CENTRE FOR ENVIRONMENTAL HEALTH

HEALTH & ENVIRONMENT LEADERSHIP PLATFORM H.E.L.P

Monograph on Green Healthcare Institutions

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List of Abbreviations

AHPI	Association Of Healthcare Providers (India)
BEE	Bureau Of Energy Efficiency
CPCB	Central Pollution Control Board
CPVC	Chlorinated Polyvinyl Chloride
ECB	European Central Bank
ECBC	Energy Conservation Building Code
EPP	Environmentally Preferred Purchasing
EU	European Union
GBP	GreenBuilding Programme
GGHH	Global Green And Healthy Hospitals
IGBC	Indian Green Building Council
LED	Light Emitting Diode
LEED	Leadership In Energy And Environmental Design
MOEF	Ministry Of Environment And Forests
NBC	National Building Code Of India
PBT	Polybutylene Terephthalate
PVC	Polyvinyl Chloride
SBS	Sick Building Syndrome
USA	United States of America
VOC	Volatile Organic Compounds
WASH	Water, Sanitation and Hygiene

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Preface

The damage caused by Climate change is not limited to human health today, and is projected to have a greater and wider impact in the foreseeable future. The cumulative threats of Climate change to health have been extensively discussed for decades now and understanding on the issue has evolved and, in the meanwhile, so have the impacts.

By 2030, Climate change could cause irreversible negative impacts on health which, it is estimated, could push more than 100 million people back to extreme poverty. Cardiovascular diseases, respiratory illnesses, etc. have direct correlation with air pollution and rise in emissions that drive Climate change will further increase these health issues. Rising sea levels and temperatures, different patterns of precipitation, and more frequent extreme weather conditions are the predominant causes leading to negative health outcomes (World Bank, 2017).

To remain operational during extreme weather events, health systems must enable their facilities to be resilient to the impacts of Climate change and respond to the long-term, climate-induced changes in disease patterns, while also responding to the respiratory and cardiovascular disease caused by air pollution. As a large consumer of energy, and products, paradoxically the health sector also contributes to these environmental health problems, even as it attempts to address their impacts.

Responding to these issues, there is a growing movement towards Climate-Smart, low-carbon healthcare.

Key elements of Climate-Smart, low-carbon healthcare include:

- Health system design and models of care based on appropriate technology, coordinated care, emphasis on local providers, and driven by public health needs
- Building design and construction based on low carbon approaches
- Investment programs in renewable energy and energy efficiency
- Waste minimization and sustainable healthcare waste management
- Sustainable transport and water consumption policies
- Low-carbon procurement policies for pharmaceuticals, medical devices, food, and other products

- Resilience strategies to withstand extreme weather events (World Bank 2017)

These low-carbon approaches also provide numerous co-benefits, these include:

- Improved health status by reduction in environmental pollution and Climate change
- Improved health system efficiency and cost savings
- Decreased escalation of costs through molding technology and models of care to the environment and disease burden
- Stimulated and anchored local economies

The health sector is already responding to these challenges in many countries throughout the world. Participants in Healthcare Without Harm's 2020 Healthcare Climate Challenge have already represented the interest of more than 10,000 hospitals and health centers in 23 countries, working to reduce greenhouse gas emission, improve resilience to Climate change and encourage physicians, staff and communities, through leadership efforts, to understand and respond to the health impacts of Climate change.

Why do we need Green Buildings?

Cities have often been blamed for causing an alarming increase in the ecological footprint since the dawn of industrial revolution (Satterthwaite, 1999). Recently, rampant urbanization has also been blamed for world's GHG emissions and disproportionately contributing towards global Climate change (Sánchez-Rodríguez, 2005). According to estimates by the United Nations Environment Program, incessant growth in the construction sector could double the emissions by 2050, Considering how compelling amounts of GHG emissions are generated through construction materials, especially insulation materials, and refrigeration and cooling systems (Brown, Marilyn A, 2008) adopting green buildings is thus more vital now than ever before. Green Buildings give a wide range of economic and environmental benefits to sustainable design, often achieved through the use of global and regional standards and systems available (Omer, 2008). According to a study by ECB, a certified green building can save energy, carbon, water, and waste, resulting in savings from 30 to 97%. Many sustainable buildings have also seen increase of up to 6.6% as return on investment, 3.5% increase in occupancy, and increase of 3% in rent. Further,

increased productivity, ambience, occupant health, better indoor air quality, are some of the other benefits of green buildings (Miller, 2008).

Increasing burden on the Health sector

Energy consumption in hospitals and the waste generated there affects the environment and health of people in the vicinity. Hospital owners ought to be held responsible for not only the treatment within the limits of the area around the hospital, but are also responsible for the environmental performance of hospital buildings, as well as for the health promotion of customers and employees. Figure 1 below shows how environmental impact caused by hospitals can increase the need for medical services, and this, in turn can lead to increased contamination (Azmal, 2014).

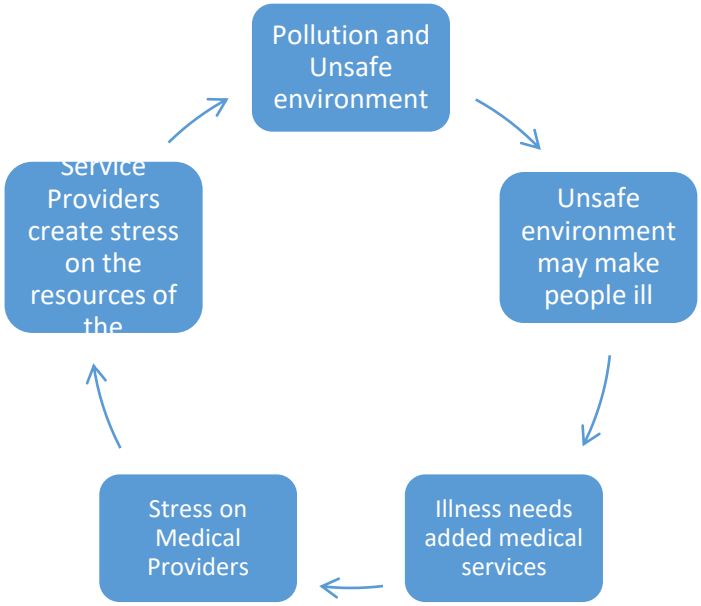

Figure 1. Relationship of environmental damage, increased illness, and environmental impacts of healthcare services. (source: Reller, 2000).

Global Green Building Standards and Certifications

To fully understand and practice green certification for buildings, details pertaining to quality of information and requirements need to be reviewed carefully. Globally, there are different labels, certification agencies and standards or acts which offer greater assurance to consumers,

designers, specifiers, and others. Listed below are some of the widely used Green Building standards and certifications around the world.

a) US Green Building Council's LEED

LEED is the most widely recognized building environmental assessment scheme. The registered projects have covered 24 different countries (Lee, W. L., and J. Burnett, 2008). Originating from the USA, LEED is also widely practiced in Europe, Asia and Australia. The LEED certification and rating is based on a set of prerequisites and credits, and each credit refers to one of the following aspects – these are sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation & design process. Here, one point is given to each credit when the conditions are met. But energy performance and renewable energy credit has a different credit system where a number of points are awarded to each credit depending on how much improvement is achieved in the performance. This counts towards the scoring system, and a total of up to 110 points can be achieved. Based on the awarded points, there are four levels the buildings can qualify: Certified – 40 to 49 points, Silver – 50 to 59 points, Gold – 60 to 79 points, and Platinum – 80 to 110 (LEED V4, 2017). LEED certifies both existing buildings and new constructions.

For certification and regulation on new and existing building design and construction refer to Tables 1 to 8 in the Appendix.

b) EU GreenBuilding Programme

The European Commission launched the GBP on voluntary basis in 2005 aiming at improving energy efficiency of non-residential buildings in Europe. The programme covers owners of both existing and new buildings to release cost-effective measures that enhance energy efficiency of their buildings in one or more technical services. Unlike the LEED rating system, GBP concentrates more on energy efficient measures to curb energy usage and reduce the carbon footprint. This system is significantly narrow in scope and is based around different calculations of energy consumptions (Sundfors, 2017).

For Elements of Energy Efficiencies on new and existing building design and construction refer to Table 10 in the Appendix.

c) Indian Green Building Council (IGBC) - India

IGBC established the IGBC Green Healthcare Rating System to address the most important national priorities, which include water conservation, handling waste, energy efficiency technologies, reduced use of fossil fuels, lesser dependence on usage of virgin materials and health and well-being of patients and occupants. The rating system includes National standards and codes such as Indian Health Facility Guidelines, NBC, ECBC, MoEF guidelines, CPCB guidelines, and several others. The objective of the rating system is to create a healthcare benchmark better than the existing national standards.

IGBC Green Healthcare rating system addresses green features under the following categories:

- Indoor Environmental Quality
- Sanitization & Hygiene
- Energy Efficiency
- Water Conservation
- Site Selection and Planning
- Building Materials and Resources
- Innovation in Design Process

The section has guidelines which enables credits and mandatory requirements for construction of Healthcare facilities of all sizes and types. IGBC Green Healthcare rating system is designed for Subcenters, Primary Health Centers, Community Health Centers, District Hospitals, Clinics, Private Hospitals and Medical Institutions. Certification depends on the total credits earned, however, mandatory requirements are non-negotiable.

For threshold criteria and certification levels, refer to table 11 and 12 in the Appendix to find the IGBC Credit point system and IGBC Green Healthcare Rating - Checklist for Mandatory requirement.

The objective of IGBC Green Healthcare rating is to address national health priorities and better the quality of life for patients and apply user friendly methods for better adaptability. The rating system evaluates certain mandatory requirements and credit points using a prescriptive approach

and other parameters on a performance-based approach (IGBC Green Healthcare Facilities, 2016).

d) Association of Healthcare Providers, India (AHPI)

AHPI established the standard for GREEN & CLEAN Hospital with the intention to establish a robust framework of vast majority of hospitals and nursing homes by way of structures, processes and outcomes, and to comply with the requirements of being an eco-friendly organization. The standard can be adopted for all categories of healthcare organizations, engaged in delivery of primary, secondary or tertiary level of health services. The standard is equally applicable for ALLOPATHIC and AYUSH medicine systems (AHPI, 2015).

The GREEN & CLEAN hospital aims to mitigate ill effects of environment (GREEN) on patients and staff and even hasten the recovery process through infection free ambience (CLEAN). The standard urges to suitably incorporate the requirements within the existing hospital system. Hospitals should develop a basic environment management system to address the standard and objective elements as per the below table. The standard element represents the holistic goal while the objective element represents the actual goals and requirement to achieve the certification. The AHPI standard is applicable to both new constructions and existing hospital buildings. The standard is certifiable by AHPI Healthcare Certification Center (AHPI, 2015).

Refer to table 12 in Appendix to find Standard and Objective element point system of GREEN and CLEAN Hospital.

Table 1: Global and National Standards and Certification available for practicing Green Healthcare

Issue	For Existing buildings refer to	For New Constructions refer to
Site Selection	• LEED • IGBC	• LEED • IGBC • AHPI

Indoor Air Quality	• AHPI • IGBC • LEED	• AHPI • IGBC • LEED
Energy Management	• AHPI • EU- Greenbuilding-Programme • IGBC • LEED	• AHPI • EU- Greenbuilding-Programme • IGBC • LEED
Water Management	• AHPI • LEED	• AHPI • LEED
Bio-Medical Waste Management	• AHPI • IGBC	• AHPI • IGBC
Green House Keeping	• AHPI • IGBC	• AHPI • IGBC
Building Materials and Resources	• AHPI • IGBC • LEED	• AHPI • IGBC • LEED

A Guide to Green Healthcare

A Green Hospital should focus on continuously reducing its impacts on the environment and eventually eliminate its role on disease burden. Moving towards green hospital includes waste and energy reduction as well as protection of resources. (Azar et al, 2015).

In order to promote sustainable operations in hospitals, leadership at all levels is essential. This means leadership makes clear the key priorities of the organization and environmental health, safety and sustainability. This can be achieved through training, goal setting, creating accountability and incorporating these priorities in all stakeholder relations through internal and external

communication. These actions and measures have to be undertaken to make major changes in the organization's culture, within a hospital and in the context of the larger health system (GGHH Agenda, 2011). Benefits of green hospital structure has proven to have a positive impact on patients and staff members (Marcus, 1999). Green hospital design should also focus on and give priority to Lighting, Indoor Air Quality – active and passive measures, Water use, responsible Waste management, Resources and Materials used, Green housekeeping, Clean and Green interior building design, and Garden and landscape (IGBC Green Healthcare Facilities, 2016). The procedures and changes that needs to be made to start green practices in a Green healthcare are discussed in detail below.

I. Site selection

Site selection and construction planning are the first building blocks in a Green Healthcare system. The decision made at this stage would have some of the biggest impact and would also pave way for a healthy green building. The choice of site location thus will influence access, resource consumption, and other related impacts on the natural health system.

Healthcare facilities unlike development of other kinds, must serve people from all social classes (Becker, 2003). Thus, healthcare facilities must prioritize developed areas and previously developed sites in order to refrain from contributing to a continued "urban sprawl"- a global, multifaceted concept centered on expansion on auto-orientated, low-density development. Research suggest that residents of sprawling neighborhood tend to emit more pollution and suffer from traffic fatalities; continuous urban sprawling may contribute to more pollution of air, water, and natural habitat (GGHH Agenda, 2011).

Action Items for new construction

- Select a site which accommodates future development
- Select a site within existing communities that supports increased development density over time
- Maximize orientation of the building to follow the path of the sun and maximize the impact of passive solar heating and cooling strategies, such as overhangs, indoor/outdoor transition strategies, and thermal mass.
- Conduct a pre-site assessment to explore options for site sustainability measures.

- Evaluate Climate change and future extreme weather risks.

Resources

- Sustainable Sites, *LEED V4 for Building Design and Construction*
- Site Selection and Planning, *IGBC Green Health rating system, October 2016*
- Structural Requirement, *Standard for Green & Clean Hospital, AHPI, 2015*
- Site Development, *Buildings Guidance Document for Members, Global Green and Healthy Hospitals*

II. Indoor air quality

Indoor air quality is crucial in a Green Building rating system. It provides owners an opportunity to earn more points under most Green Building standards, for instance, LEED certification (Vohra, 2016). Poor indoor air quality in hospitals may cause related illnesses to patients and healthcare workers (El-Sharkawy, 2014). The hospitals should therefore give utmost importance to indoor air quality as prolonged exposure to high levels of pollutants may easily affect the vulnerable group and also cause illness to the healthcare workers (WHO, 2010).

Indoor pollutants originate from both indoor and outdoor sources (Shields, 2000). Indoor sources include – office equipment such as printers, fax machines, and photocopiers; cleaning products, and equipment; and the ventilation system. Although most healthcare facilities are smoke-free zones, the location of the hospitals decides the level of pollutants it receives from the outdoor environment. For instance, healthcare facilities located less than 500m away from a congested or a busy road would have unhealthy indoor air quality levels. As restoring and safeguarding health is the main purpose of healthcare facilities, maintaining good indoor air quality becomes critical and imperative for a green hospital (IGBC Green Healthcare Facilities, 2016).

Action items for existing building and new construction

- Comply with Central Pollution Control Board Indoor air quality standards
- Define critical zones (Intensive Care Units, Neonatal Care Units, etc.) and maintain WHO indoor air quality standards
- Try to avoid artificial power generators which use fossil fuel

- Use certain species of indoor plants which produce oxygen and reduce indoor pollutants like Volatile Organic compounds

Action items for new building and construction

- Monitor and maintain indoor environmental quality by installation of air quality monitors to ensure comfort and well-being of occupants
- Install air purifiers in zones where air quality is critical
- Use zero-VOC interior materials
- Install permanent entry-way systems to capture dust particles at all primary entrances For instance, install slotted systems, grates or grills, etc.

Resources

- Indoor Environmental Quality & Wellbeing*, IGBC Green Health rating system, October 2016*
- Indoor Environmental Quality, *LEED V4 for Building Design and Construction, Indoor Environmental Quality*
- Process Requirement, Section 3 (PR-3), *Standard for Green & Clean Hospital, AHPI, 2015*

III. Energy and Ambience

A good hospital design should maximize on natural day light. Use of natural light helps the patients and members of the staff. Exposing the skin to sunlight helps them enhance their health and well-being, and reduce stress level, thus improving quality of care (Edwards, 2002). A good lighting structure helps eliminates Sick Building Syndrome for both patients and staff members (Rashid, 2008). Natural light also combats seasonal affective disorder or winter depression through view connectivity of natural vistas. Artificial lighting should not be compromised in sensitive areas like operation theatre, medical dispensaries, and other important areas (IGBC Green Healthcare Facilities, 2016). Maximizing on natural light can also be beneficial in saving energy.

Action items for both existing building and new construction

- Install occupancy sensors in passageways, storage rooms, labs, and in places the occupancy is minimal
- Install low-energy LED lighting to save indoor lighting energy cost
- Use task lights to provide illumination in areas like consulting rooms, labs, and wards

- Healthcare facilities with air-conditioners, heating systems, fans, motors, and pumps shall consider switching or choosing electrical appliances which have a Bureau of Energy Efficiency 3-star rating or above to minimize the energy input
- Encourage the use of eco-friendly refrigerants and halons in the facility, which minimize negative impact on the ozone layer, should also be considered.
- Commission systems to verify and optimize performance and functionality.

Action items for new building and construction

- Use passive energy designs to reduce heating and cooling needs and expand access to natural daylight
- Designing glazing fades which are transparent and operable to green courtyard
- Use narrow floor plates to maximize access to daylight and natural ventilation

Resources

- Energy Efficiency, *IGBC Green Health rating system, October 2016*
- Energy And Atmosphere, *LEED V4 for Building Design and Construction, Energy and Atmosphere*
- Structural Requirement, Section 4 (SR-4), *Standard for Green & Clean Hospital, AHPI, 2015*
- *Energy Guidance Document for Members, Global Green and Healthy Hospitals, 2014*

IV. Water use

Hospitals are one of the largest customers for municipal water and sewer (Huff, 2007). The design of a hospital building landscape and site has a significant impact on community water resources (Reiling J, 2008). And therefore given this extensive use, to most extent, facilities should decrease their dependence on water (K.K.Yadhunath, 2013).

Installation of rainwater harvesting system will help reduce the municipal water demand and enhance the ground water table (WaterAid,2011). The aim should be to manage rainwater on site through a range of devices, such as planting, green roofs, rainwater cisterns or bio-retention facilities that capture rainfall at or near the source (Sheng, 2016). For an effective use of the water resource, first there needs to be proper awareness on part of the patients and the hospital staff in order to make efficient use of the water resources.

Action items for both existing buildings and new construction

- Enhance efficiency of plumbing fixtures
- Locate and correct drips, leaks and unnecessary flows in bathroom, laundry, kitchen, labs, etc.
- Use of pervious, porous, or permeable paving systems that allow storm water to filter into the ground
- Installation of rainwater harvesting system will help reduce the municipal water demand and enhance ground water table
- Create awareness among patients and staff to reduce the use of water.
- Use centralized/decentralized waste water plants to reuse the grey water for flushing and other purposes.

Action items for new buildings and construction

- Minimize or eliminate the need for potable water for irrigation through the use of native, drought-tolerant landscape materials. Use recycled grey water for irrigation.

Resources

- Water Conservation, *IGBC Green Health rating system, October 2016*
- Water Efficiency, *LEED V4 for Building Design and Construction, Water Efficiency*
- Structural Requirement, Section 3 (SR-3), *Standard for Green & Clean Hospital, AHPI, 2015*
- *Water Guidance Document for Members, Global Green and Healthy Hospitals, 2014*

V. Bio-Medical Waste Management

Hospitals waste management has been brought into attention after the new notification of the Bio-Medical Waste Management rules, 2016. The rules make it mandatory for the healthcare establishment to segregate, disinfect and dispose their waste in an eco-friendly manner (Sharma M, 2002). Improperly segregated contaminated sharps or any infected disposal pose great health risk associated with hospital waste. This sluggish approach to bio-medical waste can increase risk of nosocomial infections in patients. Poor waste management in hospitals can lead to change in the microbial ecology and spread of antibiotic resistance (Gordon JG,2004).

The waste generated in a healthcare facility can be divided into two categories – hazardous and non-hazardous waste. Non-hazardous waste usually comprises of food remnants, fruit peels, wash water, paper cartons, packaging materials, etc. This constitutes about 85% of the waste generated in most healthcare facilities (Seymour Block, 2001).

Hazardous waste can be divided into potentially infectious waste and potentially toxic waste. Over the years different definitions for classifying types of hazardous waste have been coined. Potentially infectious waste includes infectious, infective, medical, biomedical, hazardous, red bag, contaminated, medical infectious, regulated and unregulated medical waste and constitutes 10% of the total waste (Seymour Block, 2001). Potentially toxic waste can be radioactive waste, chemical waste and pharmaceutical waste, which is just 1% of the total waste composition (Reller, 2000).

Proper waste management reduces the impact of waste generated and discarded on human health and environment. Handling of medical waste is complex and here success depends to a large extent on reorienting and changing waste disposal habits of the hospital staff (Farzianpour, F, 2014).

Waste segregation in hospitals takes place at different points and in phases. The waste needs to be segregated at point source. Without source separation and recycling activities in place, bio-medical waste may get disposed with general waste. Thus, the first step is to adopt a source segregation method. Normally, many hospitals around the world apply for a three-colored container system, one each for general waste, infectious waste and sharps (kindly refer to the Bio-Medical Waste Management rules (India), 2016 to know more about the bin segregation system). Among healthcare waste, sharps are a major concern for all healthcare workers– doctors, nurses, midwives, healthcare workers, recycler and community–alike (Chaerul, M, 2008). Proper precautions and trainings need to be conducted to prevent occupational hazards while handling bio-medical waste, especially while handling sharps (Diaz, 2005).

Segregated bio-medical waste further needs to be transported, handled, treated and disposed regularly. The collected waste would then be handed over to a common bio-medical waste management facility for treatment, processing and final disposal (Bio-medical waste management rules, India, 2016).

Some of the most commonly used treatment and disposal methods in infectious medical waste management include:

- Autoclaves and retorts
- Microwave Disinfection Systems
- Chemical disinfections
- Controlled and healthy landfills (Diaz, 2005)

Action items for both existing building and new construction

- For safe handling, treatment, disposal methods, and procedure for bio-waste in the health sector, kindly refer to the Bio-Medical Waste Management rules, India, 2016.

Action items for an effective bio-medical waste management

- Set up a waste management committee
- Follow an international/national/regional strategic plan
- Develop procedures, inspection protocols and materials for safe handling of waste
- Train and educate healthcare workers regularly about the importance of bio-medical waste and also its hazardous impacts if not handled with care

Resources

- *Waste Guidance Document for Members, Global Green and Healthy Hospitals, 2015*
- *Bio-Medical Waste Management rules, 2016, Ministry of Environment, Forest and Climate Change*
- Sanitization & Hygiene, *IGBC Green Health rating system, October 2016*
- Process Requirement, Section 5, PR-5*, Standard for Green & Clean Hospital, AHPI, 2015*

VI. Green House keeping

The consequences of poor housekeeping facilities can cause WASH-related illness within the heathcare facility. An estimated 15% of patients get affected by illness related to healthcare and develop infections during their stay in hospitals (Allegranzi et al., 2011). Thus, maintaining high level of hygiene and sanitation is essential for a green healthcare facility.

Accumulation of dust, soil and microbial contaminants on surface is a potential source of nosocomial (hospital-borne) infections. Effective and efficient cleaning methods and schedules are therefore necessary to maintain a clean and healthy environment in healthcare buildings. Use of cleaning products which have no carcinogen agents must be encouraged and provision of personnel training for safe handling and disposal of hospital waste, and consideration must be given to install waste water treatment system within the hospital vicinity will also be helpful in containing the spread of disease and infection which may arise from the hospitals (IGBC,2016).

Action items for both existing building and new construction

- Provide separate bins to collect dry waste (paper, plastic, metals, glass, etc.,) and wet waste (organic)
- Divert the collected waste to a centralized facility, which is easily accessible for hauling
- In addition to dry and wet waste bins, provide separate bins for safe disposal of e-wastes like batteries, lamps, and other electronic waste products
- Segregation of waste is critical, waste generated in healthcare facilities should be segregated from other municipal waste to prevent them from being mixed and sent to land-fills
- Segregate bio-medical waste at source, so as to prevent direct exposure, thereby improving sanitation and hygiene

Resources

- UN Initiative on Greening Procurement in the Health Sector from Products to Services, WHO, 2015
- IGBC Green Health rating system, October 2016
- Standard for Green & Clean Hospital, AHPI, 2015

VII. Procurement of Materials and Resources

An effective sustainable strategy for greener practices in hospitals is to adopt Environmentally Preferred Purchasing (EPP). It is defined as purchasing products or services which have less damaging impact to the environment and human health (Laustsen, 2007). It recommends various solution to minimize or eliminate waste in various stages, for instance, to avoid unnecessary

packaging would help in prevention of peruse expiry in case of laboratory chemical, etc (Reller, 2000).

While considering building material and resources for a green hospital should be prioritized according to health impacts associated with them. Every stage of material extraction, transport, use, and disposal has impacts on the ecosystem and human health. This can be reduced by choosing methods and procurements which don't have implications on the environment. Some examples of safe procurement include, supporting the use of local and regional materials, avoiding hazardous chemicals and materials such as asbestos, and metals such as mercury, lead and cadmium (GGHH, 2015).

Procurement of materials that are known or suspected to cause cancer or other serious health effects should be avoided. Further, since the staff comes in contact with the purchased products more than the patients, material used by them should also be reviewed before procurement. Thus, products which give out pollutants such as air toxins, which include dioxin and asbestos, and metals such as cadmium, mercury, chromium, and lead compounds and other products which has the probability of causing any reproductive effects or birth effects or any health impacts should be avoided. In addition to exposure from breathing air toxics, some air toxic pollutants such as mercury can deposit onto soils or surface waters, where they are taken up by plants and ingested by animals and eventually magnified up through the food chain. Thus, paints and coatings that are 100% lead and cadmium-free should be actively advocated and promoted. The existing inventory should be reviewed for all interior and exterior equipment, and instruments should be inspected for manufacturer, model, and technical specifications, including the mercury content in them. The products capable of causing any health impact should be avoided and eventually eliminated altogether.

Phasing out all mercury-based electrical devices and switching to LED lighting sources should be considered. Also, the elimination of mercury based medical devices and products should be carried out (GGHH, 2015).

Another method for greening is recycling. Facility managers must decide about items which are to be recycled. A good waste segregation plan with segregation on point source would help. Recyclable materials must be collected in using sources (for example: stores, kitchens, laundries,

pharmacies and workshops) and then to be delivered to the central storage area for transportation purposes (Reller, 2000).

Action items for both existing and new buildings

- Substitute materials containing persistent bio-accumulative toxicant's (PBT's), including PVC, CPVC, phthalates, formaldehyde, and halogens and brominated flame retardants with safer alternatives
- Develop policy guidelines for avoiding PVC and phthalates plasticizers in both building and medical products
- Use certified green building materials, products, and equipment, so as to reduce dependence on materials that have associated negative environmental impacts
- Encourage the use of eco-certified interior products that consider impacts through the life cycle, thereby resulting in lower environmental impacts

Action items for new building and construction

- Avoid use or installation of PVC, CPVC, phthalates, formaldehyde, and halogens and brominated flame retardants

Resources

- Building Materials and Resources, *IGBC Green Health rating system, October 2016*
- Materials And Resources, *LEED V4 for Building Design and Construction, Materials and Resourses*
- Materials, *Building Guidance Document for Members, Global Green and Healthy Hospitals, 2015*
- Process Requirement, Section 4, PR-4, *Standard for Green & Clean Hospital, AHPI, 2015*
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Appendix

Table 1. LEED v4 for Building Design and Construction: Hospitality, Location and Transportation

Location and Transportation	**16**
LEED for Neighborhood Development Location	16
Sensitive Land Protection	1
High Priority Site	2
Surrounding Density and Diverse Uses	5
Access to Quality Transit	5
Bicycle Facilities	1
Reduced Parking Footprint	1
Green Vehicles	1

Table 2. LEED v4 for Building Design and Construction: Hospitality, Sustainable Sites

Sustainable Sites	**10**
Construction Activity Pollution Prevention	Required
Site Assessment	1
Site Development - Protect or Restore Habitat	2
Open Space	1
Rainwater Management	3
Heat Island Reduction	2
Light Pollution Reduction	1

Table 3. LEED v4 for Building Design and Construction: Hospitality, Water Efficiency

Water Efficiency	**11**
Outdoor Water Use Reduction	Required
Indoor Water Use Reduction	Required
Building-Level Water Metering	Required
Outdoor Water Use Reduction	2
Indoor Water Use Reduction	6
Cooling Tower Water Use	2
Water Metering	1

Table 4. LEED v4 for Building Design and Construction: Hospitality, Energy and Atmosphere

Energy and Atmosphere	**33**
Fundamental Commissioning and Verification	Required
Minimum Energy Performance	Required
Building-Level Energy Metering	Required
Fundamental Refrigerant Management	Required
Enhanced Commissioning	6
Optimize Energy Performance	18
Advanced Energy Metering	1
Demand Response	2
Renewable Energy Production	3
Enhanced Refrigerant Management	1
Green Power and Carbon Offsets	2

Table 5. LEED v4 for Building Design and Construction: Hospitality, Materials and Resources

Materials and Resources	**13**
Storage and Collection of Recyclables	Required
Construction and Demolition Waste Management Planning	Required
Building Life-Cycle Impact Reduction	5
Building Product Disclosure and Optimization - Environmental Product Declarations	2
Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
Building Product Disclosure and Optimization - Material Ingredients	2
Construction and Demolition Waste Management	2

Table 6. LEED v4 for Building Design and Construction: Hospitality, Indoor Environmental Quality

Indoor Environmental Quality	**16**
Minimum Indoor Air Quality Performance	Required
Environmental Tobacco Smoke Control	Required
Enhanced Indoor Air Quality Strategies	2
Low-Emitting Materials	3
Construction Indoor Air Quality Management Plan	1
Indoor Air Quality Assessment	2
Thermal Comfort	1
Interior Lighting	2
Daylight	3

Quality Views	1
Acoustic Performance	1

Table 7. LEED v4 for Building Design and Construction: Hospitality, Innovation

Innovation	**6**
Innovation	5
LEED Accredited Professional	1

Table 8. LEED v4 for Building Design and Construction: Hospitality, Regional Priority

Regional Priority	**4**
Regional Priority: Specific Credit	1
Regional Priority: Specific Credit	1
Regional Priority: Specific Credit	1
Regional Priority: Specific Credit	1

Table 9. EU- Greenbuilding Programme's Elements of Energy Efficiencies

Elements	Energy Efficiency Measures
Heating and Ventilation	• Behavior • Maintenance
Lighting	• Improvement of luminaries • Selection of energy efficient lamps
Electric equipment	• Selection of energy efficient devices • Selection of energy efficient equipment • User specific saving potentials

Heating System	• Selection of energy efficient equipment • e.g. Installation of a low temperature boiler or a condensing boiler • Installation of well-dimensioned heating pumps + power regulation Installation of thermostatic radiator valves • Optimization of the regulation, e.g. Outdoor-temperature regulation, Improvement of regulation at secondary supply system, Activation of night-drawdown • Improvement of the heating supply system, e.g. Improvement of hydraulic system
Building Envelope	• Changing/Installation: type of glazing • Changing/Installation: type of frame • Improving insulation of envelope components • Reducing unwanted solar heat gains • Modifying geometry
Cooling System	• System based on water distribution • Systems with water and air AWS1 Improved control of classic system

Table 10. IGBC Credit point system

Certification Level	Credits (New Healthcare facilities)	Credits (New Healthcare facilities)	Recognition
Certified	50-59	45-53	Best Practices
Silver	60-69	54-62	Outstanding Performance
Gold	70-79	70-79	National Excellence
Platinum	80-100	72-90	Global Leadership

Table 11. IGBC Green Healthcare Rating- Checklist for Mandatory requirement

Mandatory Requirements Module	New Healthcare Facility	Existing Healthcare Facility
Indoor Environmental Quality & Wellbeing		
Minimum Fresh Air Ventilation	Required	Required
Tobacco Smoke Control	Required	Required
Sanitation & Hygiene		
Municipal Solid Waste Management, Post-occupancy	Required	Required
Bio-medical Waste Management, Floor & Centralized level	Required	Required
Energy Efficiency		
Ozone Depleting Substances	Required	Required
Minimum Energy Efficiency	Required	Required
Water Conservation		
Rainwater Harvesting – Roof & Non-roof	Required	Required

Water Efficient Plumbing Fixtures	Required	Required
Building Materials & Resources		
Handling of Waste Materials, During Construction	Required	Required
Site Selection & Planning		
Local Building Regulations & Safety Compliance	Required	Required
Soil Erosion Control	Required	Required
Innovation in Design Process		
Not Applicable		

Table 12. Standard and Objective element point system of GREEN and CLEAN Hospital

Category	Standard Elements	Objective Elements
Environment Management Requirement	1	3
Structural Requirement	4	34
Process Requirement	10	60
Outcome Requirement	1	3
Total	16	100