



Manual on

Sustainable Guidelines for Operation & Maintenance

A GRIHA Council Publication



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Preface



It is with great pleasure that we are introducing the manual on "Sustainable Guidelines for Operation & Maintenance" developed by GRIHA Council. As we strive to create a built environment that is both efficient and responsible, it is imperative to extend sustainability beyond design and construction into the operation and maintenance of our habitable spaces.

This manual has been developed to provide a comprehensive framework to ensure that buildings and infrastructure continue to perform optimally while minimizing their environmental impact. These guidelines go beyond just equipment efficiency, including eco-friendly practices and conservation of biodiversity within and around built spaces.

Adopting a holistic approach to sustainability, these guidelines offer thorough guidance on integrating energy, comfort, and water management measures, responsible waste management strategies, and eco-friendly solutions going beyond the conventional operation and maintenance approaches. By emphasizing efficient operational practices and sustainable maintenance strategies, it ensures that sustainability is embedded not only in design and construction but also in long-term building management. By adopting these practices, stakeholders across industries and end users can contribute to minimizing environmental impact, optimizing operational performance, and fostering a culture of ecological responsibility.

I hope these guidelines will be instrumental for building managers in promoting low-carbon and resource-efficient operation and maintenance of built premises.

ABBREVIATIONS
DEFINITIONS

1	SUSTAINABLE SITE PLANNING	1.1. Eco-Friendly Practices
		1.2. Mitigate Urban Heat Island Effects
		1.3. Preserving Biodiversity
		1.4. Promoting Universal Accessibility
2	OCCUPANT COMFORT AND WELLBEING	2.1. Visual Comfort
		2.2. Thermal Comfort
		2.3. Maintain Air Quality
3	ENERGY MANAGEMENT	3.1. Energy Efficient Lighting
		3.2. Energy Efficient Equipment
		3.3. Utilization of Renewable Energy
4	WATER CONSERVATION MEASURES	4.1. Building Water Management
		4.2. Landscape Water Management
		4.3. Rainwater Management
		4.4. Waste Water Management and Water Quality
5	WASTE MANAGEMENT	5.1. Domestic waste management



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SOCIAL STRATEGIES

- 7.1. Occupant Wellbeing and Recreation
 - 7.2. Facilities for Domestic and Service Staff
-

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GREEN BUILDING EDUCATION

ANNEXURE I

ANNEXURE II

ABBREVIATIONS

AMC	Annual Maintenance Contract
BEE	Bureau of Energy Efficiency
C_2HCl_3	Trichloroethylene
C_6H_6	Benzene
C_8H_{10}	Xylene
CFL	Compact Fluorescent Lamps
CH_2O	Formaldehyde
CO	Carbon Monoxide
CO_2	Carbon dioxide
LED	Light-emitting Diode
PV	Photovoltaic
RWA	Resident Welfare Association
SHGC	Solar Heat Gain Coefficient
SRI	Solar Reflective Index
VLT	Visible Light Transmittance
VOC	Volatile Organic Compound

DEFINITION

Biodiversity: It refers to the variety of plant and animal species on earth or in a specific ecosystem.

Biogas: It is generated when organic waste is broken down by microbes in the absence of oxygen.

Carbon Emissions: Emissions of greenhouse gases—carbon dioxide, nitrous oxide, methane, and others into the atmosphere.

Conduction: This is the form of heat transfer that happens through surface contact.

Convection : This is the form of heat transfer that happens through fluids (could be air or liquid).

Desilting Chamber: Chamber used to remove silt and other floating impurities from rainwater .

Flow Rate: It is the volume of water that passes through a specific fixture per unit time.

Greenhouse Gas (GHG): Greenhouse gas refers to any gas that by virtue of its properties, absorbs infrared radiation, that is, net heat energy emitted from the earth's surface and re-radiates it back to the earth's surface, thus contributing to the greenhouse effect.

Radiation: This is the form of heat transfer that happens through vacuum or transparent medium (could be solid or liquid).

Rainwater Harvesting: It is collecting the run-off from roof surfaces and other impervious surfaces from site in order to store it for later use or recharge to the ground water aquifer.

Solar reflective Index: The index is a measure of the ability of constructed surface to reflect solar heat as shown by a small temperature rise.

VOC: These are the carbon compounds that vaporize at normal room temperatures and participate in atmospheric photochemical reactions. This doesn't include carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate.

Water Factor Limit (WFL): Amount of water consumed (in gallons) by a dishwasher or washing machine to complete one full cycle and is measured in Litre/cycle.

Incorporating and encouraging eco-friendly practices in a housing development plays a crucial role in lowering the carbon emissions from vehicles. Simple strategies like car pooling, incorporating auto stands within the site, shuttle to nearest public transport facility, etc. are effective strategies for promoting a healthy and sustainable lifestyle.

STRATEGIES

PROMOTE SUSTAINABLE TRANSPORT



Provide e-charging facility for 2 and 4 wheelers.



Designate spaces for auto/cycle stands, bus stops and shuttle facilities in and around the site.



Put up signages to encourage car pool.

PROMOTING WALKABILITY

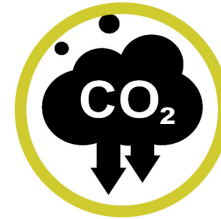


Add shading on top of pathways, pavements and outdoor seating.

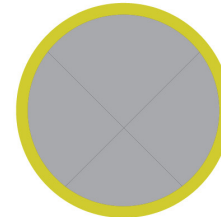


Allocate space for basic amenities within the site.

BENEFITS



Reduction in carbon emissions from vehicles.



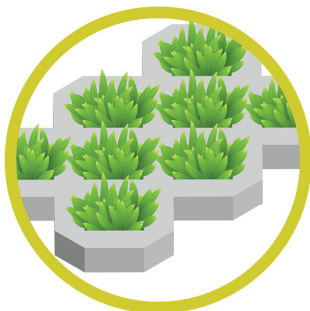
Improvement in health and wellbeing of occupants by promoting a healthy lifestyle.



Financial savings due to decreased dependency on private vehicles.

The urban fabric consists of materials such as concrete and asphalt which absorb a high percentage of solar radiation and dissipate it to the air at night. This phenomenon causes higher night-time air temperature in cities in contrast to rural environments that rapidly cool down. This results in heat islands in urban areas which are 3-10°C hotter than neighbouring rural areas.^{1,2}

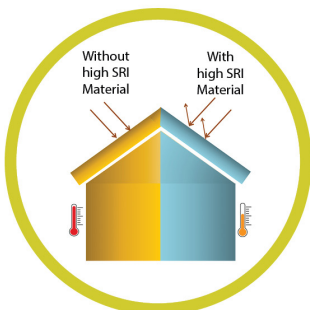
STRATEGIES



Replace hard paving with grass pavers / other soft paving.



Cover exposed paved areas with canopy / pergolas.



Paint exposed hard surfaces of roof, facade, pavement and roads with high Solar Reflective Index (SRI) paint.

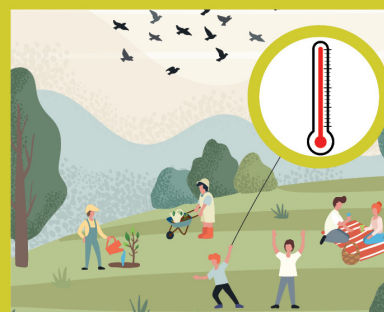


Provide small ponds / water bodies on site.

BENEFITS



Improved perviousness on site, which prevents water logging.



Reduced ambient air temperature, and improved outdoor comfort conditions for occupants.

1 US EPA O Heat Island Effect. <https://19january2017snapshot.epa.gov/heat-islands>. Accessed 14 Jun 2022 (2016)

2 Causes, Effects and Solutions To Urban Heat Island - Conserve Energy Future. <https://www.conserve-energy-future.com/effects-solutions-urban-heat-island.php>. Accessed 14 Jun 2022

Biodiversity is the key indicator of the health of an ecosystem and we must ensure that we do not disturb the existing biodiversity of the site, for e.g. birds, plants, etc. The inappropriate use of artificial lighting without considering the environment leads to environmental degradation and loss of biodiversity. The residential building sector contributes to light pollution through a variety of sources, including architectural and landscape lighting, interior nighttime lighting, and security lighting.

STRATEGIES



Provide bird feeders and bird baths on site.



Provide artificial bird nests on site.



Avoid the use of uplighters for landscape and facade.



Direct outdoor lighting downwards and ensure that they are properly shielded

BENEFITS



Pleasant spaces for social interaction in the built environment.



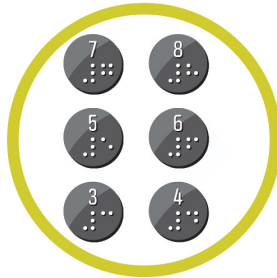
Enhances the local environment and biodiversity.

Persons with special needs, that arise due to age or medical conditions, experience day-to-day struggles in their activities due to barriers in accessing public buildings and other infrastructure. These barriers include inadequate sizing of doorways, corridors and toilets, surface level differences with no alternative accessible path of travel, lack of seating, handrails, grab-bars, signages, and sensory aids amongst others

STRATEGIES



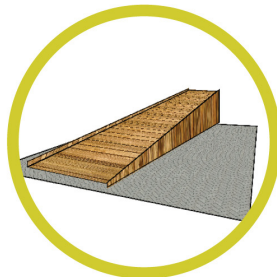
Designate parking spaces for differently abled people.



Provide braille script panels and audio assistance in elevators.



Provide toilets for differently abled people in community spaces.

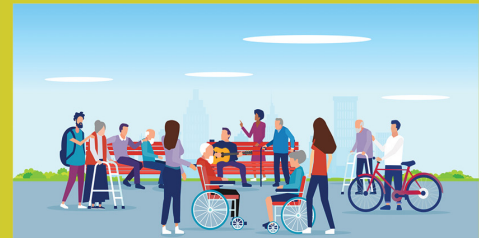


Provide removable ramps for wheelchairs.

BENEFITS



Social inclusiveness for all, hence creating an independent environment.



Safe and secure environment for all.

Lighting accounts for about 20% of the total power consumption in a building. Opting for energy efficient lighting measures greatly enhances the opportunities for energy conservation.³

Replacing or purchasing energy efficient lighting systems.

Installation of lighting controls.

Maintenance of existing lighting fixtures.

Changing user behavior and creating awareness.

PURCHASE/ REPLACEMENT

- Replace existing incandescent and CFL luminaires with LED fixtures for energy efficiency.
- Select LEDs of highest efficiency which is determined by the "luminous efficacy", on the basis of which BEE provides a Star rating for LED luminaires.
- Install sensor based lights for optimized energy use.



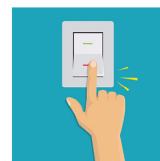
OPERATION & MAINTENANCE

Regular cleaning of lighting fixture to reduce light loss by dust accumulation



USER BEHAVIOUR

Shut off lights when not in use.



Utilize day light during day time.

Do not use excessive lighting.



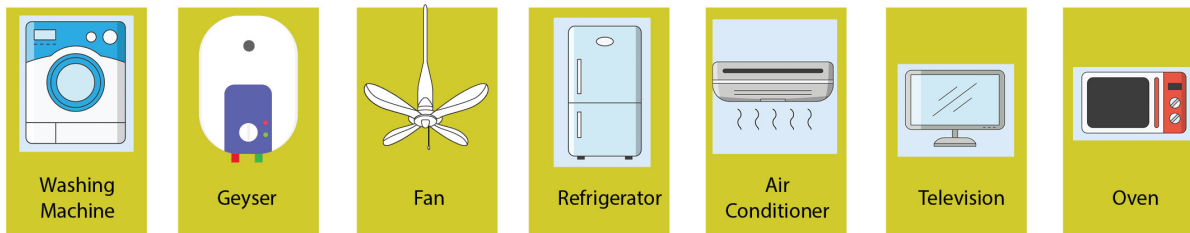
Table: Features of different types of lighting fixtures.⁴

	LED	CFL	INCANDESCENT
EFFICIENCY	80% less energy use than an incandescent	75% less energy used than an incandescent	90% of energy is wasted as heat
AVG. LIFE SPAN (hours)	50,000	10,000	1,000
ANNUAL OPERATING COST	Low	Medium-low	High

3. International Institute for Applied Systems Analysis (IIASA). n.d. Energy End-Use: Buildings. Details available at https://iiasa.ac.at/web/home/research/Flagship-Projects/Global-Energy-Assessment/GEA_Chapter10_buildings_lowres.pdf, last accessed on July 22, 2020.

4. Constellation (2016) LED vs. CFL Bulbs: Which Is More Energy-Efficient? In: Constellation Residential and Small Business Blog. <https://blog.constellation.com/2016/03/25/led-vs-cfl-bulbs/>. Accessed 14 Jun 2022

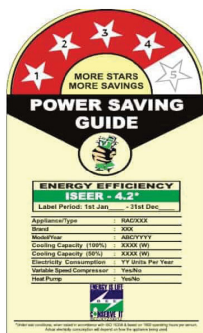
Home appliances consume a huge amount of energy. Therefore, it is ideal if we could take advantage of technological innovations, and shift to more energy-efficient practices and systems. This will help in saving money and energy, protecting the environment, and improving lifestyle.



Common Appliances Used at Home

PURCHASE/ REPLACEMENT

- Upgrade equipments to BEE star rated ones. Higher the star rating, greater its efficiency.
- Replace equipment components with higher energy efficient parts during maintenance or in case of breakdown.



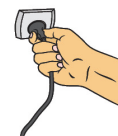
OPERATION & MAINTENANCE

- Get an Annual Maintenance Contract (AMC) for home appliances, which will help in:
 - Savings on cost in case the equipment malfunctions.
 - Prolonged life of equipment.
 - Regular maintenance for best performance.



USER BEHAVIOUR

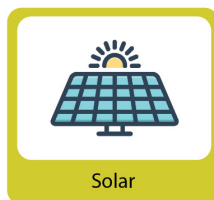
Shut off appliances not in use.
Prevent phantom / Vampire loads
“Vampire load is electricity that is used by devices that are turned off but are still plugged into an electrical outlet keeping the device on standby.”



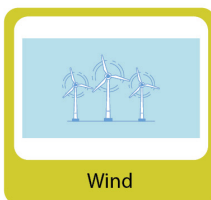
3. Avoid using unnecessary equipment during peak demand hours.



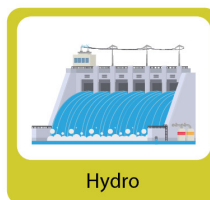
After reducing the amount of energy required in a building, we must offset the conventional energy (derived from fossil fuels) with renewable energy. Renewable energy is energy derived from natural sources that is constantly replenished and does not contribute to green house gas emissions



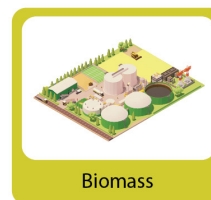
Solar



Wind



Hydro

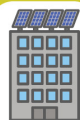


Biomass

Types of renewable energy

PURCHASE / REPLACEMENT

Solar photovoltaic : Solar PV can be installed over rooftops of common areas and buildings.



Solar street lamps: These can be used for lighting pathways and roads which offsets the building operation energy demand.



Biogas plant: Biogas can be produced at community scale from the organic waste generated on site.



Solar water heater: These can be installed in buildings for having hot water to produce hot water for domestic and other uses.



Roof top wind turbines: Small scale wind turbines installed on rooftops can be used to generate and store electricity at community scale.



Solar lanterns: These can be used at individual and home level for emergency and power backup.



MAINTENANCE

Ensure regular cleaning of solar PV panels to ensure maximum efficiency.



Get an AMC for installed renewable energy system.



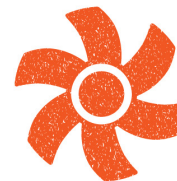
Ensure cleaning of biogas plant such as removal of debris and organic matter.



Checking for corrosion and worn out turbine blades.



Checking and tightening bolts and electrical connections.



Building water demand in a household constitutes of water required for essential day to day activities like drinking, cooking, washing clothes and utensils, cleaning, bathing and flushing. Using low flow plumbing fixtures and efficient washing equipment in a building can reduce the building water demand by upto 30-40% in comparison with conventional plumbing fixtures.⁵ Efficiency of plumbing fixtures can be measured in 'flow rates' and that of washing appliances can be measured in terms of 'water factor limit'. Lower the flow rate or water factor limit, greater is the water saving of the fixture or appliance.

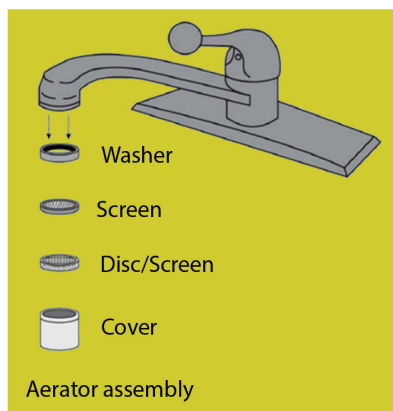
Flow rate = Litre per flush / per minute

Water Factor Limit = Amount of water used in one wash cycle.



Efficiencies of typical plumbing fixtures and washing appliances present in a household are defined as flow rate or water factor limit.

PURCHASE / REPLACEMENT



In case of faucets, water-saving aerators can be bought and installed without changing the faucet. Aerators are equipped with mesh screens that divide the flow of water into multiple small streams by adding air in between, hence reducing the volume of water coming out of the faucet.

OPERATION & MAINTENANCE



Plumbing fixtures should be regularly cleaned with a simple brush to prevent grime deposits. Additionally, sponge filters can be placed at two locations, either at the source from where municipal water is being supplied to the apartment or at the inlet of the receiving water tank.



An annual maintenance contract (AMC) should be signed for all cleaning equipment to maintain their efficiency over time.

USER BEHAVIOUR



For activities such as brushing, shaving or washing utensils, turn off water when not required to avoid wastage.



Leakages should be checked regularly and repaired as needed.

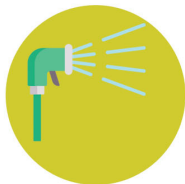


Efficient method like using buckets, water sprinkling cans should be used for showers and washing cars.

5. Salehi M, Abouali M, Wang M, et al (2018) Case study: Fixture water use and drinking water quality in a new residential green building. Chemosphere 195:80–89. <https://doi.org/10.1016/j.chemosphere.2017.11.070>

An efficient landscape design not only reduces the water consumption of a project, but helps mitigate environmental hazards like urban flooding and urban heat island effect. The key strategies to reduce the landscape water demand in any project includes sustainable planning and zoning of vegetation and, use of efficient irrigation practices and systems.

PURCHASE / REPLACEMENT



Irrigation using a hose pipe should be minimized as it uses a large amount of water in a very short span of time. This method also has higher evaporative losses.



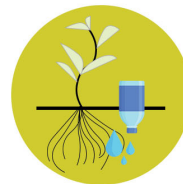
Sprinkler systems should be used to water large areas like lawns.



If no irrigation system is installed, sprinkler watering cans should be used instead of hose pipe for irrigation.



Drip irrigation system should be installed to irrigate shrubs and trees as it delivers water at a low flow rate and without evaporative losses.



Innovative techniques such as a water bottle with tiny holes can be used to achieve drip irrigation for plants in balconies and on terraces. This technique minimizes use of water for watering household plants and does not require manual watering, hence saving time.



Replace grass/lawn with shrubs and trees as they require less amount of water for maintenance. Trees especially drought tolerant/ adaptive/ local species, once mature, require the least amount of water and hence should be preferred while designing landscape. Only native species of grass, shrubs and trees should be planted as exotic varieties are much less likely to survive and require a lot of water to sustain.

OPERATION & MAINTENANCE

Irrigation systems should be regularly cleaned with pressurised means to get rid of the deposits and maintain their efficiency.

USER BEHAVIOUR

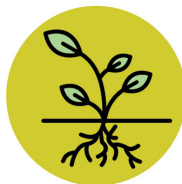
Recommendation: Coconut husk / pebbles should be added to soil as they can help retain moisture in soil for longer, hence reducing losses due to evaporation.

Rainwater is one of the purest freely available forms of freshwater. It can easily be used for cleaning, landscaping and flushing purposes. In case a project cannot install infrastructure to store and reuse rainwater, it should be redirected to an aquifer or landscape area to recharge ground water.

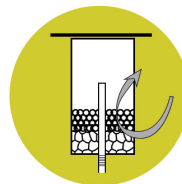
PURCHASE / REPLACEMENT



Replace impervious hard surfaces with pervious materials like grass pavers to minimize water logging and ensure percolation of rainwater into the ground.



Plant more trees in the landscape as they minimize runoff of rainwater due to their large water bearing capacity.



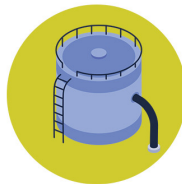
Filter media of the desilting chamber, recharge pit and the RW pipe from the roof should be regularly cleaned. In case of the recharge pit, the filter media should be put back after cleaning the silt out of it.



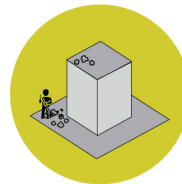
Area around the desilting chamber and RWH pit should be kept clean and accessible.



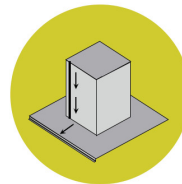
Rainwater can be directed to a pond/small waterbody on site, surrounded by trees to allow for natural filtration of water. The water body can be designed as a landscape feature and an interactive public space in the project.



Rainwater harvesting tank can be designed to store and re-use water with its overflow directed into a recharge pit.



RW storage tanks, and catchment areas like terraces and pathways should be cleaned before monsoon commences to avoid contamination of harvested rainwater. The RWH pit can be cleaned manually or by using a pressure based system due to which the sludge rises up and can be skimmed off.



The first rainfall of the monsoon carries the dirt and contaminants from catchment areas and should not enter the storage tank. A first flush diverter should be used to divert the first rain into stormwater drains or the landscape.

USER BEHAVIOUR

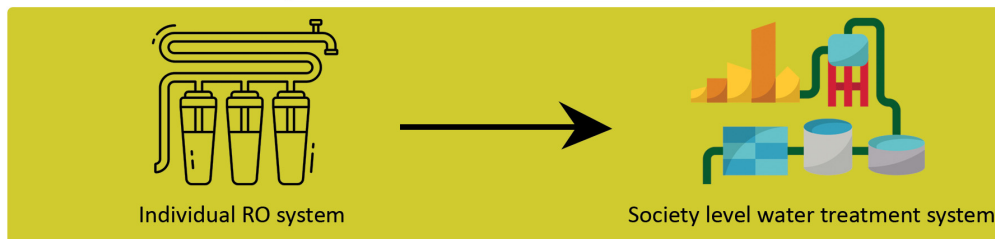


Landscape area and terraces should be kept clean and free of litter like plastic bottles, wrappers etc., as it can lead to clogging of rainwater drains hence, reducing the efficiency of the rainwater harvesting system. Signages should be installed at the project site to ensure the same.



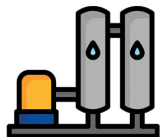
As there is a lack of finite fresh water sources, it is essential to treat and reuse waste water and become self sufficient. All the sources of water for a household including water from municipality, ground water, treated water should be tested before consumption for potable and non potable purposes.

PURCHASE / REPLACEMENT



Instead of individual RO systems, societies / townships / housing developments should install water treatment plants at society scale for better management of wastewater.

OPERATION & MAINTENANCE



Filter media inside the STP should be changed and cleaned regularly. Sludge from the sludge holding tank should be regularly removed.



Quality of STP should be as per local norms.



An AMC should be signed for annual servicing of the Sewage Treatment Plant and the Water Treatment Plant on site.

USER BEHAVIOUR



Upon installation of a community scale water treatment system like RO, any waste water should be reused for flushing by directly connecting it with the WC flush tank supply line.



Water from all sources should be regularly tested and should meet the local norms.



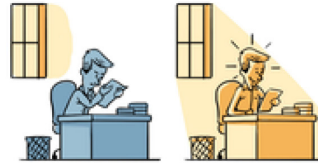
Signages should be placed at the outlet of the STP stating that STP water should not be used for domestic purposes.

Visual comfort in a building is defined as the occupants satisfaction due to the right quantity and quality of light being available in the building/room for the tasks being performed.

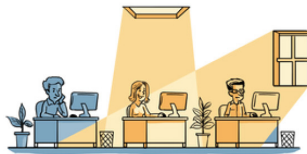
FACTORS AFFECTING VISUAL COMFORT



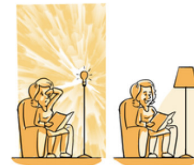
Outdoor view



Daylight quantity and quality



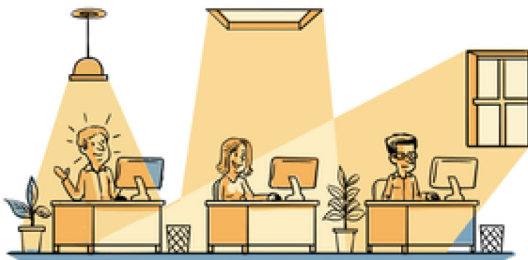
Light uniformity



Artificial light quantity and quality

ASPECTS TO CONSIDER FOR VISUAL COMFORT

Types of lighting in buildings



Artificial lighting and Daylighting

To ensure visual comfort recommended range for habitable spaces.

Table: Illuminance level for different spaces⁶

REQUIREMENTS	SPACES	ILLUMINANCE (LUX)
Low	Living	100-150-200
Moderate	Bedroom/dining	100-150
Moderate to high	Study/Reading/Kitchen counter	200-300-500

6. National Building Code of India (NBC) (2016). <http://www.bis.org.in/sf/nbc.htm>

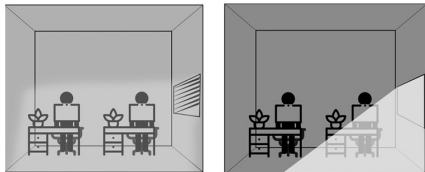
STRATEGIES TO ENHANCE VISUAL COMFORT

PURCHASE/ REPLACEMENT - DAYLIGHT

Windows: Select glass and/or solar films considering Visible Light Transmittance (VLT) values while balancing it with Solar Heat Gain Coefficient (SHGC) as per the climate.

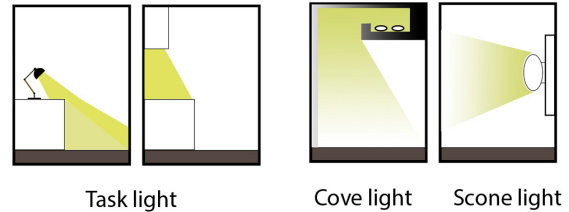


Shading: Use of blinds/curtains to control glare and optimize daylight.

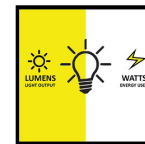


PURCHASE/ REPLACEMENT - ARTIFICIAL LIGHT

Designing of internal light should be based on task and function of the site.

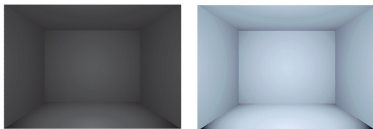


Select luminaire such as LEDs with minimum wattage and maximum lumen output



OPERATION & MAINTENANCE

When painting the interiors, selecting light colours with minimum textures helps in better lit indoors as compared to dark surfaces.



Cleaning of glazing of doors and windows to maximize daylight inside.

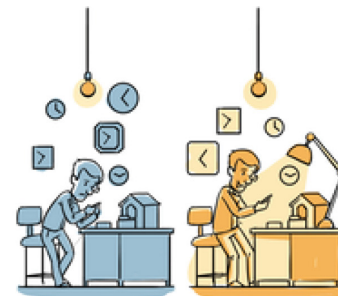
Cleaning of luminaires to avoid loss of light from the luminaire.



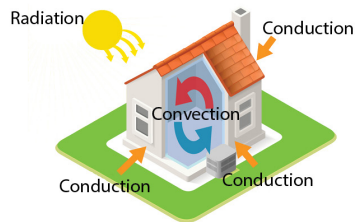
USER BEHAVIOUR

Preference 1: Maximize use of daylight during daytime before switching on artificial lights.

Preference 2: Task light over general lights if requirement is task specific.



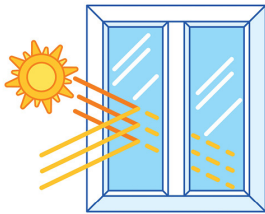
Thermal comfort is defined as that condition of mind which expresses satisfaction with the thermal environment. Thermal energy (heat/cold) can be transferred by three means which together with moisture changes influence our perception of the environment. An overall balanced thermal environment is key to feeling comfortable.



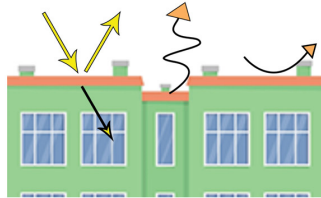
Transfer of energy

OPERATION & MAINTENANCE

Preference 1: Install solar films or external shades for windows.



Preference 2: Install high Solar Reflective Index (SRI) coating or tile on roof top

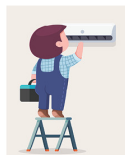
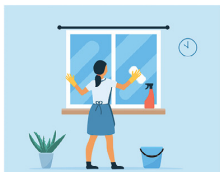


OPERATION & MAINTENANCE

Preference 1: Regular cleaning of fans, exhausts and AC filters.

Preference 2: Regular preventive maintenance for fans, exhausts and AC filters.

Preference 3: Cleaning door and window mosquito nets and glazing.



USER BEHAVIOUR

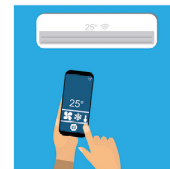
Preference 1: Use of clothing as per climate



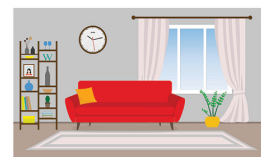
Preference 2: Take advantage of outdoor favorable climate



Preference 3: Operate air conditioners at 24-25°C



Preference 4: Installing appropriate curtains/blinds



Outdoor and indoor air carry a lot of pollutants that affect the human health. The health effects of the air quality could be immediate, seen after single or repeated exposures, or could be long term and show up after a certain duration. Therefore, treatment of air becomes a cornerstone for a healthy living.

SOURCES OF INDOOR POLLUTION



EFFECTS OF INDOOR AIR POLLUTION ON HUMAN HEALTH



STRATEGIES TO IMPROVE AIR QUALITY

PURCHASE / REPLACEMENT

Use of green cleaning products with no/low levels of chemicals



Provision of chimney in kitchen



Provision of exhaust in toilets



Doormat to be placed outside the main door



Use of indoor plants. (Refer Annexure 1)



OPERATION & MAINTENANCE

Low VOC paints, zero lead paints (Refer annexure II)



Regular cleaning of carpets for dust



Regular cleaning of upholstery



Cleaning of chimneys and exhaust

USER BEHAVIOUR

Tobacco smoking should be restricted to outside the premise or in designated zones



Plant more trees



Switch to eco friendly modes of transport such as cycles/ e-vehicles



Use public transport or reduce the use of personal transport



Solid waste is generated due to various anthropogenic activities. The quantum and type of waste generated is largely dependant on the building typology and its use. Residential units generate domestic waste that includes waste items such as: food wastes, paper, cardboard, plastics, textiles, batteries, lighting fixtures and household hazardous wastes.



Types of domestic waste generate from households

Waste can pose serious short term and long term threats to the environment and human health if not managed strategically. When not managed at source, most of the household waste find its place in the landfill. Common waste management practices followed in residential units are:

No segregation of waste at source



Unhygienic waste storage



Uncovered garbage being taken to landfill



Unmanaged landfill causing air, water and land pollution

- Excessive use of materials, leading to more waste generation
- Mixing of waste leading to loss of recyclable waste
- Unmanaged landfill leads to air, land and water pollution

The issues created by poor waste management can be easily tackled if simple strategies are adopted by every stakeholder involved in the chain. If management happens at source, then a large part of the domestic waste can be converted into resource and can be put to useful purposes. The following steps can be followed for domestic waste management at individual residences and society level for efficient management and safe disposal of waste.



Efficient management of existing infrastructure for waste

PURCHASE/ REPLACEMENT

Use multi coloured bins to segregate household waste.



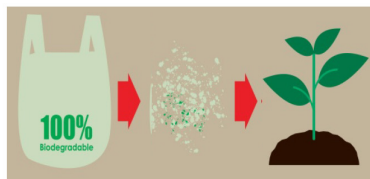
Community level collection facility should be provided for hazardous waste and waste generated in lesser quantities in individual household such as e-waste, for better management

OPERATION & MAINTENANCE

Proper labelling of waste bins helps people to dispose waste in a segregated manner.



Use recyclable composting bags for the bins



USER BEHAVIOUR

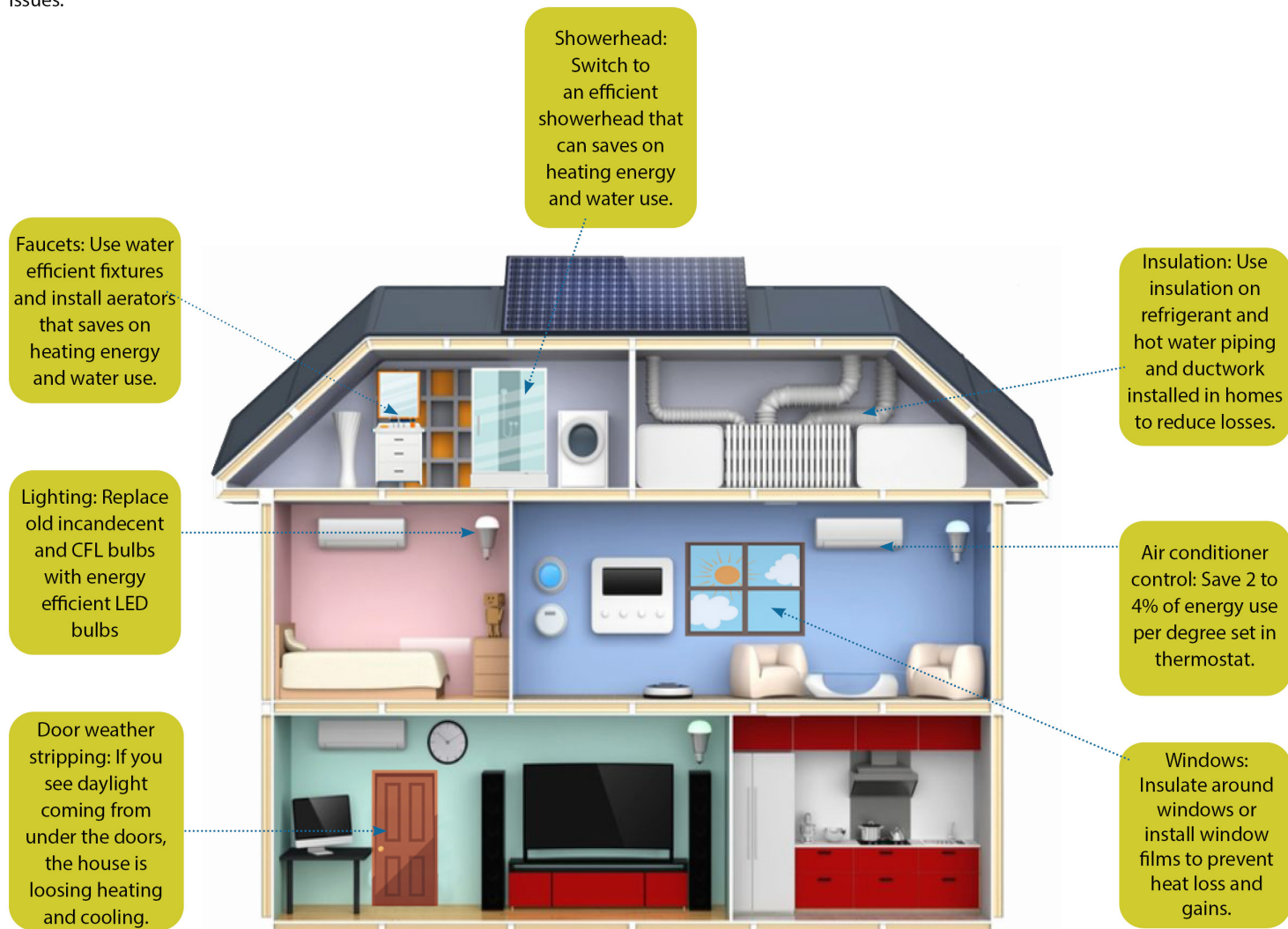
Use eco friendly lifestyle to reduce consumption. Eg: Use cloth bags instead of polythene bags.



Educate your family.



Building audits are carried out on existing buildings to determine if they are still fit for purpose and if they need remedial work done to rectify any issues.



Remember

For achieving higher saving, consult an energy auditor to check your home for more inefficiencies .

Metering helps in measuring consumption and analyzing abnormal usage patterns. Further the data can be utilized to reduce consumption. Metering in existing building can happen for two resources i.e. energy and water. To manage these resources properly, resource consumption can be tracked at a basic level or an advanced level. Resource management is the key to resource efficiency.

WATER METERING		ENERGY METERING	
BASIC METERING	ADVANCED METERING	BASIC METERING	ADVANCED METERING
Municipality supply	Flushing	Utility Grid	Basement Parking Lighting
Bore well	Domestic	On Site Renewable Energy	Community/ recreation center
Treated water outlet	Irrigation	Diesel / gas generator	Water Pumping
Captured Rainwater	HVAC		Outdoor lighting
			Lifts and common areas

STRATEGIES FOR METERING AND MONITORING

PURCHASE/ REPLACEMENT

Analog meters should be replaced with digital meters

Installed energy meters should be replaced with smart meters

OPERATION & MAINTENANCE

All meters should be regularly checked to prevent errors and erratic reading.

Replace malfunctioning meters.

USER BEHAVIOUR

Observe energy and water consumption over months and compare them with previous data.

Optimize energy and water use by comparing data.

ANALOG



Meter reader collects data from home and takes it to utility company

Consumption analysis received with monthly bills.

Not compatible with current goals for environment and energy

DIGITAL

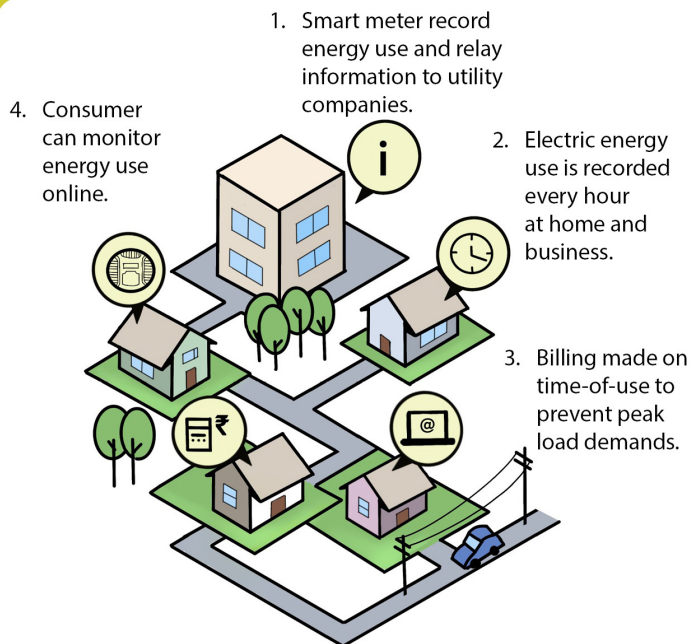


Data is transmitted through collectors to utility companies

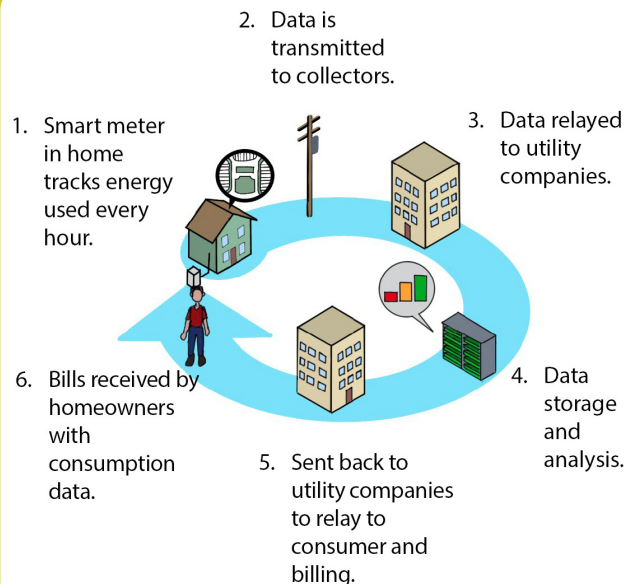
Consumer can view their energy use daily, live time.

Helps achieve current goals for environment and energy

WHAT IS IT?



HOW IT WORKS:

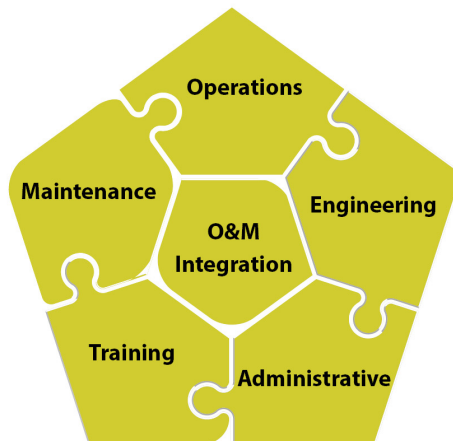


WHAT IS BMS

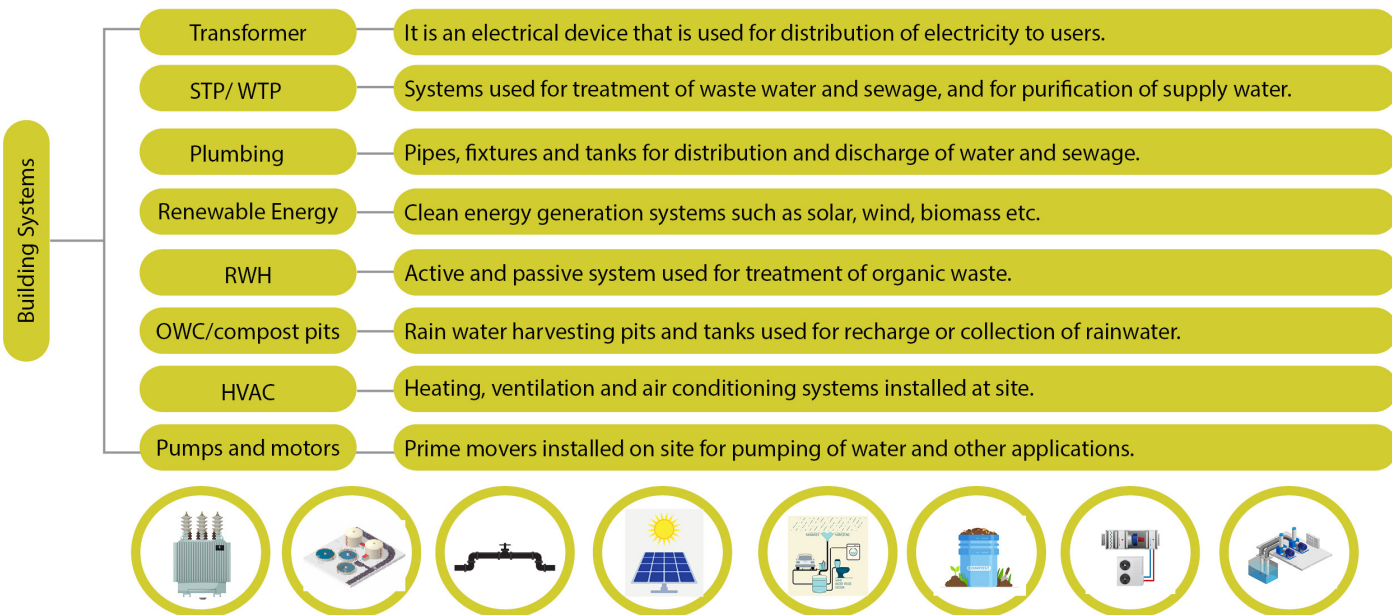
A Building Management System is a computer-based smart metering system installed in buildings to manage and monitor equipment such as air-conditioning, heating, ventilation, lighting, power systems, security devices, sensors, and utility meters.

6.2 OPERATION & MAINTENANCE

O&M include a broad spectrum of services, competencies, processes, and tools that ensures proper functioning of the built environment to meet the design objectives. O&M typically include day-to-day activities necessary for the building, its systems and equipment, and occupants/users to perform the intended function.



COMMON BUILDING EQUIPMENT THAT ARE INSTALLED AT SITE LEVEL AND NEED REGULAR MAINTENANCE OR CHECKUPS ARE:



The requirements of O&M will vary for each user. As the number of services, variety, and complexity of facilities increase, the complexities of O&M activities increases. Refer to annexure for a sample O&M checklist.

Cities are growing rapidly and resulting in shrinking green and recreational spaces. With evolving lifestyles and work patterns, the need for these spaces has become essential for physical and mental wellbeing.



Diminishing green space and community living around the world impacting mental and physical health

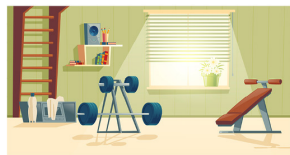
RECREATIONAL FEATURES TO ENHANCE OCCUPANTS WELL BEING

STRATEGIES

At individual level



Terrace garden



Gym rooms

At site level



Open community spaces/ play areas



Library

BENEFITS

Improved health



Reduction in the urban heat island effect



In our day-to-day life, domestic and support staff play a major role. However, often times their basic needs are not met such as access to clean toilets, drinking water facility, comfortable shelter for resting and first-aid facilities at their work places. This leads to increased stress, unsafe environment and reduced work efficiency, and calls for thoughtful considerations for them.



Lack of sanitation access



Lack of drinking water facility

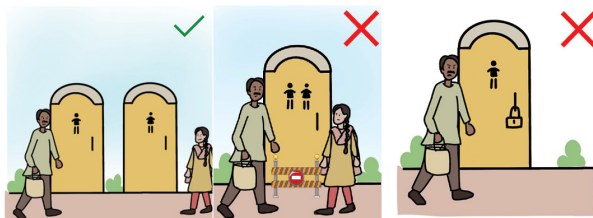


Lack of space for resting



Lack of safety measures

STRATEGIES



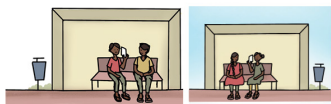
Hygienic and separate toilets for male and female workers



Clean drinking water



First-aid facility



Space to rest

BENEFITS



Sense of inclusiveness



Improved health, safety, quality of life and enhanced work efficiency

Environmental awareness that includes the social and economic well being of occupants is a necessary requirement of environmental protection and sustainable development.



Awareness and knowledge creation on sustainable living begins at individual scale. Steps should be taken to ensure sustainability first at individual and home level. Further, environmental education and ideas can be incorporated at a community level by RWA activities.

INDIVIDUAL LEVEL



Educating family members

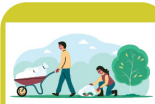


Sustainable Lifestyle



Sustainable consumerism

SITE LEVEL



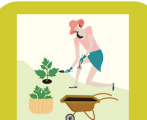
Clean up drives



Posters / media in common areas



Awareness Drives



Tree plantation

BENEFITS

- Awareness among residents and visitors.
- Create connect with nature.



- Community drives lead to reduction in carbon emission. Healthier lifestyle.



- Younger generation develops a positive connect with environment.



LIST OF PLANTS FOR IMPROVED AIR QUALITY

			
PLANTS	POTHOS	SNAKE PLANT	SPIDER PLAN
Oxygen levels	1500 ml (approx.)	900 ml (approx.)	950 ml (approx.)
Absorbs	CO ₂ , CH ₂ O, CO, C ₆ H ₆	CO ₂	CO ₂ , CO,

			
PLANTS	PEACE LILY	TULSI	WEeping FIG
Oxygen levels	950 ml (approx.)	1050 ml (approx.)	1200 ml (approx.)
Absorbs	CO ₂ , CH ₂ O, CO,	CO ₂ , CH ₂ O, CO	C ₂ HCl ₃ , C ₈ H ₁₀ , CH ₂ O, CO ₂

VOC LIMITS OF PAINTS

PAINT APPLICATION	TYPE OF FINISH	VOC Limit (g/L)
Interior coatings	Flat	<50
	Non-flat	<150
Exterior coatings	Flat	<200
	Non-flat	<100
Anti-corrosive	Gloss/semi-gloss/flat	<250

