CHERISH LIFE PROMOTE HEALTH

GREEN HOSPITAL
GREEN LIFE
GREEN PLANET

Experiences Sharing on Green Hospitals

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Compiled by Buddhist Dalin Tzu Chi General Hospital

December 2010

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PREFACE

In recent years, the increase in greenhouse gas emissions has sparked global warming, with rising average temperature across the globe. This caused increasing sea levels as well as extreme weather around the world, threatening our health, environment and socio-economic development. WHO also pointed out climate change affects the fundamental requirements for health – clean air, drinking water and sufficient food. Threats on health, such as diarrhea, malnutrition, malaria and dengue fever are related to climate change and are expected to get worse year after year.

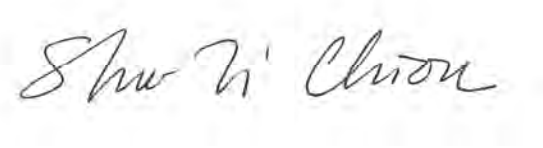
Hospitals consume a large amount of energy in providing health care. Based on the estimates by the United States Environmental Protection Agency (EPA), 73 billion kW.h of electricity use in health sector adds over US$ 600 million per year to health costs. The increased cost is mainly spent on care of asthma and respiratory illness and emergency department visits.

In the 61st World Health Assembly in 2008, the Director-General Margaret Chan described climate change as one of “three global crises looming on the horizon”. In the resolution to climate change and health, member states are urged to promote effective engagement of the health sector and its collaboration with other related sectors, agencies and key partners at national and global levels in order to reduce the current and potential health risks from climate change. In 2009, WHO invited the International Network of Health Promoting Hospitals and Health Services to collaborate on this issue. As a Governance Board member of the network, I was consulted by the Secretariat and we together established the “Task Force on Health Promoting Hospitals and Environment” in April 2010, with the full support from the General Assembly. The tasks include the following subjects: visualize environment-related health promotion issues in existing HPH Models and Tools, collect examples on best evidence practice, develop tools for monitoring the effect of environment-friendly intervention programs, disseminate best practice examples and increase health professionals’ climate change literacy, and establish a database for environmental friendly hospitals and health services programs.

The Task Force members are comprised of delegates from the WHO, directors from two WHO Collaborating Centers for Health Promotion in Hospitals, representatives from Health Care Without Harm (HCWH), and health promoting hospitals.

To promote Taiwan hospitals to take action on environmental sustainability, we have collaborated with Environmental Protection Administration and Bureau of Energy, Ministry of Economic Affairs, on establishing information exchange platform for energy conservation and CO_2- emission reduction. We launched a pledge ceremony, entitled "Health Sector Leading the Action to Reduce CO_2 Emission", in this October. Representatives from 9 hospital associations and 128 hospitals, including hospitals from 18 medical organizations, attended this ceremony. These hospitals account for more than 64% of hospitals beds in Taiwan. They committed to taking action on becoming Environment-Friendly Hospitals by reducing 13% of annual CO_2 emissions by 2020 compared to the level in 2007.

In order to exchange experience on environmental friendliness, this manual collects best practices from Taiwan hospitals and Alexandra Health Cluster from Singapore, presented in various dimensions such as energy efficiency, green building design, alternative energy generation, transportation, food, waste, water and education. With the experience exchange in this manual, we hope to encourage more and more hospitals around the globe to take action on the promotion of environmental sustainability.



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December 2010

1. Global Climate Change and Health

Dealing with “Global warming” is currently one of the most difficult issues for governments around the world. Recently, the changes in climate significantly influenced our environment, and countries are becoming more attentive to the negative impact of greenhouse effect on the society and people in the world.

The Intergovernmental Panel on Climate Change (IPCC) assesses the effect of climate change on health and releases a climate change assessment report every six years. It was jointly established by United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988. In its Fourth Assessment Report (AR4) [1]it paid special attention to the effect of climate change on human health. Due to climate change that resulted in extreme weather conditions, floods and natural disasters occurred around the world. The rising sea level as well as the severe wind and water hazards around the coastal area have negative impact on the agricultural production and disrupt global food supplies.

Climate change is not only an environmental or financial problem, but also a health problem. Over time, climate change is increasing the burden of global disease occurrence. More and more evidence shows that rising temperature provides an easier channel of infection, and makes infection spread out, resulting in the increased numbers of deaths, diseased and casualties in extreme weather conditions such as heat waves, floods and droughts[2]. The shortage of food causes malnutrition and subsequently affects the development of the children. Experts believe climate change might worsen the national and international health and other pre-existed health inequality issues.

The missions of hospitals are about rescuing life and promoting health. It should waste no time in fighting against health problems caused by climate changes. Department of Public Health and Environment of World Health Organization pointed out that the medical service industry could contribute significantly to reducing carbon footprints[3]. In many countries, the medical service industry is the second largest energy user and consumes a great deal of energy and financial resources, at least

twice as much compared with the general workplace. Furthermore, the air pollution generated induces asthma and respiratory diseases, and has a strong correlation to heart diseases, leading to high medical expenditures on treatment. We can provide more health care service for the general population by saving these expenses.

More can be done in environmental protection by hospitals just from saving electricity, which is greatly beneficial in reducing carbon dioxide emissions and costs. Although Taiwan is an island surrounded by sea, it is ranked 18th in countries with water shortage issues[4]. In Taiwan, hospitals produce around 90,000 tons of waste, and 23,561 tons of biomedical and healthcare waste every year. Processing the waste costs a lot, and if we can work on reducing waste, we will mitigate the level of pollution for the environment[5].

Initiating environmental protection, led by the hospitals, is not only good for the hospitals but also helpful for communities. By protecting the environment and saving energy, we can mitigate the emissions of greenhouse gases, promote public health, reduce pollution and minimize the waste of social resources.

2. Introduction to International Environmentally Friendly Organizations for Health Care Industry

As the earth becomes warmer, it is now generally acknowledged that the global climate is changing. This change has the potential to affect human health in a number of ways. Over the last 50 years, excessive quantities of carbon dioxide and other greenhouse gases generated by human activities have accelerated the speed of global warming. All around the world, there are more and more environmental protection organizations appealing to protect our environment and to love our planet. Their efforts include urging governments to set policies and regulations on reducing carbon dioxide emissions, and at the same time, promoting the concept of environmental protection through the mass media.

In recent years, all trades and professions including the health care industry are more attentive to this issue. In order to educate more medical facilities and their workers on the principles and methods of environmental protection and saving energy, many organizations around the world has begun to discuss the concept of building environmentally friendly green hospitals. This chapter will introduce several international environment protection organizations providing good references to those who would be engaging in the promotion of green hospitals.

Health Care Without Harm

Health Care Without Harm (HCWH)[6] is an international coalition of hospitals and health care systems, medical professionals, community groups, health-affected constituencies, labor unions, environmental and environmental health organizations and religious groups.

It supports the development of evidence -based practices and policies that can be implemented to the environmental harm of health care practices. The organization also helps hospital engage with manufactures to help them reduce the environmental impact of material, equipment and supplies used in health care operations.

「First Do No Harm」 is the major mission of Health Care Without Harm. Together with their partners around the world, they share a vision of a health care sector that does no harm and instead

promotes the health of people and the environment. The HCWH implement ecologically sound and healthy alternatives to health care practices that pollute the environment and contribute to diseases.

For example, the incineration of medical waste is a leading source of dangerous air pollutants such as dioxin and mercury, and the use of hazardous chemicals indoors may contribute to the high rates of asthma among health care workers. The huge scale of the health care sector worldwide means that unhealthy practices - such as poor waste management, use of toxic chemicals, unhealthy food choices and reliance on polluting technologies - have a major negative impact on the health of people and the environment.

The health care sector can play a leading role in solving these problems. Since it possesses massive buying power, and its mission-driven interest in preventing disease, it is hoped that the health care sector can help shift their focus on management to the development of sustainable and safe practices and services.

Healthier Hospital Initiative

In May 2010, the Healthier Hospitals Initiative(HHI)[7] was found by six U.S. health care systems — Advocate Health Care; Catholic Healthcare West; Hospital Corporation of America (HCA, Inc.); Kaiser Permanente; MedStar Health; and Partners Healthcare. It aims at charting a path for the healthcare sector to more sustainable healthcare system. It has created the Healthier Hospitals Agenda, a document that outlines specific activities that hospitals can take to minimize their carbon footprint and adverse environmental impact of their operations to improve health outcomes. The overall goal of this national initiative is to use a coordinated approach to achieve sustainability throughout the health care sector, which will prevent environment–related illnesses, create environmental benefits, and save billions of dollars in health care expenses.

Green Guide for Health Care

The Green Guide for Health Care (GGHC)[8], established in 2002, is a project of the non-profit organizations Health Care Without Harm (HCWH) and Center for Maximum Potential Building Systems (CMPBS). The work of the Green Guide is undertaken by a group of design,

engineer, facility management, environmental and green building professionals with particular expertise in the health care sector who serve on Green Guide volunteer steering committees and working groups. Together, the GGHC engage in the integration of healthcare-related tools, technical guidance and educational resources. Their goal is to build a learning community and create high-performance healing environments and to accelerate their adoption and implementation in the United States, Canada, and around the world.

Practice Greenhealth

Practice Greenhealth[9] is U.S. national networking organization for institutions in the healthcare community that have made a commitment to sustainable, eco- friendly practices. Members include hospitals, healthcare systems, businesses and other stakeholders engaged in the promotion of green health care to improve the health of patients, medical staff and the environment.

Greenhealth provides hands-on guidance to hospital personnel and has developed a number of tools, including a waste management tracking tool and an on-line clean energy purchasing program, a program that enables members to participate in custom-tailored, web-based clean energy reverse actions.

Center for Health Design

The Center for Health Design[10] was formed by forward-thinking healthcare and design professionals committed to design that could be used to improve the quality of healthcare. Through design research, educational and advocacy programs, they help healthcare professionals create healthier, and safer healing environment.

3. Actions and Experiences in Green Hospitals

Global warming and environmental protection advocacy are issues that we must undertake in national development and industry competition. In the green era, health care facilities have a huge responsibility for planning for the future and improving the quality of medical services.

Green hospital is a hospital operated with the concepts of environment protection; green hospitals not only provide health care services but also an environmentally friendly place that causes less harm to our planet.

The following section will introduce how Taiwanese and international hospitals operate to achieve energy saving and carbon reduction. Their experiences fall into the seven categories mentioned by "Healthy Hospitals - Healthy Planet - Healthy People" published by Health Care Without Harm: energy efficiency, green building design, alternative energy generation, transportation, food, waste and water. We also include education, a key strategy, in the last section.

Energy Efficiency

By implementing energy-efficient measures for lighting, air conditioning and water heating systems etc., health care facilities could decrease energy consumption. Improving energy efficiency is the most cost-effective way to save energy and has quickest effect on global warming.

Taiwan: Buddhist Dalin Tzu Chi General Hospital

Buddhist Dalin Tzu Chi General Hospital has devoted to promoting preventive medicine, community health promotion activities, and becoming a health promoting hospital since starting operation in August 2000. In the end of 2005, the hospital began to implement the health promoting hospital project that includes a hospital-wide health promoting system started in 2006, and application for membership in the Health Promoting Hospital International Network in 2007. It hopes not only to engage in staff, patients, community, and spiritual health, but also to include the environment as one of the five health promotion agendas.

For the water heating systems, the traditional coal-fueled boiler system has the risks of explosion, huge carbon dioxide emission and energy consumption. After modifying the systems, the heat pump would produce hot water from absorbing the heat from the surrounding while reducing the production of carbon dioxide. Although the cost of the heat pump system is higher, it saves almost one fourth of the energy. Meanwhile, the cool air produced by the system can be incorporated into the air-conditioning system; they would stop or start automatically and thus increasing energy efficiency by adjusting to the temperature and cold water.

In addition to the heating system, it saves 6,018,147kW.h of electricity every year by installing inverters, monitoring the operative time of the extractor machine, using electric- saving lighting equipment, supplying the heat water by heat pump system, and improving the automatic sensor lighting in the public toilets and electrical lighting. Altogether it reduces 3,971,977kg of carbon dioxide annually.

Taiwan: Changhua Christian Hospital

Changhua Christian Hospital is a medical center located in Central Taiwan. The superintendent and all staff are advocates of environmental protection and devoted to saving energy. They have won many honors and awards in energy saving and waste reduction from the government.

In their medical building, before adopting the landscape lighting photovoltaic system on its top floor, great quantity of electricity was consumed, especially during peak hours. After the installation of the 32.9kW photovoltaic system that operates along with Taipower Service, it provided clean renewable energy and reduced electricity use during peak times. It can save NT$ 195,000 and reduce carbon dioxide emissions up to 41,450 kg per year.

In order to improve energy usage in the hospital, they tried to save energy and reduce carbon dioxide efficiently from its source, and the hospital had already implemented the following renovation projects:

- Changing the air-conditioner to a centralized temperature monitor in the hemodialysis room.
- Using an anti-Legionella ozone sterilization system in the cooling tower in the Medical Building to decrease the effect

of chemicals to the environment and to save water use.

- Upgrading the water-cooling system to improve efficiency. The water-cooling system zone pumps have been used for fourteen years and the motor is less efficient. With a normal full load delivery, the electric current reaches 45 ampere. By adopting inverters, the electric current was adjusted to 28 ampere according to actual needs. It can save NT$ 161,117 and reduce 41,117 kg of carbon dioxide emissions every year.
- Renewing air-conditioning and the monitoring system in the outpatient department and burn operation room. There was no control circuit in the burn operation room prior to the renewal, and therefore the air-conditioning would operate for whole day, causing energy waste when no operation is performed. For this reason, they installed the air-conditioning switch to control the temperature. By doing so, the air-conditioning motor can save 13,965 kW.h of electricity per year.
- Changing the cooling tower radiator material to raise its heat dissipation efficiency and installing high temperature, high pressure sterilizing engineering in the supply center to save energy.

Taiwan: Chiayi Christian Hospital

Water heating uses fossil fuels such as coal, heavy oil. The hospital uses steam generated during the process as the main energy source to sterilize and heat water for wards and general use. It accounts for a major part of cost in energy consumption. Therefore, if we can intercept the wasted heat emitted by the boiler chimney for reuse, it will save energy and reduce greenhouse gas emission, lowering operation costs for the hospital.

Chiayi Christian Hospital reformed the boiler chimney by setting a preheating device to intercept the heat emitted and recycle it. The new system can not only save the consumption of diesel fuel and water. It also reduces at least 115.518 kg of carbon dioxide emission per day and achieves reduction efficiency rate of 8.467%. The new system helps save NT$ 189 of water use and NT$ 339,417 of fuel use, with a total saving of NT$ 339,606 per year. In addition, it achieved the emission reduction limitation standard by Kyoto Protocol, and has received a patent on the design.

Taiwan: Miao-Li General Hospital, Department of Health

Miao-Li General Hospital, Department of Health, cooperated with Chunghwa Telecom in 2009 and had demonstration on saving energy by heat pump and lighting efficient project, which proved to save NT$ 2 million per year. Compared with the eight months from January to August in year 2009 to 2010, the average monthly consumption of natural gas in the hospital decreased by 9,469 m^3 (54%), and saved NT$ 122,655 on natural gas use per month. By September 2010, Miao-Li General Hospital has saved more than NT$ 1.5 million. It is estimated NT$2.3 millions will be saved this year.

In the hospital compound, they changed the gas boiler to a heat pump system, and changed the lighting equipment from T8 to T5 in the administration building and outpatient department. They also cooperated with the Intelligent Energy Network of Chunghwa Telecom to monitor, measure, and confirm the electricity use to enhance the system's efficiency, which will reduce energy consumption and lower the cost.

Intelligent Energy Network (iEN) is the monitoring system that collects and controls the information of related electricity use in the monitored network. Together with the information collected, this equipment uses smart control system to improve efficiency and save energy and money.

Miao-Li General Hospital

Taiwan: Chang- Gung Memorial Hospital

Chang-Gung Memorial Hospital places a huge emphasis on the optimization of energy use. Since the start of the hospital operation, they were actively involved in energy saving by design and operation management. Furthermore, the staffs are trained to promote the comprehensive energy saving methods. Their excellent performance on energy saving has rewarded many times by the Ministry of Economic Affairs.

- Electricity

Electricity utilization goals were set up to manage load, record and control the usage. The electricity system was simplified to increase the transformer loading rate. Elevators stop during down times, at night

and on holidays, and escalators are controlled with sensors. Large drinking fountains save energy by time-controlled auto switch according to frequency and area of use. Furthermore, the smaller machines are also controlled to ensure electrical use safety and achieve energy efficiency.

- Lighting

High efficiency, disaster-proof T5 lighting equipments are used. They are used in elevators, stairways and emergency lighting boxes. Automatic control equipments are used at windows or areas with natural lighting. Low-illuminated design is used in public areas or the areas with less people at night, and the infrared control system is used in the parking lot.

The administration and outdoor areas adopted the fluorescent light and table lamps. High-pressure sodium lamp and high efficiency, high power metal halide lamps are also used outdoors. LED or photovoltaic style lamps are used in the hospital compound.

- Steam

From June to August, the steam usage reduction is achieved by reducing temperature of heated water by one to five degrees. Heat pump was built to use ice backwater to raise the temperature of hot water and decrease the temperature of cold water. The system also recycles the heat energy of steam, and stops the boiler at night, and uses electro-thermal system instead of heavy oil to maintain the temperature. Additionally, condensation water was reused, and part of the heated water can be heated during off-peak hours. The boiler chimney was also improved to increase the efficiency. The hospital would adjust the system's according to the frequency of boiler use, the necessity of steam and/or the setting of heat pump.

- Information system

Energy saving computer and peripheral devices such as LCD monitors were procured and used. In the hospital, the full-time departments would reduce the number of computers and printers turned on at night. IT related consumables such as toner cartridges would be recycled.

- Medical instruments

Priority in purchasing new medical instruments is based on energy saving or low energy consumption. However, old instruments still in use and not as efficient are used differently by reducing the standby time and energy consumption. The hospital would review energy use and replace high energy consuming equipment to reduce energy wastage. Modern, energy

-saving equipment is purchased, such as 1000RT air-conditioner with inverter, electrodeless discharge lamps and LED OA.

Chang-Gung Memorial Hospital- High efficiency, disaster- proof electrical lighting equipments

Taiwan: Taipei Medical University-Shuang Ho Hospital

As the largest green building hospital in Taiwan, Shuang Ho Hospital devotes itself to energy saving and conservation, by setting up operational energy-saving systems, and constantly monitoring their efficiency.

- Water

Water saving faucets were added in public areas while the flush system of the toilets were adjusted to save water.

- Electricity

Lighting areas were adjusted in public areas according to use and switches were added in offices. Equipments with high electrical consumption were replaced, sensor lighting lamps were adopted in medical buildings, operating times of elevators in the medical building were adjusted (only two elevators, one for visitor and the other for bed transport, are in service from 11 pm to 7 am), and the operating time of water pumps were adjusted.

- Air-conditioning

The temperature of iced water was increased by 1℃ to lower the electric current of ice water machine. It can save 6% of electricity consumption.

- Fuel use

In order to reduce the carbon dioxide emissions and air pollution, the hospital chose clean gas as fuel.

Shuang Ho Hospital

Taiwan: Mackay Memorial Hospital Tamsui Branch

A heat pump system is installed in the dormitory of the administration center. Two flood 80RT heat pumps supply both hot water and cold water. During the day, the pump provides pre-heated and pre-cooled water for the boiler system. The hot water would be mainly used for the dormitory and pumped into the heated water tank on the roof, and the cooled water is pumped into the pre-cooling tank.

The boiler heats 24.1tons of water per hour in the day, and only 17.7 tons at night. Assuming 5.1 hours of operation per day, the hospital can save approximately NT$ 700,000 per year and reduce heavy oil use by 30%. Moreover, carbon dioxide emission is reduced by 130,000 kg (49% less emissions than before).

Mackay Memorial Hospital Tamsui Branch- Heat pump system

Singapore: Alexandra Health Cluster

Within the hospital, aspects of processes, systems and technologies work together to achieve energy efficiency.

The following are some examples of increasing energy efficiency:

- Installation of motion sensor lighting equipment.
- Using compactly-stacked blade servers in the data centre frees up more space in the hospital for other purposes. These blade servers also use less power by 33% compared to the traditional rack mount servers.
- Piped water from the Yishun pond adjacent to the hospital is used to cool the data centre.

Green Building Design

Environmental sustainability can be integrated into health facilities by incorporating green building principles in design and construction. The green building design maximizes natural lighting and ventilation, preserves open space, and includes features such as rainwater reclamation system. It also promotes a healthier indoor environment.

Taiwan: National Taiwan University Hospital

National Taiwan University Hospital (NTUH), Children and Women Building is located near the NTUH original building and in the central area of Taipei. It is a 26-story, 100-meter building, with 22 floors above and 4 floors underground. It has base area of 9,570 m^2 and total floor area of 74,864 m^2. The building adopted the windmill building form which inspires children's imagination and creativity. The design symbolizes the hope, youthful vigor and health of children.

The medical building houses the medical services of Genetic Medicine, Obstetrics and Gynecology, and Pediatrics, as well as teaching and research. There are outpatient department, examination room, operation room, intensive care unit, general wards, bone marrow transplantation wards, laboratory and logistics support etc. The complexity of the facilities ensures full operational support in providing medical services.

National Taiwan University Hospital, Children and Women Building

The Children and Women Hospital is qualified in six green building design indicators of environmental protection: green environment, ground water-retention capacity, energy saving, reduction of carbon dioxide, water, sewage and waste.

- Green environment

  The ground and roof gardens measure

1,172m^2, and the design takes reference of the capital's best landscaping.

- Water-retention capacity

The hospital adopted green land, gardening soil and permeable pavement to reserve water, with the total area of 3,331 m^2.

- Energy saving

1. The Children and Women Hospital building adopted steel construction and the aperture ratio is 31.8%. The curtain wall uses external shading device and laminated glasses - green window, low-E clear glass with high insulation which can reduce solar radiation and Envelope Load (ENVLOAD).

2. The T5 lighting system used is energy-efficient with secondary control system by time- sharing.

3. The air-conditioning system adopted high efficient chiller, secondary chilling system and cooling tower and air box which all use the energy-saving inverter motors and heat exchanger to pre-cool the outer air. They used 8,000 RT-HR ice storage systems to shift the peak hours of electricity consumption and together with the heat recycle system (300RT) to maintain the temperature and humidity in the operation room and bone marrow transplant wards.

4. Established energy management system and auto control system to optimize operation and energy.

- Reduction of carbon dioxide

The main structure of the medical building and outer wall adopted light, incombustible, aseismic and metallic glass wall design. Moreover, it uses patent designs of flexural toughness scale frame and eccentrically braced frames, and light partition walls.

- Water

1. The toilets and faucet with water-saving labels are used. The faucet is aerator styled and the quantity of water consumed is 25-50% less than the traditional faucets.

2. Rain recycled by the rainwater recycling system can be used for watering.

- Sewage and waste

1. General sewage (including daily wastewater and kitchen wastewater), highly polluted wastewater, infectious wastewater, and radioactive water are discharged separately according to the emission standards into the Taipei City sewerage systems.

2. General Industrial/Commercial wastes are discharged in each floor and recycled according to waste type. Garbage in dumping stations in each

floor is delivered vertically by the tube to rotary waste compression store facility then sent to incinerator.

3. There is an infectious waste room and a cooling room for infectious waste. The combustible infectious waste can be incinerated, and the incombustible waste is sterilized by the sterilizers before smashed and buried.

4. The radioactive waste is sent to the radiation polluted waste storage room.

Taiwan: Buddhist Dalin Tzu Chi General Hospital

When stepping into the hospital lobby, you will see natural lighting on the floor and people. It illuminates indoors through the transparent ceilings and corridors between buildings, and decreases electricity use during daytime expenses. It cuts down electricity use cost and creates healthy indoor environment.

Buddhist Dalin Tzu Chi General Hospital- Collecting skylight cover in lobby

Taiwan: Changhua Christian Hospital

The new Changhua Christian Hospital's compound adopted eco-technology, green building and promoted ecological conservation. In order to create a comfortable and healthy green community, they planted trees and beautified the campus, using green building materials for buildings. In the hospital compound, they reused rain water by landscape-architectural loads and roofs to conserve the water. In addition, the greywater reclamation system reuses recycled domestic water. For the development, they used local materials to reduce harm to the environment. In the future, they will also try to adopt green building concepts for their new hospital campus in other areas.

Taiwan: Chang Gung Memorial Hospital

In 2009, Chang Gung Memorial Hospital (CGMH) made great progress in greening and gardening. There were 36,801 arbor trees, 51,323 bushes, 21,321m^2 hedgerow and 340,935m^2 lawn planted. The total number of trees is 88,124, which could reduce 853 tons of carbon dioxide emission.

By mid 2010, the hospital continued to do green work in each compound; moreover, they also planted trees in Kaohsiung Yung- Ching Memorial Park and Chiayi CGMH and applied for 100 thousand trees to afforest.

The parking tower of Linkou CGMH and advanced medical center are expected to received the award of the LEED Green Building Labeling certification, and all the other branches will follow in the near future. They also plan to use wind power, solar photovoltaic system, LED lamps, electrodeless discharged lamp and ceiling light, frequency conversion and normal temperature air- condition facilities.

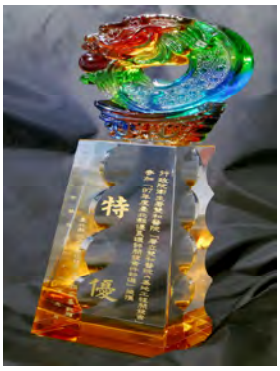
Furthermore, Chang Gung Memorial Hospital implemented green procurement policies to purchase green products and building materials, allowing them to win an award by Ministry of the Interior, Taiwan.

Taiwan: Taipei Medical University- Shuang Ho Hospital

Shuang Ho Hospital has become the largest green building hospital in terms of total floor area by winning the Green Building Label of the Ministry of the Interior and the best Environmental Impact Assessment (EIA) project award of Taipei County.

Green Building Label makes a point in “build with the least resource, and produce the least amount of waste”. Shuang Ho Hospital was awarded the Green Label Building in March 18th of 2009 and was certified in four indicators: greenery, energy saving, water resource, and waste reduction.

In 2008, the Environmental Protection Bureau of Taipei County held the first EIA project performance competition, also first of its kind nationwide. The goal of this competition is to encourage eco- friendly behaviors in developing land project and constructing buildings. Shuang Ho Hospital won the best award and was honored in the ceremony of January of 2009.



Shuang Ho Hospital- Green Label Building

Singapore: Alexandra Health Cluster

The hospital was awarded the Building and Construction Authority (BCA) Green Mark Platinum Award for its green and energy-efficient features, such

as the use of solar panels, enhanced daylight designs and natural ventilation.

Green Mark buildings contribute significantly to the environment. A Green Mark Platinum building, can achieve more than 30% of energy savings compared to a code-compliant building.

Alexandra Health Cluster- KTPH Pond view-landscape crop

Alternative Energy Generation

While facing the crisis of energy shortage and environmental problem, government and non-governmental organizations have made more efforts in saving energy and reducing carbon footprints. Taiwanese Government popularized the photovoltaic systems nationwide in 2002, and offers 50% subsidy for private organization and households using photovoltaic systems. However, most people think that the photovoltaic system is too expensive, and the cost of generating electric power is high, making it difficult to be widely accepted. In fact, we import about 98% of energy source from other countries; therefore, we cannot afford to use too much energy. From the environment protection point of view, traditional ways of power generation include using coal, petroleum or firepower that would produce carbon dioxide, increase global warming, and pose a threat to human health.

Buddhist Taichung Tzu Chi General Hospital-Photovoltaic system

Taiwan: Buddhist Taichung Tzu Chi General Hospital

Buddhist Taichung Tzu Chi General Hospital has advocated preventive services and improved the quality of care since 2007. In Buddhist Tzu Chi Foundation, Master Cheng Yen told people the importance of carbon reduction, and that we should not only do it in our daily life, but also in building design. Taichung Tzu Chi General Hospital has the biggest photovoltaic system, covering the roofs of the six main buildings with the huge solar panels that follow the direction of sun and facing south. Starting in September 2006, these six solar panels generate around 100 kilowatt (kW) per day and it was the largest photovoltaic system, serving as a model for hospitals in Taiwan to promote photovoltaic system.

In 2010, the system can provide 1.36% of the hospital's power. Small percentage it may seem, the system can reduce at least 58 thousand kilograms of carbon emission per year. Other than the solar panels on the roofs, all street lamps in the hospital compound use solar lamps.

The system can produce 384kW.h power a day at most calculated from average sunlight duration of four hours per day in Taichung. Currently, the efficient electricity generated is 300kW.h per day, that is to say, if using a 1kW air-conditioning for one hour costs 1kW.h of electricity, the system will generate power for 300 hours of electricity use. The photovoltaic system has been in used for four years, and generated more than 420,000kW.h of electricity, saving about NT$ 1 million, and reducing more than 252,000kg of carbon dioxide emissions.

Developing the photovoltaic system, in the long term, will not only reduce utility expenses and maintain the living environment, but also improve the electricity use during summer. Although Buddhist Taichung Tzu Chi General Hospital has spent more than NT$ 26 million on photovoltaic system, its objectives are to pursue Master Cheng Yen's environmental protection ideas of striving to protect the earth.

Buddhist Taichung Tzu Chi General Hospital- Solar lamps

Taiwan: Mackay Memorial Hospital Taitung Branch

Mackay Memorial Hospital Taitung Branch[11] takes action on environmental protection and electricity saving by building the photovoltaic system on the top floor in the hospital. This system started on June 11th, 2008 which is the first hospital with photovoltaic system in Taitung County, and a big step in becoming a green hospital.

Mackay Memorial Hospital group has four branch hospitals in Taiwan. The reason for choosing Taitung Branch Hospital is because Taitung County is well known for its sunny weather.

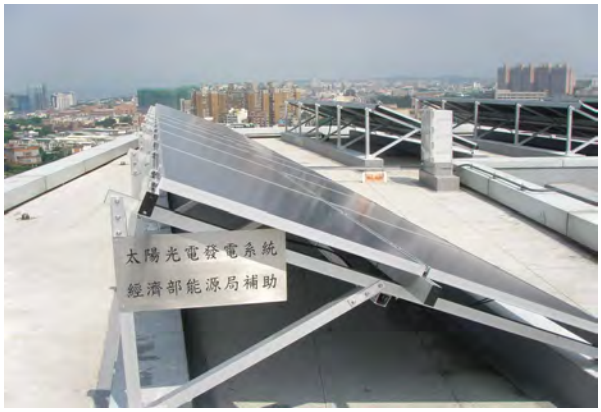
The system capacity of the photovoltaic system is 20 kilowatt-peak (kWp) which is formed by 114 polysilicons, facing south. Based on the average efficient sunlight duration of 4 hours per day, the system can save 80kW.h of energy per day and 29,200kW.h of energy per year, reducing 18,630kg of carbon dioxide emission, which is equal to the CO_2 absorption rate capacity by 980 trees. (1kW.h electricity emits 0.638kg of carbon dioxide, and one tree can absorb 19kg of carbon dioxide per year).

Mackay Memorial Hospital Taitung branch supports the green action for life by practical action and hopefully look forward to leading the whole county to pay more attention to the concepts of environmental protection and guard the last utopia in Taiwan.

When people wait in the hospital building, the billboard and television at the west wing of the lobby displays a short video showing immediate information on energy saving and photovoltaic system to teach them how to cherish our environment in daily life.

Taiwan: Mackay Memorial Hospital Hsinchu Branch

Mackay Memorial Hospital Hsinchu branch has been implementing environmental improvements for many years, one of the projects is the solar power generator system, which generates 10.16kWp and composed of 52 solar panels. Thanks to the subsidy from the Bureau of Energy, Ministry of Economic Affairs, and the best location for maximum sunlight without being blocked, the system was set up on top of the water tower on the roof of the new medical building.



Mackay Memorial Hospital Hsinchu branch- Photovoltaic system

The solar power system setup completed was on 20th April, 2010 and by 5th October the system has generated 5,279 kW.h of electricity and reduced 3,368kg of CO2 emission. The system is estimated to generate 1,000 kW.h of electricity per month, and reduce 7,656kg of CO2 emission every year.

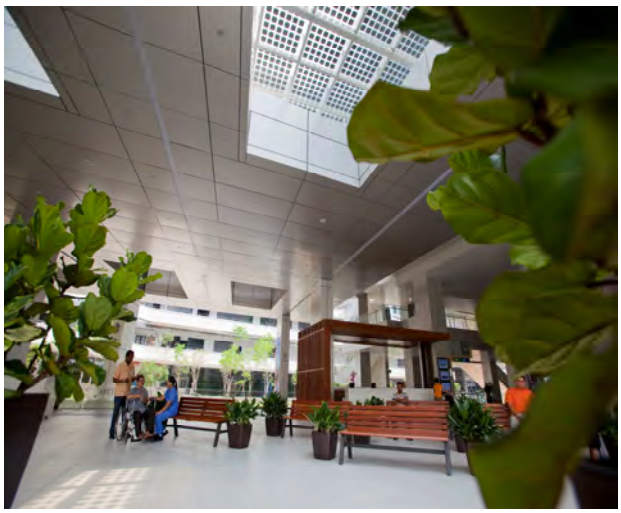
Taiwan: Buddhist Dalin Tzu Chi General Hospital

Energy supply from renewable sources is an essential strategy for reducing global warming and promoting environmental sustainability. Alternative energy can reduce the emission of green-house gases generated from burning fossil fuels. The hospital uses solar energy street lamps and lighting equipments in the hospital compound for reducing the use of electricity.

Singapore: Alexandra Health Cluster

To help offset our carbon footprint, the health cluster harness clean and renewable energy through solar energy systems. Solar panels are installed along the rooftops to directly convert solar energy into electricity used within the hospital. There are also solar thermal systems put in place to produce hot water for the hospital's needs.

Alexandra Health Cluster- Solar thermal system



Alexandra Health Cluster- Main Lobby with solar panels visible

Transportation

The main source of greenhouse gas from the transportation sector in Taiwan is the private transportation such as cars and motorcycles, both of which account for 72.4% of transportation use. Public transportation comprises only 13.4% of total transportation. Transportation produces greenhouse gas and minimizes physical activities[12]. Thus, it is important to encourage people to take the stairs instead of taking elevators, and to increase physical activities by riding bicycles. Public transportation should be utilized to decrease driving cars and riding motorcycles. When purchasing cars, we should choose vehicles using liquefied petroleum gas or electricity. Keep a good habit of turning off the engine during long idles to reduce carbon dioxide emissions.

Buddhist Dalin Tzu Chi General Hospital- Encourage staff to ride bicycles

Taiwan: Buddhist Dalin Tzu Chi General Hospital

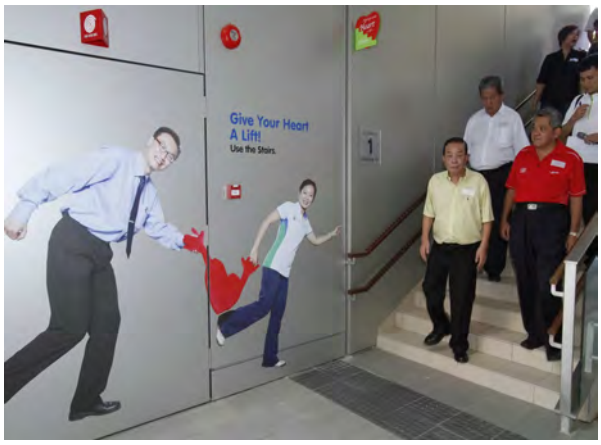
Within the hospital, we encourage people to take the stairs instead of elevators. The stairways are decorated with beautiful pictures of natural scenery and health education. Riding bicycles is encouraged instead of driving cars or riding motorcycles. This is good way to reduce the carbon footprint. Furthermore, we provide free shuttle buses routes between downtown and hospital as means to people to take public transportation.

Buddhist Dalin Tzu Chi General Hospital- Healthy stairways within hospital

Singapore: Alexandra Health Cluster

As a health promoting hospital, all staff is encouraged to exercise on a regular basis. Posters with messages advocating the benefits of walking can be seen around the hospital. Bicycle parking spaces are made available for those who ride bikes to

the hospital. There is even a bicycle for rent service available for the staff who wants to pedal around and explores the areas nearby the hospital.



Alexandra Health Cluster- Staff and visitors are encouraged to take the stairs

Food

According to the Food and Agriculture Organization of the United Nations, livestock business is the major source of carbon dioxide emission[13]. Agriculture is an important contributor to climate change. During process of the production, manufacturing, transportation, storage, selling and food consumption, considerable amounts of greenhouse gases are produced. The majority of greenhouse gases are methane and nitrous oxide and the main source is from the meat production[14]. We can cut down on the meat consumption which helps decrease the effects of global warming.

Moreover, the disease pattern is changing and many chronic diseases are diet-related. We can improve health by changing the lifestyle and dietary habit.

Taiwan: Buddhist Taipei Tzu Chi General Hospital

In order to encourage people to eat healthy vegetarian diet and use reusable utensils, Buddhist Tzu Chi Foundation constantly teach people how to eat healthy and treat the environment friendly, respect the life, and live in harmony with the nature. In order to promote the health of patients, staff and the people who visit the

hospital, they are encouraged to eat vegetarian diets. There is a “Da Ai Food Court” in the hospital that serves a variety of vegetarian food. Among the choices are buffet with more than 100 dishes Thai, Taiwanese, Japanese, Korean food, light food, hot pots and so on for people’s need.

The vegetarian diet also has the following characteristics:

1. Provide lacto-ovo-vegetarian diet;
2. Follow the recommendation of the Dietary Reference Intakes (DRIs) which is formulated by the Department of Health, Taiwan;
3. Provide seasonal fresh food and fruits;
4. Have at least two kinds of vegetables per meal;
5. Serve a variety of staples: rice, unpolished rice, noodle, porridge, and steamed bun etc.
6. Serve various meals set: for disease treatment, normal diets, for postpartum recovery.

In Da Ai Food Court, there are different styles of vegetarian diets. The nutrition labels sign, summarized by the dieticians are placed are placed in the food court entrance to give people the idea of different meals in different stands.

Buddhist Taipei Tzu Chi General Hospital- The Da Ai Food Court provides a variety of vegetarian diets.

Taiwan: Buddhist Dalin Tzu Chi General Hospital

As a Buddhist hospital, providing vegetarian food is mandatory and the most important and effective action on easing the burden of global warming. The Da Ai Farm is a farm within the hospital compound where it serves local and organic produce in the hospital’s cafeteria. By doing so, it reduces carbon dioxide emissions from transporting process. It also serves as horticultural therapy for the mentally-challenged. Besides being friendly to the environment, vegetarian diets have been proved to be healthy for people.

Buddhist Dalin Tzu Chi General Hospital- In the Da Ai Farm, staffs and families harvest together and rice with their own brand.

Singapore: Alexandra Health Cluster

Healthy eating is promoted throughout the hospital – from wards to eateries. Fresh fruits and vegetables are harvested from hospital's gardens and served to patients in the wards. In the food court, food stalls and café serve healthy yet delicious food, prepared with less oil, salt and sugar. To further encourage healthy eating, the food is not only healthier, but also cost less than restaurant food.

Alexandra Health Cluster- Hospital's gardens

Waste

The definition of waste by the World Health Organization is the waste from health care facilities that includes the waste produced during diagnosis, treatment, prevention, rehabilitation and related research. The international survey shows that the health care facilities are the major producer of biomedical waste, which constitutes 10-15% of total hospital waste. According to the 2007 data from the Department of Health of Taiwan, there are a total of 19,900 hospitals and clinics in Taiwan, and the statistics from the Environmental Protection Administration indicates that there are 90,000 tons of wastes generated each year, with 23,561 tons of biomedical waste included. The statistics also shows hospitals produce an average 64.5 tons of medical waste every day[15]. How to deal with huge biomedical waste in hospital is something the hospital administrators must take seriously.

Taiwan: Changhua Christian Hospital

Changhua Christian Hospital applied Automatic Identification and Data Capture (AIDC) system in managing their biomedical waste. For the waste recycling, they began making an effort in the management of biomedical waste, reusing infectious waste to fully implement waste

recycling. In October 2009, the plans used reusable biomedical waste such as vacant syringes, artificial kidney, and the tube of IV set. According to the 2009 data, hospitals produced 32 tons of biomedical waste per month, and after the commencement of the project in March 2010, biomedical waste was reduced by 5 tons per month. In the hospital, around 20%~30% of the used vacant syringes, artificial kidney, and the tube of IV set could be reused. Compared with the cleaning fee of traditional biomedical waste and the reclamation waste, it could save about NT$ 35,000 per month and NT$ 420,000 per year.

For example, they recycle the bottles to be reused in the nursing department, and the hemodialysis cans are provided to the recycling company. Recycled advertisement flyers are reused. Both sides of every sheet of paper are used. E-system is used instead of paper. These actions would reduce both hospital cost and the consumption of paper.

Changhua Christian Hospital insisted on adopting green consumption and reusable materials. As a health care facility, they purchase goods and equipment with the green label only, and adopt environmental promotion to decrease the need of redundant purchases and optimize the information management system to decrease and prevent pollution.

The Picture Archiving and Communication System (PACS) is used in the hospital, making viewing examination reports anywhere possible in the hospital; thus increasing efficiency and reducing the need of space and manpower. Films are displayed on screens, and physicians do not need to use the traditional X- ray photograph, reducing the use of photographic paper, developing agents and fixer solutions. As a result the hospital would produces less water waste and causes less harm to the environment. Moreover, the hospital specified the regulations on deserted property management and disclosed them on the website, and furthermore, they transferred the goods to the departments that need them and held auctions sales which will extend the usage and reduce wastage.

Taiwan: Buddhist Dalin Tzu Chi General Hospital

In health care facilities, the management of medical waste is one of the most important tasks. We use modern information technology to develop electronic health care information as part of our effort

in becoming a paper- and film-free hospital. Through e-administration system and health care information system, the hospital saves NT$ 21.5 million per year.

Quality Control Circle (QCC) programs for reducing the medical waste successfully cut down on the amount of waste production from 2.92kg/bed to 2.59kg/bed per day. In the hemodialysis room, the equipment is designd to successfully decrease the artificial kidney fluid from 0.9 kg to 0.8 kg per bed.

Buddhist Dalin Tzu Chi General Hospital- Recycling work in each nursing station. There are 9 categories recycling bins: metal, paper, plastic, soft bag, biomedical waste, glass, aluminum, PET bottle and garbage.

The recycling work is also the important strategy in hospital. In each nursing station, there are more than nine categories of recycling bins. And in the hospital compound, hospital staff and families will volunteer and gather in the recycling station to recycle the goods from hospital and local communities. Over the past three years, the general waste has decreased from 2.05kg to 1.92 kg per bed per month and the recycled was increased goods by 87,991 kg.

By not providing disposable utensils and mandating the use of reusable items whenever possible, the use of disposable chopsticks has decreased by more than 3 million pairs in 7 years.

Buddhist Dalin Tzu Chi General Hospital- Reusable utensils only in the hospital.

Taiwan: Taipei Medical University-Shuang Ho Hospital

The waste management is one of the important environmental safety management systems in Shuang Ho Hospital. For waste sorting, reduction and recycling, the hospital adopted several measures: set up a waste treatment plant for biomedical waste area, general waste and recycling area;

reduction from source of waste, processing and reduce final waste in the recycling process.

1. Reduction from source of waste: for environmental protection, paper cups are no longer provided in the meetings, greywater is used to wash toilets and irrigation, and all departments should reduce the medical waste from the source.

2. Processing: posters of different waste recycling categories in each department to teach staff how to discard the waste in the correct bin.

3. Reducing final waste: The delegated staff manages all waste and performs secondary recycling to reduce unnecessary waste and increase the amount of reusable goods (such as paper, iron, aluminum, plastic bottle and glass).

Leftover waste gets incinerated, and recycled goods are cleaned and delivered to recycling stations by the professional wastage company who is specialized in, for example, melting the recycled glasses with coal ash or other materials to become reusable bricks.

Shuang Ho Hospital- The general waste handling area and biomedical waste storage area.

Taiwan: Chiayi Christian Hospital

The hemodialysis room is one of the departments in the hospital that produces more biomedical waste them others. The major waste is the artificial kidney and catheter. They remove the wastewater remaining in the artificial kidney and circuits by dialysis machine blood pump, to lighten the weight of biomedical waste. Similarly, in order to simplify nurses' workload and prevent nosocomial infection from happening, the hospital designed a simple infectious wastewater recycling connector to discharge the infectious

wastewater to the polluted water treatment plant. After reducing these biomedical wastes, the hospital can save cost on hiring people and expenses on dealing with the biomedical waste, increasing the empty bin recycling by NT$ 180,000.

Taiwan: Chang Gung Memorial Hospital

Compared to year 2008, the recycling program yielded significant results in the year 2009. A total 642 tons of garbage were reduced, decreasing carbon dioxide emission by 578 tons, compared with the previous year. They continue to promote e-administration system and paperless system. For example, the employment of digital signature in medical information system can save 32 tons of paper, 3,514kW.h of electricity, NT$10.527 million, 48 tons of carbon dioxide emission and 184.8 m^2 of space for storing admission notes.

Singapore: Alexandra Health Cluster

'Refuse, reduce and reuse' is one of the philosophies that Alexandra Health Cluster hospitals live by. To encourage everyone from staff to visitors to patients alike to help in a joint effort in reducing waste, the following initiatives have been implemented:

- Plastic bags are only provided upon request. Clean, recycled plastic bags are provided free of charge, but new plastic bags are chargeable.
- Recycling stations are placed conveniently throughout the hospital.
- Cornware is used instead of plastic where disposable cutlery is required.

Alexandra Health Cluster- Bio-degradable cornware utensils and recycling bins placed around the hospital

Water

According to the data from the Water Resources Agency, Ministry of Economic Affair, toilet water usage is the highest among hotels, hospitals and department stores. The water consumption in hospitals is 742 liters per person per day[16]. If the hospitals adopt water-saving equipment in bathrooms and cooling tower, each person will only use 459 liters per day.

Taiwan: Chang Gung Memorial Hospital

The hospital adopted the rainwater collection system, cooling water in equipments, reverse osmosis (RO) water recycling, and water-saving toilets with infrared sensor or foot controls.

For laundry, Chang-Gung Memorial Hospital adopted the tunnel washing machine. Tumbling washers were replaced with tunnel washers, and achieved water conservation rate of over 60%. Water used in laundry is 122,712 tons/year and water recycled is 73,635 tons/year. The automatic loading continuous operation on the new equipment can reduce the use of personnel by 40% compared to the traditional equipment. The cleaning agent can be reduced by 25% when it is recycled along with the water. The tunnel washer is a continuous washing machine and tumble dry, unlike the traditional type. It could save 18% of electricity. It does not only save lots of water, but also value-adding by using less personnel, detergents and electricity.

Chang-Gung Memorial Hospital- Tunnel washers

Taiwan: Buddhist Dalin Tzu Chi General Hospital

The hospital used water saving devices such as electronic sensor water taps, dual flush toilets, and reduce water pressure as well as adjust the volume of flow on each tap to reduce consumption. Water permeable bricks, rainwater reclamation system and greywater recycle system are installed to recycle the used water and conserve the precious natural resource. The amount of water recycled per year was 23.7% of total water used in the hospital, which is equivalent of 88,800 tons and saves NT$ 840,000 a year.

Singapore: Alexandra Health Cluster

The lush greenery in and around the hospital is watered with water channeled from the Yishin pond. The water is channeled to the hospital's irrigation systems and processed before its use for landscaping needs. When it rains, sensors will regulate this water source to prevent wastage.

Alexandra Health Cluster- Yishin pond

Alexandra Health Cluster- Water from the adjacent Yishun pond is used to irrigate the gardens.

Education

The environmental protection education can teach people how to internalize the concept of recycle in our lives and reduce the damage to nature. In hospitals, it's necessary to equip the staff with environmental protection information.

Taiwan: Chang Gung Memorial Hospital

In the hospital, it's difficult to have education on environment protection because of massive crowd of patients and visitors. Furthermore, the healthcare professionals consist of the majority of the staff but they do not have the scientific knowledge and lack understanding in energy saving, therefore the results are futile. Chang-Gung Memorial Hospital undertook the following projects:

- Regular administration training:

1. Engineers plan and design the training courses with example of best practices and experience sharing.
2. Attend professional energy-saving lectures on learning new technology and skills.
3. Hold energy saving promotional activities to tell the staff the importance of energy use and its standardized operation procedures.

- Web-based e-education training:

1. Build the website which includes the methods and skills to save energy at home and on the hospital.
2. Appoint the staff to be the consultants of energy saving.
3. Regularly announce new information and knowledge on saving energy.
4. Web-based energy saving test for staff.

- Establish energy saving group to learn new knowledge and operations.
- The Engineering Department should submit a report to propose ideas of improving energy efficiency, and the hospital would provide incentives to staff for implementation.

Taiwan: Changhua Christian Hospital

The superintendent and all staff are dedicated to environmental protection and advocating energy efficiency. By actively participating and supporting energy conservation measures, they have won awards on waste reduction from the government. Furthermore, the local health bureau also set green hospitals and environmental protection as one of the most important goals in Changhua.

In order to promote and educate environment protection in the hospital, Changhua Christian Hospital held the following activities:

- Set up the Environmental Protection Committee to promote the "Save Energy and Reduce Waste" campaign and provide incentives to encourage staff to brainstorm ideas of environmental protection in the hospital.
- Designate the units in each ward to educate staff and patients on how to reuse plastic waste. Such as vacant syringes, hemodialysis cans and the tube of IV set.
- Educate people from the local communities on the importance of environment protection.
- Learn and share the experience with other hospitals on reusing and recycling biomedical waste

Changhua Christian Hospital will continue to get involved in socially beneficial activities, promote pollution reduction, and the purchasing of green products, and act in accordance to the international and national environmental protection practices.

Taiwan: Buddhist Dalin Tzu Chi General Hospital

Buddhist Dalin Tzu Chi General Hospital hopes to implement green hospital from inside out while promoting the culture of environmental protection. Buddhist Tzu Chi Foundation has practiced environmental protection for more than twenty years, therefore, Tzu Chi Hospitals also encourage staff to participate in the QCC program in the hospital. Take patient safety, for example, the nurses design the wheelchair paddle socks to keep the feet of the elderly warm; and sputum percussion by intravenous drip bottles. The nurses incorporate implemented environmental protection works into taking care of patients' safety.

Buddhist Dalin Tzu Chi General Hospital- Creative environmental protection posters.

4. Conclusion

By sharing these experiences in this manual, we hope to assist other hospitals formulate environmental management policies, establish objectives and indicators for a greener hospital, allocate sufficient resources, engage in staff education, and set up environment monitor system to become environmentally friendly hospitals.

It is truly believed that by teamwork, from an individual level to an organizational level, we can change the healthcare institution from a huge energy consumer to an environmental protector. We call upon more hospitals to join the works of environmental protection and work towards a healthy, environmentally friendly workplace.

Acknowledgements

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