

# **UCLA**

## **Electronic Green Journal**

### **Title**

Challenges and Hurdles in Establishing a Green Library: Strategies for Overcoming Them

### **Permalink**

<https://escholarship.org/uc/item/2xf7304p>

### **Journal**

Electronic Green Journal, 1(49)

### **Authors**

Sivaprasad, P.

Thanuskodi, S.

Nagaiah, M.

### **Publication Date**

2024

### **DOI**

10.5070/G314959708

### **Copyright Information**

Copyright 2024 by the author(s). This work is made available under the terms of a Creative Commons Attribution License, available at <https://creativecommons.org/licenses/by/4.0/>

Peer reviewed

## **Challenges and Hurdles in Establishing a Green Library: Strategies for Overcoming Them**

**Sivaprasad P, Thanuskodi S, and Nagaiah M.**  
*Alagappa University, Karaikudi, India*

### **Abstract**

A green library, or a sustainable library, enables us to collaborate with nature to fulfill some of our fundamental needs. This concept fosters a harmonious relationship between our community and the environment; green libraries, in essence, serve as examples for reconnecting with the beauty of the natural world. The purpose of this article is to delve into the practical challenges associated with transitioning a conventional library into a green one, as well as strategies for improvements. It explores topics such as the green library's historical background, its significance in environmental conservation, the librarian's role within it, ongoing green library projects, and initiatives promoting eco-friendly libraries, particularly focusing on India's efforts in this regard. Managing a green library poses several challenges. Firstly, the transformation process involves architectural redesign, incurring construction costs if an existing library is to be converted. Establishing a green library from scratch entails substantial initial expenses. Moreover, daily maintenance is crucial, necessitating proper employee training and ongoing efforts. Maintenance costs and the allocation of manpower are also essential considerations. Furthermore, this article examines the roles of key initiatives such as the United Nations Development Program (UNDP), Sustainable Development Goals (UNESCO), the IFLA Green Library Award, the Green Building Council of India, and LEED (Leadership in Energy and Environmental Design) in advancing sustainable practices within library settings.

### **Introduction**

Global warming has a very high impact on the world, and it is the duty of every human being to correct this. We may not have libraries in mind when we think of global warming and environmental impact, but major change in the world begins with small actions, and libraries can enact change from wherever they are. Land, water, and air are all polluted. The main cause is today's growing modern economic policies and modern industrial development. The purpose of the green library is to make an impact in the modern world by demonstrating how to manage a green building and providing a healthy environment for users and customers. However, the green library must overcome many obstacles to do so. The world is full of information, and libraries have the task of collecting it and providing access to its users. With the advancement of modern technology, human lifestyles toward growth are evolving at a rapid pace nowadays, and the required data must be obtained within a second. It is the duty of every library to provide such data in a

nature-unaffected manner to its users. This study goes into detail about what they are and how people cope with them.

### **Definition of a green library**

According to the Online Dictionary of Library and Information Science (ODLIS):

“Green library or sustainable library is defined as a library designed to minimize negative impact on the natural environment and maximize indoor environmental quality by means of careful site selection, use of natural construction materials and biodegradable products, conservation of sources like water, energy, paper, and responsible waste disposal recycling etc.”

In new construction and library renovation, sustainability is increasingly achieved through LEED certification, a rating system developed and administered by the U.S. Green Building Council (USGBC).

### **Review of Literature**

As Antonelli (2008) stated, green library research is nearing a tipping point, resulting in the "green library movement," which commits librarians, cities, and college and university campuses to greening and reducing their environmental impact. Some libraries choose to become green and sustainable by constructing a green library building using a performance standard such as LEED. Environmental issues such as energy depletion and climate change have an impact on the information resources and programs that libraries provide to their communities. (Aulisio, 2013). Sustainability has been incorporated into the curriculum and operations of many colleges and universities across the United States. Academic libraries are integral to upholding their university's mission, which often includes fostering sustainability education and practices. Despite this, there is a notable scarcity of LEED-certified academic libraries across the United States. The authors argue that a green library transcends mere architectural design. They assert that while a green library may not always entail a physically green building, it does embody a commitment to environmental stewardship through exemplary initiatives and operational strategies geared towards sustainability.

Khalid & Batool (2020) present a case study that underscores the potential of university libraries to address environmental issues through their operational practices. They emphasize the significance of individual green actions in safeguarding the planet on both national and global scales. A library guided by a sustainable vision not only benefits society but also contributes positively to the health of the planet. This conviction drives the research. The study takes a pioneering approach in elucidating the status of "green work practices" (GWP) within university libraries, with a specific focus on Pakistan. Data collection involved in-person interviews with 27 librarians, alongside observation, document review, and photographic documentation. Subsequently, a cross-case analysis was conducted to validate the findings. The results revealed an unsatisfactory status of GWP due to the absence of clearly defined guidelines. Most librarians exhibited limited familiarity or a different understanding of GWP concepts. Consequently, this study endeavors to stimulate environmental discourse among library professionals, advocating for the environmental role of university libraries and seeking to

establish a foundational understanding of librarians' perspectives on environmental issues.

Filar Williams (2011) presents how incorporating green messages into library work, tasks, programs, tools, and teaching will passively or subtly inform others without being overbearing. The library at the University of North Carolina at Greensboro completed a large, ten-module research tutorial covering topics ranging from topic development to implementation. Users gain environmental literacy by incorporating the recycling theme throughout the tutorial. This article discusses the tutorial project and the value of embedding messages within other academic areas, instruction, projects, or activities. Afacan, (2017) examines how libraries can continue to grow. Because specialized collections and archives are at the heart of educational libraries, researchers are concerned with the question of the strict climate control requirements for collection protection. Furthermore, making those collections available in an equal way, digitally supporting their documents, and maintaining indoor air quality within the framework of standard strategies eliminates special collection spaces for other library spaces. Meher & Parabhoi (2017), concludes that the libraries are grappling with space and budget limitations, as well as struggles with issues like dust, moisture, and mold that necessitate special attention for the books. The green library is a modern library where electricity consumption is minimized and the maximum use of renewable sources such as wind, sunlight, and wood are encouraged.

Nowadays, it is very necessary for a library to green its environment. Librarians need to make some decisions about participating in a green library movement. Many national and international organizations are helping to create green libraries. Some Indian libraries are trying to create successful greeneries, and librarians need to take initiatives and participate in the green library movement. Purohit (2013) is focused on "going green," and eco-friendly, sustainable information systems and services are serious issues that require the immediate attention of librarians. The first step is to recognize the need for additional information in this matter, seek information, gain insight and confidence, and then use the information for sharing and disseminating for free.

There can be dissemination of information through Library and Information Science (LIS) related websites, blogs, and literary reviews. LIS professionals can promote evidence-based decision-making in going green and develop information-based services that allow for going green to raise awareness of issues and initiatives. They can promote interpersonal awareness and cooperation to find solutions through collaboration (for example starting Green Clubs to reduce the use of printed copies).

Thomas (2014) stresses eco-friendly spaces for intellectual erudition and spiritual reflection. Providing such an environment in libraries, where people can experience the sanctity of nature and enter deep meditations and reflections, is highly recommended. Sitting close to nature, the mind is freed from all limitations and gravitational and suffocating situations. Imagination, creativity, and intuition for reality are more common in the natural environment than in artificial systems. However, one does not deny the need for the other, their importance, or their validity. Both are complementary and mutually beneficial. Fallik, Soper, & Sparks (2012) emphasize how going green is

becoming increasingly important for libraries as greenhouse gas emissions and global warming continue to rise. By making environmental efforts, libraries can significantly reduce their carbon footprint, thereby contributing to a healthier planet and a sustainable future. Going green does not have to be expensive, and it promises to save libraries money in the long run. There are numerous affordable ways to improve the ecological profile of library facilities, functions, and collections, and even the more expensive options can prove economical over time. These savings can be used to upgrade services, reinvest in green initiatives, or address other pressing needs.

### **Methodology**

For this study, some information was found through research, on websites, and in academic journals. This article is an attempt to explore them systematically.

### **Objectives**

- ❖ Understand the challenges of green library development.
- ❖ Promote the creation of green libraries to support a sustainable earth.
- ❖ Discuss products that incorporate reusable, quality materials.
- ❖ Reduce costs through the smart use of technology.
- ❖ Encourage librarians and directors to transform libraries with advanced technologies and provide green services to users.
- ❖ Demonstrate how greening the library building will save energy.
- ❖ Create environmental awareness among library stakeholders and highlight the benefits of green buildings.
- ❖ Promote the green library movement.

### **Need for Green Libraries**

Libraries often build their identities around a unique building structure, spatial design, and even art and landscaping. Construction is done using resources such as power, water, and construction materials; no building can exist without environmental impact. If the library follows the definitions of a green building, it will be a great role model because the library is a social organization. There is a social responsibility to reduce the harmful impact on the environment.

Not all library users are leaders, but all leaders are library users. The green library embodies the idea of protecting the nation's environment in the minds of leaders who are rebuilding the nation. The cost of constructing and renovating green libraries has decreased. Because the library is a social organization, librarians have a social responsibility to reduce the building's harmful impact on the environment. The term "carbon footprint" is defined as the amount of carbon dioxide (CO<sub>2</sub>) emissions associated with all the activities of a person or other entity (e.g., building, corporation,

country, etc.). It includes direct emissions, such as those that result from fossil-fuel combustion in manufacturing, heating, and transportation, as well as emissions required to produce the electricity associated with the goods and services consumed. In addition, the carbon footprint concept also often includes the emissions of other greenhouse gases, such as methane, nitrous oxide, or chlorofluorocarbons (CFCs). Economic benefits can be derived from efficient lighting systems, recycling of waste, and reuse of water. Planting trees reduces the need for irrigation on the construction site and in the surrounding grounds.

### **The Green Library Movement and Organizations Operating Internationally**

After the First and Second World Wars, new ventures in industry and innovation emerged, as well as competition among the nations of the world. This led to deforestation and land grabbing, the impact of which is still felt today. We humans can create a greener, cleaner, and healthier world by planting trees to increase carbon dioxide levels and creating a greener environment. The LEED program was developed by the USGBC in 2000. Appraisal Systems for Green Buildings provides a global rating system for green buildings. In the United Kingdom, The World Green Building Council (WorldGBC) and the British Building Research Institute Environmental Assessment System (BREEAM) from 2000 are conducting research on the health and productivity effects of green buildings on users and working with the World Bank to promote green buildings in emerging markets.

### **The Green Library Movement and Organizations' Operations in India**

The Government of India is developing various projects by various Ministries to create Green India, and Tata Motors, Nestle, Infosys, and The Energy and Resources Institute (formerly known as Tata Energy Research Institute, or TERI) in New Delhi are private companies leading the green library movement. These nationally important companies play a key role in reducing carbon emissions and mitigating the effects of climate change. In addition, some key initiatives by the Ministries of Environment, Forests, and Climate Change have started some projects: compensation for the Capacity Management and Planning Commission (CAMPA), compensation for the River Protection Authority (NRCT), capacity building for industrial pollution management (CPIPM), the National Green Tribunal (NGT), and the National Mission on Himalayan Studies (NMHS). India's first USGBC-rated green building, the CII-Godrej Green Business Centre, was established in 2001 in Hyderabad. Green Assessment for Integrated Habitat Assessment (GRIHA): Assessment of Green Buildings in India, GOI, and the National Assessment System the Green Library Movement (Science and Technology Center for Rural Development) in Castor, Kerala, works to promote a non-profit organization. The Green Building Council of India (IGPC) was established in 2001 by the Confederation of Indian Industry (CII) at the CII Green Business Centre in Hyderabad. IGPC is India's premier body for green building certification and related services.

### **Leadership in Energy and Environmental Design (LEED)**

The LEED is a widely used green building evaluation system in all parts of the world. Available for almost all building types, LEED provides the framework for healthy, highly efficient, cost-saving, and cost-effective green buildings. LEED certification is a globally recognized mark of consistency, achievement, and leadership. Four certification levels (Certified, Silver, Gold, and Platinum) are awarded according to achievement as evaluated by points using the LEED scorecard. LEED-India promotes a holistic building approach to sustainability by recognizing performance in the following five key areas: 1. site location; 2. water conservation; 3. energy efficiency; 4. building materials; and 5. indoor air quality.

### **Indian Green Building Council (IGBC)**

The IGBC was formed in 2001 as a part of the Confederation of Indian Industry. The IGBC envisions India becoming "one of the global leaders in enabling a sustainable structured environment for all" by 2025 (IGBC, n.d.). The council provides a wide range of services, including the creation of new green building evaluation programs, green building training programs, and the Green Building Congress Community, a group-based organization centered on member motivation and consensus. All stakeholders in the construction sector, including developers, corporations, architects, product manufacturers, the government, academics, and nodal agencies, participate in council activities through local chapters. The council works closely with the federal government, the World Green Building Council, and several bilateral agencies.

### **Methods for greening libraries**

Most libraries in India were built before global warming and climate change became major issues. The construction of green libraries is part of a larger ecological infrastructure movement. LEED developed a Green Building Appraisal System that promotes sustainable green building globally. Because library budgets are shrinking, not every library can build new library buildings according to LEED certification. Instead, they can look at existing buildings and implement environmental practices.

### **Sustainable green buildings in South Indian Chettinad-based buildings**

Green library designers should consider using Chettinad-based buildings in Tamil Nadu as a model. They are designed to allow sunlight to be used in place of artificial light wherever possible. They include water catchment systems, large doors and windows for better airflow, and roofs designed to aid in interior climate control. Their floors are made of Athangudi stones, which are characterized by long life, easy dyeing, and moderate cooling. The foundations of these buildings are designed to withstand earthquakes and floods. Plants and vines are grown in their courtyards to improve air quality, with some even serving as local vegetable gardens. Many of these buildings are centuries old and still look new, making them excellent examples of green buildings for sustainability and longevity.

### ***Light***

A library should have adequate windows, glass windows, and skylights that allow natural light to illuminate very efficiently from morning to evening and do not require any light that is artificially generated with the help of electricity during the day. The use of low-consumption bulbs and lamps in places where they cannot be read at night and the use of automatic electric bulbs indirectly contribute financially to the library and save overall electricity.

### ***Wind***

The wind is the most important factor today. The air we breathe should be clean and neat. The surrounding campus requires proper gardening, which provides clean and fresh air and cools the library, while the trees on the outside of the library in the empty area blow pleasant air and control the air conditioners' function in the summer. In the mountains, the building should be in a sunny place so that it heats up slightly and reduces the cost of room heaters and blowers. The larger the entrance, the better the ventilation; the larger the windows, the more air ventilation is planned to allow more air into the library easily and reduce power consumption.

### ***Electricity***

By installing a solar panel on the roof of the library building, electricity can be generated using direct sunlight. In addition, the use of air conditioners, fans, and heaters will help libraries consume extra energy and conserve excess energy when they need it most in the summer.

### ***Water***

For a good cleaning system, a library should be planned in an area where proper water is available to help keep the library clean, green, and healthy. Drinking water is a scarce resource in many areas, so storing drinking water is the responsibility of every human being. By exploring this issue, a library can reuse wastewater and rainwater in gardening, harvesting, and toilets.

## **Adjusting to obstacles**

<b>Obstacles</b>		<b>Adjustment</b>
<b>Capital finance</b>		



<p>Funding can be a major hurdle when building or remodeling a green library.</p>		<p>The green library is intended to serve as a model for environmental protection and sustainable development thinking, so it is recommended that the Central and State Governments provide financial assistance to promote this. In addition, green librarians can be promoted each year with the Best Green Library Awards and Incentives.</p>
<p><b>Site location</b></p>		
<p>It is difficult to know where to put a green library when you're just starting out.</p>		<p>When establishing a green library, it is critical that all parties have easy access to it, and that thorough research into the library's good sunlight permeability, potential access to water sources, favourable environment for tree growth, and good clean ventilation are required.</p>
<p><b>Water conservation</b></p>		

<p>The green library needs to have a clean drinking water toilet facility for its users, which requires water conservation.</p>		<p>Water supply systems are estimated to use approximately 7% of all electricity generated globally to treat, collect, and supply drinking water, as well as wastewater treatment (Wakeel et al., 2016) in some parts of the world. Proper water recycling, rainwater harvesting, and sewerage irrigation will meet the demand for water.</p>
<p><b>Energy efficiency</b></p>		
<p>Energy is wasted in various ways due to a lack of awareness among the people, and it can be rectified by proper planning.</p>		<p>Installing large ventilated windows that allow sunlight to enter the library well reduces the need for electric lights as well as the need for a fan. By setting up a solar panel and meeting the electricity demand, the use of solar energy and electricity demand are reduced.</p>
<p><b>Building materials</b></p>		
<p>To get the many building materials needed to build a building, we must trust the environment, as it depends on things like land, water,</p>		<p>Construction costs can be reduced by recycling the materials needed to build the building.</p>

and trees. It's either all or nothing.		
<b>Indoor climate control</b>		
There are many problems in adjusting the weather conditions indoors	When compared to inefficient or low star rated lighting, heating, and cooling devices, designing the right ventilation systems to control the climate and temperature systems will save a lot of energy.	

### **Further Suggestions**

- ❖ With the various sections of the library in mind, the following recommendations are made to green all libraries and to protect our environment, thereby adhering to green library policies and thereby making libraries sustainable.
- ❖ The government or the administration should consider standard policies in their buildings to be sustainable. Services and practices to reduce the negative impact on the environment on which it is based. Spread and market the green activities of the library through various projects, social media, or other means.
- ❖ Teach LIS students about green library activities and the need to put them into practice so that the next generation of libraries will follow these ideas.
- ❖ Engage in organic roof gardening, which decreases the heat of library buildings, improves the team-building capacity of staff, and improves employee morale. Institutions that require approval, as well as all businesses, must obtain permission to visit green libraries and green buildings.
- ❖ Promote sustainable collection services such as e-books and e-magazines that reduce paper consumption. Reuse and recycling ideas should be encouraged and implemented.

- ❖ The government should take steps to encourage green libraries to expand and increase their concept through awards and financial assistance to maintain libraries. Provide systematic financial assistance to organizations hosting UGC conferences, seminars on green library ideas, and projects on green library practices.

### **Use of green practices in the use of library materials and equipment**

- ❖ All equipment used for handling the library should be kept in mind for the "green library," which reduces the overall energy consumption and can take the following steps to green the library:
- ❖ Membership can be applied for through the Mode online system. The required supporting documents can only be collected in soft copy.
- ❖ The library card catalog should be replaced by an OPAC system.
- ❖ Providing online services using Web 2.0 technologies
- ❖ E-receipts can be issued via SMS or mail instead of paper receipts. This will reduce the use of paper.
- ❖ The use of electrical appliances based on the latest star rating to reduce electricity consumption also reduces electricity bills.
- ❖ LED lights and tubes can be used for lighting; they reduce electricity consumption.
- ❖ Library lights can use natural light during the day, and arrangements can be made to prevent natural light from passing through.
- ❖ Laptops that use less power than desktop versions can be used.
- ❖ Scanning documents instead of Xeroxing them can be encouraged by providing a scanning service instead of Xeroxing, which reduces the use of paper.
- ❖ The E-Writing Tablet can be used as a reference when reducing the number of papers.
- ❖ Older, power-consuming types of equipment can be replaced with new, star-rated products.
- ❖ Solar panels can be placed in library buildings to generate and use solar energy in the library.
- ❖ The structure of the library and the creation of solar energy and roof plants by the library staff improve the relationship between them and each other and give a good message to the community.
- ❖ An indoor garden inside the library, grow plants in plant pots.
- ❖ Indoor air quality can be enhanced by growing indoor plants.
- ❖ Avoid air conditioning in a library as much as possible, as it emits toxic components into the air. Air conditioning can only be used by digital libraries and laboratories.

## Conclusion

A green library is not just green; it is the beginning of a new era of green recovery. The words of Mahatma Gandhi can be overlooked here. When a person is reluctant or cares too much about himself or herself, do the following test. Bring to mind the face of any man he/she has ever seen in a very bad and weak position. Will the effort that develops in their thinking help them in any way? Will he get anything out of it? Will it redeem him from the life and destiny he leads? In other words, will it save millions of people from starvation? If yes, then remove the hesitation and change yourself. No one should think about why we should turn the library into a green library and get stuck in the dilemma of converting it (Gandhi's Talisman, n.d.).

This alternative thinking that we undertake today will be of great help to our society of tomorrow, and it will help to keep our situation stable. The green library we carry out is designed to benefit not only today's generation but future generations as well; it does not affect nature and will work with it. With the help of modern technology, libraries can catalog the data that clients need to use from wherever they are. It helps users and others care about the environment by creating a sustainable green library free of disease. An excellent library is one that provides its users with the information they need without wasting their time. Such a library tells the users about nature and the need to green the buildings so that they can understand automatically from the moment they enter the library. The green library serves as a role model for all parties to raise awareness about greenery, reduce the cost of green buildings, and use environmentally friendly, recyclable materials. Greening libraries can create a huge market for environmentally friendly buildings and their raw materials to raise awareness about their structure and operation.

---

Sivaprasad P. <[sivaprasadpunnath@gmail.com](mailto:sivaprasadpunnath@gmail.com)>, Research Scholar, Department of Library and Information Science, Alagappa University, Karaikudi, Tamilnadu, India.

Thanuskodi S. Ph.D. <[thanuskodi\\_s@yahoo.com](mailto:thanuskodi_s@yahoo.com)>, Department Head of Library and Information Science, Alagappa University, Karaikudi, Tamilnadu, India.

Nagaiah M. [nagaiyahben@gmail.com](mailto:nagaiyahben@gmail.com), Research Scholar Department of Library and Information Science, Alagappa University, Karaikudi, Tamilnadu, India.

## References

- Afacan, Y. (2017). Sustainable library buildings: green design needs and interior architecture students' ideas for special collection rooms. *Journal of Academic Librarianship*, 43(5), 375-383.
- Antonelli, M. (2008). The green library movement: An overview and beyond. *Electronic green journal*, 1(27). <https://doi.org/10.5070/G312710757>
- Aulisio, G. J. (2013). Green libraries are more than just buildings. *Electronic Green Journal*, 1(35). <https://doi.org/10.5070/G313514058>
- BREEAM: Bre Group*. BRE Group | Building a better world together. (2022, December 16). Retrieved December 21, 2022, from <https://bregroup.com/products/breeam/>
- Fallik, S., Soper, D., & Sparks, K. (2012). Green libraries on the cheap. *PNLA Quarterly*, 42-49.
- Filar Williams, B. (2011). Embedding your green message through asynchronous learning. *Electronic Green Journal*, 1(32). <https://escholarship.org/uc/item/4vt250k7>
- Gandhi's Talisman - Gandhi's Famous Quotes* | *mkgandhi.org*. (n.d.). <https://www.mkgandhi.org/gquotes1.htm>
- Green Building & Sustainable Architecture in India - about Us*. IGBC. (n.d.). Retrieved December 21, 2022, from <https://igbc.in/igbc/redirectHtml.htm?redVal=showAboutusnosign>
- Home*. World Green Building Council. (2022, November 4). Retrieved December 21, 2022, from <https://worldgbc.org/>
- India, M. (2020, December 14). *Chettinad, the forgotten splendor of tamil nadu*. MAGIK INDIA. Retrieved December 21, 2022, from <https://magikindia.com/chettinad/>
- Khalid, A., & Batool, S. H. (2020). A Qualitative Case Study of Green Environment: Practices, Attitudes and Future Strategies of Pakistani University Librarians. *Electronic Green Journal*, 1(44). <https://doi.org/10.5070/G314443701>
- Meher, P., & Parabhoi, L. (2017). Green Library: An overview, issues with special reference to Indian libraries. *International Journal of Digital Library Services*, 7(2), 62-69.
- Mission and goals*. TERI. (n.d.). Retrieved December 21, 2022, from <https://www.teriin.org/mission-and-goals>
- Odlis*. ODLIS S. (n.d.). Retrieved December 21, 2022, from [https://products.abc-clio.com/ODLIS/odlis\\_s#sustainablelib](https://products.abc-clio.com/ODLIS/odlis_s#sustainablelib)
- Prasanth, M., & Vasudevan, T. (2019). Going Green: Libraries for Sustainable Development. [https://www.researchgate.net/publication/331319223\\_Going\\_Green\\_Libraries\\_for\\_Sustainable\\_Development](https://www.researchgate.net/publication/331319223_Going_Green_Libraries_for_Sustainable_Development)

Purohit, S. (2013). Green Library: A New Concept of Library. In *International Conference on Entrepreneurial Approaches to Librarianship*.

Saini, P. K. (2017). Green Libraries: Need of the 21st Century.

Thomas M (2014). Importance of eco-friendly space for the intellectual erudition and spiritual. In *International Conference on Library Space and Content Management for a Networked Society*

Wakeel, M., Chen, B., Hayat, T., Alsaedi, A., & Ahmad, B. (2016). Energy consumption for water use cycles in different countries: A review. *Applied Energy*, 178, 868-885.

What is LEED certification? – U.S. green building council. (n.d.). Retrieved December 21, 2022, from <https://support.usgbc.org/hc/en-us/articles/4404406912403-What-is-LEED-certification->

### Acknowledgment

This article has been written with the financial support of UGC STRIDE Component-I grant sanctioned vide Letter No. F. 2-5/2019(STRIDE-I) Dt.03.12.2019.

***Electronic Green Journal, Issue 49, ISSN: 1076-7975***