Hospitals use the greatest proportion of energy during daily operations, when energy needs for heating water, lighting and telecommunications are most acute. Studies suggest that between 70 and 80% of greenhouse gas emissions (GHG) are released during this period. Because of the high level of carbon impact associated with the operational phase, it is essential to identify low-cost (often non-structural) measures that can be easily implemented. The Smart Hospitals Toolkit helps existing hospitals identify and implement low-cost adaptation measures.

Several green building rating systems exist: LEED (developed by the United States Green Building Council) and BREEAM (United Kingdom BRE Environmental Assessment Method) are two of the more well-known certification systems. Recognizing that health facilities require special attention due to the nature of their operations and services (often with strict regulatory requirements, 24/7 operations, and specific programmatic demands), LEED joined forces with the Green Guide for Health Care, a self-certifying toolkit that sets forth special requirements for hospitals and similar institutions, to create the rating system LEED for Health Care, which maintains close alignment to LEED for New Construction.

The Green Checklist developed for this Toolkit has adapted existing green building rating systems to the Caribbean context, ensuring that it covers both the building itself and the facility’s operations. Achieving certification under existing green building rating systems will be difficult in the Caribbean, due to the systems’ strict requirements, the absence of Caribbean environmental policies, as well as the cost and technical capacity available in the region. The Green Checklist outlines feasible areas and applies to planned renovation projects, which are an ideal opportunity to introduce ‘smart’ measures.

Consult the Green Checklist below or download the form through this link.
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>TITLE</th>
<th>INTENT</th>
<th>ACHIEVABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renovations</td>
<td>Water Use Reduction</td>
<td>• Are you able to monitor water usage throughout your facility?</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Have you added a rainwater capture system?</td>
<td></td>
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<td></td>
<td></td>
<td>• Are faucets and plumbing water efficient (e.g. low-flow faucets; dual flush toilets, etc.)?</td>
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<tr>
<td></td>
<td></td>
<td>• Does your facility have an educational program that highlights the need to conserve and use water efficiently?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water-efficient Landscaping (no potable water used)</td>
<td>• Have you captured rainwater and installed a drip irrigation system for landscaped areas?</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Do you have space to install an aerobic sewage treatment system so that the effluent can be used for irrigation?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Have you utilized local, drought-resistant species and mulch plantings?</td>
<td></td>
</tr>
<tr>
<td>Energy and Atmosphere</td>
<td>Renewable Energy: On-site Generation</td>
<td>• Do you have an energy conservation plan?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Has the facility’s roof been assessed to ensure that it can accommodate a PV system and/or a solar hot water heater?</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Does your roof face south/southwest to allow for maximum solar exposure?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Is your rooftop energy system secure against natural hazards?</td>
<td></td>
</tr>
<tr>
<td>Efficient Equipment/Fixtures/Appliances</td>
<td>• Have you conducted an energy audit?</td>
<td>• Do you have an energy conservation plan?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Are equipment and appliances energy-efficient rated (US/EU standards)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Have you replaced your light bulbs and electrical devices with more efficient models/types?</td>
<td></td>
</tr>
<tr>
<td>Refrigerant Management</td>
<td></td>
<td>• Do you know what type of refrigerant your devices/appliances use?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Have you phased out any devices that contain chlorofluorocarbons (CFC) and replaced them with devices that contain/use refrigerants that have a reduced global warming potential (GWP) or less potent ozone depleting substances?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Is your equipment serviced by a professional to reduce leakage/release into the atmosphere?</td>
<td></td>
</tr>
<tr>
<td>Materials and Resources</td>
<td>Management of Construction Waste</td>
<td>• Does your construction company or public works department have a construction waste management plan?</td>
<td></td>
</tr>
</tbody>
</table>
## SMART HOSPITALS INITIATIVE
### GREEN HOSPITALS CHECKLIST

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>TITLE</th>
<th>INTENT</th>
<th>ACHIEVABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Materials</td>
<td>• Have you ensured that the building materials/products utilized are rapidly renewable or have recycled content?</td>
<td>Yes Planned No</td>
<td></td>
</tr>
<tr>
<td>Mercury Elimination</td>
<td>• Have you replaced bulbs containing mercury? • Have you phased out mercury-containing medical devices?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eliminate Use of Persistent Bioaccumulative and Toxic Chemicals (PBTs)</td>
<td>• Can you avoid using building materials/products that contain Persistent Bioaccumulative and Toxic Chemicals (PBTs)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furniture and Medical Furnishings</td>
<td>• Have you procured furniture/furnishings that use wood from managed forests or that contain no PBTs, PVC, heavy metals or other harmful chemicals?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indoor Environmental Quality</td>
<td>Environmental Tobacco Smoke Control</td>
<td>• Is there a national no-smoking policy or can you establish a facility policy?</td>
<td></td>
</tr>
<tr>
<td>Natural Ventilation</td>
<td>• Have you checked that all windows are operable so that you can take full advantage of prevailing North-East Trade Winds?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-Emitting Materials</td>
<td>• Have you procured materials, furnishings, paints, sealants, adhesives, etc. with no or reduced amounts of Persistent Bioaccumulative and Toxic chemicals Volatile Organic Compounds (VOCs), Semi-volatile Organic Compounds (SVOCs), Halogenated Fire Retardants (HFR), heavy metals, phthalates, perfluorochemicals (PFCs) and other chemicals? • Have you checked labels, ingredient lists, and material safety data sheets for hazardous components or requested these from suppliers? • Have you issued specifications for composite wood products that contain no urea-formaldehyde resins? • Have you procured paints without antimicrobial ingredients and metal products that are pre-painted? • Do you avoid cleaning/sterilizing substances that contain volatile components such as Volatile Organic Compounds (VOCs), Semi-volatile Organic Compounds (SVOCs) and other harmful chemicals?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CATEGORY</td>
<td>TITLE</td>
<td>INTENT</td>
<td>ACHIEVABILITY</td>
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<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Chemical and Pollut-</td>
<td>Source Control</td>
<td>• Have you provided an entryway system, grills or mats that can capture dirt and particulates brought in from outside the facility? • Can you procure equipment that is efficient and uses less hazardous chemicals? • Have you labeled and properly stored all chemicals as per manufacturer’s recommendations? • Do you use natural cleaning products wherever and whenever possible? • Have you ensured that pesticides and other chemicals used on the exterior of the facility are applied safely by a trained professional? • Do you use local landscape plants/shrubs? • Is there an incinerator onsite? If not, is there an alternative for waste disposal?</td>
<td>Yes Planned No</td>
</tr>
<tr>
<td>Controllability of Systems:</td>
<td>Lighting</td>
<td>• Do you utilize daylight while eliminating direct sunlight? • Have you used shade trees or shading devices on the exterior to eliminate direct sunlight from the building? • Have you installed lighting controls such as light sensors and occupancy sensors in staff and patient areas? • Have you provided individual lighting controls to enable adjustments to suit individual patient while limiting disturbance in multiple-patient areas?</td>
<td></td>
</tr>
<tr>
<td>Daylight and Views</td>
<td></td>
<td>• Have you added light shelves to reflect light further into the interior?</td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Management</td>
<td>Chemical Management Policy</td>
<td>• Has a national chemical management policy that aims to reduce the purchase and use of hazardous chemicals been developed?</td>
<td></td>
</tr>
<tr>
<td>Community Contaminant</td>
<td></td>
<td>• Have you documented the purchase, delivery, storage and use of all hazardous chemicals and substances stored onsite? • Have you provided secondary containment and security for substances stored outdoors, above ground or underground? • Have you educated staff on proper handling and storage of chemicals and the proper procedures for spills/leaks?</td>
<td></td>
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<tr>
<td>CATEGORY</td>
<td>TITLE</td>
<td>INTENT</td>
<td>ACHIEVABILITY</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>---------------</td>
</tr>
</tbody>
</table>
| Indoor Chemical Contaminant Reduction: Hand Hygiene Products, Sterilization and High Level Disinfection | • Has a national policy been developed that prohibits the disposal of chemicals down drains?  
  • Have you phased out the use of Ethylene Oxide and high level disinfectants (glutaraldehyde and other hazardous substances) and replaced them with safer alternatives?  
  • Have you ensured that all sterilizing and disinfecting appliances are top-of-the-line and efficient?  
  • Have you replaced manual disinfection with automatic machine washers/disinfectors? | Yes  | Planned  | No |
| Pharmaceutical Minimization, Management and Disposal | • Have you created a policy that establishes procedures for procuring, storing, dispensing and proper disposal of all pharmaceuticals?  
  • Have you ensured that pharmaceuticals are ordered on an as-needed basis to minimize expiration and that expired/unused pharmaceuticals are properly disposed of?  
  • Have you ensured that safer alternatives, such as products that contain no Mercury or PBTs, are ordered? | Yes  | Planned  | No |
| Solid Waste Management           | Solid Waste Land Disposal                                            | • Have you established a policy and guidelines to achieve zero waste and aligned your operations and procurement with this goal in mind?  
  • Have you minimized the sources of waste?  
  • Have you properly segregated waste at all times and stored it in a secured location until disposal?  
  • Have you ensured that the solid waste facility that accepts waste from your facility is well managed? | Yes  | Planned  | No |
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>TITLE</th>
<th>INTENT</th>
</tr>
</thead>
</table>
| Solid Waste and Material Management: Waste Prevention and Reduction | • Have you made waste reduction a goal and ensured that all of your purchases—from high-end machinery and equipment to food and office supplies—are aligned with this goal?  
• Have you streamlined and computerized procedures, printing on both sides of paper and purchased paper that contains recycled content?  
• Have you procured or leased photocopiers and printers that are capable of printing on both sides?  
• Have you made arrangements to ensure that biodegradable waste such as paper, cardboard, plant-based waste and food waste can be composted on-site, in the community or at a municipal or commercial facility? | Yes Planned No |
| Regulated Medical Waste Reduction | • Have you established a waste management policy that seeks to reduce overall waste generation, ensures that all waste generated is properly segregated and stored and ensures that staff is aware of and trained in the requirements of the waste plan?  
• Do you avoid mixing infectious and other medical waste with regular garbage?  
• Have you ensured that plastics, anything containing PVC, batteries, mercury-containing products and materials treated with flame retardants are not incinerated along with other medical waste and that an effort is made to reduce the purchase, use and disposal of these materials?  
• Do you purchase supplies that use fewer raw materials and that generate less waste and are recyclable?  
• Have you considered using alternative medical waste treatment technologies in an effort to reduce the volume of waste that is incinerated or disposed of in landfills? | Yes Planned No |
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>TITLE</th>
<th>INTENT</th>
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</tr>
</thead>
</table>
| Environmental       | Environmentally Preferable Cleaning: Products, Materials and Equipment | • Do you procure cleaning products and materials that are environmentally benign or that are less toxic than other products and that still maintain the high level of cleanliness required in the facility?  
  • Have you ensured that disposable paper products, like paper and hand wiping towels, contain recycled content?  
  • Do you prohibit products that are manufactured with carcinogens, mutagens and teratogens; aerosols; asthma-causing agents, respiratory irritants, benzene-based solvents, very acidic or alkaline products; anti-microbial hand soaps; persistent, bioaccumulative and toxic chemicals (PBTs); and products requiring disposal as hazardous waste? | Yes Planned No |
| Integrated Pest Management | **Integrated Pest Management** | • Have you or the agency responsible for maintaining your facility developed and implemented an Integrated Pest Management program? | | |
| Food Services       | Sustainable Food Policy and Plan                                      | • Have you developed a sustainable food policy and plan that seeks to make the procurement of food and food services in general more sustainable?  
  • Do you encourage farmers to shift from fertilizer and chemical-dependent farming to practices that are more closely aligned with natural processes? | | |
| Local, Sustainably Produced Food Purchasing | **Local, Sustainably Produced Food Purchasing** | • Have you implemented a sustainable food plan and increased the procurement of locally and regionally sustainably produced foods? | | |
| Reusable and non-reusable Products: Food Service Ware, Non-Food Service Ware and Bottled Water Elimination | **Reusable and non-reusable Products: Food Service Ware, Non-Food Service Ware and Bottled Water Elimination** | • Do you eliminate the use of disposable products (plastic, paper, styrofoam) in food services?  
  • Do you reduce the use of non-food service paper products such as paper towels and napkins?  
  • Have you eliminated or reduced the use of bottled water for patients? | | |
| Food Waste Reduction, Donation and Composting | **Food Waste Reduction, Donation and Composting** | • Have you examined ways to reduce food waste?  
  • Have you considered donating food that remains at the end of daily operations to food banks, churches and other community groups? | | |
### SMART HOSPITALS INITIATIVE
#### GREEN HOSPITALS CHECKLIST

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<thead>
<tr>
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<th>INTENT</th>
<th>ACHIEVABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmentally Preferable Purchasing</td>
<td>Mercury Reduction</td>
<td>• Have you prepared a plan to phase out or replace items that contain mercury such as medical devices and light bulbs?</td>
<td>Yes Planned No</td>
</tr>
<tr>
<td>Electronics Purchasing and End of Life Management</td>
<td>• Have you ensured that electronic equipment is not disposed of in landfills or incinerated?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid Waste Reduction in Purchasing</td>
<td>• Have you ensured that your purchases are in line with the overarching goal to reduce solid waste generation and disposal?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxic Chemical Reduction in Purchasing</td>
<td>• Have you prepared a comprehensive list of materials, products and supplies that contain harmful chemicals and considered how they will be replaced or phased out?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Have you investigated suitable, safer building materials if renovations or alternations are planned?</td>
<td></td>
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</tr>
</tbody>
</table>
Green Checklist
Discussion Guide

Renovations

Water

Overview

One of the key benchmarks of environmental sustainability is the use of potable water. Reducing the amount of potable water used not only conserves water and saves money but also reduces emissions associated with pumping and treatment. Including a rainwater capturing system in your health facility is pivotal to reducing potable water use. Captured rainwater from roofs can be used to flush toilets, irrigate landscaping, and for other non-potable uses. Given the changing rainfall patterns, it is prudent for health facilities to consider the installation of cisterns and other rainwater capturing devices/features. These must be constructed/installed in compliance with building codes and regulations to ensure their safety against natural hazards (see the Guide for Evaluation of Small and Medium-Sized Facilities in Section 1).

Implementation Strategies

Reduced water use is a key step in making your health facility smart. Begin by determining baseline water usage, examining water bills for at least the three previous years. Refer to the Smart Hospital Baseline Assessment Tool (BAT) in Section 2 for a water audit worksheet.

Recommended Action Points

Water Use Reduction

- Add a rainwater capture system and access and upgrade plumbing to allow captured rainwater to be used for non-potable uses.

  Note: Consider installing a filtration and treatment system. Install a first flush diverter, as recommended by the Caribbean Environmental Health Institute (refer to the Resources at the end of this section for the link).

- Outfit your facility with high-efficiency plumbing fixtures, low-flow faucets, dual-flush toilets, motion-activated faucets or other innovative technologies to maximize water savings, regardless of whether or not rainwater is used in these faucets (refer to Resources section for the link to the U.S. EPA Water Sense Program/Products).

- Devise an education program for staff, patients and visitors, informing them of the need to conserve water. Highlight the fact that captured rainwater is used for all non-potable uses in your facility and point out the high-efficiency devices/appliances/fixtures.
Water Efficient Landscaping

- Install a rainwater capture system and use for irrigation, if needed.
- Use local, drought-tolerant species in your landscaping, as they are adapted to soil, temperature and water availability and will require less, if any, irrigation and maintenance.
- Consider installing an aerobic/oxygenated sewage treatment system where effluents can be used for irrigation.
- Use drip irrigation, as it is more efficient and delivers water where it is needed.
- Mulch landscape plantings to help retain moisture around the root system.
- Design your landscaping to include rain gardens that utilize storm water runoff generated from your roof or hardscape/impervious surfaces.

Resources

- United States of America Environmental Protection Agency Water Sense Program: [http://www.epa.gov/watersense](http://www.epa.gov/watersense).

Energy and Atmosphere

Overview

Energy and the way it is used is the most significant contributor to climate change. Energy conservation and utilizing renewable energy will be significant factors in making your health facility ‘smarter.’ In the health sector, energy is consumed by lighting, large and small specialized equipment and devices, appliances and transportation. Although large specialized pieces of equipment are integral to the health sector, they consume a lot of energy. Significant savings can be achieved by ensuring that all electronic equipment, devices, appliances and fixtures are certified and labeled as energy efficient under American and European labeling system.

Changing from incandescent or other inefficient lights bulbs to more energy-efficient options can result in cost savings and reduced energy usage which results in reduced emis-
sions and reduced demand. However, simply switching to more efficient light bulbs is not enough. Energy conservation must be an overarching goal. If your country has not yet phased out the use of incandescent light bulbs, replacing them with efficient bulbs, consult the U.N. Environment Programme’s en.lighten initiative (http://www.enlighten-initiative.org/).

Implementation Strategies

Establish baseline energy usage by examining electricity bills or usage information from your utility company for at least the three previous years. Refer to the Smart Hospital Baseline Assessment Tool (BAT) for the energy audit worksheet.

Photovoltaic (PV) systems capture energy from the sun and convert it into electricity, thereby reducing energy generated via fossil fuels. Consult with your utility company to determine any policies and safeguards regarding the installation of a PV system. For safety reasons, a grid-connected PV system will not be operational when the grid is offline. Therefore, although going completely off-grid is possible, the cost of purchasing and maintaining the batteries that store the energy from the PV system will be significant. Improved battery technology may make this option more feasible in the near future.

Recommended Action Points

Renewable Energy

- Develop an energy conservation plan, as this is the most cost-efficient way to reduce energy use.
- Install a rooftop or on-site PV system to offset as much of your electricity use as possible. 
  \textit{Note:} Ensure that you have sufficient space on your roof, that the roof can support the weight of the system, is secure against natural hazards and that the roof faces the south/southwest to allow for maximum solar exposure. (Panels can be tilted if required.) Roof assessment can be guided by the Hospital Safety Index. Also note that in countries where there is a volcanic hazard, panels can be affixed to the walls of the structure or on hip roofs that are designed to allow the ash to fall off during a volcanic event. All systems must be properly secured to withstand the natural hazards that affect the Caribbean.
- If space, location, prevailing wind direction and building codes allow, consider installing wind turbines in addition to or along with a PV system. 
  \textit{Note:} Ensure that your turbine is designed to automatically shut off during periods of strong winds typically associated with tropical storms and hurricanes that affect the region. Also ensure that your turbine is securely erected.
- Consider installing solar hot water heaters instead of or to supplement electrical heaters. 
  \textit{Note:} Roof assessments can be guided by the Hospital Safety Index. Any roof-mounted solar hot water heaters must be properly secured to withstand natural hazards that affect the Caribbean.

Efficient Equipment/Fixtures/Devices and Features

- Replace incandescent light bulbs or other inefficient bulbs with fluorescent bulbs with electronic ballasts or LED bulbs, if suitable for the application.
Note: LEDs are the most efficient light bulbs available on the market today but may not be suitable for all areas in a health facility. They last much longer, use less electricity and contain no mercury; however, they cost more.

- Replace existing magnetic ballasts (some of which may contain PCBs) with electronic ballasts.
- Replace T12 technology with retrofit LED or T8 or T5 fluorescent technology to suit the application.

  Note: Ensure that the energy replacement provides the lighting performance and quality that is required by the application. When making significant changes, consult an engineer or lighting designer to ensure appropriate lighting levels will be provided after the retrofit program is completed.

  LED technology has improved in the past years, however it has generally not surpassed linear fluorescent (T8s T5s) in terms of performance at the colour temperatures required for indoor applications. High K values such as 5,000K and 6,000K definitely are very efficient, but contain too much blue light for most indoor health care applications. LED colour temperatures in the 3,000K-3,500K range are generally comparable to fluorescent lamp outputs if considering high quality LED products from reputable vendors. One of the challenges in operation is heat and dissipation of the heat. Installing in tight ceiling spaces which may be subject to high ambient temperatures could impact projected product life and should be taken into consideration.

- Upgrade/replace your equipment, be it medical or office equipment, with energy efficient models. (See Resources section below for link to the U.S. EPA Energy Star Program/Products)
- Buy equipment that is made for your energy system to avoid using transformers, as they waste energy.
- Insulate your roof to reduce heat transfer into the facility and paint it a light colour such as grey or white (if surrounding uses will not be impacted by glare).

**Refrigerant Management**

- Ensure that all refrigerant-containing equipment and appliances do not use CFCs and plan to phase-out/upgrade existing equipment that contains CFCs. Weigh carefully refrigerant options, as some chemicals that do not contribute to ozone depletion contribute significantly to global warming. Opt to buy equipment that uses refrigerants that contain less potent ozone-depleting substances (ODSs) and with reduced global warming potentials (GWPs).
- Have trained professionals service your refrigerant-containing equipment on a regular basis in an effort to reduce leakage/release into the atmosphere.
- Procure equipment with increased equipment life and reduced refrigerant charge.
- Do not install fire suppression systems that contain ozone-depleting substances (CFCs, HCFCs or Halons).
### Section III: THE GREEN CHECKLIST AND DISCUSSION GUIDE

#### Ozone Depleting (ODP) and Global Warming Potential (GWP) of Refrigerants

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>ODP</th>
<th>GWP</th>
<th>Common Building Application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chlorofluorocarbons</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CFC-11</td>
<td>1.0</td>
<td>4,680</td>
<td>Centrifugal chillers</td>
</tr>
<tr>
<td>CFC-12</td>
<td>1.0</td>
<td>10,720</td>
<td>Refrigerators, chillers</td>
</tr>
<tr>
<td>CFC-114</td>
<td>0.94</td>
<td>9,800</td>
<td>Centrifugal chillers,</td>
</tr>
<tr>
<td>CFC-400</td>
<td>0.605</td>
<td>7,900</td>
<td>Centrifugal chillers, humidifiers</td>
</tr>
<tr>
<td>CFC-502</td>
<td>0.221</td>
<td>4,600</td>
<td>Low-temperature refrigeration</td>
</tr>
<tr>
<td><strong>Hydrochlorofluorocarbons</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HCFC-22</td>
<td>0.04</td>
<td>1,780</td>
<td>Air-conditioning, chillers</td>
</tr>
<tr>
<td>HCFC-123</td>
<td>0.02</td>
<td>76</td>
<td>CFC-11 replacement</td>
</tr>
<tr>
<td><strong>Hydrofluorocarbons</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFC-23</td>
<td>−0</td>
<td>12,240</td>
<td>Ultra-low-temperature refrigeration</td>
</tr>
<tr>
<td>HFC-134a</td>
<td>−0</td>
<td>1,320</td>
<td>CFC-12 or HCFC-22 replacement</td>
</tr>
<tr>
<td>HFC-245fa</td>
<td>−0</td>
<td>1,020</td>
<td>Insulation agent, centrifugal chillers</td>
</tr>
<tr>
<td>HFC-404A</td>
<td>−0</td>
<td>3,900</td>
<td>Low-temperature refrigeration</td>
</tr>
<tr>
<td>HFC-407C</td>
<td>−0</td>
<td>1,700</td>
<td>HCFC-22 replacement</td>
</tr>
<tr>
<td>HFC-410A</td>
<td>−0</td>
<td>1,890</td>
<td>Air conditioning</td>
</tr>
<tr>
<td>HFC-507A</td>
<td>−0</td>
<td>3,900</td>
<td>Low-temperature refrigeration</td>
</tr>
<tr>
<td><strong>Natural Refrigerants</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Dioxide (CO2)</td>
<td>0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Ammonia</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Propane</td>
<td>0</td>
<td>3.0</td>
<td></td>
</tr>
</tbody>
</table>


---

### Things to Remember

- Have your roof inspected by a structural engineer to ensure that it can support the weight of a PV system and/or a solar water heater.
- Check with your utility company to determine policies and regulations regarding PV systems.
- Consult the Hospital Safety Index for further guidance.
- Refer to the Smart Hospital Baseline Assessment Tool (BAT) in Section 2 for an energy audit worksheet.

### Resources

Materials and Resources

Overview

The selection of materials and resources used during construction or renovations, as well as the interior furnishings and furniture, offers a significant opportunity to reduce your carbon footprint and overall environmental impact and make your facility ‘smart’ and ‘green.’ Utilizing rapidly renewable wood and products that contain recycled components helps to protect virgin resources and reduces the impact of extraction, transportation and processing.

Debris from construction or renovation activities can be significant. Most of the waste likely ends up in a landfill or incinerator, where it can contribute to environmental degradation. However, proper construction management can eliminate some of the waste generated or redirect certain items to organizations, groups and individuals.

Toxic chemicals that can be found in building products and materials are of concern. Mercury, for instance, is known to be harmful to humans, especially to developing fetuses. It is also one of several chemicals cited as persistent bioaccumulative and toxic chemicals (PBTs). With no program in place for handling mercury-containing waste, it is likely that these products would be incinerated or placed in landfills, where they can pollute soil and water. Burning mercury releases it into the atmosphere. Health Care Without Harm (HCWH) and the World Health Organization are working to eliminate mercury from the health sector and find safer alternatives. Other PBTs specifically addressed include dioxins, cadmium and lead, all of which are known to be harmful to human health and are found in building products.

Implementation Strategies

Procurement choices impact your indoor environmental quality and the environmental, so consider the components of your building materials, furniture and furnishings. Construction debris, furniture, furnishings and other material that are incinerated release greenhouse gases and other pollutants and chemicals into the atmosphere. The ash that remains after incineration is hazardous waste and should be properly handled and disposed of. When this material is disposed of in landfills, it can lead to land and water pollution and the release of gases into the atmosphere.

Recommended Action Points

Management of Construction Waste

- Practice proper construction management to reduce waste. Consider donating usable construction waste and materials such as doors, windows, faucets, etc. to organizations, groups and community members who could use the materials.

Sustainable Materials

- When selecting materials, ensure that you specify materials that are rapidly renewable, originate from sustainably managed forests, contain recycled content, or are themselves recyclable to the extent possible. Also consider using materials that were salvaged from renovation or construction projects.
Note: Ensure that salvaged materials are suitable for re-use in a health care setting.

**Mercury Elimination**

- Specify and install low-mercury fluorescent lamps or LED light bulbs that contain no mercury. Keep in mind that fluorescent and LED light bulbs use less energy.
  
  Note: Mercury is released into the atmosphere when mercury-containing bulbs are broken. Handle with care, ensuring that the area is well ventilated and they are properly disposed of. Disposing mercury-containing bulbs in landfills may result in land contamination. Likewise, incineration releases methlymercury into the atmosphere.

**Elimination of Persistent Bioaccumulative and Toxic Chemicals (PBTs)**

- Avoid the use of building materials that contain PBTs or whose production or incineration results in the release of these substances into the atmosphere.
  
  Note: (Lent, 2007) provides the following table of chlorinated plastics to avoid in building materials and to avoid burning:

<table>
<thead>
<tr>
<th>Chlorinated Polyethylene (CPE also Brand Name Tyrin)</th>
<th>Used in buildings primarily as an additive to PVC in windows, pipes and cables.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorinated Polyvinyl Chloride (CPVC)</td>
<td>Primarily used for hot water pipes.</td>
</tr>
<tr>
<td>Chlorosulfonated Polyethylene (CSPE, also known by the brand name Hypalon)</td>
<td>Used in buildings primarily for single ply roofing membranes, geomembranes and other coated fabrics.</td>
</tr>
<tr>
<td>Polychloroprene (CR or Chloroprene Rubber, also known by the brand name Neoprene)</td>
<td>Used in adhesives, gaskets, hot tar flashings, expansion joint filler, geomembranes and coatings.</td>
</tr>
<tr>
<td>Polyvinyl Chloride (PVC)</td>
<td>By far the largest bulk of chlorinated plastics found in building materials. PVC is used in piping, roof membranes, window frames, siding, carpet backing, resilient flooring, ceiling tiles, window treatments, wall coverings and wall protection.</td>
</tr>
</tbody>
</table>

Green Guide for Health Care Technical Brief *PBT Elimination from Building Materials* (Lent, 2007, p. 5) also notes the uses of some PBTs containing materials and alternatives.

**Lead**

Lead is used in solder, roofing, gutter and flashing products, radiation shielding, and batteries and as a stabilizer in PVC products. In the past, it was used in paints and pipes and is considered a hazard in older buildings and demolition projects.

- Specify 100% lead-free solders. (Note that solders marketed as ‘lead-free’ can still legally contain >0.2% lead.)
- Avoid terne and copper roofing, flashing and gutter products.
- A major use of lead in PVC products is in the insulation jacketing for wiring. Specify lead-free jacketing where available. (Also note that Teflon®-jacketing should be avoided).
- Green Seal certified paints are assured to be free of cadmium and lead.

**Cadmium**

Cadmium is used in paints, coatings, and batteries and as a stabilizer in PVC products.
While lead has been largely eliminated from paints, cadmium remains a widely used pigment.

- Green Seal certified paints are assured to be free of cadmium and lead.
- Review material MSDS sheets if concerned that a material may contain cadmium.

The Green Guide for Health Care (hCare, 2007) asks to “consider materials that are not manufactured with chlorine or other halogens. Options include (but are not limited to) TPO, EPDM, and FPO [thermoplastic polyolefin, ethylene propylene diene monomer, flexible polyolefin] for roof membranes; natural linoleum, rubber, or alternate polymers for flooring and surfacing; natural fibers, polyethylene, polyester and paint for wall covering; polyethylene for wiring; wood, fiberglass, [high density polyethylene] HDPE, and aluminum with thermal breaks for windows; and, copper, cast iron, steel, concrete, clay, polypropylene and HDPE for piping.”

### Furniture and Medical Furnishings

- Procure furniture and furnishing that are sourced from managed forests or are free of heavy metals, PVC, PBTs and other harmful chemicals. The following table lists building products, components and materials to avoid, suggesting safer alternatives:

<table>
<thead>
<tr>
<th>Product/Material</th>
<th>Avoid</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Membrane</td>
<td>Lead, Cadmium, chlorine, halogens, heavy metals, fire retardants, chlorinated polyethylene (CPE also known by the brand name Tyrin), chlorinated polyvinyl chloride (CPVC), chlorosulfonated polyethylene (CSPE, also known by the brand name Hypalon, polychloroprene (CR or chloroprene rubber, also known by the brand name Neoprene), polyvinyl chloride (PVC), Teflon</td>
<td>Thermoplastic polyolefin, ethylene propylene diene monomer, flexible polyolefin</td>
</tr>
<tr>
<td>Flooring/Surfacing</td>
<td>Natural linoleum, rubber, or alternate polymers</td>
<td>Natural fibers, polyethylene, polyester and paint</td>
</tr>
<tr>
<td>Wall Coverings</td>
<td>Natural linoleum, rubber, or alternate polymers</td>
<td>Green Seal or similarly certified paints.</td>
</tr>
<tr>
<td>Paint</td>
<td>Polyethylene</td>
<td>Polylethylene</td>
</tr>
<tr>
<td>Wiring</td>
<td>Wood, fiberglass, HDPE, and aluminum with thermal breaks</td>
<td>Copper, cast iron, steel, concrete, clay, polypropylene and HDPE, lead-free solder</td>
</tr>
<tr>
<td>Piping</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Resources

- Articles, case studies, etc. on green building products: [http://www.buildinggreen.com/](http://www.buildinggreen.com/)
  [http://noharm.org/all_regions/issues/toxins/mercury/](http://noharm.org/all_regions/issues/toxins/mercury/)
- Sustainable Hospitals – Alternatives to mercury-containing equipment: [http://www.sustainablehospitals.org](http://www.sustainablehospitals.org).

### Indoor Environmental Quality

**Overview**

Indoor Environmental Quality (IEQ) is important in health facilities because it can negatively impact the health of staff, patients and visitors. IEQ is related to ventilation, which
is related to building design, window placement, prevailing winds, and energy use (in cases where mechanical ventilation is used). Many factors impact indoor air quality: building products, furnishings, furniture, paint, floor coverings, sealants, adhesives, varnishing, equipment, mold and other biological agents, cleaning products, tobacco smoke, chemicals, etc. Without proper ventilation, the levels of gases, chemicals and particulates can be higher indoors than outside.

Of importance to IEQ are the products and materials used on and in the building's interior and the chemicals they contain. Proper ventilation or choosing safer alternatives can significantly reduce indoor pollution.

**Implementation Strategies**

When choosing products and materials for your structure, consider the components, who uses the facility and may potentially be exposed, if there is adequate ventilation to move gases, particulate matter and pollutants out of the structure and if safer alternatives are available on the market.

**Recommended Action Points**

**Environmental Tobacco Control**

- Establish a policy that prohibits smoking in the facility.
  
  *Note:* A government regulation may need to be enacted that prohibits smoking in public facilities. If a smoking area is designated, make sure it is at least 50 feet from the facility to reduce the impact of smoke on patients, staff and visitors and to prevent interior surfaces from absorbing the smoke. Ensure that the smoking area is downwind and away from main entrances/exits, windows, air conditioning units and air intakes.

**Natural Ventilation**

- Ensure that all windows are operable to take full advantage of prevailing breezes.
  
  *Note:* Despite the energy savings and reduced environmental impact, it may not be practical to use natural ventilation at all times. Therefore, buildings should be constructed with mechanical and natural ventilation in mind. Certain areas of the hospital must be mechanically ventilated, while natural ventilation is appropriate for other areas of the hospital and could be coupled with ceiling/destratification fans to improve occupant comfort (without having to actually reduce the ambient temperature of a space).

A properly maintained mechanical ventilation system will likely provide better air quality than outdoor air, as the filtering process will remove a number of particulates, etc.

**Low Emitting Materials**

- Specify materials that contain no or reduced amounts of Persistent Bioaccumulative and Toxic chemicals (PBTs), Volatile Organic Compounds (VOCs), Semi-volatile Organic Compounds (SVOCs), Halogenated Fire Retardants (HFR), heavy metals, phthalates, perfluorochemicals (PFCs) and other chemicals that can pose harm to installers, staff, patients and visitors.
Note: If possible, allow the building to air out properly after products that contain the chemicals noted above have been installed or applied.

- Specify composite wood products that contain no urea-formaldehyde resins.
- Avoid using furniture that contains foam, as it is likely treated with a variety of flame-retardants. Use furniture with mesh instead.
- Avoid paints with antimicrobial ingredients and, if possible, specify metal products that are pre-painted.
- Avoid cleaning/sterilizing substances that contain volatile components. Use dry-applied substances instead of wet-applied chemicals.

#### Chemical and Pollutant Source Control

- Provide an entryway system, grills or mats to capture dirt and particulates brought in from the exterior; clean these often.
- Specify equipment that is efficient and that uses less hazardous materials.
- Correctly label and properly store all chemicals as per manufacturer’s recommendations.
- Use natural cleaning products wherever and whenever possible and ensure that they are not highly scented. Use dry-applied products instead of sprays.
  
  *Note: Ensure that products provide the level of disinfection needed in the facility.*

- Ensure that pesticides and other chemicals used on the exterior of the facility are applied safely by a trained professional and that only the amounts required are used.
- Do not use landscape plants or shrubs that will require synthetic inputs, instead use local, hardy, resistant species.
- Do not incinerate waste onsite.

  *Note: If onsite waste incineration cannot be avoided, locate the incinerator downwind from facility and ensure that there are no air intakes nearby.*

#### Control of Lighting Systems: Lighting

- Utilize as much daylight as possible, while minimizing direct sunlight.
- If feasible, use shade trees or shading devices on the exterior to prevent direct sunlight from entering the building.
  
  *Note: Shading devices could also serve as hurricane shutters.*

- Use lighting controls such as light sensors and occupancy sensors for staff and patient areas.
  
  - Provide individual lighting controls to enable adjustments to suit individual patient needs and preferences and to limit disturbance in multiple-patient areas.
  
  *Note: It is important that energy-efficient light bulbs are used in combination with lighting controls to achieve maximum cost savings.*

- Consider using light shelves to reflect light further into the interior.

#### Things to Do

- Encourage regional paint manufacturers to have their products Green Seal or GREENGUARD certified.
Resources

- GREENGUARD Environmental Institute was founded in 2001 and seeks to protect human health and quality of life by improving indoor air quality and reducing chemical exposure. The GREENGUARD Certification Program helps manufacturers create, and buyers identify, interior products and materials that have low chemical emissions, improving the quality of the air in which the products are used. [http://www.greenguard.org/en/index.aspx](http://www.greenguard.org/en/index.aspx).
- GreenSeal, developed in 1989, as an independent non-profit organization dedicated to safeguarding the environment and transforming the marketplace by promoting the manufacture, purchase, and use of environmentally responsible products and services. [http://www.greenseal.org/](http://www.greenseal.org/).
- The Green Label and Green Label Plus testing programs, overseen by independent labs, are designed for architects, builders, specifiers and facility managers who want assurances that carpet and adhesive products meet the most stringent criteria for low chemical emissions and help improve indoor air quality. Currently, carpet, cushion and adhesives as well as vacuum cleaners are tested in these programs. [http://www.carpet-rug.org/about-cri/cri-signature-programs.cfm](http://www.carpet-rug.org/about-cri/cri-signature-programs.cfm).

Operations

Chemical Management

Overview

Chemicals are prevalent in the health sector. They are used in building maintenance, infection control and in the overall provision of health care to patients. Some components of the pharmaceuticals, products and devices used are considered to be harmful and toxic.

Chemicals and fuels in or around the health care facility should be used with caution to prevent contamination and reduce exposure to staff, patients, visitors and the surrounding community. It is not safe to dispose of liquid waste that contains cleaning or disinfection agents down drains and this method of disposal is not recommended under any circumstances. Antibacterial/antimicrobial products and sterilization and disinfecting chemicals also are commonly used in the health sector. However, the effects of some of these chemicals on living organisms are coming to light. The effects of exposure to these agents needs more study, but they should raise concern.

Pharmaceuticals minimization, management and disposal is also of concern because medicine intended for human use may have completely unexpected and unwanted effects
on other organisms, so proper management and disposal are required. Neither disposal in landfills nor incineration is appropriate for pharmaceuticals because of the potential for land, air and water contamination. Pharmaceuticals should never be disposed of down drains.

Implementation Strategies

Chemical management in a health care setting should be a priority, given the potential negative ecological and human impact. Every effort should be made to ensure that all chemicals and pharmaceuticals are used and disposed of properly.

Recommended Action Points

Chemical Management Policy

- Develop a chemical management policy that aims to reduce the use of hazardous chemicals by purchasing less hazardous/toxic and more environmentally-benign alternatives. Ensure that the policy addresses purchasing, receiving, transporting, storage, handling and use of chemicals. Emphasize that discharges of cleaning and other chemicals down drains or into the septic or sewer system is prohibited unless specifically stated as an appropriate disposal method by the manufacturer, suppliers or the safety instructions included with the product.

  Note: Pay special attention to areas of the health facility such as laboratories, dental offices, building system operations, environmental services, food services, and diagnostic and treatment areas, where hazardous materials/substances may be used or generated. Some chemicals to watch for include solvents and disinfectants, soaps, chlorine, radioactive substance and gluteraldehyde.

  If the facility is mechanically ventilated, chemicals should be stored in areas with a negative pressure to that of surrounding areas and the exhaust air from these spaces should not be mixed with the incoming fresh air supply. This mitigates the potential transmission of odours throughout the building and exposure from the re-introduction of those exhausted from the building.

Community Contaminant Reduction: Leaks and Spills

- Properly document the purchase, delivery, storage and use of all hazardous chemicals and substances stored onsite. This will assist with leak detection.

- Provide secondary containment and security for substances stored outdoors, above ground or underground to further ensure against leaks and spills.

- Educate staff on proper handling and storage of chemicals and the proper spill/leaks procedures.

Indoor Chemical Containment Reduction: Hand Hygiene Products, Sterilization and High-Level Disinfection

- Ensure that a policy exists that prohibits the disposal of chemicals down drains and that training for staff is included.

- Phase out the use of Ethylene Oxide and the high-level disinfectant (HDL) glutaraldehyde and other hazardous substances and replace with safer alternatives.
Note: Alternatives to Ethylene Oxide include other low temperature sterilization methods such as vaporized hydrogen peroxide, hydrogen peroxide-gas plasma, liquid peracetic acid, and ozone.

- Purchase non-hazardous chemicals and/or determine opportunities to reduce highly hazardous materials.
- Ensure that all sterilizing and disinfecting appliances are top-of-the-line and efficient in an effort to reduce the use and disposal of chemicals.
- Replace manual disinfection with automatic machine washers/disinfectors to minimize staff exposure to liquid disinfectants.

**Pharmaceutical Minimization, Management and Disposal**

- Establish procedures for procuring, storing, dispensing and proper disposal of all pharmaceuticals. Be sure to emphasize that pharmaceuticals are not to be disposed of down drains or into septic or sewer systems.
- Ensure that pharmaceuticals are ordered on an as-needed basis to minimize expiration and disposal of unused portions. Investigate whether or not suppliers/manufacturers will be willing to take back un-dispensed and/or expired pharmaceuticals.
- Ensure that expired/unused pharmaceuticals are properly disposed of. Disposal in landfills is not appropriate, as chemicals can contaminate soil and groundwater. Incineration also releases chemicals into the atmosphere and the residue from burning may be considered hazardous waste. See GGHHC recommendations in the Resources section.
- Work with national or regional organizations/agencies to research and order safer alternatives, such as products that contain no mercury or PBTs, to the extent possible. Procure products with less packaging, especially if they contain hazardous chemicals/components, as the packaging could be considered hazardous as well.

Although not all of the following are applicable to the Caribbean setting, GGHHC (Care G. G., 2008, pp. 8-26) recommends these measures to minimize the generation of pharmaceutical waste:

- Improve inventory control processes.
- Reduce the number of pharmaceuticals dispensed and returned that cannot be re-prescribed.
- Substitute less toxic pharmaceuticals or mechanical methods for products containing toxic substances such as persistent bioaccumulative toxic chemicals (PBTs).
- Minimize packaging and container weight of pharmaceutical products and formulations.
- Minimize personal protective equipment waste. Mix chemicals in batches, minimize spills, and institute regular staff training.
- Institute best management practices for the handling and disposal of pharmaceuticals that act as teratogens, mutagens, carcinogens, endocrine disruptors, reproductive and developmental toxicants or pose a threat to ecosystem health.

Note: Until new technologies have been developed and legalized, the best management practice for disposal of non-regulated pharmaceuticals is incineration with regulated medical waste. As a result, facilities should actively minimize pharmaceutical waste wherever possible.
- Utilize stock rotation strategies to rotate pharmaceuticals close to the expiration date back into high use areas such as crash carts or the pharmacy as a means of minimizing pharmaceutical waste.
- Ensure all pharmaceutical samples are logged into the facility, and only allow those samples with an expiration of one year or longer.
- Discontinue disposal of all pharmaceuticals in sewers where possible and advocate updating state regulations to prohibit this practice.
- Examine all non-hazardous pharmaceutical waste and segregate it into dedicated containers for disposal.
- Avoid uncontrolled disposal of mercury-containing drugs, diagnostic agents (e.g., Thiomersal\(^*\)), disinfectants (e.g., Merbromin\(^*\), Mercurochrome\(^*\) and Nitromersol\(^*\)), and diuretic agents (e.g., mercurophyllin).

### Things to Remember

- Ensure that lab equipment functions properly and works efficiently in respect to the chemicals required and that plans are in place to upgrade inefficient/outdated equipment.
- Include an education component in the policy, as it is important that all members of staff are aware of usage, storage and handling requirements and proper disposal practices.
- Encourage and work with your government to develop a national pharmaceutical management and disposal policy.

### Resources

- World Health Organization (WHO), Hand hygiene guideline: [http://www.who.int/patientsafety/events/05/HH_en.pdf](http://www.who.int/patientsafety/events/05/HH_en.pdf).
  - Practice Greenhealth: Chemicals: [http://practicegreenhealth.org/topics/chemicals](http://practicegreenhealth.org/topics/chemicals).
Solid Waste Management

Overview

Health care facilities generate large amounts of waste, most of which is regular, solid waste that can be handled and disposed of normally. All waste should be separated at the point of origin in properly labeled containers that can be sealed to avoid pests; waste should be stored in a secure location and transported to a secure disposal or incineration site.

Because of space constraints, incineration is likely the disposal method of choice in the Caribbean region, but there are serious issues associated with burning waste. (Harm, Waste Management) “[i]n many developing world hospitals, all of this trash is mixed together and burned in low tech, highly polluting incinerators, or in the open with no controls whatsoever. It is now well established that incinerating medical waste produces large amounts of dioxin, mercury and other pollutants. These end up in the air, where they can be transported thousands of miles to contaminate the global environment, or in the ash, which is frequently dumped without thought for the load of persistent toxins that it carries.” The World Health Organization (2012) recommends the following for the incineration of medical waste:

- Good practices in incinerator design, construction, operation (e.g., pre-heating and not over-loading the incinerator, incinerating only at temperatures above 800°C), maintenance and lowest emissions;
- The use of waste segregation and waste minimization practices to restrict incineration to appropriate infectious wastes;
- Availability of good practices and tools, including dimensional construction plans, clear operational guidelines, etc.;
- Correction of current deficiencies in operator training and management support, which lead to poor operation of incinerators;
- Materials containing chlorine such as polyvinyl chloride products (e.g., some blood bags, IV bags, IV tubes, etc.) or heavy metals such as mercury (e.g., broken thermometers) should never be incinerated.

Implementation Strategies

Any efforts to manage waste should include efforts to reduce overall waste. Waste minimization practices can be achieved through training, policy changes and procurement practices. Phasing out and computerizing forms along with double-sided printing will reduce paper waste. Importantly, minimizing the amount of waste that is disposed of also depends on a national recycling program. Paper, plastic, metal and glass can all be recycled and turned into useful products.

Recommended Action Points

Solid Waste Land Disposal

- Reduce sources of waste as much as possible.
- Establish a policy and guidelines to achieve zero waste through composting and/or recycling and align your operations and procurement with this goal in mind.
  
  Note: The policy should include requirements and guidelines for composting organic, non-infectious waste and recycling.
- Keep waste properly segregated at all times and stored in a secure location until it is collected for disposal.
- Ensure that the solid waste facility that accepts your facility’s waste is well-managed, thereby reducing the potential for soil and groundwater contamination. It may be necessary to work with the government so that landfills are adequately constructed, lined, secure and safely operated.
- Biological waste should be disposed as recommended by national regulations.

**Solid Waste and Material Management: Waste Prevention and Reduction**

- Make waste reduction a goal and ensure that all of your purchases—from high-end machinery and equipment to food and office supplies—are aligned with this goal.
- Streamline and computerize procedures so that less paper waste is generated and if, possible, buy paper that contains recycled content and print on both sides. Procure or lease photocopiers and printers that are capable of printing on both sides.
- Biodegradable waste, such as paper, cardboard, plant-based waste and food waste, can be composted on-site, in the community or at a municipal or commercial facility.

**Regulated Medical Waste Reduction**

- Establish a policy that seeks to reduce overall waste generation, ensures that all medical waste is properly segregated at the point of origin into properly labeled receptacles, i.e. avoid mixing infectious and other medical waste with general garbage; ensure that staff is aware of and trained in the requirements of the waste plan.
- Ensure that plastics, anything containing PVC, batteries, mercury-containing products and materials treated with flame retardants are not incinerated along with other medical waste, as they release toxic and carcinogenic compounds into the air when incinerated. Additionally, the ash that remains when these materials are burnt is hazardous itself. Put policies in place to reduce the purchase, use and disposal of these materials.
- Consider using alternative medical waste treatment technologies in an effort to reduce the volume of waste that is incinerated or disposed of in landfills. The following table provides a brief description, the capacities and approximate costs in $US of some the alternative waste treatment technologies.
### Alternative Health Care Waste Management Treatment Technologies

<table>
<thead>
<tr>
<th>Type of Technology</th>
<th>Description</th>
<th>General operating process</th>
<th>Range of capacities</th>
<th>Approximate capital cost in USD</th>
</tr>
</thead>
</table>
| Standard gravity-fed autoclave              | Technology consists of a pressure vessel, typically cylindrical or rectangular, with or without steam jacket and designed to withstand elevated pressures. Steam is introduced by gravity displacement. | • Waste is placed inside the autoclave.  
  • Pressurized steam is introduced at a minimum of 121°C.  
  • Waste is exposed to the steam.  
  • Waste is removed and processed in a shredder if desired.  
  • Some technologies compact the waste. | 20 kg/hr to 3000 kg/hr; smaller units are available | $30,000 to 200,000; small units cost about $100 |
| Standard prevacuum autoclave                | Technology consists of a pressure vessel, typically cylindrical or rectangular, with or without outer steam jacket and designed to withstand elevated pressures. A vacuum is used to remove air and then steam is introduced. | • Waste is placed inside the autoclave.  
  • A vacuum is used to remove air.  
  • Pressurized steam is introduced at a minimum of 121°C.  
  • Waste is exposed to the steam.  
  • Steam is removed as condensate.  
  • Waste is removed and processed in a shredder if desired.  
  • Some technologies compact the waste. | 15 kg/hr to 1000 kg/hr | $30,000 to 500,000 |
| Pulse-Vacuum autoclave                      | Technology consists of a pressure vessel, typically cylindrical or rectangular with or without outer steam jacket and designed to withstand elevated pressures. Two or more cycles of vacuum and steam injection are used. | • Waste is placed inside the autoclave.  
  • A vacuum is used to remove air.  
  • Pressurized steam is introduced at a minimum of 121°C.  
  • Waste is exposed to the steam.  
  • Two or more cycles of vacuum and steam injection are used.  
  • Steam is removed as condensate.  
  • Waste is removed and processed in a shredder if desired. | 21 kg/hr to 84 kg/hr | $120,000 to 240,000 |
| Rotating autoclave                          | Technology consists of a cylindrical pressure vessel with an internal rotating drum lined with sharp vanes and designed to withstand elevated pressures. | • Waste is placed in the rotating autoclave.  
  • A vacuum is used to remove air.  
  • Steam is introduced at about 147°C.  
  • Internal drum rotates causing waste containers to break and mix.  
  • Steam is removed as condensate and waste is cooled.  
  • Waste is removed and processed in a grinder. | 90 kg/hr to 2000 kg/hr | $380,000 to 900,000 |
<table>
<thead>
<tr>
<th>Type of Technology</th>
<th>Description</th>
<th>General operating process</th>
<th>Range of capacities</th>
<th>Approximate capital cost in USD</th>
</tr>
</thead>
</table>
| Hydroclave                             | Technology consists of a cylindrical pressure vessel with an outer steam jacket and an internal mixing drum arm, designed to withstand elevated pressures | • Waste is placed in the hydroclave.  
• Steam is injected in the outer jacket until the inner chamber is heated to 1320C.  
• Internal mixing arm breaks the waste containers and mixes the waste.  
• Steam is removed as condensate.  
• Waste is removed and processed in a shredder. | 20 kg/hr to 1000 kg/hr | $70,000 to $550,000 |
| Steam treatment with internal shredding | Technology consists of a cylindrical or hemispherical pressure vessel with an internal shredder and other steam jacket. Some systems are designed on mobile units | • Waste is placed in the vessel.  
• Steam is introduced at 1320C to 1380C.  
• Waste is shredded internally and exposed to steam. Steam is removed as condensate  
• Waste is cooled.  
• Waste is removed | 40 kg/hr to 200 kg/hr | $190,000 to $470,000 |
| Steam cleaning with continuous internal maceration | Technology consists of a rectangular container with a treatment vessel connected to a pump-grinder and liquid separator. | • Waste is placed in the vessel.  
• Steam and hot water are introduced.  
• Waste slurry is re-circulated through the grinder and held at 1380C.  
• Cold water is injected and the slurry is passed through a liquid separator to filter out the waste.  
• Waste solids are captured in disposable bags. | 68 kg/hr | $200,000 |
| Semi-continuous steam treatment        | Technology consists of a hopper, shredder, rotating auger, dehydrator and discharge section. | • Waste is automatically dumped into a sealed hopper.  
• Waste passes through an internal auger where it is exposed to steam.  
• The dehydrator at the end of the auger removes excess liquid.  
• The waste is discharged into a container. | 140 kg/hr to 1800 kg/hr | $300,000 to $1,800,000 |
| Large-scale microwave treatment        | Technology consists of hopper, shredder, rotating auger, microwave generators, holding tank, secondary auger and shredder. | • Waste is automatically dumped into a sealed hopper.  
• Waste passes through an internal shredder and a horizontally inclined rotating auger where it is exposed to steam and microwave energy.  
• An optional second shredder at the end of the auger shreds the waste into a smaller size.  
• The waste is discharged into a container. | 100 kg/hr to 250 kg/hr | $600,000 and higher |
## Alternative Health Care Waste Management Treatment Technologies

<table>
<thead>
<tr>
<th>Type of Technology</th>
<th>Description</th>
<th>General operating process</th>
<th>Range of capacities</th>
<th>Approximate capital cost in USD</th>
</tr>
</thead>
</table>
| Small-scale microwave treatment      | Technology consists of a treatment chamber and one or more microwave generators. | • Waste is placed inside the treatment chamber.  
• Water or steam is added.  
• Waste is exposed to microwave energy that generates heat inside the chamber.  
• Waste is removed and shredded if desired. | 450 kg/hr to 2700 kg/hr | $12,000 to 85,000 |
| Electro-thermal deactivation          | Technology consists of size-reduction equipment, a conveyor and a high-voltage radio-frequency generator. | • Waste is placed on a conveyor.  
• Waste passes through a shredder.  
• Shredded waste is sprayed with water, compacted and then exposed to low-frequency radio waves which heat the waste.  
• Waste is discharged. | 450 kg/hr to 2700 kg/hr | Not available |
| Electron beam irradiation            | Technology generally consists of a conveyor, beam accelerator and shielding. | • Waste is placed on a conveyor.  
• Waste passes through a treatment section where it is exposed to an electron beam at doses that destroy pathogens.  
• Waste is discharged and passed through a shredder. | 180 kg/hr to 250 kg/hr | $500,000 to 1,500,000 |
| Dry heat treatment                   | Technology generally consists of a treatment chamber, resistance heater and fan to re-circulate hot air. | • Waste is placed in the treatment chamber.  
• Heated air at 1770C is circulated through the waste for a prescribed time.  
• Waste is cooled and then disposed. | 0.15 kg/hr | $5000 |
| Alkaline hydrolysis or alkaline digestion | Technology consists of a cylindrical pressure vessel with an outer jacket and an internal spry assembly or mixer, a heat source, alkali solution, load cells, pump and piping controls. The technology is designed for digesting tissues, organs, body parts and animal carcasses. | • Waste is placed in the pressure vessel.  
• Sodium or potassium hydroxide solution is added to the vessel.  
• Steam or heated oil is circulated outside the jacket.  
• Waste is exposed to heated alkali solution for several hours until the digestion is complete.  
• Wastewater is neutralized if desired and discharged to the sewer or solidified and used as fertilizer.  
• Solid waste residue are discarded or used as soil conditioner. | 14 kg to 4500 kg per cycle | $30,000 to 900,000 And higher |
### Alternative Health Care Waste Management Treatment Technologies

<table>
<thead>
<tr>
<th>Type of Technology</th>
<th>Description</th>
<th>General operating process</th>
<th>Range of capacities</th>
<th>Approximate capital cost in USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical disinfection technologies</td>
<td>Technologies typically consist of a treatment chamber and internal shredder and mixer, and some use of a solid-liquid separator.</td>
<td>Waste is passed through an internal shredder. A chemical disinfectant is mixed with waste (e.g., calcium chloride, calcium hydroxide, peracetic acid, or ozone). Some technologies discharge the waste disinfectant; some remove and reuse the disinfectant solution; and others neutralize and residual disinfectant.</td>
<td>20 kg/hr to 1000 kg/hr</td>
<td>$30,000 to 400,000 And higher</td>
</tr>
</tbody>
</table>

Source: UNDP-GEF Global Healthcare Waste Project (see link in References section).

### Things to Remember

It will be difficult to reduce the amount of waste generated if there is no recycling or composting program in place. Metals, plastic, glass, and paper can all be recycled, but there has to be a national policy that mandates such. Despite the fact that recycling may be difficult for small nations to undertake, several islands may be able to join together to make it feasible. Work with the government to formulate regulations that call for recycling and composting. The resulting compost can be used in the community or sold locally. Biodegradable waste that ends up in a landfill or incinerator adds to greenhouse gas emissions and serves no useful purpose. As compost, it can enrich soil and reduce the need for artificial inputs, some of which are harmful to the environment.

### Resources

Environmental Services

Overview

Maintaining a clean environment in and out of health care facilities is important to control infections and pests. It is also important to limit exposure of staff, patients and visitors to chemicals that could irritate, trigger medical conditions or cause serious harm. Attention needs to be paid to the components of cleaning agents, pest management chemicals and all other substances used inside and outside the facility. If products currently used contain toxic components, they should be phased out and safer alternatives found. Cleaning products should be environmentally benign or less toxic or harmful than products being used and still provide the high level of cleanliness required in the facility. Also, janitorial paper products should be evaluated for recycled content and to ensure that they do not contain harmful components.

Chemicals used to control pests indoors and outdoors can potentially affect staff, patients, visitors and applicators. Integrated Pest Management (IPM) is a concept of pest management that seeks to reduce the use of harmful chemicals, target specific pests, increase the use of safer alternatives and techniques and limit exposure of applicators, humans and other organisms to harmful substances. It is a proactive approach with the premise that if the food and habitat are not provided for the pests, they will look elsewhere. In addition, if chemicals have to be applied as a last resort, then the least hazardous chemical is applied in the lowest possible concentration and by trained personnel.

Implementation Strategies

All aspects of a health care facility’s operations come into play with regards to the overall ‘greening’ of the facility. Cleaning and pest control is especially important because they usually involve the use of chemicals that are respiratory irritants, toxic and harmful.

Recommended Action Points

Environmentally Preferable Cleaning: Products, Materials and Equipment

- Establish an environmentally preferable purchasing program and ensure that procurement of cleaning and other janitorial products supports the program.
- Procure cleaning products and materials that are environmentally benign or that are less toxic than other products while still maintaining the high level of cleanliness required in the facility.
- Ensure that disposable paper products, such as paper and hand wiping towels, contain recycled content.
- Prohibit “products that are manufactured with carcinogens, mutagens and teratogens; aerosols; asthma-causing agents (asthmagens), respiratory irritants, and chemicals that aggravate existing respiratory conditions; neurotoxins; endocrine modifiers; benzene-based solvents, butoxyethanol, chlorinated organic solvents, and paradichlorobenzene; very acidic or alkaline products; anti-microbial agents in hand soaps for patients and visitors; persistent, bioaccumulative and toxic chemicals (PBTs); and products requiring disposal as hazardous waste,” and “[u]se combination cleaner/disinfectants and dyes judiciously and only as necessary or where appropriate.” GGHC (Care G. G., 2008, pp. 10-11).
**Integrated Pest Management**

- Develop an IPM program or request that the agency responsible for maintaining your facility develops one that incorporates the following principles and practices, as noted by Practice Greenhealth (Greenhealth, 2012):
  - Design, construct, and maintain buildings to be as pest resistant as possible.
  - Ensure that roof parapets and caps are sealed, any other devices on roofs, such as traps or bait stations, are placed at documented locations and regularly checked, and nets for bird/pigeon activity are checked on a regular basis.
  - Eliminate cracks and holes to keep pests out. Lightly dust gaps between walls and other voids with boric acid before closing them up.
  - Inspect the grounds around buildings and fill burrows with pea gravel. Keep vegetation at least 12 inches from building perimeter.
  - Ensure that devices such as bait stations placed in outside areas are locked, secured, clean, and in good working order. Rodents do not like dusty and unclean bait stations.
  - Use physical barriers to block pest entry and movement (such as door sweeps, screens at air intakes, doors, and windows).
  - Train staff on proper management of food and drinks outside of the cafeteria or dining areas.

**Resources**


**Food Services**

**Overview**

Agriculture and food systems have a significant impact on the environment and on human health. Large inputs of energy and chemicals lead to degradation of soil, water and other natural resources. The use of energy releases pollution into the atmosphere and contributes to climate change. Planting, reaping, transportation, processing, packaging, shipping and the use of manmade inputs make the global farming system unsustainable. With livestock, the system is similarly unsustainable because most animal food is processed using energy, some animals are housed in controlled environments and the animals themselves contribute greenhouses gases to the atmosphere and pollute other resources as well.
In an effort to achieve an environmentally-friendly food system, health facilities must strive to eliminate the use of disposable food containers and bottled water. If no national recycling program is in place, plastic from food services and bottled water will likely end up in a landfill or incinerated. Paper products such as napkins are often used in food services, but they consume natural resources and generate additional waste. Paper products with recycled content offer a better, more sustainable option. Additionally, food waste can be removed from the waste stream and composted on-site, in the community or in a municipal or commercial facility. Compost can be reused in farms and add to the overall sustainability of the agriculture sector.

Implementation Strategies

In an effort to make health facilities and the overall health sector more sustainable, changes must be made to how food services are provided and to ensuring that the food acquired has been produced in an environmentally safe and sustainable manner. The Caribbean is a net importer of food. In order for this change to occur, agriculture must be improved locally and regionally. Governments will need to get involved, as this requires national effort. Health care systems have large purchasing power and can use that leverage to advocate for local change.

Recommended Action Points

Sustainable Food Policy and Plan

- Develop a sustainable food policy and plan that seeks to make the procurement of food and food services in general more sustainable. Include plans to seek local and regionally produced, sustainable food products over products imported from farther away and eliminate disposable food service ware like plastic and paper plates, cups, cutlery, etc. Encourage local farmers to shift from fertilizer and chemical-dependent farming to practices that are more closely aligned with natural processes.

Local, Sustainably Produced Food Purchasing

- Implement a sustainable food plan and increase the procurement of locally and regionally produced foods.
  - Note: In collaboration with the Ministry of Agriculture, encourage local farmers to shift to agriculture that relies less on manmade inputs.

Reusable and Non-Reusable Products: Food Service Items, Non-Food Service Items and Bottled Water Elimination

- Eliminate the use of disposable products in food services. If there is a need for disposable products, use biodegradable/compostable food service wares available on the market.
- Reduce the use of non-food service paper products such as paper towels and napkins or use efficient dispensing systems to control the amount of these products used. Seek out products made from recycled/natural fibers.
- Eliminate or reduce the use of bottled water for patients. If there is no national recycling program in place, work with the government to institute a program. A recycling program will significantly reduce the amount of plastic bottles and other items
tossed about, disposed of in landfills or incinerated. The concerns related to burning plastics were discussed earlier.

Food Waste Reduction, Donation and Composting

- Examine ways to reduce food waste. GGHC (Care G. G., 2008, pp. 11-30) recommends “programmatic innovations such as ‘room service,’ ‘meals on demand,’ ‘just-in-time’ food preparation, etc.
- If there is a cafeteria or other food facility located in the hospital, consider donating food that remains at the end of daily operations to food banks, churches and other community groups rather than disposing of it.
- Join with the community and staff to start an organic garden onsite, if space permits. Use organic refuse from food services to create a compost pile and reuse material in the garden. If space does not allow for a garden, a simple compost pile may be possible. Donate compost to community members.

Note: Commercial composters are available on the market that can turn discarded food into compost. Coordinate with waste management companies or authorities to establish if such a device can feasibly be used. Keep in mind that the compost can be sold locally or regionally. A national food composting initiative that includes health care facilities, restaurants, schools and other institutional uses that generate food waste can be incorporated into the program.

Resources

- Health Care Without Harm, Healthy Food Global Overview: http://noharm.org/all_regions/issues/food/.

Environmentally-Preferable Purchasing

Overview

There is no doubt that the products, pharmaceuticals, equipment, fixtures, food, and cleaning and other general supplies purchased for or by health facilities have a significant impact on the facilities’ carbon footprint. Unused or expired pharmaceuticals, chemicals disposed of in an irresponsible manner, and packaging and other materials add to the waste stream and contribute to environmental degradation. Environmentally conscious purchasing decisions can, therefore, significantly improve sustainability. Keep in mind that, the farther away the source of the goods/products/materials, the greater their carbon footprint. Therefore, a facility that strives to make its operations more sustainable will make purchasing decisions with this goal in mind.

The global movement Health Care without Harm notes that products purchased with the environment in mind should:
Section III: THE GREEN CHECKLIST AND DISCUSSION GUIDE

- Be less toxic
- Be minimally polluting
- Be more energy efficient
- Be safer and healthier for patients, workers, and the environment
- Contain higher recycled content
- Have less packaging
- Be fragrance-free

Implementation Strategies

Procurement practices need to be aligned to an overarching commitment to sustainability for a health facility or the health sector. Make every effort to reduce the amount of solid waste generated and purchase products that are environmentally benign.

Recommended Action Points

Mercury Reduction

- Prepare a plan to phase out or replace items that contain mercury.

  Note: Include in the plan how the items that are to be replaced/phased out are to be disposed of. Mercury is hazardous and anything that contains it should be treated as hazardous. Incinerating or disposing of mercury-containing items in landfills is not recommended.

Electronics Purchasing and End-of-Life Management

- Ensure that electronic equipment does not end up in landfills and incinerators where it can negatively impact the environment.

  Note: Proper recycling and redirecting equipment to appropriate markets for reuse will eliminate much of the materials in electronic equipment from being wasted. This saves natural resources, reduces energy use, has less of an impact on climate change and improves sustainability.

GGHC (Care G. G., 2008, pp. 12-38 - 12-39) recommends the following for managing electronics and electronic waste:

- Reduce generation of electronic waste by leasing equipment, purchasing refurbished electronic equipment, upgrading equipment instead of taking it out of service and/or participating in a buy-back program.
- Give preference to products registered with programs such as EPEAT, which requires all registered products to offer take-back and recycling options.
- Give preference to products that are available with extended warranties and parts for five years.
- Collect all electronics for responsible management (recycling), including but not limited to: cell phones, pagers, walkie-talkies, hand-helds, televisions, fax machines, copiers, monitoring equipment, medical equipment.
If donating retired equipment, ensure that it is mercury free, in working condition, and has all parts necessary to be of use in other locations where extra parts and servicing might not be available.

**Solid Waste Reduction in Purchasing**

- Ensure that your purchases are in line with the overarching goal to reduce solid waste generation and disposal. GGHC (Care G. G., 2008, pp. 12-10 - 12-11) recommends the following to reduce solid waste generation through environmentally preferable purchasing:
  - Collaborate with group purchasing organizations (GPO) and manufacturers to identify opportunities to reduce waste in their product or service offerings.
  - Require take back of shipping crates and pallets in contract language with manufacturers and/or distributors.
  - Require take back or leasing programs for televisions, copiers, computers, telephones and medical equipment in contract language with manufacturers and/or distributors.
  - Institute a paper prevention initiative, including review of all printed reports and opportunities for distribution sharing and printing of departmental-specific pages only. Purchase or lease printers, scanners and copiers with automatic double-sided copying capabilities.
  - Review purchasing policies and establish high-percentage post-consumer recycled content and increased recyclability in product or packaging if not in place. For example, request recycled paper packaging instead of foam plastic packaging and containers made from plastics #1 and #2, to increase potential for recycling when a reusable option is unavailable.
  - Review packaging and shipping materials to identify materials used and reduction opportunities.
  - Establish a program to divert furniture and supplies from the waste stream through donation, refurbishment or recycling.
  - Research regional recycling and reuse markets to maximize waste reduction opportunities.

To further reduce solid waste generation, GGHC (Care G. G., 2008, pp. 12-10 - 12-11) also points out that consideration should be given to using reusable alternatives for the following:

- Toters for material delivery from receiving/storeroom to user areas.
- Linens, including underpads (chux), pillows, isolation gowns, barrier protection, surgical drapes, stainless sterilization containers (versus blue wrap), lab coats and linen bags.
- Mattresses—eliminate disposable ‘eggcrate’ foam mattresses.
- Shipping containers for regulated medical waste removal.
- Sharps containers for sharps management.
- Medical devices, including instruments.

**Toxic Chemical Reduction in Purchasing**

- Prepare a comprehensive list of materials, products and supplies that contain chemicals of interest and how they will be replaced or phased out. Keep in mind that disposing of materials in landfills or incinerating might not be the most ecologically sensitive method.
Many items may be able to be recycled. Work with manufacturers, local, regional or international agencies, organizations or authorities to have items properly disposed of or preferably recycled. For items that are to be replaced or phased out, identify safer alternatives.

- Investigate suitable, safer building materials, as many contain toxic chemicals if renovations or alternations are planned.

**Things to Remember**

- Prepare a comprehensive list of mercury-containing items and suitable alternatives that do not contain mercury.
- Work with manufacturers, local, regional or international agencies, organizations or authorities to have items properly disposed of or preferably recycled.

**Resources**

- Sustainable Hospitals – Alternatives to mercury-containing equipment: [http://www.sustainablehospitals.org](http://www.sustainablehospitals.org).
- EPEAT® (the definitive global registry for greener electronics) [http://www.epeat.net](http://www.epeat.net/).