Rethinking Design Approach For Public Open Spaces Through Renewable Energy

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ABSTRACT

The discourse on implementing renewable energy resources in cities has become essential due to climate change and growing global warming, especially in areas like public open spaces that ultimately shape how the person sees the city when they pass through it. From streets to parks, gardens to boulevards, these areas form the city's skeleton and help to shape the image of the city. These spaces are essential as it helps in improving the sustainability, environmental quality, and livability of cities. Because at great extent these spaces represent the quality of life in the modern world, therefore, creating sustainable public open spaces are important. In addition, it is crucial to make these areas smarter and more energy efficient due to excessive pollution and the growing urban population development in cities. To deal with the challenges, renewable energy is widely recognized as an increasingly important solution towards a more sustainable future. Cities can lower their reliance on fossil fuels and improve the resilience, sustainability, and efficiency of their urban environments by utilizing renewable energy sources like solar, wind, etc.

This chapter intends to address the incorporation of renewable energy in public open spaces to make them more intelligent and sustainable. The chapter will explain the thought process by offering potential examples and suggestions of how and where renewable energy could be used for designing meaningful environmental experiences that shape the perception of space in modern life. Every public open space also has its own typology, design, and function; as a result, components of public open space are utilized for easy understanding of integrating renewable energy sources.

Keywords—Public open space; renewable energy; cities

I. INTRODUCTION

Public open space is a social space open to all [1]. It helps to establish the connection between the individual and the environment. These spaces have the power to develop a sense of belonging through social, cultural, and economic exchange [2]. These spaces are important as they cover 20% of cities areas with social, health, wellbeing and ecological benefits which play crucial part in impacting environment and climate change [3]. The cities of today are affected by the worst problems of climate change, which are increasing every day, and public open spaces are part of it, where it feels at human scale [4, 5]. By considering challenges like climate change as they relate to places and individuals, we can utilize public open spaces as instruments for both reducing our collective commitments to climate change and managing its up-and-coming impacts [5].

To design public open spaces in the most suitable way, renewable energy technologies are mentioned as the most sustainable tool to prevent climate change [6]. This is because the main cause of climate change is energy systems which is commonly based on fossil fuels and emits large amount of CO2 in environment [7]. However, renewable energy lowers the emission of CO2 by replacing fuels with solar, wind, tidal, hydro and biomass energy which offers a clean transition and generates low energy impact [7]. Due to its environmentally friendly and cost-effective benefits, many countries are replacing their conventional source of energy generation with renewable energy [6].

As aforementioned that public open space covers prominent part in cities and impacts inhabitants' life, therefore it will be helpful for architects and designer to know the possible integration of renewable energy in

public open spaces by presenting viable instances and recommending of how and where renewable energy could be assimilated.

II. PUBLIC OPEN SPACE

Being a physical component of public realm, public open spaces are meant to serve community wellbeing comprising social, economic, cultural, or environmental aspects [1]. They should not only visually sound, but also create a sense of belongingness through public activities [8]. These spaces are acting as a focus point which gives the identity to the city [8]. Public open space is an exterior open space including parks, grounds, streets, plaza, piazza, markets, etc., [1, 9, 10]. These spaces comprise the external spaces as well as the interface between the interior of the adjacent building (public/private) [11]. Cafes, retails, bazaars, streets, walkways, parks, etc. are included in public open space [12-15]. Public open space is an important part of modern cities as it helps in reducing the stress of people living in society by providing relaxation and generating social interaction [16]. It is a place where people can interact with other, as well as develops contact, interchange information regarding socio-economic development, work experiences, ideas, etc., apart from this, activities like, festival celebration, dance-music events, socio-cultural activities, coronations, etc., takes place in public open space [10].

A. **Types of Public Open Space**

The categorization of different types of open spaces has been done on the character of the spaces. There are many authors who define the different types of public open spaces. According to Stephen et al. [1], public open spaces are divided into eleven types as: '(1) Public parks, (2) Square and plazas, (3) Memorials, (4) Markets, (5) Streets, (6) Playgrounds, (7) Community open spaces, (8) Greenways and parkways, (9) Atrium/indoor marketplaces, (10) Found spaces / everyday spaces, and (11) Waterfronts'[1, 17]. While Gehl [10] categories public open space in completely five different forms which include 'main city square; recreational square; promenade; traffic square; and monumental square'. Dines et al. (2006) definition of types of space originated from social interaction perspectives and people perched the places. He defined public open spaces into five parts as:

- Everyday places - Daily use spaces which have an impact on users' well-being, local streets and footpaths, parks and markets are examples of it.
- Places of meaning - These public open spaces change person to person depending on specific relations, which are developed by a sense of belonging. For instance, a childhood playground or park.
- Social environments-This type of public open space helps in developing social relations. It could be a street market, park, or ground.
- Places of retreat - These are the spaces where people want to spend time alone or want to get rid of domestic or office pressure. Parks are the best example of public open space as they help in developing a sustainable environment.
- Negative aspects of public space: racism and disruptive behavior - places with a negative impact like racism could occur in a neighborhood park, public squares, streets, etc.

B. **Components of Public Open Space**

Whyte [18]; Lennard and Lennard [19]; Gehl [8]; Project for public space [20] stated various factors of Public open spaces into four basic attributes including Uses and Activities; Access and Linkages; Image and Comfort; and Sociability. These attributes include tangible and in tangible factors. However, to integrate renewable energy technology in the design of public open space, physical factors are required to elucidate each part of space. Thus, factors of public open space stated by Shafique and Majid [21] has been selected to proceed with the study. According to Shafique and Majid [21], Uses and Activities; Access and Linkages, Urban elements/ Amenities, Visual image and Identity, Maintenance & Management and Microclimate are the six components of public open spaces. Every public open space has its own typology; however, their attributes are the same. Therefore, for providing comprehensive understanding to define the integration of renewable energy for designing public open spaces, its components are considered.

III. RENEWABLE ENERGY

'Renewable' is a word given for energy resources and technologies that are non-depletable or generated by naturally recurring processes [22] [23]. Renewable energy technologies use natural or renewable energy sources such as solar energy, wind energy, falling water, geothermal energy, biomass, wave energy, ocean

currents, ocean temperature variations, and tidal energy to generate power, heat, or mechanical energy [22]. These energy sources can be converted into electricity or into motive power. Unlike fossil fuels, which are non-renewable and have harmful environmental impacts, renewable energy sources are constantly replenishing themselves, even though their availability is positively influenced by factors like climate and time [24, 25].

Nearly 80% of the world's energy is reportedly consumed in urban areas, accounting for about 60% of global greenhouse gas emissions [26]. It is therefore important that the switch to renewable energy in cities has significant positive aspects. In addition, the implementation of renewable energy technology should be done wisely as not all renewable energy is clean or green [27, 28]. Green energy can be broadly defined as energy obtained from natural sources such as wind, sunlight, and water. Clean energy, on the other hand, is energy from zero-emission sources that does not pollute the atmosphere and has the added benefit of reducing the risk of environmental hazards [27, 29]. For instance, some large hydropower plants, although technically considered “renewable"; may not be green and clean as they can cause environmental and social damage [27]. Therefore, before choosing renewable energy technologies, it is significant to determine its positive consequences.

The integration of renewable energy in our urban areas needs to be contemporary, resilient, flexible, and meet interrelated climate and social equity objectives [4, 5]. This is since when the community owns and operates the energy infrastructure, the benefits can be felt at the local level. “This sense of ownership is widely believed to contribute to resilience” [5]. Thus, small-scale resilient energy systems might be designed as community-level infrastructure that is highly self-reliant, available, and community-owned. According to several authors, focusing on small, manageable systems may be the most effective way to increase resilience and prepare communities for large-scale development and investment [30, 31]. Therefore, it is important to choose wisely when it comes to the use of renewable energy in public open spaces.

IV. RENEWABLE ENERGY FOR PUBLIC OPEN SPACES

For feasible energy-conscious design, it is important to choose renewable energy technology which along with environmental benefits has social and economic advantages too. In addition, installing renewable energy technology promotes acceptance and acknowledgment among people [32]. Moreover, it will also give opportunity to get people educate about renewables energy resources [32]. As public open space is leisure a place, which could be in different sizes. Therefore, not all renewable energy sources are feasible in such spaces. Renewable energy sources which are easy to install, need less maintenance, are aesthetically sound, provide results that can creates environmental awareness are best suited for public open space.

Since the scope of this chapter is limited to public open spaces, thus only solar energy, wind energy and human generated energy is taken into consideration, whereas geothermal, tidal, chemical energy is not considered as it is integrated with many other areas such as environment, chemistry, operational setup which has many constraints and requires large systems. Subsequently, this section of the chapter provides examples of each technology identified for possible implementation in public open spaces. The examples as follows:

A. **Solar energy**

Solar energy is one of the most common and abundant sources of energy in the world [33]. It contains the light and heat emitted by the Sun, which is used in various technologies such as solar and thermal energy [33]. It is considered one of the most efficient and clean sources of renewable energy. Solar energy has several classifications, but the scope of this chapter is related to public open space, so solar energy has been explained from the urban design aspect. Based on the recycling and distribution system, solar energy is mainly divided into active and passive solar energy [33]. Active solar technologies convert solar energy directly into electricity or heat through photovoltaic systems, centralized solar power, and solar water heating [33]. However, in the case of passive solar technologies, buildings or systems are designed according to the amount needed for the purpose [33]. For example, direction and openings of buildings, road direction, sport field, etc.

There are several solar technologies on the market today. Now it is the responsibility of architects and designers how wisely they can choose the best solar technology to make their design more sustainable. Solar cells are often described into generations. First-generation solar cells are based on crystalline silicon and consist of a single layer or multiple crystalline silicon layers [34]. Therefore, it becomes heavy and thick. Second-generation solar cells consist of multiple layers of materials like amorphous silicon and cadmium telluride [34]. These are thin and light. Third generation solar cells are the newest materials but are not yet established [34]. They are innovative and designed to integrate solar cells into a variety of complex design domains. They are mechanically very flexible, energy efficient and can be molded into a wide variety of shapes and colors [35]. Perovskite solar cells, dye-sensitized solar cells, quantum dot solar cells, and organic solar cells are examples of third-generation solar cells [35]. There are few examples of solar energy technologies that can be used in public open space design are as follows:

Photo voltaic lighting: These are the lighting systems based on the photovoltaic cells or batteries which help to convert solar energy into electricity [34]. Photo voltaic lights contain a panel of the photovoltaic cells, battery, and a lighting device. These photovoltaic cell panels are placed on the top of the light which converts solar energy into electricity [34]. The generated electricity is stored in a connected battery to the lamp and can be used when needed. These batteries are continuously charged when the solar panel receives sunlight [34]. This eliminates the need to connect the photovoltaic lighting system to power cables. So, the photovoltaic lighting system is always wireless which makes them best suited for street lighting.

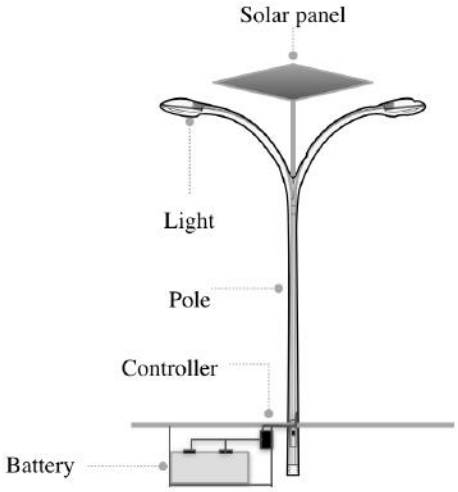


Figure 1: Solar Light

Figure 2: Photo Voltaic Panels. Source: [42]

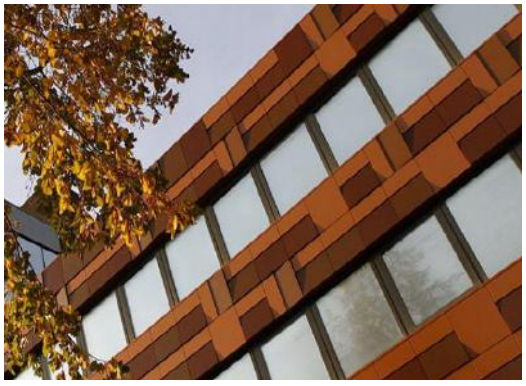
In addition to these characteristics, Photo voltaic lights have several other characteristics that make them perfect for any area. For example, photovoltaic lighting systems are easy to install because they do not require wiring and can be installed in a variety of terrains. Besides this, due to its ease of installation and good cost performance, it is ideal for outdoor spaces such as parks, squares, and streets. Moreover, since it can be used in a variety of designs, it can be installed outdoors as well.

Solar murals: Solar murals are made up of Amorphous Silicon Photovoltaic and Custom Lamination. Amorphous silicon (a-Si) is the non-crystalline form of silicon which forms to make a thin layer solar cell [32, 41]. These are also known as second generation solar cells [47]. The silicon solar cells are transformed into various kinds of flexible layers that can be made of plastic, metal, glass, etc. Lamination on solar cells can be used as artwork. Various types of paintings, or other works of art that can reflect the culture of the city can be placed on this laminate (Figure 3). It can also be used for advertisements and moral messages in the city. This is one of the sustainable ways to add aesthetics to cities through energy generation [48].

Figure 3: Examples of Solar Mural. Source: [43]

Organic thin photovoltaics film: The organic thin-film solar cells consist of one or more thin layers of photovoltaic cells into a under layered. It can be made of different materials including glass, plastic, or metal [41, 47]. These films are much thinner than the conventional crystalline silicon based solar cell [47]. These are also known as third generation solar cells, made up of thin layers of materials like amorphous silicon (a-Si), cadmium telluride [41]. Due to its flexibility and high performance, it can be molded into different shapes and color [47, 49]. Additionally, organic solar panels can be made translucent, making them suitable for use in windows. This property of organic film makes is suitable for future energy efficient building. There are several solar companies related to design and architecture that are converting this organic solar film into their desire material. For example Dutch Solar Design Photovoltaics is an organic film that can reprinted into any color and being used especially in outer walls (Figure 5) [50]. Similarly, Polycrystalline Silicon PV cells can be molded into any of almost any custom modules. This can be used for enhancing building aesthetics as well as installation (Figure 6) [50]. Apart from this, Heliatek company makes flexible and colorful organic solar film can be converted into desired shapes like the hexagonal forms that can be applied in a variety of creative applications. Roof of German Pavilion at the Milan Expo in 2015 has been made using this material (Figure 7) [50].

Figure 4: Example of Organic thin photovoltaics film. Source:[44]



5: Dutch Solar Design Photovoltaics Cell . Source:[50]

Figure 6: Polycrystalline Silicon PV cells. Source: [50]

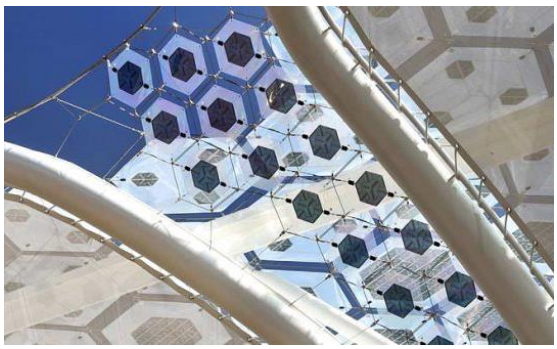


Figure 7: Hexagonal forms Organic solar cells. Source: [50]

Figure 8: Dye-Synthesized Cell. Source:[46]

Dye-synthesized solar cell: These are solar cells like thin photovoltaics film solar cell. It is made up of a semiconductor designed between a photo-sensitized anode and an electrolyte, a photoelectrochemical system [51]. This is the most effective and low cost third generation solar cell [51]. Due to its low-density property, it is suitable to be used for large scale purposes [41]. For instance, facades of buildings, windows, etc. (Figure 8).

B. **Wind energy**

Wind energy is generated by converting wind power into electricity [52]. It harnesses the kinetic energy of wind with the help of large turbines, mainly located in large open areas. When the wind blows, the turbine's rotor blades rotate clockwise, recovering energy [53]. This rotates the main shaft of the wind turbine, which is connected to a gearbox inside the nacelle [53]. The gearbox sends wind energy to the generator and converts it into electricity [53]. It is considered as cost-effective, domestic source of energy, sustainable source of energy, as it does not produce any greenhouse gases. However, wind energy has its limitations. It is more workable where

the speed of wind is higher. It cannot be installed in closed space where the speed of wind is less. Unlike solar energy, it does not have diverse options of installation [54].

Vertical axis wind turbines: A vertical-axis wind turbine is a wind turbine in which rotor shaft is place transverse to the wind while other major components are placed at the bottom of the turbine which make it easy to repair as wind turbines main generator and gearbox is placed closely at the bottom [53]. A wind turbine named "wind trees" looks like a tree has been designed by who works on small air currents flowing along buildings and streets [55]. The size of this installation is around 9 meters tall and 7 meters wide which could be placed in gardens and urban centers. This wind turbine installation is clean, cost-effective, and makes easy use of wind energy [55]. This can be customized into different shapes and sizes.

Figure 9: Vertical wind Turbine (Wind Tree). Source: [52]

C. **Human Generated energy**

Person Day to day activities like walking, jogging, exercising, playing, etc. exert energy. This energy is stored by the mechanical devices which further convert this energy in electricity [56]. This type of energy is mostly generated in public open spaces like parks, plazas, squares, streets, etc. there are several examples of it which are as follows:

Foot Energy Pavers: It is a technology that uses footstep energy to generate electricity [57, 58]. This renewable energy generates energy when a paver equipped with pressure sensors is pressured by the weight of a pedestrian. The generated energy is stored and converted into electricity [57, 58]. The upper part of the pressure sensor is installed in the pedestrian zone. The pressure of the person's foot causes the plate to drop slightly. The downward movement of this plate generates electricity, which is stored in batteries and used when needed [58]. This technology is used when pedestrian movement is high, like, in footpaths, parks, plazas, etc. [59].

Figure 10: Foot energy paver. Source: [60]

Kinetic Energy Play Structures: The human power energy is generated when a person stands still against a spinning or motion-producing rides for instance see saw, trampoline, swing, etc. [61, 62]. When a linear or rotary motion is produced, with the help of motors and generators, it can be easily converted into mechanical energy, and further into electrical energy [61, 62].

Kinetic Energy Exercisers: Nowadays most of the parks and open spaces have exercisers including rider, single/double arm wheel, single/double ski walking, bicycle, push and pull chair, abductor, and stepper, etc. similarly like play structures, the energy produced by the motion of these exercisers is converted into mechanical energy and further converted into electrical energy with the help of motor and generators [65].

Figure 11: Kinetic energy See saw. Source:[63]

Figure 12: Kinetic energy swing. Source:[64]

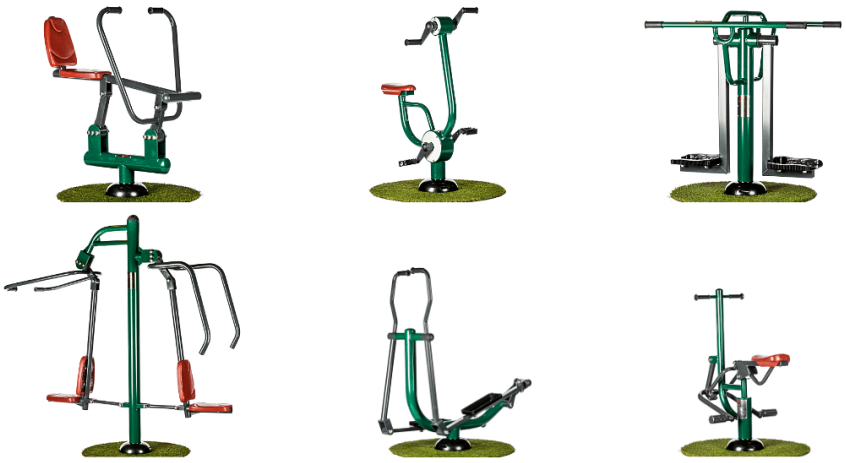


Figure 13: Kinetic energy exercisers. Source:[66]

V. INTEGRATING RENEWABLE ENERGY IN PUBLIC OPEN SPACES

Designing energy-efficient public open spaces requires a combination of several smart design approaches with sustainable technologies. Therefore, along with the integration of renewable energy resources, this chapter will also discuss the design considerations, to make public open space design output more functional. Each public open space is unique in its typology, layout, and purpose, so instead of discussing the integration of renewable energy resources in different types of open spaces, the elements of public open spaces are adopted to explain in detail, including Uses and activities, Access and linkages Urban elements/ Amenities, Visual image and identity Maintaining & management and Microclimate.

A. **Access and Linkages:**

This element of public open space defines a connection of a space with the surrounding as well as the inner and outer circulation [21]. This includes entry/exit of a public open space, pathways connecting different areas, parking area, taxi and bike stands, etc. These spaces connect public open spaces with the surroundings [21]. The following are a few examples of how renewable energy can be used into architecture to make these areas more sustainable:

- Parking lots cover a sufficient amount of area in public open spaces. An open parking space sometimes helps to convert any open land into a heat island produced by asphalt [32]. Organic thin solar film can be installed, which produce energy and give shade, can be utilized in parking to solve this problem.
- To further promote the use of green energy, charging stations for cars and motorcycles should be installed. Providing charging stations positively influences an individual's thought process and helps them embrace new social changes.
- To generate power, vertical tree wind turbines can be installed across motorized roads and in open areas. There are several attractively designed wind turbines on the market that can act as an abstract to attract visitors and in some cases, help improve the image of public spaces.
- Instead of traditional lighting, streetlights with photovoltaic panels should be installed. This reduces the electricity expenses and brightens the streets at night. These are inexpensive and can be installed in any open space easily.
- Kinetic energy pavers should be planted in pathways or high footfall areas which help in converting human footstep energy into electricity. This technology could also be integrated into pedestrian crossings, allowing cars and bicycles to contribute to energy generation while crossing [32].
- Apart from renewable energy, more and more plants should be planted in parking areas, pathways, and access areas to reduce impact of heat and providing fresh and healthy air to encourage people to visit public open spaces.
- Instead of using conventional shades in pathways. Organic thin solar film can be installed. This is light and thin which can easily cover the large of walkways. Moreover, for enhancing safety, this organic shade can also be used vertically for segregating cycling path from other spaces.

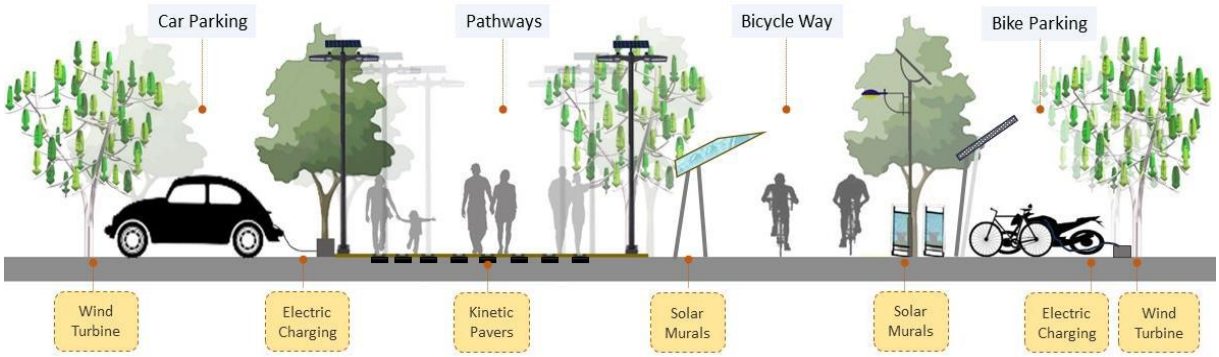


Figure 14: Section of public open space showing integration of renewable energy installations.

B. Uses and Activities

This element is related to the types of activities taking place in public open spaces. This includes kiosks, seating areas, shops, restaurants, etc. [21]. To make these space more energy efficient, following are a few suggestions of how renewable energy can be used into uses and activities to make these spaces more sustainable:

- Solar organic thin film shade, which can be either opaque or translucent depending on the needs of the space, can be used to provide protection from sunshine and precipitation in outdoor dining and seating areas. This organic film shade converts solar energy into electricity which can be used for powering needed installations in public open spaces.
- Additionally, organic thin films can be used for advertising placed near seating areas or as outdoor art galleries for works by artists and the community individuals [32].

- The generated energy from solar installations can be used to power temporary structures, like kiosk of street vendors, food trucks, etc., as well as give power in sitting areas for changing electronic devices.

C. Urban Elements/ Amenities:

These include installation of small visually pleasing urban elements like sit outs, installations, children play equipment's, exercisers, drinking water facility, security cameras, street lighting, etc. [21]. Examples of how renewable energy can be incorporated into urban elements to make them more sustainable include the following:

- Streetlight is one of the important urban elements of public open space. Therefore, convert traditional streetlight into solar photovoltaic light will be an imminent change in the public open space.
- Replacing conventional children's play equipment with power producing swings, seesaw, trampoline helps in involving children into responsive energy production and generated energy can be used in required electric needs of public open space.
- Likewise, converting conventional exercisers with energy generating equipment including rider, single/double arm wheel, single/double ski walking, bicycle, push and pull chair, abductor, and stepper, etc., helps in utilizing human energy and converting it into electricity.
- The electricity produced by these elements can be used to serve other amenities like security cameras, digital information desk, drinking water dispenser, community fridge, etc.

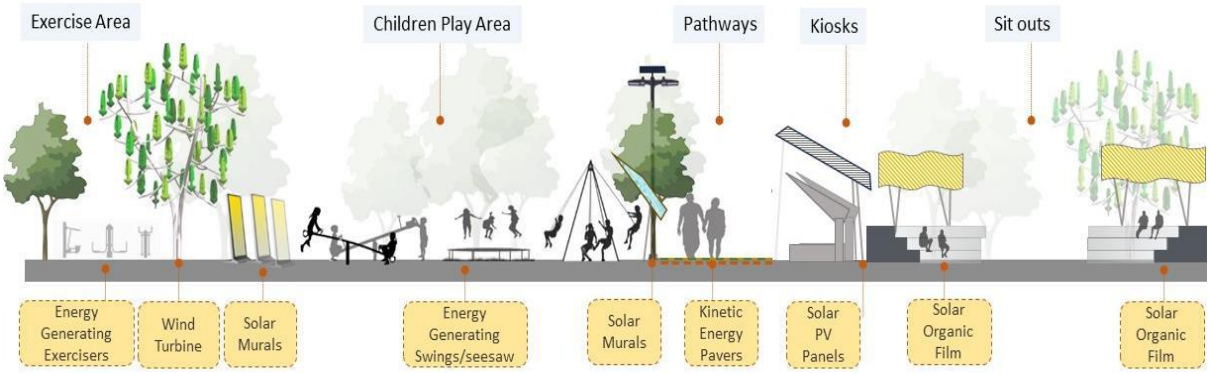


Figure 15: Section of public open space showing integration of renewable energy installations.

D. Visual image and identity:

This component is related to the image of the public open space. It includes public art, installations, canopies, facades, view, and vistas [21]. The following are some instances of how renewable energy can be implemented into visual image and identity to make them more sustainable:

- Displaying art and community work is one of the important features of public open space. Solar murals are a one of the beneficial technologies to display artwork while generating energy.
- Solar murals can also be used for outdoor galleries for advertisement, signages, professional or community work.
- Instead of using only art works or painting, Solar murals, a thin layer solar cell can be used to display artworks. This encourages cultural identity of a place by producing energy. In addition, this can be used as shades as well as vertical displays in pathways and bicycle ways.
- Solar organic thin film which could be change into different colors as well as comes in different transparency can also be used to display art forms, advertisement, etc.
- Vertical wind turbines (wind tree) also work as an attractive installation as well as helps in producing electricity.

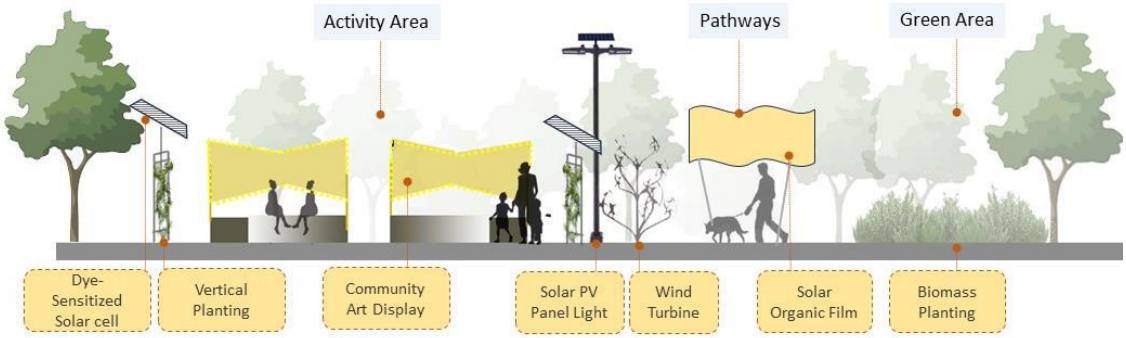


Figure 16: Section of public open space showing integration of renewable energy installations.

E. Maintenance and management

This component includes how the space is managed. But as part of this on-the-ground response, little can be done to achieve sustainability. Although, these are not directly related to renewal energy sources, but it can come under the design consideration for reusing and conserving natural resources for making sustainable public open space.

Improper disposal of solid waste can cause pollution, spread disease, and pose a risk to public health, so waste disposal is one of the must-haves for any public space. Three types of bins, including combined bins (non-plastic), bins (plastic), and recycling bins, should be placed at every corner of public vacant lots. This supports waste segregation and can be reused for multiple purposes [67].

Another important point on site is stormwater management. Installing small storm drains can help conserve and restore groundwater [32].

F. Microclimate:

This includes shades, vegetations, waterbodies, hardscapes, etc. which helps to maintain the microclimate of the public open space [21]. The following are a few recommendations of how renewable energy can be used to effect microclimate of public open space in more effective way:

- By placing shade canopies in places where trees are unattractive or difficult to grow, with the help of dye-synthesized panels and solar photovoltaic shades one can generate energy while maintaining the environment's microclimate.
- By installing vertical plantation with solar panels, one can maintain microclimate as well as produce energy. Moreover, by planting this installation at the outer side of public open space can help to reduce noise pollution.
- In open space, like gardens, cultivation of biomass shrubs can be done.
- Rainwater diverting into approved stormwater bioswales can also done for make public open spaces sustainable.

VI. CONCLUSION

Renewable energy is abundant on earth. It is up to designers and architects to find out how this energy can be used wisely to tackle the problems of climate change and global warming. It is important to make people aware that energy infrastructures are not complicated anymore through using renewable energy components in easy and intriguing way in design of public open space. As it seems challenges for people to adopt renewable energy installation in small projects which is likely due to perpetuation of the belief that only expert can handle this installation. However, due to extensive research on renewable energy made its installations small and attractive. Through captivating integration of renewable energy installation in public open space design, one can increase acceptance and educate users about need of replacing depleting energy with renewable energy. An energy-conscious design of public open space can help to uplift environmental, economic, and social aspects.

The chapter advocates that solar, wind and human generated energy can be easily utilized in public open space with small installation to make space more sustainable. Solar technologies like Photovoltaics panels, solar lights, thin organic films, solar murals, and Dye-synthesized solar cell can be used to generate electricity as well as act as a major element in design of public open space. These elements could be used for lighting, shades,

segregation, signages, advertisements, exhibit art, powering vehicles and electronic items, etc. Besides this, wind energy includes vertical wind turbine (wind tree) which can be used an art installation or in places where trees are difficult to grow. Besides this, very smartly human generated energy can also be used to produce energy. For instance, energy from footstep, energy generated from children swings, see saw, etc., and from outdoor exercisers can be used to produce energy which can be used for in lighten up temporary kiosks, markets, information desk, etc., of public open spaces. Apart from this, conserving available resources is also important to make public open space sustainable. For example, installing small storm drains can help conserve and restore groundwater or divert this water into biowales. Further, waste accumulated from different parts of public open space can be segregated and can be deposed or reused for other multiple purposes.

In conclusion, it is important to use and educate people about under-utilized renewable energy technologies and it is the responsibility of architects and designers to make energy-efficient design a priority to reduce the high demand for electricity in cities. Offering energy-conscious projects using renewable energy sources is only part of the solution. Other sustainable design practices should also be adopted in order to make projects more environmentally friendly.

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