such as cadmium telluride, make up thin-film solar cells. Thin-film solar cells use semiconductor layers only a few micrometers thick. Table 1 provides a summary of the module efficiencies of the various types of solar cells.

Fig. 3. Boston, Massachusetts' Williams Building.
A total of 372 modules were used, giving the system a 31-kW output.

Table 1. Typical Efficiency of Different Types of PV

Module Efficiencies	Single crystal	14–19%
	Multi-crystal	13–17%
	Thin film	6–11%

Installing building-integrated photovoltaic devices on older structures is a viable option during extensive restorations. Single-ply membranes, standing-seam metal roofs, and similar systems, as well as tiles, building facades, and skylight glass, are all under the purview of these technologies [5]. The integration of this technology onto roofing shingles is seen in Fig. 4. Buildings with integrated photovoltaics can help raise the acceptability of a project with a visible surface, but they can add expense and complexity in some cases and may not be universally available.

Fig 4. Thin-film solar PV shingles.

Most current PV installations use flat-plate layouts, which are made up of solar cells packaged into modules with 40 cells each. Ten to twenty solar panels are used to generate electricity for the average American home. When several solar panels are combined into one system, it is called a solar array. For big electric utility or industrial uses, hundreds of solar arrays are joined to form a huge utility-scale PV system [6]. Although these systems are usually stationary, they can be installed on structures that move from east to west throughout the day or tilt annually to follow the sun. The common parts of a PV system are shown in Fig. 5.

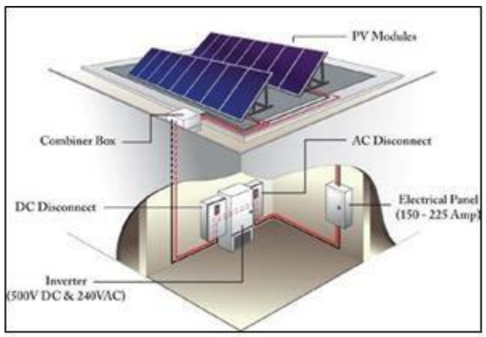

Fig. 5. PV system components.

Utility-scale, commercial, and domestic solar installations are the three most common types.

- Utility-scale installations are massive arrays that may power hundreds of homes or thousands of businesses and are typically built on undeveloped property.
- Commercial systems are more compact and can supply electricity to a campus, complex, community, or other special district that contains many commercial or municipal buildings.
- Locational advantages for commercial solar PV systems are possible. Instead of trying to find spots for solar panels on individual buildings, a commercial-scale system might be installed somewhere less conspicuous, like on top of a parking garage or in an empty lot. It is crucial to minimize distances since power can be wasted during transmission from these arrays to the end-use location. The electricity produced by residential PV systems is intended for consumption alone by the homeowner.

Siting PV technologies for maximum electricity generation is challenging. A perfect solar power plant would sit in a clear, south-facing area, tilted at the correct degree, and deliver generated power to a location with a need for it. However, solar technology cannot be implemented everywhere. When deciding if solar energy systems are right for your home or business, consider these tips.

- Find a spot without any trees or large buildings that could block the sun's rays between 9:00 and 15:00, when solar panels are most effective. The output of solar panels can be diminished by the presence of trees, surrounding buildings, and roof apparatus or features (such as chimneys).
- In the northern hemisphere, fixed-mount solar panels should face south, while in the southern hemisphere, they should face north. The effectiveness of solar panels decreases when they are angled away from due south or due north. However, the magnitude of this impact varies from place to place.
- Adjust the array's tilt to coincide with the latitude at which the PV system is installed to increase the system's annual energy output. The optimal tilt for a system at 40 degrees north latitude is 40 degrees, allowing for maximum annual efficiency. Mount solar panels to the ground (pole-mounted) or flush to the roof (tilt-mounted), or incorporate them into the structure itself (e.g., a roof, a window, an awning). Roof pitch, wind, and snow might make it difficult to achieve the appropriate inclination angle. Weight-bearing factors to think about. Panels could be set up at an angle other than 90 degrees if necessary. Tilt angle has a location-specific,

potentially insignificant effect.

- Learn everything you can about the dimensions and characteristics of your electric load so you can pick the right PV system. PV systems can be wired to the utility grid (grid-connected), made to operate autonomously (stand-alone, with batteries), or used in a hybrid (dual mode) configuration. Depending on the available space for the panels, the sun's availability, and the utility's policy regarding the sale of extra energy, the systems can be built to power any percentage of an electric load, from a very small amount to over 100% of the load. It is vital to understand the relevant norms and rules of the providing electric utility company when planning a grid-connected system.
- Take into account the wide range of PV module efficiency. A PV system's efficiency is more important than either its available or necessary area. Compared to modules built with a lower efficiency cell (such as thin film), those made with a higher efficiency cell (such as single crystalline) may produce the same amount of power with fewer of them. Therefore, a more effective, though probably more expensive, module may be the best option if the project location has limited room. A less efficient and cheaper module may be more practical for a project with adequate area.

2.2 Solar Thermal Energy

By eliminating the need for electricity or fossil fuel and the related costs and environmental implications, solar water heating can be a competitive way for producing heated water or air.

Heat your water with the sun. Collectors in solar hot water systems soak up the sun's rays and transport that heat to the water in a storage tank. According to the optimal temperature for delivering heat, solar collectors are categorized as either low-temperature (unglazed collectors), intermediate-temperature (flat-plate collectors), or high-temperature (evacuated tube collectors). Take a look at Fig. 6.

Fig. 6. From left to right, examples of unglazed, glazed, and evacuated tube solar hot water systems

The lack of moving parts in solar water systems makes them reliable and low-maintenance. Most solar water heating systems include collectors and heat transmission equipment including heat exchangers, pumps, hot water storage, and controllers to manage the system.

Solar thermal systems should be sited according to the same criteria as solar electric systems. Installing a solar thermal system will be more productive and economical if site issues are thought out beforehand.

Solar ventilation systems with preheating. Solar ventilation preheating systems warm ventilation air for spaces that need lots of it. Theoretically, the sun heats the collector surface, which in turn warms the air in a thermal boundary layer. Fans then pull the boundary layer through the collector's apertures (Fig. 7) to prevent heat loss through convection.

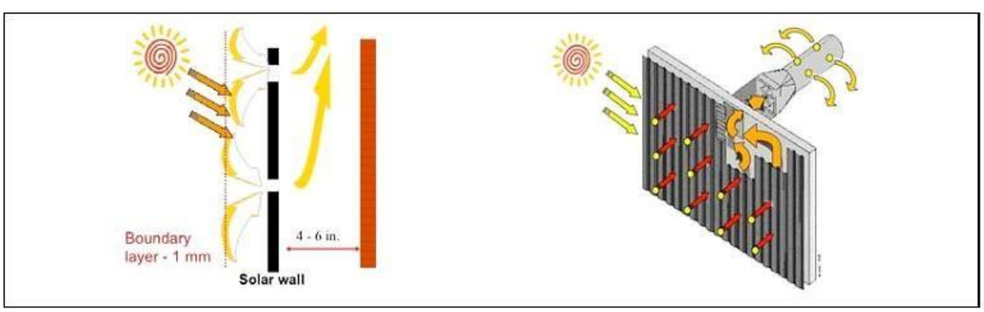

Fig. 7. Solar ventilation preheating collector operation.

Collectors for solar ventilation preheating can be installed in an existing building as part of a retrofitting project. There should be a relatively long heating season, high utility costs for heating, and enough space on a south-facing wall of the building to mount the collector for solar ventilation preheating to be a possibility (Fig. 8). Integration strategies between the solar ventilation preheating system and the high voltage alternating current system are also something to think about. These setups don't need any extra space for storage, are cheap, dependable (no moving parts apart from the fan), and low-maintenance.

Fig. 8. The National Renewable Energy Laboratory Research Support Facility has a solar ventilation preheating system installed by the United States Department of Energy.
Source: Photo by Patrick Corkery, NREL/PIX 17412

2.3 Geothermal

The heat from deep below the Earth is harnessed by geothermal systems. Magma is a high-temperature molten rock found deep below the earth, and geothermal resources also include the heat retained in shallow ground, heated water and rock located a few miles below the earth's surface, and this retained heat. The temperature of the top three meters of soil is generally between 10 and 16 degrees Celsius all over the world. Geothermal heat pumps can use this heat source to both heat and cool buildings and homes. Advanced technologies allow for the direct use of heat from deeper and warmer geothermal reservoirs, or for the generation of heat and electricity from these reservoirs, respectively [7]. Geothermal heat exchangers and direct utilization of the geothermal resource are two examples of how this technology is put to use in buildings. This study will not delve into any other forms of geothermal energy generation because geothermal heat pumps are the most often used kind of geothermal energy generation for buildings.

Geothermal heat exchangers take advantage of the stable temperature of the earth to transfer heat. Even while summer heat and winter cold can be intense in many parts of the world, the temperature of the ground about a meter below the surface is rather stable all year round.

When properly installed, geothermal heat pumps may warm or cool a building and even supply hot water to its residents. The three main components of a geothermal heat pump system are the heat pump itself, the air supply system (ductwork), and the heat exchanger, which is a network of underground pipes. In the winter, the heat pump draws warmth from the heat exchanger and distributes it throughout the building via the high voltage alternating current system. The heat pump works by transferring heat from the indoor air to the heat exchanger during the warmer summer months. In the summer, you can get free hot water by using the heat from the inside air.

There are four distinct types of geothermal heat pumps. There are three types of closed-loop systems: horizontal, vertical, and pond/lake. An open-loop system is the fourth type of system. Climate, soil characteristics, available acreage, and local installation costs all play a role in determining the best system for a given area. All of these methods can be used in either private homes or public buildings [8].

The complexity of installing a geothermal heat pump in a building retrofit increases when the circuits must be located on-site and the system must be connected to the high voltage alternating current system already in use in the building. It is crucial to analyze these and other design issues at the outset when calculating the financial viability of installing geothermal heat pump systems.

2.4 Wind

Wind energy is generated when the surface of the Earth is heated unevenly by the sun. Modern wind turbines can convert the motion of the wind into electrical energy. Wind turbines harness the energy of the wind with the help of blades that spin like a propeller.

It is important to assess the local wind resource before putting in a wind turbine. The annual potential to generate electricity from wind resources is categorized in Table 2. The availability of wind in a given location can be gauged using a wind resource map, however there may be significant variation in the wind resource at the microscale. A detailed examination of the target area is necessary before committing to wind system investments.

Table 2. Types of Wind Resource

Wind Power Class	Resource Potential	Wind Speed at 50m (m/s)
1	Poor	<5.6
2	Marginal	5.6–6.4
3	Fair	6.5–7.0
4	Good	7.0–7.5
5	Excellent	7.5–8.0
6	Outstanding	8.0–8.8
7	Superb	>8.8

If the site has a class 3 wind resource, you might want to look at installing smaller wind turbines (100 kW or fewer) or larger turbines that operate at lower wind speeds. Wind power may be an affordable option if the site has a wind resource of class 4 or higher, and even larger, utility-scale turbines may be an option.

Despite the low likelihood of economic viability, sites with lower wind resources should nevertheless be considered if they are located in a class 2 area and there are concentrations of class 3 resources in close proximity [9].

The vast majority of wind turbines have a 20-year lifespan with no upkeep. On-site wind power generation is often restricted to projects with adequate land area for placement of wind turbines (Fig. 9). Rooftop wind systems are being used on a growing number of construction projects. Architects and engineers must weigh the benefits of using building-mounted systems against the potential drawbacks, such as the increased risk of structural failure, the increased potential for unwanted noise, and the higher installation costs.

Fig. 9. The City of Medford, Massachusetts, USA owns aNorthern Power Systems Northwind 100 wind turbine sited at McGlynn Elementary and Middle School.

2.5 Bioenergy

Biomass is organic matter that can be utilized to create fuels, chemicals, and energy. Biomass includes things like plants, agricultural and forestry residue, and the organic component of municipal and industrial trash. Heating using wood has been done for thousands of years. As a result of this versatility in materials, biomass technologies have become increasingly popular [10].

Biomass technologies decompose plant and animal matter to liberate the solar energy that has been stored in them. The type of biomass and its final application determine the processing method. Biofuels and biopower, for instance, can be used to heat and power homes and businesses.

Biofuels are fuels made from biomass that can be burned in liquid or gaseous form. While the vast majority of biofuels are used in vehicles, some are also burned to generate power [11]. Ethanol and biodiesel are two examples of biofuels.

The term "biopower" refers to the generation of thermal or electrical power from biomass. Direct combustion, co-firing, and anaerobic digestion are all examples of biopower technology [12].

3. Connecting to the Electrical Grid

Distributed generation (DG) systems, often known as "grid-tied" systems, are renewable energy generators installed on or attached to a building's electrical utility grid. Integration of a DG system into a building project necessitates careful planning of the system's connection to the utility grid. Interconnection and net metering agreements, as well as the rates the utility will pay for excess renewable energy power generation that is returned to the grid, are all matters that project managers should discuss with the utility.

Electricity can flow in either direction from a DG system connected to the grid thanks to net metering. Excess power generated by a customer is fed back into the grid when use falls short. The customer's electricity usage is effectively offset at a later point during the same billing cycle, or carried over to the next billing period. Policies on net metering might vary widely. When consumers generate more energy than they need, they might get paid either the wholesale or retail rate depending on the net metering program. There are laws in place that limit the size of renewable energy systems that can take advantage of net metering.

The process by which a household connects a renewable energy system to the grid is governed by interconnection standards, which outline the technical and operational steps involved. System owners and utilities are obligated to follow these guidelines, which outline the technical and contractual arrangements necessary for operation.

Sometimes utilities are hesitant to allow distributed generation (DG) systems to interact with one another. Typical causes include worries about the security of utility workers and the need to ensure that all customers have access to consistent, high-quality power despite the intermittent nature of renewable energy power generation [13]. As more DG systems are integrated into the grid, many utilities still lack adequate knowledge of how to best manage them. As a result, these utilities tackle interconnection issues one by one, which can slow down the process of drafting interconnection agreements significantly.

If you're interested in installing renewable energy systems that link to the grid for use in construction projects, here are some things to keep in mind.

- Take advantage of any rebates or other incentives the utility may be offering for the installation of renewable energy systems by holding regular meetings with utility representatives and formulating a plan to implement any rate structure modifications.
- Get a reliable installer or contractor who has experience with interconnections.
- Avoid grid-feeding by sizing the DG system smaller than the bare minimum of electrical consumption.
- Make sure the system can prevent itself from becoming a "island," by cutting off electricity to the grid (depending on the use case) if the utility power goes out.
- Carry out technical analyses and bargain for reduced rates to upgrade utility lines
- Be sure to get your interconnection proposal in early.

4. Integration Of Renewable Energy Systems into Historic Buildings

The preservation of the original design of an existing building is often a top priority during renovation projects. Repurposing existing structures, especially when combined with renewable energy sources, is also seen as an environmentally responsible practice. About twenty percent of a building's total energy consumption can be attributed to its embodied energy (the energy used in the construction of the building's materials and components) (UNEP, 2007). Investment in building retrofit projects is bolstered by the availability of grants, tax credits, and other incentives to promote historic preservation in many areas. Installing a renewable energy system on or near a building can be beneficial to the environment and the economy, but it requires careful planning to avoid damaging the building's aesthetics or structural integrity.

Many countries have preservation groups on scales ranging from the national to the municipal level. The primary functions of these organizations include the identification of historic properties, the provision of information and assistance for preservation efforts, and the imposition of regulatory constraints with which such efforts must comply. It's important to understand which restrictions apply to projects involving historic structures before looking into renewable energy installation choices.

Determine which of the building's original energy efficiency elements, such as daylighting, natural ventilation, and thermal storage, may be restored before beginning work on a historic building. Next, think about how to establish renewable energy systems in your facility. The installation of a biofuel generator or a geothermal heat pump, for example, can be done invisibly. It is possible to include solar electric and solar thermal systems into the "skin" of a structure, such as the roofing material or shading devices, as shown in Fig. 10. These systems can also be installed in places where people won't see them, such as on the opposite side of the building's roof, hidden by parapets, in an adjacent building like a parking garage, or even on the ground elsewhere on the property.

Fig. 10. The White House in Washington, DC has a solar water heating array built into its historically accurate, teme-coated copper, standing-seam roof.
Source: Photo from Solar Design Associates, Inc., NREL/PIX 15663

5. Implementation Process

The stages involved in incorporating renewable energy projects into preexisting structures are outlined below (Fig. 11).

Fig. 11. Methodology for bringing renewable and efficient energy initiatives to fruition [5]

5.1 Step 1: catalog possible participants and projects.

Identifying relevant stakeholders and potential project sites is crucial when considering a renewable energy project for an existing building.

Valued Stakeholders Recognized. The project's outcome is heavily dependent on the timeliness with which all essential stakeholders are identified and involved. There may be parties involved, such as facilities engineers and companies that construct renewable energy systems. Easement holders and individual and commercial property owners will play a significant role because they own the land or property on which renewable energy projects may be possible. Financiers familiar with rebates, subsidies, third-party financing, and tax credits, as well as government entities with funding requirements and renewable energy goals, are also involved [14].

The project's goals, purpose, and funding mechanism all play a role in deciding who should be included as stakeholders. Possible stakeholders, which is by no means an exhaustive list, include:

- Adjacent property owners
- Technical assistance providers such as equipment vendors
- Public recipients of grants or funding
- Planners
- Contractors
- Engineers

- Property owners
- Federal agencies
- Non-profit preservation and environmental groups
- Local government.

Manufacturers, contractors, and others involved in the building process who have an interest in the marketing, sales, or implementation of energy-efficient or renewable energy products may be consulted for technical information relevant to the discussion, but they are not considered stakeholders.

Identify Projects. A good place to start when looking for new ideas is with a goal setting session. Together with the right people, defining and directing the project's development from the start at the outset will assist ensure success. Municipal targets for energy reduction or renewable energy consumption, building or neighborhood environmental regulations, and the motivations of building owners or tenants are all examples of such aims. Building stock analysis can help determine which buildings have the greatest potential for installing renewable energy sources; an analysis of the impact on the building's defining characteristics; an understanding of electricity costs or incentives available for energy projects; and an understanding of energy efficiency measures implemented in previous building retrofit projects can all contribute to the identification of projects.

High energy costs, incentives and rebates for renewable energy installations, legislation, and the necessity for energy security all factor into the decision to construct renewable energy projects on existing buildings. Installing solar panels on a carport over a parking area or a ground-mounted array elsewhere on the property are two examples of non-rooftop alternatives to locating the renewable energy system. In rare cases, a solar array cannot be installed on a roof without significantly altering the building's unique design. Alternative energy sources, such as those found in one of these remote areas, may be considered in such instances.

Renewable energy systems can be installed anywhere, not just at one central location. "District renewable energy" and/or sites further away than the site allowed are both viable options. As an alternative to having every system on a visible roof, a hidden placement may be preferred in certain districts when clustering solar installations on a big institutional rooftop, open field, or parking lot. There are distance-related technological concerns and legal and regulatory hurdles to overcome when dealing with several properties.

5.2 Step 2: Consult with Stakeholders

It is crucial to involve stakeholders after identifying projects and stakeholders to guarantee that architectural preservation needs are addressed, all available resources are put to good use, and better choices are made. The likelihood of the project succeeding will rise as a result of this.

Location and nature of the project will determine the best method for incorporating relevant parties. There will be multiple rounds of participation from a wide range of interested parties. Who is involved might be determined in part by laws or by ordinances in the area. Public notices, laws and mandates, Web announcements, conferences, seminars, awards, publications, solar commercials, funding announcements, and public hearings are all potential avenues for gaining support from the general populace [15]–[17]. If all options are investigated and many stakeholders are taken into account, the outcome of the project improves.

5.3 Step 3: Adhere to Appropriate Review Requirements

Depending on the specifics of the project and its location, the evaluation process for renewable energy installations may look different. Properties with historic designations may be protected by laws designed to preserve historic resources or local landmarks. Therefore, approval processes might differ greatly according to state and federal laws protecting historic buildings and neighborhoods. Get in touch with the appropriate local historic building authority for advice on the evaluation process for your project.

It is also important to look into environmentally safe practices that can be implemented on a smaller scale. For instance, preservation or conservation easements shield some land. The owner of the easement should be involved in the renewable energy project from the ground up.

5.4 Step 4: Putting the Plan into Action

The project is ready for implementation once stakeholders have been included, the project location, the renewable energy technology, and the scale of the renewable energy system have all been determined. Open dialogue between the installers of renewable energy systems, the stakeholders, and the local community is essential for a successful implementation, which may involve several parties. It's important to think about how the building's or area's function and the people who live there will be affected by the project's execution and construction. The implementation of renewable energy initiatives also needs to take into account the preservation of the building's architecture and the maximization of energy output.

5.5 Step 5: Review the Project's Outcomes

Success rates for future renewable energy projects can be increased by careful evaluation. It is suggested that the implementation phase of the project be reviewed to see what steps were successful and what could be improved. Planning, installation, property owner, utility, and energy bill payer collaboration should be evaluated at multiple points throughout and after the installation process. The evaluation needs to think about how it will affect things like policies and locals. The lessons learned can be documented in the form of case studies or best practices and disseminated to organizations and individuals working to replicate the work.

6. Conclusion

Across their entire lifespans, buildings are responsible for about 45 percent of worldwide CO_2 emissions according to research conducted in Europe. Due to their sizeable impact on global emissions, buildings are prime candidates for retrofits that lessen energy use and decrease pollution. There are several synergies between the use of renewable energy and energy-efficient existing buildings. By conserving and rehabilitating already-existing buildings, we can cut down on energy use, prices, and emissions of greenhouse gases. When compared to creating a brand-new building, the energy used to retrofit an existing structure is much more cost-effective. There are many already-built buildings that could benefit greatly from the installation of renewable energy and efficiency systems. Light, air, and thermal storage are just some of the energy-saving features built into many antique buildings.

Reference

[1] M. I. El-Afifi, M. M. El-Saadawi, B. E. Sedhom, and A. A. Eladl, "An IoT-fog-cloud consensus-based energy management algorithm of multi-agent smart energy hubs considering packet losses and uncertainty," *Renew. Energy*, vol. 221, no. June 2023, p. 119716, 2024, doi: 10.1016/j.renene.2023.119716.

[2] A. A. Eladl, M. I. El-Afifi, M. M. El-Saadawi, and B. E. Sedhom, "A review on energy hubs: Models, methods, classification, applications, and future trends," *Alexandria Eng. J.*, vol. 68, pp. 315–342, 2023, doi: 10.1016/j.aej.2023.01.021.

[3] A. A. Eladl, M. E. El-Afifi, and M. M. El-Saadawi, "Communication Technologies Requirement for Energy Hubs: A survey," *2019 21st Int. Middle East Power Syst. Conf. MEPCON 2019 - Proc.*, pp. 821–827, 2019, doi: 10.1109/MEPCON47431.2019.9008006.

[4] A. A. Eladl, M. I. El-Afifi, M. A. Saeed, and M. M. El-Saadawi, "Optimal operation of energy hubs integrated with renewable energy sources and storage devices considering CO2 emissions," *Int. J. Electr. Power Energy Syst.*, vol. 117, no. November 2019, p. 105719, 2020, doi: 10.1016/j.ijepes.2019.105719.

[5] M. I. El-afifi and M. M. Saadawi, "Cogeneration Systems Performance Analysis as a Sustainable Clean Energy and Water Source Based on Energy Hubs Using the Archimedes Optimization Algorithm," 2022.

[6] A. A. Eladl, M. E. El-Afifi, and M. M. El-Saadawi, "Optimal power dispatch of multiple energy sources in energy hubs," *2017 19th Int. Middle-East Power Syst. Conf. MEPCON 2017 - Proc.*, vol. 2018-Febru, no. December, pp. 1053–1058, 2018, doi: 10.1109/MEPCON.2017.8301312.

[7] A. A. Eladl, M. I. El-afifi, M. M. El-saadawi, and B. E. Sedhom, "Distributed Optimal Dispatch of Smart Multi-agent Energy Hubs Based on Consensus Algorithm Considering Lossy Communication Network and Uncertainty," 2023, doi: 10.17775/CSEEJPES.2023.00670.

[8] M. I. E.-A. Hesham. A. Sakr, PLVAR team, "Intelligent Traffic Management Systems: A review," *Nile J. Commun. Comput. Sci.*, vol. 5, no. 1, pp. 42–56, 2023, doi: 10.21608/NJCCS.2023.321169.

[9] H. A. Sakr, H. M. Ibrahim, and A. T. Khalil, *Impact of Smart Power Efficient Modes on Multimedia Streaming Data Beyond 5G Networks*, vol. 125, no. 1. Springer US, 2022.

[10] M. Abdel-Azim, M. . Awad, and H. . Sakr, "VoIP versus VoMPLS Performance Evaluation.," *Int. J. …*, vol. 11, no. 1, pp. 194–198, 2014, [Online]. Available: http://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=16940784&AN=94483469&h=80tr2GWRqNimHK9RACopOHXM2OeNATtspyexSCAwoBkGlBfcyfG+WWfcvCOEZukczwOq+C1WHD1gEp1199foxw==&crl=c.

[11] H. A. Sakr and M. A. Mohamed, "Performance Evaluation Using Smart: HARQ Versus HARQ Mechanisms Beyond 5G Networks," *Wirel. Pers. Commun.*, vol. 109, no. 3, pp. 1503–1528, 2019, doi: 10.1007/s11277-019-06624-3.

[12] A. T. Khalil, A. I. Abdel-Fatah, and H. A. Sakr, "Rapidly IPv6 multimedia management schemes based LTE-A wireless networks," *Int. J. Electr. Comput. Eng.*, vol. 9, no. 4, pp. 3077–3089, 2019, doi: 10.11591/ijece.v9i4.pp3077-3089.

[13] R. M. Ibrahim, M. M. Elkelany, A. Ake, and M. I. El-afifi, "Trends in Biometric Authentication : A review," vol. 6, no. December, pp. 1–12, 2023.

[14] H. A. Sakr, A. I. Abdel-Fatah, and A. T. Khalil, "Performance evaluation of power efficient mechanisms on

multimedia over LTE-A networks," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 9, no. 4, pp. 1096–1109, 2019, doi: 10.18517/ijaseit.9.4.7910.
[15] N. A. Mansour, A. I. Saleh, M. Badawy, and H. A. Ali, *Accurate detection of Covid-19 patients based on Feature Correlated Naïve Bayes (FCNB) classification strategy*, vol. 13, no. 1. Springer Berlin Heidelberg, 2022.
[16] A. H. Rabie, N. A. Mansour, A. I. Saleh, and A. E. Takieldeen, "Expecting individuals' body reaction to Covid-19 based on statistical Naïve Bayes technique," *Pattern Recognit.*, vol. 128, p. 108693, 2022, doi: 10.1016/j.patcog.2022.108693.
[17] A. H. Rabie, N. A. Mansour, and A. I. Saleh, "Leopard seal optimization (LSO): A natural inspired meta-heuristic algorithm," *Commun. Nonlinear Sci. Numer. Simul.*, vol. 125, no. June, p. 107338, 2023, doi: 10.1016/j.cnsns.2023.107338.