

# Green Hospital and Climate Change: Their Interrelationship and the Way Forward

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## ABSTRACT

Climate change is a reality, and the modern healthcare sector not just contributes towards this grave phenomenon but is itself being affected by it. The present review was thus conducted to understand the meaning of 'Green Hospital', to identify the many ways in which health sector is contributing towards climate change, to explore possibilities for countering this grave trend and last of all to look for institutions that are pioneering change. Data for the review was extracted from multiple online sources using the Google search engine. It was found that hospitals, being resource intensive establishments, consume vast amounts of electricity, water, food and construction materials to provide high quality care. It was also found that certain healthcare institutions, by employing simple, smart and sustainable measures can greatly reduce their environmental footprint. But constructing Green Hospitals can be a challenge considering the local conditions and growing customer expectations.

**Keywords:** Resource intensive, Environmental footprint

## INTRODUCTION

The deteriorating health of our environment, a painful reality, is an issue of grave national and international importance because it has a direct bearing on human health, but the sad irony is that the health sector itself has a role to play in bringing about climate change. Health sector operates in the same environment as any other industry, an environment that sustains billions of humans. It is influencing and in return is being influenced by that very same environment. Treating sick patients - with the help of modern medications and sophisticated technologies - is indeed the primary purpose of this sector, but performing these complicated and resource-intensive processes has a panoply of serious implications both for the environment and humans.

There is no refuting the fact that in the latter half of the 20<sup>th</sup> century humans have tinkered with the ecosystem as has never been done before. Climate change, chemical contamination, and unsustainable resource use are all exacerbating ill-health the world over. These environmental health problems are increasing pressure on, and eroding the capacity of, already thinly stretched health care systems. Climate change is no more a scientific fantasy, it is a reality, which has a detrimental effect on the human health and the burden of disease due to our altered environment is on the rise [1].

Healthcare sector, through its consumption of a large number of resources, construction and operation of large and small, but complex establishments, employment of sophisticated energy-intensive technologies and generation of an array of wastes, has itself become a public health concern [1]. For instance, Brazilian hospitals consume 10.6% of the energy utilized for commercial purposes [2]. National Health Service (NHS) – the biggest healthcare provider in England – is responsible for almost a quarter of the total public sector emissions, to the tune of 18 million tons of CO<sub>2</sub> per annum [3]. U.S. health sector is the largest consumer of carcinogenic chemicals [1]. In India the commercial sector, which includes the healthcare sector, consumes 7.58% of the total electricity [4]. According to Central Pollution Control Board (CPCB) of India, the country generates approximately 1.48 million tons of healthcare waste per year [5].

Health sector can play a vital role in mitigating climate change. As members of WHO's Health Security and Environmental Cluster

wrote in the American Journal of Preventive Medicine, "The health sector is one of the most trusted and respected sections of society, and it is also one of the largest employers and consumers of energy. This presents both: a duty and a window of opportunity to achieve climate-neutrality, efficiency and cost reduction all at the same time" [6]. In order to be environmentally-friendly, health sector can deploy some basic measures like: improvement of hospital design, introduction of sustainable waste-reduction and management strategies, sustainable use of natural resources such as water and energy, and utilization and purchase of such products and chemicals, which have a minimal impact on the environment [7].

## SEARCH STRATEGY

A systematic search was conducted to understand the broad issues of climate change, green hospitals and environmental sustainability. Google was chosen as the preferred search engine and a thorough search was conducted by typing-in the following words and phrases: 'green hospitals', 'green hospitals in India', 'energy saving in health sector', 'energy generation in health sector', 'green construction for hospitals', 'climate change and health sector', 'defining green hospitals', etc. Important reports and articles were collected in full text for further reference.

## LITERATURE SURVEY

### Defining Green Hospital

Green hospital can be defined in a number of ways. Office of the Federal Environmental Executive defines a green or sustainable building as "the practice of increasing the efficiency with which buildings and their sites use energy, water, and materials, and reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal—the complete building life cycle" [8].

United States Environmental Protection Agency defines green building as, "the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design

concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high performance building” [9].

According to Healthcare Without Harm, “A green and healthy hospital is the one that promotes public health by continuously reducing its environmental impact and ultimately eliminating its contribution to the burden of disease. A green and healthy hospital recognizes the connection between human health and the environment and demonstrates that understanding through its governance, strategy and operations. It connects local needs with environmental action and practices primary prevention by actively engaging in efforts to foster community environmental health, health equity and a green economy” [1].

According to Indian Green Building Council, a green hospital building can be defined as one which enhances patient well being, aids the curative process, while utilizing natural resources in an efficient, environment-friendly manner [10].

## HISTORY OF GREEN HOSPITALS

Green hospitals are sustainable hospitals. The concept of ‘green buildings’ can be traced to the United Nations concerted efforts, over the years, to bring to the fore the idea of ‘sustainability’ in all aspects of human development. The first such effort made in this direction was the United Nations Conference on Human Environment, held in 1972 at Stockholm. Within the declaration of this conference it was proclaimed that, “The protection and improvement of the human environment is a major issue which affects the well-being of people and economic development throughout the world, it is the urgent desire of the people of the whole world and the duty of all governments” [11].

World Commission on Environment and Development Report, also called Brundtland Report, published in 1987 realized that ‘Environment’ and ‘Development’ are not separate challenges, but are inexorably inked in a system of cause and effect. The report defined ‘sustainable development’ as, “a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations” [12].

The United Nations Conference on Environment and Development, famous as The Earth Summit, convened in Rio de Janeiro in 1992, resulted in Agenda 21 and the Rio Declaration of Environment and Development [13]. Agenda 21 was a comprehensive blueprint for global action in all areas of sustainable development, while the declaration consisted of 27 principles intended to promote sustainable development around the world [14].

The concept of developing sustainable green buildings received a further fillip with the introduction of Triple Bottom Line (TBL) an approach, which was introduced and popularized by the green business guru – John B Elkington in the mid 1990s [15], intends to bring about sustainability in business practices. TBL approach tends to measure the business performance in three key areas: economic, social and environmental thereby suggesting that a corporation that lacks social and ecological integrity shall not remain financially viable in the long run owing to high operational cost and low customer loyalty [16]. According to TBL approach, the primary goal of designing a green building should be to reduce the use of resources [17] such as land, water, energy, and supplies so that the people who live, work, learn and heal in green buildings are healthier, happier and more productive [13].

These movements, in a way, became precursors for the establishment of ‘green building councils’ in different countries bolstering the fact that green healthcare is inseparably connected to the global challenges of climate change, toxification, freshwater shortages and resource depletion [13]. United States Green Building Council (USGBC) is one of the earliest such councils. It

was established in the year 1993 and is a membership-based, non-profit organization that promotes sustainability in how buildings are designed, built, and operated. World Green Building Council (World GBC), which was formally established in the year 2002, is a coalition of national green building councils in more than one hundred countries. World GBC helps to standardize and promote green building practices across the globe through its wide membership [18].

Confederation of Indian Industry (CII) established Indian Green Building Council (IGBC) in the year 2001 with a view to promote the development of climate-neutral and sustainable buildings, so that India becomes a global leader in the sustainable built environment by 2025 [19]. Various services offered by IGBC include: developing new rating systems, certifications, conducting training programmes and organizing an annual Green Building Congress. IGBC is licensed by US Green Building Council to give Leadership in Energy and Environment Design (LEED) certifications to buildings in India.

With the increasing awareness about the benefits of ‘going green’, several green building rating systems have been developed. More than six building rating systems are being used in different parts of the world, most notable are: Leadership in Energy and Environmental Design or LEED (United States, Canada, China and India), Building Research Establishment Environmental Assessment Methods or BREEAM (UK and Netherlands), Green Star (Australia, New Zealand and South Africa), Comprehensive Assessment System for Building Environmental Efficiency or CASBEE (Japan) and Green Mark Scheme (Singapore) [17].

Leadership in Energy and Environment Design or LEED rating system, developed by USGB and launched in 2000, helps to measure the sustainability of different buildings including hospitals. LEED ratings are classified into four categories: LEED-certified, Silver, Gold and Platinum with platinum being the highest rating. Buildings are rated in five key areas in order to achieve LEED certification, the key areas being: sustainable site development, water savings, energy efficiency, material selection and indoor environment quality [20].

About 28 hospitals in the United States have Gold and Platinum LEED certifications [21]. Kohinoor Hospital in Mumbai – a 150-bedded multispecialty hospital – became the first hospital in Asia and second in the world to achieve LEED platinum certification under Indian Green Building Council [20].

## Barriers to create “green hospitals”

Greg L Roberts [22], in his article “shades of green” has cited different barriers to green health facilities, which are as follows:

- **System redundancy** — Requirement of secondary and tertiary backup systems to ensure that operations do not cease during emergencies.
- **Regulatory compliance** — Health and safety regulations and building codes prevent hospitals to adopt sustainable practices.
- **Operational hours** — Health facilities function uninterruptedly throughout the year.
- **Infection control** — Hospitals require strict infection control protocols which often run counter to sustainability practices.
- **Ventilation rates** — More frequent air changes are required in a hospital as compared to other commercial office spaces.
- **Accreditation and licensing demands** — Compliance with central, state and accreditation standards might prevent facilities to make environmentally sound choices.
- **Intense energy and water use** — Health care uses 2.1 times more energy per square foot than commercial buildings, and hospitals typically use 80-150 gallons of water per bed per day.
- **High-volume waste stream** — About 0.5 Kg of hazardous waste is generated per bed per day.

- **Chemical use** — Hazardous chemicals used to clean and disinfect, sterilize equipment, treat certain diseases and for laboratory research and testing can be toxic and hazardous.
- **Life cycle** — the exteriors of hospital buildings can last long, but interiors require renovations every few years.

A survey conducted by Health Facilities Management (HFM) in collaboration with the American Society for Healthcare Engineering (ASHE) and the Association for the Healthcare Environment (AHE) in 2013 identified many barriers/ challenges that prevent hospitals from adopting environmentally sustainable practices; the top five among them are: competing investment or spending priorities, inadequate staffing for initiatives, underfunded operations and maintenance budgets, perceived higher costs over traditional materials or systems and time limitations [23].

## ELEMENTS OF A GREEN HOSPITALS

### A. Energy Conservation

Hospitals operate 24 hours a day, seven days a week and 365 days a year. This coupled with the fact that the demand for high quality care is increasing it is no wonder that hospitals need more energy. Standard operating procedure for most large western-style hospitals requires significant energy use for heating water, temperature and humidity controls for indoor air, lighting, ventilation and numerous clinical processes with associated significant financial cost and greenhouse gas emissions. Yet gains in energy efficiency can be made without sacrificing the quality of care [1]. Several energy use assessment studies in hospitals indicate high potential for energy savings, nearly 20-30% of existing cost [4].

Smaller measures such as switching to compact fluorescent and light-emitting diode (LED) light bulbs, turning thermostats down by just a few degrees in the winter or up a little in the summer, purchasing energy-efficient products, reducing “stand-by” energy use, and retrofitting buildings to cut energy waste can have a major impact [24]. The Sir J.J. Hospital in Mumbai launched an awareness campaign to reduce energy use throughout the hospital. The campaign included slogans, posters and other tools and measures such as, systematically turning off office equipment, using natural light during daylight hours in hospital corridors, and plugging leaks in the air conditioning. The project resulted in a total energy savings of 812 000 kWh from 2002 to 2004, and a cost saving of US\$ 90 000 [25].

### B. Alternative Means of Energy Generation

Most of the energy utilized in the hospital is procured from outside, either in the form of different fuels or electricity, and thus constitute a significant proportion of a hospital's operational cost. Air conditioning and ventilation units, water pumps, lighting, and innumerable other appliances, gadgets and devices used directly or indirectly for the provision of patient-care consume electricity. Processes such as catering, laundry and instrument sterilization requires steam. Furnace Oil or gas (LPG) fired boilers are used to generate steam. Diesel guzzling and smoke belching standby power generation sets are commonly employed for energy-generation in hospitals across India, because of chronic power shortages [4].

In energy-poor settings, the advent of low-energy and no-energy medical devices can be harnessed, together with deployment of renewable energy sources to improve access to basic health services [26]. Renewable resources include the sun, wind, water flows, organic matter and geothermal heat. Tripolia Social Service Hospital, a private charitable hospital in Patna uses solar energy to sterilize medical equipment, sanitize the hospital's laundry, heat water for baths, light outdoor pathways at night and power residential building and office [27].

### C. Designing Green Buildings

Rapid construction of healthcare infrastructure puts a great burden on the local and indigenous building material supplies and methodologies beyond their sustainable capacities [1]. Healthcare facilities can become environmentally sustainable by siting hospitals near public transportation routes, using local and regional building materials, planting trees on the site, and by incorporating design components like day lighting, natural ventilation, alternative energy, water harvesting and green roofs [3,28].

Studies have found out that there is no significant difference in average costs for green buildings as compared to non-green buildings [29]. Carnegie Mellon University Center for Building Performance and Diagnostics identified 17 international studies that document the relationship between improved indoor air quality and positive health impacts on illness, including asthma, flu, sick building syndrome, respiratory problems and headaches, the improvements ranged from 13.5 to 87% [30]. The Sambhavna Trust Clinic, founded in 1996 in Bhopal is a green structure in every sense. It has been constructed from local materials, and is low-cost and durable. It combines beauty with function while blending-in with the landscape and is passively cooled, day lit, harvests the rainwater and uses solar water heaters [31].

### D. Waste Management

Most of the hospitals, nursing homes and clinics, in both public and private sector, in India have no systems for effective and safe disposal of their waste, which finds its way to the open bins on the roadside or the low lying areas or is discharged into the water bodies [32]. A 10% to 15% of the total waste generated in a healthcare facility is hazardous waste [33], which has the potential to harm both, its handlers and the environment [34]. Improper disposal of such waste, especially as open dumps, attracts a host of disease vector [35], release unpleasant odours and may also lead to transmission of diseases like typhoid, cholera, HIV, Tuberculosis, Hepatitis B and C through injuries from sharps contaminated with human blood [33].

Health facilities can cut waste and emissions through composting, recycling, better purchasing (minimizing packaging, using reusable rather than disposable products, and buying recycled products), and minimizing waste transport [24]. The infected plastics can be landfilled after disinfection, rather than incinerated, since burning plastic produces greenhouse gases and toxic pollutants such as dioxins and furans [36,37]. Embassy Medical Centre Colombo, Sri Lanka converts sewage from the hospital and Colombo's underdeveloped neighborhoods into carbon-neutral renewable energy using a high-temperature thermophilic anaerobic digester. This hi-tech compost system will naturally creates bio-methane that will be polished into Bio-Natural Gas (BNG). The BNG is then used in a co-generation plant to power the hospital and water purification systems [38].

### E. Water Conservation

Healthcare facilities utilize vast quantities of water. Climate change, with its accompanying impacts of drought, glacier melt and aquifer depletion, will exacerbate water scarcity. Health facilities can conserve water by harvesting rainwater and recycling water for non-drinking purposes. At Bhopal's Sambhavna Trust Clinic, for example, rainwater is harvested during the monsoon season and stored for use during the dry months of the year, recycled, or grey water is used for irrigation on hospital grounds [1].

### F. Reducing Transportation Cost

The health care sector consumes countless litres of fossil fuel when patients and medical professionals travel to and from appointments, pick up prescriptions, and obtain tests and results [39]. Transport has powerful impacts on health. Transport sector is a major source

of greenhouse gas emissions, and thus an important focus of climate change mitigation [40]. In Delhi, the transport sector accounts for over 70 percent of air pollution [1].

Health-care facilities can cut their transportation emissions by effective siting (near public transportation infrastructure) of hospitals, using alternative-fuel (CNG, Electric) vehicles, encouraging hospital staff and patients to use bicycles, public transportation and carpools, and by purchasing from local suppliers or/and suppliers who use fuel-efficient transportation [1,7,40]. Telemedicine has the potential of reducing air pollution, by reducing travel and transportation [40].

## G. Providing Healthy Food

Diets based on saturated fats, refined carbohydrates and processed foods are increasing the burden of non-communicable diseases, which require long-term therapies. This increases the healthcare cost and also the healthcare sector's environmental footprint.

Health care industry can promote health by providing fresher, good tasting, nutritious food choices for patients and staff and also by supporting food production that is local, humane, and protective of the environment and health. Dominican Hospital, in Santa Cruz, California, USA, buys produce from a nonprofit, community-based organic farm program as part of their commitment to investing in their local community as well as healing the sick [41].

## CONCLUSION

Modern health care facilities are highly resource intensive. In their bid to provide high quality care to their patients, they are damaging the environment. Hospitals operate non-stop throughout the year, they utilizing sophisticated and modern medical technologies, and perform complex medical procedures, which require adequate lighting and temperature. This cannot be accomplished without more electricity. As the implications of climate change become apparent, water is becoming scarcer but hospitals require more water for cleaning, laundry, hand washing, food preparation, drinking. Unsustainable and inefficient buildings, unsafe disposal of hospital waste and untreated sewage, heavy reliance on processed foods and a fleet of fuel guzzling vehicles are just a few factors that increase the health sector's carbon footprint, thus making the environment sick. However, the above stated examples are proof enough that the scenario is changing and the future is brighter. Healthcare facilities in India and around the world are paving the way. J.J. Hospital, Tripolia Hospital and their ilk have proved beyond doubt that high quality patient care and environmentally sustainable health facilities are not mutually exclusive and that 'green hospital' is not just a vague concept but a reality worth emulating.

## REFERENCES

- [1] Karliner J, Guenther R. Global green and healthy hospitals agenda. *Health Care without Harm*; 2011 October, 41p. Available from: [www.greenhospitals.net](http://www.greenhospitals.net)
- [2] Szklo A, Soares J, Tolmasquim M. Energy consumption indicators and CHP technical potential in the Brazilian hospital sector. *Energy Conversion and Management*. 2004 ;45(13-14):2075-91. doi: 10.1016/j.enconman.2003.10.019
- [3] Pencheon D, Cointet S, Brown J, Howley J, Tennison I, Greensmith H, et al. Saving carbon, improving health: NHS carbon reduction strategy. Fulbourn (CB): NHS Sustainable Development Unit (UK); 2009 January. 76p. Available from: [www.sduhealth.org.uk](http://www.sduhealth.org.uk)
- [4] Kapoor R, Kumar S. Energy efficiency in hospitals: best practice guide. New Delhi: United States Agency for International Development; 2011 March. 41p.
- [5] Over 1 Million tonnes Medical Waste Headache for India. *The Pharma Times* Available from: <http://www.thepharmatimes.in/index.php/news/general/national/237-over-1-million-tonnes-medical-waste-headache-for-india>
- [6] Neira M, Bertolini R, Campbell-Lendrum D, Heymann DL. The year 2008: a breakthrough year for health protection from climate change? *American Journal of Preventive Medicine*. 2008;35(5):424-5. doi: 10.1016/j.amepre.2008.08.011.
- [7] Karliner J, Matthiessen C, Wilburn S, Atkinson J, Dora C, DeDominicis, et al. Healthy hospitals, healthy planet, healthy people: addressing climate change in healthcare settings. Discussion Draft. Arlington (VA): World Health Organization and Health Care Without Harm; 2009. 28p.
- [8] Howard JL. Federal commitment to green building: Experiences and expectations. Office of Federal Environmental Executive (US); 2003. 89p. Available from: [http://www.ofee.gov/sb/fgb\\_report.html](http://www.ofee.gov/sb/fgb_report.html).
- [9] Bandhauer K, Gerber MA, Simon S, Smith S, Buffo C, Gitlin S, et al. Sustainable design and green building toolkit for local governments. Environmental Protection Agency (US); 2013 June. 100p. Report No.: EPA904B10001. Available from: <http://www.epa.gov/greenbuilding/pubs/about.htm>
- [10] Srinivas S. Technical Bulletin: Green Hospitals. Available from: [https://igbc.in/igbc/html\\_pdfs/technical/Green%20Hospitals.pdf](https://igbc.in/igbc/html_pdfs/technical/Green%20Hospitals.pdf)
- [11] Sohn BL. The Stockholm declaration on the human environment. *The Harvard International Law Journal*. 1973;14(3):423-515.
- [12] Brundtland GH, World Commission on Environment and Development (WCED). *Our Common Future*. Oxford: Oxford University Press; 1987.
- [13] Guenther R, Vittori G. Sustainable Healthcare Architecture. 2<sup>nd</sup> ed. Hoboken, New Jersey, USA: John Wiley & Sons, Inc.; 2013.
- [14] Burhenne-Guilmin F, Hassan P, Robinson NA. Agenda 21 and UNCED proceedings. New York: Oxford University Press; 1993.
- [15] Berkovics D. Alternative Management Observatory. Oxford; Capstone Publishing: 1999. Available from: [http://appli6.hec.fr/amo/Public/Files/Docs/148\\_en.pdf](http://appli6.hec.fr/amo/Public/Files/Docs/148_en.pdf)
- [16] Robert G, Guenther R. Environmentally responsible hospitals. In: Marberry SD, editor. Improving healthcare with better building design. Health Administration Press. 2005
- [17] Wu Z. Evaluation of a sustainable hospital design based on its social and environmental outcomes (MSc Thesis). Ithaca, New York: Cornell University; 2011. Available from: <http://iwsip.human.cornell.edu/files/2013/09/Ziqi-Wu-2011-19cxn60.pdf>
- [18] Wikipedia contributors. Green Building Council [Internet]. Wikipedia, The Free Encyclopedia; 2015 Feb 26, 07:55 UTC [cited 2015 Jun 9]. Available from: [http://en.wikipedia.org/w/index.php?title=Green\\_Building\\_Council&oldid=648908264](http://en.wikipedia.org/w/index.php?title=Green_Building_Council&oldid=648908264).
- [19] Indian Green Building Council [Internet] 2014. Available from: <https://igbc.in/igbc/redirect.html?redVal=showAboutusnosign>
- [20] Rich CR, Singleton JK, Wadhwa SS. Sustainability for healthcare management: a leadership imperative. Abingdon, Oxon; Routledge: 2013. Available from: <https://books.google.co.in>
- [21] Herman B. 28 Hospitals with Gold or Platinum LEED Certification. *Becker's Hospital Review*. [Internet] 2012. Available from: <http://www.beckershospitalreview.com/lists/28-hospitals-with-gold-or-platinum-leed-certification.html>
- [22] Roberts GL. Shades of green. *healthcare facility management*. 2011 January. Available from: <http://www.hfm magazine.com>
- [23] Burmabl B, Hoppszallern S. Shades of green. *healthcare facility management*. 2013 July. Available from: <http://www.hfm magazine.com>
- [24] Health Care Without Harm, Practice Green health. Addressing climate change in the health care setting: opportunities for action. Arlington: Health Care Without Harm; 2009 February. Available from: <https://practicegreenhealth.org/pubs/toolkit/reports/ClimatChange.pdf>
- [25] Promoting an Energy-Efficient Public Sector (PePS). Energy conservation awareness drive at Sir JJ Hospital, Mumbai, India. Case Study [Internet]. 2015 [cited 2015 June 10]. Available from: <http://www.mahaurja.com/PDF/JJ%20Case%20Study.pdf>
- [26] Fletcher ER. Health in the green economy: health co-benefits of climate change mitigation. Geneva: World Health Organization; 2010. Available from: <http://www.who.int/>
- [27] Boyle G, Krishnamurthy A. Empowering Bihar: case studies for bridging the energy deficit and driving change. Bengaluru: Greenpeace India Society; 2010 October. 39p. Available at: <http://www.greenpeace.org>
- [28] Guenther R, Vittori G, Vernon W. Green guide for health care: best practices for creating high performance healing environments. Pilot Report. Austin (TX): Center for Maximum Potential for Building Systems; 2007. 37p. Available at: <http://www.gghc.org/>
- [29] The Business Case for Greening the Healthcare Sector, Institute for Innovations in Large Organizations, January 2008. Available at [www.iloinstitute.org](http://www.iloinstitute.org)
- [30] Berglund B, Brunekreff B, Knöppel H, Lindvall T, Maroni M, Mølhave L, et al. Effects of indoor air pollution on human health. Luxembourg: Commission of the European Communities; 1991. 43p. Report No.: EUR 14086 EN
- [31] Guenther R, Vittori G. Sustainable Healthcare Architecture, New York: Wiley 2008. Available at: <https://books.google.co.in>
- [32] Muduli K, Barve A. Barriers to green practices in health care waste sector: an indian perspective. *International Journal of Environmental Science and Development*. 2012;3(4):393-99.
- [33] Chartier Y, Emmanuel J, Pieper U, Prüss A, Rushbrook P, Stringer R, et al., editors. 2<sup>nd</sup> edition. Safe management of waste from health-care activities. World Health Organization (WHO). 2014. Available from: <http://www.healthcare-waste.org/>
- [34] Manzurul HM, Ahmed SA, Rahman AK, Biswas TK. Pattern of medical waste management: existing scenario in Dhaka City, Bangladesh. *Journal of BMC Public Health*. 2008;8:36. doi: 10.1186/1471-2458-8-36
- [35] Gupta S, Boojh R. Report: Biomedical waste management practices at Balrampur Hospital, Lucknow, India. *Waste Management Research*. 2006;24:584-91.
- [36] World Health Organization. Safe health care waste management. Policy paper. Geneva: Department of Protection of the Human Environment, Water, Sanitation and Health; 2004. Available from: <http://www.who.int>
- [37] Calculations from United States Environmental Protection Agency's waste reduction model [Internet] 2015. Available from: [http://epa.gov/climatechange/wywd/waste/calculators/Warm\\_home.html](http://epa.gov/climatechange/wywd/waste/calculators/Warm_home.html)
- [38] Pierce D, Guenther R. A state of sustainable design in healthcare: a commentary. Asian Hospital and Healthcare Management [Internet]. Available from: <http://www.asianhm.com/facilities-operations/sustainable-design>

- [39] Holmner A, Rocklov J, Ng N, Nilsson M. Climate change and eHealth: a promising strategy for health sector mitigation and adaptation. *Global Health Action*. 2012 June;5:doi: org/10.3402/gha.v5i0.18428
- [40] Hosking J, Kane L, Mudu P, Dora C, Bhatia R, Jennings G, et al. Health in the green economy: health co-benefits of climate change mitigation – transport sector. Geneva: World Health Organization; 2011. Available from: <http://www.who.int>
- [41] Health Care Without Harm. Healthy Food in Health Care: A Pledge for fresh, local, sustainable food. Reston (VA): Healthy Food in Health Care Pledge [Internet]. Available from: [http://noharm.org/lib/downloads/food/Healthy\\_Food\\_in\\_Health\\_Care.pdf](http://noharm.org/lib/downloads/food/Healthy_Food_in_Health_Care.pdf).

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