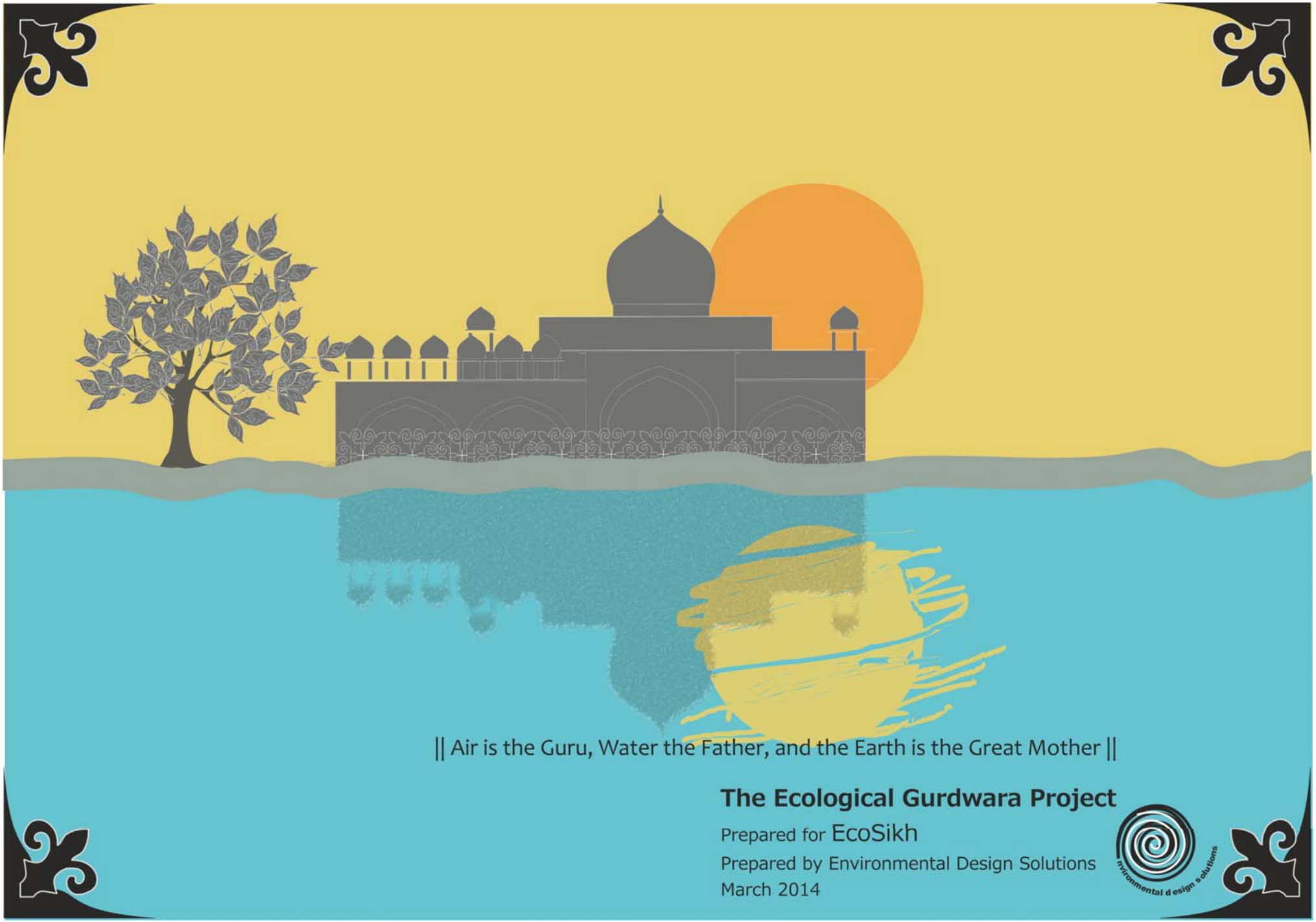

|| Air is the Guru, Water the Father, and the Earth is the Great Mother ||

The Ecological Gurdwara Project

Prepared for EcoSikh

Prepared by Environmental Design Solutions

March 2014

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1. Overview

Spiritual buildings are valuable centres for like-minded individuals to form, discuss, and exchange ideas and beliefs. Sacred places breed trust and receptivity – two key ingredients for embracing the concept of universal collectivity. Therefore, to disseminate the message of sustainable living, environmental stewardship, and the cosmology of 'oneness', what better place to start than the Gurdwara itself?

Objective

The world is awakening to the idea that conservation of ecology and the environment need interventions that extend beyond technical remediation and international treaties. The ecology has, in essence, a deep spiritual connect with people. The term 'conservation' is indicative of a disconnect – it is often understood to connote that governments, administrative bodies, or other institutes are responsible for conserving the ecology. The intensity of the connection between people and ecology may be restored through a faith-based initiative. Such an initiative may rekindle our innate kinship with our environment – propelling us to nurture and cherish rather than merely protect and conserve. So "while many wish to legislate our way out of these crises, the faiths wish to guide, not with ethics and codes but by example and mindfulness, care and companionship rooted in their experience down the centuries and even millennia"[1].

A deep reverence for all creation is an integral part of the Sikh way of life. This document is an extension of the belief 'that a sustainable, more just society is possible, where water, air, land, forests, and biodiversity remain vibrant, living systems for our generation and future generations'[2]. Towards this larger goal, we can begin with examining the physical environment and prevalent practices at our local Gurdwaras. It is an excellent place to start as places of worship have a deep impact on perception, behaviour, understanding, and motives.

A thing is right when it tends to preserve the integrity,
stability, and beauty of the biotic community.
It is wrong when it tends otherwise.

-- The Land Ethic [3]

1 Faith Commitments to Protect the Living Planet, The Alliance of Religions and Conservation
2 http://www.ecosikh.org/about/vision/
3 Aldo Leopold, The Sand County Almanac, with other essays on landscape from round river 240 (enlarged ed. 1966)

The objective of this document is to raise awareness about the depleting resources, endangered eco-systems, and rising levels of pollution on our planet, and to outline concrete steps that could be taken to counter them. The arguments and suggestions are persuasive from both a technical and rational point of view, as well as a spiritual and cognitive perspective.

Introduction

As early as the 15th century, Guru Nanak deemed the earth as 'mother', directing His followers to respect 'mother earth'. [4] A beautiful thought ensconced in Sikh teachings states that humankind surrounds itself with creations that are, in essence, a reflection of their inner state. This may be extrapolated to posit that our depleting environment is directly linked to the spiritual void that has engulfed humans. Sikhism has a strong history of compassion, with countless anecdotes that demonstrate the Sikh Gurus' love for animals, plants, trees, mountains, and rivers. The teachings also emphasize simplicity, encouraging followers to take cognizance of their inner spark rather than seek temporal pleasures. The scriptures declare that human beings are meant to exist in harmony with all creation, without conflict or dominance of one over the other.

In the *Guru Granth Sahib*, Guru Nanak says:

Nature we see
Nature we hear
Nature we observe with awe, wonder and joy
Nature in the nether regions
Nature in the skies
Nature in the whole creation…
Nature in species, kinds, colours
Nature in life forms
Nature in good deeds
Nature in pride and in ego
Nature in air, water and fire
Nature in the soil of the earth
All nature is yours, O powerful Creator
You command it, observe it and pervade within it ||[5]

(Guru Granth Sahib)

[4] http://www.religioustolerance.org/tomek17.htm
[5] http://www.bbc.co.uk/schools/gcsebitesize/rs/environment/sikhstewardshiprev1.shtml

Sikhism and the Environment

Sikhs frequently use the term eco-sophism (meaning 'wisdom of the universe'), while teaching that the natural environment and humankind are inextricably linked. Sikhism urges its followers to respect the dignity of all forms of life, linking this understanding to kindling one's divine inner spark. As one learns to recognise and nurture one's own divinity, one starts to cherish it in other manifestation of this divine entity. The religion firmly rejects the idea of human domination or an anthropocentric universe, instead embracing harmony and co-existence of all forms of creation. Caring for the environment is thus linked to spiritual progress.

According to the Sikh theologian, Kapur Singh, Guru Nanak's teachings imply that there is no duality between spirit and matter[6]. The following verse postulates this thought beautifully:

The Creator created Himself
And created all creation in which He is manifest!
You Yourself the bumble-bee, flower, fruit and the tree.
You Yourself the water, desert, ocean and the pond.
You Yourself the big fish, tortoise and the Cause of causes.
Your form cannot be known.[7]

This is a far-reaching conceptualization, from the spiritual as well as the environmental point of view. Caring for the environment is imperative because it is a manifestation of the same divinity that resides within you and me. Taken further, the verse emphasizes that indeed, we *are* the desert, the oceans, the plants, and animals that constitute our environment. Perhaps even more relevant is the emphasis of the religion on earth-consciousness -- that spiritual progress must be pursued with a firm grip on day-to-day living, so that the 'world itself may be transformed into a spiritual plane of existence'.[8] Clearly, progress in one realm may not be achieved at the cost of the other planes of existence. This interspersing of spiritual and mundane goals is unique to Sikhism and very relevant to the cause of caring for our mother earth. The emphasis is on unity of spirit and matter, and inclusivity, and not on renunciation and abandonment.

When I saw truly, I knew that all was primeval.
Nanak, the subtle (spirit) and the gross (material) are, in fact, identical.[9]

[6] http://www.rsesymposia.org/themedia/File/1151633266-Sikhism.pdf
[7] *Guru Granth Sahib* p.1016
[8] http://www.rsesymposia.org/themedia/File/1151633266-Sikhism.pdf
[9] *Guru Granth Sahib* p. 281

Sikhism follows cycles that span three centuries, the most recent of these beginning in the year 1999. This period (1999-2299) has been nominated the 'cycle of creation'. This is decidedly relevant, and potentially impactful, given the current state of our planet. On a temporal level, the Akal Takhat, the highest spiritual body of Sikhs, has been making definite strides towards addressing and reversing environmental degradation. The Jathedar Gurbachan Singh has stated that caring for the environment is the 'moral and spiritual duty' of Sikhs[10]. To transform these concerns into action, Kali Bein, a rivulet of Beas that is heavily polluted with industrial waste and public refuse, is being cleaned up. The Jathedar went as far as to state that cleaning up of natural resources should be accorded a higher priority over building new Gurdwaras.

EcoSikh and Sikh Environment Day

As a response to the threats of environmental degradation and climate change, a worldwide organization called EcoSikh was launched in the year 2009. The 'organisation arose as part of the Long Term Plans for Generational Change programme initiated in 2009 by the United Nations Development Programme (UNDP) and the Alliance of Religions and Conservation (ARC) to help the world's major religious traditions create long-term plans to improve their relationship with the environment'[11]. March 14, celebrated as *Gurgaddhi* of Guru Har Rai as well as *Nanashahi* New Year, has also been designated Sikh Environment Day, as part of an environmental awareness initiative of EcoSikh.

Figure 1 | Gurdwaras are valuable resource centres

"It is a day of remembrance of our connection with the environment," according to Bandana Kaur, Program Ambassador, Special Initiatives, EcoSikh. It is celebrated in a manner similar to the *Gurpurab* -- by singing *kirtan*, presenting *katha* on the environment, planting trees, and initiating community-level cleaning drives. Other activities, like seminars and processions that promote sustainable living and provide information on energy conservation, are also undertaken.

Gurdwaras as Resource-Centres

Traditionally, Gurdwaras have always played the role of resource-centres for the community. Gurdwaras were specifically designed to

[10] http://www.sikhnet.com/news/environmental-protection-sikhism
[11] http://www.ecosikh.org/about/

include artificial or natural water bodies that were considered a community resource. Moreover, Gurdwaras were always surrounded by community land, jagirs, which served as shelter groves and a source of firewood. The role of the gurdwara as a community centre further expands to include community kitchens (langars), primary medical care centres, and education centres. Typically, guest-rooms are also included on the premises to serve as rest areas for travellers.

Organization of the Document

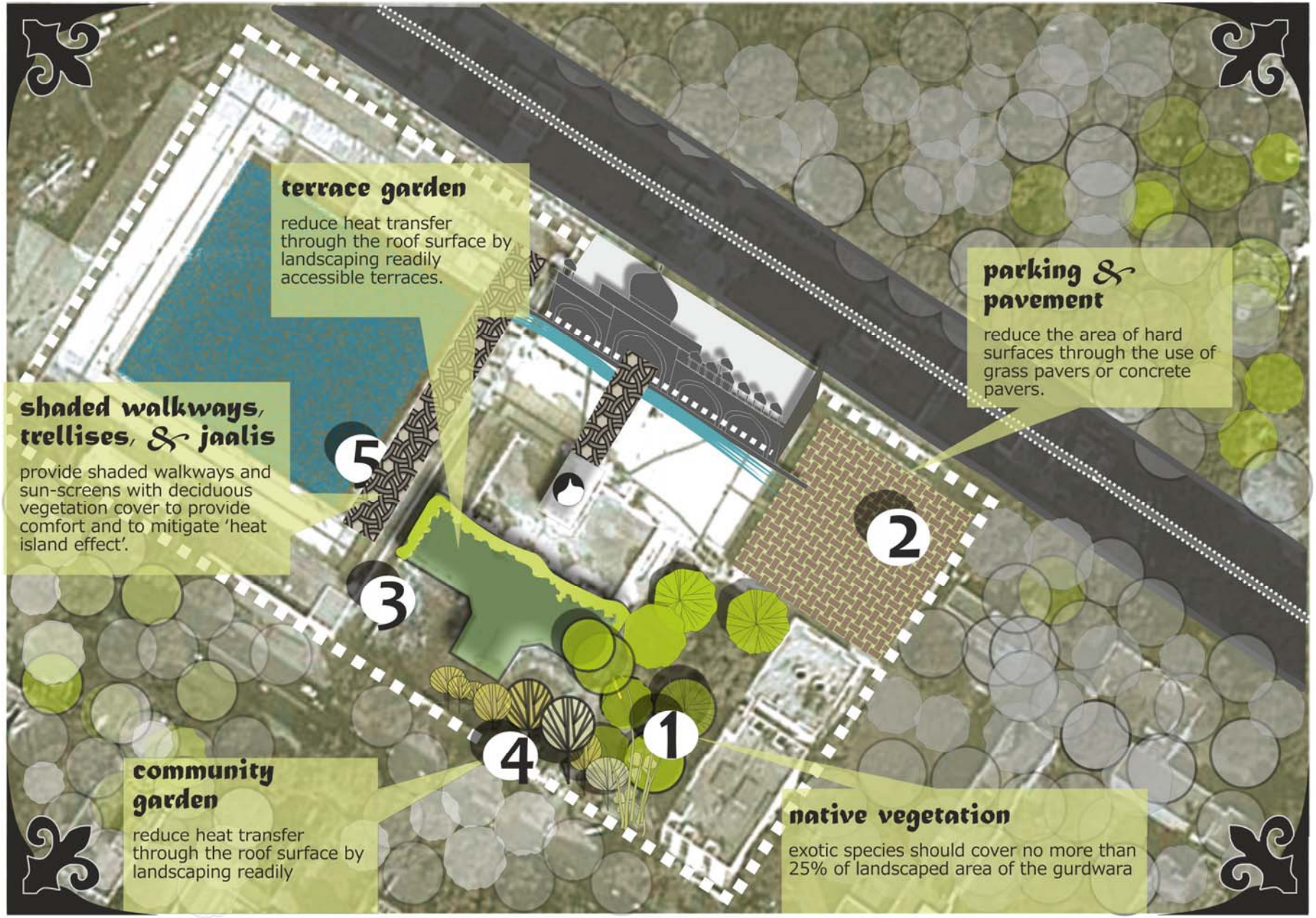
In keeping with the spiritual and environmental mandate of Sikhism, this document has been conceived as a guide for facility managers, caretakers, and members of the gurdwara management. The manual may also interest individuals from the sangat or the community who are looking for resources for practicing sustainable living. The document will help identify and implement appropriate sustainable technologies and environmental practices for Gurdwaras all around India. It is intended to inspire and inform the central Gurdwara committees that facilitate the day-to-day functioning of the Gurdwara, and set overall goals for the future.

It addresses the more technical issues of sustainable landscaping, composting, water conservation, and energy efficiency. However, if there is going to be a real environmental improvement in the regions in which Sikhs live and pray, then it is clear that Gurdwaras need to be leaders in reinforcing green thinking through education, advocacy, religious teachings, and partnership with secular bodies. Such issues have been addressed under the chapter on Green Practices and Education and Waste Reduction. A Glossary of Terms introduces readers to definitions and brief descriptions of frequently encountered terminology, without distracting or disturbing the flow of the main text.

The guidelines are organized under seven chapter headings:

1 Overview
2 Green Landscaping and Sustainable Sites
3 Energy Efficiency
4 Water Conservation
5 Waste Reduction
6 Green Practices and Education
7 Glossary of Terms

Figure 2 | Organization of the Green Guide


terrace garden
reduce heat transfer through the roof surface by landscaping readily accessible terraces.
parking & pavement
reduce the area of hard surfaces through the use of grass pavers or concrete pavers.
shaded walkways, trellises, & jaalis
provide shaded walkways and sun-screens with deciduous vegetation cover to provide comfort and to mitigate 'heat island effect'.
5
2
3
4
1
community garden
reduce heat transfer through the roof surface by landscaping readily
native vegetation
exotic species should cover no more than 25% of landscaped area of the gurdwara

2. Green Landscaping

A garden provides tremendous opportunities for showcasing the environmental cause. Simultaneously, it improves the aesthetics and air quality of the surroundings. At a more tangible level, it provides opportunities for water and energy conservation.

The current approach to landscaping often involves a 'dress-up' with extensive lawns, exotic species, and a groomed appearance. Working with the existing terrain, natural topography, and local species on the other hand, yields a landscape that is not only in-context but also benefits the environment. The garden must be seen as the transitional space that it is – one that enables the forsaking all that is mundane and worldly, and provides a sentient path towards the sacred. In order to bring to the fore this important transition, the garden must be a robust indicator, if not an embodiment, of the consciousness and awakening that the pilgrim seeks. The sangat, therefore, needs to view the surroundings of the gurdwara as a significant space that can inform, facilitate, and further the quest of the seeker. In spiritual texts too, the garden is a recurring metaphor for the macrocosm, as illustrated by this *gurbani* in the musical measure *Raag Aasa* by Guru Arjun Dev *ji*:

There is a garden
It has so many plants created within it
And each bears the sweet-nectared Naam as its fruit ||1||
Consider this, O wise one,
In this garden you may seek the means by which to attain eternal bliss.
O brothers and sisters of Destiny,
This garden has dark pools of poison here and there,
But it also contains the ambrosial nectar within it ||1||

There is only one gardener who tends it.
He takes care of every leaf and branch ||2||
He brought all these plants and planted them there.They all bear fruit – none is without fruit ||3||
The one who receives the ambrosial fruit of the Naam
From the Guru – O Nanak,Such a servant has a way to pass over the ocean of illusion ||4||5||56||[12]

[12] http://www.arcworld.org/faiths.asp?pageID=172

Native Vegetation

Figure 3 | Maintaining the natural balance of species ensures reduced water use and lower maintenance.
Source: http://www.nishan-e-sikhi.org/Environment_album.htm

Native plantation refers to plant species that grow naturally in a region. They are accustomed to the variations in temperature, rainfall patterns and soil conditions that are typical for that region. This means they are usually relatively low maintenance in terms of water usage, and are hardy against local pests. Beyond the first year or two, native flora will stabilize and need no watering.

In addition to reducing water-use, such plants play a significant role in supporting birds and insects that naturally thrive in the region. On the other hand, excessively changing the balance of natural flora and fauna may lead to permanently disturbing the ecological balance of that area.

Recommendations

- It is recommended that exotic species should cover no more than 25% of the landscaped area of the gurdwara.
- Reduce lawn area in the garden to the minimum. This reduces the amount of water that is needed for irrigation.
- Use locally available grasses, which re-establish the balance of species, and provide food for birds, insects and animals.

Parking and Pavements

Surfaces topped with concrete, stones, or tiles absorb a significant portion of the solar radiation. This heat energy is later re-radiated, raising the temperature of the ambient air. However, hard surfaces are often considered essential for pavements, pathways, driveways, and car parks. The solution lies in using permeable grass pavers that are now beginning to replace traditional pavements in low-traffic parking areas, pedestrian walkways, driveways, patios, and other paved areas that are seldom used for vehicular traffic.

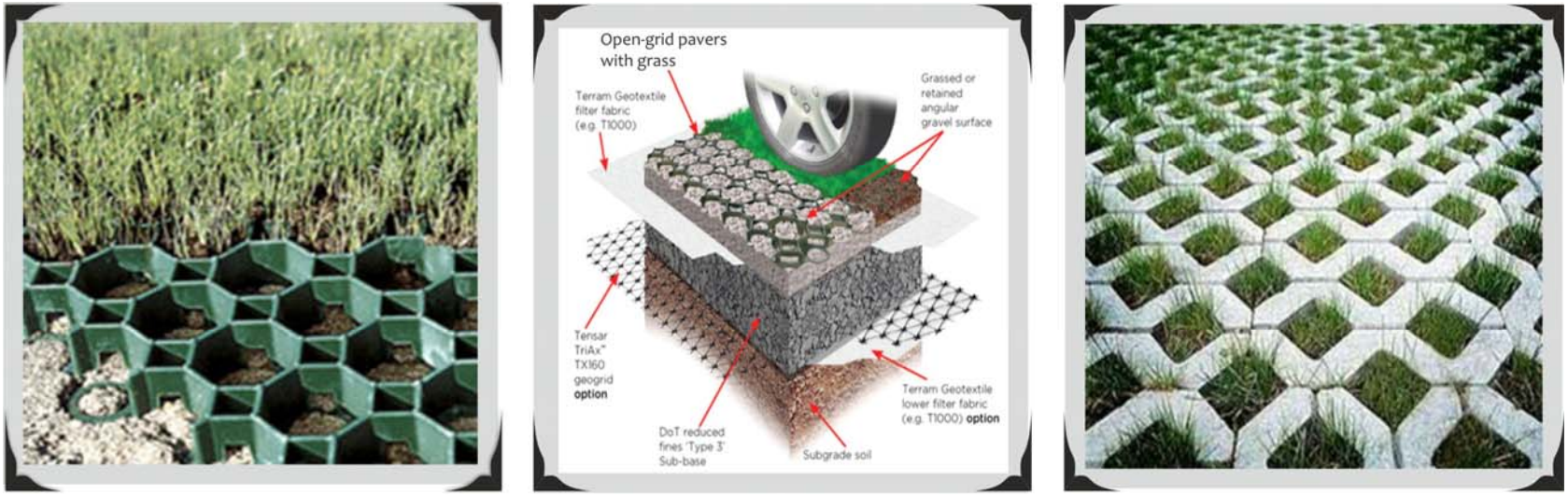


Figure 4 | Open grid pavers maintain the water table by permitting water drain to the soil below.
Source: http://www.nishan-e-sikhi.org/Environment_album.htm

Open grid pavers are usually prefabricated lattice structures made of concrete, plastic, or metal specifically designed to let water drain to the soil below while people walk on them, or drive light vehicles across them. The openings in the lattice blocks are filled with soil, sand, seed, gravel, or turf. The lattice blocks are typically 40 mm in depth. They are usually available in honeycomb-patterned interlocking modules that sit on a sheet of geotextile. *Concrete grass pavers* may be used where a heavier vehicular traffic is expected. They have more structural strength than the open grid pavers. The concrete may be cast in-situ or pre-cast. *Permeable polypropylene pavers* are recommended for pedestrian walkways, patios and other non-traffic areas.

The pavers reduce storm water run-off, allowing the water to permeate through the soil. This recharges the ground water and maintains the water table. In the absence of open grid pavers, the storm water will simply end up in sewers and drains. Eventually, this will deplete the water table. The pavers provide an aesthetically pleasing alternative to concrete surfaces, enhancing the visual appeal of the landscape. Absence of hard surfaces also ensures lower ambient temperature. It is also more pleasant for pedestrians to walk on a green, soft surface that does not radiate heat.

Recommendation

- Reduce the area of hard paved surfaces through the use of polypropylene grass pavers.

- For areas with heavier vehicular traffic, concrete pavers may be used.

Shaded walkways and parking lots

Provide shaded walkways and parking lots where possible. Not only is this more comfortable to visitors but it also ensures reasonable ambient conditions throughout the year, mitigates probability of *heat island effect*, enhances the microclimate, and contributes to the visual appeal of the approach to the gurdwara. Heat island effect is the term given to the absorption and re-radiation of heat by hard surfaces like concrete. This gives rise to higher surface and ambient temperatures near such surfaces. Shading the concrete surface significantly reduces the incident heat, thereby reducing the amount of heat that the surface absorbs and re-radiates. Temperatures for shaded surfaces can be 1-5°C lower than unshaded surfaces.

Recommendations

- Plant trees where possible to create walkways.
- Investigate the possibility of creating "structural shading" using recycled and otherwise discarded components. See figure XXX below. Installing structural shading with a minimum Solar Reflectance Index of 29 (usually materials with light, reflective surfaces) absorbs less heat, and mitigates the probability of heat islands.

Green Roofs

Creating a new building, or an extension of an existing building can often involve destroying existing terrain and vegetation. Green roofs can counter this loss of green cover– and they can also be aesthetically attractive. Establishing plant material on rooftops provide numerous ecological and economic benefits including efficient storm water management, energy conservation, mitigation of the urban heat island effect, and increased longevity of roofing membranes.

Vegetative roof systems typically comprise of a lightweight growing medium, plants, and a root repellent layer on top of the regular components of a roof. The additional components and thickness of the growing medium provides thermal insulation, while the green cover lowers ambient temperatures through evapo-transpiration. However, green roofs may require regular maintenance and involve high first costs. Green roofs are particularly effective if they are applied to the serai (guest house) and langar (community kitchen) areas of the gurdwara.

There are three distinct types of green roofs -- intensive, extensive, and modular block. Intensive vegetative roof systems feel and function like gardens, can look beautiful, and may be accessible as "parks" or as a building amenity. Such systems add a considerable load to the

structure of the roof, requiring a minimum soil depth of 300 mm. Small trees, shrubs, and other landscape features may add an additional load of up to 400 to 750 kg/m2 for the building.

Extensive roof systems are primarily built for environmental benefits. They require a soil depth of 25 to 125 mm and may contain a modest green cover of succulents, thick grasses, and hardy, drought-resistant plants. Additional loads are between 75 and 250 kg/m^2.

The modular block system is made up of several portable, self-contained units arranged on a rooftop. The blocks are typically made of a heavy gauge metal with 100 mm soil depth and a low-growing plant species. A sheet or pad fastened to the underside of the container regulates the flow of water. Such systems weigh 60 to 90 kg/m^2.

A functional and durable green roof needs meticulous planning and execution. A sturdy roof structure is a prerequisite for installing a green roof, as the structure needs to support significantly more dead weight compared to regular roofs. Depending on the soil depth and the kind of garden planned, this weight may vary between 60 kg to 750 kg/m^2.

Recommendations

- It is best to plan for a green roof before building the structure as soil and plant add significant load to the roof. If the green roof is being planned for an existing structure, it is best to keep it simple through planting using modular blocks or through an extensive roof system that uses hardy and drought-resistant plants with minimal water requirements.
- A leaking green roof is difficult to repair as locating and fixing the leak can prove to be a formidable exercise. It is advisable to pay attention to waterproofing while planting a green roof. Green roof waterproofing must be elastic (to withstand building movement), non-biodegradable, and resistant to roof penetration. A thick, rough synthetic mat is recommended for further protecting the water proofing or root barrier membrane.
- Typically green roofs thrive better with engineered soil that is lightweight, has good water retention capacity, is low on organic content, and represent a good mix of particle sizes.
- Above all, the species to be planted on the roof must be carefully selected to minimize maintenance and water requirements. Sedums and herbs, which are characterized by shallow roots, are highly recommended. Native plants will work best as these plants are acclimatized to local conditions.

Community Gardens

If there is sufficient land available on the gurdwara premises, a complete kitchen garden that contributes towards providing organic and seasonal vegetables, fruits, and herbs for the langar, could be planned. This is also an inspiration for children in the community: as families become more and more urbanised, children are

It is proposed that a vacant piece of land near Patshahi Chevi, Bani Badurpur, Haryana, be cultivated as an orchid garden.

less aware about where their food comes from. It is also an ideal teaching tool about pesticides, organic growing, and the importance of local provision that could be adapted from the community to the family level.

Even if there is very limited land available, community gardens or allotments close by to the gurdwara can be a great platform for communities to come together and develop a special bond while working towards a benign goal. Seasonal flowers and herbs could be grown if space is limited. The gurdwara could also host regular classes or meetings to encourage people to make vegetable gardens at home.

Recommendations

- Plan an organic community garden around the gurdwara that grows delicious fruits, vegetables, and herbs.
- Use the garden to develop a sense of community and collective responsibility within the sangat.
- Use this garden to impart information about organic methods, and encourage the community to act against excessive use of pesticide and fertiliser (see below).

Figure 5 | A community garden is a tremendous opportunity to showcase the environmental cause.
Source : http://www.ecosikh.org/wp-content/uploads/2012/02/EcoSikh-Newsletter-February-2012-Web.pdf

Pesticides and Fertilisers

Pesticides and fertilisers are rampantly used in modern gardening and farming. Pesticides have the potential to harm

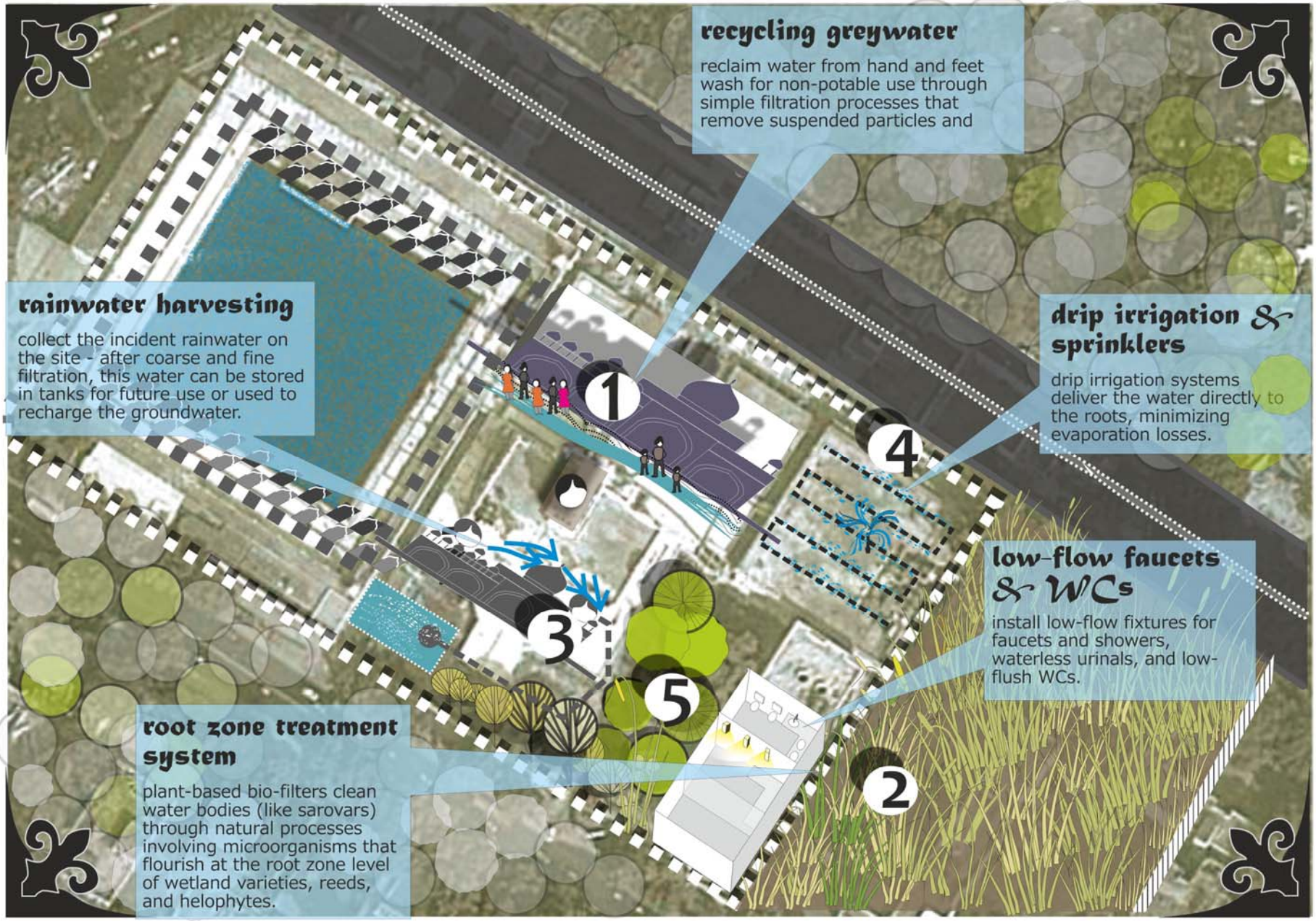
human health and the environment. Children and developing organisms are especially vulnerable to negative potentialities of pesticides. A World Health Organization study estimates that pesticides adversely affect 3 million people every year[13]. Sustained exposure to pesticides can cause severe neurological damage ranging from loss of memory, reduced speed of response to stimuli, and reduced motor skills. Pesticide exposure is also linked to cancer, skin diseases, imbalances in the endocrine system, reduced visual acuity, and infertility. When fertilisers are applied to lawns it can wash down storm drains and end up in lakes, ponds, streams, and eventually, reservoirs, and drinking water. This can cause algae to bloom on the water surface which can deplete the oxygen levels in the water: such blooms are a leading cause of fish deaths. Unabsorbed nitrogen from fertilizers can find their way into the atmosphere and contribute to air pollution and acid rain.

However, they have advantages too. Pesticides help destroy weeds, insects, and worms that are detrimental to the growth of plants. Similarly, fertilizers enhance the amount of nutrients available to plant and help increase their growth. The key to Integrated Pest Management is to discover the type of pest affecting the plants and then to eliminate them through "biopesticides". These are produced from organic and non-chemical resources, and have a more targeted approach to pest management. The key biopesticides being used in India include Bacillus Thuringensis, NPV, Trichoderma and ones based on the bitter leaf of the neem tree[14]. In the case of fertilizers, the key is to determine how much is appropriate. Soil testing[15] can help determine if fertilizer application is necessary, and if so how much to apply. Organic, biobased, or slow-release fertilizers can also be used in place of conventional fertilizers. Animal manure, composts, mulches, and grass clippings are excellent alternatives to chemical fertilisers.

Recommendations

- Eliminate the use of chemical fertilisers and pesticides; instead use organic fertilisers and biopesticides on the gurdwara premises.
- Educate the sangat about the negative impact of pesticides and fertiliser on human and aquatic life, and the environment.
- Convert all organic waste including food waste generated onsite into compost to be used in landscaping and community gardens within the complex (this has been explained in detail in the Section on Waste Reduction [Composting])

[13] http://www.toxipedia.org/display/toxipedia/Effects+of+Pesticides+on+Human+Health
[14] http://coe.mse.ac.in/taxproj.asp
[15] http://greenfaith.org/files/turf-maintenance-planning-r-s



water efficiency

3. Water Efficiency

Water plays an important role in the daily functioning of gurdwaras, with large ponds (called *sarovar*s in Punjabi) often forming an integral part of the complex. Devotees and visitors to the shrine flock to the *sarovar*s for a bath or holy dip. A gurdwara complex uses water for cooking and cleaning, washing and maintenance, ablutions, and landscaping. Many complexes provide lodging for pilgrims – this adds to the water requirements. In order to maintain the spiritual ambience of the complex, utmost cleanliness and hygiene is observed for general maintenance and preparation of the *langar* – this often leads to water being used excessively for washing and cleaning. Additionally, gurdwara complexes use water for cooking, maintenance, ablutions, landscaping and preparation of *langar*. Water requirements for a gurdwara must be reassessed to align it with Sikh teachings that emphasize a philosophy of eco-sophism and conservation. Water must be used efficiently, and used or grey water must be recycled to the extent possible. The following measures illustrate ways to recycle used water and reduce water use.

Washing of Feet

Figure 6 | Ablutions and cleansing are integral to the Sikh way of praying.
Source : http://www.ecosikh.org/wp-content/uploads/2012/02/EcoSikh-Newsletter-February-2012-Web.pdf

Isnaan or cleansing of the body and soul is an important tenet of Sikhism. All gurdwaras have drinking water and hand wash facilities. Many gurdwaras provide a channel of running water across sunken floors close to the entrance, for devotees to dip and wash their feet in. This

practice did not originate as a ritual, its purpose is to cleanse the feet of dust and malodour. The running water is often drained out and finds its way to municipal waste water disposal. This is an unnecessary practice as this water can easily be reclaimed for non-potable purposes like irrigation, flushing, and groundwater recharge. Maintaining a gentle slope across this channel will ensure that water flows at an even rate and at low pressure. Consider switching off the flow of water at unoccupied periods or periods of low occupancy. Similarly, grey water from wash basins and drinking water fountains should also be reclaimed and utilized for non-potable purposes. Drinking water faucets may be equipped with mechanical devices or electronic sensors for automatic switch off after use.

Recycling waste water from cooking and the scullery is a more elaborate process because of the robust presence of nutrients and other organic loads, in addition to detergents, soaps, and inorganic waste materials. Researchers in India have recently devised a cross flow microfiltration process involving tubular ceramic membranes configured in multi layers for filtering kitchen waste water. The process is supplemented by an adsorptive treatment by the prepared roots of an aquatic weed. However, the system is yet to acquire commercial viability. A detailed section on filtration processes for recycling water has been included in this chapter.

Recommendations

- Reclaim and recycle the water that is used for washing through simple filtration processes.

Water Bodies

In Sikhism, the term used for a water body surrounding the gurdwara is *sarovar.* Originally envisioned as a moat-like structure surrounding a gurdwara, the word *sarovar* has variously come to mean a pool, a covered tank, a well, *baoli,* tanks, or even a trough containing water. Considered extremely sacred by all Sikhs, it is believed that its water is vibrated by the spiritual recitals in the vicinity. Many historic gurdwaras in India have *sarovars* incorporated in the gurdwara building complex. It is customary for devotees who visit these shrines to bathe in the holy waters of these pools for worldly and spiritual cleansing. It is imperative that *sarovars* be periodically drained and cleaned to remove common pollutants from the water.

Root Zone Treatment Systems

As water from such sources is likely to be cleaner than greywater obtained from other sources, it could be used for non-potable needs of the gurdwara and its vicinity. A viable alternative for maintaining the cleanliness of *sarovars* is the introduction of plant-based bio-filters, helophytes (wetland plants), and reeds. The scientific term for such plant-based bio-filters is phytoremediation or root zone treatment systems (RZTS). The process works through extraction and degradation of pollutants by microorganisms that are found at the root zone level of certain helophytes. The process needs to be supplemented through the introduction of fine and coarse filtration material like sand and gravel. RZTS contain aerobic, anaerobic, and anoxic zones, sheltering many strains of microorganisms and giving rise to many biochemical pathways. This diversity makes RZTS extremely efficient at de-nitrification, removal of phosphorous, and reduction of pathogens.

Figure 7 | A devotee performing *isnaan* in a *sarovar*.
http://www.thehindu.com/todays-paper/tp-national/tp-newdelhi/a-new-beginning/article1094092.ece | Photo: V. V. Krishnan

RZTS are simple to construct, maintain, and operate. They require no electricity or chemicals to operate, and are highly efficient removers of pathogens. However, it is important to consult an engineer or related professional to fittingly size and design the treatment system.

Recommendations

- Use bio-filters or natural filtration processes to clean water bodies.

Green Landscaping and Efficient Irrigation System

As discussed in the Section on Landscape [Native Vegetation], planting native species leads to a reduction in water demand for irrigation. Incorporating certain varieties of trees would require no permanent irrigation after the first year. Moreover, the shade provided by trees has a cooling effect on the microclimate as well as thermal conditions indoor. If there is an extensive garden that mandates the need to provide a permanent irrigation systems, micro-irrigation techniques could be employed. Such techniques deliver the water very near to the roots or plants and minimize water loss through evaporation.

Drip Irrigation

Drip irrigation is a method where water is allowed to slowly drip onto the soil surface or directly to the root zone. The rate of dripping could be between 2 - 20 litres per hour, depending on the water requirement. A network of tubes, valves, and emitters distribute the water. The technology could be used across most terrain types, soil types, and landscape design. No additional energy is required to run the system. However, the capital cost of the system may be considerable. Additionally, the water should be filtered to be devoid of sediments, algae, or other impurities, to ensure that the emitters do not get clogged. Some maintenance may be required from time to time to ensure that the system remains decongested. However, this is a simple enough technique that once installed, runs itself.

Micro Sprinklers

Micro sprinkler refers to low-pressure irrigation systems that spray, mist, or sprinkle. The water discharge pattern could differ based on emission device and specific application and requirements. Micro-irrigation components include pipes, tubes, water emitting devices, flow control equipment, installation tools, fittings, and accessories. Minimal additional energy is required to run the system. The system also offers scope for automation through timers. The capital costs for the system is high. In addition the system is maintenance intensive.

Recommendations

- Install drip systems where extensive irrigation is required. Micro sprinklers may be used maintaining water-intensive species.
- As far as possible, keep irrigation water requirement to the minimum by avoiding maintenance intensive lawns and exotic species.
- Irrigating manually will best serve small gardens. Staff and volunteers must be trained to conserve water while watering the plants by delivering the water close to the root zone.

Figure 8 | Drip irrigation is an effective measure for water conservation.
Source http://www.thehindu.com/news/cities/Tiruchirapalli/adopt-drip-irrigation-and-get-water-efficiency-of-up-to-80/article3839301.ece /
Photograph R M Rajarathinam

Water Fixtures

Gurdwaras often serve as guest-houses for pilgrims and are briskly occupied through the year. The guest rooms and toilets offer opportunities for realizing water savings through installing water-efficient fixtures. It is recommended that dual flushing water closets (WC) with flushing volumes no more than 3 / 6 litres per flush be installed (standard WC uses 10 to 13 litres per flush).The dual flush WC, is a simple water closet with two options of flushing, one using 3 litres and the other utilizing 6 litres. The dual flush water closet is readily available in the market by several manufacturers, starting at Rs 4000. However, precisely because of its ready availability, there is also a lot of confusing information regarding the technology used by these water saving WCs. Such information must be set aside to make a selection based on what matters most – the potential for water savings. Waterless urinals, which cost approximately RS 1300, should be installed in public toilets. Waterless urinals work through replacing the conventional water trap by a trap that uses an immiscible and bio-degradable liquid that seals foul odours and sewer gases. These require no plumbing lines for flushing and no flush valves and are therefore, hygienic alternatives for public toilets. The sealing liquid must be replaced after 1200-1500 uses.

Low-flow faucets and showerheads (if provided) are essential water conservation measures. There are two types of low-flow fixtures – aerated and non-aerated. The aerating type mixes air into the water stream. It maintains full pressure and gives the feeling of a full volume spray while heavily regulating the actual volume of flow. Aerators can simply be screwed on to the faucet threads. The non-aerating kind

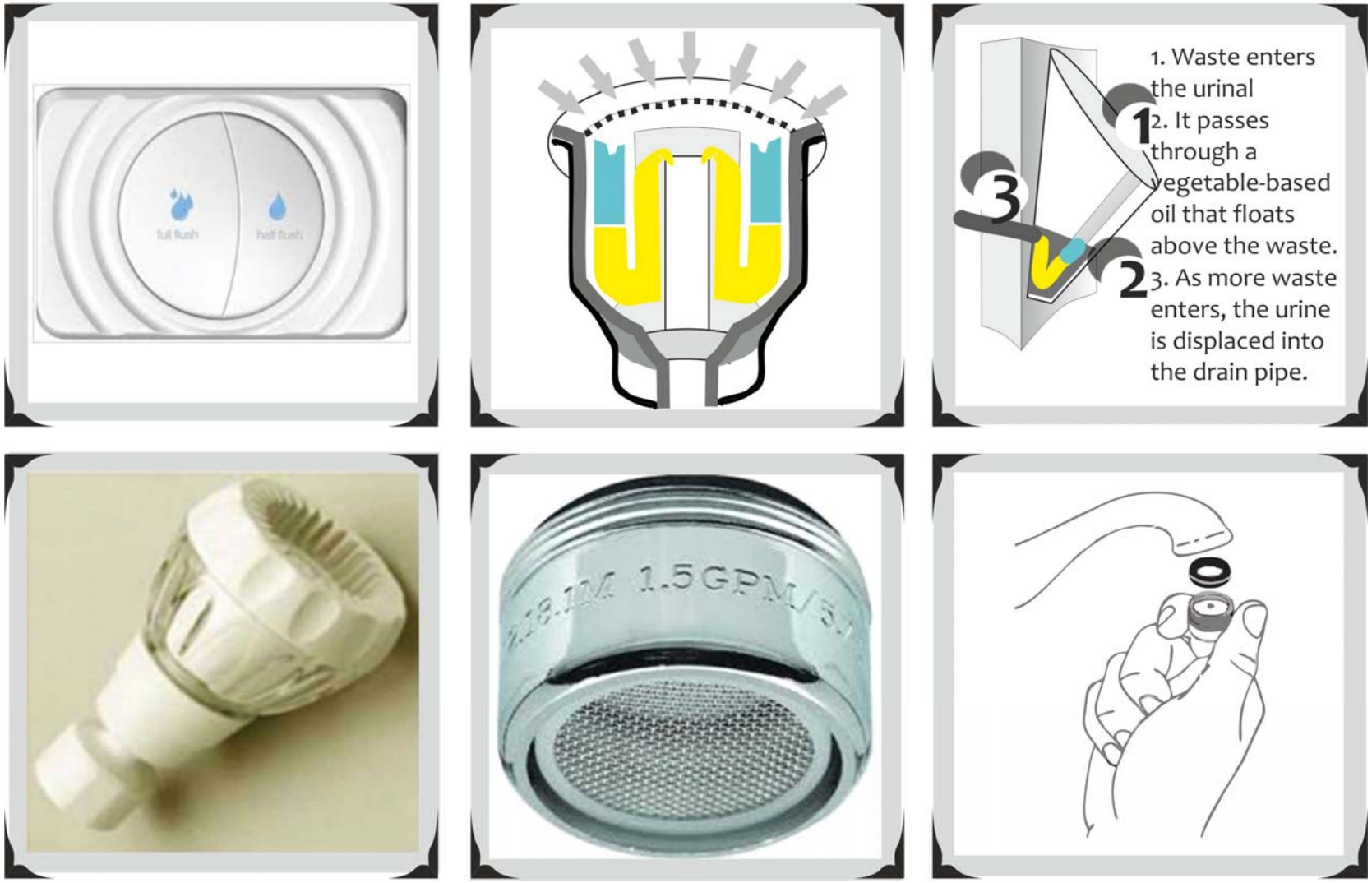


Figure 9 | Low-flow faucets and showerheads, waterless urinals, and WCs with low flush volumes are effective in reducing water use by over 30%.

does not mix air into the water stream and gives a fuller volume of flow, usually between 5.6 to 8.3 litres per minute. Low-flow water faucets should be installed in the kitchens and scullery to prevent water wastage during preparation of food and washing utensils. Low-flow faucets and showerheads are inexpensive measures that may reduce water consumption by up to 50%.

Recommendations

- Use dual-flush WCs with a water volume of 3 / 6 litres per flush
- Use low-flow fixtures for faucets
- Use aerators for sink faucets and showerheads

Rainwater Harvesting

About 25 gur and panchaya Jalandhar dis retrofitted wi harvesting te according to news release

Rainwater harvesting is a simple technique that not only conserves water but also reduces the burden on centralized water supply systems. It consists of collecting and storing rainwater that runs off roof tops, pavements, walkways, other hard or paved surfaces, and open fields. The area from where the rainwater is 'harvested' is known as the catchment area. The collected water may either be stored for future use or recharged to the ground. The latter process is termed groundwater recharging. The decision whether to store or recharge water depends on the rainfall pattern and the sub-surface geology of the region. More arid areas with short rainy seasons may be better suited for practising groundwater recharge as the relatively dry sub-strata is a more ready recipient for absorbing the rainwater. Moreover, drier regions will require larger storage capacities for the system to be a reliable source of water supply. For example, Delhi, Rajasthan, and Gujarat where the rainy season lasts less than 2 months, groundwater recharging is practised. In places like Kerala, Mizoram, Tamil Nadu, and Karnataka where rain falls throughout the year barring a few dry periods, a small tank is sufficient for storing water for shorter periods (as a spell of rain is likely before the water runs out). Storing the water is also warranted wherever sub-strata are impermeable (and therefore does not permit percolation of water for recharge). The six basic components of rainwater harvesting are[16]:

1. Catchment Area | Surface upon which rainwater falls and is collected
2. Gutters and Downspouts | Transport channels from collection area to storage area
3. Leaf Screens and Roof Washers | Coarse filters for remove leaves and large debris
4. Cisterns or Storage Tanks | Space for storing the collected rainwater
5. Water Treatment | Settling, filtering, and disinfecting the collected water

[16] http://cpwd.gov.in/Publication/rain_wh.pdf

6. Conveying | The delivery mechanism for treated rainwater

The total rainfall over a given site is termed the rainwater endowment for that site. The volume of water that can be channelized towards collection is termed rainwater harvesting potential. A rule of thumb estimating this potential is:

Volume = Catchment Area x Annual Rainfall x Run-off Coefficient x Constant Coefficient

Where,

Volume = Total volume of water harvested (and therefore the volume of the storage tank)
Catchment Area = Surface area from which the rainwater will be collected
Run-off Coefficient = The ratio of the volume of water that runs off a surface to the total rainfall incident on that surface, it is higher for paved and impervious surfaces that do not allow water to seep through
Constant Coefficient = 0.80, this accounts for the reduction in rainwater harvesting potential due to evaporation, spillage, and first flush wastage (a term for the first instance of rain which is not utilized for collection as it contains high levels of pollutants and contaminants)

Filtration Processes (for Waste Water and Rain Water)

Proper filtration mechanism needs to be adopted before using the rain water either for storage or recharging of ground water (the water from washing of feet, pools, hand wash and water fountain can be treated using similar mechanisms). Filters are used for effective removal of turbidity, colour, and microorganisms. In addition to applying filtration techniques to the collected water, utmost attention must be paid to underground sewer lines to ensure that pipes are not punctured or leaking. It is also essential to ensure that water from the first instance of rainfall is not collected or is flushed from the collection system. Some common filtration methods are outlined here:

Sand Gravel Filter

These are commonly used filters, constructed by brick masonry and filleted by pebbles, gravel, and sand as shown in the figure. Each layer should be separated by wire mesh.

Charcoal Filter

Charcoal filter can be made in-situ or in a drum. Pebbles, gravel, sand and charcoal should fill the drum or chamber. Each layer should be separated by wire mesh. Thin layer of charcoal is used to absorb odour if any.

PVC- Pipe filter

This filter can be made by PVC pipe of 1 to 120 cm length, while the diameter of the pipe depends on the area of roof. A pipe diameter of 6-inch is enough for a 1500 ft^2 roof and an 8-inche diameter pipe should be used for roofs more than 1500 ft^2. The pipe is divided into three

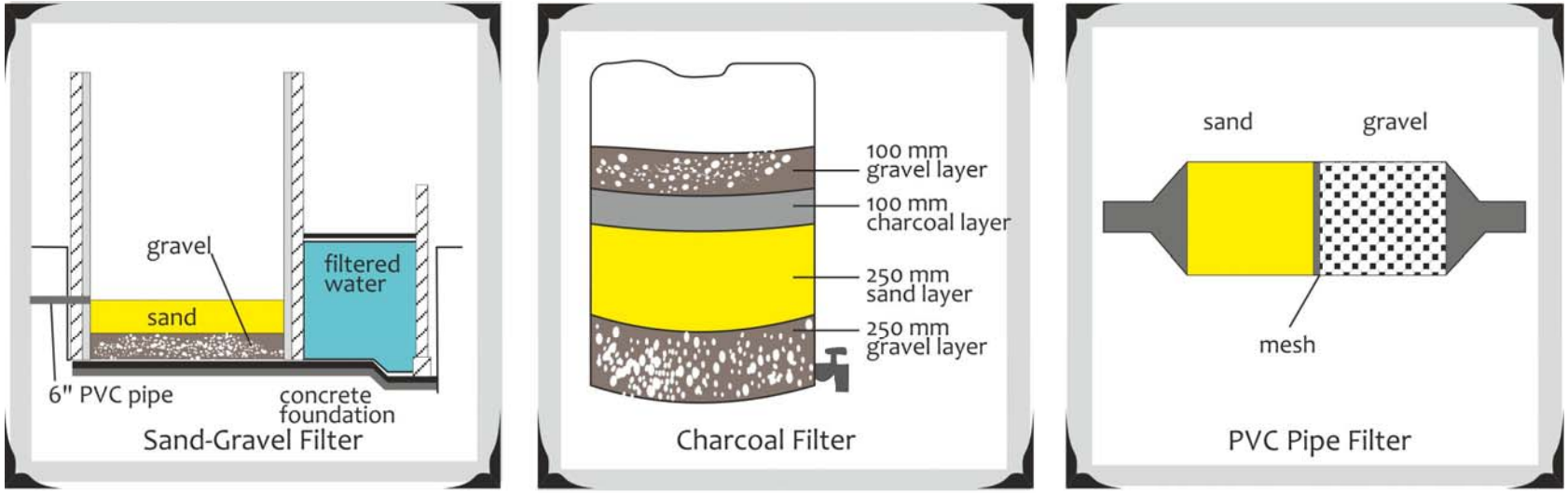


Figure 10 | Several filtration techniques could be applied to the collected rainwater before using it for irrigation or other non-potable purposes.

compartments by wire mesh. Each component should be filled with gravel and sand alternately. A layer of charcoal could also be inserted between two layers.

Both ends of filter should have reduced of required size to connect inlet and outlet. This filter could be placed horizontally or vertically in the system.

Sand Filters

Sand filters are typically a two-chambered arrangement, where the first is a settling chamber, and the second is a filter bed filled with sand or another filtering media. As stormwater flows into the first chamber, large particles settle out, and then finer particles and other pollutants are removed as stormwater flows through the filtering medium. Sand filters consume little space and are suited for urban sites or where there is space constraint. Sand filters might not be suitable for larger areas unless it is designed taking risks of clogging into

consideration. Sand filters would not be very efficient in a flat site. Sand filters are maintenance intensive and cannot perform any other function such as ground water recharging. Sand filters take minimum area. And it is easy to retrofit into existing buildings.

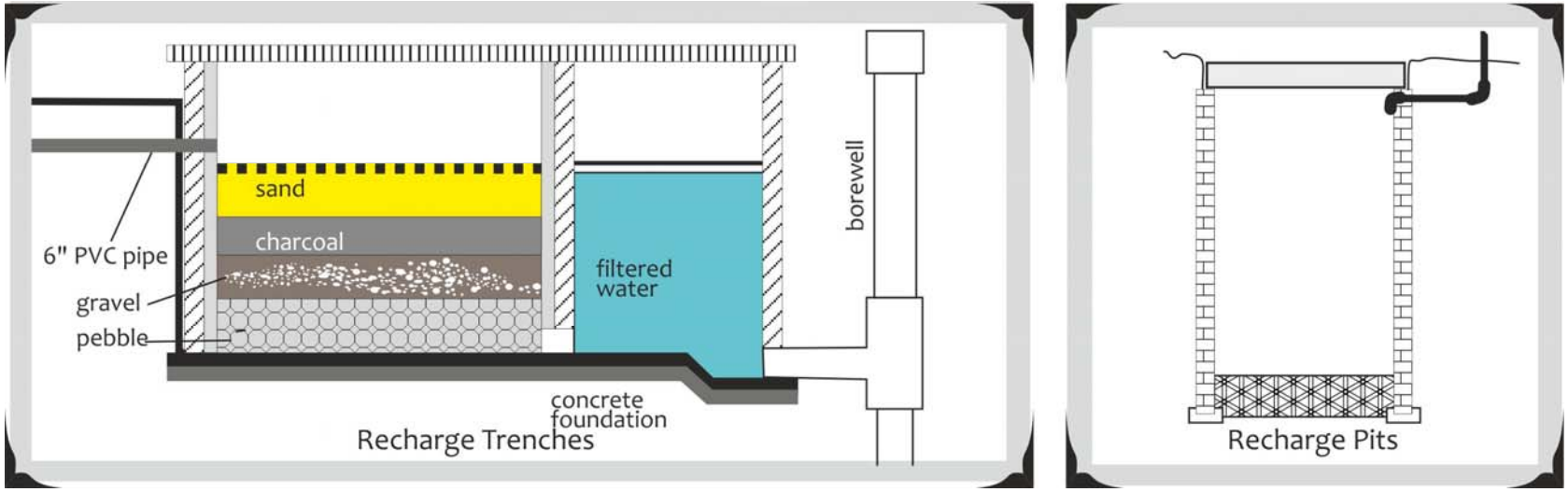


Figure 11 | The collected rain or stormwater could be used for recharging the groundwater through recharge trenches and pits.

Storage of Water for Reuse

There are a number of options for storing the collected rainwater. It may be stored in cylindrical, rectangular, or square tanks made of reinforced cement concrete (RCC), ferrocement, masonry, plastic (polyethylene) or metal (galvanised iron) sheets. Depending on space availability these tanks could be constructed above ground, partly underground, or fully underground. The water stored in the tanks can be used for landscaping, washing utensils for langars, cleaning of floors and toilets. It is essential to follow some maintenance measures like cleaning and disinfection to ensure the quality of water stored in the container.

Recharging the Ground Water

Recharge Pits

Recharge pits are small pits of any shape rectangular, square or circular, contracted with brick or stone masonry wall with weep hole at regular intervals. Top of pit can be covered with perforated covers. Bottom of pit should be filled with filter media. The capacity of the pit

can be designed on the basis of catchment area, rainfall intensity and recharge rate of soil. Usually the dimensions of the pit may be of 1 to 2 m width and 2 to 3 m deep depending on the depth of pervious strata. These pits are suitable for recharging of shallow aquifers, and small houses.

Recharge Trenches

Recharge trench in provided where upper impervious layer of soil is shallow. It is a trench excavated on the ground and refilled with porous media like pebbles, boulder or brickbats. It is usually made for harvesting the surface runoff. Bore wells can also be provided inside the trench as recharge shafts to enhance percolation. The length of the trench is decided as per the amount of runoff expected. This method is suitable for small gurdwaras, with not much of open space and landscape. The recharge trench can be of size 0.50 to 1.0 m wide and 1.0 to 1.5 m deep. The recharging of ground waters in gurdwaras prevent the runoff from going to sewer or storm drain, thereby reducing the load on treatment plant.

Benefits

- In areas where there is inadequate groundwater supply or surface
- Resources are either lacking or insufficient; rainwater harvesting offers an ideal solution.
- Helps in utilising the primary source of water and prevent the runoff from going into sewer or storm drains, thereby reducing the load on treatment plants.
- Reduces urban flooding.
- Recharging water into the aquifers help in improving the quality of existing groundwater through dilution.

Grey Water Recycling

Grey water is any wastewater generated within the Gurdwaras (with the exception of wastewater from toilets, which is known as ‘black water’). Typically, 50-80% of wastewater in Gurdwaras is grey water from kitchen sinks, dishwashers, bathroom sinks and showers. The generic grey water treatment includes Pre-treatment, Primary treatment, Secondary treatment and disinfection. All stages of grey water treatment can be done, in combination of various techniques. The type of treatment to be used depends upon the kind of wastewater generated. Largely considering the gurdwara waste please refer to the various grey water recycling techniques described below.

Pre-treatment

Screens

A screen is a device with openings for removing bigger suspended or floating matter in sewage which would otherwise damage equipment or interfere with satisfactory operation of treatment units. At the outlet of pipes of grey water from different sources the Screen is kept. Screen can be a mesh with less than 10 mm size to remove coarse particles. The load to common screen can be reduced if mesh is kept at the inlet to the piping system of sources such as bathroom, kitchen etc. The screens can be cleaned manually and solids disposed off along with solid waste. The screens to be applied at the end of all pipes discharging grey water.

Oil and Grease Trap

The oil and grease trap is used to intercept most greases and solids before they enter a wastewater disposal system. Very large amounts of oil from food production in kitchens and restaurants can overwhelm the septic tank or treatment facility, causing a release of untreated sewage into the environment. Also, high viscosity fats and cooking greases such as lard solidify when cooled, and can combine with other disposed solids to form blockages in drain pipes. Therefore they are trapped before the primary treatment of grey water is started.

Figure 12 | The on-site filtration sequence for grey water.

Primary Treatment

Equalization tank

Equalization or settling tank is an important component of grey water treatment system. It is required to balance flow to take into account the fluctuations in water use. Adequate aeration by providing baffles and mixing must be provided to prevent odours and solids deposition in equalization tank. Baffles can also be provided in equalization tank though it may restrict settling of particles. There are two types of equalization tanks: flow equalization and constituent equalization. Flow equalization refers to changing the variations in rate of flow throughout the processing and clean up cycles to a steadier rate that is more nearly equal to average flow rate for that period of time.

Constituent equalization refers to the concentration of the target pollutants in the waste stream. Throughout 24hr day, the concentrations of individual constituents in a given industrial waste stream typically vary over wide ranges as processes are started up, operated, shut down and cleaned.

Grit Chamber

Grit chambers are basin to remove the inorganic particles to prevent damage to the pumps and to prevent their accumulation in sludge digestors. For small sanitary sewer systems, the grit chambers may not be necessary, but grit removal is desirable at larger plants.

Secondary Treatment

Aerobic

Filters. Filtration is a very important process in grey water recycling. Some of the common used filter include but not limited sand gravity filters, Trickling filters etc. The type of filter required for a grey water system depends largely upon the amount of grey water to be filtered, the type of contaminants present and end use.

Oxidation Pond. Oxidation ponds, also called lagoons or stabilization ponds, are large, shallow ponds designed to treat wastewater through the interaction of sunlight, bacteria, and algae. Algae grow using energy from the sun and carbon dioxide and inorganic compounds released by bacteria in water. During the process of photosynthesis, the algae release oxygen needed by aerobic bacteria Mechanical Aerators may also be provided to maintain aerobic conditions.

Anaerobic

Up-flow Anaerobic Sludge Blanket

The up-flow anaerobic sludge blanket (UASB) reactor is a methanogenic (methane-producing) digester.

UASB uses an anaerobic process whilst forming a blanket of granular sludge which suspends in the tank. Wastewater flows upwards through the blanket and is processed (degraded) by the anaerobic microorganisms. The upward flow combined with the settling action of gravity suspends the blanket with the aid of flocculants. The blanket begins to reach maturity at around 3 months. Small sludge granules begin to form whose surface area is covered in aggregations of bacteria. In the absence of any support matrix, the flow conditions creates a selective environment in which only those microorganisms, capable of attaching to each other, survive and proliferate. Eventually the aggregates form into dense compact bio films referred to as "granules". Biogas with a high concentration of methane is produced as a by-product, and this may be captured and used as an energy source.

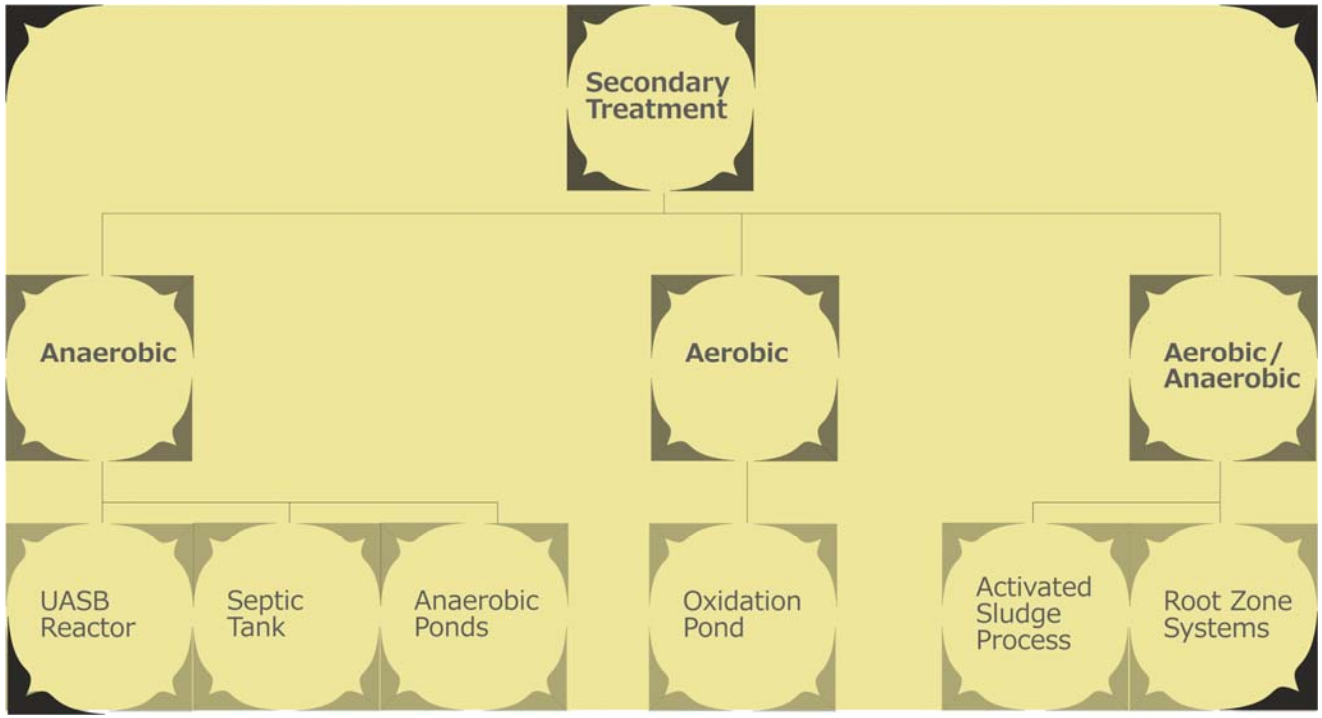


Figure 13 | Several filtration techniques could be applied to the collected rainwater before using it for irrigation or other non-potable purposes.

Septic Tanks

A septic tank is a key component of the septic system, a small scale sewage treatment system common in areas with no connection to main sewage pipes. Septic systems are a type of On-Site Sewage Facility. The term "septic" refers to the anaerobic bacterial environment that develops in the tank and which decomposes or mineralizes the waste discharged into the tank. Septic tanks can be coupled with other on-site wastewater treatment units such as bio filters or aerobic systems involving artificial forced aeration.

Anaerobic Ponds

The lagoon is divided into two distinct layers: sludge and liquid. The sludge layer is a more solid layer formed by the stratification of sediments from the manure. After a while, this solid layer accumulates and eventually needs to be cleaned out. The liquid level is composed

of grease, scum and other particulates. The liquid level CAFO wastewater enters at the bottom of the lagoon so that it can mix with the active microbial mass in the sludge layer. These anaerobic conditions are uniform throughout the lagoon, except in a small surface level. Sometimes aeration is applied to this level to dampen the odours emitted by the lagoons. If surface aeration is not applied, a crust will form that will trap heat and odors. Anaerobic lagoons should retain and treat wastewater from 20 to 150 days.

Anaerobic/ Aerobic

Activated Sludge Process

The process involves air or oxygen being introduced into a mixture of primary treated or screened sewage combined with Micro-organisms to develop a biological flock which reduces the organic content of the sewage. The combination of wastewater and biological mass is commonly known as mixed liquor. In all activated sludge plants, once the wastewater has received sufficient treatment, excess mixed liquor is discharged into settling tanks and the treated supernatant is run off to undergo further treatment before discharge. Part of the settled material, the sludge, is returned to the head of the aeration system to re-seed the new wastewater entering the tank.

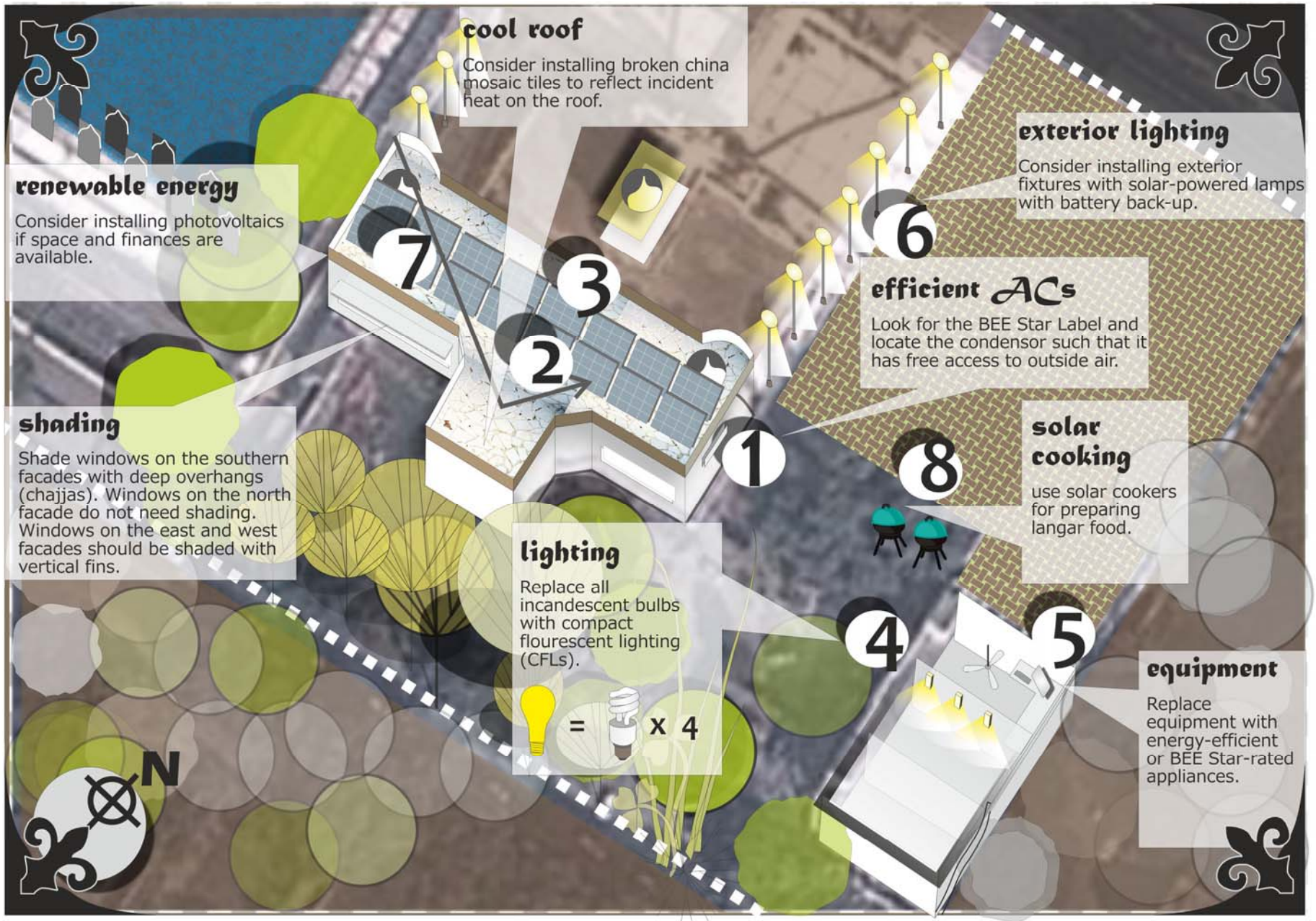
Treatment System using Plants

After primary treatment of grey water, roots of the plant can be used to treat water. The grey water contains nutrients, which can be taken up by the plants. In this process the grey water gets filtered and treated. Various species of plants such as phragmites can be used.

Disinfection

Chlorination

Water which has been treated with chlorine is effective in preventing the spread of waterborne disease. The type and dose of chlorination will depend on the end use of recycled water. Freshly generated grey water is relatively clean, but if stored for as little as 24 hours, the bacteria use up all the oxygen and the water becomes anaerobic and turns septic. The safest way to handle grey water is to introduce it directly to the biologically active topsoil layer, where soil bacteria can quickly break it down, rendering the nutrients available to plants. This biological water purification is much more effective than any engineered treatment, thus protecting the quality of groundwater and surface waters.



energy efficiency

4. Energy Efficiency

Energy efficiency measures include strategies that reduce the utility bills of a facility, enhance the thermal comfort of an occupant, or accomplish both. A number of simple measures contribute to more equitable indoor temperatures without the help of air-conditioning. Such measures, termed 'passive' measures, are highly recommended for their ease of implementation and reduced dependence on electricity. Moreover, passive techniques pave the way for maintaining and enhancing the connection between humans and nature by relying on strategies that do not completely disconnect with the outside. For instance, operable shutters, shading through deciduous trees, placing windows along the north and south facades, providing shades for windows, and courtyards with fountains for evaporative cooling, are passive strategies that enhance thermal comfort within a building. Ceiling fans (for humid climates) and evaporative coolers (for dry climates) are effective 'active' strategies for maintaining thermal comfort.

To achieve thermal comfort while minimizing the use of non-renewable sources of energy, the following approach is recommended:

1. Minimize heat gain (for hot climates) / losses (for cold climates), through well-designed building envelope
2. Efficiently dissipate heat from the interiors (for hot climates), through well-ventilated spaces and air movement
3. Install efficient cooling devices to meet the residual

Passive Solar Design

'Passive' measures are those measures that need little or no mechanical energy or electricity for implementation. Most such measures must be integrated at the design stage as these involve due consideration for location on the site and orientation of glass. Frequently, such measures may be accommodated during retrofits or as add-ons.

Orientation

Ideally, glazing area should be restricted to the north and south facades of the building. The north orientation brings in light without the accompanying heat. Although windows located on the south facade of a building receive direct solar radiation (which means that in addition to light the windows will also let in the heat), they are relatively easier to shade through overhangs.

Seasonal Shading

Simply shading the glazing adequately will reduce energy bills by 5-7% during summer months. Ideally, the shading should be provided as overhangs or vertical fins. Internal shading (such as blinds and chics) is not as effective as external shades. The southern facade should be shaded through deep overhangs (80-100 com deep), verandahs, or corridors, while the east and west glass should be shaded through vertical fins. Deep overhangs are effective for cutting off the high sun during summer, fins are more effective for cutting off the low sun angles as experienced during winter, or at sunrise and sunset.

Landscape

Strategically placed trees can increase shade cover on top of the gurdwara which lowers the internal temperature, reducing the need for energy to cool the building in the summertime. A decrease in energy usage could translate into big cost savings for those gurdwaras in hot climates whose main energy usage in the summer is for air conditioning. The planting of trees can also act as carbon sinks which can absorb carbon dioxide from the air which can reduce impacts to our global climate. It has been speculated that the planting of trees in and around urban areas can reduce net cooling and heating energy usage by 25% [17]. Trees planted on the west and south sides of a house or building can reduce summertime electricity use by 5.2%. Saving on summertime electricity use also saves on carbon emissions.[18] Shade trees are known to decrease the urban heat island effect, or increased temperatures in our cities. Other benefits from planting trees include improved air quality and lower greenhouse gas emissions, enhanced stormwater management and water quality, and improved quality of life[19].

Equipment

Using refrigerators, air conditioners (ACs) & fluorescent lights that bear the Bureau of Energy Efficiency (BEE) Star-rated Energy Efficiency Labels will help save energy compared to conventional appliances. The BEE Energy Star Efficiency Labels have been created to standardize the energy efficiency ratings of different electrical appliances and indicate energy consumption under standard test conditions. These labels indicate the energy efficiency levels through the number of Stars highlighted in colour on the label. The BEE Star Labels include a Star Rating System that ranges from One Star (least energy efficient, thus least money saved) to Five Stars (most energy efficient, thus most money saved). All gurdwaras should install appliances that have the Star rating. Appliances with star rating should replace older appliances.

[17] http://www.sciencedirect.com/science/article/pii/S0269749101002640
[18] http://www.sciencedirect.com/science/article/pii/S037877880900005X
[19] http://www.epa.gov/heatisld/mitigation/trees.htm

Additionally, simply turning off unused equipment will contribute towards energy-efficiency. Consider installing motion sensors for lighting in intermittently used spaces (like closets, meeting rooms) and dimmers or daylight sensors for large public spaces like (like assembly or prayer hall).

Recommendations

- Replace old or inefficient appliances and equipment with BEE Star-rated equipment.
- Install motion sensors for intermittently used spaces and daylight sensors for large public spaces.
- Make it a policy to turn off all equipment that is not in use.

Daylighting and Controls

Daylighting is the term for using windows, skylights, clerestories, and other apertures in the building to provide lighting for the space. Most gurdwaras function primarily during daylit hours – a well-lit building, therefore, offers enormous potential for reducing energy bills. Daylighting also constitutes a better quality of light and is proven to positively impact occupant health and well-being. However, in a tropical or composite climates, ensuring that a space is adequately lit as well as cool and glare-free, may pose a challenge. Daylighting must be an integral goal of the project during the design phase, in order to realize its full benefit. A well-designed daylit building will also need electric lighting as a back-up for overcast days. These lights should be arranged in parallel rows to the source of daylight, allowing the the occupant to turn off the lights row-wise. The electric lights could also be fitted with dimmable ballasts or daylighting controls that continuously dim the electrical lighting based on available daylight.

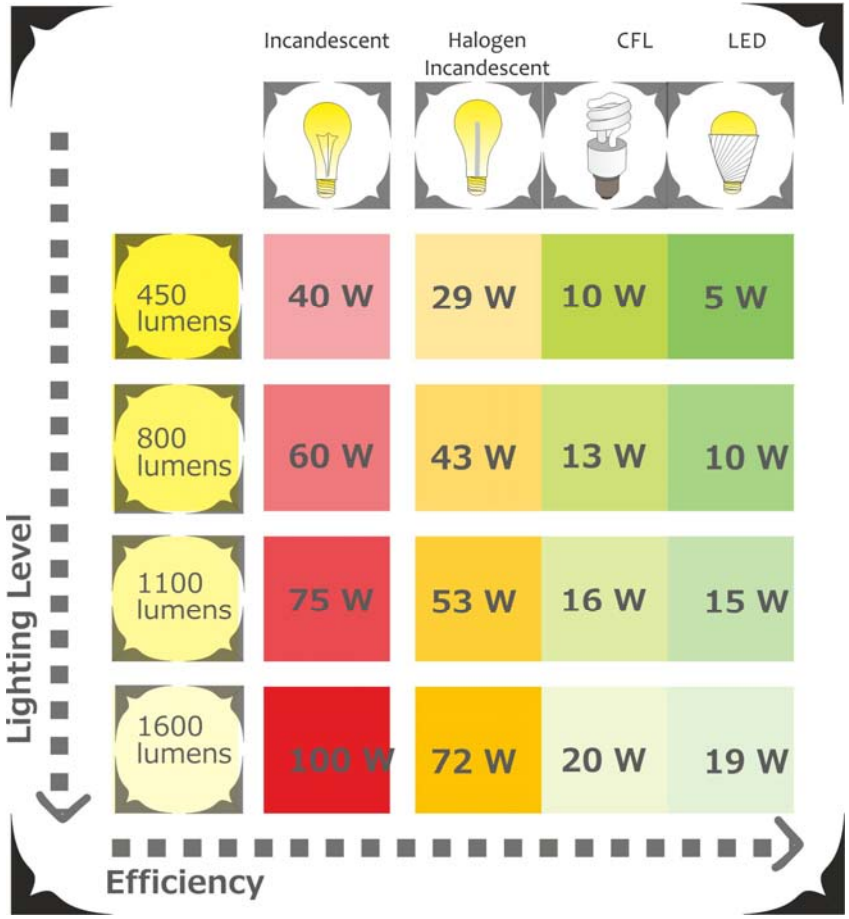
Recommendations

- Use windows and clerestories to bring in daylight.
- Align electric lighting in rows parallel to the source of daylight. Equip electric with dimmable ballasts or daylighting controls.

Lighting

Replacing traditional incandescent light bulbs with compact fluorescent bulbs (CFLs) is a simple way to reduce overall energy use as this technology can reduce energy use due to lighting by 50-75%. CFLs provide the same level of lighting (lumens) while using only a quarter of the energy that an incandescent bulb uses. It also lasts significantly (7 to 10 times) longer. Though initially more expensive than traditional

incandescent light bulbs, CFLs have an average payback time of about 9 months. Retrofit tubular fluorescent lights from T-12s to T-8s as the T-8s are about 20-25% more efficient than T-12's.Retrofit or replace emergency exit signs with incandescent bulbs with LED inserts. [20]



Recommendations

- Use power strips for 'phantom' loads. Chargers, TVs, computers, microwaves, and other devices that constantly use what is termed as phantom loads. Ensure that these are plugged into power strips – so they may be easily turned off when not in use.
- Replace appliances with BEE star-rated appliances only.
- If the gurdwara uses a washing machine, regularly clean the lint screen.
- Regularly check lighting controls to endure that they are functional.

Exterior Lighting Design

High illumination levels are usually not required for outdoor functions. Lighting design for exterior uses could be planned accordingly to provide the required amount of light without overdesigning. Photocells are recommended to turn on or turn off lighting based on sunlight availability. Alternatively timer based controls are useful for operation at specific hours. Solar powered lighting fixtures typically have solar panel connected to a metal halide or LED lamp. The lamps are designed to operate for more than one night even under overcast sky conditions.

Figure 14 | A comparison of energy efficiency of incandescent, halogen incandescent, compact fluorescent, and LED sources of lighting.
Source : Natural Resources Defence Council (NRDC)

[20] http://greenfaith.org/resource-center/stewardship/energy-conservation/the-twelve-priority-measures-to-save-energy

For signboards, metal halide lamps for externally illuminated boards and fluorescent lights or LEDs for internally illuminated boards, depending on the application are ways to reduce overall energy use. [21]

Insulation

Thermally insulating the walls and roof is an important step towards reducing electricity bills while maintaining the required comfort levels. Thermal insulation reduces heat transfer between the inside and outside and helps maintain indoor temperatures. Therefore, interior spaces stay cooler during summer months and warmer during winter months.

Some common insulating materials include cellulose, fiberglass, rock wool, polystyrene, urethane foam, vermiculite – these may be available in the form of amorphous wool or rigid sheets, or require in-situ pouring. In most cases, where the gurdwara building already exists, consider retrofitting the external walls of regularly used spaces with rigid insulation like XPS (extruded polystyrene). A half-brick wall should be constructed along the external surface of the insulation for its protection. Insulation is rated in terms of R-value. Higher R-values denote better insulation and translate into more energy savings.

In hot climates, insulating the roof is more beneficial than insulating the walls, as bulk of the direct radiation from the sun falls on the roof. Insulating the roof and walls of the gurdwara alone could lead to 10% drop in heating or cooling energy use. If the gurdwara does not have air-conditioners installed, the insulation will contribute to enhanced thermal comfort. During summer months in hot climates, thermal insulation must be combined with an effective ventilation strategy at night (when it is cooler) to flush out the heat.

Air-conditioning

Although passive measures will improve thermal comfort, air-conditioning may be essential for maintaining comfort conditions during peak cooling (or heating) season. The two most common types of air conditioners (ACs) are room air conditioners and central air conditioners. A meld between the two types of systems is provided by ductless, mini-split air conditioners. The following sections describe the three types of systems mentioned here.

Window Units and Split ACs

Window units and split ACs are suitable for small spaces measuring no more than 40 m^2. In a split system the evaporator is housed in a cabinet inside the space where as the condenser and compressor are enclosed in an outdoor cabinet. Such systems cool a space rather than a building. Although their low first costs make them attractive, the systems come with low efficiencies.

[21] Outdoor Lighting Research Report, California Energy Commission, Eley Associates

Ducted Splits and Packaged Air Conditioners

Ducted Splits and Packaged ACs are more common for medium-size spaces, starting at 50 m^2 and going up to 1,000 m^2. In such systems, the air is cooled at one point and then distributed to the space/s through a system of supply and return ducts. The evaporator, condenser, and compressor are all housed in a cabinet located away from the space that needs conditioning. Ducted splits are ideal gurdwaras that do not have additional space to house the packaged ACs. Other considerations too, make this category of ACs the best suited for a medium-sized application. The initial cost is higher than that of window units but the efficiency is higher. It offers flexibility in terms of different operating hours for different zones of the gurdwara. It requires low maintenance that involves little more than periodic cleaning. Compared to central plants, such systems can be installed quicker.

Central Air Conditioners

In central air-conditioning, the cooling takes place in a chilled water plant. The chilled water is delivered throughout the building through a system of air handling units that serve discreet zones with varying cooling requirements. They are serviced by outdoor condensers that may be air or water cooled (cooling towers). Central air conditioners are more efficient than room air conditioners or packaged systems. In addition, they are quiet and out of sight. However, these are complex systems that need plenty of installation space as well as regular and dedicated maintenance. These systems are suitable for large buildings that require more than 30 T of cooling capacity.

Proper sizing and installation are key elements in determining air conditioner efficiency. Too large a unit will not adequately remove humidity. Too small a unit will not be able to attain a comfortable temperature on the hottest days. Improper unit location, lack of insulation, and improper duct installation can greatly diminish efficiency.

Installation and Location of Air Conditioners

Some simple steps to ensure correct installation go a long way in realizing optimal performance and energy efficiency. The best rated systems often underperform because of improper installation. For existing systems as well as new systems, it is advisable to pay attention to the location of the supply and return registers, location of the unit itself, insulation of ducts, and placement of the thermostat:

- Ensure that all ducts are firmly sealed and well insulated
- Refrigerant piping must have as few bends as possible
- Supply registers or indoor units are not located close to or opposite doors or entry points
- Locate the condensing unit away from the space to be served, if possible (these units tend to be noisy)
- The condensing unit should be located such that it has an uninterrupted flow of air and stays cool and shaded
- The initial refrigerant charge and air flow rate of the system should be verified to be the same as guaranteed by its manufacturer's specification

- The thermostat should be located at a thermally neutral spot, i.e., away from windows, supply registers, light fixtures, and appliances that may produce heat
- It is a good practice to plan and allow adequate indoor space for the installation, maintenance, and repair of the system.

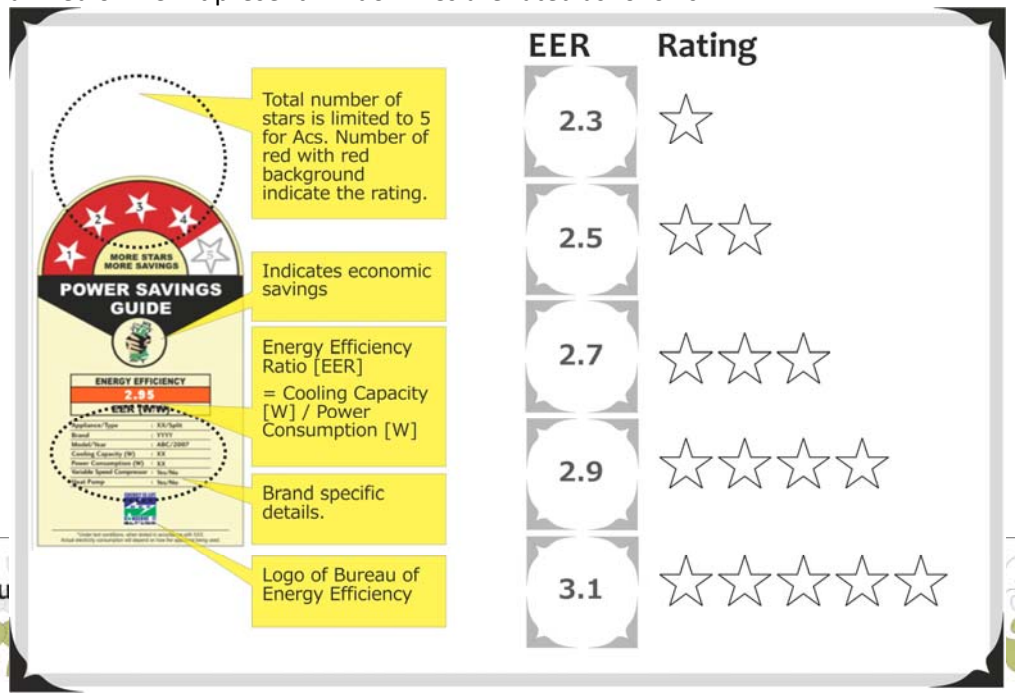
Energy Efficiency of Air Conditioners

BEE Star Rated Label

An important consideration while purchasing air-conditioning equipment should be its rated energy performance.

Energy efficiency ratio (EER) is the ratio between the cooling capacity and the power input of the air conditioner. For example, if a 1 TR (3500 W) AC consumes 1000 watts, then the EER of the Air conditioners is 3.5 W/W. ACs with high EER consume less power. Co-efficient of Performance (COP) is similar to EER. This represents the energy efficiency of chillers.

Energy labelling of appliances, launched by the Bureau of Energy Efficiency (BEE) sets energy performance standards - called Star Rated Labels – for air conditioners. Labelled products have been in the market since 2006. Star rated ACs cost more but the payback period for the incremental cost is under 2 years. The incremental cost of the next higher rating is in the range of INR 750-1000. Moreover, according to estimates, the first cost of AC equipment contributes only 11% of the total lifecycle cost of owning an AC, the other contributors being operating costs (60%), and maintenance cost. It therefore makes economic sense to invest in energy efficient systems. Affixing BEE star label been made mandatory for Room ACs from January 2010. While selecting the air conditioner, do refer to the BEE Star Rated Label affixed on AC. At present window ACs are rated as follows[22]:



Sizing

Air conditioning systems must be sized optimally – bigger is not necessarily better. If the systems have a larger cooling capacity than required for the space, uniform cooling is difficult to achieve. A small unit running for an extended period is more efficient than a large system that needs to cycle on and off frequently. Assess in detail the occupancy pattern of the gurdwara. If the facility is more likely to operate

at a fraction of the peak load most of the time, the part-load efficiency of the central plant will be a better indicator of the system performance than peak-load efficiency. If required, different types of ACs may be selected for different parts of the gurdwara. For instance, split units may serve guest rooms best, while a packaged outdoor unit may be best suited for the main prayer hall.

Figure 15 | The BEE Star Label rates ACs and other appliances for energy efficiency.
Source : http://beeindia.in/schemes/documents/ecbc/eco3/SnL/Guide%20on%20Energy-Efficient%20Room%20Air%20Conditioner.pdf

Operation and Maintenance

After selecting and installing an energy-efficient system, it is crucial that it be scrupulously operated and maintained in order to realize energy savings. The best rated systems may not show the expected energy savings if its actual operation is not synchronized with the assumptions made at the design stage.

Many building owners choose a lower (colder) setting for the thermostat while turning on the AC for the day. This practice is best avoided as this does not cool the space any quicker, and may waste energy by cooling down the space to a low temperature. A lower temperature differential between the outdoor and indoor temperature will result in lower energy use. Therefore, it is advisable to set the thermostat as high as comfortably possible (24°-26°C) during summer, and as low as comfortably possible (20°-22°C) during winter. Setting the thermostat higher than the standard 22°C may yield savings of 5-10% per degree of increase[23]. It is recommended that a ceiling fan be installed and run along with the AC. This improves air circulation and reduces the cooling load as more air movement also means more thermal comfort. At times, the ceiling fan can take care of the cooling load without being supplemented by the AC. On drier days, the system fan should be set to highest speed. On humid days a low fan setting ensures slower air movement across the cooling equipment, and results in more effective removal of moisture from the space.

Recommendations

Here is a list of features and instructions that optimize operation and maintenance:

- Ensure that the filter is easily accessible and slides out for routine cleaning and decongestion.
- Air-conditioning should be used only when the building is occupied.
- Keep room doors and windows closed when air-conditioning is operating. Gaps around window AC units should be sealed to prevent air infiltration.
- To maximize air flow, ensure that air outlets of air conditioners are not blocked by furniture or interior elements.

[23] SEAV, 2004, HVAC Tips
http://www.seav.vic.gov.au/manufacturing/sustainable_manufacturing/resource.asp?action=show_resource&resourcetype=2&recturing/resource.asp?action=show_resource&resourcet

- Properly insulate refrigerant pipes and seal AC ducts - having the heating and cooling ducts tested and sealed by a qualified contractor can help deliver energy savings
- Periodically check and change filters - change the disposable filters or clean the permanent filters on your AC unit on a fortnightly to monthly basis (depending on operating hours). Filter maintenance on all window air-conditioners is critical to their efficient performance, and should be performed prior to the start of the air-conditioning season. Dirty filters not only hamper air-flow but could even damage the system.
- Install window AC in the shade. Window air conditioners tend to work best when kept out of direct sunlight. If possible install units on the north or east side of the building, or, if you install on the west or south facades, use shade trees and other passive cooling measures to keep the unit out of direct sunlight.
- All AC units should be periodically serviced to ensure maximum efficiency of operation. Special attention should be given to belt drives, controls, and refrigerants. Ductwork should be inspected to identify gaps and cracks, and sealed accordingly to prevent pressure loss.
- Periodically clean the outdoor coils if they accumulate dust. AC performance degrades rapidly when the system gets dusty.
- Give the annual maintenance contract of AC directly to the manufacturer or its authorized company which has trained and well-qualified technical staff.
- Total current drawn by an AC (measured in Amperes) is a reliable measure of its electricity consumption. Ensure that the maintenance technician measures and makes a note of total current drawn to assess system performance.
- An AC that is over 10 years old or needs major repairs may no longer meet the performance standards of new and energy efficient systems. Consider replacing the AC with more energy efficient units.

Evaporative Coolers

Evaporative cooling is an effective method for delivering cool air during the hot and dry cooling season. Evaporative coolers cool air by filtering it through water, thus lowering its temperature. Evaporative coolers produce humid air because the air absorbs water during the cooling process. These systems work best when a small amount of outside air circulates into the space while the cooler is on. Conventional cooling may become a necessity for dehumidification and comfort during a few hot and humid months.

The major advantage of an evaporative cooler is that its operating costs are typically half those of a central air conditioner. Their operating costs are even lower compared to conventional cooling systems. In dry climates, evaporative coolers may lower cooling bills by 75%. Evaporative coolers also operate without the use of ozone depleting chlorofluorocarbons (CFCs) that are used by conventional refrigerant-based systems. These coolers can also be used in conjunction with traditional window ACs.

Two-stage Evaporative Coolers

As the name suggests, two-stage evaporative coolers cool the air twice. The first time through an indirect process (where the air does not come in direct contact with the water). This pre-cooled air at 20°C (depending on the conditions) then goes through the next stage of direct evaporative cooling. Such coolers cool more effectively and efficiently. They also add less humidity to the space. However, they come with an added cost.

Sizing

Evaporative coolers are rated by the cubic feet per minute (cfm) of air that they deliver to the space. Most models range from 3,000 to 25,000 cfm. Manufacturers recommend providing enough air-moving capacity for 20–40 air changes per hour, depending on climate. An accepted rule-of-thumb states 2-3 cfm/ft^2 of floor area for warm climates and 3-4 cfm/ft^2 of floor area for hot and dry desert-like climates[24].

Installation

Typically, evaporative coolers are installed to either directly deliver cool air to a central location in the space or to connect to a ductwork that delivers cool air to different zones in a larger building. While the former option works best for small spaces, the latter option is appropriate for a medium-sized gurdwara. Portable coolers on wheels are also readily available. Small, portable evaporative coolers on wheels are available as well. It is best to have an opening (operable window) located on the leeward side of the space to allow an equivalent amount of hot air to exit the space while the cool air is supplied. Roughly, an opening of 2 ft^2 will well serve a unit of 1,000 cfm cooling capacity. This opening should be located not too far from the cool air supply, else hot outside air may enter the space.

Operation and Maintenance

Operating an evaporative cooler is a simpler than operating conventional cooling systems. Many coolers are equipped with 2-speed options and/or a vent-only option. These options greatly enhance the performance of coolers. The vent-only option lets the cooler work as a fan during mild cooling periods. Often, coolers are equipped with dust filters to clean the incoming air.

Maintenance and upkeep of coolers is a critical to good performance. Cleaning and draining regularly prevents build-up of sediments. Pads, filters, reservoirs, and pumps must be cleaned every month. Pads may even need replacement during the process. The process, while essential, is not elaborate and cleaning with soap and water should suffice. Extensive cleaning is essential at the beginning and end of the cooling season. The device must be unplugged before routine maintenance.

These simple steps may be followed to ensure that the devices work effectively and last longer:

[24] http://www.energy.wsu.edu/documents/AHT_Energy%20Efficient%20Home%20Cooling.pdf

- Have the cooler serviced twice a year, prior to the cooling season and midway through summer. Regular maintenance will help extend the life and efficiency of the equipment.
- Before starting up the unit, perform these simple maintenance steps:
    - Remove old pads and thoroughly clean pad frames. Use a wire brush to scrape away scale. Paint all surfaces with a cooler protectant.
    - Drain and flush the reservoir. Scrape away scale and paint with protectant.
    - Clean the water distribution system, including the pump screen, pump impeller and water distribution tubes. Replace any cracked tubing. Lubricate the pump impeller with motor oil.
    - Inspect electrical wiring and switches for poor connections or worn insulation. Inspect the belt for cracks and wear. Replace or repair worn parts.
    - Adjust motor bolts for proper belt tension. Set the belt tension so that moderate hand pressure will depress the belt about one inch at the center.
    - Turn on the water supply and make sure water is wetting the entire cooler pad. Too little water will cause dry spots and reduce the cooler's efficiency.
    - Check the water level in the reservoir. Adjust the float valve to maintain about three inches of water.
- Replace the cooler pads and reinstall the frames. Ideally, the first five steps should be performed at season's end. If you will not be using the unit during the winter, shut off the water supply and disconnect electricity to the unit. Then drain the water line to prevent possible wintertime freezing. Close the duct dampers and cover the unit.

Applicability

While evaporative coolers may reduce operating costs by 75-90%, their applicability may be limited based on climatic conditions. They are highly recommended for hot and dry desert-like climates, but are ineffective for other climatic conditions like warm and humid, cold, or temperate. In composite climates they may work well for a couple of months, but are ineffective after the onset of the monsoon season. They require regular maintenance and upkeep. Some of their advantages and disadvantages are listed below:

Advantages

- Lower first cost (typically less than half the cost of ACs)
- Lower operating costs
- Is readily available and does not require professional help for installation
- Maintenance can be carried out in-house

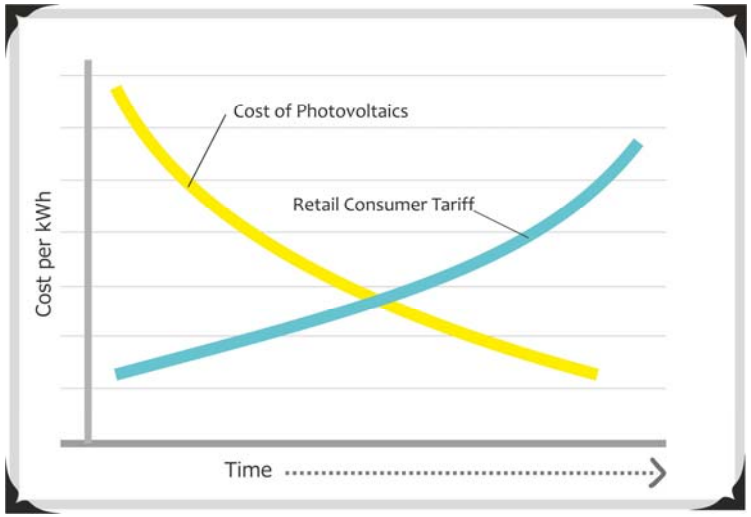
Disadvantages

- Difficult to control space temperature
- Delivered air is cleaner and better filtered in the case of ACs
- Requires operable windows (or vents)
- Requires regular and frequent maintenance
- Adds humidity to the space
- Not suitable for humid climates

Renewable Energy

The Sikh Gurdwara Sahib in San Jose, California, is expected to convert to solar energy, EcoSikh members announced. And Gurdwara Ontario Khalsa Darbar,

Renewable energy is energy that is harvested from continuously and quickly replenished natural resources. These include the energy from sunlight, wind, tides, flowing water, and geothermal energy. Currently, in India, less than 11% of the total electricity generated comes from renewable sources.



A majority of the electricity produced come from fossil fuels like natural gas, oil, or coal. All of these sources are considered “fossil fuels” because they took millions of years to come into being, and cannot be replaced. Wherever possible, gurdwaras are encouraged to get energy from providers that incorporate renewable energy sources into their energy mix. Moreover, installation of photovoltaic (PV) panels could be considered in gurdwaras where space and finances are available. The cost of the power produced is high (hovering between INR 5-6 per kWh), but not formidably so. In fact, the World Bank cites India as ‘amongst the lowest cost destinations for grid-connected solar power in the world[25]’. In addition, PVs have tremendous demonstration value and are a visible statement of commitment to sustainable living.

Figure 16 | Over the last decade the electricity tariff for retail consumers has steadily risen while the cost of photovoltaics has declined significantly.
Source : Natural Resources Defence Council (NRDC)

[25] http://www.worldbank.org/en/news/feature/2013/12/12/transforming-indias-future-with-solar-power

Depending on the location and its local jurisdiction, and if space is readily available, it may be judicious to consider being a part of a net-metering or feed-in-tariff program. Net-metering allows for the electricity generated on-site to be connected to the power grid, while the facility continues to use this electricity. Only the surplus electricity finds its way to the grid – and depending on the prevailing jurisdiction, the owner may be entitled to be paid for this net supply. Feed-in-tariff allows the facility to sell electricity produced on-site directly to the power grid. Such programs have been introduced in states such as West Bengal, Karnataka, Gujarat, and Tamil Nadu[26].

The Guru Nanak Gurdwara, Bedford, UK, has received support for its recently installed photovoltaic solar panels. The photovoltaic panel will help the temple save several thousand in electricity bills per annum apart from greatly reducing its carbon footprint. Half the funding for the panels was furbished by the Mayor's Climate Change Fund, while the other half was provided by the Gurdwara itself (a prerequisite for being eligible for the funding).

Solar Hot Water Systems

Solar hot water (SWH) systems are simple devices that consist of solar collectors and storage tanks. SWH systems convert solar energy into thermal energy. Typically, a flat plate collector is placed such that it has a surface exposed to the sun. The solar radiation falls on the dark-coloured absorber plate of the collector. The absorber plate absorbs the radiation, converts it into heat, and in turn heats the water circulating in the tubes housed within the collector. Most solar water heaters require a well-insulated storage tank. Solar storage tanks have an additional outlet and inlet connected to and from the collector.

India, with high insolation levels of 4 – 6.5 kWh/ m^2 /day for an average of 280 sunny days, has the ideal climatic conditions for this technology. SWHs are a promising technology in India and is steadily gaining commercial viability. On an average, a single collector system may, depending on climate condition, act as a substitute for two medium-sized geysers. The incremental cost of installing a SWH that replaces two geysers is approximately Rs 15,000. This is assuming that the cost of installing two geysers (including plumbing) is Rs 10,000, and that of installing the SWH (including plumbing and controls) is Rs 25,000. Depending on hot water requirement at the facility, the savings from a single collector system may range between Rs 5,000-10,000 per annum. Many state governments have incentivized the installation of SWHs, making the payback period even

As a result of the EcoSikh program, Gurdwara Guru Nanak Darbar, in Connecticut, switched to solar energy this year. Costs for the solar installation in the main Gurdwara building were fully reimbursed by the state, and the sangat chose to pay for the installation in other of its buildings, according to a February EcoSikh news release.

Leicester's Guru Tegh Bahadur Gurdwara, in Evington, has installed 400 solar panels on its roof in what leaders believe is a first for any temple in England.

[26] Solar Rooftop PV in India, Need to prioritize in-situ generation for self-consumption with a net-metering approach, Prayas Policy Discussion Paper, Prayas (Energy Group)

more attractive.

Although vendors willingly assist with calculating the number of collectors needed for a particular project, several web-based calculators accurately estimate the heating capacity of SWHs - http://www.prosunindia.com/calculations.html

Maintenance and regular cleaning of SWHs is essential for good performance. Accumulation of dust on the collector surface severely reduces its capacity to absorb the incident direct radiation. Ideally, the collector and its controls monitor should be located in a space that is easily accessible. The piping and storage should be well-insulated to ensure availability of hot water during evening and early hours of the morning.

Solar Cooking

Solar cookers concentrate the energy of the sun to produce high temperatures over a small area. Broadly speaking, there are two types of solar cookers – Dish Cookers and Solar Steam Generating Systems.

Figure 17 | The Guru Tegh Bahadur Gurdwara at Leicester, Evington, England, has installed 400 photovoltaic panels.

Dish Cookers

The most popular type of dish cookers are the box cookers, with several hundred thousands of them in operation in India alone[27]. Box cookers are simple to assemble, and cook at moderate to high temperatures. Their flat structure enables them to accommodate several pots at once. These cookers are applicable for single-family cooking.

Parabolic cookers or curved concentrator cookers cook fast as they are able to focus the incident heat to a small area, generating high temperatures (350°-400°C)[28]. However, they may require closer tracking of the sun for optimized performance and supervision for safe operation. Smaller parabolic cookers (aperture diameter 1.4 meter) can efficiently cook food for 10-15 people and are priced at Rs 6,000.

[27] http://www.solarcookers.org/basics/how.html
[28] http://mnre.gov.in/file-manager/UserFiles/Brief_Dish_Solar_Cooker.pdf

Annually, the cooking quantum is comparable to that of 8-10 LPG cylinders. The larger cookers that are more appropriate for institutional cooking are expensive at Rs 30,000, but viable as they may be able to replace 30 LPG cylinder over a period of one year. They have the capacity to prepare food for approximately 40 people at a time.

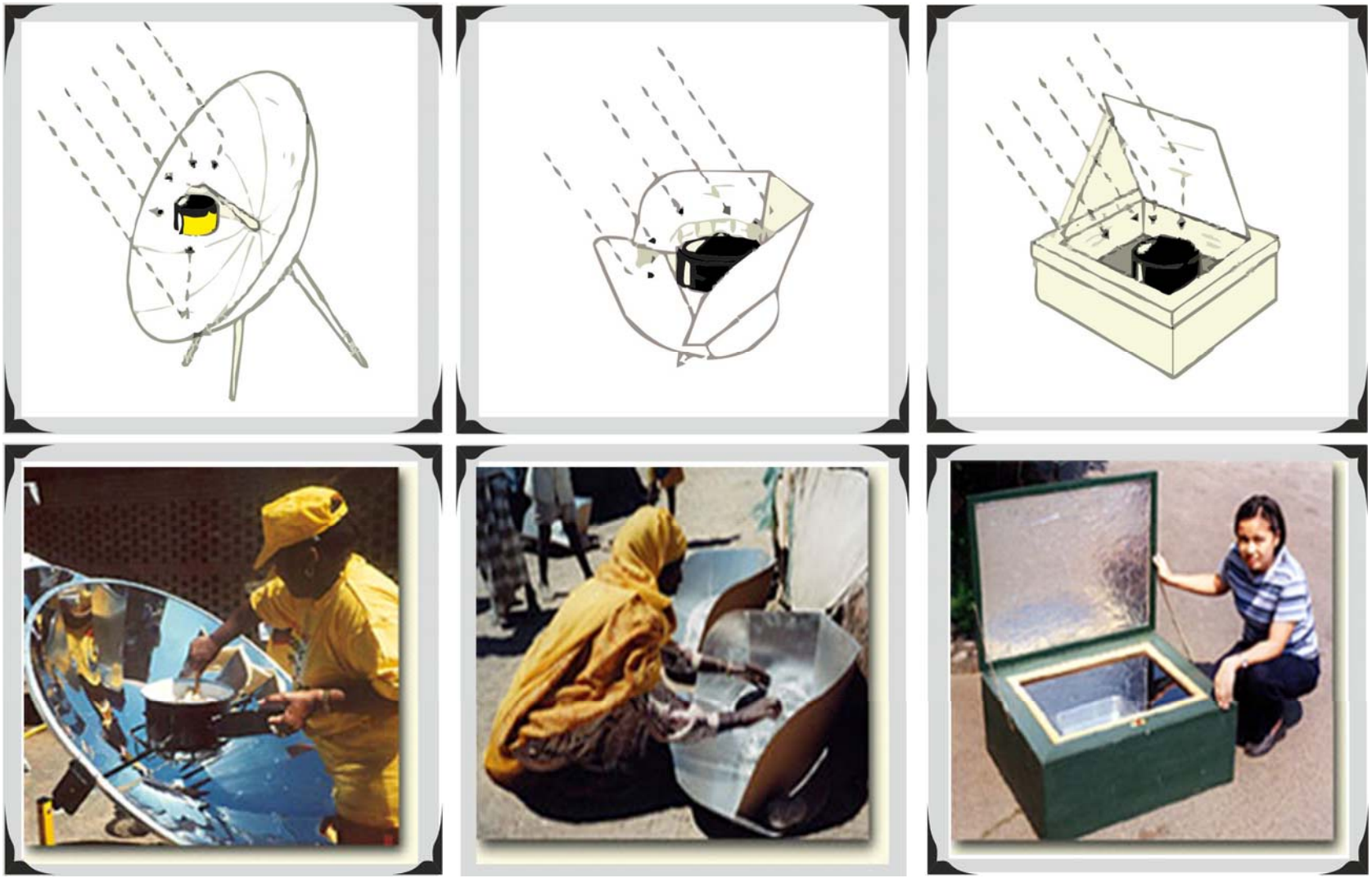


Figure 18 | Curved Concentrator cookers, dish cookers, and box cookers are popular types of solar cookers in India.
Source : http://mnre.gov.in/schemes/decentralized-systems/solar-systems/solar-cooking-steam-generating-systems/

Solar Steam Generating Systems

Solar steam generating systems consist of large (7-16 m^2) receive that concentrate the incident solar to pipes with water inlets. The process generates steam that is then extracted and diverted to kitchens for cooking. At a given instance, a single dish is sufficient for preparing food for 50-100 people. The system is well suited for preparation of *langar* for large *sangats*. At a unit cost of Rs 12,000-14,000 per m^2 of dish area, a single dish may cost anywhere between Rs 75,000 – 116,000. The quantum of cooking is equivalent to that of 30-65 LPG cylinders per annum.

Recently, the Shiromani Gurdwara Parbandhak Committee (SGPC) has approved the installation of solar cookers for the preparation of Guru Ram Dass *langar* at the Harmandar Sahib, Amritsar. The *langar* at the Harmandar Sahib is legendary, feeding approximately 40,000 people every day, with the number going up to 100,000 during festivals or special days. The project is budgeted at Rs 1.5 crore.

Learning from Places of Worship of Other Faiths

Mosque in Levenshulme, Manchester, UK

The Al-Markaz Al-Najmi mosque in Manchester, UK, made waves after its inauguration in 2008 for it exemplary eco-friendly features. Its under-floor heating system works well as prayers are offered while sitting on the floor. Other features on display at the mosque are its energy-efficient lighting, infra-red sensor-fitted faucets, and energy efficient fenestration. The glass allows plenty of daylight to filter through while shielding the interiors

Figure 19 The mosque at Levenshulme, Manchester, United Kingdom.
Source : http://mosques.muslimsinbritain.org/show-mosque.php?id=1788 *and http://www.manchestereveningnews.co.uk/news/greater-manchester-news/eco-mosque-ready-to-open-959510*

from the heat component of the sunlight during summer months. The mosque has responsibly sourced its building materials and extensively uses sustainable wood and reclaimed stone. After considerably reducing the load on its cooling and heating systems, the mosque meets the residual load through solar panels installed on its roof.

Lord Vishnu Temple, Tirumala, India

The picturesque temple town of Tirumala houses one of the most popular pilgrimage destinations in India – the Lord Vishnu Temple. An estimated 50,000-100,000 people visit the shrine every day. Its community kitchen prepares enormous quantity – to the tune of 50,000 kg of rice with lentils - of food every day to feed the devotees. The food is prepared using 4,000 kg of solar generated steam. The high pressure steam at 180°C cooks the food faster and more economically. An average of 500 l of diesel fuel is saved each day.

The temple has also incorporated several guidelines related to sustainable site planning, energy efficiency, building materials, indoor environmental quality, and water efficiency, stipulated by the Leadership in Energy and Environmental Design (LEED) rating system, earning a LEED

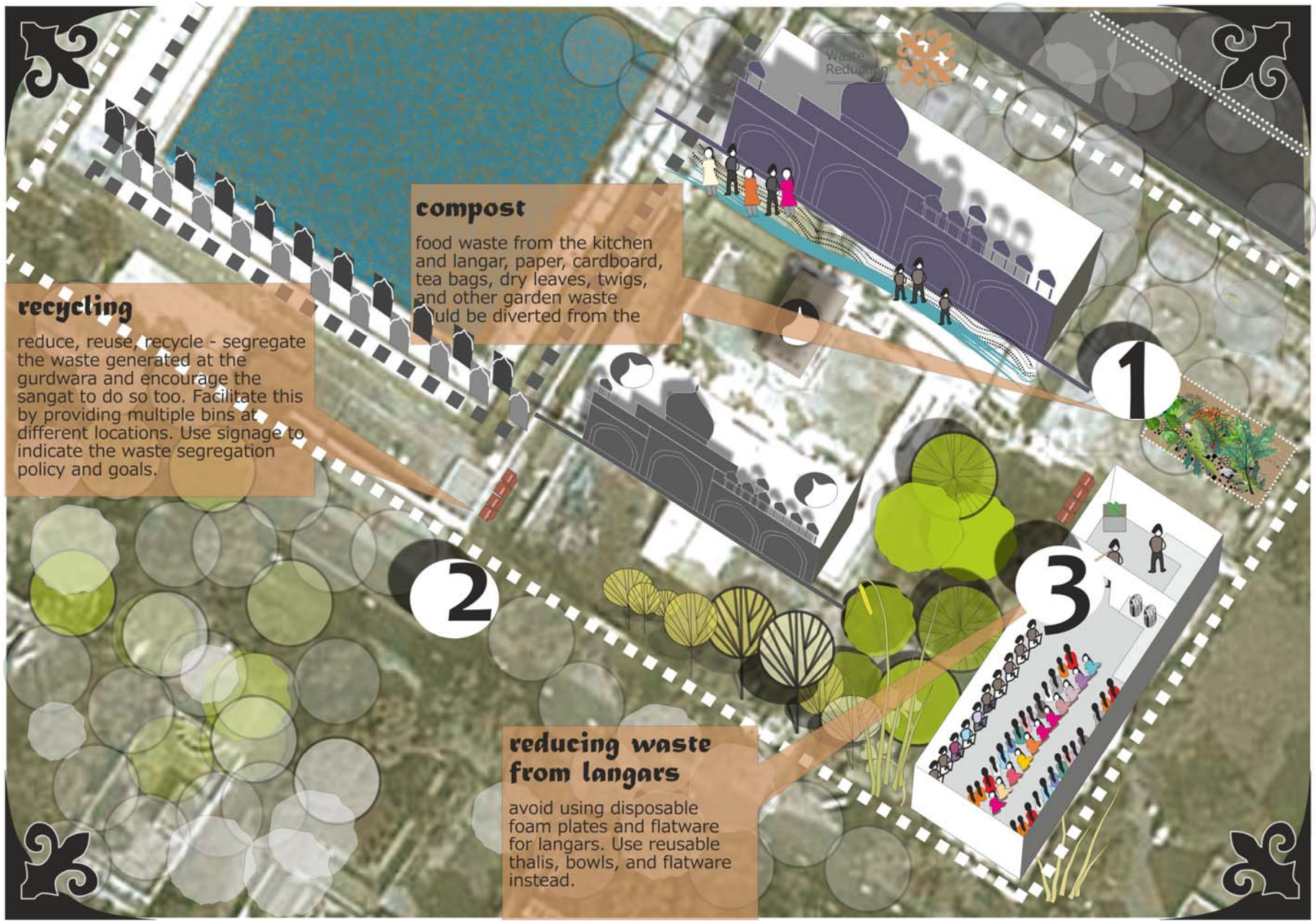
Figure 20 | Solar cookers atop the roof of the Lord Vishnu Temple, Tirumala, India.
Source : http://dilipkumar.in/articles/tirupati/tirumala-temple-going-greener-way-uses-solar-and-wind-power.html

gold rating. This has led to lowered carbon emissions by the Temple. This carbon 'offset', once quantified, is accrued by the facility as a carbon credit (that can be sold to a facility that has a high carbon footprint). With the help of companies like Suzlon and Enercon, the Temple harnesses the readily available wind energy at the top of the surrounding hills, generating 7.5 MW of power.

Shirdi Saibaba Temple, Shirdi, India

Figure 21 | Steam cooking in progress at the Shirdi Saibaba Temple, Shirdi, India.
Source : http://solarcooking.org/newsletters/scrapr10.htm

The Shirdi Saibaba Temple located in Maharashtra is one of the most revered pilgrimage destinations in the country. It boasts of a massive solar steam cooking system with a daily capacity of 40,000-50,000 meals per day. The system comprises of 73 roof-mounted Scheffler reflectors with aperture area of 16m^2 each. The dishes need realigned at the beginning of the day and then continue to automatically track the sun through the day. The system is supplemented by an (existing) LPG-powered steam boiler that provides the crucial back-up during overcast periods (and evenings). The system cost Rs 1.5 crore, but government subsidies lowered the burden on Temple to Rs 85,00,000. The annual savings are estimated at Rs 22,50,000 – indicating a payback period of 4 years.



waste reduction

5. Waste Reduction

Waste from *Langars*

Figure 22 | Steel *thaalis* ready to be used for *langar*.
Source : http://twistedsifter.com/2012/08/kitchen-at-the-golden-temple-feeds-people-for-free-langar/
Photograph by Alicia Nijdam

A number of gurdwaras have introduced disposable dinnerware for *langars* as it is more convenient to simply send them to the trash bin. However, keeping in mind the sheer number of sangat members who partake of the *langar* food, this practice needs to be overhauled. The expanded polystyrene (commonly referred to as thermocol in India) plates and glasses end up in landfills where they do not decompose readily, not for thousands of years. Re-introducing the steel *thali* and cutlery is beneficial for the environment in the long run, even while taking into account the increase in water-use for washing the dishes. A comprehensive study commissioned by the School Nutrition Council, US, found that using reusable ware for school meals was conclusively more beneficial for the environment and cost effective compared to using disposable ware[29].

Gurdwara Bridgewater, New Jersey, stopped using disposable materials for langar and has taken steps to power the gurdwara with solar energy.

Composting

Composting is the 'transformation of organic material (plant matter) through decomposition into a soil-like material'.[30] Composting is a natural cycle that occurs continually. Aptly, it has been termed 'black gold' as it yields the richest nutrients for plants out of discarded

[29] Life Cycle Environmental and Cost Analysis of Disposable and Reusable Ware in School Cafeterias, Including Dishwasher Operation, Prepared by Franklin Associate, a Division of ERG, 2009

[30] http://www.howtocompost.org/info/info_composting.asp

organic material that were headed for a landfill. Although all organic matter will eventually decompose, there are certain steps that may be adopted to accelerate the process.

Ingredients

Food waste generated during cooking of *langar* food is ideal raw material for a compost. These include vegetable peels and roots, fruit peels and seeds, stems, tea leaves, coffee, and food scraps from *thalis*. There is a great deal food scraps generated during the cooking process of *langar*, and they usually end up in landfill. Garden waste like grass or plant clipping, fallen dry leaves, roots, stems, branches, sawdust, and wood chips are extremely useful ingredients for the compost. Additionally, paper that cannot be recycled (like used paper plates, used paper bags), cardboard, pizza boxes, and litter from vegetarian animals and birds are also welcome ingredients for the compost bin. Throwing in excessively greasy food, left-over oil, weeds and weed seeds, and waste from meat-eating animals should be avoided.

Process

The process is simple and sustains itself without external intervention, provided it four key ingredients are present:

1. Moisture
2. Oxygen (air)
3. Carbon and Nitrogen (brown and green organic matter)
4. Microorganisms

Commercially available compost bins, while convenient, are not essential. A pit dug in the backyard of the gurdwara premises will allow the compost to be in touch with bare earth that is beneficial for accelerating the decomposition. A bed of twigs, straws, and woody materials should be laid out next, to keep the pile aerated (providing oxygen). Next, dry brown materials like dried leaves, saw dust, barks, paper, cardboard, and wood bits – these provide carbon - should be alternated with green moist materials like fruits and vegetable peels and seeds, flowers, and tea bags (that provide nitrogen) over the next few layers. The layering should be topped by carbon rich material. The entire pile should now be covered with a few inches of grass clippings and regular soil from the garden. The pit should be covered with a plastic sheeting or wood to conserve the heat and moisture that is generated. The pile should be 'turned' every few weeks to keep it aerated. Turning the compost is a chore and easy alternative is to ensure that there is a ready supply of coarse material, like straw and twigs, in the compost. If the mix appears dry, water may be added to restore the moisture. Depending on climate conditions, the compost should be ready for supply in 3-8 weeks.

A healthy compost needs well-balanced proportions of carbon and nitrogen. Too much nitrogen gives a dense mass of malodourous material that decomposes very slowly. Carbon not only speeds up the process, it also makes the compost light and fluffy with a fresh odour. A good rule of thumb is two parts of carbon to one part of oxygen. It is better to err on the side of adding excess carbon.

Notably, Gurdwara Sahib in Fremont, California, already composts its *langar*.

Figure 23 | The ingredients for a nutrient-rich compost.

Recommendations

- Use nutrient-rich food scraps and garden debris to create a compost bin. Use the compost as fertilizer for plants in the garden.
- If sufficient space is available, the compost could be prepared for and distributed to the sangat/community.
- Participate in municipal level programs that encourage or subsidize composting. Offer to be the recipient for segregated organic waste generated within the community.

Recycling

Reduce, reuse, recycle is the mantra of our times. Its intonation implies that 'recycling' is, in fact, the *third* phase of the process of reducing consumption. The first two aspects - reducing and reusing - are critical to the success of the process, as they address environmental harm that accompanies extraction of raw materials, embodied energy of products, and the manufacturing.

Organized collection of segregated waste is not a common practice in India. Fortunately, the unorganized sector ensures that the rate of plastic recycling in India is the highest in the world. Other wastes like paper, glass bottles, and metal cans are also readily picked up by the

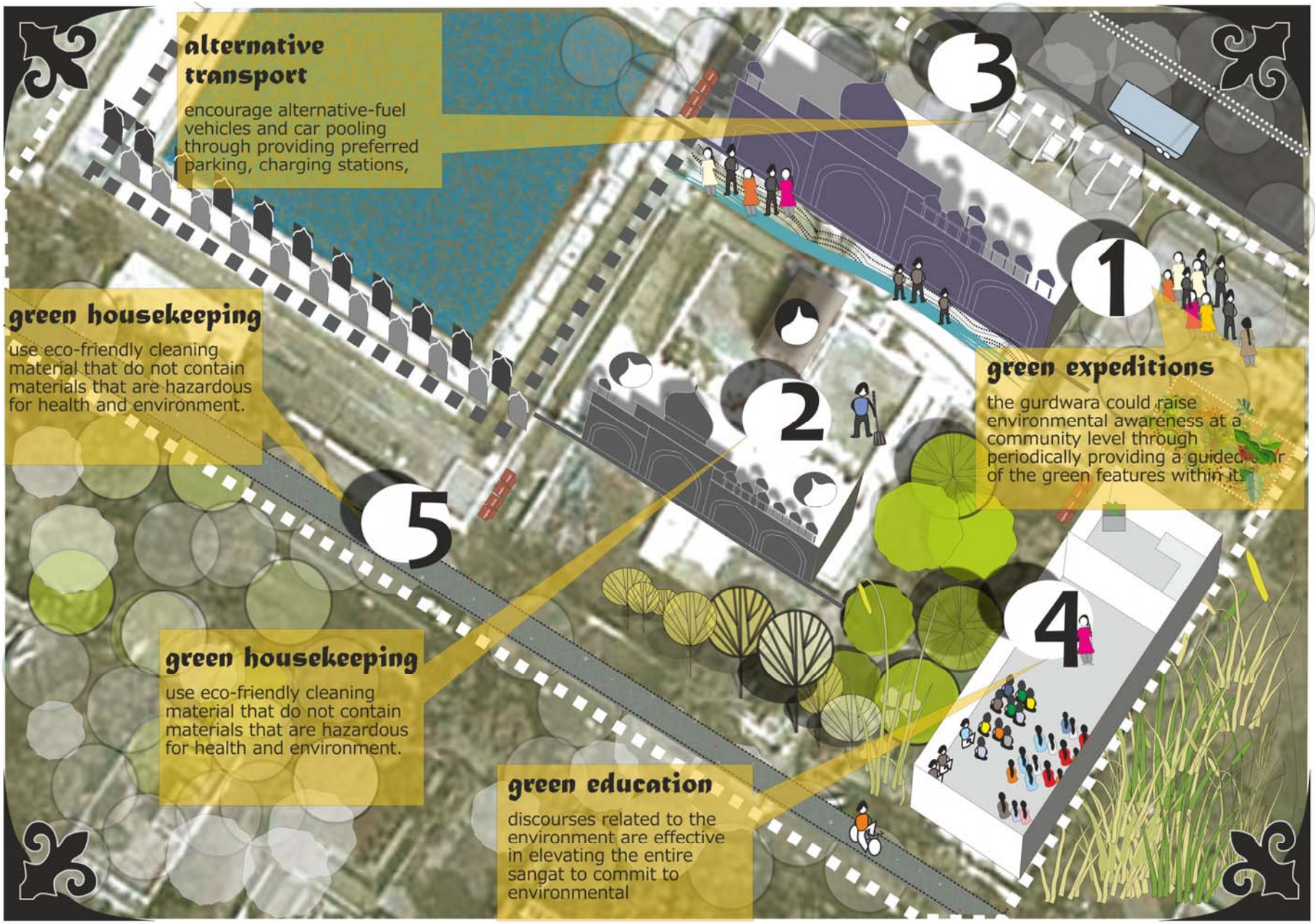
kabadiwalahs. The key to having a successful recycling program on the gurdwara premises is to make it convenient for the staff and the sangat.

To increase recycling within the gurdwara, place recycling bins next to trash bins so that they are never hard to find. Create signs that list what items are recyclable and put signs reminding the sangat to recycle. The gurdwara can also be a great place to have community recycling for "odds and ends." This can include things such as electronics, CFLs, CDs, printer cartridges. This may make it easier for sangat members to recycle these items.

Recommendations

- Comprehensive signage and labelling that clearly marks the area and bins for recycling makes it easy for the sangat to adhere to waste segregation.
- At a prominent location, a write-up on the recycling goals of the gurdwara should be pasted. This must clearly outline what can or cannot be discarded into a particular bin.
- At the very least there should be clearly marked bins for organic waste, paper, metal, plastics, and bottles.
- Depending on the size of the gurdwara, a set of bins should be placed at multiple convenient locations. At all collection points, bins for all types of waste should be available.
- E-waste must be handled and managed with due care. Contract with private e-waste collectors are gaining popularity. The gurdwara could also play the role of a nodal collection point for community e-waste.31

[31] http://greenfaith.org/resource-center/stewardship/waste-reduction-and-recycling/recycling-tips-info/recycling-tips-info/?searchterm=recycling


alternative transport
encourage alternative-fuel vehicles and car pooling through providing preferred parking, charging stations,
3
1
green expeditions
the gurdwara could raise environmental awareness at a community level through periodically providing a guided tour of the green features within it.
2
green housekeeping
use eco-friendly cleaning material that do not contain materials that are hazardous for health and environment.
5
4
green housekeeping
use eco-friendly cleaning material that do not contain materials that are hazardous for health and environment.
green education
discourses related to the environment are effective in elevating the entire sangat to commit to environmental

6. Green Practices

Green practices refer to green measures that are more intangible in nature than the ones described so far. These may involve a shift in lifestyle and a deeper commitment to the environmental stewardship as they extend beyond technology and design. Green practices help the *sangat* in aligning with and imbibing the core values of sustainability. They also help the *sangat* to explore and establish the connectedness of man, habitat, faith, and the cosmos.

Food Sources

Fresh vegetables, locally produced, help to reduce the carbon footprint of the gurdwara. Sometimes, food is shipped over thousands of kilometres – this is wholly unnecessary and unhealthy for the environment. If an alternative is available locally, it should be given precedence over food that was grown in another region. This could be taken one step further by producing food on the gurdwara premises. Apart from lowering environmental impact, local produce come with the host of benefits – it ensures a community-level investment into livelihood for local farmers, tends to be safer than mass-produced food that is meant for export, and promotes health and well-being as it goes through fewer steps between its source and destination.

We are what we eat. Therefore, pesticide-free and organically-grown local ingredients should be a top priority when cooking *langar* in the gurdwara. By serving vegetarian meals, gurdwaras are already ensuring a lower carbon footprint.

Recommendations

- Buy locally – even if it entails a higher cost.
- Produce locally, or on the premises, if space permits. If this is not possible, buy produce and grains that have been organically grown.
- Promote local vendors, farmers, and economy.

Green Material

This refers to the first two terms of the dictum ‘reduce, reuse, recycle’. An immense amount of energy is spent in manufacturing and transporting building materials – this is known as the embodied energy of the material. Recycling building material, therefore, reduces the need to spend additional energy on manufacturing fresh building material or components. Waste or left-over material from wholesalers or

retailers of stone, tiles, and other durable goods could be used for flooring or cladding in innovative ways. Several suppliers of building components stock or salvaged components from dismantled buildings. These components include doors, windows, wooden or metal beams, columns, trimming, hardware (like brackets, handles, clasps, and links), metal staircases, cabinets, shelves, and furniture. While refurbishing or renovating a space in the gurdwara, sourcing recycled or 'used' material will drastically reduce the total embodied energy of the project.

When using new material, the recycled content as well as the recyclability of the material should be important considerations. This information is commonly available with the manufacturer. The US Green Building Council (USGBC) maintains a guide list for choosing material with high recycled content:

List of Common Recycled-Content Building Products[32]

Carpet	Fiberboards
Cellulose Insulation	Fiberglass Insulation
Ceiling Tile Ceramic/Porcelain Tile	Floor Mats
Concrete Masonry Units	Lumber
Ductwork	Structural Steel

Other important considerations while sourcing building material are:

1. Can the material be termed 'local'? Although the definition of 'local' may vary according to the context, a good rule of thumb may be to establish one's own comfort radius. The USGBC defines regional material as material that is extracted, processed, and manufactured within 500 miles of the project location.
2. Does the material have low Volatile Organic Compound (VOC) content? Many paints, coatings, and varnishes contain high levels of VOC that are harmful to the health of the installer as well as the occupant. VOC content is usually mentioned by the manufacturer on the container, or on material safety data sheets (MSDSs). Low-VOC products are usually marked as such.
3. Is the material natural, plentiful, or rapidly renewable? Material that cannot replenish itself quickly should be used sparingly and responsibly. Several material now come with a certification stating that it has been responsibly harvested.

[32] http://www.usgbc.org/Docs/Archive/General/Docs5497.pdf

Green Education

A place of worship must lead by example. Many 'green' features however, function quietly in the background, without presenting an opportunity for the sangat to learn and to derive inspiration from it. Green education is a term that applies to all initiatives that disseminate and promote sustainable living and philosophy. The gurdwara should reiterate its institutional commitment to sustainability goals through making its green initiatives demonstrable and replicable.

Green Expeditions

Periodically organizing a guided walk through the gurdwara premises helps the *sangat* (and those outside it) learn about green features on a hands-on basis. While sustainable landscaping and green building features may be simpler to see and comprehend, the tour could also talk cover passive technologies, intelligent controls for energy efficiency, heating or cooling systems, and water efficiency. A tour schedule may be made available to the *sangat* in advance to encourage them to make this a community event.

Signage and Booklets

Summary of all the green features of the building, and additional information on sustainable practices could be compiled as a booklet to be distributed to devotees, or displayed as signage at various points within the complex. Information covered could range from waste management to energy efficiency and sustainable 'way of life'. Signs must not only convey information but also tell the *sangat* what to do. The signs could quote *shabads* that are relevant to the issue. Signage in *Punjabi* in the *Gurmukhi* script (with translations in English/Hindi and regional language) will enhance their reach and reinstate the religious connect of the message.

Green Discourses

Making a public institutional commitment to environmental stewardship helps the *gurdwara* and the *sangat* to deploy their internal checks and balances. It is one thing to implement green features in a building and quite another to have all occupants understand and adhere to the philosophy and operating guidelines for such features. In short, ideally, the *sangat's* commitment to the environment should be synchronous with the *gurdwara's* environmental goals, and go beyond the gurdwara premises. Green discourses, youth camps for *Gurmat* studies, and group discussions can incorporate text that enunciates sustainable and simple living from the *Guru Granth Sahib*.

Labelling of Flora

A garden is a beautiful centre of learning – labelling the flora enhances its capacity to teach. This practice involves naming the species and informing the visitor if the species is native or exotic. Other information like preferred habitat, benefits or uses, and water requirement may also be included.

Alternative Transportation

Alternative transportation refers to transportation practices that reduce pollution and demand on resources. Alternative transportation arrangements come with multiple benefits – they reduce the carbon footprint of the commuter, reduce demand for fuel, require less parking areas, and counter heat island effect.

Preferred Parking for Car Pools

Encourage the *sangat* to pool in their resources for visits to the gurdwara by providing preferred parking for carpools. Carpooling encourages sharing of private transport by multiple parties. Encourage the sangat to enter into long-term car-sharing arrangements for their trips to the gurdwara, especially for visits during the weekend or special days (when such an arrangement can be made in advance). For other days, 'casual' carpooling is more practical. A space on the notice board may be reserved for posting notes from car owners seeking potential car poolers or car poolers seeking car owners from a particular location.

Alternative Fuel or Zero-emitting Vehicles

Committees of gurdwaras such as the Golden Temple, Amritsar, already provide the facility of ferry from bus stops and railway stations. Gurdwara committees should further insist on using alternative fuel (like CNG, or electricity) or zero-emitting vehicles for such use. Electric cars are gaining popularity – the gurdwara could further encourage its sangat to use such vehicles by providing easily accessible electric charge stations as well as preferred parking.

Bicycles

Bicycling is one of the most sustainable and inexpensive mode of transport. The 2001 Census indicates robust cycling numbers for India, with 35-65% of households in medium to large cities indicating bicycle ownership. A study published in the Institute of Urban Transport Journal asserts a positive correlation between accessibility and income security[33]. However, despite clear indicators for boosting infrastructure for bicycles, urban road networks continue to ignore the needs of the cyclist.

Gurdwaras can step in and encourage its *sangat* to use the bicycle for short commutes and for visits to the gurdwara. Gurdwaras could also provide parking for bicycles and plan cycling events. This month (February 2014), the Nishan Sahib Gurdwara, Ludhiana, has launched an initiative to persuade its *sangat* to cycle to the gurdwara. A permanently installed bicycle at the premises is brightly coloured to attract attention, sports a flower bed on its carrier, and inscribed with the words:

Cycle chalao, sehat banao, vatavaran bachao [cycle to save health and the environment].

[33] Tiwari G, Jain H, 'Bicycle in Urban India', Transportation Research and Injury Prevention Program (TRIP), IIT Delhi, New Delhi, 2007

Green Housekeeping

Many conventional housekeeping cleaning products contain hazardous chemicals. Prolonged exposure to such compounds may give rise to incidence of illnesses among building occupants and building staff. There is also the risk of long-term environmental degradation associated with such chemicals, when discharged, finding their way to ground water and water reservoirs. Fortunately, many eco-friendly alternatives are now available for replacing the conventional laundry detergents, soaps, degreasers, dish washing liquids, surface cleaners, and floor- and toilet-care products.

Green housekeeping products include housekeeping and maintenance products, laundry detergents, degreasing and floor care products, among others. Eco-friendly cleaning products with negligible or no toxic components promote healthy indoor conditions, reduced risk of toxic discharge into the environment and reduced risk of pollution. In addition there is less risk of environmental deterioration during manufacture. Their discharge into water ways and soil would not adversely affect the habitat, as they have the ability to be broken down into simpler non- hazardous components through biodegradation. Usage of housekeeping chemicals that area Green Seal certified. The following table gives an overview of various green seal standards applicable to various housekeeping chemicals.

Figure 24 | Green housekeeping includes use of eco-friendly cleaning material.

Green Building Rating

Green building ratings bench-mark green buildings, awarding them a rating that is commensurate with the number of green features (as stipulated by the rating authority) incorporated by the buildings. A building that applies for such a rating tends to approach the green building idiom in a systematic, comprehensive, well-documented manner. Such ratings come along with great visibility and demonstration value. Also, a rated building is required to deploy a rigorous commissioning process that ensures that all systems meet and perform in accordance with the design goals – a crucial step towards optimizing performance. New as well as existing buildings are eligible to apply for green building ratings, albeit under different categories and with differing sets of pre-requisites, norms, and prescriptions. The ratings however, come at a cost. The rating authority usually charges a registration fee for all projects seeking a rating. In addition, the documentation and energy simulation procedures may need to be carried out by professionals. Some of the measures prescribed by the rating system may come at additional costs. Interested and competent members from the sangat may be impanelled as a committee that

coordinates day-to-day activities with the design and documentation team (often called 'facilitators' of the rating process). The facilitators will examine the existing (or new) gurdwara to set energy performance goals and rating level to aspire for, given a budget.

The two popular rating systems that are used in India are Leadership in Energy and Environmental Design (LEED) and Green Rating for Integrated Habitat Assessment (GRIHA). LEED is an initiative of the US Green Building Council (USGBC). A LEED rating can be applied for under several categories, including New Construction (NC) and Existing Buildings (EB). Developed by The Energy and Resources Institute (TERI), GRIHA has been adopted by the Ministry of New and Renewable Energy (MNRE), Government of India, since 2007. Both rating systems list a set of pre-requisites and optional measures that are categorized under site planning, water efficiency, energy efficiency, green materials, indoor air quality, and related green building features. Depending upon how many of these credits are attempted by a project, the ratings assign levels of achievement to the project (certified, silver, gold, and platinum levels under LEED and one to five stars under GRIHA).

Out of the Gurdwara and into the Community

As an extension to green discourse program, greater community participation in setting environmental stewardship goals for the area must be encouraged. This community should extend beyond the members of the *sangat*. Gurdwaras could act as a spearheading authority for community-level programs. Many measures mentioned in this Guide – community gardens, organic food, alternative transportation, bicycle initiatives, recycling, and rainwater harvesting, for instance - will work best when implemented at a macro level. Waste segregation and composting, for instance, can be managed better when implemented to a wider radius. The benefits too, encompass the entire community.

Amritsar was officially declared a Green Pilgrimage City, heralding its joining a consortium of international cities that consider the environment an important parameter for developing their urban goals and master plans. Its Green Amritsar program will propel the city towards adopting green measures that improve its air

Figure 25 | Greater community participation ensures better propagation of environmental stewardship goals.
Source : Natural Resources Defence Council (NRDC)

quality, green cover, water security, transportation, waste management, and overall quality of life. Eco-rickshaws, introduced to the city a few years ago, have lowered air pollution. The city has also witnessed rapid increase in its green cover (an additional 16 square kilometres).

7. Glossary

blackwater

The wastewater generated by toilets. It contains human or animal waste. Some sources may also list water from kitchen sinks as blackwater as it contains a wide variety of wastes including food waste. Blackwater can be recycled only after treatment by biological or chemical agents and disinfection.

building commissioning (Cx)

The start-up phase of a new or remodeled building. This phase includes testing and fine-tuning of the heating, ventilating, and air conditioning (HVAC) and other systems to assure proper functioning and adherence to design criteria. Commissioning also includes preparation of the system operation manuals and instruction of the building maintenance personnel.

carbon footprint

The total amount of greenhouse gases produced to directly and indirectly support an activity or task, calculated over a fixed time-frame, and usually expressed in equivalent tons of carbon dioxide (CO_2).

clerestory

Any high windows above eye level, specifically intended to provide lighting to the interior.

constructed wetland

Any designed systems that approximate natural wetlands, use aquatic plants, and can be used to treat wastewater or runoff.

detention

In stormwater management, making runoff in pools and basins into ponds to improve water quality and prevent floods.

embodied energy

Embodied Energy is the total energy sequestered from a stock within the earth in order to produce a specific good or service including extraction, manufacture, and transportation to market.

fenestration

Any opening, or arrangement of openings, in a building (normally filled with glazing) that admits daylight and any devices in the immediate proximity of the opening that affect light distribution (such as baffles, louvers, draperies, overhangs, light shelves, jambs, sills, and other light-diffusing materials).

fertilizers

Fertilizers are substances that are used to increase the nutrients available to plants and help to increase their growth. When too much fertilizer is applied to lawns it can wash down storm drains and end up in local lakes, ponds and streams, and our drinking water. This addition of fertilizer to water bodies can cause algae to bloom on the surface of the lakes and streams which can deplete the oxygen levels in the water. Low oxygen levels make it difficult for life to survive and algal blooms are a leading cause of fish kills in water bodies.

flushout

A process used to remove VOCs from a building by operating the buildingss HVAC system at 100 percent outside air for a specific period of time.

fly ash

The fine ash waste collected from the flue gases of coal combustion, smelting, or waste incineration. It is now used for manufacturing fly ash bricks for building construction.

formaldehyde

A gas used widely in production of adhesives, plastics, preservatives, and fabric treatments and commonly emitted by indoor materials that are made with its compounds. It is highly irritating if inhaled and is now listed as a probable human carcinogen.

geotextiles

Cloth or cloth like materials intended for use in the soil, usually for filtering or containing soil water. Some types are used to prevent or control erosion.

glare

The effect produced by luminance within one's field of vision that is sufficiently greater than the luminance to which one's eyes are adapted; it can cause annoyance, discomfort, or loss in visual performance and visibility.

graywater

Graywater (or greywater) is defined as any wastewater, except from the toilet, produced from baths and showers, washing, and clothes washers. This water can be recycled for irrigation, flushing, or other non-potable uses with little or no treatment.

greenhouse effect

A natural warming process of the earth. When the sun's energy reaches the Earth some is reflected back into the atmosphere and Space and the rest is absorbed. The absorbed energy warms the Earth's surface which then emits heat back toward Space as longwave radiation. This is partially trapped by carbon dioxide, methane, water vapour and other gases which then radiate the energy in all directions, warming the earth's surface and atmosphere. Without these greenhouse gases the Earth's average surface temperature would be some 33 degrees Celsius cooler than it is now.

greenhouse gases

Naturally occurring greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide, and ozone. Certain human activities, add to the levels of most of these. Carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), and wood products are burned. Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock. Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels. Some powerful greenhouse gases are not naturally occurring: these include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6), which are generated in a variety of industrial processes.

humus

Decomposed organic material that is an essential component of fertile soil; produced through composting.

LEED

A building environmental certification program developed and operated by the U.S. Green Building Council. Acronym for 'Leadership in Energy and Environmental Design'.

material safety data sheets (MSDSs)

Documents supplied by manufacturers of potentially hazardous products. MSDSs contain information regarding potentially significant airborne contaminants, precautions, steps for inspection, health effects, odor description, volatility, expected contaminants from combustion, reactivity, and procedures for clean-up.

native vegetation

A plant whose presence and survival in a specific region is not due to human intervention. Certain experts argue that plants imported to a region by prehistoric peoples should be considered native. The term for plants that are imported and then adapt to survive without human cultivation is n a t u r a l i z e d.

natural cooling

Use of environmental phenomena to cool buildings, e.g., natural ventilation, evaporative cooling, and radiative cooling.

offgas/outgas

A process of evaporation or chemical decomposition through which vapors are released from materials.

open grid pavers

Are pavers that provide sufficient structural strength (for parking and pedestrian movement) but do not drastically alter the permeability of the paved ground.

orientation

The relation of a building and its associated fenestration and interior surfaces to compass direction and, therefore, to the location of the sun.

pesticide

A pesticide is any substance or mixture of substances used to prevent, destroy, repel or lessen the number of pests.[34] "Pests" are any living things, such as weeds, insects, worms or other animals that grown in unwanted areas. Pesticides include insecticides, used to control insects and bugs, as well as herbicides, and fungicides. There is a certain amount of harm to human health and the environment that is present due to the nature of pesticides.

photovoltaic

Generation of electricity from the energy of sunlight, using photocells.

post-consumer recycled content

Post-consumer Recycled Content refers to material that has been used by consumers, such as used newspaper, and has been diverted or separated from waste management systems for recycling. To "close the recycling loop" we want to support products that make use of the highest post-consumer content. See post-industrial recycled content.

post-industrial recycled content

Post-industrial Recycled Content is waste that is produced during the manufacturing process that is recycled back into the industrial process. In many cases, industry was already recycling this material back into the process and thus post industrial recycled content is not as significant as post-consumer. See post-consumer recycled content.

pre-consumer recycled material

A material that is removed from source gathering or production processes (such as scrap, breakage, or returned inventory) and returned to the original manufacturing process or an alternative process. Pre-consumer recycled materials have not yet reached a consumer for the intended use.

recycled material

Material that would otherwise be destined for disposal but is diverted or separated from the waste stream, reintroduced as material feed-stock, and processed into marketed end-products.

[34] http://www.epa.gov/pesticides/about/index.htm

renewable

A renewable product can be grown or naturally replenished or cleansed at a rate that exceeds human depletion of the resource.

renewable energy

Renewable energy is an energy resource that is replaced rapidly by natural processes. Some examples of renewable energy resources are sunlight, wind, geothermal, micro scale hydropower, and wood. When you use some sunlight to warm your building, more is made almost immediately available. Water flowing in the river or creek is continually replaced by rainfall. If you chop down a tree and burn its wood in your campfire, it takes a while for the forest to grow enough to replace that wood, but it will happen within your lifetime.

serai

Langar guest house. This can be an important location for Gurdwaras showcasing their green credentials.

solar reflective index (SRI):

Solar reflectance Index is a combination of the emissivity and reflectivity of a material, and is the ability of the material to reject heat.

shading coefficient (SC)

Is a coefficient that defines the thermal performance of glass. It is the ratio of the solar heat gain through a given glass and the solar heat gain through 3mm clear glass.

storm water runoff

Stormwater runoff is unfiltered water that is incident on impervious surfaces during precipitation and eventually reaches streams, lakes, and oceans. Impervious surfaces do not absorb water thereby reducing the amount of ground water and lowering the water table. Impervious surfaces include pavements, roads, roofs, parking lots and driveways.

supply air

Is the cooled (or heated) air delivered by an air-conditioning system to a conditioned space.

sustainable

The condition of being able to meet the needs of present generations without compromising those needs for future generations. Achieving a balance among extraction and renewal and environmental inputs and outputs, as to cause no overall net environmental burden or deficit. To be truly sustainable, a human community must not decrease biodiversity, must not consume resources faster than they are renewed, must recycle and reuse virtually all materials, and must rely primarily on resources of its own region.

thermal comfort

Is defined as 'that condition of mind that expresses satisfaction with environmental factors'. In other words, when the occupant is feeling neither too hot nor too cold.

unconditioned space

A space that is not air-conditioned (mechanically heated or cooled) is called unconditioned space.

urban heat island effect

Areas with hard surfaces – like roofs, roads, parking, and paving – exhibit higher ambient temperatures than their surroundings. This phenomenon is called urban heat island effect.

U-value

Is a measure of the heat conductance of a material or an assembly. The U-value is defined as the rate at which thermal energy is conducted through unit area, per kelvin temperature difference between its two sides. Its unit is W/m^2K. Higher U-value implies more heat loss (or gain) across that surface.

volatile organic compound (VOC)

Chemical compounds based on carbon and hydrogen structures that are vaporized at room temperatures. VOCs are one type of indoor air contaminant. Although thousands have been identified in indoor air, only a few are well understood and regulated.

water budget

The estimated water use within a facility. Flow rates of fixtures and appliances, occupancy, and landscape needs are calculated.

water harvesting

Collection of both runoff and rainwater for various purposes, such as irrigation or fountains.

water reclamation

Reuse of effluent from wastewater treatment facilities through irrigation, land application, or other recycling methods.

water table

Is upper level of an underground surface in which the soil or rocks are permanently saturated with water. In other words, it is the level at which ground water is found.

xeriscape

Xeriscaping is derived from the Greek word "xeros", meaning "dry" and combined with "landscape", xeriscape means gardening with less than average water. It refers to seven basic principles for conserving water and protecting the environment. These include: (1) planning and design; (2) use of well-adapted plants; (3) soil analysis; (4) practical turf areas; (5) use of mulches; (6) appropriate maintenance; and (7) efficient irrigation.

Appendix

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