Journal of Engineering Research and Reports

20(12): 143-161, 2021; Article no.JERR.74323
ISSN: 2582-2926

Renewable Energy: Sources, Integration and Application: Review Article

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/JERR/2021/v20i1217426
Editor(s):
(1) Dr. Djordje Cica, University of Banja Luka, Bosnia and Herzegovina.
Reviewers:
(1) Tan Wei Hong, Universiti Malaysia Perlis, Malaysia.
(2) Shamrita Zaman, North South University, Bangladesh.
Complete Peer review History: https://www.sdiarticle4.com/review-history/74323

Review Article

Received 05 July 2021
Accepted 15 September 2021
Published 20 September 2021

ABSTRACT

Renewable technologies are technically viable and economically attractive; traditional energy technology receives many investment dollars. This study examines the integration of renewable energy sources using functions that associate emissions with power generation; traditional producing units can represent these emissions. The environment friendly design has become a significant concern in the first decade of the 21st century. As a result of climate change and a limited supply of traditional energy sources (fossil fuel), the world needs to take renewable energy seriously. Renewable sources of energy are derived from the energy flow that occurs naturally in a continual manner. Many people define renewability as the ability to regenerate at a rate equal to or faster than a given energy source's depletion rate. Currently, fossil fuels are used to meet most energy needs, which should be replaced in the future by cleaner energy sources, such as renewables or nuclear energy. Building integration systems aim to replace a building element with a solar panel array to boost the RES system's viability. Renewable energy sources can be used to lessen the use of fossil fuels when certain criteria are satisfied. The use of renewable energy sources in buildings has well-understood environmental and economic benefits in this study. By relying on sustainable sources of energy, we can save as much energy as feasible.

Keywords: Renewable energy; traditional; sources; building; integration; systems.

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1. INTRODUCTION

It is believed that renewable energy could solve the problem of ever-increasing energy use and attendant environmental concerns [1]. It could be a viable option for developing countries, which may face several difficulties meeting their energy demands shortly as an alternative to existing energy sources. Although energy-efficient and renewable technologies are technically viable and economically attractive, traditional energy technology receives many investment dollars. No matter how hard countries try, renewable energy hasn't significantly boosted its percentage of total energy consumption. Their potential is not being realised because of the barriers that prevent them from being realised. Financial and non-financial challenges must be identified and addressed to implement special policy measures for financing Renewable energy technologies (RETs) on an international and domestic level [2].

Solar, wind, geothermal, and hydroelectric energy generation minimises greenhouse gas emissions from the power industry and helps combat climate change. Aside from the fact that they produce fewer emissions, renewable energy is more difficult to govern and pose a challenge to grid operators because their output depends on the availability of natural resources [3].

In peri-urban and rural areas, renewable energy can play an essential role in helping to meet basic energy needs through the employment of contemporary technologies. Agro-processing enterprises and solar water heaters are examples of small-scale energy sources used for specific purposes. There may be several obstacles that must be overcome. A few examples are finance schemes, appraisals; testing; technology transfer; employment development, product manufacturing, and many more [4].

Economy and energy development are intimately intertwined. Fossil fuels provide most of the world's commercial energy, and the pollutants they produce cause local, regional, and global environmental issues. According to projections, energy demand is expected to skyrocket by 2050, most of this growth occurring in developing countries. Not only are these levels of energy production and consumption from present energy sources thought to be challenging to accomplish, but they are furthermore feared to not only be sustainable. This means that to lessen harmful effects on the environment, there must be an improvement in the ability to efficiently use electricity and increase the reliance on clean energy sources [5].

Renewable energy integration is concerned with the integration of renewable energy sources, distributed generation, energy storage, thermally activated devices, and demand response into the electric distribution and transmission systems. Renewable and distributed systems are being developed and demonstrated utilising a systems-based approach. For capacity planning, grid operations, and demand-side management, the integration delivers commercially viable models. As a result of the electric grid, carbon emissions and other air pollutants are reduced. They can also increase dependability, security, and resilience in critical infrastructure protection and minimal parts of the electricity grid [6].

Solar and wind power are increasingly being used in intelligent power grids. Most of these are in industrialised and developing countries, although a few are scattered around the globe. Several studies have shown that these technologies are capable of providing a dependable and relatively low-cost electrical system. Aside from satisfying the world's needs, renewable energy sources offer alternatives that allow for the consideration of environmental impacts and socio-economic concerns [7]. Renewable energy technologies (RETs) such as hydropower, biomass, wind, and solar photovoltaic have been successfully proved over time. Only 19% of electricity is now generated from renewable sources, with hydroelectric power accounting for 83% of the total. As a practical and long-term solution to grid electrification, biomass power generation is an inefficient use of biomass resources, producing only around 20% of what could be converted using current, more efficient technologies. The use of biomass as a modern energy source, especially for electricity generation, has seen an increase in attention on a global scale in the past decade. Wind power has become the fastest-growing source of electricity in the world [8].

For this reason, it's essential to consider the fact that wind energy is both scattered and available locally. The use of solar PV for grid electricity has been justified and warmly endorsed. Back in the day, solar panels were prohibitively expensive. This study examines the integration of renewable energy sources. Because of this, this article discusses renewable energy technology and its uses in great detail [9].

2. RELATED REVIEW

2.1 Conventional and Renewable Sources of Energy

In response to an ever-increasing need for power, the world's energy consumption is rising at an alarming rate. Fossil fuel stocks are diminishing, and energy costs have skyrocketed in recent years. There are now stronger regulations on pollutant emissions as a result of the growing concern for environmental protection [10]. As a result of their substantial ecological impact, sulfur dioxide and nitrogen oxides are the most important pollutants in the power generation business to be taken into account. By using functions that associate emissions with power generation, traditional producing units can represent these emissions. Out of all of the environmental issues being discussed, global warming is one of the most important. As a result of human activity, greenhouse gas emissions have increased since coal, oil, and gas combustion produces most carbon dioxide. Since the late 19th century, global temperatures have risen by 0.6 degrees Celsius and 0.2 to 0.3 degrees in the previous 25 years (National Oceanic and Atmospheric Administration) [11]. Despite this, the world's electric power consumption continues to grow at an alarming rate. The fact that numerous governments have set explicit targets for lowering carbon dioxide emissions to slow or stop global warming in its tracks is not a secret to anyone. This can be achieved in two ways: by implementing energy-saving measures and by using renewable energy widely. Environmentally, renewable energy sources emit less carbon dioxide, particulate matter and sulfur dioxide than traditional energy sources [12].

Renewable energy resources are mainly untapped. Additional sources of energy include wind and solar. As a result, these environmentally friendly resources might meet the growing energy demand. Renewability is a term used to characterise these power generation systems that do not deplete any resources to produce their respective energy sources. In the natural world, renewable energy sources can be continuously generated and are unrenewable. When it comes to renewable sources or processes that are constantly renewed, it's called "clean energy [11]." The sun or the wind, for example, continue to shine and blow, regardless of the time or weather. But while harnessing nature's power for heating, transportation and lighting are typically considered novel technology; it has been employed since the dawn of civilisation. The wind has propelled seafaring vessels and grain mills. After a day of sunshine, a fire was lit to keep us warm. People have turned to cheaper and dirtier energy sources such as coal and fracking gas during the past 500 years [12].

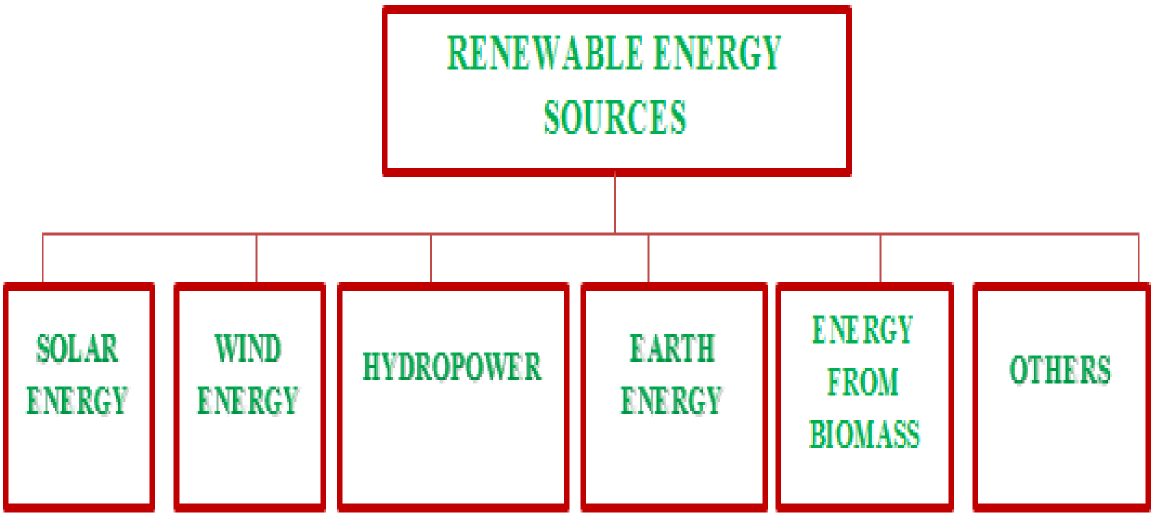

Fig. 1. Renewable energy sources

Biomass from plants has been the primary energy source for humans for much of human history. When fossil fuels became the primary energy source in the United States in the early 1900s, renewable energy sources began to be phased out. As an energy source, biomass is still used for house heating in rural areas and supplements urban areas [13]. A big part of the reason why biomass and other renewable energy sources began to grow in popularity in the mid-1980s was due to incentives to make use of them, particularly in the production of electricity. Numerous countries are attempting to improve the amount of renewable energy they utilise to minimise and avoid CO_2 emissions. Other alternative energy sources such as hydropower and biofuels will not be explored here due to space constraints. More information can be found in the corresponding literature. It focuses on time-dependent energy sources such as wind and solar power, which may substantially affect the power system's reliability in grid integration [14].

As previously mentioned, the current environmental catastrophe is driven by climate change and greenhouse/polluting gas emissions. Energies independence can be achieved by developing new renewable energy technologies that safeguard our planet and provide healthier surroundings for humans. It is now possible to dramatically boost the use of renewable energy and alternative fuels by bringing together a wide range of knowledge from a wide range of sectors. As most renewable energy is derived from the sun, this resource will not be depleted any time soon. Another benefit of using 100% renewable energy is that it will reduce the country's dependence on imported fossil fuels, which will improve energy security. Many alternative energy sources are explored in this section. Solar panels, wave power, tidal power, and geothermal energy are some of the sustainable energy sources that are looked into [15].

2.2 Fuel Energy

Currently, most of the world's energy consumption is derived from conventional energy sources, such as coal, oil, and gas. Since they consume finite resources that are dwindling, becoming inefficient, or causing environmental harm to recover, these fossil fuels are nonrenewable. A significant downside of old Fuel-Fired Generators (FFGs) is the release of polluting gases (pollution). Because environmental rules are growing increasingly rigorous around the world and because coal has been a reliable and abundant fuel supply for a long time, coal-fired power generation is coming under increasing criticism as a result [10]. For fossil fuels to remain a primary energy source in the power industry, they need a cost-effective air pollution control plan. Combining fossil fuels and alternative cleaner sources may be a viable strategy to reduce pollution emissions while meeting specific cost and reliability requirements. Renewable energy-based distributed generation (DG) is connected to the utility grid at the distribution level in the restructured power market to mitigate some disadvantages of traditional central generating units. Renewable energy sources can play a significant role in mitigating the negative environmental impacts of fossil fuel-fired electricity [16].

2.3 Wind Turbine

Energy from wind is abundant, renewable, widely spread, and environmentally friendly. Onshore and offshore wind turbines may convert wind energy into electricity. For example, it can be employed by big wind farms for nationwide electricity networks and small wind turbines for rural houses or grid-isolated locales [9]. "Power for WTGs is provided by windmills, which are normally run as part of a utility or independent power producer (IPPs). Onshore or offshore, they are located in windy regions. Since pollutant emissions are a key negative of traditional fossil-fuel-based generating, wind energy's efficient use is particularly desirable in this regard [17].

On the other hand, weather conditions significantly impact wind power availability, which can fluctuate dramatically over a year or even a day. When developing a renewable-based power plant, wind power's instability should be taken into account in full. The study uses various power sources to reduce or level out the variations produced by wind power's inconsistency. Around the world, wind power has become increasingly popular. So, the average growth in wind energy in the United States over the past five years is 24 per cent. Germany, Spain, Denmark, and the Netherlands are the top wind power producers in Europe, accounting for 84 per cent of the total European wind capacity. Wind power is expected to meet nearly half of the region's residential needs by 2020 [6].

2.4 Photovoltaic Cells Energy

PV panels may directly convert sunlight into electricity. To generate electricity from sunshine, photovoltaic panels use semiconductors with a photovoltaic effect. Meteorological circumstances have a significant impact on solar electricity production, just as they do on wind power. As a result of its inconsistency, additional power sources, such as storage batteries, are frequently required to smooth out the fluctuation [18]. Photovoltaic (PV) panels do not emit any direct emissions, making them eco-friendly. In recent years, the cost of installing a PV system has dropped considerably, and PVs require less maintenance due to breakthroughs in manufacturing technology. Europe and the United States have installed PV power plants with capacities ranging from 300 kW to 500 kW connected to the electrical networks of their respective countries. Significant research is undertaken to generate less priced but more efficient PV cells, which are now under development [19].

2.5 Battery Energy

A hybrid power system with energy storage is particularly desirable because WTGs and PVs are intermittent power sources. Energiespeichern (energy storage) smooths out the variability in wind and solar electricity. Stored energy batteries can be thought of in some ways like buffers, which help balance the supply and demand of energy sources. Whenever the energy delivered by WTG and PV systems exceeds demand, it will be stored in the batteries within their overall storage capacity. Storage of energy reduces operating costs by reducing power waste [20].

2.6 Other Sources of Energy

2.6.1 Solar energy

People have used solar energy for centuries to raise crops, remain warm, and dry food. A study by the National Renewable Energy Laboratory found that the sun's energy falls on the world in one hour more than the entire planet consumes each year. There are various uses for solar energy these days, such as heating residences and businesses and heating water and powering electrical gadgets [21].

Solar cells, often known as photovoltaics, turn sunlight into energy using silicon or other materials (PV). Distributed solar systems produce electricity locally for homes and businesses due to rooftop panels or solar community projects that power entire neighbourhoods. Thousands of homes can be powered by solar farms, which employ mirrors to focus sunlight onto solar cells. It's possible to employ wastewater treatment facilities and non-sensitive bodies of water for photovoltaics or floating solar farms. Less than 1% of the electricity produced in the United States comes from solar power. Only natural gas generated more new generation capacity in 2017 than solar. There are no air pollutants or greenhouse gases released during the production process of solar energy systems [22].

2.6.2 Hydro-energy

For electricity generation, hydropower dominates, although wind energy is anticipated to overtake it shortly. By spinning a generator's turbine blades, hydropower turns the force of water into energy. Large hydropower plants, often known as mega-dams, are typically viewed as nonrenewable sources of energy, both nationally and internationally. Because mega-dams distort and limit natural flows, animals and people who rely on rivers cannot get the water. Because they divert only a percentage of the flow, small hydroelectric plants (with an installed capacity below roughly 40 megawatts) tend not to inflict as much damage to the environment as large hydroelectric plants [12].

For its immense potential as an option for sustainable power generation, fuel cells have recently been dubbed "the microprocessor of the energy industry." In its simplest form, a fuel cell is an electrochemical device that converts hydrogen and oxygen into the water while simultaneously creating electricity. Fuel cells have the advantage of not emitting hazardous fumes or consuming oil. Fuel cells are precious as a power source in remote or isolated locales such as spacecraft and rural areas. Electric and hybrid automobiles and off-grid energy-generating are only a few of the other uses for them [23].

2.6.3 Biomass energy

Crops, scrap wood, and trees are all examples of biomass. Plant materials generated for biofuel and biodegradable trash that can be burned for fuel are all examples of biomass. Sediment treatment plant gas is mainly comprised of solid waste and biofuels. A sustainable energy source, biomass has a role to play in global warming. Emissions pollution will also occur if it is burned directly without suitable emissions filtering mechanisms in place. In the current technological environment, producing liquid fuels from biomass is not cost-effective due to the costs associated with biomass production and its subsequent conversion to alcohol. Electricity generated by biomass is predicted to treble by 2030, meeting 2 per cent of the world's energy consumption [8].

Biomass must be burned and the chemical energy released as heat. It is a myth that biomass is an environmentally benign and clean alternative to coal and other fossil fuels. Biomass emits more carbon dioxide than fossil fuels, according to scientists. The environment also feels negative repercussions. A low-carbon solution is possible with various forms of biomass energy under the right conditions. It's possible to use low-carbon energy sources such as sawdust and chips from sawmills [24].

2.6.4 Geothermal energy

As the name implies, geothermal energy is derived from the earth's heat, and it can be used to provide clean energy sources. Power generated from geothermal sources is more competitive in countries with limited fossil fuel resources. A global increase of roughly 8,000 megawatts (MW) in geothermal energy for electricity generation has been observed since 2007. Geothermal energy has become more economically attractive as a result of recent high and dramatically fluctuating electricity rates. On account of radioactive decay in rocks in the planet's core, the earth's core is about as hot as the sun's surface. Wells are drilled into the earth to bring heated subsurface water up to the surface and power turbines. Plants that recycle the steam and water they utilise have fewer emissions than those that do not. However, there are techniques to establish geothermal plants in regions without subterranean reservoirs, although there are fears that they may raise the risk of an earthquake in areas already deemed geologically active [25].

2.6.5 Tides energy

Even though tidal and wave energy is still in its infancy, the moon's gravitational pull will always dominate the ocean, making harnessing its power an attractive option. Animals may suffer from the effects of tidal barriers, such as hydroelectric dam installations in ocean bays or lagoons. Dams or ocean floor-anchored devices provide tide and wave energy at the sea's surface [26]. By harnessing the energy contained in waves or tides, tidal power has a relatively high-efficiency rate. While it has a high initial investment cost, it has relatively low operating and maintenance costs compared to other renewable sources of electricity. To counteract this, installing a barrage might dramatically alter the water quality and interfere with fish activity in the basin. When it comes to intermittent renewable energy sources, tidal power is considered the most reliable and consistent and is expected to grow significantly in the future years [27].

However, tidal energy could become one of the world's most vital energy sources. One can use tide energy in two different ways. In general, the corporation claims, tidal generators are environmentally neutral and have no impact on existing ecosystems. Wind power is similar in that regard. Energy from the Earth-Moon system's motions is the only direct source of energy. In addition to the earth's rotation, the Moon-Sun tidal forces cause the tides to rise and fall [28].

2.6.6 Irradiant energy

Radiant energy allows one to save up to 99 per cent on the cost of regular electricity by using it instead. Electricity behaves similarly, but it's not the same. When Nikola Tesla invented the first wireless telephones in the early 1900s, he used radiant energy to transmit signals wirelessly [29].

2.6.7 Natural gas compressed energy

Compressed natural gas (CNG) can be utilised to fuel gasoline, diesel, and propane. In the event of a spill, it fades quickly into the environment, making it safer to use. During their burning, a little amount of greenhouse gases is released. Compressed natural gas is used as a fuel source instead of gasoline (CNG) to convert gasoline-powered cars to bi-fuel vehicles [13].

2.6.8 Nuclear energy

Atomic energy proponents say the technology cuts carbon emissions and improves energy security by reducing reliance on foreign oil. A nuclear reaction called nuclear fission is utilised to generate electricity using nuclear reactions that are carefully regulated. Electricity or propulsion can be generated by using utility-scale reactors to produce steam [3].

2.6.9 Grid-connected solar energy system

A more significant percentage of renewable energy would require conventional backup power and energy storage on the electricity system. These would be essential to compensate for naturally occurring fluctuations in energy production due to the time of year or weather conditions like sunlight or wind. It's expensive to incorporate renewable energy sources since the electrical infrastructure can't handle this fluctuation. Find more about the notion of smart grid renewable energy, its pros and limitations. It was also discovering the function of renewable energy and distributed generation in a smart grid [30].

An intelligent electricity grid is a network of power plants and customers who work together to efficiently distribute electricity with a high-capacity output and a wide area of coverage that is affordable and accessible. When it comes to the development of smart grids, one of two main concepts for better electric power exchanges between utilities and customers tends to drive it. A renewable energy installation requires a deliberate effort from inception to completion [31].

2.6.10 The role of renewable energy and distributed generation in smart grid

Around the world, there is a need for a change in the way electricity is produced. Therefore, renewable energies and distributed generation receive increased support, and their share of electricity generation is increasing. For both inventors and practitioners of intelligent grid systems, an inflexible system with a growing amount of renewable energy is a significant challenge [32]. For two reasons, distributed generation does not get market signals or participate in system management. As a general rule, distributed power is sourced from renewable energy sources. Since feed-in tariffs are predetermined and market prices are not, it is favoured. System management systems in balancing markets are in short supply in many distribution networks, and they are poorly equipped. Another issue is that the increasing amount of renewable energy could cause congestion in distribution networks. A lack of dispatch capabilities and intermittent renewable energy supply are other major challenges [33].

A smart grid is a system that uses digital technologies to transmit power from suppliers to consumers to reduce energy costs, improve reliability, and automate control and monitoring. It's possible to combine renewable energy sources such as wind and solar by collaborating on innovative grid technology [34].

Unlike fossil fuels, renewable energy sources do not diminish over time and are widely dispersed geographically. It won't pollute the environment in any way. The use of renewable resources has the main advantage of being available all year round. If we invest once, we can draw energy for decades without harming the ecosystem [35].

2.6.11 Solar energy

As a clean, safe, and reliable energy source in the future, solar energy has great promise. Over a year, humans consume 200 times as much commercial energy as solar energy that falls on earth's continents. To stimulate the usage of solar electricity, the government gave subsidies. Overage electricity can be sold to local utilities by homeowners using solar panels. The cost of solar panels might be reduced by 50% during the next ten years, making solar-powered electricity competitive with traditional fuel sources [36]. It is possible to classify solar energy into two categories. The two types are passive and active. Stagnant solar energy is the use of thermal energy from the sun, both directly and indirectly. Buildings and structures are the only places where energy can be used indirectly. The sun's beams are maximised when a building faces south. During the summer, unique metal leaf coverings on windows and roofs can screen the light. Warm water can be heated using special thermal solar collectors. As a result, these chips are inefficient and can only be utilised for small power devices (i.e. calculators, watches, radio etc.) [30].

2.6.12 Wind turbine

In the end, the wind is nothing more than a technique to harvest energy. The sun also heats the atmosphere, causing it to be blown by the wind. Even on cloudy days or during the rainy season, it'll work. For a wind turbine to work well, its placement is crucial. On a tower, the windmills are usually set at a 30m or higher height. Wind turbine blades are spaced 5-15 times their diameter to prevent turbulence from impacting the wind flow at nearby turbines. Windmills work in both horizontal and vertical directions [9].

Each system has a similar foundation. The wind turbine produces electricity by converting wind energy into mechanical power and transferring it to an electrical generator. At wind speeds below 13 km/h, wind turbines will not function properly. In areas where the wind blows at an average of 22 km/h, they perform best. Nowadays, most wind farms include three-bladed horizontal axis machines of 15-30m diameter and 50-350kw of electricity. Unlike fossil fuels, wind energy does not pollute the air or water, and it does not use any harmful or hazardous compounds [16].

2.6.13 Biomass energy

Agriculture's primary energy source is biomass. It is possible to energise entire rural communities in India by capturing bio-energy, which is abundant in the country. Also, biodegradable trash, a by-product of accessible biomass, can generate this energy source. Plant and animal wastes are used to produce biomass energy. Energy is stored in chemical bonds inside organic matter, which is known as biomass. These chemicals release energy when the links between carbon, hydrogen, and oxygen molecules are broken by digestion, combustion, or decomposition. One can generate biomass power by converting organic matter. Heated starch is transformed into sugar during alcohol fermentation. Once the sugar has been fermented, it is distilled to produce ethanol, mixed with another fuel [13]. Biomass, notably municipal solid waste and market waste, is converted through aerobic digestion. While the organic material is being broken down, methane and carbon dioxide are produced by facultative bacteria. In addition to being ecologically friendly and cost-effective, bioconversion does not emit pollutants. As a fertiliser, the affluent and digester leftovers are high in nitrogen and phosphorus. In an air-tight tank, the biomass is mixed with water and stored. They are collected separately, dried naturally and shredded to a maximum particle size of 2 to 4 millimetres before being recycled into municipal solid waste (MSW). Anaerobic digestion was carried out using this material which was stored at room temperature in a plastic container. Domestic waste was gathered and hauled away before being disposed of on a college campus. The present investigation was utilised to dilute the feedstock in all anaerobic digestion experiments. Les expériences ont été réalisées dans un semi-continuous batch reactor with a 5 liter capacity, which was fed daily. Digestion took place at room temperature for 25 days at a constant hydraulic retention time [17].

2.7 Tidal Power

Oceans cover two-thirds of the earth's surface. This water is a massive renewable energy reserve. Seawater kinetic energy is transformed into electrical power by the movement of water along the shoreline's coastline. Depending on the region, the energy density can be as high as 65 MW/mile of shoreline, allowing cost-effective wave-generated electricity. When water columns oscillate, the force of waves entering a stationary device is used to generate electricity. Air is compressed by waves that enter a vertical pipe. This compressed air can be utilised to generate electricity by using a turbine generator that uses compressed air. When it comes to wave power plants, cyclones and severe storms pose the most threat. During this time, the plant will not be operating as usual [37].

2.8 Geothermal Power

As the name suggests, geothermal energy is generated by the earth's heat. It's clean and environmentally friendly, which I appreciate. A few miles below the earth's surface are hot springs and hot rock, and much further down is the molten rock known as magma,' which has extraordinarily high temperatures [38].

Geothermal heat pumps can be used to heat and cool buildings. It is possible to integrate the geothermal heat pump with the air supply system (ductwork) and the ground heat exchanger (a network of pipes near the structure). The heat exchanger heats the interior air supply system in winter. This process can be reversed by using a heat pump while it's hot outside. Heating water can be obtained for free by extracting heat from the indoor air during the summer months [39].

2.9 Uses of Renewable Energy Resources in Buildings

Early on, the relevance of energy usage began to be considered in the project's design phase. The environment friendly design has become a significant concern in the first decade of the 21st century. The optimum time to start a new revolution is right after the industrial revolution. On the other hand, this transformation is about reclaiming natural resources that have been exploited over the past century. As a result of climate change and a limited supply of traditional energy sources (fossil fuel), the world needs to take renewable energy seriously [40].

There are several reasons for using energy in a building's lifetime. During the consumption phase, heating, ventilation, and air conditioning (HVAC) systems utilise 94.4 per cent of the total energy used. Rather than relying on mechanical systems for comfort, passive approaches and renewable energy sources should be used to minimise this rate. Buildings can thus be designed to have better physical conditions for human health [16].

Renewable sources of energy are derived from the energy flow that occurs naturally in a continual manner. Many people define renewability as the ability to regenerate at a rate equal to or faster than a given energy source's depletion rate. They include biofuels, geothermal and hydrogen energy, as well as water and wind power. A probable depletion of the most commonly utilised energy sources, such as coal and oil, has led to new energy sources. It's important to choose renewable energy sources that do not harm the environment, for example [41].

2.10 Use of Solar Energy Systems in Construction

Energy from the sun is virtually limitless. Buildings designed to harness solar power follow the following principles. Conduction, convection, and radiation are employed to transfer solar thermal energy. As a result of the building design, these natural processes can be controlled [36].

There are three ways to deal with solar radiation coming into contact with the surface of the building: reflection, transmission, or absorption. There is also a predictable air circulation within planned zones due to solar heat. Materials and construction architectural features that will deliver heating and cooling effects within a building based on this basic principle of solar heat must be selected. There are many factors to consider: thickness, density, heat conduction coefficient, specific heat, surface absorption, and reflection coefficient, as well as smoothness, cavity, and fullness. Through architectural design, solar energy can be harnessed both actively and passively [40].

Mixing active and passive systems is the most effective way to reduce carbon dioxide emissions. The passive solar design uses a building's form and shell to collect, store, and distribute energy from renewable sources. Passive systems provide space heating and cooling without mechanical or electronic devices - it is most typical to use passive heating systems intolerant solar architectures. It's possible to boost the winter solar heat gains with passive solar techniques. For solar energy to be used for heating, the building's roof, walls, and floor must be well-insulated to make use of solar radiation as much as feasible [23].

The opening size affects the amount of energy collected (windows, skylight, greenhouse, etc.). The thermal insulation and sealing of the building envelope are critical to energy conservation. A building's thermal performance and its location determine how much energy can be stored in a structure. Thus, Socrates's residence from 470 to 399 BC represents the most straightforward instance of passive heating. A lengthy side faces the sun, but the northern side is smaller because his house faces the sun and is compact and trapezoidal. When the sun is at the lowest position in its orbit, the eaves on the south roof provide shade in summer and let sunlight in winter. Winter winds are kept at bay by the roof sloping down at the back [35].

Lighting consumes 17% of the world's total energy consumption, according to the International Energy Agency. 70% of the lighting demands may be met by the sun with the appropriate design. The simplest way to provide natural lighting is to use big apertures in the building envelope. In the traditional home models shown below, window configurations allow for abundant natural light. Natural lighting can be given in areas lacking direct sunlight-friendly facades [40]

When it comes to collecting solar energy from the sun, storing it, and distributing it, dynamic solar systems differ from passive solar systems, which rely on the fabric of the structure. Passive systems, components are used for heat collection, storage, and forced distribution. Active solar energy systems are comprised of mechanical and electrical components that transform the solar radiation captured by specially designed collectors into the appropriate form of energy and allow it to be used in the structure's construction. Radiation from the sun can be converted into heat and electrical energy with the help of these technologies. There are two types of solar thermal systems: those that produce heat and provide electrical energy. Below is a short description of these systems [35].

2.11 The use of Photovoltaics into Building

Photovoltaic (PV) systems are made up of various components that use solar radiation to generate electricity. For electricity production, PV systems can be found in a wide range of applications such as road lights or lighthouses and vehicles, buildings, and power plants, in various configurations. When needed, a photovoltaic system can store generated energy and reliably transport it to the fields of use. As solar energy hits the building's facades and roofs, photovoltaic batteries transform it into electrical energy. Through an inverter, solar cells for home use are connected to the power grid, reducing the need for battery storage [31].

2.12 Incorporation of wind power into Buildings

For a long time, the wind has been used as a source of electricity, and it has grown increasingly essential in recent years as a source of environmentally friendly energy. Wind energy can be harnessed in both passive and active systems. By utilising energy-free passive systems, it is feasible to maintain certain levels of comfort in a building that are necessary for human health and job efficiency. For thermal comfort and interior air quality, the effect of natural ventilation is particularly significant. Passive cooling is based on the principle of preventing the building from gaining heat [32].

The design phase of the house should contain a plan for this function as part of the overall plan. Heat gain in buildings can be prevented by using thermal mass and thick structural elements like mudbricks, stone, and shade. For different climates, numerous passive cooling technologies have been created, such as the following. Assembling a building's shading and solar heat reflection systems insulating the building's structural elements using ground, wind, water and evaporative coolers; exotic passive cooling technologies; and seasonal cold storage [25].

Because of this, passive cooling differs depending on the environment. Location and surroundings dictate the methods used. There will be some approaches that are more useful than others, depending on the situation. Diverse techniques for passive cooling can be utilised independently or in combination based on location, climate, available materials and expertise, and economic factors. Using wind catchers to cool a building using natural airflow is the simplest method. Fresh air is drawn into the structure through the thermal chimneys. This approach accelerates the entry of air from the external environment into the structure. Wind chimneys, also known as "badger," are highly common in traditional Middle Eastern architecture. Air mass's kinetic energy is converted into mechanical energy in the form of wind energy. Wind energy is renewable, non-polluting, non-radioactive, and has no detrimental influence on the environment or human health. It is also a fast-growing source of energy for technological advancement [42].

On the earth's surface, wind can be used to generate power. In 2040, wind is expected to provide 40% of the world's energy. Wind turbines are wind energy technologies that actively utilise wind energy. Small and medium-sized wind turbines power the buildings. These wind turbines can be erected in the garden or on the roof, depending on the location. There are examples of wind turbines fitted into multi-story high-rise buildings [43].

3. ENERGY EFFICIENCY IN BUILDINGS BY USING GEOTHERMAL ENERGY

Geothermal energy is obtained by releasing subsurface heat into the earth through fractures. Underground hot water or steam can be recovered from the ground. In the heating and cooling of buildings, greenhouses, and agriculture, geothermal energy is used. Heat pumps, in-well heat exchangers, and heat pipes are three various ways geothermal energy systems can be used. Heat pipes are a typical kind of utilisation in structures. A heat pump can also be used to harvest heat from the earth at "normal" temperatures [44].

Geothermal energy can also be harnessed by utilising soil temperature—temperatures at some level range from 45 to 75 degrees Fahrenheit (7.22 to 23.88 degrees Celsius). Water or air can utilise this soil temperature. Aerated air obtained from the open chimneys is transported to the system at different depths in the soil, where it equalises soil temperature by bringing internal volume to the same level. It can be used in the winter for heating and in the summer for cooling [45].

3.1 Hydrogen Energy in Building

Water heating, cooking, and power can all be done with hydrogen energy. It is necessary to make and store hydrogen before it can be used. As a result of renewable energy sources like the sun and geothermal energy, hydrogen can be created from these sources. The solar-hydrogen hybrid system is currently the most efficient renewable energy source. Some components are required for such a system [46]. These include solar photovoltaic (PV) panels, electrolysers; fuel cells; hydrogen tanks (H_2); battery groups; and converter units. In the solar-hydrogen house energy system, the system operates as follows:

During the winter, a catalytic hydrogen burner (1.5 kW) is used to heat the ventilation system by burning hydrogen flameless. And the fuel cell gets activated if there's a need for more electricity.

3.2 Biomass Energy in Buildings

All living beings use solar energy. Any material that contains energy is combustible, and the energy is released when the material is heated up. To convert solar energy into chemical energy for storage, plants use photosynthesis (biomass) [47]. The evaluated bioenergy technologies are wood, oilseed plants, carbohydrate plants, fibre plants, vegetable residues, animal waste and urban and industrial waste. There are several advantages to using biomass as a sustainable, strategic source of energy. It can be grown anywhere and contributes to socio-economic growth. Biomass fuel can be produced by burning it directly, or it can be improved through various processes, resulting in alternative biofuels that have qualities that are comparable to those of conventional fuels [20].

There are physical procedures (size reduction—crushing and grinding) and conversion processes that produce fuel from biomass (biochemical and thermochemical processes). Biogas is produced via airless digestion of biomass from homes. The pyrolysis procedure yields ethanol, while the direct burning method yields hydrogen [48].

3.3 Application of Renewable Energy Sources (RES)

Living a modern lifestyle requires a lot of energy to maximise efficiency and comfort. Currently, fossil fuels are used to meet most energy needs, which should be replaced in the future by cleaner energy sources, such as renewables or nuclear energy. Globally, everyone must adhere to the ideology of sustainable development to meet the needs of the present without jeopardising the ability of future generations to meet their own. Determining how to use, conserve, and sustainably restore resources is also a part of sustainable development, as is realising that our choices today will majorly impact future generations [21].

3.4 Integration of Renewable Energy (Solar System)

Both are visually appealing. Building integration systems aim to replace a building element with a solar panel array to boost the RES system's viability. An early application of solar panels on buildings was to provide shading. Installation over equator facing windows of buildings replaces typical overhangs. It provides shade on transparent elements and power from PVs, positioned at the best direction and angle for maximum shading while maximising radiation collection. The cost-effectiveness of PV panels can be improved by having them perform additional functions, such as active solar heating and daylighting [28].

In this technique, PV panels are used to replace shingles on the roof or wall cladding. When compared with traditional "add-on" strategies, it offers significant advantages. By eliminating an extra component (such as shingles), the panel also eliminates pre-existing envelope penetrations required for attachment. These BIPV systems must be integrated into the architecture and have an attractive appearance. This method can improve overall performance, but it can also improve the durability of the system. This type of system distributes electricity to the building or the grid, depending on where it is located [49].

It has been estimated that PV panels convert between 6 and 18 percent of the incident sun's energy into electricity, with the remainder of the sun's power being captured as useable heat energy. In most cases, this energy is lost as heat to the outdoors. Water or air is cycled behind the panel to remove heat that can be put to use. That's because a higher-than-normal panel temperature will reduce the panel's efficiency, which is a good thing. Open-loop or closed-loop configurations are both possible with this method. It is possible to use the recovered heat for room heating, preheating ventilation air or heating domestic hot water—either directly or through a heat pump—in an open-loop arrangement. This system offers both electrical energy, either to the building or grid, and thermal energy, which meets a portion of the building's thermal load [50].

Many issues need to be addressed for the PV system to be economically viable. Rain penetration and protection issues, the increase in the building component's temperature, and resulting thermal load are some of the issues that arise during summertime when it comes to the weather [51].

Sunlight is allowed to penetrate through semitransparent PV windows as part of this technology. When the incident sunlight is converted to electricity, only a small part can be used for illumination. Thin-film photovoltaic cells that allow some sunlight to pass through are commercially available and can be utilised for this. Window temperature rise and heat gain during building cooling are two of the most challenging aspects of the design process for windows. As a result, they can be employed as shading devices. Power and daylight are supplied to the building or the grid, which provides a portion of the facility's lighting requirements [52].

3.5 Renewable Energy Supply Technologies

There is a steady increase in the supply of renewable energy. These past several years have seen significant investment, and technological advancements have allowed countries to produce renewable energy more cost-efficiently. Forecasts predict an increase in nations producing more than 100 megawatts (MW) of renewable energy [36]. Some harmful and permanent externalities of conventional energy production necessitate promoting and developing renewable energy solutions. As a matter of production cost, these technologies may not be equivalent to traditional fuels, but they may be in terms of externalities, such as environmental and social impacts. Economies of scale could also play a crucial role in reducing the unit production cost; it should be highlighted. Neither conventional nor renewable energy differs significantly in terms of transmission and distribution costs nor technology [47].

3.6 Hydro-Energy

Hydropower plants are the most common type of small hydropower plants; the cost-benefit analysis does not apply to hydropower plant growth. There are both negative environmental externalities and positive dynamic spillover effects in hydropower facilities [53].

Climate change impacts on hydropower potential in Europe were analysed by using an analysis model. It was necessary to look at both gross hydropower potential and developed hydropower potential to gain a clear picture of current and future power generation levels. Consequently, the hydropower potential in Europe could be lowered by 25% or more in countries to the south and southeast. Between 2070 and 2080, Europe's gross hydropower potential is expected to diminish by about 6 per cent. For water management in Europe to be successful in the future, widespread acceptance has been acknowledged [54].

For example, they showed that 97% profit margins could be achieved by using electricity pricing for the day ahead of time. It is not necessary to make a long-term prognosis to maximise profits from power price arbitrage. Models include daily average estimation, final hourly projections and dynamic adjustments based on recent historical data. It was stated that the model offers real-world answers to the technical and economic issues faced by SHPPs. For SHPP operation and maintenance, the authors found that power generation forecasting is necessary. They also concluded that power plant maintenance schedules and bid proposals on the market are dependent on power generation projections [23].

3.7 Wind Turbine

Three primary power sources for each renewable energy type are solar radiation, gravitational forces, and radioactive decay. Sonnenenergie (thermal) and photovoltaic (PV) energy are created when solar energy is captured. Energy from the sun is also used to produce energy from other sources like wind and hydroelectricity indirectly. These skills could develop over time, according to Tester. Wind power costs 6.5 cents per kilowatt-hour if externality expenses are included, according to Tester's calculations. This is comparable to natural gas CCGTs and coal power plants. Also, wind power plants can be erected quickly, have lower investment costs than nuclear and hydroelectric plants, have economies of scale, do not require fuel and have lower operation and maintenance expenses than nuclear or hydroelectric plants [47].

Energy production from a 1,500-kW(e) wind turbine was calculated using an input-output technique. He discovered that this method could replace some fossil fuels based on comparing five ratios for delivered electricity. Remote wind conversion systems in the US provide less net energy than fossil fuel-based electricity sources. His simulation model considered wind speeds, residential electricity consumption, and parameters from the generator, inverter, and storage components to estimate the energy production from the wind power plant. Other systems were found to be inferior in terms of net energy. Haack stated that conversion efficiency could be improved by adding steps to getting fuels using new technology [29].

The energy consumption and emissions are calculated using Denmark's Life Cycle Analysis (LCA) model for offshore wind farms. Materials and energy requirements for production, manufacturing and waste management were all factored into her calculations. For example, he compared the amount of primary energy used in production with waste materials. So, at 40 per cent, the payback period is 0.39 years or less than 2 per cent of the 20-year lifespan [55].

Wind turbines can reduce energy consumption and CO_2 emissions throughout their lifetime. Due to the energy expenditure necessary for the materials, one-kilowatt wind turbines consume substantially more energy throughout their lifetime than larger turbines do. Uncertainty can be reduced by using established approaches and input-output methods. While wind turbines may not be practicable in all locations, those with better wind resources may find them preferable to natural gas or coal generators [44].

3.8 Photovoltaic (Solar) Power

Several studies have been conducted in the last two decades to determine the economic viability of solar power for residential, commercial and industrial applications. Industrialised nations such as Japan and Germany seek alternatives to primary energy sources, such as solar power. In the early 1990s, Japan became the first to use large-scale solar photovoltaic (PV) electricity generation. Germany quickly followed. Each country is a leader in solar power technologies today. Solar power generation costs in China have decreased due to inexpensive labour and government subsidies in recent years [56].

Solar energy, like wind energy, is dependent on the weather. Wind and solar electricity have distinct advantages and disadvantages. Several technologies harness sun radiation, such as thermal energy, CSP, solar chimneys or towers, and photovoltaic systems. For example, solar panels can be installed on external walls, windows, and roofs. Photovoltaic technology makes it possible to integrate solar panels into buildings. However, using materials in PV systems can cause some environmental and health risks regarding solar panel difficulties, such as dust concerns [52].

The global market is increasingly interested in expanding the usage of renewable energy, particularly solar power. Satellites, remote industries, rural communities, solar home systems, and remote homes might be considered niche markets for solar PV electricity, using diesel power plants as an example. The study found that PV systems are most economical, up to 15 kWh per day regarding pricing. Solar power's break-even point grows as the cost of solar panels rises, and diesel costs fall [25].

In a recent research study, the US, Germany, China & Japan PV market sales and manufacturing development based on Granger causality. In the United States, Germany, and Japan, the results suggest that market sales growth affects the innovation scale. PV market sales and manufacturing development have a bidirectional relationship, as well. This industry is heavily influenced by local demand, government backing, and other supporting industries. Researchers at the University of British Columbia used solar PV to compute the Levelised cost of energy (LCOE) for a case study in Canada. According to the study, solar PV systems have already reached grid parity in some areas, and the feasibility of solar PV systems will continuously increase as the technology expands geographically [24].

On the earth, geothermal heat is generated and stored; it has been used for bathing, heating, and even cooking throughout history. In the earth's core, temperatures can exceed 4,000 degrees Fahrenheit, generating geothermal energy. Even though geothermal energy is widely available, a characteristic known as the geothermal gradient determines whether a region is suitable for enactment. One can use this tool to determine the pace at which temperature rises as it go deeper into the earth's crust. French geothermal gradients, for example, ranging from 10 C/100m in Alsace to 2 C/100m in the Pyrenees. The gradient in Iceland and the volcanic regions can exceed 30 C/100m [3].

Global geothermal energy investment expenses are expected to reach 15-20 billion dollars over the next decade. However, in the IEA analysis, these expenses were estimated at 104 billion dollars worldwide between 2010 and 2020 to achieve the desired targets. For example, geothermal energy could be employed in base and peak load power plants, according to Fridleifsson and Freeston. Several experts argued that new technologies could mitigate the environmental difficulties caused by the emission of steam and fumes into the river, along with hot water. As a result of the lack of funds and infrastructure knowledge, geothermal energy cannot be used in underdeveloped countries using readily available technology [57].

The German geothermal industry is strongly reliant on political assistance and favourable electricity market circumstances. However, they also recommended that geothermal technology may be employed as a stable baseload power source, despite its downsides of high investment costs and the danger of insufficient heat. Geothermal fields require a re-injection plan to reduce the risk of groundwater pollution. Geothermal re-injection processes have different effects on geothermal reservoirs, depending on the system [58].

4. MAIN USE OF RENEWABLE ENERGY TECHNOLOGIES

4.1 Security of Energy

In 1973, the Arab oil embargo raised concerns about energy security. An increase in competition from growing economies, political unrest in key oil-producing countries, and the impact of any disruption to energy supplies on developed and rapidly expanding countries were all considerations. The danger of supply disruption and the expected expenditures associated with security improvements were used to determine the level of insecurity [59]. Energy security threats, in his opinion, can be divided into strategic and domestic system risks, he says. As a result of energy insecurity, also identified damage costs and control costs. However, he said that it was difficult to quantify how much money is spent on control costs. It's pretty challenging to quantify the amount of money spent when it comes to estimating how much the United States has spent on oil security [11].

As a result of climate change concerns, energy security aims were also affected. Energy security could be improved by diversifying the energy supply. Renewable energy sources were widely employed before the industrial revolution when coal became the primary energy source (mid-19th century) [9]. Energy sources like hydropower, solar power, and biomass can be used worldwide to provide clean energy and improve long-term sustainability. Security difficulties may arise from renewable energy sources due to their intermittent nature, such as solar and wind energy or insufficient rainfall in hydropower [60]. As a result, such considerations should be considered in industries that primarily rely on these sources. It's a win-win for energy producers and consumers alike that renewable energy technologies exist. It has been shown that renewable energy technologies minimise foreign energy sources and boost export energy sources. Iranian natural gas, for example, was the world's fourth-largest output in 2011, although the country was a net importer due to high local consumption in 2011. A firm reliance on imports could also pose a serious concern if the energy supply is disrupted in any way. When Russia cut off Ukraine's gas supplies in 2006, European countries could not acquire natural gas from Russia [61].

4.2 Impacts on the Economy

Significant economic benefits include job creation, industrial innovation, and the balance of payments. When it comes to solar and wind energy, countries with plentiful solar and wind resources can employ these energy resources for domestic use with support from renewable energy technology. If renewable energy technologies are developed, these countries may even utilise renewable energy sources with long-term export potential to meet their energy needs in the long run [62]. Costs associated with imports may also affect economic growth. By employing renewable energy instead of fossil fuels, these countries might cut the amount of money they owe and invest more in other industries as a result." If business continues, ETP 2012 6°C (6DS) will aim to reduce carbon dioxide emissions by 50% using 2005 as the benchmark. One hundred three trillion dollars might be saved between 2010 and 2050 by reducing fossil fuel consumption. In conjunction with the impact of falling fuel prices, the figure could reach as high as 150 trillion dollars [48] [63].

The potential for employee development is a significant economic motivation for the advancement of renewable energy technology. Five million people are anticipated to be employed in the renewable energy industry. Because of recent global economic downturns, coupled with policy changes, several nations (e.g. Germany and Spain) are experiencing a decline in employment [64].

The renewable energy industry currently employs more than 1.6 million people. Many jobs in the renewable energy industry are in China, Brazil, and other countries in North and South America and Europe. Regarding job development in the renewable energy industry, Germany has been Europe's top performer in recent times. In 2008, renewable technologies accounted for roughly 15 per cent of the country's total electricity production. Renewable energy regulations in the European Union have gross and net effects [64].

On the whole, they looked at how renewable energy policies affected employment and the economy on a national level and a local level. To attain Europe's 20 per cent renewable energy target by 2020, they determined that existing regulations might be improved to increase the present economic benefits of renewable energy industries. For example, they said that increasing the share of renewable energy sources in the economy will cause no harm and could even assist by creating jobs and raising GDP. If external expenses were factored in, the economic benefits of renewable energy might be considerably more significant [62].

5. CONCLUSION

Solar energy provides heat and air conditioning, ventilation, natural lighting, and hot water in a home or business. Wind energy is used in ventilation and cooling systems, both active and passive. As an alternative to fossil fuels, geothermal energy can be used for heating and cooling. It is possible to use hydrogen energy for heating and hot water delivery and cooking and electricity production. Because they are simpler and more cost-effective, passive systems should be used to use renewable energy sources. Whenever passive systems are insufficient, active systems should be used to make up for the shortfall. Renewable energy sources can be used to lessen the use of fossil fuels when certain criteria are satisfied. Therefore, governments must design and enforce suitable legislation and incentives to encourage the use of renewable energy sources in building construction and penalties and fines.

Regarding the irregularity and unpredictability of renewable energy integration, there are a variety of approaches. This is why the best integration choices for each electric grid are different. As more utilities and system operators integrate renewable energy, various tools and operational methodologies have been developed. Most of the world's and region's energy use comes from buildings. A huge amount of energy is used in the building's consumption phase as a result. It's no secret that energy-related environmental issues are on the rise. The use of renewable energy sources in buildings has been well-explained with the prospect of environment and economic benefits. By relying on sustainable use of renewable energy sources, we can save as much energy as feasible.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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