



HEALTHY HOSPITALS HEALTHY PLANET HEALTHY PEOPLE

Addressing climate change
in health care settings



World Health
Organization



Discussion Draft

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This paper is the first step in a WHO project in collaboration with Health Care Without Harm (HCWH) aimed at addressing the climate footprint of the health sector.

A second step, to be taken together with HCWH, the Health and Environment Alliance (HEAL) and other intergovernmental and nongovernmental organizations, will be a series of consultations that will lead to the establishment of a global network for climate-friendly health care.

The network will be a knowledge-based learning network and community of practice that supports efforts to mitigate the climate footprint of the health sector. It will serve as a vehicle for information exchange and will provide technical tools for the health sector on how to improve energy efficiency, the built environment, alternative energy generation, sustainable transportation, and procurement. It will emphasize the health, economic and social co-benefits of climate mitigation that can be achieved through measures within the reach of health facilities. The network will also create a global framework for policy-related activities.

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Preface

It is growing increasingly clear that climate change is not only a reality, but that it is threatening to become a far more destructive phenomenon far more quickly than scientists had even recently predicted.

We know that climate change has the capacity to produce severe consequences for human health. We also know that the health sector can play a pivotal role in helping nations across the globe adapt to these serious consequences. This paper could not come at a more important moment.

It is clear that the health sector can also play a leadership role in *mitigating* climate change – that is reducing its magnitude and consequences – by getting our own house in order. By doing so the health sector will create a series of health, economic and social co-benefits that improve the health of the population in addition to the traditional role of the health sector in the delivery of quality health care.

Hospitals are energy- and resource-intensive enterprises that, as they operate today, contribute substantially to climate change while inadvertently contributing to respiratory and other illnesses. Procurement, resource use, transportation and other policies and practices contribute to the health sector's significant climate footprint. By reducing this footprint and moving toward carbon neutrality, the health sector can demonstrate the path forward in response to climate change, thereby playing a leadership role in advocating for a healthy and sustainable future.

This discussion draft is based on the World Health Organization's (WHO) mandate from member states to develop “programmes for health systems that will contribute to reducing their own greenhouse gas emissions”.¹ It also takes root in Health Care Without Harm's (HCWH) more than 12 years of experience of working globally to transform the health sector so that it is no longer a source of harm to human health and the environment.

The paper begins to define a framework for analysing and addressing the health sector's climate footprint – including identifying seven aspects of a climate-friendly hospital. It also draws on a series of examples from around the world that demonstrate that the health sector is indeed already beginning to provide leadership in this most important area of concern to the global community.

We hope that this paper will help support and catalyse an ongoing transformation of the health sector as a force for environmental health in this age of global warming.



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The health sector can play a leadership role in mitigating climate change

Seven elements of a climate-friendly hospital

1 **Energy efficiency**

Reduce hospital energy consumption and costs through efficiency and conservation measures.

2 **Green building design**

Build hospitals that are responsive to local climate conditions and optimized for reduced energy and resource demands.

3 **Alternative energy generation**

Produce and/or consume clean, renewable energy onsite to ensure reliable and resilient operation.

4 **Transportation**

Use alternative fuels for hospital vehicle fleets; encourage walking and cycling to the facility; promote staff, patient and community use of public transport; site health-care buildings to minimize the need for staff and patient transportation.

5 **Food**

Provide sustainably grown local food for staff and patients.

6 **Waste**

Reduce, re-use, recycle, compost; employ alternatives to waste incineration.

7 **Water**

Conserve water; avoid bottled water when safe alternatives exist.

1. Global Climate Change, Human Health and the Health Sector

Global climate change is no longer an ominous future threat but a dawning reality – one that is already creating disturbing shifts in the natural and human environment and eroding the delicate balance of our planet's ecosystem and the species that depend on it.

The phenomenon of human-induced global climate change can no longer be refuted. According to the 2007 report of the Intergovernmental Panel on Climate Change (IPCC): “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.”²

The IPCC report concludes that current efforts to mitigate climate change are inadequate, and that immediate action must be taken to prevent more extreme effects in the future: “Continued GHG [greenhouse gas] emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would *very likely* be larger than those observed during the 20th century.”³

Since the IPCC issued this report in 2007, climate change trends appear to be surpassing scientists' predictions. For instance, at a meeting in March 2009 organized by an international consortium of universities, over 2500 scientists from more than 80 countries concluded that “recent observations confirm that, given high rates of observed emissions, the worst-case IPCC scenario trajectories (or even worse) are being realised”. They went on to note that “rapid, sustained, and effective mitigation based on coordinated global and regional action is required to avoid ‘dangerous climate change’ regardless of how it is defined... Delay in initiating effective mitigation actions increases significantly the long-term social and economic costs of both adaptation and mitigation.”⁴

The International Energy Agency (IEA) issued a report in 2008 that concluded that “current global trends in energy supply and consumption are patently unsustainable – environmentally, economically, socially”. The IEA called for “a rapid transformation to a low carbon, efficient and environmentally benign energy supply”, stating that “what is needed is nothing short of an energy revolution”.⁵

One of the most disturbing implications of climate change is its potentially devastating impact on human health. The World Health Organization (WHO) has reported: “A warmer and more variable climate threatens to lead to higher levels of some air pollutants, increase transmission of diseases through unclean water and through contaminated food, to compromise agricultural production in some of the least developed countries, and increase the hazards of extreme weather.”⁶

WHO predicts that temperature shifts will encourage the spread of infectious diseases. Many of the major killers are highly climate sensitive as regards to temperature and rainfall, including cholera, and the diarrhoeal diseases, as well as diseases including malaria, dengue, and other infections carried by vectors. In sum, climate change threatens to slow, halt or reverse the progress that the global public health community is now making against many of these diseases.⁷ Moreover, an increase in extreme weather events like floods and droughts will have a dramatic impact on health, especially the health of people living in coastal and small island communities.⁸

While everyone on earth will be touched by climate change, WHO makes it clear that the effects will be more calamitous for some than for others. The organization says that “health impacts will be disproportionately greater in vulnerable populations”,⁹ including the very young, the elderly and the medically infirm.

The health sector can play a key role in helping societies adapt to the effects of climate change and the risk it poses to human health. Among other adaptation measures, WHO has called for strengthening public health systems, emergency response programmes, and research around the globe.¹⁰

The health sector can also play an essential part in mitigating the effects of global climate change by taking steps to limit its own significant climate footprint. In Brazil, for instance, hospitals account for 10.6% of the country's total commercial energy consumption.¹¹ In the United States of America, health-care buildings are the second most energy-intensive commercial sector buildings; the health sector spends US\$ 8.5 billion on energy every year to meet patient needs, and hospitals use about twice as much total energy per square foot as traditional office space.^{12, 13} The National Health Service (NHS) in England has calculated its carbon footprint at more than 18 million tonnes of CO₂ each year – 25% of total public sector emissions.¹⁴

There is also evidence that the health sector's energy use and resulting toxic emissions undermine the health of the very communities the sector is meant to serve. On the basis of estimates by the United States Environmental Protection Agency (EPA), the United States health sector's 73 billion kWh "conventional" electricity use adds over US\$ 600 million per year in increased health costs – including increases in asthma, respiratory illness and hospital emergency department visits. In addition, the United States health sector's 341 trillion BTUs (or British thermal units) for heat and cooling contributes to even more polluting emissions, adding billions of dollars more in health-care bills and hundreds of billions more in indirect costs to society.^{15, 16, 17}

The same practices that contribute to climate change and undermine public health can also have a serious impact on the budget of a hospital or ministry. This is true both in well-resourced contexts, where in some cases bloated health systems have become an overwhelming financial burden on a nation's economy, as well as in countries where health systems have very limited resources. For example, a large modern hospital in a tropical region of a small South American country was constructed without following traditional ventilation and lighting practice. As a result, the facility became a heat sink that required huge inputs of energy for cooling, so resources that would otherwise have gone to health care had to be used to pay the power bill.



These collective problems of global warming emissions, local pollution and financial strain are something that most health systems around the world experience in one form or another. Yet the health sector can take steps to address all of these problems simultaneously; it can work to mitigate climate change, contribute to public health and save money all at the same time.

To honour its commitment to first, do no harm, the health sector has a responsibility to put its own house in order so that its practices, the products it consumes and the buildings it operates do not harm human health and the environment. To achieve this, there are basic steps the health sector can take – from improving hospital design to reducing and sustainably managing waste, using safer chemicals, sustainably using resources such as water and energy, and purchasing environmentally-friendly products.

In recent years, the health sector in many countries has taken an increasingly active role in environmental stewardship efforts like these. Now it is time for the health sector to respond to the reality of climate change by taking a moral and tangible leadership role in mitigation efforts around the globe, beginning with its own policies and practices.

2. Leading By Example. Reducing the health sector's climate footprint

No one knows the precise size of the health sector's global climate footprint, but we know that it is substantial.

In all industrialized and many developing countries, provision of health-care services is a massive energy-intensive activity. The health sector is also a major consumer of water, computers, medications, food and other resources. This consumption enlarges the health sector's climate footprint beyond the mark made by energy.

Because its climate impact is so vast, the health sector can play a major role in mitigation efforts around the world. As members of WHO's Health Security and Environmental Cluster wrote recently 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 responsibility and an opportunity to be an 'early mover' to achieve climate-neutrality in its own operations, and to demonstrate that this can go hand-in-hand with improved effectiveness and cost savings."¹⁸

Many health systems, particularly in Europe and North America, have begun to develop comprehensive strategies to reduce their climate footprint and move toward climate-neutrality. Many others, some examples of which are detailed in this paper, are taking steps to address a particular aspect of the problem. Reducing the health sector's climate impact, however, is as complex as the broad diversity of health systems that exist in the world.

For instance, in many parts of the world it is necessary to improve the delivery of health care and this may require an increase in energy consumption. In Brazil, for example, small and medium-sized hospitals exclusively managed by the Government Health Unified System account for one third of all bed capacity in the country but use less than 8% of the energy consumed by the total health sector. Improvement of the quality of care in these hospitals, and the primarily poor population they serve, will necessarily increase their energy consumption.¹⁹ However, if such increases are accompanied by a focus on energy efficiency and the deployment of clean, renewable energy-generation technologies, then the delivery of higher-quality health care can coincide with a climate protection strategy.

Indeed, climate-friendly technologies can improve the quality of primary care to some of the lowest resource settings in the world. Energy is often a scarce and unreliable resource in many facilities in developing countries. In these regions, given appropriate financing, small-scale and renewable energy projects – solar or wind technologies, for example – can provide a reliable, off-grid, low-cost and environmentally sustainable source of power for local hospitals and clinics, as examples from Rwanda and Tanzania demonstrate.

Generating clean and reliable energy is but one example of how the health sector can create a series of co-benefits by pursuing climate-friendly strategies. In general, these co-benefits can be grouped into three categories – health, economic, and social. Each of these is examined below.

2.1 Health co-benefits

Important health co-benefits result from reducing the health sector's climate footprint. Fossil fuel combustion associated with energy use in buildings and transportation produces not only global warming gasses such as carbon dioxide, but also a series of other pollutants that add to the environmental burden of disease. WHO reports document how air pollution, water contamination, and other forms of environmental degradation already cause millions of deaths around the world each year – problems that will only grow worse if steps are not taken to mitigate climate change.²⁰

Climate-friendly technologies can improve the quality of primary care. Masasi District of Tanzania, where photovoltaic systems provide energy for health where there is no grid electricity.



Worldwide, addressing climate change can carry significant co-benefits in terms of environmental health. For instance, according to the European Commission, air pollution causes 369 000 premature deaths in Europe each year.²¹ In the United States, EPA-based calculations show that emissions from energy production ultimately consumed by health-care facilities – including sulfur dioxide, nitrogen oxide, carbon dioxide and mercury – cause an increased disease burden in the general public, including conditions such as cardiovascular diseases, asthma and other respiratory illness.^{22, 23}

By reducing its climate footprint, the health sector in many countries can contribute to improving the health and living conditions of populations in heavily polluted areas.

For example, one report by several international nongovernmental organizations (NGOs) speculates that if the European Union cut greenhouse gas emissions by 30% below 1990 levels by 2020, the co-benefits would include a dramatic improvement in health outcomes, including 105 000 fewer life years lost, 5300 fewer cases of chronic bronchitis, 2800 fewer hospital admissions, and many millions fewer days of restricted activity.²⁴

Disease prevention can reduce the health sector's climate footprint

In the United States, the organization Practice Greenhealth has created an Energy Impact Calculator (EIC) that allows hospitals to estimate some of the health impacts caused by their consumption of energy based on fossil fuels – including premature deaths, contributions to chronic bronchitis, asthma attacks and emergency department visits. Based on EPA peer-reviewed data, the EIC displays the projected number of incidents, estimates of medical treatment costs, their external costs to society, and the likely emissions permit costs for the greenhouse gas carbon dioxide, thus allowing health-care facilities to understand the specific health co-benefits they can gain through energy efficiency and onsite renewable energy generation (see www.eichealth.org/)²⁵

By installing onsite, renewable, clean energy technologies, hospitals gain the advantage of being less vulnerable to disruption in the case of a natural disaster than when using traditional energy sources – thus providing the co-benefit of increasing a health-care facility's resilience and disaster preparedness. In this regard, a hospital or health system can create synergies between initiatives for climate mitigation (by reducing its climate footprint) and adaptation (by bolstering the health sector's ability to operate during the increasingly frequent and severe extreme weather events that climate change is expected to bring about).

The promotion of climate-friendly health care can also provide the co-benefit of increased access to primary care in developing countries around the world. As alternative energy technologies are harnessed to power local clinics and hospitals, they can create a more affordable, reliable and sustainable source of power while also meeting basic health needs. This is already occurring in the Masasi District of Tanzania, where the Solar Electric Light Fund (SELF) has installed solar energy systems at rural health clinics to provide lighting, refrigeration of vaccines, and power for computers where there is no grid electricity.²⁶

Finally, in many countries, emphasis on primary health care demonstrably lowers the need for more resource-intensive therapies later on.²⁷ By reducing the demand for more intensive therapies through disease prevention strategies, the climate footprint of the health sector will also be reduced. This in turn creates a positive spiral, reducing the burden of disease that the health sector's fossil fuel consumption contributes to. In this regard, by reducing the need for energy-intensive health-care services, primary health care and disease prevention can be seen as forms of climate mitigation.

2.2 Economic co-benefits

The potential economic benefits of improving the health sector's climate footprint are significant. In recent years, health systems around the world have seen their budgets shaken by volatile energy prices. The cost of fossil fuels promises to increase further in the years to come, so conservation, efficiency and alternative energy measures will carry long-term financial benefits.

In developing countries, the prohibitive cost of traditional fossil fuels can be a major barrier to health access in many resource-limited communities. Conservation measures and alternative energy technologies can potentially help remove that barrier by providing low-cost and reliable energy so long as adequate financing mechanisms are available. This is true for remote rural clinics where power is scarce, and also for urban hospitals that often spend a significant portion of their budget on energy. In Jaipur, India, for instance, Central Hospital, a 350-bed facility, cut its electric energy use and total energy bill by half between 2005 and 2008 through a series of conservation measures – and by installing solar water heaters and solar lighting to illuminate hospital grounds.²⁸ Similarly in Brazil, one efficiency project reduced the demand for electricity of a group of 101 hospitals by 1035 kilowatts, thus reducing electric energy consumption by 5769 MWh/year and costs by 25%.²⁹ Energy savings like these, which are detailed in many of the examples below, can be reinvested in the health facility for enhanced patient care.

Climate mitigation can contribute to public health and save health care systems money

Energy costs are also a problem for health-care facilities in Europe and North America, where emissions from the health sector carry a huge price tag. In Europe, the cost of premature deaths, health care and medication associated with air pollution amounts to significant impacts on the European Union's gross domestic product, according to the European Commission.³⁰ In contrast, 30% reductions in greenhouse gas emissions by 2020 could result in savings of as much as €25 billion a year.³¹ In the United States, the health sector's use of electricity adds over US\$ 600 million per year in direct health costs and over US\$ 5 billion in indirect costs. In the Midwest of the United States a 200-bed hospital using 7 million kWh/year causes over US\$ 1 million a year in public health costs and US\$ 107 000 a year in direct health costs, according to estimates by Practice Greenhealth.³² According to one calculation, every dollar a hospital in the United States saves on energy is equivalent to generating US\$ 20 in new revenues.^{33, 34} Reducing its climate footprint will provide the health sector with more resources for patient care and other priorities.

2.3. Social co-benefits

Because of its size and influence, the health sector can play a unique leadership role in mitigating the consequences of climate change. Around the world, health workers – physicians, nurses, technicians, health-care managers, and public officials – touch the lives of people at every level of society, and as such can be important agents for change in communities large and small. Growing evidence demonstrates that health professionals are eager to do their part. For instance, when England's NHS launched its ambitious plan to reduce its climate footprint, it won 95% support from NHS staff.³⁵ International health associations have also taken strong positions on climate change:

- The International Council of Nurses (ICN), a federation of national nurses' associations representing nurses in more than 128 countries, has identified climate change “as an important issue for the nursing profession, particularly in light of the impact on people's health and nursing's shared responsibility to sustain and protect the natural environment from depletion, pollution, degradation and destruction.”³⁶

- The World Federation of Public Health Associations (WFPHA), an organization of more than 70 national and regional public health associations, has declared: “The public health community needs to act by increasing research, education, prevention, monitoring, and assessment pertaining to long-term, intergenerational public health issues that may likely arise from climate and ecological change.”³⁷
- The UK-based Climate and Health Council has issued a declaration signed by more than 150 organizations and individuals, primarily in Europe, that calls on “health-related institutions to adopt sustainable practices, recognising that in doing so we will be greatly enhancing the persuasive power of our advocacy as well as contributing to the transition to a low carbon world”.³⁸



By fostering energy efficiency and shifting to clean renewable energy, health care can help mitigate climate change and reduce its share of local air pollution. ○

3. Specific Actions and Examples of Change in the Health-care Setting

The health sector can employ seven key strategies to become more climate-friendly, while at the same time saving money and generating significant health, environmental and social co-benefits. Many of these strategies can be implemented by a shift in the health sector's procurement policies and practices.

In countries around the world, the health sector plays a significant role in the economy. The sector purchases everything from linens to computers, medical supplies and transportation vehicles, and does so in large volume. The NHS in England calculates that it spends 20 billion pounds a year on goods and services, which translates into a carbon footprint of 11 million tonnes – 60% of the NHS's total carbon footprint.³⁹

The health sector can take advantage of its considerable economic leverage by “shopping green” – i.e. purchasing environmentally sustainable materials and products whenever possible, including products with minimal carbon impact. This can be done in a multitude of ways, from purchasing low-energy lighting fixtures, serving only local and organic produce in hospital cafeterias, to buying energy efficient fleet vehicles, computers and medical devices. By doing so, the health sector can not only make its operations more sustainable but can help leverage broader change throughout the economy.

Health facilities around the world are already taking steps in these and other areas to reduce their climate footprint. Some projects that provide examples to illustrate the seven key strategies are described below.

3.1 Energy efficiency

Standard operating procedure for most hospitals requires significant energy use – for heating water, temperature and humidity controls for indoor air, lighting, ventilation and numerous clinical processes – with associated significant greenhouse gas emissions. Hospitals can implement many measures to improve energy efficiency while satisfying the energy requirements of these important energy-consuming end-uses.

Using combined heat and power (CHP) technology, for example, facilities can generate onsite electricity and capture waste heat from the generation process as thermal energy. This can double energy efficiency by eliminating losses associated with the grid delivery of electricity.⁴⁰ In Brazil, according to one study, hospitals have the technical potential for 500 MW of efficient CHP technology.⁴¹ In addition, CHP technology increases reliability, as power can continue uninterrupted when the grid fails.

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.⁴² Energy efficiency measures are the easiest and most common way, and the most important first step, that hospitals can take to cut costs, reduce emissions, and improve human and environmental health.

Cuba: Hospital General Dr Agosthino Neto, Guantanamo. In 2006, Hospital General Dr Agosthino Neto launched its “Integrated System for Saving and Reducing Energy.” The first step was to organize a hospital-wide committee to conduct an audit of the hospital's total energy consumption. The audit calculated that the hospital's energy use was 80% electricity, 14.5% fuel oil and 2.6% liquid gas. The audit pinpointed 30 problems in hospital energy practices. To date, 23 of these problems have been addressed and resolved. For instance, 171 air conditioners and 52 refrigerators have been replaced with more efficient models, the electrical system and boilers have been upgraded, and fuel oil consumption has been slashed. Overall, the hospital has achieved a 21% reduction in energy use – an achievement that hospital staff attribute to a hospital-wide education campaign and the participation of everyone, including physicians, boiler operators and clothes washers.

Brazil: 101 health facilities in the state of São Paulo.

In 2003–2004, the Brazilian energy holding company Companhia Paulista de Força e Luz (CPFL) initiated a programme to help 101 hospitals and clinics in the state of São Paulo to reduce energy costs and cut greenhouse gas emissions. The simple energy-saving measures, which included installing compact fluorescent lights and improving light circuits, cut energy use (and energy bills) by 25% at the 101 health facilities. The measures were implemented free of charge through CPFL's Program of Corporate Responsibility and Sustainability.⁴⁴

Poland: Torun City Hospital, Torun. The Polish city of Torun is a member of WHO's "Healthy Cities" project, so when the city hospital needed renovation and expansion, authorities included environmental sustainability criteria in the plans. Both new and renovated buildings in this 249-bed hospital have upgraded insulation, room temperature controls, modern heaters, and advanced valves, among other measures. Energy savings are approximately 30% in the renovated buildings, and new buildings use 54% less energy than standard newly-built hospitals.⁴⁵

India: Sir Jamshedji Jeejeebhoy (Sir J.J.) Hospital, Mumbai. The Sir J.J. Hospital is among the oldest and largest hospitals in South-East Asia. It has 1352 beds and spreads over 65 acres in the centre of Mumbai. In 2001, following the Indian prime minister's call for all states to implement energy conservation plans, hospital authorities launched an awareness campaign to reduce energy use throughout the hospital campus. The campaign included slogans, posters and other tools. Modest energy conservation measures were also implemented campus-wide, including 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. The Sir J.J. staff are now considering adopting additional conservation measures, including solar water heating and energy-efficient lighting.⁴⁶

Mexico: Gynaecology and Obstetrics Hospital, Centro Medico Nacional La Raza, Mexico City.

Hospital administrators at the Gynaecology and Obstetrics Hospital organized a comprehensive energy-saving campaign that has allowed the hospital to cut its electricity costs significantly. A key element of the programme has been educational: hospital staff were instructed to turn off lights and computers, and to unplug electronic devices when not in use. In addition, more efficient lighting was installed throughout the facilities, as well as controls to take advantage of natural light during daylight hours. Hospital staff also monitor the use of air conditioning, depending on temperature conditions, and reduce power use at weekends. Finally, a bank of energy capacitors was installed to reduce energy use during peak use periods.⁴⁷

Australia: Hervey Bay Hospital, Queensland. The government of the state of Queensland has launched an ambitious programme to reduce its health system's climate footprint, and Queensland Health introduced energy efficiency measures at its health-care facilities. One facility, Hervey Bay Hospital, with 104 beds, reduced its energy consumption by 20% between 2005 and 2007 – an annual carbon reduction equivalent to taking 600 cars off the road, according to Patrick McGuire, the head of Queensland Health's Eco-Efficiency Unit. The hospital made the cuts by improving its lighting and air conditioning system, and by upgrading its computerized building management system which monitors and controls building functions, including air conditioning, medical gases, water heating and steam production. The hospital has stepped up water conservation efforts by installing flow restriction devices and by recycling water for air conditioning and irrigation.⁴⁸



Energy efficiency saves money while protecting the climate and public health. Centro Medico Nacional La Raza, Mexico City

3.2 Green building design

Environmental sustainability can be built into health facilities by incorporating green building principles in design and construction, as well as in hospital retrofits. From siting hospitals near public transportation routes, using local and regional building materials, planting trees on the site, to incorporating design components like day lighting, natural ventilation and green roofs, new health facilities can moderate their climate footprint even before they open their doors.^{49, 50} This applies to large, industrialized health-care facilities such as Changi General Hospital in Singapore and to small clinics such as the Sambahavna in Bhopal, India. At both facilities, the structure, orientation and landscaping reflects a commitment to human and environmental health.

Tools like the *Green Guide for Health Care* are now beginning to conceptualize and plan for carbon-neutral or carbon-negative hospitals – facilities that produce zero global warming emissions, or even ones that actively reduce carbon in the environment.⁵¹ This “regenerative” building vision – buildings that move beyond “less harm” to “no harm” and “restoration” – is a powerful idea for a sector with a core mission to heal. While no hospitals have yet achieved a carbon-neutral or carbon-negative, zero-waste, water-balanced, toxic-free built environment, there are examples around the globe of organizations engaged in aspects of this challenge.

Singapore: Changi General Hospital, Simei. At Changi General Hospital, the lobby features koi ponds, palm trees and orchid murals. There is a hydroponic garden on the hospital roof, which grows produce for the hospital kitchen while cooling the building. Other environmental initiatives include sun-shading devices, use of natural light, automatic doors to maximize cooling efficiency, energy-efficient ceiling fans, motion sensor lighting, and low-flow water fixtures. The resulting reduction in energy and water costs saves US\$800 000 a year.^{52, 53}



Italy: Meyer Children’s Hospital, Florence. This 150-bed children’s hospital was designed to create a healing environment for patients and landscape alike. The hospital is airy and bright with high ceilings and lots of open space, which creates a serene, peaceful setting for young patients and their families. The facility was built into a sloping hill so it causes less disruption to the surrounding environment. It features a greenhouse, landscaped roofs, skylights, open “buffer” space, and an energy-efficient hybrid ventilation system. To monitor and conserve energy, the hospital design also includes a “building energy management system” and light tubes that create natural light throughout the building. The hospital consumes 35% less energy for heating and cooling, and 36% less electricity than a standard newly-built Italian hospital.^{54, 55}

Many hospitals are using green principles in design and construction



○ Meyer Children's Hospital – Florence, Italy

Architects are developing plans for “carbon-neutral” hospitals: facilities that emit no global warming gasses.

Peru: Hospital National Dos de Mayo, Lima. This 645-bed hospital, which offers major medical and surgical care, has a respected infectious disease and tropical medicine department. The hospital’s original design included features that maximize natural ventilation such as high ceilings, large windows and skylights. Many of the wings of the hospital were situated to take advantage of the prevailing winds from the ocean. Windows on both sides of many wards provide excellent cross-ventilation, thus keeping hospital air fresh and comfortable. However, ventilation was poor in some of the modern areas of the hospital, including the busy outpatient waiting room where as many as 300 patients often crowd during consulting hours. By taking the simple step of opening sealed skylights, which cost only U.S.\$1000, the hospital increased ventilation in the waiting room three-fold.⁵⁶

China: Grantham Hospital, Hong Kong. Located on an open hillside, Grantham Hospital provides comprehensive treatment for heart and lung diseases. It is the only hospital in Hong Kong that treats children and infants with heart problems. The facility’s tuberculosis (TB) wards are all located on the seventh floor of the hospital building. Since Grantham’s construction in 1957, natural ventilation has been employed to keep the TB wards cool and airy. The building was situated at a distance from other buildings for maximum airflow, and angled to catch summer breezes and avoid direct summer sunlight. The wards have no central air conditioning, and windows and doors are kept open at all times. In recent years, various modifications have been adopted to keep the TB wards comfortable during the hot and humid summer season, including spot cooling systems and exhaust fans.^{57, 58}



USA: Dell Children’s Medical Center, Austin, Texas.

Environmental sustainability was built into the design of this 169-bed acute care hospital, which opened its doors in 2007. The hospital’s CHP generating facility minimized the hospital’s energy requirements, and energy demand was further reduced by design elements – such as seven courtyards throughout the building to increase daylight, and heat-recovery technology. While hospital officials elected not to include solar panels in the original construction, the roof was angled to accommodate future solar panel installation.⁵⁹ The hospital is located on a mitigated “brownfield,” a site that was previously used for and contaminated by industrial activities.

India: Sambhavna Trust Clinic, Bhopal. Since the 1984 methyl isocyanate leak at the Union Carbide pesticide plant in Bhopal, many local residents who survived the initial accident have developed chronic illnesses. The Sambhavna Trust Clinic, founded in 1996 to treat Bhopal victims, sees approximately 10 000 patients a year. The building was designed to create a green environment – literally and figuratively – and includes tropical gardens, a rainwater harvesting system, recycled water for irrigation, solar water heaters, passive ventilation, and extensive use of natural light.⁶⁰

Germany: Constance Hospital, Baden-Wuerttemberg.

During a recent modernization, Constance Hospital implemented a number of energy-saving measures that allowed it to cut CO₂ emissions by over 25%. The hospital installed solar panels and CHP technology that has 75% efficiency (versus 35% efficiency of conventional generators). In addition, buildings and windows throughout the hospital were equipped with thermal insulation.⁶¹



Constance Hospital – Baden-Wurttemberg, Germany

Onsite solar and wind energy is employed in a diversity of health settings

3.3 Alternative energy generation

Health-care facilities can significantly cut greenhouse gas emissions and energy costs over time by using alternative forms of clean and renewable energy – such as solar and wind energy and some biofuels. Alternative energy sources can be used for lighting, heat generation, and pumping and heating water – which account for a large portion of the energy bill for health facilities in both developed and developing countries.

For hospitals, alternative energy means an initial investment with potential savings later on. This makes both environmental and economic good sense, especially when financing mechanisms are structured to support this shift. At the same time, given its formidable energy demands, the health sector can play an important role in shifting the economies of scale and making alternative energy more economically viable for everyone. For regions that have no access to electricity, alternative energy sources can fuel primary health-care facilities in even the most remote areas. Finally, alternative sources of energy give health facilities an advantage in terms of disaster preparedness, since alternative energy sources are less vulnerable to disruption than traditional fossil fuel systems.

United Kingdom of Great Britain and Northern Ireland: Pilgrim Hospital, Lincolnshire. Pilgrim Hospital aims to cut its CO₂ emissions by 50% by installing a biomass boiler which is planned to start operation this year. The boiler will run on locally harvested and renewable woodchips. Heat from the boiler will be supplemented by a CHP plant which will generate electricity for hospital operations, including additional heat.⁶²

Rwanda: Partners in Health clinics in Mulindi, Rusumo, Rukira, Nyarabuye, and Kirehe. Since only 5% of Rwanda is on the power grid, operating health-care facilities there is a challenge. Partners in Health (PIH), an organization established by physician Paul Farmer to provide health care in poor communities around the world, faced the choice of using diesel power to run its five clinics in eastern Rwanda or choosing an alternative energy option. Since diesel fuel is expensive, polluting and unreliable, PIH turned to the Solar Energy Lighting Fund (SELF) for assistance in setting up a solar system. SELF developed solar diesel hybrid systems for the five PIH clinics. The sun now provides 90% of the clinics' energy, with diesel as back-up in case of heavy use or extended periods of rain.⁶³

USA: York Hospital, York, Maine. Almost a decade ago, York Hospital officials took steps to slash the facility's fossil fuel consumption by buying renewable energy from the state of Maine. Since then, 90% of the hospital's energy purchases have come from alternative energy sources, including wind power, hydro power and biofuels from wood-fired boilers. As a result, the hospital reduced its carbon emissions by 24% between 2000 and 2006, a decline of about 300 tonnes a year despite an overall increase in energy utilization. Hospital officials estimate that the shift to alternative energy fuel sources has saved the hospital over US\$ 100 000 a year.^{64,65}

Liberia: Liberia Institute for Biomedical Research Clinical Research Center, Bolahun, Liberia.

The Special Programme for Research and Training in Tropical Diseases (TDR) is cosponsored by UNICEF, UNDP, the World Bank and WHO and conducts research and training for tropical diseases. For its Phase III clinical trial of the drug moxidec-tin (for the treatment of onchocerciasis or "river blindness"), TDR scientists needed a remote trial site where people had not been treated with the current drug used for onchocerciasis control, ivermectin (Mectizan®). TDR, in collaboration with the Ministry of Health and Social Welfare and the Liberia Institute for Biomedical Research selected Bolahun, a small and remote village in northern Liberia, as one of four trial sites in Africa, and painstakingly constructed a clinical research center using local materials and labour. The center was constructed with a number of sustainable features including locally manufactured mud-bricks and a design to keep rooms relatively cool without air conditioning, and more are planned. Because Bolahun has no source of electricity, TDR officials have explored alternative energy sources. Through pro-bono help of the Gesellschaft fuer Technische Zusammenarbeit and the Hochschule fuer Technik und Wirtschaft, Berlin, they obtained the design for a photovoltaic system that would also provide energy for the local health centre and Bolahun's high school, and are seeking funds to underwrite this. In the meantime, the clinic has a diesel-powered generator which clinic staff hope to convert to biofuels, using scrap waste from surrounding rice fields and banana trees.⁶⁶



3.4 Transportation

Throughout the world, transportation is a major source of greenhouse gas emissions. The health sector – with its fleets of hospital vehicles, delivery vehicles, and staff and patient travel – is a transportation-intensive industry. In England, for example, transportation is responsible for 18% of the NHS's total carbon footprint.⁶⁷ Health-care facilities can cut their transportation emissions by effective siting and programming of medical care delivery, using high-efficiency or alternative-fuel 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.⁶⁸

Sweden: The Green Ambulance Project, Stockholm.

In 2001, officials at AISAB, one of Stockholm County Council's leading ambulance operators, decided to create a "green" ambulance. As a first step, AISAB focused on driving practices. Drivers at three of AISAB's ambulance stations received intensive training in "eco-driving" (i.e. driving in a manner that reduces fuel consumption and wear on the vehicle). AISAB drivers were sceptical at first in case eco-driving would mean a slower and less efficient journey to the hospital and greater risk for patients with injuries or other urgent health conditions. However, after a trial lasting 18 months, AISAB's drivers found that eco-driving reduced fuel consumption by as much as 10% with no increased risk to patients. It turned out that eco-driving did not mean slower driving; it meant planning ahead and driving efficiently. It also resulted in 50% fewer insurance claims, and less wear and tear on ambulance tyres and brakes. In 2005, as a result of the AISAB experiment, the Stockholm County Council mandated that all its ambulance drivers should practice eco-driving. AISAB is now considering converting all its ambulances to biofuel, and equipping vehicles with sustainable materials.⁶⁹



United Kingdom: Addenbrooke's Hospital, Cambridge.

Addenbrooke's Hospital, part of the Cambridge University Hospital System, is reported to be the largest source of traffic in the county of Cambridgeshire. To encourage use of public transportation, the NHS commissioned a bus to serve the hospital. Staff, patients and visitors are encouraged to use the bus or to cycle to the hospital. Incentives include discounted bus passes and interest-free bicycle loans, as well as a car share scheme. Addenbrooke's travel plan is having an impact: the number of cars used on the hospital campus is down 16% and staff car use is down 22%.⁷⁰

USA: Pitt County Memorial Hospital, Greenville, North Carolina. Pitt County Hospital has its own biodiesel fueling station. Today, all 35 of the hospital's fleet vehicles, including ambulances and service trucks, run on B20, a blended fuel containing 20% biodiesel. Pitt County is the first hospital in the United States to install an onsite biodiesel fueling station.^{71, 72}

Hospitals are cutting transportation emissions through various strategies

Sourcing and serving healthy food can reduce hospitals' climate footprint and improve patient health

3.5 Food

There is growing public awareness that our highly industrialized food system, with its reliance on petrochemicals at every stage in the process, has far-reaching health and environmental impacts. According to the United Nations Food and Agriculture Organization (FAO), the livestock sector alone generates an estimated 18% of global greenhouse gas emissions.⁷³ Food waste also contributes significantly to the waste stream, comprising 12% of the total municipal solid waste stream in the United States, for instance.⁷⁴

While people seldom visit hospitals to enjoy the dining, health-care facilities in many countries are major consumers of food. The NHS is one of the largest purchasers and providers of food in the United Kingdom, for example.⁷⁵ Health-care facilities can reduce their climate footprint and improve patient health by making changes in hospital service menus and practices, including limiting the amount of meat in hospital meals, producing their own food onsite, composting food waste, and buying local and organic produce – thereby promoting local, sustainable production. By promoting and supporting nutritious, localized sustainable food systems, the health sector can both reduce its own climate footprint and support food access and nutrition, thereby helping to foster the prevention of disease.

United Kingdom: Ealing General, Lambeth Hospital, St. George's Hospital and the Royal Brompton Hospital, London, England. These four NHS hospitals are participating in a effort to boost the amount of local and/or organic food they serve by 10%. The NHS calculates that it spends about 500 million pounds on food to serve 300 million meals in 1200 hospitals each year, so increasing the amount of its local and organic food offered can have a tremendous impact. As part of its effort to reduce its climate footprint, the NHS has also proposed offering fewer meat and dairy products on its menus.^{76, 77}

USA: St Luke's Hospital, Duluth, Minnesota. This comprehensive care hospital admits over 12 000 patients a year, and treats close to 400 000 more in its many clinics.⁷⁸ Over the last decade, St. Luke's has taken steps to make the food it serves to patients, staff and visitors increasingly fresh and sustainable while launching a programme to divert food waste and provide for the local community. Food service staff purchase produce from the local farmers' market and buy products from local vendors, thus reducing emissions from transportation. Since 2003, the hospital has partnered with the group Second Harvest to donate excess food from the hospital kitchen to local families, instead of simply throwing it away. Every day, extra food is labeled and frozen for distribution to local food banks and soup kitchens, providing about 1000 meals a year. The hospital composts almost 40 000 pounds of food waste every year, thus removing it from the waste stream and reducing emissions. This year the facility will introduce an onsite garden as a means to introduce fresh food in the food service operations.⁷⁹



○ St. Luke's Local sustainable food service

Sustainable health care waste management cuts emissions

3.6 Waste

Hospitals and other health facilities generate significant amounts of waste – HCWH calculates, for instance, that a single San Francisco medical centre produces an average of six tonnes of waste every day.⁸⁰ In the United Kingdom, the NHS generates one in every 100 tonnes of domestic waste, and most of it ends up in landfills.⁸¹ Disposing of all that waste in landfills and incinerators pumps tremendous amounts of greenhouse gases into the atmosphere. Recycling and composting not only reduce emissions from waste facilities, but significantly reduce demand for primary materials, thus reducing deforestation, mining, and oil drilling and their associated greenhouse gas emissions.⁸²

Health facilities can cut waste and emissions through composting, recycling (including anaesthetic gases), better purchasing (minimizing packaging, using reusable rather than disposable products, and buying recycled products), and minimizing waste transport (local treatment and disposal).⁸³ The small portion of medical waste that is potentially infectious has a high proportion of plastics and can be landfilled after disinfection, rather than incinerated, since burning plastic produces high quantities of greenhouse gases in addition to toxic pollutants such as dioxins and furans.^{84, 85}



Sri Lanka: Embassy Medical Center, Colombo. This hospital project, while still in the planning stage, is worth noting due to its ambitious strategy to become climate-neutral. It aims to incorporate a variety of innovative climate-saving strategies, including a plan to use waste from local open-air dumps to fuel the hospital operations. The 180-bed hospital will provide health care for local residents. It will also service the medical tourism market – i.e. patients from overseas seeking high-quality medical care at lower cost (85% of hospital patients will come from the surrounding community). Sixty percent of Colombo's residents live in slums where garbage is disposed of in open-air dumps. Hospital planners knew they wanted the building to have a sustainable energy design but wind and solar energy were deemed unfeasible so they turned instead to a plentiful local resource – organic waste.

The hospital plans to meet all its energy needs by collecting waste through local sanitation stations that it will install near Colombo's dumps. These stations will provide clean water and latrines for the local population – a significant health co-benefit of this climate mitigation strategy. Waste from the latrines, as well as waste from the dumps, will be collected and transported via electric autorickshaw for processing in an organic waste digester to produce methane gas. The biogas will provide energy for the hospital and the local community. The waste digester will make the hospital completely energy self-sustaining – an important feature in an area with an unreliable power grid. In addition, the hospital is planned to be able to continue operations and serve as a refuge in case of natural disaster – a pressing concern for a region hard hit by the 2004 tsunami. Hospital design will include a water collection system, capturing rain during the yearly monsoons and storing water in basement tanks for use during the dry season. Rainwater will be treated to potable grade; grey water will be recycled for landscaping and other non-drinking uses. The 500 000 square-foot hospital building will require 30% less energy and 40% less water to operate than other hospitals of similar size. Finally, the hospital will employ local people at every point in the process, from construction to waste transport to building maintenance, and will offer training programmes for health-care positions at the facility.^{86, 87, 88}

○ Plans for the Embassy Medical Center – Colombo, Sri Lanka

3.7 Water

Health-care facilities consume vast amounts of water and use energy to heat, pump and dispose of it. Climate change, with its accompanying impacts of drought, glacier melt and aquifer depletion, will exacerbate water scarcity. Health facilities can conserve this precious natural resource by closely monitoring water use, installing water-efficient fixtures and technologies, growing drought-resistant plants, and making sure that leaks are quickly repaired. To have even more of a conservation impact, hospitals can harvest rainwater and recycle 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.⁸⁹ Finally, depending on a hospital's location, potable water may or may not be readily available or plentiful. In areas where potable water is available, health-care facilities can make a tremendous positive impact by eliminating the purchase and sale of bottled water. The California-based Pacific Institute recently estimated that the energy required to produce bottled water in the United States in 2007 was as much as 2000 times that of producing tap water – an energy equivalent to 32–54 million barrels of oil. Report authors estimate that three times that much energy was required to meet global bottled water demand.⁹⁰

Royal Children's Hospital, Melbourne, Australia.

In its replacement hospital scheduled for completion in 2011, Royal Children's will capture and store 85% of rainfall on the site. In addition, an onsite sewage treatment plant will filter and recycle captured rainwater and wastewater for re-use in toilet flushing, cooling plant, and interior and exterior garden irrigation. Biomass boilers will provide heating and solar panels will satisfy 40% of domestic water heating needs. These are zero-carbon solutions.⁹¹



USA: Jewish Home Lifecare, New York. This nonprofit nursing facility has over 1600 beds and treats 10 000 patients on three campuses. In 2008, the facility decided to eliminate bottled water and now uses pitchers of water and re-usable glasses in meetings and conferences, thus removing 42 000 plastic bottles from the waste stream and saving over US\$ 10 000 annually.⁹²

USA: Norwood Hospital, Norwood Massachusetts. By instituting a range of water conservation measures, this hospital was able to cut its water use by 29% in three years, from 51.2 to 36.6 million gallons a year. Water conservation measures include improving pump design, replacing flush valves on toilets and urinals, retrofitting water faucets and refrigeration systems, and other measures. These strategies resulted in a saving of about US\$ 14 000 a year.⁹³

Water conservation and climate mitigation can go hand-in-hand

4. Opportunities for Action

Urgent action from all sectors of society is necessary to mitigate the impacts of climate change. The risk to human health and the environment is high. WHO and HCWH suggest that policy-makers, health facilities and health professionals around the world consider the following opportunities for action to place the health sector at the forefront of global climate mitigation efforts.

4.1 For multilateral and bilateral aid agencies, international institutions and intergovernmental negotiations

- International agreements and financing mechanisms developed by the parties to the United Nations Climate Change Conference (COP 15) in Copenhagen in December 2009 should promote ecological sustainability and public health by supporting climate change mitigation by the health sector throughout the world.
- Multilateral and bilateral agencies financing hospital construction or health sector operations should collaborate with national and private-sector counterparts to ensure that such financing promotes the development and operation of climate friendly and environmentally sustainable health facilities.
- The establishment of a global economic framework that will promote health, social justice, and survival for current and future generations, rich and poor, both locally and globally should be supported.

4.2 For national ministries of health

- Strengthen public and policy-maker awareness of the current and projected adverse and inequitable health impacts of climate change, as well as the potential for significant health benefits and consequent cost-savings from well-conceived climate-control policies.
- Prioritize primary health care and pursue disease prevention strategies so as to lower the future need for more resource-intensive therapies, thereby reducing the health sector's costs and climate footprint as well as the burden of disease to which the sector's fossil fuel consumption contributes.

International agreements and national policies can support climate change mitigation by the health sector

- Develop national plans of action to reduce significantly the health sector's contribution to climate change, and incorporate mitigation in the health sector into broader national plans and regulations.
- Identify, support and publicize health-care facilities and health-care organizations as they work to reduce their climate footprint by adopting sustainable policies and practices.
- Foster cross-disciplinary partnerships to ensure wide-ranging and effective mitigation and adaptation in the health sector and beyond.
- Ensure that the role that the health sector can play in the mitigation of climate change is reflected in national positions vis-à-vis international dialogues and negotiations on climate change.

4.3 For hospitals and health systems

- Educate hospital staff about climate change issues. For teaching institutions, make environmental health, climate change and the health sector's role in climate change mitigation and adaptation efforts part of the required curriculum.
- Review facility procurement practices, and patronize local vendors who carry sustainable products and follow sustainable practices whenever possible.
- Audit, measure, monitor and reduce hospitals' and health systems' climate footprint.
- Identify potential co-benefits of climate mitigation efforts.
- Educate accreditation bodies about the intersection between environmental sustainability, human health and health care standards. Identify ways that sustainability practices can be incorporated into accreditation standards.

ENERGY EFFICIENCY

- Create an infrastructure for action, e.g. a committee to spearhead hospital-wide sustainability measures by assessing baseline emissions, developing priorities, and preparing guidelines for environmental initiatives.
- Adopt facility-wide energy efficiency and conservation practices and incentives.
- Make sure that hospital buildings are sited to take advantage of microclimate influence such as sun and wind, and are built or retrofitted to be well-insulated and energy-efficient, and conduct regular energy audits.
- Install energy-efficient lighting and occupancy sensor switches throughout hospital facilities, use natural light whenever possible, and install solar lighting in hospital parking lots.
- Turn thermostats down a few degrees in winter and up in summer. Even a slight shift can create significant energy savings.

BUILT ENVIRONMENT

- Mandate the incorporation of sustainable elements in the siting, design, construction and landscaping of new buildings, and in building expansion and/or retrofit projects. Work toward building carbon-neutral or carbon-negative hospitals.
- Support broader aspects of sustainability in the built environment. Support the use of local and regional materials (reducing transportation energy), utilize salvaged and recycled materials (reducing energy otherwise expended on new production), and support toxic-free products and manufacturing processes.

Health professionals can help lead the world in addressing climate change

ALTERNATIVE ENERGY

- Install onsite renewable energy sources, such as solar panels and wind turbines.

TRANSPORTATION

- Provide health care in locations that are accessible to patients, staff and visitors without causing them unnecessary travel. Consider community-based primary care, home care, and co-locating medical services with related social services or community programmes.
- Improve the energy efficiency of hospital fleet vehicles, and encourage staff, patients and visitors to walk or use car pools, public transport or bicycles whenever possible. Install showers, lockers and bicycle storage facilities to encourage staff to adopt healthy modes of transportation. Negotiate discounts for public transport to provide incentives for its use.

WASTE

- Adopt waste reduction, composting and recycling practices at health facilities.
- Reduce or eliminate the incineration of medical waste.

WATER

- Implement potable water conservation strategies (to reduce the energy required to convey and treat potable water supplies). Conserve water by installing efficient faucets and toilets, and routinely check plumbing and pipes to prevent leaks. Landscape grounds using drought-resistant plants to minimize water use. Consider harvesting rainwater, and/or recycling water, if practical. Eliminate bottled water facility-wide if potable water is available.

FOOD

- Purchase sustainably produced products from local suppliers or/and suppliers who use sustainable products and practices.
- Reduce meat on hospital menus.

4.4 For health professionals

- Encourage the health facilities where you work to lead by example and adopt measures to reduce their climate footprint.
- Encourage professional associations to explore and address the issue of climate change and the role the health sector can play in mitigation.
- Work with associations of health professionals and teaching institutions to make climate literacy a mandatory requirement for all clinical education programmes.
- Become an informed advocate for climate mitigation and adaptation efforts.
- Set an example: do your part to understand and minimize your own climate footprint.



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