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Developing Climate Masjids Through Building, Energy, Water, Waste, and Land Use Standards

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Abstract

The research analyzes the masjids based on a Climate Bonds Standard (CBS), focusing on five aspects: building, energy, water, waste, and land use. Based on the Climate Bond Standards through the green standard application, this study is expected to provide a comparison for assessing and improving the practice of green masjid deeply. The research methodology integrates best practices specific to Indonesia by conducting similar research in several masjids and other best practices. The findings suggest that buildings should be efficient and green, energy can be optimized with solar power and other renewable sources, local providers and recycling water management can efficiently supply water, waste can be effectively recycled for better function, and land use or eco-friendly practices, such as planting and using eco-enzymes, can significantly benefit overall sustainability. Despite the potential benefits, implementing these environmentally friendly solutions requires large investments, despite significant long-term benefits. This may be the first paper proposing a Masjid based on climate criteria.

Keywords: *Climate, masjid, solar, water, recycling*

Introduction

The mosque is the first institution established by the Prophet to support the Islamic society in Madina. It serves as a place of worship, a source of religious guidance and information control, and the center of scholarly activities. When the Prophet Muhammad (PBUH) and the believers migrated to Madina, those who migrated (muhājirīn) and those who welcomed them (anṣār) had a strong desire to be guided by revelation. They sought to attain Allah's pleasure and fulfill their purpose as Muslims to serve Allah and lead a well-ordered life. Consequently, the Prophet's initial plan was to construct a mosque with simplicity. He used sand and pebbles for the flooring, palm branches for the ceiling, and tree trunks for the pillars. However, when it rained, the ground could become muddy; moreover, he ensured there was a space for dogs to pass in and out of the walls (Al-Ghazali, 1999). From the Prophet's example, we learn that when building a mosque, considerations such as modesty and simplicity,

the use of available and affordable natural materials, and the local climate should be taken into account.

Furthermore, mosques, as building and infrastructure investments belonging to the ummah, should be maintained following climate standards that comply with values related to the issue of net zero emissions and best practices in adaptation and resilience. Thus, this is in line with the words of the Almighty: Mosques should be visited and sustained as a form of faith in Allah and the Last Day (Mosques of Allah must be visited and maintained as a form of belief in Allah and the Last Day) (9:18). Therefore, the Climate Bond Standards as an international best practice for green building investments in line with the Paris Agreement goal of 2 Degrees Celsius warming have been formulated by the Bond Secretariat Climate. They are from the Technical Working Groups (TWGs) and Industrial Working Groups (IWGs), consisting of independent and external scientists and experts in their respective fields who have developed and determined physical and infrastructure investments in line with the net zero emissions target by 2050 .

The recommendation to maintain the cleanliness of the mosque and its fragrance is an order of the Prophet Muhammad as well. According to Aisyah (may Allah be pleased with her), she reported that Rasulullah (pbuh) commanded the construction of mosques in villages, and these mosques must be maintained as clean and fragrant (Bulughul Marām, mosque chapter, hadith no. 262 narrated by Ahmad, Abu Daud, and At-Tirmidhi (Al-Asqalani, 2010). However, it is stated in the Quran chapter 2 verse 30, "… They said, "Will You place upon it one who causes corruption therein and sheds blood, …". Therefore, God has informed us that human beings would bring destruction upon the earth. Thus, as Muslim, we have to concern with this issue.

The research gap lies in the adoption of Climate Bonds Standards (CBS) in masjid applications, such as buildings and their infrastructure. Thus, the novelty of this paper is to reconstruct the standards for Green masjid based on Climate Bonds Standards (CBS) and its modifications, which have yet to be standardized. This can also be referred to as climate masjid, representing the highest standard for green issues.

Literature Review

Climate Bonds Initiative has identified several challenges in generating revenue that addresses green issues such as clean energy, sustainable water and wastewater management, low carbon buildings and the built environment, as well as agriculture, including waste management and recycling. This can be a significant concern for this issue (Climate Bonds Initiative, 2018). The standards have been reviewed by experts and reference the Paris Agreement (Climate Bonds Initiative, 2022).

Numerous green projects, such as renewable energy initiatives or green buildings, have cited the Climate Bonds Initiative (CBI). This practice has gained traction in various countries (Sobik, 2023). This includes water harvesting infrastructure that adheres to these standards (Lazurko & Venema, 2017).

The Climate Bonds Standard (CBS) encompass several categories (see Figure 1). Each category consists of units, for example, energy, transport, water, buildings, land use, marine resources, industry, and waste. In the case of masjid qualification for climate standards, we only adopt certain relevant categories for our study. Additionally, not all standards are accessible due to separation and preparedness of the standards.

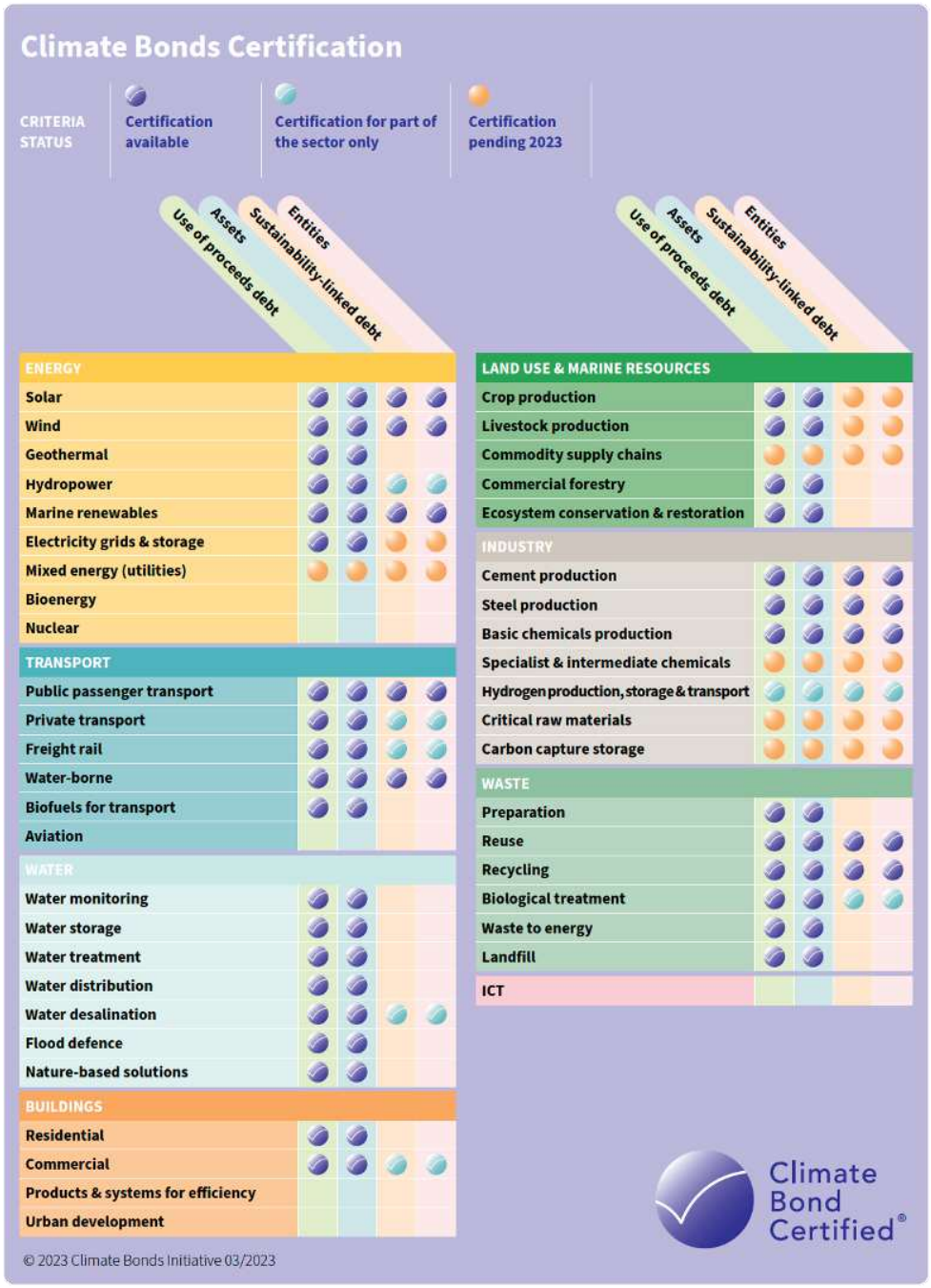


Figure 1. Climate Bonds Certification
Source: https://www.climatebonds.net/standard/taxonomy

These are types of taxonomy in the Climate Bonds Standard (CBS) that can be applied to masjid applications and infrastructure. They are:

a. Buildings

Buildings have certain requirements to comply with the Climate Bonds Standard (CBS). The key point is that the building must have low carbon or, alternatively, the lowest greenhouse gas (GHG) emissions. For example:

i. Low-carbon buildings

The building should not require significant power to support its electricity needs, utilizing features such as open spaces, transparent sunlight, and good air circulation. Refer to the low-carbon building criteria.

ii. Efficiency

It should utilize the smallest electrical tools, thereby consuming minimal electricity in addition to non-fuel resources.

Specific standards for building criteria refer to Climate Bonds Standard v4.0.

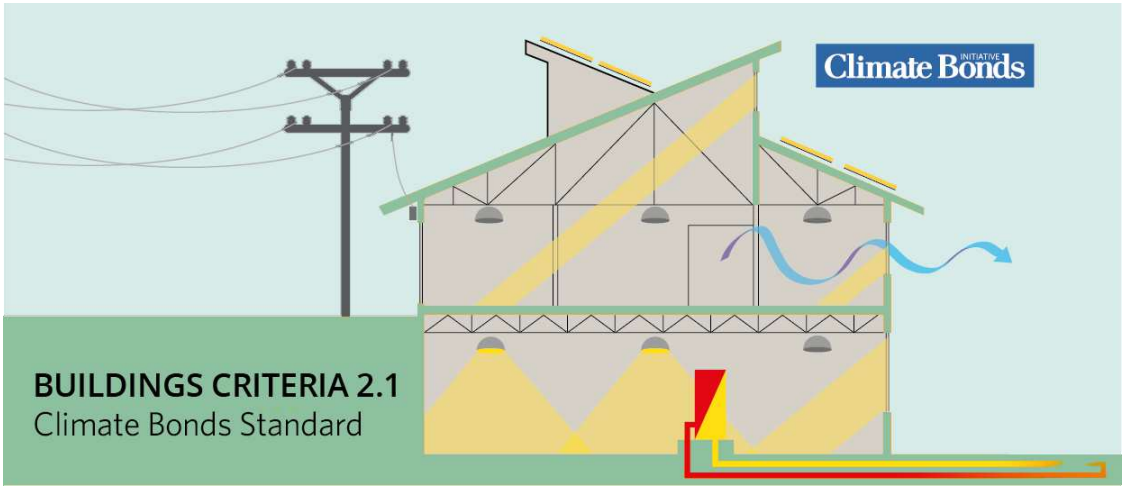


Figure 2. Building Criteria
Source: https://www.climatebonds.net/standard/buildings

b. Energy

i. Electrical utilities

Electrical tools or utilities are essential to decrease electricity use or resources. In addition, the use of fossil fuels power should be eliminated to reduce pollution which can cause Greenhouse House Gases (GHG). Basically, there are two issues:

a. Climate change mitigation
b. Climate adaptation and resilience.

This covers the power, transmission, distribution network, and end use (see Figure 3).

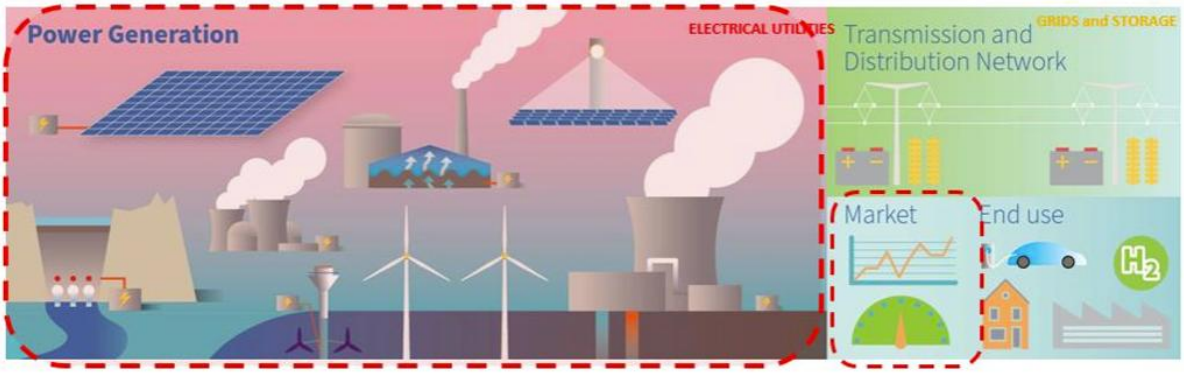


Figure 3. The electricity value chain

Source: CBI (https://www.climatebonds.net/files/files/cbs-electrical-utilities-background-document.pdf)

ii. Solar energy

Solar energy can be defined as electricity power source based on solar panel use (see Climate Bonds Standard v4.0).

iii. Wind energy

Similar to solar energy, this is based on wind (see Climate Bonds Standard v4.0).

c. Water

i. Water infrastructure

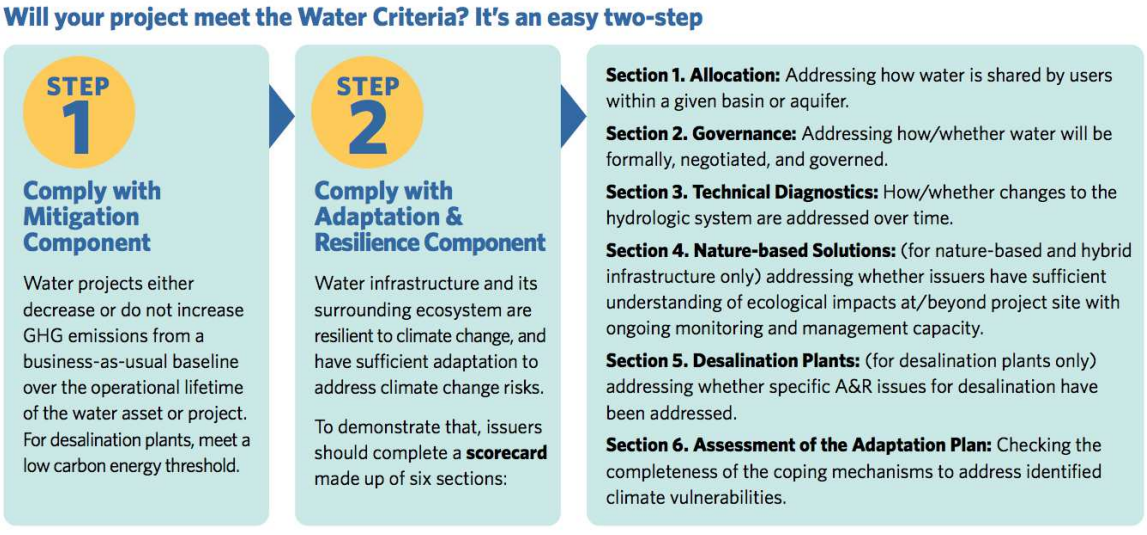


Figure 4. Water infrastructure criteria

Source: https://www.climatebonds.net/standard/water

According to Climate Bond criteria, the water infrastructure should meet the easy two steps (see Figure 4), Step 1 must comply with mitigation components and Step 2 must adhere to the components of adaptation and resilience. There are six sections as stated above. This is prepared by water consortium, they are Climate Bonds Initiative, Ceres, World Resources Institute (WRI), CDP and the Alliance for Global Water Adaptation (AGWA), which is supported by Stockholm International Water Institute (SIWI).

d. Waste

i. Waste management

Based on the Climate Bonds Standard, to increase ecosystem resilience to climate change, the management of the Climate Mosque must be able to prevent the entry of waste, emissions, and other pollutants into the masjid's environment. However, climate change can impact the strength of assets and facilities through the intensity of weather events, beach inundation, and more extreme temperatures. To address this issue, the Climate masjid management must ensure special requirements regarding resilience and adaptation to climate change, that waste management facilities are strong enough to mitigate climate change, and that waste management assets/projects do not harm climate resilience or the surrounding area of operation. In addition, the climate risks posed to the waste management sector are more due to the resilience of asset levels and facility placement [1].

Therefore, at least several things that can be learned from the Climate Bonds Standard for Waste Management and implemented by climate mosques are (a) Collection (b) Sorting (c) Reuse and recycling (d) Composting & anaerobic digestion of green/garden/yard and food waste.

e. Land use and marine resources.

i. Forestry, land conservation and restoration

This subject requires a project to have land conservation and forestry as much as possible. This includes plantation and to maintain land.

These standards are developed by some independent groups such as California State Teachers Retirement System (link is external) (CalSTRS), Institutional Investors Group on Climate Change (IIGCC), The International Cooperative and Mutual Insurance Federation (ICMIF), Investor Group on Climate Change, Ceres Investor Network and The Natural Resources Defense Council.

[1] Source: The Waste Management Criteria Climate Bonds Standard December 2019.

Method

The research method employed in this paper was based on a qualitative approach. We utilized both secondary and primary data. Secondary data were sourced from websites, articles, and documents, while primary data were derived from researchers' observations. However, this does not include human or animal experiences. Using the available data, the researchers compared it to the Climate Bonds Standard (CBS), and for any standards that were unavailable but relevant to the characteristics of masjid, the author made recommendations.

Result and Discussion

1.1. Buildings

Referring to CBS, buildings have negative aspects as they can emit carbon, even if the amount is not substantial. A masjid can be categorized as a commercial building, which is typically larger than a house or residential structure. A masjid should have ample sunlight to minimize the need for artificial lighting and ensure good air circulation to reduce reliance on air conditioning (AC), which consumes significant electricity and contributes to carbon emissions. Furthermore, buildings should be constructed using green and safe materials. Additionally, each dimension of a building requires energy, which can lead to CO2 emissions. (see Figure 5).

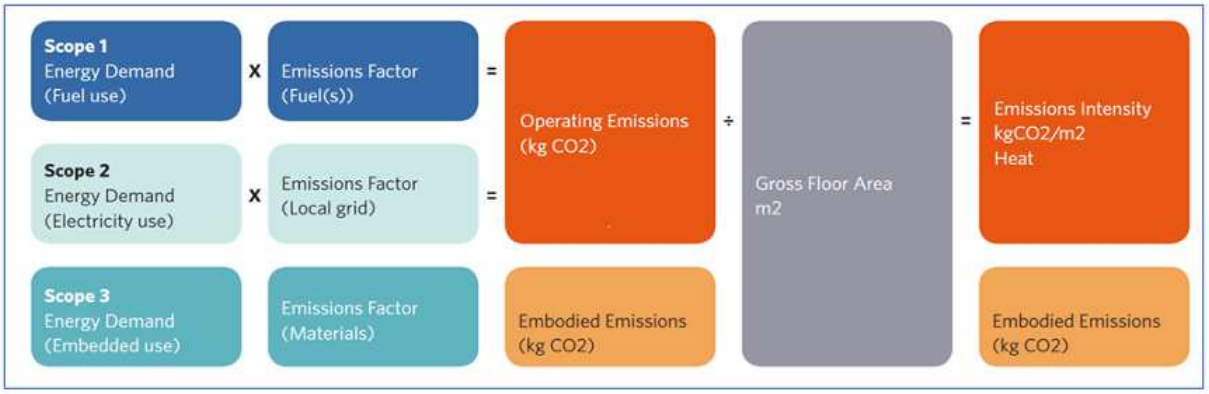


Figure 5. Conversion to CO2 emissions

Source: (CBI: Buildings Criteria - Background Paper, 2023)

Based on CBS, to get low carbon emissions, buildings should have approved technologies such as Energy-Efficient HVAC Systems, LED Lighting, Renewable Energy Systems, Building Envelope Technologies, Low-Emissivity coatings, Double and Triple Glazed windows, Advanced Building Automation and Controls, Water Efficiency Technologies, Sustainable Materials, Energy Storage Solutions, Indoor Air Quality Technologies, and Smart Building Technologies (CBI, 2023).

1.1.1. Open space

Masjid, which is filled with people praying, should have excellent air circulation and ventilation to prevent hot and unclean air. Therefore, an open-space masjid is one of the solutions. With an open area, it would minimize the need for fans or air conditioning, which can lead to high electricity consumption. This would also decrease the reliance on lamps, as sunlight can enter through the glass or open space. Additionally, it reduces the use of materials such as cement, sand, and steel for wall construction. See Figure 6, which illustrates an open-space masjid that is highly efficient in energy usage.



Figure 6. Masjid with open space, sunlight penetrating and good air ventilation

Source: https://www.ui.ac.id/ada-apa-dengan-ramadhan-di-masjid-ui-tahun-ini-2/



Figure 7. Big sliding window or door for good air ventilation

In case masjid must have a wall, the windows must be quite large and based in sliding scheme for windows or doors. So, air can circulate well (see Figure 7).

1.1.2. Anti heat paint and roof

Using paint that can reduce heat would also lower carbon production; additionally, the temperature inside the masjid would not be as hot because this paint can reflect heat from sunlight. Meanwhile, the roof also has certain specifications to help reduce heat. This technology should be adopted by masjids to lower the temperature inside and improve air circulation (see Figure 8).



Figure 8. Anti-heat paint and colling roof

1.2. Electricity

1.2.1. Solar panel Hybrid

Masjid should install solar panel for electricity, the scheme can be hybrid which is beneficial in the daylight or afternoon where solar panel can reduce the use of electricity from government. In addition, excess energy can be stored in the battery which can be used in the evening or during the electricity is off (see Figure 9).

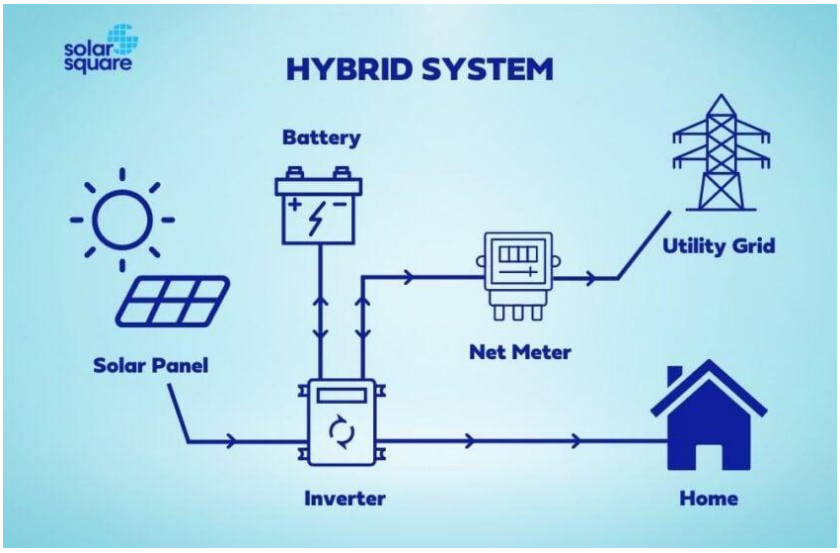


Figure 9. Hybrid solar panel system
Source: https://www.solarsquare.in/blog/hybrid-solar-inverter/

1.2.2. Led lamp

Led lamp or efficient lamp must be used by masjid in order to reduce electricity usage. This saving can also reduce carbon which used by normal lamps.

1.2.3. Lamp solar panel

Lamp solar panel can be used outside masjid like in the street and part. It is easy for installation and can save electricity. In addition, it has automatic lamp which can lower the light if there is no movement or people below.



Figure 10. Solar panel lamp

1.3. Water

Eventhough, masjid does not directly attach to the water management and system. But it can adopt some standards such rain water absorption, water recycle, and water management

1.3.1. Water control

To control the water, the students from Bakrie University brought innovation while studying the saving of water flow for ablution purposes. Two important technological devices, the *flow restrictor* and the *solenoid valve*, control water flow for ablution purposes. These two devices can help save water usage for climate mosques as well. When the ablution faucet is installed with one of these technologies, the result is that this *flow restrictor* set can save water from the usual usage of ±2816 liters to 933 liters (67%), which has been tested for use at the Bakrie University prayer room (Mushola). In contrast, the faucet has a *solenoid valve*, saving water volume up to 37.5% (Madonna et al., 2013). In addition, the flow of water can be minimized with straw.

1.3.2. PAM (local water facility) water

Avoiding using water from soil is not for the long term as water would shortage and the soil level would be decrease. If masjid would like to use soil water they should be efficient and having very good absorption to inside soil. So soil water conservation can be maintained well.

1.3.3. Recycle wudhu water

Using recycled water for ablutions is a good water-saving measure that can be followed up in mosques throughout Indonesia. *Wuḍū'* (ablution) is known as a water purification of the face, hands, head, and legs based on the Qur'anic verse, (O ye who believe! When ye prepare for prayer, wash your faces and your hands (and arms) to the elbows; rub your heads (with water) and wash your feet to the ankles (5:6), and the Prophet's hadith (God does not accept the prayer of any of you if he in the state of impurity/ *hadath* until he performs ablution)[2] and *ijmaʿ* - the consensus was reached on the legitimacy of ablution from the Prophet Muhammad (Sābiq, 1995). Hence, prayer would be acceptable if it is done after water purification unless there are certain conditions such as unavailability of water, travel due *(safar),* or sickness that caused them to avoid water.

[2] Narrated by the two sheikhs, Abu Dāwud and Al-Tirmidhi.

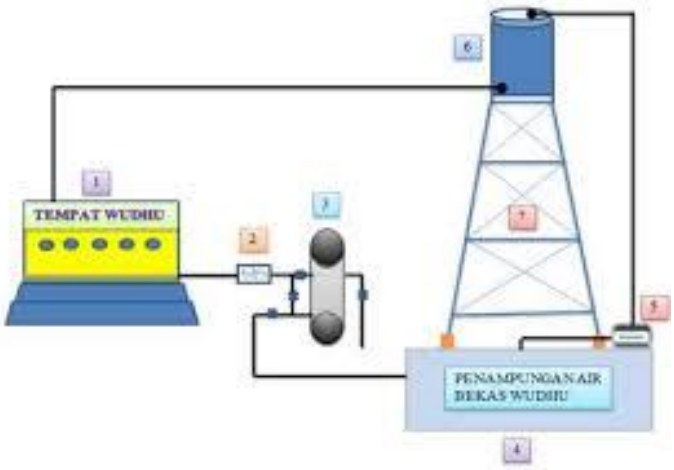


Figure 11. Recycle wudhu water

Source: (Lubis and Sutisna, 2006)

Some scholars differ in their opinion regarding pure water being changed by the presence of pure objects such as tree leaves, soap, potash, or pure ingredients if they are not dominant in the resulting mixture. The sound opinion says that the water produced is still considered pure and can be used for purification, such as ablution (Al-Fawzan, 2005). Therefore, water use for ablution should be managed and recycled effectively, as was done by the Ulil Albab Mosque, Indonesian Islamic University (UII), in planning efforts to save the quantity of clean water used at the Ulil Albab Mosque-UII. The illustration can be seen in Figure 11.

1.3.4. Rain Tandon



Figure 12. Tandon rainwater

Source: https://citarumharum.jabarprov.go.id/yuk-bikin-sumur-resapan/

This can mean that water from rain would be allocated to soil with more than 5 m wells. So, all water that fell from the roof of the masjid would be absorbed by the soil (see Figure 12).

1.3.5. Bio-pore hole

The advantage of bio-pore making is that it can fertilize the soil and make natural compost, and it does not require land, costs, or much effort to make (Komara, 2023). Therefore, this should be created in some places around the masjid to absorb water (see Figure 13).

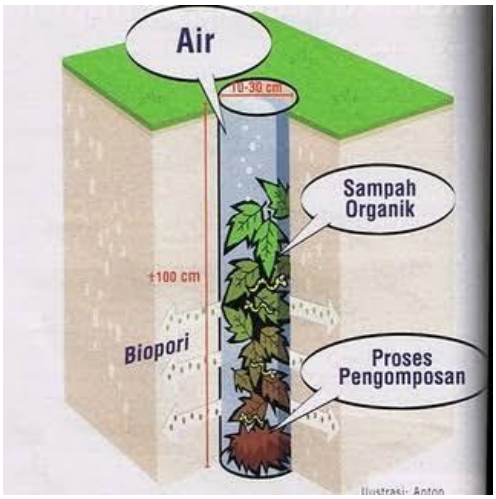


Figure 13. Tandon rain water

Source: https://sitaliya.sch.id/?p=1066

1.4. Waste

Masjid is, in general, where many people gather and have a lot of activities. It usually produces a lot of waste. So, CBS is suitable to be a standard in waste management. So far, masjid has sorted garbage into three parts: organic, non-organic, and toxic waste. Therefore, it is more efficient and beneficial to recycle the waste.

1.4.1. Organic waste

To reduce waste, they divide it into *organic* and *non-organic* waste. Organic waste is household waste produced as vegetables, food, fruit, etc. Meanwhile, non-organic waste, made from non-biological materials, can be synthetic products or the result of technological processes, such as paper, plastic, and electronic waste. After that, the sorted waste can be deposited into the Mosque Waste Bank using two schemes: pure *infaq* (charity) or savings. However, waste bank customers choose it practically as pure charity. From the original total waste produced by 936 household heads, ±65.37 m^3 was reduced by 11.18 m^3 to 54.18 m^3. As a result, the *jama'a* of the masjid and the community

who participated in it not only get the cleanliness benefit but also contribute to the religious and building Masjid As-Sa'adah funds through waste sorting (Sunardi, 2021).

1.4.2. Plastic garbage

The waste sorting is directed at sorting waste into four classifications: (a) plastic waste, (b) paper waste, (c) residual waste, and (d) organic waste. The plastic and paper garbage groups are ready to be separated from the household's meeting point. (Komara, 2023). Hence, from this beneficial and environmentally caring act, the people of Al-Falah Mosque have developed awareness of better behavior towards handling waste to save their environment.

1.4.3. Used cooking oil waste

Another spectacular action in saving the earth from waste is processing used cooking oil *(jelantah).* Furthermore, this cooking oil is used oil that is unhealthy if reused for cooking. However, it can have a harmful impact if thrown away carelessly. Moreover, it will be economically valuable if collected in large quantities and resold to others (agents who rebuy back the oil). Al-Ihsan Green Waqf, Permata Depok Residents, has applied for this waqf scheme, open for used cooking oil donations from Monday to Saturday from 07.00-11.00 am. Fascinatingly, from the collected used cooking oil gathered ±155 kilograms in seven containers sold for Rp 888.000, - has been donated for the waqf land acquisition[3] (see Figure 14).



Figure 14. The Used cooking oil donation flier (Source: @sahabatwakaf6270)

[3] https://www.youtube.com/watch?v=dH6BOPXBhHs (accessed on September 8, 2024).

1.5. Land use and marine resource

1.5.1. Planting

Green Wakaf Al-Ihsan (GWA) has green spaces for plantations to promote the green endowment movement. These green spaces are allocated for several medical herbs, green plant food, and a variety of vegetables as well. When the plants are ready to harvest, visitors interested in consuming them at home can pick up all the plants. Therefore, people may enjoy harvesting the plants and vegetables by donating the charity for waqf land acquisition without any limited price based on sincerity.[4]

Some of the collections of green plants in the land of Al-Ihsan are various types of mint leaves, green beans, long beans, spinach, chili variants such as red and purple chilies, albino (white) eggplant, yellow and white corn, *ciplukan (physalis angulate)* and many more. *Ciplukan* is an herbal plant originating from South America and Central America. This traditional medicine, good for antioxidants, lowering blood sugar for diabetes sufferers, and lowering anti-inflammation, has been used by the Incas, Maya, and Aztec ethnicities for centuries.[5]

1.5.2. Eco enzyme

Eco enzyme (EE) products can be used to preserve the environment by recycling organic waste. It is an extraction of fermented liquid from leftover vegetables and fruit with brown sugar as a substrate. Dayah Baitul Qur'an, located in the Baitul Ahad Mosque Residents, Siem, Aceh Besar, has turned discarded waste into something useful and of economic value. To continue to produce Muslim cadres from underprivileged groups to receive formal education, the Dayah must finance their operational costs by producing and marketing the products of *eco enzymes*. Producing this *eco-enzyme* product is generally simple, like composting products, but with some additional water. Besides, it does not require large media or land using reused bottles or containers such as mineral water or other products for fermentation.

From the analysis above, we can state that the adoption of CBS in masjids can create a better vision of preserving the environment. In addition, other issues or recommendations for climate masjid, which is eco-friendly, can also be added. The comparison can be seen in the table 1.

Table 1. Modification of CBS to Climate masjid

[4] https://www.instagram.com/wakaf.masjidalihsanperdep/reels/.

[5] https://wartapilihan.com/koleksi-green-wakaf-al-ihsan-gwa-ciplukan-buah-mini-dengan-khasiat-maksi/

Description	CBS	Climate masjid
Building	Low carbon	Open space, good air ventilation, sunlight penetration
Energy	Solar, Wind	Solar panel, low-watt electricity
Water	Recycle	Recycle of wudhu, water absorption
Waste	Sort, recycle	Sort, recycle
Land Use	Deforestation	Planting, eco enzyme

Conclusion

The paper discusses how CBS can serve as a standard for climate-friendly or high-green masjid with modifications. Buildings for masjid can be designed with open spaces that allow for good air ventilation and sunlight penetration. Masjid must also incorporate solar panels for energy and facilitate low-watt electricity usage. Water conservation should be well-maintained, including provisions for wudhu. Waste should be sorted and recycled, which is beneficial. Planting should be a top priority, along with eco-enzymes to promote eco-friendly products.

The limitation of this paper is that only specific masjids were observed within a short timeframe. Future research for this study should focus on preparing indicators for climate-friendly masjids, enabling people to easily measure these indicators to achieve eco-friendly masjids with high standards.

Funding Declaration

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethics Declaration

This research did not involve human participants or animal subjects. No human or animal data, personal information, or biological materials were collected, used, or analyzed in this study. Therefore, ethical approval and informed consent were not required.

Data availability

All information is included in the paper.

Permission to use third-party material
All information and figures are public and do not require any permissions.

Author contributions
Dodik Siswantoro – Conceptualizing, writing and reviewing paper
Mariati Aprilia Harahap - Witing and reviewing paper.

Consent to Participate declaration: not applicable

Consent to Publish declaration: not applicable

Ethics approval and Consent to participate' declarations: not applicable

Consent to participate: Informed consent was obtained from all participants involved in the study.

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