Table of Contents

Introduction

This document is a reference guide that is designed to help hoteliers understand, evaluate and implement environmental best practices.[1]

Where possible, this document provides actual examples to illustrate the environmental and financial benefits that can be achieved by implementing the proposed environmental best practices.

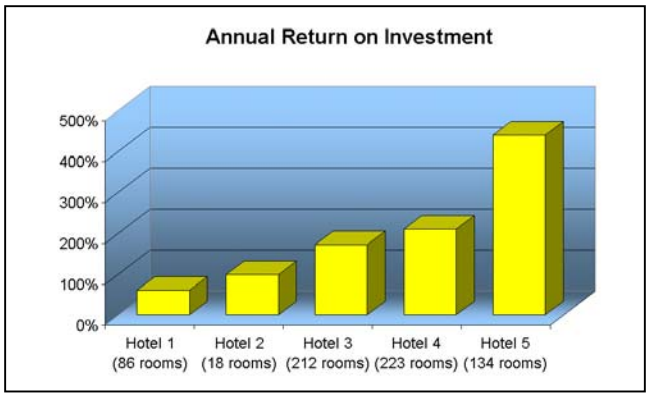
What are the benefits of environmental management in hotels?

Environmental management is a systematic approach to finding practical ways to improve the operating efficiency of hotels without compromising the quality of guest service. Given that hotels and resorts in the Caribbean use large amounts of water, energy, chemicals and materials, even small efficiency gains can lead to large cost savings. In addition, conservation and waste reduction help protect the region's natural beauty and ensure the long-term sustainability of the tourism industry.

Actual results from Caribbean hotels

Most hotels can quickly achieve substantial utility cost savings with a modest investment in a proactive environmental program. According to a recent survey of Caribbean hoteliers by PA Consulting Group, half of the region's hotels spend over 10% of operating costs on utilities, and almost a quarter of them spend over 20%. Practical no-cost or low-cost water and energy conservation measures can reduce these costs significantly.

A study conducted at five Caribbean hotels that recently implemented an environmental program revealed that all of these properties achieved remarkable financial and environmental benefits. Some of the results quantified by this study are outlined below and serve as direct evidence of the effectiveness of an environmental program.



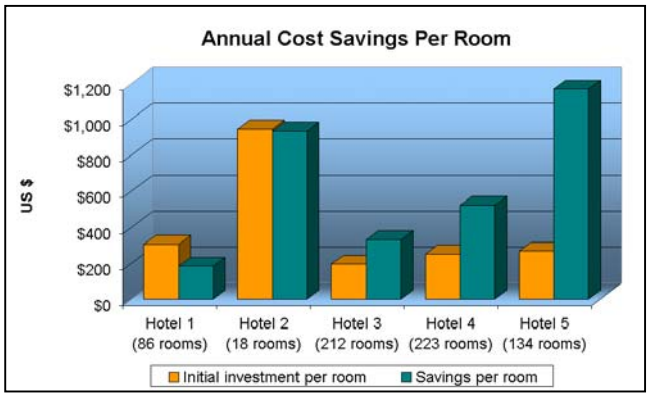


Figure i.- Annual return on investment and savings per room at 5 hotels that implemented an EMS.

[1] For properties that have participated in the Small Hotel Environmental Assessment (SHEA) program, many of the recommendations in this guide are listed in the Environmental Best Practices Questionnaire (Section 5 of the SHEA report).

- Average annual cost savings at the five hotels: US$ 75,000 per year or US$ 625 per room per year.
- Average annual Return on Investment (ROI): 196%.
- Annual water savings at the five hotels: 31 million US gallons or 47,000 US gallons per room per year.
- Annual energy savings at the five hotels: 1 million kWh of electricity, 161,000 liters of diesel, and 90,000 liters of LPG.

Additional benefits of environmental management

- **Enhanced reputation.** Adopting environmental best practices can help a property stand out from the competition and be recognized through certification programs, awards, tour operator programs, and other special promotions. Getting recognized for a commitment to environmental management can enhance a property's image with environmentally conscious guests and tour operators.
- **Improved staff motivation and reduced turnover.** Hoteliers are discovering that an environmental management program can improve staff morale and instill a sense of pride about where they work. Staff feel better about where they work if they know their employer cares about their community.
- **Protection of natural areas.** Each year more than 30 million tourists flock to the Caribbean to experience the natural and cultural treasures that the region has to offer. Protecting the "natural assets" such as clear water, white sand beaches and colorful reefs, that bring visitors to the region helps ensure the long-term sustainability of the industry.

Figure ii. - Environmental management helps preserve unique destinations for future generations.

What is a Small Hotel Environmental Assessment?

The Small Hotel Environmental Assessment involves a team of two trained experts working on property for 2-3 days. The team reviews a property's facilities, operations, and baseline performance and evaluates the property against a comprehensive list of environmental best practices. The team then delivers a report that lists the best opportunities for cost savings and environmental performance improvements and provides guidance on how to implement them.

Figure iii. - An assessment is a systematic evaluation of a property's facilities, equipment, practices, and procedures.

The assessments focus on identifying practical ways to conserve water and energy and minimize waste. Typical strategies include:

- Utility monitoring and preventative maintenance;
- Standard operating procedures for energy and water conservation and waste minimization;
- Water conservation devices such as efficient showerheads and faucet aerators;
- Energy-efficient lighting and lighting controls;
- Weather-stripping of air conditioned areas, and insulation of hot water pipes and refrigerant lines; and
- Composting of yard and green kitchen waste.

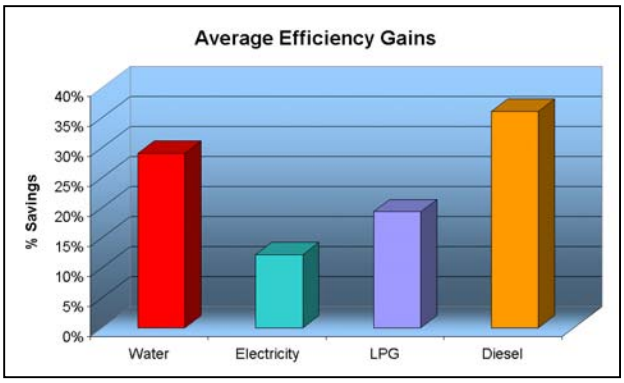


Figure iv.- Average efficiency gains for properties implementing an EMS.

What is an EMS?

Maximizing environmental improvements and cost savings requires that environmental management and conservation be incorporated into all aspects of property management, operations, and procedures, not just facilities and equipment. An Environmental Management System (EMS) is a framework that helps organizations improve operating efficiency and reduce environmental impacts. However, training and motivating managers and line staff to adopt new procedures or merely be vigilant about reducing waste is a tremendous challenge. It is not something that can be achieved overnight. Instead, it requires a long-term commitment and a continuous process of improvement be integrated in the daily operations at a pace that is right for each property. An EMS provides a roadmap for making this happen.

How does an EMS work?

An EMS involves a set of activities, led by a core group of staff (the "Green Team") that includes meetings, planning, training, incentive programs, utility monitoring, and reporting progress. Developing an EMS typically involves the following steps.

1. Getting top management commitment to environmental excellence and defining an environmental policy.
2. Setting targets for improvement and creating an action plan that lays out how to achieve them.
3. Implementing the plan.
4. Measuring progress and monitoring performance.
5. Reviewing the entire effort on an annual basis, evaluating what worked and what didn't work, and defining new targets and action plans for the upcoming year.

The different components of an EMS are described in Section 2 of this document.

Why is an EMS important? An example.

Installing low-flow showerheads and faucet aerators can save a lot of water and money, but if they are not properly maintained the savings may only be temporary, reducing the potential returns on the investment.

In addition, some of the most significant water, energy and materials savings are achieved not by new equipment, but by improving standard operating procedures and motivating the staff to use resources efficiently. Most of these measures have a very low implementation cost and a payback period of close to zero!

What does it mean to have your environmental program "certified"?

Certification programs such as Green Globe 21 or Quality Tourism for the Caribbean (currently under development) can be thought of as an official "stamp of approval" of an environmental program. These programs require that a property have a third party (an accredited "auditor") come in and evaluate its environmental program against an established set of criteria. Getting certified can help a property stand out to environmentally conscious travelers and tour operators by "proving" to them that the property is as green as it claims to be. Because today's travelers and tour operators are increasingly aware of environmental issues, this could emerge as an important competitive advantage in today's fast-moving marketplace.

Figure v. - Certifying your environmental program can be thought of as a "stamp of approval" for your property's program.

How to use this guide

After a property has conducted some type of environmental assessment (e.g. a small hotel environmental assessment (SHEA) or an environmental walk-through), the property should use this guide to identify which measures it should consider adopting and learn more about how to implement them. Some of the best practices descriptions listed in this document contain examples drawn from Caribbean hotels that have already implemented them, and others contain estimates of approximately how much they will cost to implement, and how much energy, water, materials, and money they could save each year.

Units

In order to avoid confusion among the different unit systems (metric, imperial and US) and currencies used in the Caribbean, all cost figures presented in this document are in US$ and all engineering figures generally follow the US customary system (US gallon[2], foot, pound, °F).

[2] 1.0 US gallon (USG) = 0.833 imperial gallon = 3.78 liters = 0.00378 cubic meters (m^3)

1. Property management

1.1 Make sure the environmental program has the complete support of the property's top management and department heads

An environmental program can yield significant cost savings, environmental improvements and other benefits to the property, but it requires buy-in and effort from the entire staff, and changes in staff practices and behavior which generally won't happen unless they are driven from the top down. Therefore, managers and department heads should demonstrate a strong commitment to the environmental program and to conservation in general, and demand it from the staff.

Ensuring the support of top management and department heads is the single most important step towards establishing a successful environmental program. It is also one of the most cost effective measures a property can implement: it costs nothing more than a bit of effort and can lead to large savings and performance improvements almost immediately.

1.2 Develop an environmental policy

An environmental policy is an important tool for communicating, both internally to employees and externally to guests, tour operators and others, that the property is serious about its role in preserving and protecting the environment. The policy should, therefore, embody the property's commitment to the environment and define the goals it wishes to achieve.

The formulation of the environmental policy should be a concerted effort, involving the owners, management, the Green Team and all interested staff members. This combined effort will ensure that the environmental policy is understood and respected by all, and will provide the staff with a sense of ownership over the property's environmental program.

An example of a hotel's environmental policy is given below.

Sample Hotel Environmental Policy

We recognize that our business has an important role to play in protecting and enhancing the environment for future generations, and to help secure the long-term sustainability of the tourism industry.

- To this end our hotel is committed to taking action:
- To achieve sound environmental practices across our entire operation
- To comply fully with all environmental legislation
- To minimize our use of energy, water and materials
- To reduce our pollution to a minimum and, where appropriate, to treat effluents
- To invite our customers, suppliers and contractors to participate in our efforts to protect the environment
- Where we can, to work with others in the tourism industry, in public agencies and the community to achieve wider environmental goals
- To provide all employees with the training and resources required to meet our objectives
- To openly communicate our policies and practices to interested parties
- To monitor and record our environmental impacts on a regular basis and compare our performance with our policies, objectives and targets

Figure 1.1 - Sample Hotel Environmental Policy (source: International Hotels Environment Initiative).

The environmental policy must be clearly communicated and explained to all current employees and all new hires. It should be discussed in staff meetings, included in employee handbooks and posted on the staff notice board. Once the property has put into practice the key elements of its EMS and achieved the first noticeable results, management should ideally place a framed copy of the environmental policy in the hotel lobby, in full view to all guests and visitors.

1.3 Appoint an Environmental Officer

Once it is ready to move ahead with its environmental program, the property will need to appoint an Environmental Officer who will take the lead for coordinating and implementing the program. This responsibility is generally given to a upper- to mid-level manager in a small to medium-size hotel (e.g., the maintenance supervisor or the executive housekeeper) or to a dedicated environmental officer in a large property.

This person must have a good operational knowledge of the hotel, the respect of other employees, a commitment to the project, and the full support of the property's owners and top management. The Environmental Officer should keep the environmental program on line, ensure that good business and environmental results are achieved, and promote the participation and cooperation of all staff members.

The property should, however, make sure the Environmental Officer is given enough time to carry out his or her new duties. If an overworked manager is appointed as the Environmental Officer without first shifting some of his or her responsibilities to others, the environmental program will not receive adequate attention and will fail to produce results.

The property should view the creation of this new position as a wise investment rather than an additional expense. In fact, the financial savings that can be achieved by an effective environmental program will generally far outweigh the additional labor cost incurred by the property.

1.4 Create a Green Team

The creation of a Green Team is crucial to introducing and implementing an environmental program in a hotel. The functions of the Green Team include:

- assisting the Environmental Officer in the day-to-day management, supervision and troubleshooting of the environmental program;
- keeping the property's staff motivated and dedicated to the principles of the environmental program;
- developing new ideas and strategies for improving the program;
- acting as the principal link between the property and local community groups or environmental organizations.

Figure 1.2 - Green Team of a Jamaican hotel.

To be most effective, the Green Team should be composed of highly motivated individuals, selected from each of the property's departments and representing all levels of employee hierarchy - from executive-level to line-level employees. The actual size of the Green Team will depend on the requirements of the property's environmental program; however, when assembling the team, the property should keep in mind that as the group gets larger, it becomes less focused and less productive.

The employees selected for the Green Team must have the motivation and character needed to ensure the success and the dissemination of the program. Criteria for the selection of team members may include:

- recommendations by managers or supervisors;
- nomination by fellow employees; or
- a simple application process that requires the candidates to explain their expected contribution to the environmental program and their reasons for wanting to join the team.

1.5 Develop an EMS Action Plan

The Green Team should review the results of the Small Hotel Environmental Assessment (SHEA) and prioritize the proposed recommendations, or actions, based on their potential for reducing operating costs and improving the environmental performance of the property.

After completing this evaluation, the Green Team should meet with each relevant department head to draft and finalize an EMS Action Plan for his or her department. This Action Plan should define performance targets, outline the actions selected for implementation, assign responsibility for completing each action, and set a completion date for each action. Department heads should officially sign-off on their departmental Action Plan, indicating that they agree to follow it.

A sample Action Plan for the maintenance department of a hotel is shown below.

2002 Action Plan for the Maintenance Department of Hotel ****				
Environmental aspect	**Target**	**Action**	**Responsibility**	**Completion date**
Water use	Reduce water consumption per guest-night by 10% in 2002	Train the staff to identify and report defective plumbing fixtures (e.g., toilets, faucets, showerheads).	Mr. Jones	February 1, 2002
		Install 2.5 gpm tamper-proof aerators on kitchen work faucets and on all bar faucets.	Mr. Smith	February 15, 2002
		Install 0.5 gpm tamper-proof aerators on all kitchen hand wash faucets.	Mr. Smith	February 15, 2002
		Install a pedal valve on the main bar faucet.	Mr. Clark	April 1, 2002
		Devise a preventative maintenance checklist for the plumbing fixtures installed in guestrooms, back-of-house and public areas.	Mr. Jones	April 1, 2002
		Install sub-meters to monitor water consumption in the following areas: the laundry, the main kitchen, the guestroom block, and the irrigation system.	Mr. Smith	May 1, 2002
Energy use	Reduce electricity consumption per	Action 1	etc.	etc.
		Action 2	etc.	etc.

	consumption per guest-night by 5% in 2002	Action 3	etc.	etc.
Solid waste generation	etc.	etc.	etc.	etc.
etc.	etc.	etc.	etc.	etc.

1.6 Train and motivate employees to conserve water, energy, chemicals and materials

Now that the property has committed itself to becoming more environmentally responsible, employees at all levels need to understand **how** exactly this will be accomplished and **how** this will impact day-to-day operations, activities and tasks. Not only should employees learn how to perform their daily tasks in a manner that will maximize conservation, they should also understand **why** the property is undertaking this effort, and understand the positive effects this effort will have on them, their families and the local community. Employees must realize that resources are limited and that waste minimization and proper waste disposal are critical in an island environment. This understanding will provide the staff with a sense of ownership in the environmental effort that will contribute to its long-term success.

The property should consider incorporating in this training and motivation efforts some of the suggestions discussed below.

- Have an "all hands" meeting to present the property's new environmental program, introduce the Green Team, and explain what the property is going to do and why. Encourage all staff to view environmental management as a key part of their responsibilities. Conserving water, energy, and natural resources is a TEAM EFFORT which requires everybody's participation.
- Use staff meetings or training sessions to educate employees on the financial and environmental cost of their actions; discuss the ways in which they can reduce their consumption of energy, water, chemicals and materials; and collect ideas for improving the property's environmental performance and efficiency.

  Don't use cost savings as the sole justification for the program when training line staff. For example, emphasize that conserving water and energy helps reduce demand and thus ensure that everyone has access to these resources, and preventing waste helps preserve the island's environment for future generations. Remind them that the waste generated by the property ends up outside the property's walls, where they and their families live.

The importance of training, an example

When properly planned and implemented, a towel reuse program allows a property to save water, energy and chemicals, reduce its discharge of laundry wastewater, reduce the workload on its laundry equipment and staff, and increase the service life of its towels. Although these great benefits can be achieved with a negligible capital investment, the vast majority of the towel reuse programs in place in Caribbean hotels fail to deliver any results because of the lack of training.

A towel reuse program can be truly effective only if the front desk staff and bell-hops are trained to inform the guests about the program, housekeepers are trained to respect the decision of the guests who decide to reuse their towels, housekeeping supervisors are trained to enforce the policy and monitor towel use in guestrooms, and all staff members are aware of the importance of the program.

Unfortunately, in most hotels housekeepers are only trained when the program is first launched, the front desk staff and bell-hops are never involved in the program, and no one is asked to monitor towel use and track the effectiveness of the program. After a few weeks the only thing left of the towel reuse program are the guestroom stickers or tent cards that encourage the guests to participate in an effort that no one on property cares to respect.

- Incorporate environmental management, and water, energy, materials and chemicals conservation issues in the staff training programs.
- Draft detailed operating procedures for all operations that have an important impact on the property's water and energy consumption or on its overall environmental performance. Line staff often have only verbal instructions to guide their daily tasks or operate the property's equipment. Although verbal instructions are sometimes effective, they generally become distorted and lose their specificity with time. Clear written instructions constitute a solid, reliable and unchanging reference point to guide operations.

1.7 Establish an incentive program to encourage and motivate staff to conserve resources and reduce waste

In most cases, the hotel staff will not embrace sound conservation practices unless they are properly trained and motivated. In fact, experience shows that employees will often adopt new practices only if they are clearly instructed on what must be done, informed of the benefits of these practices, encouraged and rewarded. Since staff participation in the environmental program can save the property a lot of money and have a huge impact on its efficiency and performance, management should take the time to devise an appropriate and effective incentive program to support its environmental initiative.

While the structure of the incentive program should match the needs and concerns of the individual property, some of the elements that could be included in this program are listed below.

- Nominating and rewarding the "environmental employee" of the quarter or year.
- Nominating and rewarding the "most environmentally friendly department" of the year.
- Organizing water and energy conservation competitions between departments.
- Awarding scholarships for the children of staff members. These scholarships could be paid from part of the savings achieved through the environmental program.
- Awarding a quarterly prize to the staff member who proposes the best suggestion for improving the environmental performance of the hotel.

In addition, management and the Green Team should demonstrate continued leadership and commitment to the environmental program, acknowledge and reward progress, take action to correct failures, and continually refresh enthusiasm in the challenge of transforming the property into an environmentally friendly property. Like customer care, good environmental management practices must become part of the management culture.

1.8 Develop an environmental communication plan

- **Communicate the property's environmental program to the guests.** Guests should be aware of the environmental program and invited to participate in the property's effort to preserve the local environment. Some of the strategies that the property can use to communicate its environmental program to the guests include:
  - Having the front desk staff inform the guests about the property's environmental program during check-in.

- Giving the bell-hops the responsibility to introduce the guests to key features of the property's environmental program, such as the recycling or towel reuse program.
- Including information about the property's environmental program, accomplishments and awards in promotional materials and guestroom literature.

- **Improve the use of signage, posters and other materials to reinforce environmental objectives.** Signage, posters, bulletins, and other materials should be posted in back-of-house areas and distributed to staff to reinforce the property's environmental objectives, specifically those that relate to the conservation of water, energy, products and chemicals. These materials can also be used to communicate successes in particular areas, awards given to staff members, and other goals or achievements of the environmental program.
- **Communicate with other properties on issues related to environmental management.** Many hotels that have adopted environmentally friendly practices are willing to share their experiences with other properties. This is a great way to take advantage of the lessons learned by other properties. For instance, hotels can obtain valuable insight on rainwater collection, composting, water conservation, energy efficiency, waste reduction and alternative chemical products from other properties in their area to determine what has worked well for them and what has not.

Figure 1.3 - Example of signage to encourage conservation.

1.9 Implement a program to monitor the use of disposable products and chemicals by all departments

Monitoring the purchasing information and examining the purchasing needs of each department can provide useful insights into how resources are used on property. Knowing how much is used and by whom is the first step towards eliminating waste because, as the old saying goes, "you can't manage what you don't measure!" Also, if supervisors are aware that product use by their department is being monitored and evaluated, they are much more likely to actively encourage staff to avoid waste.

The property should develop a monitoring program that allows the cost controller to track the monthly consumption of key products and chemicals in each department. However, the property should not try to track everything, but rather focus mainly on the products and chemicals that are being targeted for reduction.

Typical products and chemicals that can be targeted for reduction in hotels	
Single-portion and disposable items	▶ Individually packaged guestroom amenities (e.g., soap, shampoo, body lotion) ▶ Single-serving food items (e.g., packaged sugar, butter, condiments, cereals) ▶ Single-use items used by the Food and Beverage Department (e.g., sternos, paper napkins, straws, and disposable plates, cups, placemats, aprons and cook hats) ▶ Paper towels ▶ Plastic garbage bags

Chemicals	▶ Laundry chemicals (e.g., detergent, bleach, fabric softener) ▶ Pool chemicals (e.g., chlorine, pool acid, algaecide) ▶ Chemicals used for water and wastewater treatment (e.g., chlorine, rock salt used by the water softener) ▶ Specific housekeeping and stewarding products and cleaning agents (e.g., aerosol air fresheners and insecticides, acid and caustic cleaners, degreasing agents) ▶ Maintenance chemicals (e.g., refrigerants, drain clearing chemicals, solvents, paint) ▶ Motor oil used by the property's generators, motor boats and vehicles ▶ Gardening chemicals (e.g., pesticides, synthetic fertilizers)

The monitoring information should be used to set annual targets for product consumption and thus encourage all departments to become more efficient in their use of products. The efficiency with which an individual product is used can be evaluated by calculating the amount of product consumed by the property, or a department, per guest-night and comparing this figure with the baseline information gathered in the preceding years.

A sample product monitoring form and product monitoring chart are shown below.

Product monitoring form (2001 = baseline year)

Month & year	Plastic bags		Plastic cups		Handy fuel		Paper towels	
	Units - Rolls (1000 bags/roll)	Cost (US$)	Units - Sleeves (100 cups/sleeve)	Cost (US$)	Units - Individual canisters	Cost (US$)	Units - Rolls	Cost (US$)
Jan-01	1080	6480	78	117	893	223	389	97
Feb-01	1088	6528	78	118	900	225	392	98
Mar-01	1080	6480	95	143	1188	297	389	97
Apr-01	1088	6528	78	118	900	225	392	98
May-01	782	4692	69	104	900	225	345	86
Jun-01	1111	6666	99	149	900	225	223	99
Jul-01	689	4134	62	111	1044	261	309	77
Aug-01	869	5214	63	125	719	180	313	78
Sep-01	888	5328	100	150	1008	252	333	83
Oct-01	557	3342	66	99	1260	315	266	67
Nov-01	879	5274	63	95	727	182	317	79
Dec-01	1083	6498	78	117	896	224	390	98
2001 units per GN	**0.32**	**1.91**	**0.03**	**0.04**	**0.32**	**0.08**	**0.12**	**0.03**
Baseline occupancy (2001) = 35100 GN/year								
Jan-02	857	5142	62	93	708	177	309	77
Feb-02	905	5430	65	98	540	135	326	82
Mar-02	1152	6912	83	125	396	99	415	104
Apr-02	1136	6816	82	123	940	235	409	55
May-02	918	5508	66	99	759	190	331	83
Jun-02	654	3924	47	71	541	135	236	59

Jul-02	785	4710	57	85	649	162	283	71
Aug-02	694	4164	50	75	574	143	250	62
Sep-02	628	3768	45	68	519	130	226	57
Oct-02	561	3366	40	61	465	116	202	51
Nov-02	495	2970	36	54	410	102	179	45
Dec-02	429	2574	31	46	355	89	155	39
2002 units per GN	**0.24**	**1.45**	**0.02**	**0.03**	**0.18**	**0.05**	**0.09**	**0.02**
Occupancy in 2002 = 37200 GN/year								

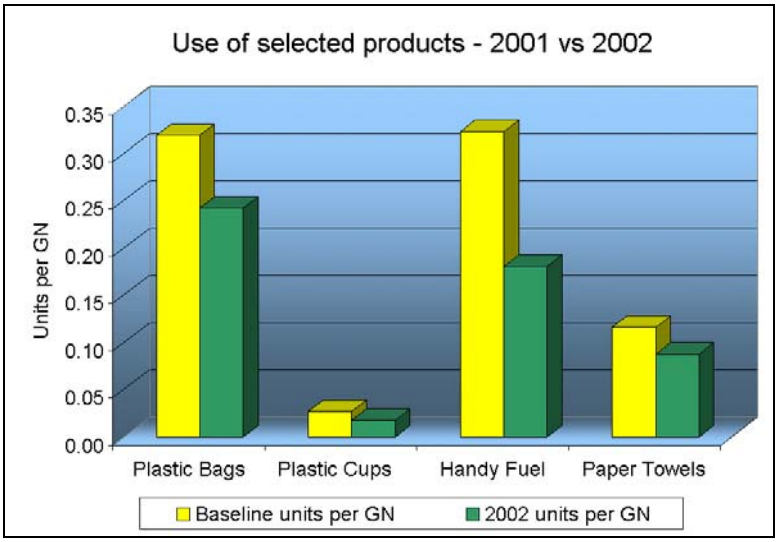


Figure 1.4 - Sample product monitoring chart.

The data collected by the product monitoring program should also be used to periodically calculate the reduction in waste generation and the financial savings achieved by the environmental program.

1.10 Implement a property-wide waste management program

The property should implement a comprehensive waste management program to reduce, reuse and recycle all possible wastes that are currently generated in its operations. This program should be coordinated by the Environmental Officer and facilitated by the Green Team. An effective waste management program will significantly reduce the property's impact on the environment, save money by improving the use of materials and resources, and probably lower the property's waste disposal costs. Since a large portion of hotel garbage is generally composed of materials that can readily be eliminated from the waste stream (e.g., green yard waste, food scraps, packaging waste, disposable items, and recyclable items), a property can reduce the volume of waste it sends to the local dump by more than 50% by putting in place an effective waste management program.

A waste management program is composed of the following components.

1) Reduce the generation of waste

The property can reduce the impact and the amount of waste it produces by:

- using materials efficiently and discarding them only when they are no longer fit for use;
- using durable goods that need to be discarded less frequently;
- avoiding the purchase of goods that are sold with an excessive amount of packaging; and
- minimizing the use of hazardous materials and products that harm the environment.

Reducing the generation of waste is the most effective and the first option that should be considered by the property. It is also the option that yields the greatest cost savings because it reduces the amount of money spent on supplies and reduces the volume of waste hauled away to the dump.

The bulk of the responsibility for reducing waste generation generally lies with management and the Purchasing Department: they decide what is brought into the property and thereby determine what eventually leaves the property as waste. Nevertheless, all employees should also contribute to this effort by using products as efficiently as possible.

Examples of standard waste reduction measures for the hotel industry include:

- Avoid purchasing items that are sold with an excessive amount of packaging material (e.g., cardboard boxes, plastic film, styrofoam packages, glass, metal and plastic containers). Packaging alone can account for up to 40% of a hotel's waste stream.
- Instead of purchasing food items in single-serving packages (e.g., sugar, salt, pepper, jam, condiments, butter, cereals, syrup, cream, juice), purchase them in bulk and serve them in refillable dispensers. Food items purchased in bulk are less expensive and create less packaging waste.
- Reduce or eliminate the use of single-use items such as paper napkins and disposable plates, cups, cutlery, place mats, aprons and cook hats. In most cases, disposable items can be easily and cost-effectively replaced with durable items.
- Minimize the use of straws by using self-serve straw dispensers or giving out straws only with blended drinks.
- Use durable coasters instead of paper napkins that must be replaced with every drink.
- Eliminate the use of doilies.
- Reduce the use of plastic film by purchasing durable plastic containers to store food in refrigerators and freezers.
- Where possible, use cloth cleaning rags instead of disposable paper towels or disposable J-cloths.
- Use cloth bags or baskets instead of plastic bags to collect and return guest laundry and guestroom towels and linens.
- Use refillable amenity dispensers in guest bathrooms.
- Purchase chemicals in bulk and dispense them from refillable pump bottles or containers.
- Collect yard waste in canvas bags, wheelbarrows or carts rather than in disposable plastic bags.
- Use electrical resistances, refillable alcohol burners or LPG burners instead of sternos (Handy Fuel) to keep food warm in buffet lines.
- Avoid using laundry, kitchen, or housekeeping detergents that contain phosphates.
- Minimize the purchase and control the use of harsh or hazardous chemicals (e.g., drain cleaning chemicals, solvents and bleach).
- Consolidate the property's purchasing process to reduce the number of orders placed with each vendor. This generally saves money and reduces packaging waste.

2) Reuse all possible items

Whenever possible, the property should reuse items in their original form for the same or a different purpose rather than disposing of them. If an item cannot be reused on-site, the property should investigate the possibility of selling it or giving it to employees, charitable organizations, and local schools or businesses. Examples of standard reuse measures for the hotel industry include:

- Only serve beverages that are packaged in refillable bottles or kegs that can be returned to the supplier.
- Give preference to vendors that supply their products in returnable or refillable containers.
- Donate unserved food to a local charity.
- Donate food waste to a local farmer who can use it as animal feed.
- Use the back side of computer and office paper to print draft documents and internal memos.
- Remove partially used amenities from guest bathrooms only at check-out. These products should then be reused around the property (e.g., soap bars can be used to pre-soak or hand-wash laundry) or given away to charities.
- Replace the plastic liners that are used in guestroom garbage bins only when they are soiled or unsuitable for further use.
- Repair and reuse damaged furniture or donate it to interested parties.

3) Recycle all possible items

Many items that cannot be reused in their original form can be sold or given away to processors for recycling. Even if the property does not directly profit from its recycling efforts, diverting items from the waste stream should allow the property to reduce the frequency and the cost of garbage collection. The items which can generally be recycled include:

- green waste from kitchen and garden (this material should ideally be composted on property);
- white paper, mixed paper and newspaper;
- cardboard;
- glass bottles and jars;
- plastic bottles and containers made of PET (a plastic typically used for soft-drink and water bottles) and HDPE (a plastic typically used for milk jugs and chemical containers);
- aluminum cans and foil;
- steel cans;
- steel scrap such as old pipes and appliances;
- other metals such as copper and brass;
- used cooking oil;
- used motor oil; and
- used printer and copier cartridges.

1.11 Incorporate energy and water efficiency concerns in the design phase of construction and refurbishing projects

The following list provides an overview of the practices that should be maintained or considered by the property in future construction or refurbishing projects.

- Make sure that all new plumbing fixtures purchased and installed on property are water efficient. For example:
  - Install effective low-flow showerheads that consume no more than 2.5 USG/min in guestrooms, staff restrooms and public areas. Use tamper-proof showerheads in all areas where tampering is a problem.
  - Equip guestroom, staff bathroom and public restroom faucets with aerators that restrict their maximum output to 1.5 USG/min or less.
  - Equip all possible kitchen and bar faucets with aerators that restrict their maximum output to 2.5 USG/min or less.
  - Install only water-saving toilets that consume 1.6 USG per flush. Make sure the water-saving toilets selected for future construction or refurbishing projects have a proven track record on the local market.
  - Give preference to flush valve or pressurized-flush toilets for all new toilets installed in high use areas, such as staff and public restrooms. These toilets are generally more durable and less prone to tampering than gravity-flush toilets.
- Keep in mind that a hotel often discards a lot of water that is clean enough to be reused in some of its operations. Examples of these “clean” flows include
  - rainwater from the roofs,
  - storm water runoff from paved surfaces or lawns,
  - defrost water from ice makers,
  - cooling water from water-cooled refrigeration equipment (e.g., ice makers, water coolers),
  - backwash water from pool filters, and
  - condensed water from air conditioning systems.

  In future construction and refurbishing projects, the property should consider collecting and reusing these flows. For example, clean and soft water flows (e.g., rainwater from roofs and condensates from a/c units) can be used as laundry wash water, and all flows can be used for irrigation.
- Take the following criteria into account when purchasing and installing new air conditioners.
  - Purchase a/c units that have an Energy Efficiency Ratio (EER) greater or equal to 10.7. The EER is the ratio of the a/c unit’s rated cooling capacity (in BTU/hr) divided by its electrical input (in Watts) at standard operating conditions. The best available units have EERs around 11.7, while base units have EERs around 8.5. Typically, there is only a relatively small cost difference between base models and high efficiency models.
  - If purchasing equipment from the US, select equipment that has the US EPA/DOE’s Energy Star rating. These units meet minimum energy efficiency standards.
  - Do not oversize air conditioners. This causes the units to frequently cycle on and off, decreasing their efficiency, reducing their ability to control humidity, increasing energy use, and shortening their service life.

- Properties located on the coast should give preference to a/c equipment that is specifically designed for marine environments and is thus more resistant to salt-corrosion.
- Properly insulate all refrigerant lines and seal/caulk all wall penetrations.
- Do not vent refrigerants to the atmosphere. They contain CFCs and HCFCs that harm the ozone layer.
- Provide shading for the a/c condensers that are exposed to direct sunlight.

Figure 1.5 - Examples of condenser shading options used in hotels.

- Minimize air infiltration in air conditioned areas by implementing the following measures.
  - Make sure all exterior doors and operable windows are weather-stripped.
  - Make sure exterior doors have a door sweep.
  - Avoid louvered or jalousie windows in air conditioned areas. These windows are extremely drafty and will substantially increase air conditioning costs. Where louvered windows are already in place, consider replacing them with solid glass windows or covering them with glass or plexiglas.
  - Make sure all cracks and gaps around door frames, window frames and other features are properly caulked.

  According to studies conducted in several Caribbean hotels, a/c energy use can be reduced by 12 to 54% by weather-stripping doors and windows, installing door-sweeps and sealing other air-leaks. In addition to these energy savings, the reduced a/c runtime also lowers the maintenance requirements and extends the service life of the a/c equipment.
- Reduce air conditioning costs by insulating exterior walls, insulating and venting attics, and installing a radiant barrier in attics. An attic that is properly vented, insulated and equipped with a radiant barrier can lower air conditioning loads by 10 to 30% in the rooms below.
- Reduce heat gains by shading windows and glass doors that are exposed to direct sunlight. This can be achieved with trees and landscaping, awnings or shades, or with special window-films that reduce light transmittance through the glass panes.
- Always take energy efficiency into account when purchasing new equipment, including motors, lighting, office equipment, and kitchen equipment.
- Insulate all hot water lines, including CPVC lines. Also, avoid running hot water lines on the ground: they can come in contact with pools of standing water and experience important energy losses.

1.12 Train staff to properly and safely store, use, and dispose of harmful chemicals

Many properties improperly store, use and dispose of chemicals (and the same generally goes for the independent contractors who work on property). These careless practices waste money, pose

unnecessary hazards to staff and guests, and threaten the long-term health of the local environment. In order to avoid these problems, the property should consider implementing the following measures.

- Obtain the MSDS (Material Safety Data Sheets) for all chemicals used on property. Use the information contained in the MSDS to inform area supervisors and staff on the potential risks posed by the chemicals used in each department.
- Train the staff in the safe and proper handling, use and disposal of chemicals.
- Provide protective equipment such as gloves and eye protection to staff when appropriate.
- Insist that contractors follow proper procedures when handling, using and disposing of their chemicals.

1.13 Review progress on a yearly basis and create an annual report

Once a year, the property should to step back to check the progress of its environmental program. This review should ideally be conducted by the Environmental Officer and take the form of a short report containing targets, results and monitoring data related to the environmental measures implemented since the start of the program.

The review should cover the property's environmental performance as well as the progress made with specific environmental actions. It should include:

- **A summary of measured achievements against the targets and objectives.** Use the EMS Action Plan as a guide to determine whether or not the planned actions were implemented and targets met. If targets were not met, determine why and try and set a new target date, or if appropriate, revise the nature of the action. Summarize progress and highlight key achievements.
- **Discussions with relevant staff members to identify the difficulties encountered, the successes achieved, and their recommendations for future actions.** This component of the review process is invaluable. It will highlight problem areas as well as help identify problems with the environmental program and potential solutions. Management and the Green Team can then begin to plan for the coming year -- but this time on the basis of the experience acquired over the past year.
- **A general review of the property's environmental performance improvements.** This is a critical step because it allows the property to assess the impact of the program, and quantify the cost savings and performance improvements that have resulted. Demonstrating performance improvements and cost savings is critical to maintaining management commitment to the program, otherwise, no one will know whether or not it is working and will begin to lose interest.
  - Use data collected as part of the utility monitoring and product/chemical monitoring programs.
  - Display the information in graphs if possible (Microsoft Excel is a wonderful tool for managing environmental performance information and creating colorful charts and graphs).
  - To quantify performance improvement, calculate the performance index for utilities (see Section 2.1 for an explanation of consumption indices for water, electricity, LPG, and diesel) and compare to those from the beginning of the year. An example is below.

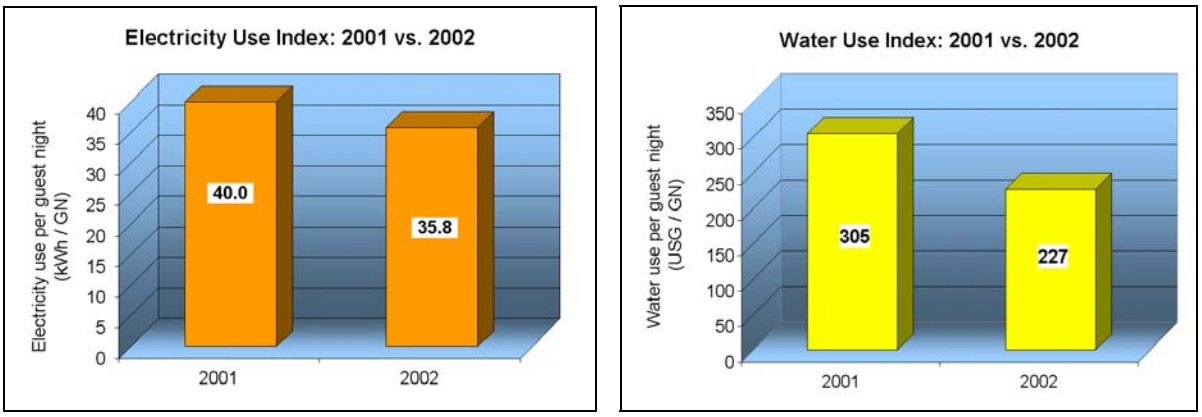


Figure 1.6 - Example of charts demonstrating yearly performance improvements.

2. Maintenance

2.1 Create a utility monitoring program

A utility monitoring program is a planned and documented system that is used to collect and analyze information on the amount of water and energy (e.g., electricity, diesel and LPG) consumed by the property. An effective utility monitoring program should allow the property to

- define its normal water and energy consumption patterns;
- track the long term trends in its use of water and energy;
- identify unusual shifts in consumption that may be indicative of equipment or operational problems;
- ensure that employees comply with established water and energy conservation practices;
- check the effectiveness of its preventive maintenance operations; and
- evaluate the progress and savings achieved through its conservation and environmental efforts.

In order to establish an effective utility monitoring program, the property should ideally implement the following measures.

- Install sub-meters to monitor water and electricity consumption in high-use areas. Sub-meters are inexpensive monitoring tools that can help define how water and energy use is distributed throughout the property; identify and locate equipment problems (e.g., water leaks); and measure the effectiveness of water and energy conservation measures in specific areas of the property. Sub-meters can also be used to promote accountability in areas where careless staff operations needlessly increase water and energy use.

Hotel areas that should typically be sub-metered[3]	
Water sub-meters	Electricity sub-meters
▶ Guestroom blocks. ▶ Kitchens and laundries. ▶ Irrigation systems. ▶ Swimming pools. ▶ Large sub-sections of the property, such as a back-of-house block.	▶ Guestroom blocks. ▶ Kitchens. ▶ Laundries (if equipped with high-capacity electric dryers or presses). ▶ Major electrical equipment, such as banks of electric water heaters or packaged a/c systems. ▶ Large sub-sections of the property, such as a back-of-house block.

Typical costs of water and electricity meters	
Water meters	Electricity (kWh) meters

[3] A small and compact property (e.g., a hotel with less than 20 rooms where all facilities are concentrated in a single building) may not need any sub-meters and could get by simply by monitoring its main utility meters.

▶ US$ 50 for a ¾-inch cold water meter ▶ US$ 120 for a ¾-inch hot water meter ▶ US$ 500 for a 2-inch cold water meter	▶ The cost generally ranges from US$ 400 to 800 depending on the capacity of the kWh meter.

- Monitor water and energy use frequently enough to be able to identify problems and take timely corrective action if there is a significant change in consumption or a large deviation from targeted performance. Ideally, the main water meters, electricity meters and fuel tanks should be checked every day at approximately the same hour. Sub-meters that measure water or electricity consumption in smaller sections of the hotel (e.g., a kitchen) can be monitored less frequently, but should be read at least once per month. All the collected data should be recorded in a monitoring log.[4]
- Use the daily meter and fuel tank readings to calculate the amount of water, electricity or fuel consumed during the last 24 hours. Compare these daily consumption figures with those calculated for the preceding days to check for unusual or unexplainable changes in consumption, which may be indicative of operational or equipment problems.
- At the end of each month, use the utility consumption and occupancy data to calculate the monthly water and energy use indices for the whole property and for each sub-metered area.[5] Compare these indices with those calculated for the preceding months or for the same month of the previous year. Check for and investigate unusual shifts in water or energy consumption.

Example: How to calculate water and energy use indices

In June 2000, the occupancy and utility consumption data of a 31-room hotel audited by the EAST project was as follows:

- ▶ Monthly guest-night occupancy = 551 GN
- ▶ Monthly water consumption = 267,500 USG
- ▶ Monthly electricity consumption = 45,600 kWh
- ▶ Monthly LPG consumption = 455 USG

Given this data, the hotel's utility use indices can be calculated as follows:

- ▶ Monthly water use index = (267,500 USG) / (551 GN)
  = 485 USG/GN
- ▶ Monthly electricity use index = (45,600 kWh) / (551 GN)
  = 82.8 kWh/GN
- ▶ Monthly LPG use index = (455 USG) / (551 GN)
  = 0.83 USG/GN

[4] Sample water and energy monitoring forms are presented in Appendix A.

[5] The monthly water (or electricity or fuel) use index is calculated by dividing the monthly water (or electricity or fuel) consumption by the monthly guest-night occupancy. It therefore represents the average amount of water (or electricity or fuel) that was used by the property per guest-night during that particular month. Monthly utility use indices are generally expressed in terms of gallons/guest-night for water, kWh/guest-night for electricity, and gallons/guest-night for fuels such as diesel or LPG.

- Use graphs similar to those presented below to track the monthly water and energy consumption figures and the monthly water and energy use indices. Since graphs can be interpreted more easily than the long lists of numbers contained in monitoring logs, they allow the property to effectively identify problems and monitor its use of water and energy.

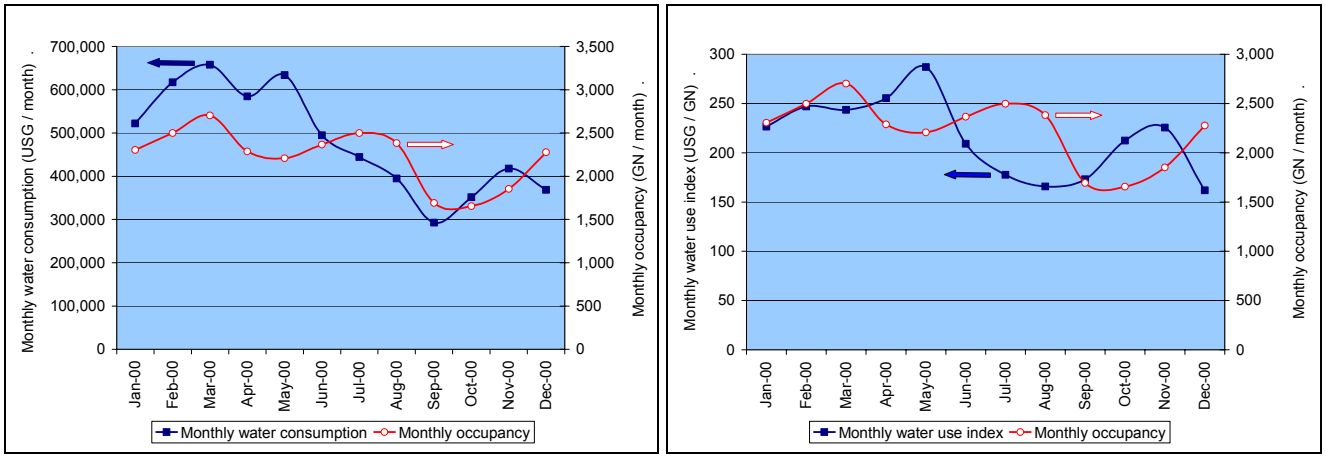


Figure 2.1 -Monthly water consumption and monthly water use index graphs for a 50-room property.

- At the end of each month, take hourly readings of the main water meters over one complete day and use the collected data to draw the daily water consumption curve of the whole property and of each metered area (see figures below). In most hotels, domestic water consumption peaks in the morning and afternoon but should be very low from 1:00 AM until 6:00 AM. If water use remains unexplainably high during the night, the property is probably loosing lots of water through leaking pipes and plumbing fixtures and should take action to address this problem.

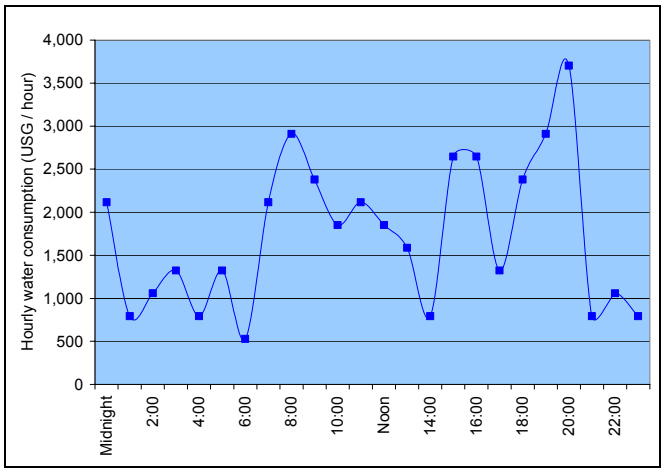


Figure 2.2 - "Normal" daily water use profile measured in a 240-room Caribbean hotel. Note the large drop in nighttime water consumption.

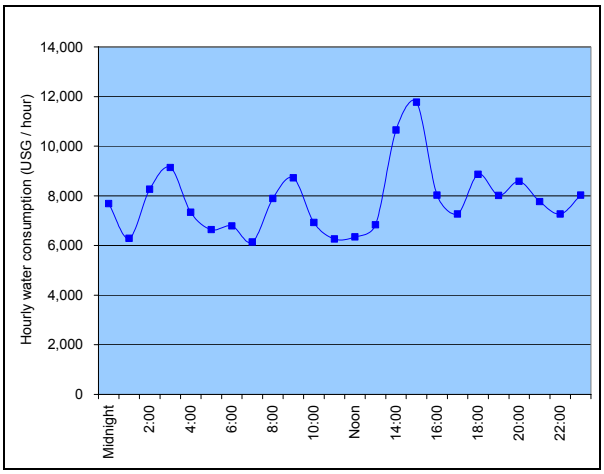


Figure 2.3 - Abnormal daily water use profile measured in a 350-room Caribbean hotel. Note that the hourly water consumption is relatively steady regardless the time of day.

- At the end of each month, take hourly electricity demand readings (in kW and/or kVA) from the main electricity meters over one complete day and use the collected data to draw the daily demand profile of the whole property and of each metered area (see figure below). Use the resulting graphs to define

how energy is used on property throughout the day, identify the peak demand periods, and develop strategies to reduce the property's peak demand and energy consumption.[6]

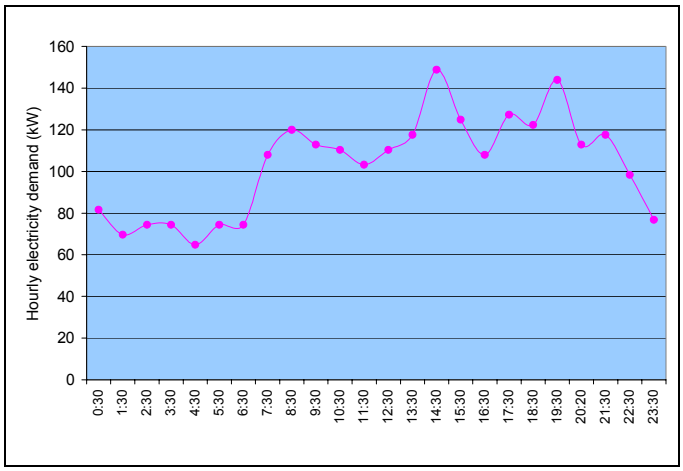


Figure 2.4 -Daily electricity demand profile measured in a 50-room Jamaican hotel.

- At the end of each year, use the utility consumption and occupancy data to calculate the annual water and energy use indices for the whole property and for each sub-metered area.[7] Compare these indices with those calculated for the preceding years to gauge the long-term trends in the property's use of water and energy and the impact of its conservation efforts.
- Periodically check the accuracy of the data collected by the monitoring program by comparing it with the meter readings and the consumption figures presented in the fuel, electricity and water bills. Investigate and correct significant or chronic discrepancies between the water and energy data collected by the monitoring program and the information given in the utility bills.
- Share the monitoring information with the staff since, after all, they are the ones who largely control the property's use of water and energy. For example, graphs showing the monthly water and energy use indices for the whole property and for specific areas (e.g., kitchen, laundry) could be posted on the central staff notice board.

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[6] Depending on the arrangement (or billing rate) between the property and the electric utility (JPSCo in Jamaica), the property may be charged for the maximum amount of power it draws from the electricity grid at any given time during the billing period in addition to its electricity or kWh consumption. The maximum amount of power drawn by a property is typically referred to as "peak electricity demand" and is measured in kW or kVA. Many electric utilities also use a demand "ratchet" mechanism that allows them to bill a customer for the greater of its actual monthly peak demand or a percentage (often 80%) of the highest peak demand recorded during the past 6 to 12 months. Thus, if a property has an unusually high demand on a single day, it may have to pay for it for the next 6 to 12 months.

Since electric utilities generally offer a range of different options (or rates) to their customers, the property should clearly understand how it is billed for the electricity and power it consumes, and make sure that it is billed on the most favorable rate. Information on billing rates can be obtained either by consulting the local electric utility or a knowledgeable energy engineer.

[7] The annual water (or electricity or fuel) use index is calculated by dividing the annual water (or electricity or fuel) consumption by the annual guest-night occupancy. It therefore represents the average amount of water (or electricity or fuel) that was used by the property per guest-night during that particular year. Annual utility use indices are generally expressed in terms of gallons/guest-night for water, kWh/guest-night for electricity, and gallons/guest-night for fuels such as diesel or LPG.

2.2 Put in place a preventative maintenance program

Many hotels practice mainly "breakdown" maintenance, which consists in maintaining, repairing or replacing appliances and equipment only after they fail to operate properly. This practice forces the maintenance staff to react quickly to unforeseen equipment problems and can thus severely disrupt hotel operations. Preventative maintenance (PM), on the other hand, consists in carrying out regular and predetermined maintenance work on equipment, regardless of their operating condition, in order to forestall future problems and equipment failure. The benefits offered by preventative maintenance and a PM program include:

- Reduced "breakdown" maintenance costs by up to 30%.
- Greater equipment and system reliability.
- Fewer and less frequent large scale repairs.
- Increased operating efficiency of the property's equipment, appliances and fixtures.
- Increased service life of the equipment and appliances.
- Easier identification of breakdown causes which can then be monitored and controlled.
- Reduced standby equipment and spare parts requirements.
- Steadier workload on the maintenance staff.

In order to establish a PM program, a property should ideally implement the following measures.

- Develop an inventory of existing equipment and appliances (e.g., air conditioning units, kitchen and laundry appliances, motors, and water heaters). Each item in this inventory should be accompanied by a brief description that includes brand, model and serial number, date of installation, capacity, and the important technical characteristics of the piece of equipment.
- Develop a written maintenance schedule for all major appliances and areas of the property (e.g., guestrooms). The schedule should indicate how often the inspection should be made, who should conduct the inspection, and how much time should be allowed for the inspection.

Typical frequency of preventative maintenance checks on hotel equipment[8]	
▶ Kitchen gas equipment	every month
▶ Laundry equipment	every month
▶ Gas and diesel water heaters	every 2 months
▶ Guestrooms	every 3 months
▶ Air conditioning systems	every 3 months
▶ Electric water heaters	every 6 months
▶ Electricity distribution system	every year
▶ Water pumps	every year

[8] The frequencies shown in this table are indicative of the typical PM practices in well-maintained properties. Nonetheless, the recommendations of the equipment manufacturers should be adhered to at all times.

- Create written maintenance checklists or guidelines that specify what items should be checked and what should be done when conducting preventative maintenance work on an appliance, piece of equipment, or an area of the property.
- Obtain operating and maintenance instructions from the equipment manufacturers or draft maintenance procedures for some of the more involved maintenance operations.
- Track all maintenance requests and activities in a logbook.

Either the property can devise its own “manual” PM program or it can purchase one of the many PM packages or services available on the market today. Some commercial PM programs are based on software that is run from an on-site computer or accessed over the Internet, while others are controlled by a service provider who faxes daily or weekly work orders to the property. The property should identify and select the system that best meets its needs and budget.

In addition to establishing a PM program, the property should train staff, and in particular its housekeepers, to identify and report basic maintenance problems. For example, some of the typical guestroom maintenance problems that can be easily spotted by well-trained housekeepers include:

- leaking toilets;
- poor toilet flushes (sometimes toilets do not flush properly because there is not enough water in the toilet tank or in the toilet bowl, or because the flapper valve closes too soon);
- malfunctioning toilet flush mechanisms;
- damaged or missing faucet aerators;
- clogged showerheads and aerators;
- excessively high showerhead and faucet flows;
- missing, leaking or damaged sink and tub stoppers;
- high water temperatures in guestrooms and public areas;
- malfunctioning a/c units and a/c controls;
- dirty air filters in a/c units;
- damaged door sweeps or weather-stripping around doors and windows;
- doors, windows and louvers that do not shut tightly and therefore allow outside air to leak into air conditioned rooms; and
- damaged door seals or ice build-up in guestroom refrigerators.

2.3 Reduce the pressure carried by the property’s water distribution system

The flow output of most plumbing fixtures (e.g., faucets, showerheads and hose bibs) and the volume of water lost through leaks is directly related to the pressure in the water supply system: the higher the pressure, the greater the flow produced by the fixtures or lost through leaks. The change in flow output with changes in water pressure can be quite dramatic for most plumbing fixtures. For example, as shown in the following figures, lowering the water pressure from 70 to 50 psi results in

- a 40% reduction in the flow rate from leaks, and faucets, hose bibs, showerheads and other fixtures that are not equipped with aerators or flow restriction devices, and
- an 18% reduction in the flow rate from faucets, showerheads and other fixtures that are equipped with aerators or flow restriction devices.[9]

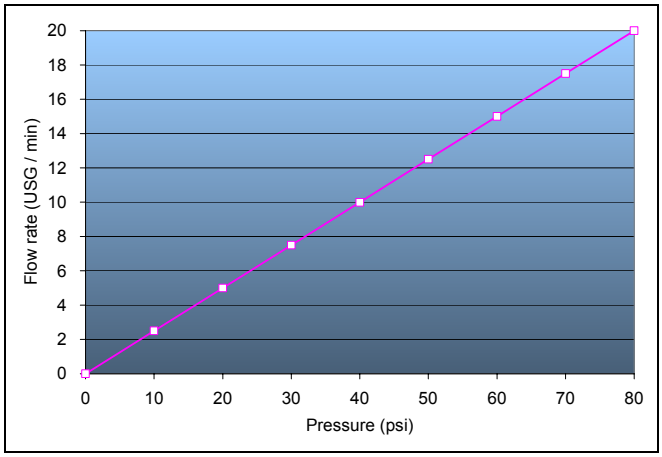

Figure 2.5 - Flow rate versus pressure for a faucet that is not equipped with an aerator or a flow restriction device (source: Neoperl).

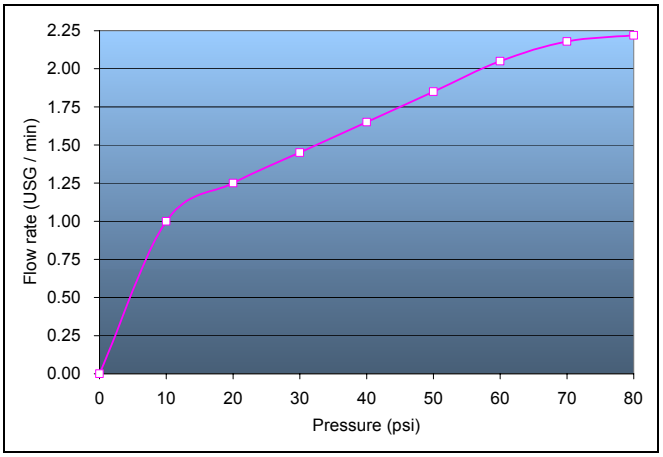

Figure 2.6 - Flow rate versus pressure for a faucet that is equipped with a 2.2 USG/min aerator (source: Neoperl).

A property that operates at a high water pressure can, therefore, significantly reduce its water consumption simply by lowering the pressure in its water distribution system. Given the flow reduction figures presented above, reducing the water pressure from 70 to 50 psi could lower the total water consumption of a property by 10 to 20%. In a typical 50-room hotel, this water conservation measure could save from 500,000 to 1,000,000 USG/year.[10]

A hotel should ideally operate at the lowest acceptable water pressure; that is, the lowest water pressure that still allows its equipment and plumbing fixtures to perform properly (e.g., laundry washers, dishwashers, pressurized-flush toilets, guestroom showerheads). Although hotels are generally able to operate with a water pressure of 40 to 50 psi, many operate with water pressures that range from 50 to 100 psi.

A property that draws and pumps its water from a storage tank or a well can control the pressure carried by its water distribution system simply by modifying the setting on the pump's pressure switch. This modification requires only a minimum amount of effort and no investment.

A property that is supplied by a water utility can control its water pressure by installing a pressure reducing valve on its connection to the water main. This measure requires only a modest investment: in the US, the cost of a 2 to 3-inch pressure reducing valve ranges from US$ 500 to 700 depending on size, brand and features. In addition, since the pressure carried by water mains can at times reach unreasonably high levels (80 to 100 psi nighttime spikes are not uncommon in certain areas), the use of a pressure reducing valve also protects the property's water supply system and plumbing fixtures.

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[9] 1 psi = 6.89 kPa or 0.0689 bar.

[10] These calculations are based on the following assumptions: the hotel has an average occupancy of 70%; there are on average 2 guests per occupied room; and the hotel consumed 200 USG per guest-night before reducing the pressure in the water distribution system.


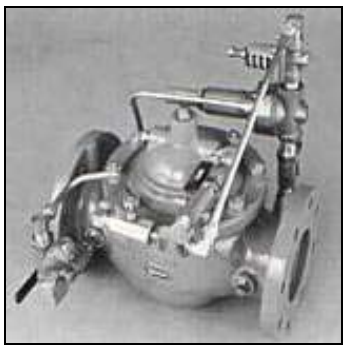

Figure 2.7 - Pressure reducing valves for small diameter pipes (left) and for large diameter pipes (right, WATTS ACV, www.wattsacv.com).

2.4 Minimize water leaks and losses

Leaks can waste a considerable amount of water and have a large impact on a property's water consumption and costs, yet many properties fail to take effective action to minimize leakage losses in their plumbing fixtures, water distribution system and storage tanks. Although in most cases the highly visible leaks, such as dripping faucets and showerheads, are quickly identified and repaired, many of the less obvious leaks, such as creeping toilets and damaged underground pipes, can go undetected for months.

Water leaks are particularly insidious because they are generally continuous and don't just occur when a particular fixture is in use. Dripping faucets or leaking underground pipes lose water 24 hours per day; thus, even a minor leak adds up to a substantial volume of water over time. For example, a dripping tap or valve can easily waste up to 30 USG/day or 11,000 USG/year, and a leaking toilet flapper valve can lose more than 200 USG/day or 73,000 USG/year.

It is interesting to note that the value of the water lost over a short period of time by a malfunctioning fixture can often exceed the cost of the fixture itself. For instance, a toilet in a Jamaican property recently audited by the EAST project had a broken inlet valve that wasted 1.8 USG/minute or 2,600 USG/day. Given the average cost of water and the sewerage fee at this location (10.5 US$/1000 USG), the value of the water lost by this valve in only 5 days (US$ 135) was equal to the cost of a whole new toilet.

Major underground water leaks occur infrequently, but unfortunately they are not uncommon and can instantly waste a significant amount of water. A large underground water leak in a 35-room hotel audited by the EAST project wasted 24,000 USG/day and increased overnight the property's total water consumption by a factor of three. Since this property did not monitor its daily water consumption and the leak occurred in highly porous ground (marl fill), the leak went undetected for a week and cost more than US$ 1,700.

In order to minimize the amount of water lost through leaks, the property should ideally implement the following measures.

- Establish a monitoring program to track the property's water use (see Section 2.1). An effective water monitoring program is generally the best tool to promptly detect costly underground leaks.
- Establish a preventative maintenance program (see Section 2.2) that covers the property's plumbing fixtures, water distribution system and water storage tanks.
- Ensure that the property's toilets receive frequent checks as part of this preventative maintenance program. As discussed in Section 2.7, toilets are often the main source of leaks in hotels.

- Provide effective maintenance to the plumbing fixtures located in back-of-house areas. Plumbing fixtures in work and staff areas are often overlooked and generally account for most of the leaks found in hotels.
- Train the staff, and especially housekeepers, to identify and report leaks and malfunctioning plumbing fixtures (see Section 4.1).

2.5 Implement water conservation measures for showers and tubs

The topics covered in this section include:

- low-flow showerheads,
- flow restrictors,
- self-closing shower valves,
- showerhead and diverter valve maintenance,
- tub stoppers,
- bath tubs and whirlpools, and
- cost-effectiveness of using efficient showerheads and implementing other simple water conservation measures in guestrooms.

2.5.1 Low-flow showerheads

All showerheads installed in guestrooms, staff changing rooms and public areas should consume no more than 2.5 USG/min. Showerheads that produce higher flows waste water and energy and should, therefore, be replaced with effective low-flow showerheads.

Well-designed low-flow showerheads generate a satisfying shower flow while using 2.0 to 2.5 USG/minute. They are readily available on the market and come in a wide range of quality, price, material and style. In the US, a low-flow showerhead generally costs from US$ 5 to 30. The average payback period for replacing an inefficient showerhead with a low-flow model ranges from 1 to 6 months.

Tamper-proof showerheads should ideally be used in all areas where tampering is a problem. Well-designed tamper-proof fixtures have a small set-screw that locks the base of the showerhead on the shower arm, and a special design that prevents the body of the showerhead from being easily taken apart. These showerheads are available in limited style options and are therefore used mainly in staff bathrooms and in public areas (e.g., pool and beach showers). In the US, the cost of a tamper-proof low-flow showerhead generally ranges from US$ 5 to 15.

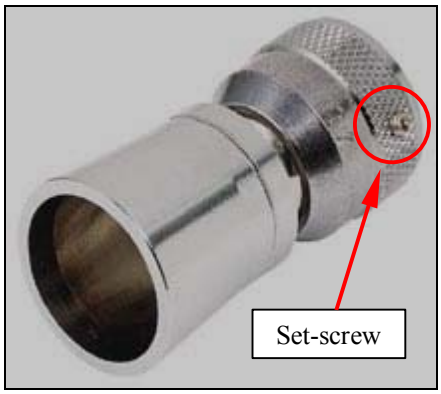

Figure 2.8 -Tamper-proof showerhead (Maintenance Warehouse, www.mwh.com).

Before buying new showerheads, the property should check with the supplier to make sure the fixtures they offer are indeed water efficient, and test a few samples to make sure they perform well. Properties that have low water pressure (e.g., less than 30 psi) should purchase only low-flow showerheads that have a pressure-compensating feature or are specifically designed to work with low water pressures.

Although the cost-effectiveness of low-flow showerheads is well-known in the hotel industry, many properties in the Caribbean and elsewhere around the world still use showerheads that consume from 3 to 8 USG/min of water. As shown in the following example, hotels that use inefficient showerheads are literally throwing money down the drain.

Impact of using inefficient showerheads in guestrooms

A 50-room hotel with 70% occupancy and guestroom showerheads that consume 4 USG/min can waste approximately 665,000 USG of water and 65,100 kWh of energy per year.[11] For an average water cost of 10.5 US$/1,000 IG and an average electricity cost of 0.10 US$/kWh, these inefficient showerheads would add 13,500 US$ to the property's annual utility costs.

If this hotel decided to replace its inefficient showerheads with new low-flow showerheads (with an estimated cost of US$ 30 each), it would spend US$ 1,500 and recover this investment is less than 2 months.

2.5.2 Flow restrictors

If a property is unable to purchase new low-flow showerheads, it should try using flow restrictors to reduce the flow output of its inefficient showerheads. A flow restrictor is a small stainless-steel washer that is placed at the connection between the shower arm and the showerhead to restrict its output to less than 2.5 USG/min. However, since flow restrictors reduce the output of the existing showerheads, they should be used only if they do not significantly affect the strength and quality of the shower flow. Generally, an inefficient showerhead equipped with a flow restrictor will not perform as well as a low-flow showerhead, even if both fixtures use the same amount of water.

[11] These calculations are based on the following assumption: there are on average 2 guests per occupied room; each guests uses the shower for a total of 15 minutes per day; the new low-flow showerheads have an average flow of 2.25 USG/min; the water supplied to the property has a temperature of 68°F; the water used in the showers has an average temperature of 106°F; and the water is heated with an electric water heater that has an efficiency of 95%.

The cost of flow restrictors ranges from US$ 0.25 to 0.50, and the average payback for installing these devices on existing inefficient showerheads is generally less than 2 weeks.

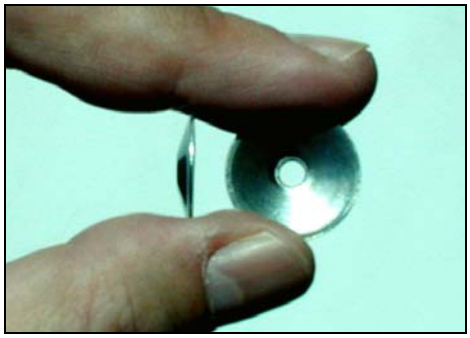

Figure 2.9 -Stainless steel flow restrictors.

2.5.3 Self-closing shower valves

If staff bathroom or public area showers (e.g., pool or beach shower stands) are often left needlessly on, they should ideally be equipped with self-closing valves. These types of valves have a spring-loaded mechanism that shuts off the flow a short time after the valve's lever, push-button, or chain is released. Although the main objective of self-closing valves is to ensure that the flow is off when no one is using the shower, these devices also save water by encouraging people to take shorter showers.

Self-closing shower valves are relatively inexpensive devices. For example, the lever/chain activated valve shown below has a cost of US$ 40 to 50.

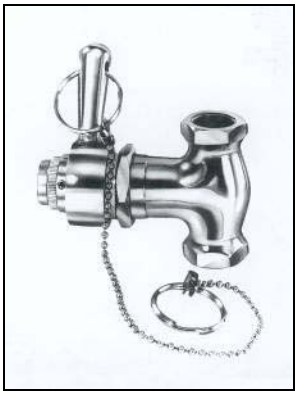

Figure 2.10 -Self-closing shower valve (www.plumbingsupplies.com).

2.5.4 Showerhead and diverter valve maintenance

The property should periodically inspect the guest, staff and public area showers to ensure that they are in proper working order. In particular, the property should pay close attention to the following issues.

- Make sure the showerheads are relatively free of scale and produce a satisfactory flow. The build-up of scale affects the quality of the shower flow and may encourage guests or employees to dismantle the

showerheads, remove existing water conservation devices or, where applicable, take baths instead of showers. Clogged showerheads can be easily cleaned by scraping off the visible scale, and soaking them overnight in vinegar or another safe descaling product.

- Make sure the showerheads have not been tampered with and do not produce excessively high flows (i.e., more than 2.5 USG/min). It is not uncommon to find in hotels low-flow showerheads that have been tampered with and therefore consume a lot more than their original rated output.[12]

How much water do your showerheads and faucets consume?

Use the following procedure to measure the output of a showerhead, faucet or of any other plumbing fixture.

1) Turn on the shower, faucet or fixture at full flow (i.e., both the hot and the cold valves should be fully open).
2) Place a suitable container under the fixture and measure how much time it takes to fill it with water. The size of the container needed will depend on the magnitude of the flow produced by the fixture: the higher the flow, the larger the container needed to carry out the measurement. Faucets can generally be measured with a ½ USG container and showerheads with a 1 USG container.
3) If the flow is not steady, repeat the measurement two or three times and calculate the average time needed to fill the container.
4) Calculate the flow rate using the following formula:

$$\text{Flow rate (in USG/minute)} = \frac{\text{Volume of water collected in the container (in USG)}}{\text{Time needed to fill the container (in minutes)}}$$

- Make sure the valves that divert the water from the tub spout to the showerhead do not leak excessively. In some extreme cases, a leaking diverter valve can send more water out of the tub spout than out of the showerhead.

2.5.5 Tub stoppers

Surprisingly enough, in many of the hotels audited by the EAST project more than 30% of the tub stoppers did not seal properly and allowed water to seep out of the tub. Although this problem is relatively minor, it forces guests to consume more water than necessary either by overfilling or periodically refilling the tub while bathing.

Ensuring that all tub stoppers work and seal properly allows a hotel to save water and energy, and requires only a minimum amount of effort and expense.

[12] A low-flow showerhead generally has a flow restriction device that limits its maximum output to less than 2.5 USG/min. If this restriction device is removed, the flow output of the showerhead can easily increase by a factor of two.

2.5.6 Bath tubs and whirlpools

- Filling a typical bath tub consumes 40 USG of water, or at least 60% more water than a 10-minute shower taken with a water-efficient showerhead.
- The amount of water used by whirlpool tubs varies widely depending on size and configuration, but there is no doubt that they are by far the most wasteful bathing option for guest bathrooms. Since the capacity of a 5-foot whirlpool ranges from 45 to 80 USG and that of a 6-foot whirlpool[13] ranges from 75 to 125 USG, a bath in a whirlpool tub can consume as much water as an 18 to 50-minute shower. In addition, whirlpools come equipped with a 1 to 2-HP pump to circulate water through the jets and, sometimes, with an in-line electric heater to keep the water at a pre-set temperature.[14] Although these pumps and heaters do not consume a large amount of energy because, in most cases, whirlpools are not used for long periods of time, they can significantly increase the energy cost of any property that is billed for its peak electricity demand. In Jamaica, for example, a single 2-HP whirlpool pump could increase the property's electricity demand costs by up to 280 US$/year.[15]

In order to conserve water, energy and reduce its utility costs, the property should ideally adopt the following measures and options.

- Make sure that the low-flow showerheads installed in guest bathrooms are effective and well maintained. Showerheads that are clogged with scale, or are of a poor design that produces a weak and unsatisfying flow, will drive many guests to take baths instead of showers.
- Do not install bathtubs in guest bathrooms. This option has been adopted by many hotels around world and makes a lot of sense especially in areas where water is scarce, or where water and energy costs are particularly high.
- Do not install whirlpool tubs in guest bathrooms. Whirlpool tubs can have a significant impact on a hotel's utility bills and on its maintenance workload (by adding one motor, one pump, one set of controls and, possibly, one electric water heater in each guestroom that is equipped with a whirlpool tub).
- Evaluate the total impact that whirlpool tubs can have on utility costs before deciding to install them in guestrooms. This detailed evaluation should be particularly important for properties that pay for their peak electricity demand (e.g., Jamaican hotels that are billed on JPSCo's "rate 40") or are subjected to high water and energy costs.

2.5.7 Cost-effectiveness of using efficient showerhead and implementing other simple water conservation measures in guestrooms

The figure below shows the water consumption curve of a guestroom block in a beach hotel before and after the guestrooms were given a water conservation retrofit. This retrofit consisted in

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[13] These dimensions refer to the overall length of the whirlpool and not to the length of the bathing well.

[14] It is interesting to note that the power rating of a whirlpool pump is equal to that of the typical pump used in small to medium-size hotel pools.

[15] In September 2001, the Jamaican electric utility (JPSCo) billed its "rate 40" customers a monthly peak demand charge of approximately 13.80 US$/kVA. Since the apparent power (in kVA) drawn by a motor is equal to the real power (in kW) drawn by the motor divided by its power factor (i.e., kVA = kW / power factor), a 2-HP (1.5-kW) whirlpool motor with a power factor of 0.9 can increase the property's monthly peak demand by up to 1.67 kVA.

- replacing the existing inefficient showerheads with new low-flow showerheads,
- replacing the existing inefficient faucet aerators with 1.5 USG/min aerators,
- repairing toilet leaks, and
- adjusting the water level in the toilet water tanks.

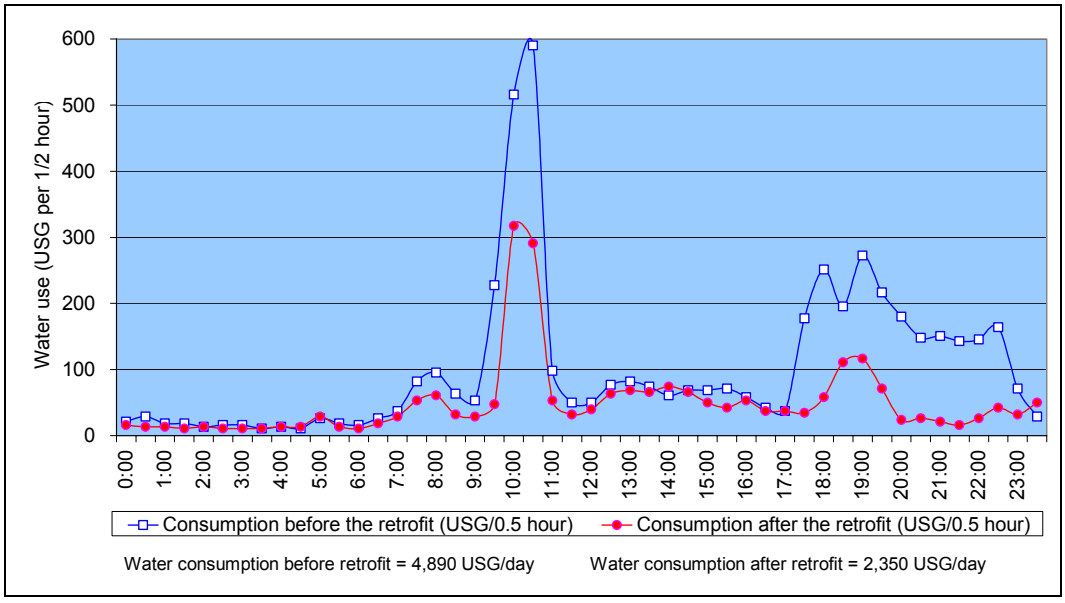


Figure 2.11 - Daily water use profile of a guestroom block (14 rooms, 25 guests) before and after the water conservation retrofit.[16]

The water conservation retrofit carried out in the 14 rooms of this guestroom block required only 2 hours of labor and US$ 170 worth of materials (i.e., a US$ 2 aerator and a US$ 10 showerhead in each room). In return, this retrofit reduced the guestrooms' water consumption by 52% or 102 USG/GN. Given that this 75-room hotel had an occupancy of 34,450 GN/year and a water cost of 10.5 US$/1000 USG, it could have reduced its water consumption by 3,510,000 USG/year and save 36,800 US$/year by giving a similar water conservation retrofit to all of its guestrooms.

2.6 Implement water conservation measures for faucets and sinks

The topics covered in this section include:

- faucet aerators,
- aerator maintenance,
- faucet shut-off valves,
- flow restrictors,
- metering faucets,

[16] This data was collected over two consecutive days, during which the same 25 guests occupied the same 14 rooms.

- pedal valves, and
- sink stoppers.

2.6.1 Faucet aerators

An aerator is a simple water conservation device that screws directly at the end of a faucet and reduces its output without affecting, in most cases, the "feel" of the flow. This device lowers the output of a faucet either by mixing air into the water flow, throttling the flow through a small aperture, or splitting the flow into a spray pattern. Aerators should not be confused with screen caps which have no effect on the faucet output.

The basic aerator characteristics that must be defined when purchasing faucet aerators include flow output, thread type and thread size.

- Flow output: The rated output of aerators generally ranges from 0.5 to 2.5 USG/min. As shown in the table below, the output of an aerator should be suited to the use given to the faucet on which it is installed.

Rated aerator output[17]	Recommended application
▶ 0.5 USG/min ▶ 1.0 USG/min	Staff and public bathrooms, hand-wash sinks in kitchens and bars, and other areas where high flows are not required[18]
▶ 1.5 USG/min ▶ 2.0 USG/min	Guestrooms, and staff and public bathrooms
▶ 2.2 USG/min ▶ 2.5 USG/min	Work area faucets in kitchens, bars, laundry rooms, and linen closets

- Thread type: The type of thread on an aerator must match the type of thread on the faucet on which it is installed. An aerator with male threads will fit only a faucet that has female threads and, conversely, an aerator with female threads will fit only on a faucet that has male threads.[19] Dual-thread aerators have both male and female threads and can thus be installed on faucets that have either male or female threads.
- Thread size: The size of the thread on an aerator must also match the size of the thread on the faucet on which it is installed. Fortunately, most faucets have a standard thread size and can be equipped

[17] Aerator output is rated at a line pressure of 60 psi (410 kPa or 4.1 bar). The actual output of an aerator can therefore be different from its rated output depending on the actual water pressure at the property.

[18] The property is encouraged to purchase only the 0.5 and 1.0 USG/min aerators that produce a spray-like flow (similar to a showerhead flow). At such low flows, spray aerators are more effective than aerators that generate a single stream of water.

[19] Male aerator threads are cut on the outside surface of the aerator's metal housing, while female aerator threads are cut on the inside surface of the housing.

with aerators that have “regular” male or female threads.[20] Faucets that require aerators with “junior” or metric threads are generally uncommon in most parts of the Caribbean.[21]

In addition to the basic aerator characteristics presented above, several manufacturers also offer special aerator features and options that may be of interest to some hotels. These special features and options include:

- Tamper-proof aerators: Tamper-proof aerators are equipped with a rotating security sleeve that prevents theft and tampering. These aerators can be installed on and removed from a faucet only with the use of a special key.
- Spray aerators: Although “standard” aerators produce an “aerated” or “foamy” flow of water, some aerators produce a spray flow similar to that of a showerhead. Generally, 0.5 to 1.0 USG/min aerators are manufactured as spray aerators because the spray pattern is able to produce a vigorous flow while consuming a minimum amount of water. For this reason, all 0.5 to 1.0 USG/min aerators installed in hotels should ideally be spray aerators.
- Dual-spray aerators: Dual-spray aerators can be adjusted to produce either a single aerated flow or an open spray flow. These aerators are more versatile and practical than “standard” aerators and are thus ideally suited for use on kitchen and bar faucets.
- Pressure compensating aerators: These aerators produce a relatively constant flow output over a broad range of water pressure (20 to 80 psi). Pressure compensating aerators are thus recommended for areas that have low or variable pressure conditions.
- Anti-scaling feature: These aerators have a non-metallic outlet screen that prevents lime build up and thereby reduce maintenance problems in hotels that have hard water.
- Anti-clogging screen: These screens are designed to capture the particles and sediments contained in the water and prevent them from clogging the aerators.
- Feature combinations: Some manufacturers offer aerators that combine several of the special features listed above. For example, NEOPERL manufactures aerators (of various flow rates, and various thread sizes and type) that combine tamper-proof, pressure compensating, anti-clogging and anti-scaling features.




[20] The dimensions of “regular” male threads are 15/16” - 27, and the dimensions of “regular” female threads are 55/64” - 27. These are the typical thread sizes found on most of the aerators and faucets used in the US and in the Caribbean.

[21] The dimensions of “junior” male threads are 13/16”-27, and the dimensions of “junior” female threads are 3/4”-27.

Standard aerator (Neoperl, www.Neoperl.com).	*Aerated flow produced by a standard aerator (Neoperl, www.Neoperl.com).*	*Spray flow produced by a spray aerator (Neoperl, www.Neoperl.com).*	*Dual-spray aerator (AM Conservation Group, www.amconservationgroup.com) .*

Figure 2.12 - Examples of different types of faucet aerators.

The use of aerators is particularly important on faucets that are used frequently (e.g., in public and employee bathrooms), are left running for long periods of time (e.g., in kitchens and laundry rooms), or have very high outputs. In addition to conserving water, aerators also save energy by reducing the amount of hot water that is drawn from faucets. Aerators must only be periodically cleaned and de-scaled and thus require little maintenance.

In the US, the cost of these devices ranges from US$ 1 to 2 for "standard" aerators, US$ 2 to 4 for tamper-proof aerators, and US$ 4 to 10 for dual-spray aerators. The average payback period for installing aerators varies from 3 to 6 months in guest bathrooms, 1 to 3 months in public and staff bathrooms, and less than 1 month in kitchens and bars.

Impact of using efficient faucet aerators in guestrooms

The assessment of a 100-room hotel revealed that 67% of its guestroom faucet aerators were either damaged or missing, and allowed the faucets to produce flows of up to 5.5 USG/min. In addition, many of the aerators that were still intact were inefficient and produced flows of up to 3.4 USG/min.

The assessment team estimated that, by installing 1.5 USG/min aerators in all guestrooms, the property could have reduced its water consumption by more than 225,000 USG/year and saved 2,400 US$/year. Since this measure required a US$ 200 investment, it offered a payback period of only 5 weeks.

2.6.2 Aerator maintenance

Although faucet aerators are standard and well-known water conservation devices (faucets are generally sold with aerators), many hotels fail to adequately maintain them and ensure that they are not tampered with or removed from the faucets. The following table illustrates this point by presenting the results of a faucet survey conducted at five-star hotel. Surprisingly enough, at the time of the survey, this hotel was less than 2 years old and all its faucets had originally been supplied with aerators.

Example results of a faucet survey conducted at a five-star hotel

Location	% of faucets with damaged or missing aerators	Maximum flow measured on the existing faucets	Maximum faucet flow recommended for each location
Guestrooms	67 %	5.5 USG/min	2.0 USG/min
Public bathrooms	100 %	5.5 USG/min	1.5 USG/min
Staff changing rooms	100 %	3.3 USG/min	1.0 USG/min
Kitchen - work faucets	90 %	6.5 USG/min	2.5 USG/min
Kitchen - hand wash faucets	100 %	6.5 USG/min	1.0 USG/min
Bars	100 %	5.0 USG/min	2.5 USG/min

In order to avoid these problems, the property should ideally include the following activities in its standard maintenance operations.

- Periodically check all of the property's faucets to ensure their aerators are in proper working order and produce no more than the required flow.
- Clean and descale the aerators as needed in order to minimize guest complaints and tampering problems -- clogged aerators are often dismantled or removed by frustrated guests, housekeepers or other members of the staff. Faucet aerators can be easily descaled by soaking them overnight in vinegar or another safe descaling product.

2.6.3 Faucet shut-off valves

The output of faucets can also be reduced by partially closing the shut-off valves that are generally installed on the pipes that convey water to the faucets. These valves are often wide open and thus subject the faucets to the full pressure carried by the water distribution system. This measure should be applied to all faucets that cannot be equipped with aerators, or that still produce more water than necessary even when equipped with aerators. Adjusting faucet shut-off valves requires a minimum amount of effort and can yield significant savings.

Figure 2.13 -Typical faucet shut-off valves.

Impact of reducing high faucet flows by adjusting the shut-off valves

The guest bathrooms of a 75-room property assessed by PA Consulting were equipped with faucets that were not designed to use aerators. These faucets produced an aesthetically pleasing "cascade flow" that unfortunately consumed up to 5 USG/min.

Tests conducted at this property showed that the output of these faucets could be reduced to less than 2 USG/min simply by partially closing their shut-off valves. By implementing this simple measure in all guestrooms, the property could have reduced its water consumption by 200,000 USG/year and saved 2,100 US$/year.

2.6.4 Flow restrictors

A flow restrictor is a small stainless steel washers that is placed in the water pipe ahead of a plumbing fixture, such as a faucet or a hose bib, to restrict its output to less than 2.5 USG/min. However, since the periodic maintenance (cleaning or de-scaling) of the flow restrictors installed on faucets and hose bibs requires some effort, these devices should be installed only on fixtures that cannot be equipped with aerators or controlled by adjusting their shut-off valves.

The cost of flow restrictors ranges from US$ 0.25 to 0.50. The average payback period for installing flow restrictors varies from 1 to 2 months in guest bathrooms, less than 1 month in public and staff bathrooms, and less than 1 week in kitchens, bars and other work areas.

Figure 2.14 -Stainless steel flow restrictors.

2.6.5 Metering faucets

Metering faucets are equipped with a mechanism that either limits the duration of the flow or activates the flow only when the user's hands are under the faucet. Examples of such mechanisms include electronic sensors, electronic timers and spring-loaded valves. Metering faucets are also generally equipped with aerators to further reduce their water consumption. It is generally estimated that metering faucets installed in public or staff bathrooms use 50 to 75% less water than conventional manually-operated faucets.

Although metering faucets are more expensive than regular faucets, they are cost effective especially when installed in heavily-used public or staff bathrooms, used to replace bathroom faucets that are often left running needlessly, or installed in hotels that have high water costs.

The principal features and characteristics of electronic and mechanical metering faucets are presented below.

Electronic metering faucets can be classified in two categories.

- Touch-free (or sensor-controlled) metering faucets: These fixtures are equipped with a sensor that automatically activates the flow only when the user's hands are under the faucet. Since the user does not need to touch any part of the fixture, touch-free metering faucets are considered to be more hygienic than push-button or mechanical metering faucets.
- Push-button electronic metering faucets: These fixtures are equipped with a button that controls the faucet flow: touching the button turns on the faucet on for a pre-set length of time. The duration of the flow can be adjusted by programming the fixture's electronic timer, and in most models the flow setting can range from 5 to 120 seconds per cycle. These faucets are generally factory-set at 10 sec/cycle.

There are two different options for the energy source used by electronic metering faucets.

- Batteries: Electronic metering faucets can be powered by batteries (e.g., 3 VDC lithium battery) that are mounted either in the body of the faucet or under the sink counter. A long service-life battery can last up to 500,000 cycles, but must be replaced at the end of its service life. Battery-operated electronic metering faucets are often preferred for retrofit jobs because they do not require the installation of an electrical outlet under the sink.
- Transformers: Electronic metering faucets can also be powered by DC current generated by a transformer mounted under the sink counter. These metering faucets require an AC outlet under the sink.

The cost of electronic metering faucets can vary widely depending of brand, style, quality and features, but in the US it generally ranges from US$ 300 to 400.

Mechanical metering faucets are equipped with a spring-loaded valve that must manually activated to start the flow. This valve is generally equipped with a dampening mechanism that shuts off the flow a short period of time after the lever or the push-button is released.

In the US, the cost of mechanical metering faucets generally ranges from US$ 75 to 150. Since mechanical metering faucets are less expensive and less prone to tampering than electronic metering faucets, they are often installed in more demanding areas such as staff bathrooms.

Advantages (+) and disadvantages (-) of electronic metering faucets	**Advantages (+) and disadvantages (-) of mechanical metering faucets**
+ Use 50 to 75% less water than conventional faucets. + More hygienic (for touch-free models). + Faucet output and flow duration is largely unaffected by water temperature and pressure. + Battery powered metering faucets are relatively easy to install.	+ Use 50 to 75% less water than conventional faucets. + Less expensive than electronic metering faucets. + Generally rugged and durable. + Easy to install.
- More expensive than conventional faucets or mechanical metering faucets. - Batteries must be changed periodically (for battery operated models). - Will not operate during power outages (for transformer operated models). - Transformer-operated models require power outlets and thus may be more difficult to install in some bathrooms. - Some models are vulnerable to tampering.	- Faucet output and flow duration are affected by water temperature and pressure. However, most models can be calibrated to account for specific pressure and temperature conditions. - Less “elegant” than conventional faucets or electronic metering faucets.

Figure 2.15 - Touch-free metering faucet installed in a public bathroom.

Figure 2.16 - Mechanical metering faucet (Chicago Faucet, www.chicagofaucet.com).

2.6.6 Pedal valves

A pedal valve allows bar or kitchen workers to operate a faucet simply by stepping on a valve located under the sink. As soon as the pedal is released, the valve automatically shuts off the faucet flow. The use of pedal valves saves water and energy, reduces food-borne cross contamination by allowing hands-free faucet operation, and reduces the wear and tear on standard faucets by eliminating the twisting and over-tightening of faucet valves.

Given the type of work carried out in kitchen pot sinks, their faucets often produce very high flows (4 to 8 USG/min), use a large amount of hot water, and are left running for long periods of time. Since scullions generally don't have the time to worry about conservation while washing piles of greasy pots, installing pedal valves on heavily used pot sinks is often the best way to reduce water and energy use in these areas. Tests conducted in US hotels and restaurants have shown that pedal valves can save from 25,000 to 100,000 USG of water per year per sink.

The cost of pedal valves ranges from US$ 100 to 500 depending on brand, quality and design. The average payback period for these fixtures varies from 3 to 12 months when installed on frequently used kitchen and bar sinks.

Figure 2.17 - Pedal valves installed under a kitchen sink (Pedal Valves Inc., www.pedalvalve.com).

Figure 2.18 - Hot/cold water pedal (Chicago Faucet, www.chicagofaucet.com).

2.6.7 Sink stoppers

It is not uncommon to find hotels in which more than 30% of guestroom sinks do not have stoppers or are equipped with stoppers that leak or do not operate properly. Leaking, damaged or missing sink stoppers force the guests to use running water, for example, when shaving or washing clothes and thus needlessly waste water and energy.

2.7 Implement water conservation measures for toilets

The topics covered in this section include:

- water-saving toilets,

- maintenance of gravity-flush toilets, and
- water conservation devices for gravity-flush toilets.

2.7.1 Water-saving toilets

Most toilets manufactured today are water-saving toilets which use 1.6 USG per flush. Earlier models were far less efficient: the "water-saver" toilets manufactured in the 1980s consumed 3.5 USG/flush, and, before that, standard toilets used 5 to 7 USG/flush.

In hotels that are not equipped with water-saving toilets, toilet flushing alone can accounts for 25 to 40% of all indoor water use. Since water-saving toilets use 50 to 75% less water than their older and inefficient counterparts, installing effective water-saving toilets can significantly reduce the total water consumption of a hotel.

Impact of water-saving toilets on water consumption

Replacing a single inefficient guestroom toilet with a water-saving toilet can save[22]

- 4,400 USG/year if the inefficient toilet consumes 3.5 USG/flush, and
- 7,800 USG/year if the inefficient toilet consumes 5.0 USG/flush.

Replacing a single inefficient toilet in a public or staff bathroom with a water-saving toilet can save[23]

- 27,700 USG/year if the inefficient toilet consumes 3.5 USG/flush, and
- 49,600 USG/year if the inefficient toilet consumes 5.0 USG/flush.

The water-saving toilets that are suited for hotel applications can be classified in three categories: gravity-flush, pressurized-flush and flush valve toilets.

- Gravity-flush toilets, like older traditional toilets, rely on gravity to inject the water from the toilet tank into the bowl with enough force to flush out the waste. The particular design of the toilet bowl and trapway, and the location and manner in which the flush water is injected into the bowl allow the new gravity-flush toilets to use only a fraction of the water consumed by older toilet models. The cost of a gravity-flush water-saving toilet varies widely depending on brand, quality, design and style, but typically ranges from US$ 100 to 400.
- Pressurized-flush toilets are equipped with a device that pressurizes the flush water before it is injected into the bowl. The high pressure and velocity of the flush water, in addition to the toilet bowl and trapway design, allow these toilets to flush out the waste with a minimum amount of water. In most pressurized-flush toilets, the flush water is pressurized in a closed vessel by an air cushion that is exposed to the pressure carried by the water distribution system. When the flush mechanism is

[22] These calculations are based on the following assumption: the hotel has a 70% average occupancy rate; there are on average 2 guests per occupied room; each guest flushes the toilet 4 times per day; and the housekeeper flushes the toilet once when cleaning an occupied room.

[23] These calculations assume that toilets in public and staff bathrooms are flushed on average 40 times per day.

activated, the compressed air cushion acts as a spring and pushes the flush water out of the vessel and into the bowl at high velocity. Since the pressurization system is generally contained in the "water" tank, pressurized-flush toilets look like standard gravity-flush toilets.

Pressurized-flush "mechanism" are generally made by a few specialized companies and then incorporated in the water-saving toilets produced by various manufacturers. It is therefore quite common to find different toilets, by different manufacturers equipped with the same pressurization system. In such cases, the main difference between the pressurized-flush toilets is style rather than performance. The cost of pressurized-flush water-saving toilets varies widely depending on brand, quality, design and style. On average, a toilet equipped with a pressurized-flush mechanism costs US$ 100 more than a gravity-flush toilet of comparable quality and design.

A comparison of some of the features of gravity-flush and pressurized-flush toilets is given in the following table.

Gravity-flush water-saving toilets	Pressurized-flush water-saving toilets
Lower cost.	Higher cost.
Quieter flush.	Most pressurized-flush toilets have a noisier flush than gravity-flush toilets.
Relatively simple installation.	Relatively simple installation.
Some models have inadequate "rim cleaning" during the flush.	High flow velocity ensures good "rim cleaning" during the flush.
Some models have more clogging and incomplete flush problems than traditional toilets.	Have fewer clogging and incomplete flush problems than gravity-flush water-saving toilets.
Not more difficult to maintain than traditional toilets.	Flush mechanisms are high-tech, but generally rugged, durable and proven. Some manufacturers have more than 15 years of experience with the technology.

- Flush valve toilets: These toilets do not have a water tank but are equipped with a flush valve assembly that is directly connected to the water distribution system. Like pressurized-flush toilets, these types of toilets produce a vigorous and effective flush. Since flush valve toilets are generally durable, effective, and more resistant to tampering than most gravity-flush toilets, they are often used in public and staff bathrooms. Although the costs of flush valve toilets varies widely depending on brand, quality, design and style, typical costs range from US$ 120 to 300 for the toilet bowl and US$ 100 to 150 for the flush valve assembly.

Figure 2.19 - Gravity-flush toilet (tank cover has been removed to shown the components of the flush mechanism).

Figure 2.20 - Pressurized-flush toilet (tank cover has been removed to show the pressurization system).

Figure 2.21- Flush valve assembly of a flush valve toilet (Sloan, www.sloanvalve.com).

Cautions and comments

- Hoteliers are often concerned that replacing older "high-volume" toilets with water-saving toilets will increase clogging problems in the existing drainage lines. However, experience has shown that standard sewer-pipe diameters and slopes, both inside and outside buildings, can carry wastes from water-saving toilets adequately and with sufficient velocity to prevent clogging. This is because water-saving toilets maintain a peak discharge rate comparable to that of the older "high-volume" toilets, and it is this peak flow that transports the waste down the drainage pipes. Most of the water consumed by older "high-volume" toilets generally precedes the waste down the pipe and therefore does not do much work.

  Nonetheless, the property should seek the advice of an experienced plumber to ensure that the new water-saving toilets are indeed compatible with its drainage system. The property should also test a few water-saving toilets before introducing them widely in all hotel areas.

- When purchasing pressurized-flush or flush valve toilets, make sure that the selected model is compatible with the property's water pressure conditions. Most pressurized-flush and flush valve toilets will not operate properly at low water pressures.

- When purchasing water-saving toilets, find out from other hoteliers which brands and models have a proven track record in the local market.

2.7.2 Maintenance of gravity-flush toilets

Audits conducted by PA Consulting in the Caribbean have shown that it is not uncommon to find hotels that have leaks and other water-related maintenance problems in more than 40% of their toilets. Although these problems are often considered to be relatively minor and dismissed by the maintenance staff, they can easily increase the total water consumption of a hotel by more than 20%.

Impact of poor toilet maintenance on water consumption

Auditors of the EAST project found three malfunctioning toilets in a 35-room hotel, which combined wasted 3,900 USG or US$ 41 worth of water per day. Given that the hotel used on average 9,200 USG/day, these three toilets alone accounted for more than 40% of its total water consumption.

These toilet leaks were fixed by adjusting the position of two of the floats and replacing a damaged flapper valve. This effort required less than 15 minutes of labor and US$ 5 worth of spare parts.

In order to avoid wasting water, the property should periodically conduct the following basic maintenance checks on all of its gravity-flush toilets.

- Make sure the toilets flush properly. Sometimes toilets may not flush well because there is not enough water in the toilet tank or in the bowl, or because the flapper valve closes too soon.
- Ensure that all flapper valves are in good condition and properly seal the outlet of the water tank. Clean or replace old flapper valves as necessary.
- Ensure there is no scale build-up that prevents the flapper valves or mechanisms from sealing properly the outlet of the water tank.
- Ensure that the toilet flush mechanisms operate without jamming. Check for obstructions or other problems that could prevent the flush mechanisms from closing properly (e.g., excessively long or short flapper valve chains, rusted or loose flush handles). A damaged or jammed flush mechanism can waste more than 4 USG/minute (or 5,700 USG/day) until it is detected and corrected.
- Make sure that the rate at which the water flows out of the refill valve and into the water tank is not excessively high. In some cases the turbulence caused by a high inflow rate can prevent the flapper valve from closing properly. If needed, reduce the flow rate into the water tank by partially closing the shut-off valve that is installed on the toilet's water supply line.
- Check the water tanks to make sure that the water level is at the proper height. If needed, correct the water level in the tank by adjusting the position of the float. The optimal water level is often indicated by a mark inside the water tank. If not, it should be determined by the maintenance staff for each type of gravity-flush toilet used on property.
  - If the water level is too high, the toilet will use too much water with each flush or may constantly lose water through the top of the overflow pipe.
  - If the water level is too low, the toilet will not function properly and will have to be flushed more than once to evacuate the waste.
- Make sure that the refill valves are in proper working order and are not clogged with dirt or scale.
  - Dirt particles or scale can prevent the refill valve from closing properly, allowing water to continuously trickle from the refill valve into the tank.
  - Toilets that have a clogged refill tube (i.e., the small rubber hose that feeds water to the overflow pipe while the toilet tank is refilling) often have too little water in the toilet bowl and may not flush properly.
- If applicable, make sure that all water conservation devices and features are properly installed, operate as intended, and do not interfere with the flush mechanism.

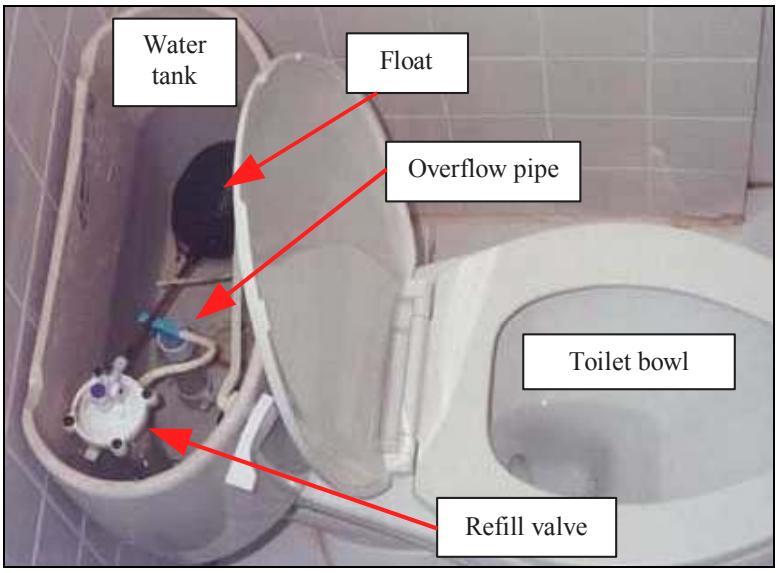


Figure 2.22 -Typical gravity-flush toilet.

2.7.3 Water conservation devices for gravity-flush toilets

There are various water conservation devices that can be retrofitted on gravity-flush toilets to reduce the volume of water used with each flush. Depending on their type and design, as well as the characteristics of the toilet on which they are installed, these water conservation devices can generally save from 0.25 to 1.5 USG per flush.

Water conservation devices for gravity-flush toilets can be classified in two categories: devices that reduce the amount of flush water discharged from the toilet tank, and flow diverters that reduce the amount of refill water discharged into the toilet bowl.

1) The types of water conservation devices that reduce the amount of flush water discharged from the tank of gravity-flush toilets include displacement devices, toilet dams and early-closure devices.

   Displacement devices are objects, such as bags or bottles filled with water, that are placed in the tank of gravity-flush toilets to reduce the volume, but not the height, of the water stored in the tank. By reducing the volume of water contained in the tank, displacement devices automatically reduce the volume of water used with each flush. Displacement devices must not interfere with the flush mechanism and should be attached to the tank wall to prevent them from migrating inside the tank. Displacement bags cost US$ 1 to 2 per unit, and have a typical payback period of 3 to 6 months. However, most hotels make their own displacement devices out of empty plastic bottles or containers.

   Toilet dams are flexible stainless steel or plastic panels that are used to block off, or dam, part of the water tank of a gravity-flush toilet. When the toilet is flushed, the water that is trapped behind the dam cannot escape and is therefore saved. Toilet dams cost US$ 1.5 to 3 per unit, and have a typical payback period of 4 to 9 months.

   Early-closure devices. An early-closure device replaces the existing flush valve or acts on the existing flush valve and saves water by closing the outlet of the water tank before it is empty. Early-closure devices such as short flush flapper valves cost US$ 5 to 10 per unit, and have a typical payback period of 1 year.

Cautions and comments

- The water conservation devices discussed above are designed for use only on "high-volume" gravity-flush toilets (i.e., toilets that are equipped with large water tanks and use 3.5 USG/flush or more). They should **never** be installed on water-saving toilets (1.6 USG/flush): these toilets are already designed to use a minimum amount of water and won't operate properly if equipped with these water conservation devices.

- As a general rule, water conservation devices cannot be automatically installed on all "high-volume" toilets. Instead, the property should determine (by trial and error if needed) which devices can be installed on its existing "high-volume" toilets, and test the effectiveness of the water conservation devices before installing them in all hotel areas.

2) Flow diverters are simple water conservation devices that save water by avoiding overfilling the toilet bowl: once the water reaches the maximum allowable level in the bowl, all additional water added to the bowl is automatically discharged from the toilet and wasted. Flow diverters are placed at the end of the hose that feeds water to the toilet bowl through the overflow pipe, and divert to the water tank part of the flow that would otherwise drain to the bowl.

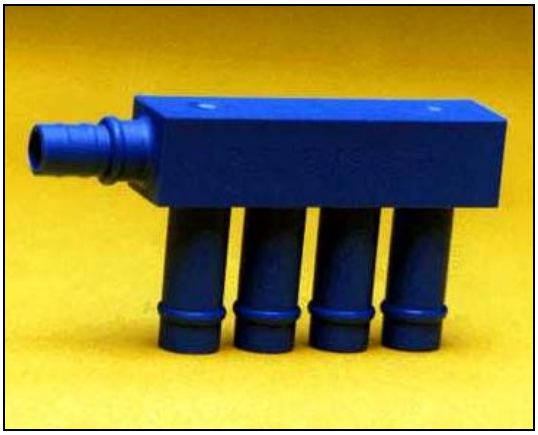


Figure 2.23 - Flow diverter with three adjustment positions (The Fuller Group, www.aquasaver.com).

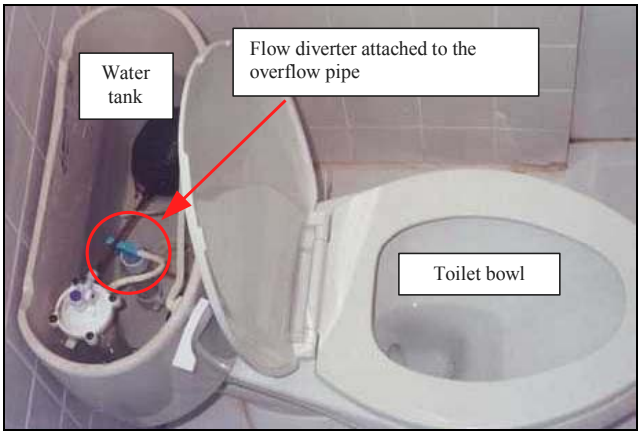


Figure 2.24 - Flow diverter installed on a gravity-flush toilet.

Flow diverters can generally be used on any gravity-flush toilet that has an excessively long bowl refill cycle; that is, a toilet where the bowl fills up faster than the water tank and, therefore, allows water to trickle into the bowl long after the water level in the bowl has reached its maximum level. Depending on its design and on the characteristics of the toilet on which it is installed, a flow diverter can save from 0.2 to 0.5 USG per flush. Flow diverters cost US$ 1 to 2.5 per unit, and typically have a payback period of 8 to 12 months.

Cautions and comments

Flow diverters should **never** be automatically installed on all gravity-flush toilets. Instead, the maintenance staff should inspect all gravity-flush toilets to determine how many of them have excessively long bowl refill cycles and could thus be equipped with flow diverters.[24]

[24] A toilet has an excessively long bowl refill cycle if water trickles into the bowl long after the water level in the bowl has reached its maximum level.

2.8 Harvest and use rainwater

Many parts of the Caribbean are blessed with an ample supply of rain, yet many hotels in the region fail to take advantage of this resource. Even hotels that pay a high price for their water, or complain about water shortages, often allow the rainwater that falls on their roofs to simply drain away onto the surrounding ground or into their drainage system. This common practice not only wastes a valuable resource but can also generate problems such as overloaded sewers and wastewater treatment systems, and soil and beach erosion.

Properly harvested rainwater is clean and chemically pure and can thus be used in most hotel operations that do not require potable water.[25] The principal benefits of harvesting and using rainwater are presented below.

- The use of rainwater instead of hard tap water in the laundry can significantly reduce the consumption of detergents and other laundry chemicals. For example, a 1 grain/gallon (17 mg/liter) reduction in the hardness of the wash water can reduce the consumption of some detergent by up to 1 oz/100 lb of linen.
- The use of rainwater water in the laundry can greatly reduce or eliminate the need to treat the wash water in a water softening column or with water softening chemicals.
- Rainwater is naturally soft and does not deposit scale in water lines, plumbing fixtures and water heaters.
- Rainwater harvesting reduces the amount of rainwater that is discharged to the ground or beach during storms. This in turn reduces surface runoff, soil or beach erosion, and the water logging problems that often affect the performance of soakaways and tile fields during the rainy season.

Comparison between rainwater and tap water		
Parameter	Rainwater	Typical tap water
Hardness	< 10 mg/liter < 0.6 grain/gallon	150 to 300 mg/liter 8.8 to 17.5 grains/gallon
TDS	< 50 mg/liter	300 to 600 mg/liter
pH	5.5	7.0

- Harvesting, handling, storing and using rainwater is a relatively simple and low-cost process, which has been practiced around the world for thousands of years. Although the best time to think about rainwater harvesting is before the construction of the hotel, many existing buildings in hotels can be transformed fairly easily into effective rainwater collection surfaces. There is plenty of useful information on how to design, build, operate and maintain a rainwater harvesting system on the Internet. Some of the better rainwater harvesting Internet sites include:
  - http://www.twdb.state.tx.us/publications/pub.htm (A complete “Rainwater Harvesting” document can be downloaded from this site. The link to the document is located in the “brochure” section of the web page.)
  - http://www.eng.warwick.ac.uk/DTU/rwh/index.html

[25] Rainwater is naturally soft and virtually free of iron and total dissolved solids (TDS).

- http://www.greenbuilder.com/sourcebook/Rainwater.html#contents
- http://www.rdrop.com/users/krishna/rainwatr.htm

Although rainwater can be used for most applications that do not require potable water (e.g., flushing toilets, showering, washing clothes and irrigating the gardens), it generally offers the greatest financial and environmental benefits when used as a source of laundry wash water. Unless the hotel has very large storage tanks or is located in an area where rainfall is well distributed throughout the year, the common practice of using rainwater for irrigation is not very effective because the maximum supply of rainwater is available during the rainy season when irrigation needs are the lowest.

The volume of rainwater that can be harvested varies widely depending on local rainfall and the size of the roofs. In areas with heavy rainfall, such as Port Antonio, Jamaica, hotels can collect enough water to meet all their non-potable water needs (e.g., showers, toilets, laundry, pool and irrigation). In areas that receive less rainfall, such as Negril and Montego Bay, Jamaica, hotels can often collect enough rainwater to fully supply their laundry operations.

Rainfall is generally expressed in terms of inches (or millimeters)[26] of rain: one inch of rain deposits 0.62 USG of rainwater per square foot of surface. Therefore, in a place like Negril, which receives on average 57 inches of rain per year, each ft^2 of a catchment area can collect approximately 35.3 USG of rainwater per year.

Figure 2.25 - Rainwater catchment system. Rainwater is collected from the roof of this back-of-house building to supply water to the laundry. The large-diameter downspout conveys the water from the roof's gutter to the concrete storage tank.

2.9 Collect and reuse the "clean" water flows discarded by the property

In addition to the rainwater that falls on the roofs, many hotels discard a lot of water that is clean enough to be reused in some of their operations. The following table presents a list of the typical "clean" water flows that are discarded by hotels and some of the possible reuse options for these flows.

[26] One inch = 25.4 millimeters (mm).

Source	Reuse options	Comments
Defrost water from ice makers	▶ Laundry water ▶ Irrigation water	Although in most cases defrost water is not pure enough to be returned to the hotel's general water supply, it certainly is sufficiently clean to be used as laundry wash water. Based on measurements taken by EAST auditors, a medium-size ice maker (capacity = 500 lb of ice per day) can discharge as much as 40,000 USG of defrost water per year.
Cooling water from water-cooled ice makers or drinking fountains	▶ General water supply ▶ Laundry water ▶ Irrigation water	The cooling water that is used by some refrigeration equipment is generally perfectly clean and should be collected and reused. If the discarded cooling water is free of contamination, it can even be returned to the hotel's general water supply. Water-cooled refrigeration equipment can consume a huge amount of water. For example, a single water-cooled drinking fountain that was installed in the gym of a hotel audited by the EAST project managed to discard more than 80,000 USG of cooling water per year.
Condensed water from air conditioning system (mini-splits or packaged a/c units)	▶ Feed water for a/c cooling towers ▶ Feed water for a steam generator ▶ Water supply for the laundry irons or steam press ▶ Laundry water ▶ Irrigation water	Condensed water is perfectly soft and virtually free of total dissolved solids. Therefore, it should ideally be used in a system that can benefit from its chemical purity, such as a cooling tower of an a/c system or a steam generator. Packaged a/c units can produce a large volume of condensates. For example, one of the hotels audited by the EAST project cooled its public areas with a packaged a/c unit that produced 70,000 USG of condensed water per year. A singe through-the-wall or mini-split a/c unit can produce as much as 5 USG of condensed water per day.
Storm water runoff from lawns, landscaped areas, tennis courts and other paved surfaces	▶ Irrigation water	Storm water should ideally be filtered through a filter bag, or another simple filtration device, and left to settle in a "irrigation" water storage tank before it is used to water the gardens.
Backwash water from pool filters	▶ Irrigation water	Backwash water should ideally be filtered through a filter bag, or another simple filtration device, and left to settle in a "irrigation" water storage tank before it is used to water the gardens. Pool water generally contains only a bit more chlorine than tap water (1.5 to 2 mg/liter). Backwash water can therefore generally be used for irrigation, especially if it is mixed with other "clean" flows such as storm water runoff or defrost water from an ice maker.

The equipment and infrastructure that is typically needed to collect and reuse most of these "clean" water flows includes:

- Piping to convey the water from the source to the storage tank. The collection system should ideally be designed so that the water flows by gravity from the source to the tank.
- A storage tank. The size of the tank will depend on the rate at which the water is collected from the source and the rate at which it is consumed by the hotel. For instance, if a tank is used to collect storm

water flows and hold the water for several days until it can be used up in irrigation, it will need to have a large capacity (e.g., 10,000 USG or more). On the other hand, if a tank is used to collect the relatively steady flow of defrost water discarded by two ice makers and hold the water until it is consumed in the daily operation of the laundry washers, it will only need to have a fairly small capacity (e.g., 200 to 400 USG).

- If the tank is used to collect storm water or backwash water, the inlet to the tank should be equipped with a mesh screen or a filter bag to remove the large solids that are contained in the flow (e.g., leaves and twigs). This filtration system should have a fairly large surface area to prevent it from clogging up too quickly.

- A centrifugal pump, equipped with a pressure tank and a pressure switch, to pump the collected water from the storage tank to the point where it will be reused. The size of the pump needed will depend on the rate at which the collected water will be used. For example, if the water is reused to in irrigation sprinklers which consume water at a fairly high rate, the pump will probably need to have a minimum capacity of 2 to 3-HP. On the other hand, if the water is reused to feed a cooling tower or a washing machine which consumes water at a fairly low rate, the pump will probably need to have a capacity of only ½ to 1-HP.[27]

In most cases, the cost of installing and operating a collection, storage and pumping system should be fairly low compared to the value of the water the property can save by reusing some of its "clean" water flows.

2.10 Adopt sound wastewater management practices and optimize the performance of the property's wastewater treatment and disposal system

As a general rule, properties should practice the following wastewater management practices regardless the manner in which they treat and/or dispose of their wastewater flows (i.e., septic tanks and soakaway pits, septic tanks and tile fields, packaged wastewater treatment plants, or municipal sewers and wastewater treatment plants).

- Use water efficiently to reduce the volume of wastewater sent to treatment/disposal system. Reducing the wastewater flow can greatly improve the performance of septic tanks, tile fields, soakaway pits, and wastewater treatment plants.

- Use graywater and clean wastewater flows for irrigation (see Section 9.2) in order to reduce the volume of wastewater sent to the treatment/disposal system.

- Avoid discharging problematic wastes into the drainage system, including sanitary napkins, cooking oil, grease and fat, lint, and wet-strength paper towels. These wastes clog drainage pipes and sewers, obstruct the outlet tees of septic tanks, reduce the holding capacity of the septic tanks, and can reduce the absorption capacity of tile fields and soakaway pits.

- Minimize the use of harsh and toxic chemicals on property to avoid harming the bacteria that purify the wastewater in septic tanks, tile fields and wastewater treatment plants. Harmful products include:

  - brine and salt from a water softener,

  - bleach,

  - many toilet, sink and tub cleaners,

[27] The cost of a 1-HP pump, equipped with a small pressure tank and pressure switch, should not exceed 600 US$. If the pump is operated for only a few hours each day, its annual operating cost will be negligible.

  - disinfectants,
  - drain cleaners,
  - strong acids and caustic.
- Make sure that maintenance chemicals (e.g., motor oil, spent solvents, paint) are disposed of properly rather than dumped down the drain. Some maintenance chemicals can severely disrupt the operation of septic tanks, tile fields and wastewater treatment plants.
- Make sure that kitchen drains are equipped with well designed and well maintained grease traps. In order to ensure the proper performance of its grease traps, the property should
  - clean them regularly (by manually skimming the floating grease and solids, and removing the solids from the bottom of trap);
  - do not use chemicals, such as drain cleaners and acids, to dissolve the grease and solids that accumulate in the trap;
  - do not use hot water to dissolve and flush out the grease collected in the trap;
  - minimize the discharge of solids and grease into the kitchen sinks; and
  - make sure the grease traps are equipped with effective outlet tees.
- Minimize water surges into the wastewater collection system. For example, roof gutters should never be connected to the wastewater collection system because the high flows produced during storms can easily overload septic tanks, tile fields, soakaway pits and wastewater treatment plants.

In addition to implementing the wastewater management practices listed above, the properties that operate their own wastewater treatment plant should make sure the plant operator is well trained and regularly test the quality of the treated effluent. This training and quality control is particularly important if the treated wastewater is used for irrigation.

The basic tests that should be regularly carried out to monitor the performance of the treatment system and the quality of the treated effluent include:

- dissolved oxygen content and pH of the wastewater in the aeration tank,
- sludge volume fraction in the aeration tank,
- sludge settleability,
- pH of the final effluent, and
- residual chlorine in the final effluent.

2.11 Turn lights and equipment off when they are not needed

Hotels often leave a surprisingly large number of lights, a/c units and other appliances on unnecessarily. This oversight can be quite costly because not only does it add to the property's electricity bills, but also needlessly shortens the actual service life of the fixtures and equipment, and increases the workload on the maintenance staff. Many properties could therefore greatly benefit from incorporating the following common-sense energy conservation practices in their daily operations.

- Avoid turning the grounds and exterior lights on earlier and off later than needed. Given the large number of lights that are often used to illuminate gardens and exterior areas, hotels should leave these light fixtures on only when there is not enough natural light.
- Do not leave decorative lights on throughout the night. Hotels should turn off all possible decorative lights in garden, beach and front-of-house areas in the early morning hours, after most guests have gone to sleep. Ideally, only security lights should be left on all night.
- Turn off the lights during the daytime in all front and back-of-house areas that receive enough natural light.
- Make sure the lights are kept off in unoccupied mechanical rooms, storage areas, linen closets, walk-ins and other infrequently used areas. In many hotels the lights in these areas are left on for 12 to 24 hours per day.
- Turn off the circulation pumps of decorative fountains at night.
- Install guest-operated wind-up timers on whirlpool blowers, sauna heaters and other similar equipment that are intermittently used by the guests. Some hotels run their whirlpool blowers and sauna heaters continuously for 12 to 16 hours per day even though the whirlpools and saunas are occupied only for a fraction of the time. The wind-up timers installed in hotels should allow the equipment to function for only a reasonably short period of time (e.g., 10, 15 or 20 minutes): whirlpool blowers or sauna heaters that are equipped with long timers (1 hour or more) often end up working continuously.
- Make sure that air conditioners and fans are turned off in offices and other back-of-house areas at the end of the work day.
- Train and motivate the F&B and laundry staff to turn off any equipment that is not being used. The appliances that are often left running longer than necessary in F&B areas and in the laundry include:
  - extractor fans;
  - plate warmers (they should be turned on only during meals);
  - ranges, stoves, grills and fryers;
  - sump heaters in dishwashers (they should be turned off during the night);
  - coffee/tea urns;
  - toasters;
  - irons and flatwork ironers.
- Train and motivate the housekeepers to follow energy conservation practices when preparing guestrooms (see Section 4.1).

Impact of leaving lights and appliances on when they are not needed

- An 85-room property assessed by PA Consulting used 200 80-Watt incandescent spotlights in its large grounds to illuminate palm trees and architectural features. These decorative lights burned all night and were turned off only at 6:00 AM. Turning these lights off at 1:00 AM could have saved the property 29,000 kWh/year (worth approximately US$ 2,900 in a typical Jamaican hotel) and 365 replacement bulbs/year.
- The same property left 75 light fixtures equipped with 60-Watt incandescent bulbs burning during the daytime in the lobby, restaurant, public bathrooms and other areas that received plenty of natural light. Turning these lights off during the 10 brightest hours of the day could have saved the property 16,400 kWh/year (1,600 US$/year) and 270 replacement bulbs/year.
- Leaving a single a/c unit needlessly running overnight in a back-of-house office can waste up to 5,000 kWh/year (500 US$/year).

The control strategies and systems that are typically used in hotels to keep lights and equipment off when they are not needed include:

- manual control;
- wind-up timers;
- continuous timers;
- occupancy sensors for lighting systems;
- occupancy sensors for air conditioning systems; and
- photocells.

These control strategies and systems are discussed in the following sections.

2.11.1 Manual control

If the employees are motivated, trained and aware of the need to conserve energy and resources, the property can rely on them to keep most lights, a/c units and appliances off when they are not needed. This is often the most effective way to conserve energy, but it is unfortunately often hard to implement or sustain in many properties. People forget, get busy or sidetracked, some lights and appliances are always forgotten, and accountability and enthusiasm dissipates with time. This approach can thus be truly effective only if the property is able to sustain its staff's interest and participation through effective training and motivation, promote personal responsibility and accountability among employees, and perform periodic spot checks to ensure lights and equipment are actually being turned off as needed.

The security staff can play a major role in this manual control program by turning off unneeded lights and a/c units as part of their regular night rounds. For example, in some hotels the security staff is given the responsibility to turn off decorative garden lights late at night.

2.11.2 Wind-up timers

A wind-up timer is basically an electrical switch that is equipped with a spring-loaded timer dial. When the dial is manually turned on by a guest or staff member, it closes the switch and allows the piece of equipment to operate for the amount of time indicated by the position of the dial. Wind-up timers can generally be purchased with maximum operation times of 10, 15, 20, 30, 60 minutes or more.

Hotels often use wind-up timers to control the operation of whirlpool blowers, sauna heaters and other similar pieces of equipment that are used only intermittently by guests. These wind-up timers must however have a reasonably short maximum operation time (e.g., 10, 15 or 20 minutes) because appliances that are controlled by long timers (of 1 hour or more) often end up working almost continuously.

Wind-up timers generally cost less than US$ 30 and have a payback period of less than 1 month.

Savings achieved by installing a guest-operated wind-up timer on a whirlpool blower

A property assessed by the EAST project had a large heated whirlpool that was equipped with a 3-kW blower. The blower operated continuously from 8 AM to midnight and had an actual power consumption of 2.5 kW. It was estimated that by using a 15-minute wind-up timer to control the operation of the blower the property could have

- reduced the running time of the blower by 4,380 hours/year (a 75% reduction),
- reduced the energy consumption of the blower by 11,000 kW/year, and
- saved 1,100 US$/year on its electricity bills (for an electricity cost of 0.10 US$/kWh).

2.11.3 Continuous or 24-hour timers

A continuous timer can be used to automatically turn lights, appliances and equipment on and off at certain times of the day. These timers range from simple electro-mechanical devices, which control circuits on a simple 24-hour basis, to more complex electronic controllers that can handle more detailed yearly schedules. In hotels, continuous timers are often used to control the operation of lighting circuits and pool pumps.

Electro-mechanical timers: These are the simplest and cheapest types of continuous timers. They have a dial that moves around with time and carries adjustable settings that trip an electrical switch on and off at the pre-determined times. The main drawbacks of electro-mechanical timers are: 1) they have limited control and cannot be adjusted to follow different schedules on different days of the week; 2) their clock must be manually reset whenever the power goes out for a long period of time; and 3) the clock is prone to drift over time and must be adjusted periodically. The typical cost of electro-mechanical circuit timers ranges from US$ 40 to 140.

Electronic timers: These timers use electronic circuitry to control a relay that turns a circuit on or off. They have many more programming options than electro-mechanical timers and can, for example, handle different schedules for weekends or for different months. They are also more accurate and do not require the frequent adjustments that electro-mechanical devices require. Some electronic timers can even control multiple circuits with different schedules.

2.11.4 Occupancy sensors for lighting systems

An occupancy sensor is an electronic device that is designed to monitor a room's occupancy. It does this either through an infrared sensor which detects body heat, an ultrasonic sensor which senses movement, or a combination of the two sensors. The sensor is connected to a switch that turns the lights off if no occupancy is detected for a period of time, and turns them back on as soon as someone enters the room. In hotels, occupancy sensors are generally used to control lighting circuits in public and staff restrooms, gyms, conference rooms and other areas that often remain unoccupied for long periods of time.

The three different types of occupancy sensors available on the market are discussed below.

1) Passive infrared sensor: A passive infrared sensor detects heat (infrared energy) from a body. If a change in heat (i.e., a person moving in the room) is detected, the sensor turns the lights on. If no movement is detected after a set time, the sensor trips into unoccupied mode and turns the lights off. A passive infrared sensor can only sense occupancy in a direct line of sight with the sensor and thus cannot detect movement around corners or behind doors. A key advantage of a passive infrared sensor is that it does not confuse moving objects (e.g., curtains fluttering in the wind) for a person and, therefore, does not turn the lights on unnecessarily in unoccupied areas. A passive infrared wall-mounted occupancy sensor generally costs from US$ 50 to 70.

2) Ultrasonic sensor: An ultrasonic sensor bounces ultrasonic sound waves around the room and measures the amount of time it takes the sound to return. Movement by a person in the room causes the sound waves to return at a higher or lower frequency and triggers the sensor. The sound waves are high above the range of human hearing and pose no hazards to humans. Because the sound waves bounce around the room, they are better able to detect motion behind bathroom stalls than infrared detectors. However, they have a tendency to misinterpret fluttering curtains or breezes as occupancy. An ultrasonic ceiling-mounted occupancy sensor and power pack generally costs from US$ 125 to 160.

3) Dual technology sensor: Some occupancy sensors incorporate both a passive infrared and an ultrasonic sensor to provide better control in areas that cannot be effectively handled by a single type of sensor. A dual technology ceiling-mounted occupancy sensor and power pack generally costs from US$ 160 to 200.

Recommended applications for each type of sensors technology.

Type of sensor	Good applications	Poor applications
Passive infrared sensor	▶ Enclosed offices. ▶ Warehouses. ▶ Hallways. ▶ Areas with high airflow. ▶ Areas requiring 100% coverage cut-off. ▶ Wall switch replacements. ▶ High ceiling mount locations.	▶ Restrooms. ▶ Areas where only very little motion is present.
Ultrasonic sensor	▶ Open office spaces. ▶ Conference rooms. ▶ Restrooms. ▶ Enclosed hallways. ▶ Large areas up to 2000 square feet.	▶ Spaces with high air flow or vibration. ▶ High ceiling mounts above 14 to 16 feet. ▶ Small areas that are not enclosed. ▶ Spaces with areas of unwanted detection.

Dual technology sensor	▶ Computer rooms. ▶ Large conference rooms. ▶ Open office spaces with defined aisles. ▶ Lunchrooms. ▶ Areas with high ceilings. ▶ Areas needing 100% cut-off and small motion sensing.	▶ None. Dual sensor technologies will work fine in all locations; however, using single technology sensors may be more cost effective in some applications.

Sensor features:

- Integrated sensor and switch: Some sensors can be ordered as a combined sensor and switch unit that replaces an existing light switch. This makes wiring very easy and cost effective. Other than replacing the switch, no other modification is needed.
- Ceiling mounted sensors: Some areas, such as large conference rooms or office areas, cannot be adequately covered by a sensor mounted at the original switch location. For such areas, there are sensors that can be mounted in the ceiling, in a corner of the room or another location that gives them optimal coverage. These sensors operate with 24-Volt DC current and thus require a transformer or a power pack.

Caution: Proper sensor mounting location, aiming and calibration is essential for good sensor performance. The manufacturer's installation and calibration instructions should therefore be carefully followed to ensure the sensor will operate effectively.

2.11.5 Occupancy sensors for air conditioning systems

Occupancy sensors for a/c systems are discussed in Section 2.21 of this report.

2.11.6 Photocells

A photocell is a simple electronic device that is designed to automatically turn lights on only when it does not detect sufficient light (e.g., at sunset). Photocells can be used to control the operation of any number of lights, from a single light fixture to a whole lighting circuit (for example, a single photocell can be used to turn on/off the exterior lighting circuit). They are particularly useful to ensure that outdoor lights, and interior lights in areas that receive ample natural light, do not operate any longer than necessary.

When installing photocells, the hotel should ensure they are properly aimed and calibrated so that they turn the lights on and off exactly when required. Since most hotels have dozens or hundreds of exterior light fixtures, turning the lights on too early in the evening or turning them off too late in the morning can waste a lot of energy over the course of a year. The cost of photocells generally ranges from US$ 10 to 20.

2.12 Maximize the use of natural light in public and back-of-house areas

Keeping lights on in areas that receive sufficient natural light needlessly wastes energy and increases the number of light bulbs that must be purchased by the property. Consider the following issues.

- As shown in the table below, leaving a single incandescent bulb needlessly on for 10 hours per day can waste up to 360 kWh or US$ 36 of electricity per year.

Type of bulb	Annual energy use if operated 10 hours/day	Corresponding annual energy cost (at 0.10 US$/kWh)
100-Watt	365 kWh/year	36.5 US$/year
75-Watt	275 kWh/year	27.5 US$/year
60-Watt	220 kWh/year	22.0 US$/year
40-Watt	145 kWh/year	14.5 US$/year

- Most of the energy consumed by lamps is eventually transformed into heat. Therefore, leaving lights on in air conditioned areas that receive sufficient natural light needlessly increases the workload on and the amount of energy consumed by an a/c system.
- The service life of an incandescent bulb typically ranges from 800 to 1200 hours. Therefore, a light fixture that is left needlessly on for 10 hours per day (or 3,650 hours per year) will require 3 to 4 additional bulb changes each year.

2.13 Make sure light fixtures are well designed and maintained and are thus able to transmit most of the light produced by the lamps

- The design of the light fixtures should ideally allow them to transmit most of the light produced by their lamps. Poorly designed fixtures, such as those which nearly encapsulate the lamp with an opaque or dark cover, often transmit only a small fraction of the total amount of light produced by the lamps. For instance, a well-designed light fixture with a 40-Watt lamp can produce as much useful light as a poorly-designed fixture with a 100-Watt lamp while consuming 60% less energy.

Figure 2.26 - An extreme example of a poorly designed light fixture: A 40-Watt bulb is first covered by a frosted lens and a thick protective mesh; the whole fixture is then placed upside down in a narrow alcove cut in a stone pillar.

- Light fixtures, especially those located in areas such as gardens and kitchens, should be periodically cleaned by the maintenance staff. The dust, dirt or grease that collects on the bulbs or on the surface of the lenses can significantly reduce the light output of the fixtures.

- The gardeners should periodically trim the vegetation that grows around outdoor light fixtures to prevent it from blocking the light produced by the lamps.

Figure 2.27 - These two light fixtures are completely covered with overgrown vegetation. Other than creating a unique "burning bush" effect, these lights no longer serve any useful purpose.

- Since some light fixtures, especially the adjustable spotlights, can be easily knocked out of position, the property should periodically inspect its outdoor light fixtures at night to ensure they are still illuminating their intended targets. In one property assessed by the EAST project, the auditors found that approximately 20% of its outdoor decorative spotlights were either pointing straight up to the sky or out to sea. These spotlights still consumed energy but failed to provide any useful illumination.

2.14 Avoid over-lighting areas of the property

The property should make sure that none of its areas are excessively lit. Over-lighting wastes energy, increases maintenance costs and generates higher heat loads in air conditioned areas. Although the Illuminating Engineering Society (IES) and other similar organizations provide detailed recommendations on appropriate lighting levels, one can generally rely on simple common sense to identify areas that are excessively lit. The areas that are often excessively lit in hotels include hallways, guest bathrooms, lobbies and gardens. However, when adjusting lighting levels, the property should ensure not to compromise safety or the activities that are generally carried out in each particular area.

The main options that can be used by hotels to lower excessively high lighting levels are listed below.

- Install lower wattage lamps in existing light fixtures. For example, replace 40-Watt fluorescent tubes with 34-Watt tubes, or replace 100-Watt incandescent bulbs with 60-Watt bulbs.
- Remove some of the lamps from existing fluorescent light fixtures. For example, two fluorescent tubes can be removed from an existing four-lamp fixture to reduce its lighting output by approximately 50%. However, the unused ballasts should also be disconnected, otherwise they will continue to draw up to 14 Watts of energy even if they are not driving a lamp.
- If possible, reduce the number of light fixtures installed in excessively lit areas. For example, in hallways or other areas that have dropped ceilings and lay-in fluorescent fixtures, it is often possible to increase the spacing between the light fixtures and thus eliminate a few of the existing fixtures.
- Create lamp replacement guidelines to prevent the maintenance staff from replacing a burnt-out lamp with a new lamp that has a different wattage than the original lamp. In many hotels, when bulbs burn

out they are generally replaced by whatever bulbs are available at the time in the maintenance stores. For instance, in one of the properties assessed by the EAST project, the outdoor light fixtures were equipped with a random mixture of 40, 60 and 75-Watt bulbs even though they originally had been designed only for 40-Watt bulbs. Because of this oversight, the property's outdoor light fixtures were consuming approximately 40% more energy than when first installed.

2.15 Use energy efficient lighting in all possible areas of the property

The main energy efficient lighting options that are applicable to small and medium-size hotels include

- the use of energy efficient fluorescent "tube" lamps in back-of-house areas and in a few other locations, such as public bathrooms, guest bathrooms and hallways;
- the use of compact fluorescent lamps instead of incandescent bulbs in all possible fixtures that operate for more than 8 hours per day and use medium to high-wattage incandescent bulbs (60 Watts or higher);
- the use of metal halide and high pressure sodium lamps for high-output lighting needs; and
- the use of light-emitting diodes (LEDs) in exit signs.

These options are discussed in the following sections.

2.15.1 T8 fluorescent "tube" lamps

A new-generation fluorescent lamp is available to replace older 4-foot, 34-Watt and 40-Watt T12 fluorescent lamps. This new lamp, commonly referred to as a T8, is more energy efficient and brighter, produces a higher quality light, and better maintains its light output over time than T12 lamps. It also does not have the flicker and hum sometimes noticeable in T12 lamps.

The principal features of T8 fluorescent lamps are discussed below.

Energy efficiency: T8 fluorescent lamps coupled with electronic ballasts are more energy efficient than older 34-Watt and 40-Watt T12 fluorescent lamps. For example, a single 4-foot, 40-Watt T12 fluorescent lamp with an old-style magnetic ballast consumes 51 Watts, while a single T8 lamp with an electronic ballast consumes only 28 Watts, or 45% less energy. As shown in the table below, the exact energy savings achieved by a retrofit with T8 lamps varies depending on the number of lamps and the type of ballast used in the existing fluorescent fixtures.

No. of lamps in the fixture	Type of lamp used in the fixture	Type of ballast used in the fixture	Power drawn by the fixture	Power saved by using T8 technology
1	40-Watt T12	Older magnetic	51 W	45%
2	40-Watt T12	Older magnetic	88 W	34%
4	40-Watt T12	Older magnetic	175 W	39%
1	34-Watt T12	"Energy efficient" magnetic	42 W	33%
2	34-Watt T12	"Energy efficient" magnetic	69 W	16%
4	34-Watt T12	"Energy efficient" magnetic	139 W	23%
1	32-Watt T8	Electronic with low-power output	28 W	

2	32-Watt T8	Electronic with low-power output	58 W	
4	32-Watt T8	Electronic with low-power output	107 W	

Color temperature: The “correlated color temperature” of a lamp describes the appearance of its light output, and is rated in degrees Kelvin (K). For example, incandescent bulbs have a slightly yellowish (“warm”) light output, with a color temperature around 2500-3000 K. A “cool-white” fluorescent lamp produces light richer in greens and blues, and has a color temperature around 4150 K. T8 fluorescent lamps come in a range of different color temperatures and can provide a variety of lighting “moods” and effects. Typical color temperatures for most T8 applications are either 3000-3500K (slightly warm) or 4000K (a little cooler), but other color temperatures are also available for T8 lamps.

Color rendering index: The color rendering index, or CRI, is a measure of how “natural” objects appear under the illumination of a particular lamp. Daylight has a CRI of 100. T8 lamps have a much higher CRI than the T12 lamps, which tend to leave colors somewhat washed-out. Thus, with T8 lamps reds appear redder, blues appear bluer, and colors are more natural. The improved color rendering ability of T8 lamps is particularly desirable in restrooms and other areas where guests pay particular attention to their appearance (e.g., when applying makeup). T8 lamps can be ordered with a CRI either in the 70s or in the 80s.

Shape and length: T8 lamps are available as straight 2-foot, 4-foot and 8-foot tubes, and in U-tube configurations.

Ballast: Fluorescent lamps require a ballast to operate: the ballast produces the high voltage necessary to strike and maintain the arc through the lamp. Magnetic ballasts use a magnetic coil transformer to generate the required voltage. Older style magnetic ballasts are the least efficient and consume 13 to 16 Watts. Newer, “energy efficient” magnetic ballasts are slightly more energy efficient, but still consume a fair amount of power. Electronic ballasts are the most efficient ballasts available and consume only 3 to 5 Watts. Electronic ballasts operate at high frequencies (20,000 Hz) compared to magnetic ballasts which operate at the power line frequency of 50 or 60 Hz. This high frequency allows the T8 lamp to operate more efficiently and eliminates the annoying hum and flicker that often characterizes magnetic ballasts. T8 lamps should **only** be used with electronic ballasts. For existing fixtures, magnetic ballasts can be easily replaced with electronic ballasts.

High & low light output ballast options: Electronic ballasts can be ordered with varying light/power outputs (low-power output, regular-power output, or high-power output). A low-power output ballast under-drives the lamp, producing less light and reducing power consumption, while a high-power-output ballast over-drives the lamp, producing more light and slightly increasing power consumption. This range of ballast output provides some flexibility for optimizing an area’s lighting. For example, since a T8 lamp is brighter than the T12 lamp it replaces, using a T8 lamp with normal-power output ballast will produce more light than the original T12 lamp. To maintain the existing lighting level, a low-power output ballast should be used with the new T8 fixtures. In situations where the room is too dim, a high-power output ballast can be used to increase lighting levels without having to add additional fixtures.

Dimming ballasts: Ballasts can be ordered with special dimming controls that allow the light output to be varied from 10% to 100% of the rated output. These dimming ballast are typically used for day lighting or conference room applications.

Ballast configurations: While a magnetic ballast can run a maximum of 2 lamps, a single electronic ballast can run up to 4 lamps. A single electronic ballast can thus replace two magnetic ballasts in a 4-lamp fixture, resulting in energy savings and reduced installation and replacement costs. The number of lamps that will be operated by the ballasts must be specified when ordering electronic ballasts.

Another advantage of being able to run 4 lamps from of a single electronic ballast is that two adjacent 2-lamp fluorescent fixtures can be “tandem wired.” That is, a single 4-lamp ballast can be installed in one

fixture, and an electrical connection run to the other fixture to eliminate the need for a ballast in that fixture. Tandem wiring can be used on fixtures that are up to 12 feet apart. A tandem wiring and a T12 to T8 retrofit is shown in the following figures.

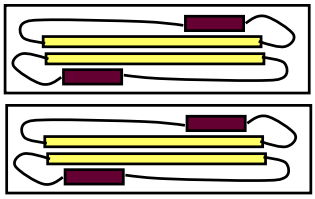


Figure 2.28 - Typical fluorescent fixture with four 40-Watt T12 tubes and four 1-lamp ballasts. Power drawn by the fixture = 168 to 204 Watts depending on the type of ballast used.

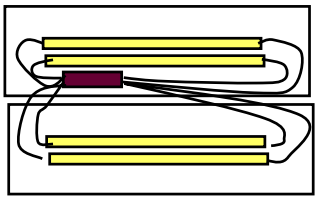


Figure 2.29 - Retrofitted fixture with four 32-Watt T8 tubes and one 4-lamp, low power output electronic ballast. Power drawn by the fixture = 107 Watts.

Total harmonic distortion: Total Harmonic Distortion, or THD, is a measure of the distortion, or "noise" that a ballast (or any other electrical device) puts back on the power line. Typically, electronic ballasts can be ordered with THD either less than 20% or less than 10%.

Cautions and comments:

- 32-Watt T8 lamps should not be installed in fixtures that are designed for 40-Watt T12 lamps unless the fixture is also equipped with a new electronic ballast. Given the cost of the new ballast and of the T8 lamps, this type of retrofit is generally cost effective for fluorescent fixtures that operate for more than 8 hours per day.
- If a property is unable or unwilling to retrofit its 40-Watt T12 fixtures with T8 lamps, it should at least make sure its fluorescent fixtures are equipped with 34-Watt T12 Energy Saver lamps. These 34-Watt T12 lamps can be installed on existing 40-Watt T12 fixtures and consume 15% less energy than 40-Watt T12 lamps. The price difference between 34-Watt and 40-Watt T12 lamps is generally small.
- The property should select a robust and reliable ballast, as there have been problems with some electronic ballasts in areas that are affected by voltage fluctuations and other power quality issues. Well-established name-brand manufacturers should be considered over cheaper, unknown brands. Ideally, the electronic ballasts should have a CBM (Certified Ballast Manufacturer) certification to ensure they are indeed high quality products.
- Most major ballast manufacturers offer a 5 to 12-year warranty on their ballasts. The property should therefore inquire about product warranty before purchasing electronic ballasts.
- Exercise care when disposing of magnetic ballasts. Some of the older magnetic ballasts contain PCBs (a carcinogen) and should handled by an appropriate ballast recycler/disposal firm rather than sent to a landfill. Some of the newer magnetic ballasts do not contain PCBs. As a rule of thumb, if a magnetic ballast does not contain PCBs, it will be explicitly stated on the label; if no claims are made on the ballast label, the ballast must be assumed to contain PCBs. Electronic ballasts do not contain PCBs.

2.15.2 Compact fluorescent lamps

Compact fluorescent lamps, or CFLs, are direct replacements for incandescent bulbs and can therefore be installed in most light fixtures that are designed for incandescent bulbs. CFLs last up to 10 times longer and use 70 to 80% less energy than incandescent bulbs for the same light output. Although more expensive initially, they usually have lower lifecycle costs than incandescent bulbs. CFLs come in a wide

variety of styles, colors and other characteristics and are thus able to meet the functional and aesthetic requirements of most light fixtures.

The principal features of CFLs are discussed below.

Energy efficiency: CFLs are highly efficient and generally need 70 to 80% less energy to produce the same light output as incandescent bulbs. For example, an 18-Watt CFL produces the same light output as a 75-Watt incandescent bulb while drawing 75% less power. The following table summarizes the wattage of equivalent incandescent bulbs and CFL lamps.

Incandescent bulb wattage	Wattage of an equivalent CFL
120 W	23 W
90 W	20 W
75 W	18 W
60 W	16 W
40 W	11 W
25 W	9 W

In addition to consuming less energy, CFLs also reduce air conditioning loads when installed in air conditioned areas. By using 70 to 80% less energy, CFLs also produce 70 to 80% less heat than incandescent bulbs and thus reduce the amount of heat that must be removed by the air conditioning system.

Ballast type: CFLs cannot operate without a ballast. There are two types of ballasts available on the market: electronic ballasts and magnetic ballasts. Magnetic ballasts use a magnetic coil transformer. They are often used in smaller wattage CFLs, and are less efficient than electronic ballasts. Electronic ballasts produce a high frequency AC voltage to drive the lamp. They are more energy efficient, and are often used in higher wattage CFLs.

Lamp/ballast configuration: There are three different ways in which the ballast can be connected to the lamp: 1) the ballast and lamp can be integrally connected and form a one-piece unit, 2) the lamp and ballast can be modular units that can be separated and replaced as needed, and 3) the ballast can be mounted remotely and connected to the lamp by wires. These three lamp/ballast configurations are compared in the table below:

Lamp/ballast configuration	Description	Comments
Integral lamp/ballast configuration	The ballast and lamp are made as a single unit and must be replaced together.	Integral lamp/ballast CFLs are often designed as direct replacements for existing incandescent lamps, and come with screw in-bases. They are easy to install. Their main disadvantage is that when the lamp fails, the ballast must also be replaced.
Modular lamp/ballast configuration	The lamp can be disconnected from the ballast.	The lamp can be replaced without also replacing the ballast. The ballast typically lasts for 3 to 5 lamp replacements and thus reduces replacement costs.
Remote-mounted ballast configuration	The ballast and the lamp are mounted separately and connected by wires. The ballast is often placed above the ceiling	Remote-mounted ballasts last longer than modular or integral ballasts because the ballast does not absorb as much heat from the lamp and thus runs at a lower temperature. Poorly vented light fixtures that are

	in ceiling-mounted fixtures.	equipped with higher wattage lamps should be equipped with CFLs that have remote-mounted ballasts.

Lifetime: CFLs have an average lifetime of 10,000 hours and, therefore, last about 10 times longer than incandescent bulbs.[28] Modular ballasts last for 3-5 lamp replacements. Remote-mounted ballasts last even longer; some manufacturers even offer a 10-year warranty on their remote-mounted ballasts.

Color temperature: The "correlated color temperature" of a lamp describes the appearance of its light output, and is rated in degrees Kelvin (K). For example, incandescent bulbs have a slightly yellowish ("warm") light output, with a color temperature around 2500-3000 K. A "cool-white" fluorescent tube produces light richer in greens and blues, and has a color temperature around 4150 K. Compact fluorescent lamps come in a variety of color temperatures, ranging from a "warm" 2500K to a "cool" 5000K, thus, and can therefore match the color output of existing incandescent bulbs as well as meet other lighting needs and moods.

Lens/reflector: CFLs come in many different lens and reflector configurations, from bare lamps to bulb-shaped coverings, which produce a diffuse light, to parabolic and elliptical reflectors.

Figure 2.30 - Example of CFLs with lenses and reflectors (AbleLight USA, Inc., www.energysavinglightbulbs.com).

Cautions and comments:

- Before purchasing CFLs, find out from other local hotels which brands of CFLs work well and have a proven track record in the local market.
- When selecting CFLs, make sure they are well suited to the local conditions. For example, some CFLs are designed for outdoor use in colder climates and come equipped with a heavy glass lens. These lenses trap the heat and affect the performance of the lamps if they are used in hot climates.
- Install CFLs preferentially in light fixtures that operate for long periods of time (more than 8 hours per day) and use higher-wattage incandescent bulbs (60 Watts or higher). It is often not cost effective to install CFLs in light fixtures that operate for short periods of time or are equipped with low-wattage incandescent bulbs.
- Use CFLs that produce a "warm" light, comparable to that of an incandescent bulb, when installing CFLs in guestrooms and other sensitive areas.
- Give preference to compact fluorescent systems that have separate ballasts and lamps (i.e., modular lamp/ballast and remote-mounted lamp/ballast CFL models). These systems have slightly higher initial costs but lower lifecycle costs because the ballasts can be reused several times.
- Give preference to hard-wired systems over screw-in systems. Hard-wired systems, such as some modular lamp/ballast CFL models and all remote-mounted lamp/ballast CFLs, are harder to dismantle and reuse and therefore reduce theft problems.

[28] The lifetime of incandescent bulbs typically ranges from 800 to 1,000 hours.

- Since ballasts are sensitive to high temperatures, use only CFLs that have remote-mounted ballasts in completely enclosed or poorly vented light fixtures that are equipped with higher wattage lamps.
- Give preference to compact fluorescent systems equipped with electronic ballasts. Electronic ballasts have higher initial costs but are more energy efficient than magnetic ballasts. Electronic ballasts also eliminate the annoying 'lamp-flicker' and ballast-noise that often characterize CFLs equipped with magnetic ballasts.
- Standard CFLs are incompatible with light dimmers and should never be installed on lighting circuits controlled by such devices. However, some manufacturers do produce "dimming CFLs" that are specially designed for such applications.
- Make sure that the particular lamp selected is suited for outdoor conditions. Be careful with fixtures along the beach and on piers: the salt spray may reduce lamp life. Test a couple of CFLs first before replacing all lamps in these areas.

2.15.3 Metal halide and high pressure sodium lamps

Metal halide (MH) and high pressure sodium (HPS) lamps are two high-efficiency and high-output light sources, which are well suited for outdoor lighting applications requiring large amounts of light and for auditoriums and other high-ceiling indoor applications. Wherever possible, they should be used to replace high-wattage incandescent, quartz-halogen and mercury vapor lamps.

The principal features of MH and HPS lamps are discussed below.

Energy efficiency: Metal halide and high pressure sodium lamps are five to ten times more efficient than quartz-halogen and incandescent lamps, and twice more efficient than mercury vapor lamps. The following tables summarize the characteristics of the equivalent metal halide lamps that can be used to replace existing mercury vapor and incandescent lamps.

Existing mercury vapor lamp			Equivalent replacement metal halide lamp		
Watts	**Initial lumens**	**Mean lumens**	**Watts**	**Initial lumens**	**Mean lumens**
400 W	20,000 - 22,500	13,000 - 14,000	325 W (GE Mercury Vapor retrofit lamp)	24,000 - 28,000	11,800 - 13,300
			or 250 W (new lamp & ballast)	21,500 - 23,000	14,700 - 16,100
250 W	11,000	8,200 - 8,400	150 W	11,200 - 12,500	7,700 - 8,600
175 W	7,800	6,800	150 W	11,200 - 12,500	7,700 - 8,600
			or 100 W	7,600 - 9,000	4,900 - 6,200
100 W	4,000	2,600	70 W	4,500 - 5,500	3,000 - 3,300
75 W	2,700	2,250	50 W	2,900 - 3,900	1,600 - 2,300

Existing incandescent lamp		Equivalent replacement metal halide lamp		
Watts	**Mean lumens**	**Watts**	**Initial lumens**	**Mean lumens**
1000 W	17,700 - 23,000	400 W	31,000 - 36,000	17,000 - 24,000
750 W	13,000 - 14,500	250 W	21,500 - 23,000	14,700 - 16,100
500 W	6,500	150 W	11,200 - 12,500	7,700 - 8,600

400 W	5,000 - 6,000	100 W	7,600 - 9,000	4,900 - 6,200
250 W	2,500	50 W	4,500 - 5,500	3,000 - 3,300

The preceding tables should only be used for general reference. When selecting retrofit metal halide or high pressure sodium lamps, the property should consult a products catalog or a vendor because various factors can affect the actual output and performance of a lamp, including its operating position (base up, base down or horizontal), the type of reflector, the shape of the lamp, and special bulb coatings.

Color temperature: The "correlated color temperature" of a lamp describes the appearance of its light output and is rated in degrees Kelvin (K). For example, an incandescent bulb produces a slightly yellowish ("warm") light output, with a color temperature of around 2500-3000 K. A "cool-white" fluorescent lamp produces a light that is richer in greens and blues, with a color temperature of around 4200 K. Metal halide lamps generally have a color temperature of 4000-5000K, but special metal halide lamps are available with a color temperature as low as 2900K. High pressure sodium lamps are "warmer," with color temperatures ranging from 1800 to 2800 K.

Color rendering index: The color rendering index (CRI) is a measure of how "natural" objects appear under the illumination of a particular lamp. Daylight has a CRI of 100. High pressure sodium lamps have a relatively low CRI ranging from 20 to 30, and produce a light under which colors are washed out and harder to distinguish. Metal halide lamps have a much better CRI, ranging from 65 to 80, and produce a light under which colors are brighter and more distinguishable. Given the higher CRI of metal halide lamps, they are generally installed in areas where aesthetic concerns are important.

Lifetime: Lamp lifetime ranges from 10,000-20,000 hours for metal halide lamps and 16,000-24,000 hours for high pressure sodium lamps. Both types of lamps thus compare favorably with incandescent or quartz-halogen bulbs, which only last for 1,000-2,500 hours.

Ballasts: Metal halide and high pressure sodium lamps cannot operate without ballasts. Since ballasts are generally designed to operate a specific type and size of lamp, they should not be used with a different lamp type or size unless specified by the manufacturer.

Cautions and comments:

- As a general rule, hotels should avoid using mercury vapor (MV) lamps, and all existing MV fixtures should be replaced or retrofitted with higher efficiency lamps. Although MV lamps use a similar technology to that of MH and HPS lamps, they are less efficient and instead of burning out they generally grow dimmer and dimmer while increasing their power consumption by up to 25%. Since they don't burn out completely, MV lamps are often left in place and can thus waste a lot of energy.
- Some manufacturers produce special retrofit MH or HPS lamps that can operate with the ballast of existing mercury vapor lamps.
- Quartz-halogen fixtures are generally incompatible with MH and HPS lamps. The retrofit from quartz-halogen to MH or HPS lamps therefore typically requires the replacement of the complete light fixture.

2.15.4 LED exit signs

A Light Emitting Diode (LED) array can be used to replace incandescent and compact fluorescent lamps in exit signs. An LED consumes 82 to 96% less energy and lasts 5 to 20 times longer than the incandescent or compact fluorescent lamps used in conventional exit signs.

The principal features of LED arrays are discussed below.

Energy efficiency: The nominal energy consumption for a conventional double-faced exit sign ranges from 40 Watts, when equipped with two 20-Watt incandescent bulbs, to 10 Watts, when equipped with two 5-Watt compact fluorescent lamps. In contrast, a double-faced LED exit sign consumes only 1.8 Watts, or 82 to 96% less energy than a conventional exit sign. Over the span of a year, an LED exit sign will consume 72 and 335 fewer kWh than a compact fluorescent and an incandescent exit sign, respectively.

Lifetime: The lifetime of the light sources used in exit signs ranges from 6 months for incandescent bulbs, 2 years for compact fluorescent lamps, and 10 to 20 years for LED arrays. Thus over the 10-year minimum life of an LED array, a conventional exit sign would require 30 incandescent bulb replacements or 10 fluorescent lamp replacements.

Retrofit kits: Retrofit kits are available to convert existing incandescent and fluorescent exit signs to LEDs. However, if the faceplate backing (the red or green translucent panel behind the faceplate) of the existing sign is discolored or darkened it should be replaced with a new backing to ensure the sign produces enough light.

Cost: A universal LED retrofit kit that fits a variety of different lamp sockets costs from US$ 15 to 20, and a new faceplate cost approximately US$ 1.50. The cost of a new LED exit sign ranges from US$ 35, for a single-faced sign with no battery backup, to US$ 60, for a double-faced sign equipped with a battery backup.

2.16 Shade or protect windows and glass doors against direct exposure to sunlight

Solar radiation coming through windows can significantly increase air conditioning costs and affect guest comfort. In extreme cases, the area directly in front of windows or glass doors may become unusable because of excessive direct solar radiation. For example, in a hotel assessed by the EAST project in Jamaica, the average temperature in a guestroom was 77°F but rose to 107°F in the areas exposed to the direct sunlight that streamed through the windows.

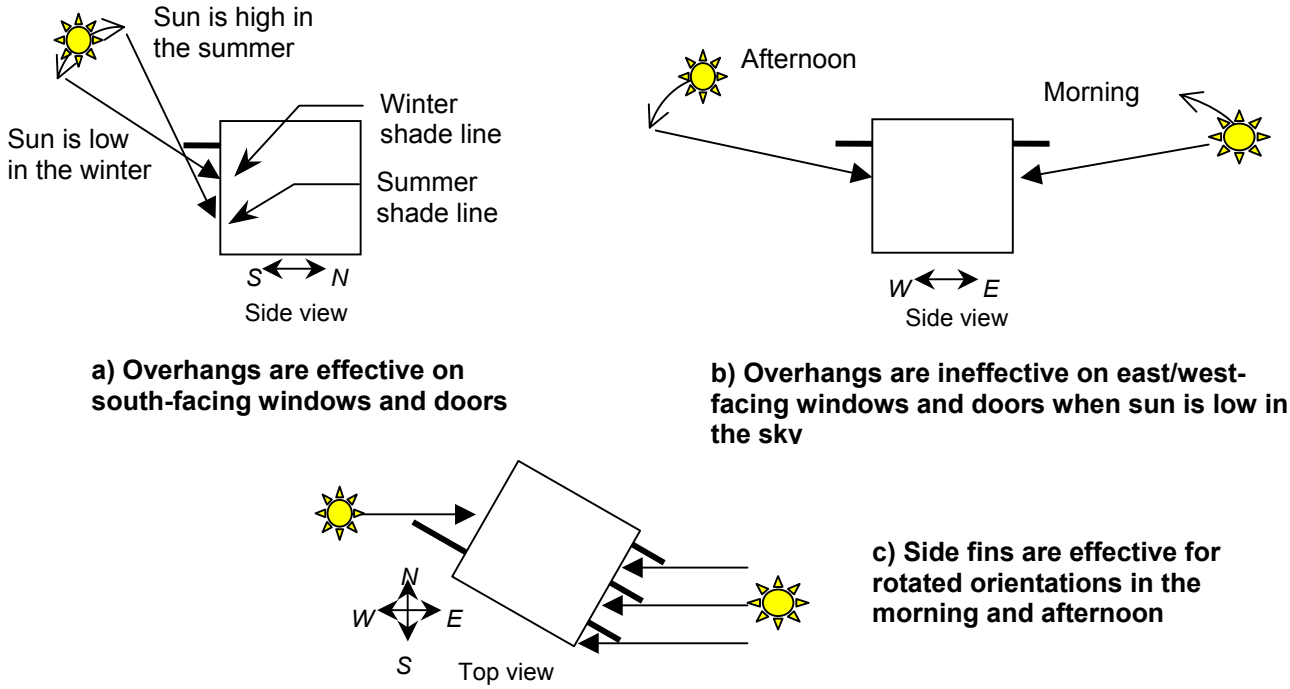
The property should consider implementing where applicable the following measures to reduce solar gain through windows and glass doors.

1) Install awnings or other shading devices on windows and glass doors.

   As shown in the following figures, hotels can use a wide variety of shading devices to effectively reduce the amount of direct solar radiation coming through windows and glass doors.

Figure 2.31 - Balcony overhangs, wooden shutters, fabric awnings and fixed louvers are all examples of effective shading devices.

However, before installing shading devices, the property should consider the orientation of the building and the path of the sun to make sure the devices are truly effective. For example, a simple overhang is effective at blocking sunlight on south-facing windows, but ineffective against morning or afternoon sunlight for east and west-facing windows. For these windows, side-fins or fixed louvers would be much more effective than overhangs.



a) Overhangs are effective on south-facing windows and doors

b) Overhangs are ineffective on east/west-facing windows and doors when sun is low in the sky

c) Side fins are effective for rotated orientations in the morning and afternoon

Figure 2.32 - Consider the orientation of the building and the path of the sun before installing shading devices.

2) Use the landscaping to provide shading.

A well designed landscaping scheme can reduce air conditioning costs by 15 to 50%. In addition to reducing direct solar gains, shading and evapotranspiration (i.e., a plant's natural breathing process which generates an evaporative cooling effect) from trees can also reduce surrounding air temperatures by up to 9°F.

Landscaping should ideally be used not only to shade the walls and roofs of buildings, but also the surrounding areas and paved surfaces. However, the landscaping should not block air flow around or through buildings, nor restrict air flow through a/c condensers.

3) Use solar-control window films to reduce the amount of solar energy and UV radiation entering air conditioned areas.

   These are thin polymer films with an adhesive backing that are applied on the inside of windows or glass doors. They reflect from 40 to 70% of the heat that is normally transmitted through a pane of glass and thus significantly reduce air conditioning loads and improve comfort. These films also block out 98 to 99% of the UV radiation and thereby greatly reduce fading and bleaching of carpets, fabrics and upholstery. They are durable and scratch resistant and available in a wide range of aesthetic options (e.g., reflective or non-reflective, colored or clear) and light transmission grades (from almost clear to very dark).

   Some manufacturers offer impact and hurricane resistant films. These films are significantly thicker than ordinary solar-control films and offer added protection against hurricanes, accidental breakage and forced entry. Even if the window is shattered in a storm, the film keeps the fragments in place and minimize water penetration into the building. Some laminated windows have passed southern Florida's "large missile impact test," resisting penetration by a 2x4 stud traveling at 80 miles per hour.

   The cost of window film depends mainly on the type of film selected and on the size (primarily width) of the windows and doors. In general, the complete installed cost of window film in the US ranges from 4.5 to 5.5 US$/ft^2 for lower-end films, and from 8 to 12 US$/ft^2 for higher-end films. However, these costs include expensive US labor rates and could be lower in parts of the Caribbean.

2.17 Whenever possible, use natural ventilation rather than air conditioning in public and back-of-house areas

Although general back-of-house areas are typically not air conditioned in most small to medium-size Caribbean hotels, some properties do air condition many of their front-of-house areas such as lobbies, restaurants, bars and lounges. Unfortunately, given the constant guest and staff traffic and the relatively large size of front-of-house areas, this practice can have a significant impact on energy consumption and costs.

The choice of whether to air condition or not front-of-house areas is often guided by style or perceived need, rather than by energy concerns. For example, many upscale properties feature open-air lobbies and restaurants in order to incorporate the surrounding gardens and landscape into the interior design of the hotel. On the other hand, other properties, upscale or not, believe their guests would be greatly inconvenienced by the heat and thus go through the trouble and expense of air conditioning their front-of-house areas. Nonetheless, given the large number of properties in all parts of the Caribbean and across all hotel categories that use open-air front-of-house areas, there is no doubt that this practice is widely accepted and does not necessarily compromise guest comfort. Properties should therefore seriously consider using, whenever possible, natural ventilation and ceiling fans over air conditioning in front-of-house areas. The principal benefits offered by this practice are discussed below.

- Reduced energy consumption: Switching from air conditioning to natural ventilation and ceiling fans can reduce cooling costs by 80 to 100%.
- Reduced peak demand: The a/c systems that are typically used to cool large front-of-house areas draw a large amount of power which increases the property's peak electricity demand. Therefore, air conditioned front-of-house areas can have a significant impact on the energy costs of hotels that are

charged for their peak electricity demand in addition to their electricity consumption.[29] For example, cooling the front-of-house of a Jamaican hotel with a 5-ton a/c unit, which draws on average 6 kW of power, can increase the property's electricity demand costs by up to 1,150 US$/year.

- Reduced capital costs: Ceiling fans are inexpensive appliances. The investment needed to keep an open-air area cool with ceiling fans is minor compared to the cost of an a/c system.
- Reduced maintenance requirements: Ceiling fans are low-tech appliances that are significantly easier and cheaper to maintain than the packaged or split air conditioning systems commonly used in hotel lobbies and restaurants. Ceiling fans generally require a minimum amount of care and provide years of trouble-free operation.

2.18 Use fans, cross ventilation features and window screens to promote the use of natural ventilation in guestrooms

Air conditioning guestrooms can account for up to 40% of a hotel's total energy consumption and costs. Although most guests in Caribbean hotels air condition their rooms, many would often prefer using natural ventilation over air conditioning if their rooms were sufficiently airy and protected against insect intrusion.

In order to promote the use of natural ventilation in guestrooms, hotels should ideally implement the following measures.

- Make sure guestrooms are designed to take advantage of natural ventilation. For example, windows should ideally be positioned in a way to ensure good cross-ventilation in the guestroom. For example, some hotels place small windows above or on the front doors of their guestrooms to improve the flow of air through the room.

Figure 2.33 - Operable window on a guestroom door.

- Add ceiling fans in all guest rooms. The combination of open windows and a ceiling fan is often sufficient to keep a room sufficiently cool at night during most of the year.

[29] In September 2001, the Jamaican electric utility (JPSCo) billed its "rate 40" customers a monthly peak demand charge of approximately 13.80 US$/kVA. Since the apparent power (in kVA) drawn by an appliance is equal to the real power (in kW) drawn by the appliance divided by its power factor (i.e., kVA = kW / power factor), a 6-kW a/c unit with a power factor of 0.85 can increase the monthly peak demand by up to 7.06 kVA and the monthly demand costs by up to US$ 97.

- Place window screens to keep mosquitoes and other insects out of guestrooms when the windows are open. Most guests will not sleep with open windows if they are not equipped with screens and will, therefore, rely on air conditioning to keep their rooms cool at night.

2.19 Ensure that air conditioned areas have tight-sealing doors, windows, louvers and skylights to minimize the infiltration of outside air

Reducing the infiltration of outside air in guestrooms and other air conditioned areas can have a dramatic impact on a/c use. Given that air conditioning is a highly energy-intensive activity, which can account for up to 50% of the total energy use in a hotel, ensuring that air conditioned areas are relatively air-tight is generally the most effective and profitable energy conservation measure that can be taken by Caribbean hotels.

Figure 2.34 - Typical air infiltration problems in air conditioned areas: gaps around doors and through-the-wall a/c units, gaps between the slats of louvered windows, and fixed open louvers on doors.

Measurements made by the EAST project in an upscale 52-room property in Montego Bay, Jamaica, revealed that reducing outside air infiltration in guestrooms lowered daytime and nighttime air conditioning use by 60% and 40%, respectively.[30] Based on these measurement, it was estimated that improving the air-tightness of the guestrooms could reduce the total electricity consumption of this property by approximately 19%. In addition to saving energy, minimizing the infiltration of outside air also reduces the maintenance requirements and extends the lifetime of the a/c units, and reduces problems of moisture condensation on the walls and floors of air conditioned areas.

[30] Since these measurement were made on a relatively mild March day, the savings should be even more dramatic during the summer months. The “air-tightness” of the rooms in this hotel was not much different from that found in most other properties assessed by the EAST project (i.e., louvered windows, no weather-stripping, and no door sweeps).

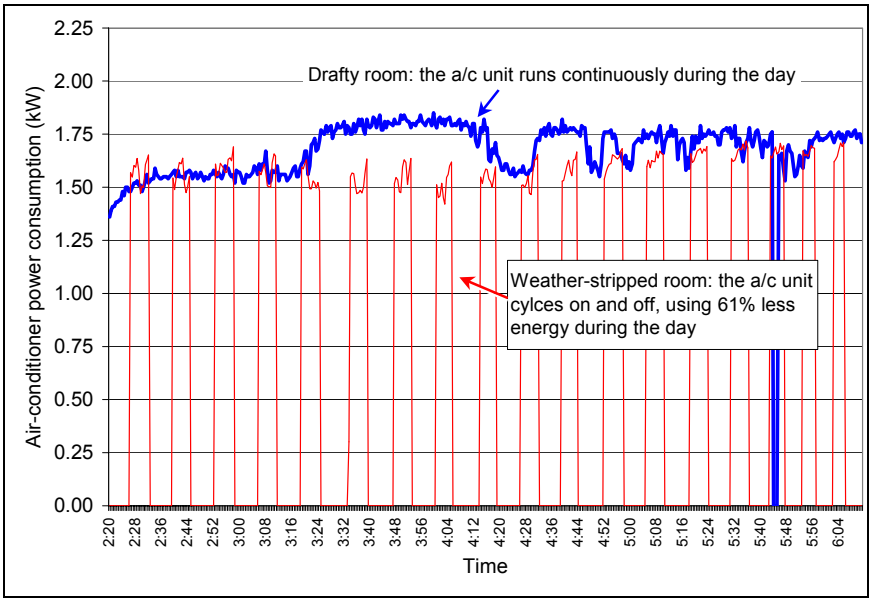


Figure 2.35 - Daytime a/c use measured in a guestroom of a Montego Bay property before and after it was weather-stripped.

The infiltration of outside air into air conditioned areas can be significantly reduced by implementing the following measures.

- Do not use louvered or jalousie windows in air conditioned areas: these types of windows are generally a major source or air infiltration and substantially increase air conditioning costs. Where louvered windows are already in place, consider replacing them with solid glass windows or covering them with panes of glass or plexiglas.
- Weather-strip all windows and all doors that lead to areas that are not air conditioned. Weather-stripping material is inexpensive and can be installed with a minimum amount of effort. Most weather-stripping material is either self-adhesive or can be nailed in place.

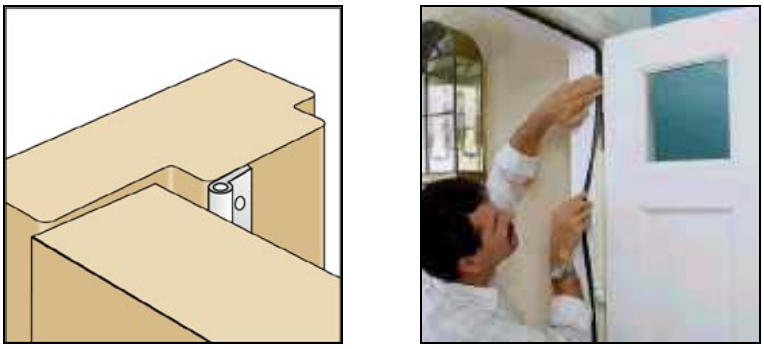


Figure 2.36 - Nail-on weather-stripping (left) and tape-on weather-stripping (right).

- Install door sweeps on all doors that lead to areas that are not air conditioned.

Figure 2.37 - Commercial door-sweeps: a rubber strip fixed on the base of the door (left) and a brush strip attached to the bottom edge of the door (right).

Figure 2.38 - Low cost door sweep made from a strip of felt material.

- Seal all gaps around through-the-wall a/c units and other objects that penetrate the walls of air conditioned areas (e.g., water pipes and a/c refrigerant lines).
- Caulk all cracks and gaps around door frames, window frames and other features.
- Install automatic door closers on doors that lead to air conditioned areas, especially in areas of heavy traffic such as lobbies and offices.
- Install backdraft dampers on the exhaust fans used in guest bathrooms. A backdraft damper opens when the fan is turned on to allow air to leave the bathroom, and closes when the fan is turned off to minimize the infiltration of outside air.
- Wire the bathroom exhaust fans to the light switches to ensure they only operate when the bathrooms are occupied.
- Keep the doors of air conditioned areas closed. Although this seems intuitive, it is not uncommon to find air conditioned shops, restaurants and lobbies with their doors wide open.

Impact of reducing the infiltration of outside air in guestrooms

A study conducted at a 52-room Jamaican hotel showed that by reducing the infiltration of outside air in the guestrooms (i.e., weather-stripping the doors and windows, installing door sweeps on front and patio doors, and covering the wooden louvers with glass panes) this property could achieve the following savings.

- Electricity savings = 163,000 kWh/year or 19% of its total electricity consumption.
- Financial savings = 16,300 US$/year (for an electricity cost of 0.10 US$/kWh).

This measure required a US$ 10,000 investment and yielded a payback period of 7.5 months. More than 80% of the investment went to covering the louvers with glass panes. The cost of the door sweeps and of the weather-stripping material was minor.

2.20 Ensure that the ceilings/attics in top-floor air conditioned areas are properly designed, insulated and protected to minimize heat gain

A roof can easily heat up to 160°F on a sunny day and, unless the roof is properly designed, much of this heat can be transmitted into the air conditioned rooms below, resulting in increased air conditioning costs, poor temperature control and possible guest discomfort. Unfortunately, many properties in the Caribbean fail to incorporate even basic energy efficiency features in the design of their roofs.

The principal energy efficiency features for roofs are discussed below.

1) Use light-colored and reflective roofing materials

   The color and the type of roofing material used largely defines how much solar radiation is absorbed by the roof and transmitted to the air conditioned spaces below. In hot climates, roofing materials should ideally have the highest possible solar reflectance and infrared emittance.[31] The thermal properties of common roofing materials are shown in the following table.

Thermal performance of various roofing materials[32]

Roofing material	Solar reflectance	Infrared emittance	Temp rise with respect to ambient temperature (°F)
Red clay tile	0.33	0.90	58
Red concrete tile	0.18	0.91	71
Unpainted cement tile	0.25	0.90	65
White concrete tile	0.73	0.90	21
New, bare galvanized steel	0.61	0.04	55
Aluminum	0.61	0.25	48
Metal roofing with special, reflective white coatings	0.59 - 0.67	0.85	37 - 28
Asphalt shingle, white	0.21	0.91	68
Asphalt shingle, light brown	0.19	0.91	70
Asphalt shingle, tan	0.16	0.91	72
Asphalt shingle, black	0.05	0.91	82
Built-up-roof, dark gravel	0.12	0.90	76
Built-up-roof, light gravel	0.34	0.90	57
Built-up-roof, white-coated gravel	0.65	0.90	28

[31] The solar reflectance of a roofing material is a measure of how much of the incoming solar energy is reflected back by the material. The solar reflectance can range from 0 to 1: materials that reflect most of the incoming energy have a high solar reflectance (e.g., around 0.7), while those that reflect only a small fraction of the incoming energy have a low solar reflectance (e.g., around 0.1).

The infrared emittance is a measure of how well a material radiates heat. The infrared emittance of a material can range from 0 to 1. A roofing material with a high infrared emittance (e.g., around 0.9) radiates more of the absorbed heat from the sun back out into the air, while a material with a low infrared emittance (e.g., galvanized steel) radiates less heat back out into the surrounding air and thus gets hotter.

[32] Source: http://eetd.lbl.gov/coolrf/asshingle.htm

If the existing roofs are in good condition and will not be replaced in the near future, the property should consider painting them with a highly reflective paint. Many manufacturers produce special roof paints that are more reflective than ordinary paint and are able to withstand the harsh outdoor environment and UV rays of the sun. These reflective coatings are especially effective for flat concrete and built-up roofs. For example, as shown on the preceding table, painting the gravel ballast of a built-up-roof with a reflective coating could reduce the roof temperature by up to 48°F.

Figure 2.39 - Reflective paint applied to this roof reduces the roof temperature and associated solar heat gains into the spaces below.

Manufacturers of reflective roof coatings include:

- Hydro-Therm Products, http://hydrotherm.arn.net/products.html
- Progressive Building Systems, http://www.progressivebuilding.com

2) Install radiant barriers in attics and other areas

A hot roof radiates approximately 80 to 90% of its heat down into the attic; this heat is then absorbed by the ceiling and conducted into the rooms below. The transmission of heat from the roof to the air conditioned rooms can be greatly reduced by laying a radiant barrier on the attic floor or stapling it to the rafters. A radiant barrier is a reflective sheet of aluminized paper foil that reflects the incoming radiant energy back towards the roof and allows only about 5% of the roof's heat to be radiated down into the ceiling of top-floor rooms.

Additional information on radiant barriers can be obtained from "Radiant Barrier Attic Fact Sheet" at www.ornl.gov/roofs+walls/radiant/rb_01.html

Figure 2.40 - Radiant barrier installed on an attic floor.

3) Ensure exterior walls and attics are properly insulated

Insulation reduces the flow of heat from hot to cold areas and can thus significantly reduce a building's air conditioning load. The recommended insulation levels range from R-38 for attics to R-11 for exterior walls.

Figure 2.41 - This attic of a Jamaican hotel has no insulation or radiant barrier. Heat from the metal roof is radiated directly onto the gypsum-board ceilings and into the rooms below.

4) Ensure attics and cathedral ceilings are properly vented

The final step towards reducing ceiling heat gains is to ensure that attics and cathedral ceilings are properly vented. Venting removes excess heat and reduces the cooling loads in the spaces below the roof. In order to have proper venting, there should be vents along the eves to allow cooler air to enter at the bottom of the roof, and vents near the top of the roof to allow the heated air to escape as it rises. Ridge vents that extend along the entire length of the roof's ridge provide better venting than several discrete vents.

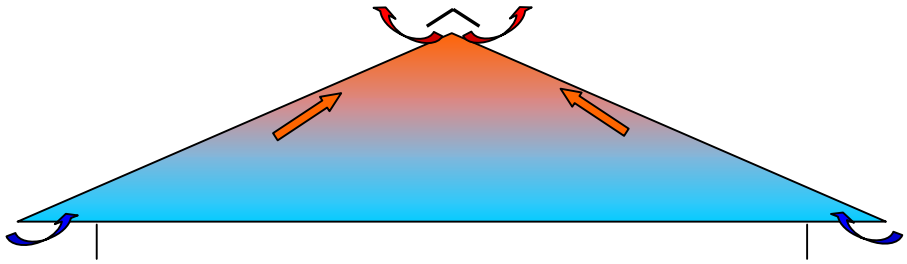


Figure 2.42 -Proper attic venting lowers attic temperatures.

2.21 Use an energy management system to control the operation of guestroom a/c units

Sold rooms are often unoccupied for up to 60% of the time while guests are out enjoying the beach, local attractions, and the various services provided by the hotel. Unfortunately guestroom a/c systems often operate continuously, even when no one is in the room. By installing guestroom occupancy control systems to limit the operation of a/c systems in empty rooms, hotels can generally reduce their air conditioning energy use by 30 to 50%.

Guestroom occupancy sensor controllers operate as follows:

- An occupancy sensor is used to detect the presence of people in the room.
- If the room is occupied, the a/c system works normally and gives the guest full control of the thermostat.
- If the room is unoccupied, a secondary thermostat takes over and resets the room temperature to a warmer and more energy efficient level. This secondary temperature setting can be adjusted by the maintenance staff and is typically 14°F (8°C) warmer than the "occupied" temperature set-point.
- As soon as someone enters the room, the a/c system automatically returns to its normal operating mode and quickly cools down the room to the "occupied" temperature set-point.

In addition, some guestroom occupancy controllers can be purchased with the following optional features:

- Exterior door/window lockout: These door or window sensors are designed to turn the a/c unit off if an exterior door or window is left open for a long period of time.
- Compressor delay: These built-in compressor delay devices prevent the compressor of the a/c unit from "short cycling."
- Data logger: Some control units can be ordered with a data logger that tracks guest occupancy, temperature and humidity levels, as well as energy use and savings.
- Humidity and condensation control: Some control units have humidity sensors that are designed to ensure that humidity in the room does not become too high, resulting in condensation on the walls and other related problem. If humidity increases beyond the set-point, the controller automatically turns the a/c unit on to remove the excess moisture.
- Remote occupancy detection: This optional feature allows housekeepers to know if a room is occupied or not, without having to knock on the door and disturb the guest.
- Refresh cycle: This function turns the fan on for a few minutes every half hour to prevent the room from becoming "stale" or stuffy.
- Surge protection: Some control units are programmed to restart in the unoccupied mode after a power failure. This prevents all of the a/c units from starting at once and creating a large power surge.
- Manual override: The manual override allows the property to temporarily disable the occupancy sensor control for maintenance purposes or at the request of a guest.
- Light turn-off: Some control units can be configured to turn off guestroom lights when the room is unoccupied.
- Interface with a Direct Digital Control (DDC) Building Management System (BMS): Some controllers are designed to interface with a property's computerized Building Management System. This can allow remote monitoring and control of guestroom a/c systems.

There are also less sophisticated and less costly "energy-saver switches" that can be used to control the a/c unit. The operation of these energy-saver switches is as follows.

- When the guest enters the room, he inserts a key-card into the energy-saver switch to "enable" the operation of the a/c unit and lights.
- When the guest leaves the room, he removes the key-card from the switch and the system automatically turns off the a/c unit (or puts it in standby mode) and lights after a short delay.

Figure 2.43 - Card-activated energy-saver switches that are used to control the operation of guestroom a/c systems and lights.

Manufacturers of guestroom occupancy controllers include:

- Alerton Technologies - Ibex Controller (www.alerton.com, 011-425-869-8400)
- Energy IQ Systems - IQ Genius Controller (www.energyiq.com, 011-609-227-2660)
- Lodging Technologies Corporation - Gem controller (www.lodgingtechnology.com, 011-540-362-7500)
- Senercomm - SensorStat Controller (011-407-775-9889)
- VingCard - Energy-saver switch that uses room key-cards (http://www.vingcard.com)

Savings achieved by installing an energy management system to control a/c units in guestrooms

An energy audit conducted by the EAST project in a 52-room Montego Bay property revealed that it could save 132,000 kWh/year, or 15% of its total electricity use, by installing sensor controllers on its guestroom a/c units. The financial savings resulting from this reduction in electricity consumption amounted to more than 13,000 US$/year. This measure required a US$ 15,000 investment and thus yielded a payback period of 14 months.

2.22 Keep the condenser coils of a/c and refrigeration equipment clean

The condenser and evaporator coils on a/c and refrigeration equipment must be kept clean and free from ice buildup. Dirty or blocked coils force the units to work harder than necessary, leading to increased energy use, poor performance and shortened service life. Regular coil inspection and cleaning should be included in the preventive maintenance program of all a/c and refrigeration equipment, including the smaller units such as ice makers and refrigerated cabinets.

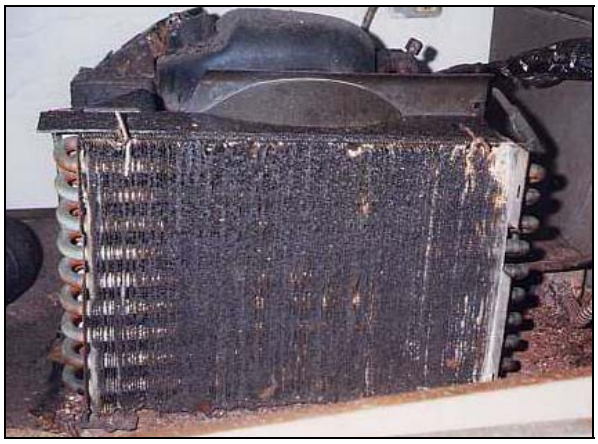


Figure 2.44 - Typical condition of condenser coils found in many hotel kitchens.

Figure 2.45 - Condenser coils of a refrigerated kitchen cabinet before and after cleaning.

Condenser coils that are located in a kitchen environment clog surprisingly fast with grease and dirt and should be checked on a monthly basis.

2.23 Make sure that the refrigerant lines of a/c and refrigeration equipment are properly insulated

Hotels should properly insulate the refrigerant lines of all their a/c units and refrigeration equipment, and protect all insulation that is exposed to rain and sunshine with a waterproof and UV resistant jacket or coating. This protection extends the service life of the insulation material by preventing water penetration and UV degradation.

Refrigerant lines that are not insulated needlessly waste energy and, as shown in the following graph, can easily reduce the capacity of a/c or refrigeration equipment by 5% or more. In addition, insulation that is ripped, cracked or otherwise damaged allows water to condense and saturate the insulation, increasing thermal losses and accelerating the decay of the insulation material.

Insulating refrigerant lines is inexpensive and generally offers a payback period of 6 months.

Figure 2.46 - Bare refrigerant line connecting the condenser to the evaporator of a mini-split a/c system.

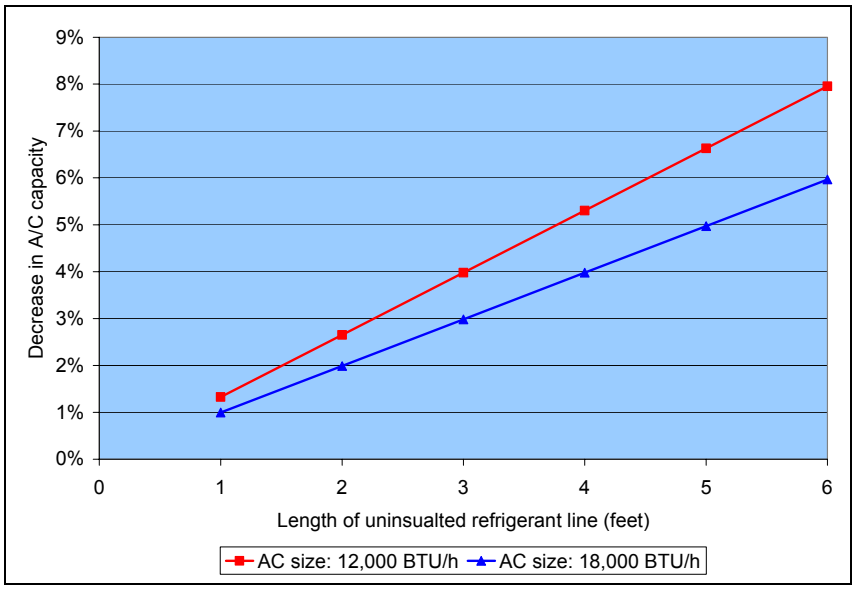


Figure 2.47 - Impact of bare refrigerant lines on the capacity of an a/c unit.

2.24 Purchase energy efficient air conditioners

The property should take the following criteria into account when purchasing new air conditioners.

- Purchase a/c units that have an Energy Efficiency Ratio (EER) greater or equal to 10.7. The EER is the ratio of the a/c unit's rated cooling capacity (in BTU/hr) divided by its electrical input (in Watts) at standard operating conditions. The best available units have EERs around 11.7, while base units have EERs around 8.5. Typically, there is only a relatively small cost difference between base models and high efficiency models. In Jamaica, purchasing guestroom a/c units that have an EER of 11.7 instead of 8.5 would typically save 1,800 kWh/year or 180 US$/year per unit. Over the expected 15-year lifetime of the equipment, these savings would amount to 2,700 US$/unit.
- If purchasing equipment from the US, select equipment that has the US EPA/DOE's Energy Star rating. These units meet minimum energy efficiency standards. Be wary of low-cost brands that fail to meet efficiency requirements of US, European or other recognized standards.
- Do not oversize air conditioners. This will cause the units to frequently cycle on and off, decreasing their efficiency, reducing their ability to control humidity, increasing energy use, and shortening their service life.
- If the property is located next to the beach, it should give preference to a/c equipment that is specifically designed for marine environments and is thus more resistant to salt-corrosion. This additional protection increases the service life of the unit and its operating efficiency over the life of the unit.
- Properly insulate all refrigerant lines and seal/caulk all wall penetrations.
- Do not vent or dispose of old refrigerant to the atmosphere. Refrigerants contain CFCs and HCFCs that deplete the ozone layer.

- Consider shading the a/c condensers that are exposed to direct sunlight. This measure can improve their efficiency by 2 to 10%. However, make sure that the shading feature does not restrict airflow to the condensers or divert some of the hot exhaust air back to the condenser.

2.25 Use waste heat or a renewable source of energy to heat the property's hot water supply

The topics discussed in this section include:

- solar water heaters, and
- heat recovery systems.

2.25.1 Solar water heating

Solar water heating is a proven and readily available technology that uses solar energy to replace or supplement conventional water heating systems. A typical solar water heater can reduce by approximately two thirds the amount of energy that is used to heat a property's hot water supply: some form of backup heating is generally required on solar systems to produce hot water during periods of heavy water use and on cloudy days.

The types of solar systems that are commonly used in hotels include integrated collector-storage systems, thermosyphon systems, and active systems.

- Integrated collector-storage solar water heating systems: An integrated collector-storage hot water heater combines the collector with the hot water storage system. The collector has large diameter copper pipes that hold a large volume of water, typically around 40 gallons per panel. The cold water enters at the bottom of the collector and is heated when the sun is out, and the heated water then exits through the top of the collector. There is generally a conventional water heater downstream of the solar collector to provide supplemental water heating if needed. This system is thus essentially a water pre-heater that is mounted in-line with an existing water heater. The advantage of this type of solar system is its simplicity: there are no pumps, valves or other moving parts, and the piping is straightforward (cold water line in and hot water line out). This system operates at the pressure carried by the water distribution system. The collectors are typically 8" to 10" thick. The disadvantages of this system are that the roof must be able to hold the combined weight of the collector and the stored water, and that its efficiency can be lower than that of the other systems.

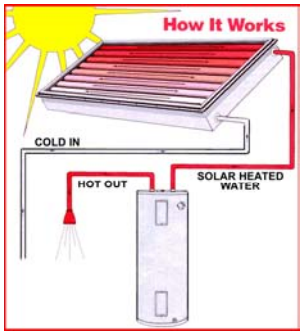


Figure 2.48 -Typical integrated collector-storage solar water heater.

- Thermosyphon solar water heating systems: A thermosyphon water heater is composed of a collector and a storage tank that is typically mounted directly above the collector. Cold water enters at the base of the collector, becomes less dense as it heats up, and rises first to the top of the collector and then to the top of the storage tank. The cooler water contained in the bottom of the storage tank sinks to the bottom of the collector where it is heated by the sun. This cycle repeats itself as long as there is sunshine and the water gets progressively hotter with each pass through the solar collector. This thermosyphon loop operates naturally without any pump. Thermosyphon systems can operate either as pressurized systems, at the pressure carried by the water distribution system, or as unpressurized systems: unpressurized systems are typically less expensive than pressurized systems. In either case, the roof must be able to hold the combined weight of the collector and the water storage tank.

- Active solar water heating systems: Unlike an integrated collector-storage and a thermosyphon solar water heater, an active solar system uses a pump to circulate water through the collectors. The pump is typically controlled by temperature sensors that are placed in the hot water storage tank and on the collectors. When the sun is out and heating up the water in the collectors, the sensors turn the pump on to circulate the water from the hot water storage tank to the collectors. During the night and periods of low sunshine, these sensors keep the circulation pump off. The main advantage of an active solar water heater is that only the collectors are on the roof and, thus, the roof carries less weight. For this reason, active solar systems are better suited for larger water heating needs. The main disadvantage of this system is its mechanical complexity with pumps, valves and controllers which all require more maintenance and upkeep. The maintenance of an active solar water heater, however, should not be a problem in hotels that have a good maintenance staff or maintenance provider.

Auxiliary heating: Some form of auxiliary heating is required in solar systems to maintain a constant supply of hot water during times of high demand or low sunshine. A thermosyphon solar water heater generally comes with a built-in electric or gas auxiliary heater, which makes the system a stand-alone unit that has no requirements other than the connection to the energy source and the plumbing. An integral collector-storage system and an active solar system both require a conventional electric or gas water heater. These auxiliary water heaters can either be purchased as a unit with the solar system, purchased separately, or taken from the property's existing water heating system.

Absorber selective surface options: The solar collector's absorber is the metal surface that absorbs solar radiation and transfers the energy to the water. The absorber is coated with a special material, or selective surface, that enables it to absorb as much radiation as possible while limiting the reflection and re-radiation of thermal energy. Some manufacturers offer a choice between a relatively inexpensive black paint selective surface and a more expensive, and often proprietary, higher-performance coating. However, in warm and sunny locations, like the Caribbean, these costly coatings are generally not that important to the overall performance of the system.

Glazing options: The glazing is the outer pane of glass or plastic that covers the collector. Its principal function is to let the solar energy enter into the solar collector and keep it trapped inside the collector box. Various techniques are used to improve the effectiveness of the glazing, including the use of special low-iron solar glass, coatings, films and high-performance plastics. However, in warm and sunny locations, like the Caribbean, the standard glazing options are generally adequate and the use of a high-cost, high-performance glazing is not warranted.

Cautions and comments:

- System sizing: Appropriately sizing a solar hot water heating system is important. An oversized system will cost significantly more than the incremental energy savings, and an undersized system will under-deliver on energy savings.

- Solar panel orientation: Siting the solar panels is very important for system performance. The panels should be mounted in an unshaded location and oriented due south for best performance. Nonetheless, orientations that deviate by 15 to 25 degrees away from due south do not significantly impact performance. The tilt of the collector is also important. A general rule of thumb is that the tilt should be approximately equal to the latitude of the site.

- Maintenance: Maintenance is an important element of an effective and long-lived solar water heating system. Active solar systems in particular require regular maintenance and inspections. Although these maintenance operations are not difficult, the valves, pumps, temperature sensors and controllers of active solar systems must be periodically inspected for proper operation. Many solar systems in the Caribbean fail because of simple and low-cost maintenance problems. If maintenance is a problem at a property, it should consider using only integrated collector-storage systems.

- Wind-resistant mounting: Care must be taken to ensure that the mounting system that is used to secure the solar heating panels to the roof is able to withstand the strongest winds that the location is likely to experience. Most manufacturers offer special mounting hardware for high-wind conditions.
- Roof penetrations: If the roof is penetrated either for mounting or for plumbing a solar system, care must be taken to ensure that the penetration is adequately sealed. If possible, roof penetrations should be avoided to eliminate possible leaks.

Costs and payback periods:

The cost of solar water heaters varies widely depending on the type of system used, the options selected, whether or not an auxiliary storage tank and heater are included, and the size of the system. However, the cost of a complete system, excluding shipping, taxes, and installation, generally ranges from US$ 380 to 570 per m^2 of collector surface.

Typical payback periods range from 3 to 6 years for solar water heaters that replace or supplement electric water heaters, and 5 to 15 years for solar water heaters that replace or supplement diesel or LPG water heaters.

2.25.2 Heat recovery systems

An average Caribbean hotel spends a great deal of money on the energy that is consumed by its water heaters and by its a/c units, which basically draw heat from guestrooms and other air conditioned areas and vent it to the atmosphere as waste heat. However, if the waste heat produced by the a/c units were recovered and used to heat water, instead of being discarded to the atmosphere, the hotel could virtually eliminate the energy consumption of its water heaters. In fact, the amount of useable waste heat produced by the a/c units of a hotel is generally far greater than the amount of energy consumed by its water heaters.

A desuperheater is a heat recovery device that recovers waste heat from the air conditioner's hot refrigerant gasses to heat water up to a temperature of 140^oF. It is essentially a counterflow heat exchanger that is installed on the hot refrigerant line between the air conditioner's compressor and condenser. It has specially vented, double-wall pipes that are designed to avoid contaminating the potable water with refrigerant in case of a pipe failure or leak. Since a desuperheater only recovers the "superheat" from the refrigerant gasses, it can be easily and inexpensively retrofitted into an existing a/c system (e.g., one or more mini-split a/c units) without having to perform extensive modifications and control upgrades. A desuperheater recovers 15 to 20% of the total heat available from the air conditioners; the remaining 80 to 85% of the available energy is released when the hot refrigerant gas is condensed back to liquid in the condenser.

In addition to reducing water heating costs, the use of a desuperheater also improves the efficiency of the a/c system and can reduce its operating costs by 10 to 15%. Furthermore, since installing a desuperheater on an air conditioning system is equivalent to adding 15% more condenser capacity, it lowers the compressor head pressure and thereby prolongs the life and improves the operation of the air conditioning system.

Figure 2.49 -A desuperheater (www.doucetteindustries.com).

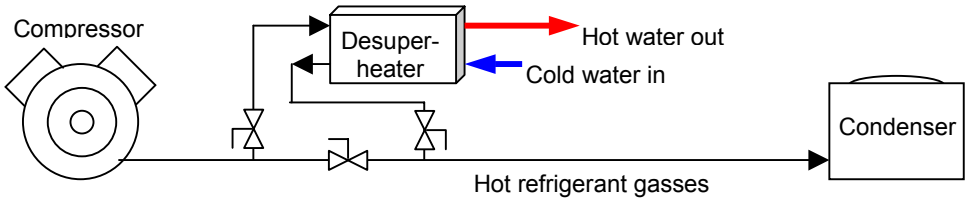


Figure 2.50 -Installation of a desuperheater to recover waste heat from an air conditioning system.

Doucette Industries is one of the companies that produce a line of desuperheaters suitable for use in hotels. Additional information on desuperheaters and heat exchangers can be obtained at www.doucetteindustries.com and at other Internet sites.

Use of a desuperheater to recover waste heat from guestroom a/c units

The EAST project carried out a study to evaluate the feasibility of installing a heat recovery system in a 36-room Jamaican hotel whose guestrooms were equipped with mini-split a/c units and electric water heaters. The guestroom block of this hotel had a total installed air conditioning capacity of 540,000 BTU/hour, which meant that its a/c units could remove up to 540,000 BTU/hour (158 kW) of heat from the guestrooms and reject it to the atmosphere through the condensers. The peak capacity of the nine electric water heaters serving the guestrooms was of 81 kW.

The study showed that connecting a single desuperheater, equipped with four separate refrigerant circuits, to a group of two 18,000-BTU/hour and two 24,000-BTU/hour a/c units would be able to meet most of the block's hot water needs as long as these four rooms were kept occupied. It was estimated that, under full load conditions, this desuperheater would be able to heat 1.44 USG of water per minute from 79 to 120^{o}F (or 2,070 USG/day), and recover 29,520 BTU/hour of energy.

At this property, this measure required an investment of US$ 2,400 and could have saved approximately 29,000 kWh/year of electricity. For a unit electricity cost of 0.10 US$/kWh, this measure could have reduced the property's electricity bills by 2,900 US$/year and yielded a payback period of 10 months.

2.26 Use LPG (gas) rather than electricity to heat the property's hot water supply

In areas where electricity is generated by burning fossil fuels, the cost of fossil fuels per unit of energy (i.e., US$/kWh) is significantly cheaper than that of electricity. For example, many hotels in Jamaica pay

approximately 0.100 US$/kWh for electricity[33] and 0.044 US$/kWh, or 56% less, for LPG and diesel. Part of the reason why there is such a large difference between the unit cost of electricity and fossil fuels is that the generation of electricity is an inefficient process. In many electricity generation plants only 30% of the energy contained in the fuel consumed by the generators is actually transformed into electricity, the remaining 70% is often lost as waste heat.

Given this large cost difference, it is generally much cheaper to use LPG or diesel rather than electricity as the source of energy for water heaters. For example, the environmental assessments conducted by the EAST project have shown that in Jamaican hotels the operating cost of an LPG-fired water heater is generally 40 to 50% lower than that of an equivalent electric water heater.

Using LPG or diesel rather than electricity for heating water also makes sense from an environmental perspective. Due to the low efficiency of the electricity generation process, an electric water heater actually consumes more fossil fuel and generates more air emissions than an equivalent gas or diesel water heater. However, the true environmental impact of electric water heaters is largely invisible because the waste of energy and the generation of air emissions occur at the power plant and not on property.

Economics of using gas versus electric water heaters in a Jamaican hotel

A 25-room property assessed by the EAST project used electric water heaters for its guestrooms. This property had an average occupancy of 70% and 12,800 guest-nights per year. It was estimated that by replacing the electric water heaters with LPG heaters, this property would reduce its total electricity consumption by 131,600 kWh/year and save approximately 13,200 US$/year in its electricity bills. In exchange, its LPG consumption would increase by 5,420 USG/year or 6,350 US$/year. Overall, the property could have saved 6,850 US$/year (a 52% reduction in energy cost) by using LPG rather than electricity to generate the hot water consumed by its guestrooms.

2.27 Ensure that water heaters and all exposed hot water lines are properly insulated

Many hotels fail to properly insulate their water heaters, hot water storage tanks and hot water distribution lines. These hotels often pay a steep price for this neglect because energy losses from the surface of hot storage tanks and water lines can be surprisingly high.

The following table shows the annual cost of the energy lost by bare hot water pipes in a property that uses LPG water heaters. In properties that use electric water heaters and pay on average 0.10 US$/kWh for electricity, the value of the energy losses can be 60 to 70% higher than those indicated in the table.

	Annual energy losses per foot of bare pipe (US$ per foot per year)[34]					
Pipe material ⇒	*CPVC (plastic) pipes*			*Steel pipes*		
Water temperature ⇒	*100°F*	*130°F*	*160°F*	*100°F*	*130°F*	*160°F*

[33] This is the total average cost for electricity and includes consumption charges (US$/kWh), peak electricity demand charges (US$/kVA.month), and other fees charged by the electric utility.

[34] The figures presented in this table are calculated for pipes and surfaces that remain hot 24 hours per day, 365 days per year (e.g., water heaters, hot water storage tanks, and the pipes of a hot water distribution system that is equipped with a circulation loop), and for a cost of LPG of 1.17 US$/USG or 0.31 US$/liter.

1.5” pipe diameter	1.7	4.2	6.7	22.1	56.2	88.7
1” pipe diameter	1.3	3.2	5.1	19.1	47.7	76.4
0.75” pipe diameter	1.2	3.0	4.9	11.9	29.1	46.6
0.5” pipe diameter	1.0	2.4	4.1	10.5	26.5	42.4

It is worth noting that, even though bare CPVC pipes lose less energy than bare steel pipes, they still produce costly energy losses and should be insulated. Since insulation generally costs US$ 1 to 2 per foot, insulating CPVC pipes offers a payback period of 6 months to 2 years and insulating steel pipes offers a payback period of 1 week to 3 months.

The insulation used on pipes that are exposed to rain and sunshine should be protected with a waterproof and UV resistant jacket or coating. This protection extends the service life of the insulation material by preventing water penetration and resisting UV degradation.

Given their large exposed surface area, water heaters and hot water tanks should also be well insulated.

Figure 2.51 -Example of a well-insulated hot water storage tank.

Impact of poorly insulated hot water pipes on energy consumption

Auditors found more than 1,250 ft of bare or poorly insulated hot water pipes in a 52-room Jamaican property assessed by the EAST project. These pipes carried 130°F water in guestroom and front-of-house areas and 160°F water in back-of-house areas. It was estimated that the energy losses in these poorly insulated pipes increased the property’s consumption of LPG by 40%, or 6,350 USG/year, and cost 7,450 US$/year (for a LPG cost of 1.17 US$/USG or 0.31 US$/liter).

Insulating these hot water lines would have cost US$ 2,000 and yielded a payback period of 3.5 months.

2.28 Use high or premium efficiency motors

As a matter of practice, all new motors purchased by a hotel should be high or premium efficiency motors. Depending on the size of the motor, the high efficiency models can be up to 15% more efficient than standard motors. The following table provides a list of recommended replacement motor efficiencies.

Horse Power	kW	Standard motor efficiency (%)	Recommended premium motor efficiency (%)
0.5	0.4	70	80
0.75	0.6	72	84
1	0.75	79	85.5
1.5	1.1	80	87.5
2	1.5	80	88.5
3	2.2	81	90.2
5	3.7	82	90.2
7.5	5.6	85	91.7
10	7.5	86	92.4
15	11	87	92.4
20	15	88	92.6
25	19	88	93.0
30	22	89	93.6

Premium efficiency motors generally cost 5 to 15% more than standard motors. However, the small incremental cost paid for the higher efficiency motors can be quickly recovered through energy savings.

2.29 Use laundry washers that have a high speed (high G) extraction cycle or a stand-alone centrifuge extractor to reduce the amount of energy consumed by the dryers

Drying is the most energy-intensive part of laundry operations and often has a large impact on a property's energy use. For example, more than 10% of the total amount of electricity consumed by a 50-room property assessed by the EAST project was actually used by its single electric laundry dryer.

The energy consumption of laundry dryers can be dramatically reduced, however, by increasing the amount of water that is extracted from the linens before they are dried. This can be achieved by spinning the wet linens at high speed either in a washer that has a special high G-force extraction cycle or in a stand-alone centrifuge extractor.

Base model washers have a final extraction cycle that spins the drum at a velocity that generates a force of 80 to 90 Gs[35] on the linens. At the end of this extraction cycle, towels have a water retention of approximately 95%; that is, if 50 pounds of dry towels are washed, they generally will contain 47.5 pounds of water and have a total weight of 97.5 pounds when they are taken out of the washer.

Higher efficiency washers have extraction cycles that generate a force of 230 to 350 Gs and thereby spin much more water out of the linens than base model washers. Towels spun in extraction cycles of 230 and 350 Gs have a water retention of 72% and 64%, respectively. 350 Gs is about the maximum extraction force that can be achieved in a combined washer-extractor.

Specially designed, stand-alone centrifuge extractors achieve even lower water retention levels by generating extraction forces of 980 to 1000 Gs. Towels spun at 1000 Gs have a water retention of 18%, or

[35] A "G" is a unit that is used to measure the force on a body undergoing acceleration and express it as a multiple of the body's weight. For example, a body exposed to an acceleration of 100 Gs will feel like it is 100 times heavier than its actual weight.

81% less water than towels processed in a base model washer. It should be noted that centrifuge-extractors are not washers; these appliance are simply designed to reduce the amount of water contained in the linens that are removed from the washers.

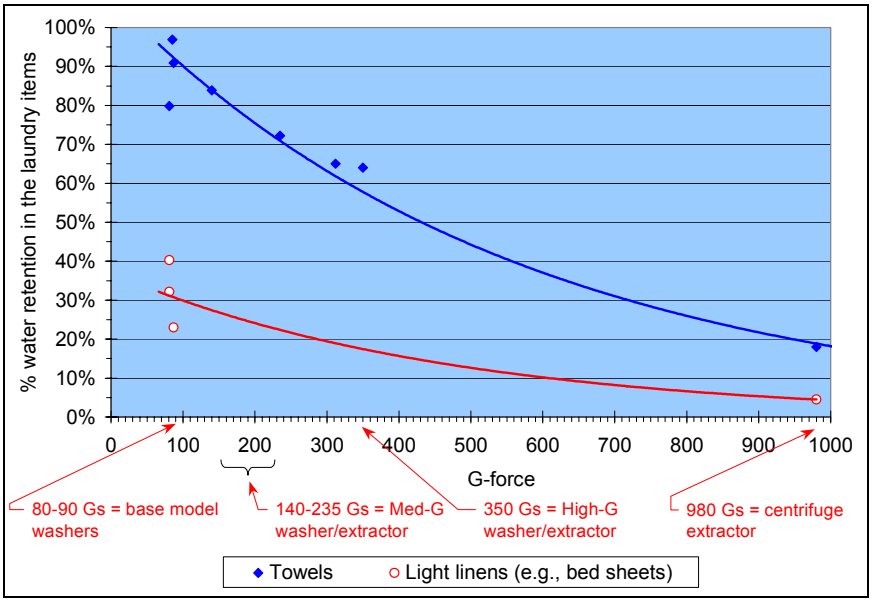


Figure 2.52 -Relationship between water retention in towels and bed linens and extraction force.

By reducing the water content of the linens, high-speed extraction cycles can reduce the dryer's energy consumption by approximately

- 25% for a 240-G extraction cycle,
- 45% for a 350-G extraction cycle, and
- 80% for a 1000-G extraction cycle.

In addition to reducing drying times and energy consumption, a high G-force extraction cycle also allows some of the lighter linens (e.g., napkins and table cloths) to bypass the dryer altogether and go straight to the press. Furthermore, reduced drying times minimize the amount of linting and thereby extend linen life.

The typical retail prices of washer-extractors and centrifuge extractors in the US are shown in the following table. Since a high-G washer-extractor costs approximately US$ 2,000 more than a base model washer of the same capacity, properties should seriously consider purchasing these higher-efficiency models the next time they need to replace their existing washers.

Manufacturer	Model	Capacity (lb of linen)	Final extraction force (Gs)	US retail cost (US$)
Wascomat	Washer extractor, EXSM-230	65	220	9,045
Wascomat	Washer extractor, ESXM-350	80	220	14,240
Unimac	Washer extractor, UW60-PVQ	60	235	7,400
Unimac	Washer extractor, UW60-P3	60	140	7,100
Unimac	Washer extractor, UF50	50	345	10,800

Bock Engineering	Centrifuge extractor	35	980	9,300
Bock Engineering	Centrifuge extractor	60	980	10,375
Bock Engineering	Centrifuge extractor	100	980	13,125

Additional information on high-G washer-extractors and centrifuge extractors can be obtained from the following sources.

- Unimac (www.uniwash.com, 800-587-5458)
- Wascomat (www.wascomat.com, 800-645-2204)
- Speed Queen (www.speedqueen.com, 800-345-5649)
- Heubsch (www.heubschonline.com)
- Bock Engineering (www.bockengineered.com, 419-726-2645)

Energy saved by using a stand-alone centrifuge extractor in a hotel laundry

A study was conducted by the EAST project to determine the cost-effectiveness of installing a centrifuge extractor in a 50-room Jamaican hotel that washed 270,000 lb of linens each year. Its laundry was equipped with two base model washers, with a final extraction cycle of 90 Gs, and a single electric dryer.

This study showed that by using a stand-alone 60-lb, 980-G centrifuge extractor to pre-dry the clothes the property would achieve the following benefits:

- Electricity savings = 71,800 kWh/year (an 83% reduction in dryer energy use)
- Financial savings = 7,200 US$/year (for an electricity cost of 0.10 US$/kWh)

Since the centrifuge extractor had a cost 10,400 US$, this measure yielded a payback period of 18 months.

2.30 Use LPG (gas) rather than electricity as the main source of energy for the property's dryers, flatwork ironers, ovens, ranges, fryers, and other similar appliances

In areas where electricity is generated by burning fossil fuels, the cost of fossil fuels per unit of energy (i.e., US$/kWh) is significantly cheaper than that of electricity. For example, many hotels in Jamaica pay approximately 0.100 US$/kWh for electricity[36] and 0.044 US$/kWh, or 56% less, for LPG. Part of the reason why there is such a large difference between the unit cost of electricity and fossil fuels is that the generation of electricity is an inefficient process. In many electricity generation plants only 30% of the energy contained in the fuel consumed by the generators is actually transformed into electricity; the remaining 70% is often lost as waste heat.

[36] This is the total average cost for electricity and includes consumption charges (US$/kWh), peak demand charges (US$/kW.month), and other fees charged by the electric utility.

Given this large cost difference, it is generally much cheaper to use LPG rather than electricity as the main source of energy for appliances such as laundry dryers, flatwork ironers, ovens, ranges and fryers. For example, the environmental assessments conducted by the EAST project have shown that in Jamaican hotels the operating cost of an LPG-fired appliance is generally 25 to 50% lower than that of an equivalent electric appliance.

Using LPG rather than electricity for thermal applications also makes sense from an environmental perspective. Due to the low efficiency of the electricity generation process, an electric appliance, such as a dryer, actually consumes more fossil fuel and generates more air emissions than an equivalent gas-fired appliance. However, the true environmental impact of electric appliances is largely invisible because the waste of energy and the generation of air emissions occur at the power plant and not on property.

Cost savings achieved by replacing an existing electric dryer with a gas-fired dryer

A study was conducted by the EAST project to quantify the savings achieved by replacing an existing electric dryer with an LPG dryer, of the same capacity, in a 50-room Jamaican hotel. This property processed 270,000 lb of linens each year using two base model washers, with a final extraction cycle of 90 Gs, and a single 50-lb electric dryer. The key results of this study are listed below:

- Electricity consumption of the existing electric dryer = 86,000 kWh/year
- Operating cost of the existing electric dryer = 8,600 US$/year (for an electricity cost of 0.10 US$/kWh)
- LPG consumption of an equivalent LPG dryer = 3,700 USG/year
- Operating cost of an equivalent LPG dryer = 4,350 US$/year (for an LPG cost of 1.17 US$/USG or 0.31 US$/liter)
- Financial savings achieved by using an LPG dryer = 4,250 US$/year (49% reduction in energy costs)
- Cost of a new LPG dryer = US$ 3,250
- Payback period = 9 months

3. Purchasing

3.1 Adopt an Environmental Purchasing Policy

Purchasing decisions in hotels are largely based on the initial cost, quality, style and availability of products. Although the selection process is generally controlled by the purchasing manager, individual departments or employees often provide their own recommendations and skew purchasing decisions towards products that are convenient to use and ease their workload. Since this standard approach pays little attention to the total financial and environmental cost of the products (e.g., operating cost, disposal cost, hazards to staff and guests), hotels often unwittingly select products that have surprisingly large hidden costs or undesirable impacts on the environment.

By creating an Environmental Purchasing Policy and ensuring that all or most purchases respect this policy, a property can significantly reduce its operating costs and improve its environmental performance. An Environmental Purchasing Policy is basically an instrument that ensures that purchasing decisions are based on a broader range of factors, including

- the operating cost of fixtures, appliances and equipment over their lifetime;
- the volume of waste generated by the use of a particular product (e.g., packaging waste) and the related waste handling and disposal costs;
- the potential health risks associated with the use of a particular product or chemical;
- the effect of a chemical on the property's wastewater treatment or disposal system, and
- the effect of a particular product or chemical on the local environment.

As a general rule, an Environmental Purchasing Policy should be designed to give preference to the following:

- environmentally friendly products and chemicals;
- products sold in bulk or concentrate form (to reduce packaging waste);
- products sold in refillable containers or reusable packaging;
- products that are supplied with a minimum amount of packaging;
- products packaged in materials that can be recycled locally;
- products that are made from or contain recycled materials;
- energy and water efficient fixtures, appliances and equipment;
- products that are reusable and durable (instead of disposable items); and
- products manufactured locally (to support the local economy and community).

The property should appoint a knowledgeable employee as the "implementer" of the Environmental Purchasing Policy. Ideally, this person should be the purchasing manager or the cost controller. This person's duties should focus on:

- Communicating the importance of environmentally friendly purchasing to the department managers and working with them to identify environmentally friendly products when applicable.

- Reviewing current purchasing practices to determine how purchasing decisions impact the property's waste generation and disposal.
- Assessing all current purchases to identify the products that should be targeted by the new environmental purchasing guidelines.
- Establishing a system to accurately evaluate the savings achieved by the Environmental Purchasing Policy (e.g., by eliminating unnecessary products and chemicals, or replacing disposable items with durable items).
- Notifying vendors of the property's Environmental Purchasing Policy and new purchasing guidelines.

3.2 Purchase recycled paper products

Most paper products manufacturers produce environmentally friendly alternatives that contain a minimum of 20% recycled paper fiber obtained from POST-CONSUMER waste. The price and quality of recycled paper products are generally comparable to those of virgin paper products. By using recycled paper products (office paper, toilet paper, facial tissues, paper towels, etc.), the property can help foster the local market for recycled products and convey its concern for the environment to its guests.

3.3 Minimize the purchase and use of disposable items

The property could reduce costs and the volume of waste it generates by minimizing the use of disposable items. In order to achieve this goal, the purchasing staff, in conjunction with each of the property's departments, should

- identify the disposable items that are currently used on property;
- devise ways to eliminate or minimize the use of these disposable items;
- look at the cost of the disposable items and evaluate the possibility to replace them with reusable items; and
- monitor the use and prevent the overuse of disposable items.

Some of the disposable items used that are commonly used in hotels and possible alternatives are presented in the following table.

Item	Possible alternatives
Paper cocktail napkins	▶ Replace with reusable coasters.
Disposable plastic cups	▶ Replace with durable plastic cups.
Disposable lunch boxes, plates and cutlery	▶ Use durable plates and cutlery in all parts of the hotel, including in the staff canteen.
Paper towels	▶ Where possible, use durable cleaning cloths made from old towels or table cloths.
Plastic aprons	▶ Replace with durable aprons.
Disposable cook caps	▶ Replace with durable, washable caps.

Plastic garbage bags	▶ Use durable bags, containers or wheelbarrows to collect yard waste. ▶ Use cloth bags or baskets to handle linens and guest laundry. ▶ Use garbage bins that do not need plastic liners in all areas that produce mainly dry waste (e.g., offices, guestrooms and gardens).
Sternos used in the kitchen and restaurants	▶ Replace the solid fuel canisters with refillable alcohol burners. ▶ Use electric elements or gas burners to heat up the buffet warmers.

3.4 Reduce the number of plastic bags purchased and used by the property

Most properties use a surprisingly large number of plastic bags to collect innocuous dry waste (e.g., paper waste in offices) and yard waste, and collect and return hotel linens and guest laundry. They could however drastically reduce their consumption of plastic bags by replacing them, whenever possible, with durable canvas bags, durable containers, or garbage bins that do not need plastic liners. These alternatives will be discussed later in this document, but the purchasing manager should tightly control the purchase and use of these bags.

Figure 3.1 - Examples of unnecessary use of plastic bags.

3.5 Evaluate the chemicals used on property and switch whenever possible to more environmentally friendly products and to products that are sold in bulk containers

Many properties use too many different chemical products, and their staff often use the wrong chemicals or far more than is needed for a particular task. In addition, many properties purchase large amounts of chemicals in small, ready-to-use containers, a practice which increases costs, encourages the inefficient use of the products and generates a lot of solid waste.

In order to avoid these problems, a property should ideally conduct a comprehensive review to determine what types of chemicals it uses, how they are purchased and packaged, who uses them, and where, why and how they are used. After completing this review, the property should consider implementing the following recommendations.

- Work with department heads to find ways to reduce the number of different chemicals used.
- Reduce costs and packaging waste by purchasing all possible chemicals in bulk rather than in small, ready-to-use containers.

Figure 3.2 - Chemicals used by a single housekeeper in a hotel audited by the EAST project.

- Contact the property's bulk chemical suppliers and ask them to pick-up and refill empty product containers. The property could even receive a credit for each container returned, as is often done in the US and Europe, and should give preference to the chemical suppliers who are willing to collect and reuse their empty containers.
- Ask chemical suppliers to provide the MSDS (Material Safety Data Sheets) for all chemicals used on property (in many countries they are required by law to do this if asked). Use the information provided in the MSDS sheets to identify hazardous chemicals and ask the chemical suppliers for less, or non-hazardous substitutes. Harsh and toxic chemicals pose a threat to the health of employees and guests, and often harm the environment.
- Ensure that each department head or supervisor has a copy of the MSDS on file for all chemicals used by his or her department. Copies of the MSDS for all chemicals used on property should also be filed in a central location.
- Identify and purchase laundry and dishwashing detergents that do not contain phosphates. Phosphorus is a nutrient that is harmful to natural bodies of water and cannot be effectively eliminated by most wastewater treatment systems.
- Encourage each department to identify, develop, and test natural or alternative cleaning agents. For example, use a mixture of baking soda and vinegar to clean ovens or replace the use of bleach in housekeeping operations.

3.6 Minimize the use of aerosol products

Avoid the use of aerosol air fresheners and cleaning products even if they do not contain CFCs. Beyond the hazards of the active ingredients of the product contained in the aerosol spray cans, the propellant gases themselves often present a danger to staff and guests. Many hotels have successfully replaced aerosols with alternative products. For example:

- aerosol air fresheners can be replaced with liquid air fresheners dispensed from refillable pump bottles; and
- aerosol laundry starch can be replaced with a home-made mixture of powdered starch and water.

These alternative products are often less expensive, since they can be purchased in bulk, and they also reduce the amount of packaging waste produced by the property.

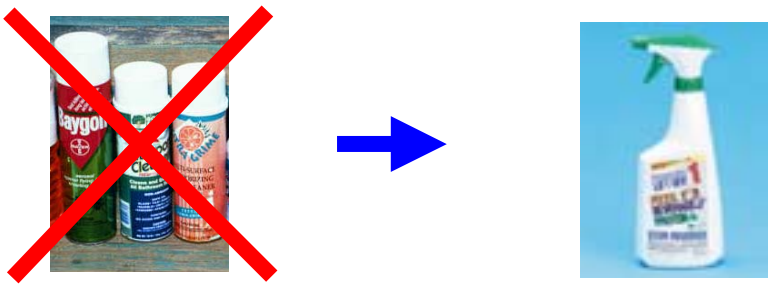


Figure 3.3 - Whenever possible, switch from spray cans to refillable trigger-spray bottles.

4. Housekeeping

4.1 Create a checklist for housekeepers that incorporates conservation measures in the standard procedures for servicing guestrooms

Since guestrooms account for a large share of energy, water, chemicals and product use in hotels, housekeepers can play a critical role in any resource conservation and waste reduction program. However, housekeepers must be trained on how to apply conservations measures in their work and given a checklist to ensure these measures are permanently incorporated into the guestroom servicing routine.

Examples of the type of conservation measures that should be included in the housekeepers' standard operating procedures for servicing guestrooms are listed below.

- Before leaving a guestroom:
  - make sure all lights, the TV set and the a/c unit are off;
  - make sure that the toilet and faucets are not running; and
  - fully close the sheers and partially close the curtains (e.g., 3/4 closed) on windows and patio doors that are exposed to direct sunlight during the course of the day.

Figure 4.1 - Curtain and sheer set-up for rooms that are exposed to direct sunlight.

- Check for and report malfunctioning equipment and fixtures. Pay particular attention to:
  - creeping toilets,
  - sticking toilet flush handles or malfunctioning flush mechanisms,
  - excessively high flows from faucets or showerheads,
  - clogged aerators or showerheads,
  - bathtub or sink stoppers that don't close or seal properly,
  - scalding hot water,
  - windows and doors that do not close properly or are otherwise damaged,
  - malfunctioning or excessively noisy fans, and
  - malfunctioning a/c systems and controls.

- Use the Maintenance Department's work-order/reporting system to report maintenance problems.
- Do not replace the towels that have been hung to dry by the guests in accordance with the instructions of the towel reuse program.
- Replace the bed linens in accordance with the property's linen reuse program.
- Do not replace the garbage bin liners (plastic bags) unless these are soiled or otherwise unacceptable for further use.
- Collect separately all recyclable items left in guestrooms and bring them to the recycling center located in the linen room.
- Remove used soaps and amenities only at checkout.

Examples of the type of conservation measures that should be included in the housekeepers' standard operating procedures for the turn-down service are listed below.

- Leave only one of table lamp on.
- Leave all other lights, the TV set and the a/c unit off.
- Check the bathroom for running faucets or toilets.

Housekeepers should be periodically trained to ensure they are well aware of these conservation measures and supervisors should perform spot checks to ensure compliance.

4.2 Implement a towel reuse program

Up to 40% of the total weight of items processed in hotel laundries consists of towels that have been used only once and are basically clean. Washing these towels consumes a significant amount of effort, water, energy and chemicals, and produces a large volume of wastewater that is contaminated with bleach, detergents and other laundry chemicals. In an effort to conserve resources and avoid generating needless waste, many hotels have adopted a towel reuse program to encourage their guests to use their towels for more than a single day. A towel reuse program is straightforward: guests are asked to leave their towels hanging on the towel rack or on the shower rod if they wish to use them again, or drop them in a basket or in the tub if they wish to have them replaced.

Figure 4.2 - A towel reuse program can save significant amounts of water, energy, and laundry chemicals.

Contrary to what some hoteliers think, guests almost never object to a towel reuse program, and if they do, they can simply choose not to participate. Surveys conducted by PA Consulting in tourist resorts revealed that more than 80% of the interviewed guests were willing to participate in a towel reuse program if this option were offered to them. A towel reuse program invites the voluntary participation of the guests and has no effect on the star or diamond rating of the hotel.

Properties that have or are planning to start a towel reuse program should pay attention to the following issues.

- Inform the guests: Any guest who is not aware of the towel reuse program will never participate and will complain if a housekeeper fails to replace a used towel that was inadvertently left hanging on the towel rack. The property should therefore make sure that its guests are aware of the program. For example, the property could place a sign explaining the program in all guest bathrooms and use the front desk staff or the bellman to introduce the guests to the program at check-in.
- Train the housekeeping staff: Once the towel reuse program is in place, the property must ensure that its housekeepers respect the decisions of the guests who chose to reuse their towels. In many hotels that have a towel reuse program, housekeepers routinely short-circuit the program by replacing all bathroom towels, including those that are left hanging by the guests. Most towel reuse programs fail to produce results because the housekeepers are poorly trained and not, as commonly believed by hoteliers, because the guests do not participate.
- Let the towels dry properly: When preparing a guestroom, the housekeepers should leave the "reused" towels to dry in a suitable place (e.g., on the towel rack, shower rod or on a hook) rather than folding them in accordance with the hotel's "standard" presentation. Although this may slightly alter the "look" of the prepared bathroom, the guests who participate in the program generally realize that the towels can be reused only if they are properly left out to dry. If a towel that is hung to dry by the guest is too damp, housekeepers can replace it with a fresh towel at their discretion.
- Think of the pool and beach towels: Since pool and beach towels often account for a large portion of the total laundry load, hotels should consider including them in the towel reuse program.

Effect of a towel reuse program on laundry operations[37]

The estimated impact of implementing a towel reuse program in a 50-room hotel is as follows:

- Reduction in laundry volume = 42,500 lb/year
- Reduction in washer & dryer loads = 1,700 loads/year in a 50-lb washer and dryer
- Reduction in water use = 107,000 USG/year
- Reduction in electricity use = 6,200 kWh/year
- Reduction in detergent use = 320 lb/year
- Reduction in bleach use = 120 lb/year

In addition, the towel reuse program will

- increase the service life of the laundry's washers and dryers;
- reduce the maintenance requirements of the laundry's equipment;
- reduce the wear and tear on the towels; and
- reduce the labor requirements in the laundry.

[37] These calculations are based on the following assumption: the hotel has a 70% average occupancy rate; there are on average 2 guests per occupied room; the towel reuse program reduces by 40% the total weight of towels processed by the laundry; and that the laundry is equipped with an electric water heater and dryer.

4.3 Implement a linen reuse program

In hotels where bed linens are changed daily, up to 30% of the total weight of items processed in the laundry consists on bed sheets and pillowcases that have been used only once and are basically clean. Washing these linens consumes a significant amount of effort, water, energy and chemicals, and generates a large volume of wastewater that is contaminated with bleach, detergents, and other laundry chemicals. In an effort to conserve resources and avoid generating needless waste, many properties have adopted a more environmentally-friendly linen change policy and change the bed linens every two or three days unless they are soiled. Like towel reuse programs, this type of program is practiced by 5-star hotels such as Half Moon in Jamaica and has no impact on star or diamond ratings.

Figure 4.3 - An effective linen reuse program saves water, energy and chemicals, and extends the service life of the laundry equipment and linens.

There are three standard ways to implement a linen reuse program.

1) The property implements a policy of changing bed linens every two (or three) days.[38] The program is not announced to guests at check in, nor is there a card in the guestroom that describes the program. If a guest makes an inquiry about their linens, the property explains the policy and notes that it is part of their environmental program, and offers to change their linens every day if the guest wishes. Of course, any guest who objects to this practice can have his/her bed linens changed daily. This is generally the most effective and the easiest way to implement a linen reuse program (this type of program has been successfully used for years at Half Moon in Jamaica).

2) The guest is asked to leave a card on the bed indicating that it is not necessary to change the sheets that day. This approach works but gets fairly low guest participation, since even environmentally concerned guests often forget to leave the card in the correct place.

3) The guest is informed that, in an effort to protect the environment and conserve resources, the hotel only changes sheets every two (or three) days. If the guest would like to have the sheets changed more frequently, the guest is asked to place a card on the bed to have them changed that day. This method requires an action from the guest if he/she wants the sheets to be changed and, therefore, achieves better results.

The CHA and several other organizations sell attractive, colorful in-room materials to communicate the linen reuse program to the guests.

As with the towel reuse program, the success of the linen program relies on the effective participation of the property's housekeepers. Therefore, if this program is implemented, all housekeepers should be thoroughly trained to ensure they clearly understand their role and responsibilities.

The water, energy and chemical savings and other benefits achieved by adopting a more environmentally friendly linen policy are similar to those achieved by a towel reuse program.

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[38] Another option is to change sheets "top-to-bottom" every 2 to 3 days (meaning the bottom sheet is removed, the top sheet replaces the bottom sheet, and a new top sheet is added). Because the bottom sheet tends to get soiled much faster than the top sheet, this practice is more efficient than changing both sheets.

4.4 Monitor the performance of the towel and linen reuse programs

Monitoring the performance of the towel and linen reuse programs allows the property to

- measure the savings achieved by comparing towel and linen use per guest-night (GN) before and after the start of the program;
- make appropriate corrections to the program if the monitoring data does not show a reduction in towel and linen use per GN;
- determine when it is necessary to retrain the housekeepers and increase spot checks to ensure compliance with the program; and
- determine the guests' acceptance of the program.

In order to monitor the performance of the towel and linen reuse program the property must keep track of the number of each type of item (e.g., bath towels, beach towels, bed sheets, pillowcases) processed each day by the laundry. This data should then be used to

- calculate at the end of each month the total number of items processed by the laundry during the past month;
- calculate at the end of each month the average number of items used per guest-night during the past month;
- calculate at the end of each year the total number of items processed by the laundry during the past year;
- calculate at the end of each year the number of items used per guest-night during the past year; and
- produce graphs to track the monthly and annual changes in item use per guest-night.

A sample towel reuse program monitoring log and graphs are shown in the following table and figures.

Towel reuse program monitoring data					
Month & year	**Occupancy (GN)**	**Total beach towel use**	**Beach towel use per GN**	**Total bath towel use**	**Bath towel use per GN**
Jan-00	2,578	3,258	1.26	3,892	1.51
Feb-00	2,533	3,116	1.23	3,920	1.55
Mar-00	3,362	3,268	0.97	3,892	1.16
Apr-00	3,501	3,452	0.99	3,920	1.12
May-00	2,634	2,698	1.02	2,916	1.11
Jun-00	1,945	1,897	0.98	2,227	1.14
Jul-00	2,268	2,314	1.02	2,683	1.18
Aug-00	3,073	2,489	0.81	3,332	1.08
Sep-00	1,256	1,149	0.92	1,447	1.15
Oct-00	1,792	1,695	0.95	2,007	1.12
Nov-00	2,766	2,787	1.01	3,166	1.14
Dec-00	2,820	3,102	1.10	3,602	1.28
Totals for 2000	**30,528**	**31,225**		**37,004**	
Item use per GN in 2000			**1.02**		**1.21**
Jan-01	2,821	2,254	0.80	3,087	1.09
Feb-01	3,048	2,391	0.78	3,260	1.07
Mar-01	4,024	3,389	0.84	4,152	1.03
Apr-01	4,172	3,654	0.88	4,094	0.98

May-01	3,504	2,628	0.75	3,307	0.94
Jun-01	2,639	2,174	0.82	2,357	0.89
Jul-01	2,881	2,547	0.88	2,827	0.98
Aug-01	2,423	1,987	0.82	2,499	1.03
Sep-01	2,428	1,997	0.82	2,261	0.93
Oct-01	1,985	1,608	0.81	2,023	1.02
Nov-01	1,669	1,569	0.94	1,785	1.07
Dec-01	1,309	1,378	1.05	1,547	1.18
Totals for 2001	**32,904**	**27,576**		**33,199**	
Item use per GN in 2001			**0.84**		**1.01**

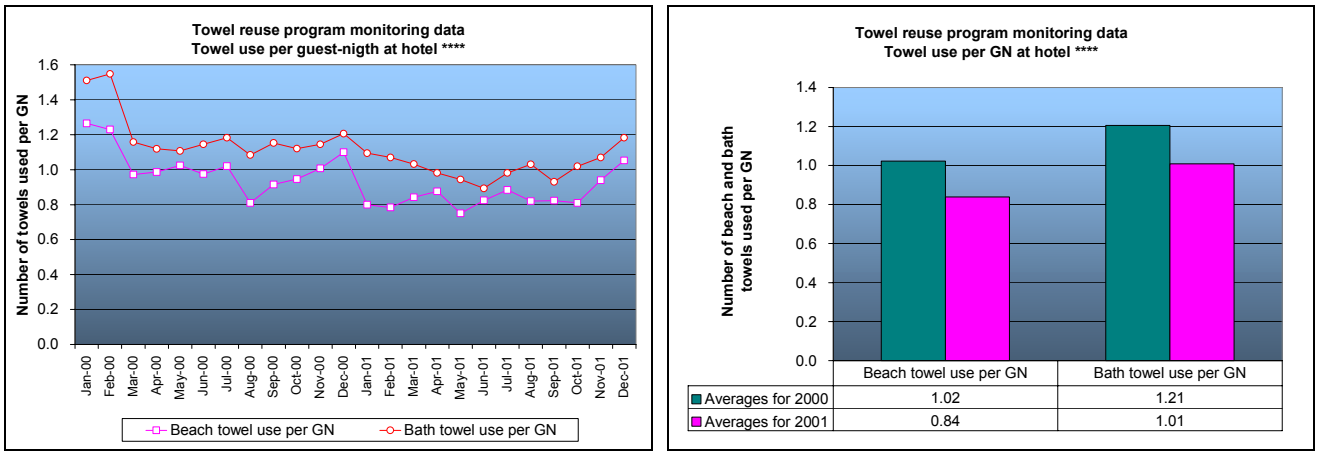

Figure 4.4 - Monthly and annual tracking of towel use per GN.

4.5 Reduce the number of plastic bags used by the housekeeping staff

Many properties use a surprisingly large number of disposable plastic bags to collect dirty laundry and linens from guestrooms, return clean linens and laundry to guestrooms, and line guestroom garbage bins. Since using disposable plastic bags for these applications needlessly increase costs and the volume of waste produced by a hotel, the housekeeping department should consider adopting the following measures.

- Use durable cloth or canvas bags to collect dirty linens from guestrooms. These bags can either be purchased or made from old sheets or tablecloths.
- Use baskets, carts or durable cloth bags to return clean linens to guestrooms.

Figure 4.5 - Avoid using plastic bags to transport laundry to and from guestrooms.

- Use durable cloth bags to collect dirty guest laundry from the rooms.
- Use durable cloth bags, baskets or garment bags to return guest laundry to the rooms.

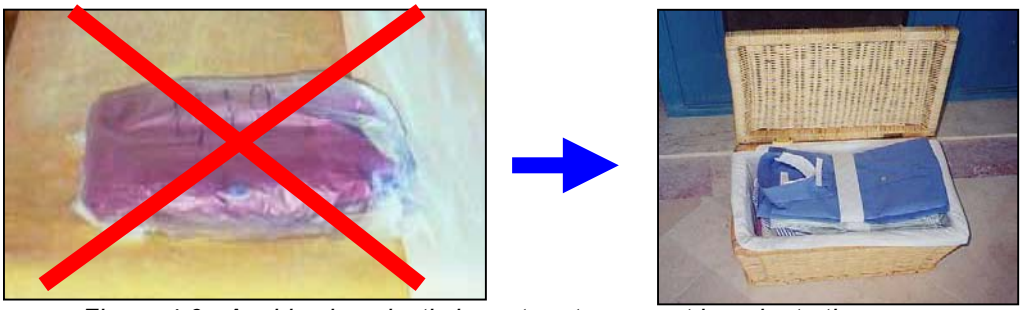

Figure 4.6 - Avoid using plastic bags to return guest laundry to the rooms

- Do not use garbage bins that need a disposable plastic liner in guestrooms. If the garbage bins must be fitted with liners, make sure they are replaced only when soiled or unfit for further use.

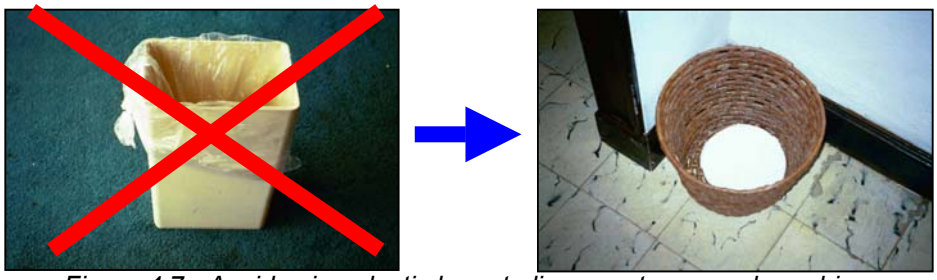

Figure 4.7 - Avoid using plastic bags to line guestroom garbage bins.

4.6 Replace disposable guestroom amenities with refillable amenity dispensers

Since disposable guestroom amenities are relatively expensive, when compared to the value of the product they contain, and increase the volume of waste generated by hotels, they should ideally be replaced with amenity dispensers that can be refilled with products that are purchased in bulk. As shown in the following figures, the market offers a wide selection of guestroom amenity dispensers that should be able to meet the requirements, style and budget of most hotels.

Figure 4.8 - Refillable guestroom amenity dispensers.

4.7 Reduce the amount of waste generated by the use of guestroom amenities

If the property uses individually packaged guestroom amenities, it should consider adopting the following measures.

- Instead of replacing the guestroom amenities that have been partially used by the guests (e.g., a bar of soap that is less than half of its original size), the housekeepers should provide spare amenities as needed but remove the used amenities only at check-out. The guests, not the housekeepers, should decide when to throw away their used amenities.
- Instead of discarding the partially used amenities collected from guestrooms, the property should either make them available to staff, donate them to charity, or reuse them on property (e.g., soap bars can be used to hand-wash or pre-soak laundry).
- Consider reducing the size of the amenities if they typically are only partially used by the guest (e.g., less than 50%) during an average guestroom stay.
- Avoid using guestroom amenities that are sold with an excessive amounts of packaging material (e.g., a plastic shampoo bottle packed in a cardboard box).

4.8 Train the housekeepers in the safe and proper handling, use and disposal of housekeeping chemicals

Figure 4.9 - Housekeepers often use chemicals inappropriately.

Some of the typical problems related to the use of chemical products by housekeepers include:

- The use of the wrong chemical product for a particular task (e.g., the use of a “inert surface disinfectant” spray as an air freshener).
- The routine use of chemicals for problems that can generally be solved by non-chemical means (e.g., the use of drain cleaning chemicals as the first alternative when dealing with clogged drains).
- Excessive and improper use of insecticides (e.g., the general “spraying down” of a guestroom, mattress included, with an all-purpose insecticide to fight an ant infestation problem).
- The use of chemicals in concentrated rather than dilute form.
- The mixing of incompatible chemicals (e.g. ammonia and chlorine bleach).
- The use of more product than what is needed to get the job done. This problem occurs frequently when housekeepers don’t use pump bottles to dispense their chemicals.
- The use of hazardous chemicals (e.g., drain cleaning acid) without following the manufacturer’s instructions or using the required protective equipment (e.g., plastic gloves).
- The use of used beer or soft drink bottles to store cleaning chemicals.
- The disposal of used cleaning solutions down storm drains. In most beach-front hotels, storm drains are directly connected to the sea.

By training housekeepers on how to properly handle, use and dispose of their chemicals, the property can minimize hazards to staff and guests, reduce its consumption of chemicals and protect the environment.

4.9 Use a dispensing system to dilute and safely transfer chemicals from the bulk containers to the refillable pump bottles used by housekeepers

Transferring and diluting cleaning chemicals by hand generally results in spillage and improper dilution ratios. Furthermore, if the housekeepers are given the responsibility to dilute their own chemicals, they will invariably use more product than necessary because they feel they can do a better job by using highly concentrated cleaning solutions.

In order to avoid these problems, the property should consider purchasing housekeeping chemicals from a company that offers a dispensing system for its bulk products. A good quality dispensing system automatically dilutes the chemicals as it safely transfers them from the bulk containers to the pump bottles that are used by the housekeepers.

Figure 4.10 - Dispensing system for housekeeping chemicals.

Savings achieved by using a dispensing system for housekeeping chemicals

A 212-room Jamaican hotel assessed by PA Consulting installed a dispensing system to transfer concentrated cleaning chemicals from bulk containers to the housekeepers' refillable pump bottles. By eliminating spills and respecting the recommended dilution ratios, this dispensing system has helped the property reduce expenditures on room cleaning supplies by 3,100 US$/year.

4.10 Minimize the use of harsh chemicals

Whenever possible, the property should try to avoid using harsh chemicals in its housekeeping operations. Harsh chemicals can generally be replaced with milder cleaning products that are safer for the housekeepers and better for the environment. In some cases, commercial chemicals can be replaced by homemade products that are safer and cheaper to use. For example, vinegar can be used instead of descaling acid to clean scale from showerheads and fixtures, an a mixture of vinegar and baking soda can be used instead of bleach to clean tiled surfaces and countertops in guest bathrooms.

5. Laundry

5.1 Draft an operations checklist for the laundry staff

The property should create a checklist for the laundry staff to ensure they are aware of and comply with the conservation measures adopted by the property. This checklist should ideally be posted in the laundry room for easy reference.

Examples of items that should be included in this list are given below.

- Wash and dry only full loads. Any partial loads remaining at the end of the day should be left to wash with additional items the following day.
- Separate out all heavily soiled items before loading the washing machines. These items should be pre-soaked to reduce the amount of material that is re-processed in the laundry.
- Sort sheets and towels into separate loads. Different fabric types and weights require different wash formulas and drying times.
- Set the drying time based on the type of load instead of always selecting the maximum drying time.
- Clean the lint trap of the dryers at least once per day.

Once these procedures have been established, the laundry supervisor should perform periodic spot checks to ensure compliance.

5.2 Line dry bedspreads, blankets, rugs, and other heavy items

Line drying laundry is the simplest and most cost-effective use of solar energy in a hotel. It requires only a negligible investment (lines and clothespins) and a modest amount of labor and yields great benefits. Consider the following issues.

- Sunshine is free and plentiful in the Caribbean.
- Line drying reduces energy costs and increases the service life of the dryers.
- Line drying is gentler on fabrics and therefore reduces the wear on the linens.

Given these benefits, the property should strive to line dry (fully or partially) as many laundry items as possible, and in particular the heavier items such as blankets, bedspreads, bath mats and area rugs.

5.3 Eliminate the use of plastic bags in the laundry

- Use durable cloth or canvas bags to collect dirty linens from guestrooms. These bags can either be purchased or made from old sheets or tablecloths.
- Use baskets, carts or durable cloth bags to return clean linens to guestrooms.
- Use durable cloth bags to collect dirty guest laundry from the rooms.
- Use durable cloth bags, baskets or garment bags to return guest laundry to the rooms.

5.4 Ask suppliers to provide the MSDS (Material Safety Data Sheets) for all chemicals used

The laundry supervisor and staff should be well informed on the risks associated with all chemical products used in the laundry. The property should therefore consider implementing following recommendations.

- Ask suppliers to provide the MSDS (Material Safety Data Sheets) for all chemicals used in the laundry (chemical suppliers are required by law in many countries to provide this information). Use the information provided in the MSDS sheets to identify hazardous chemicals (i.e., chemicals that require excessive caution when handled or used) and ask the chemical suppliers for less hazardous, or non-hazardous substitutes. Harsh and toxic chemicals pose a threat to the health of employees and guests, and often harm the environment.
- The laundry supervisor should keep a copy of the MSDS for all laundry chemicals, and ensure that all chemicals are stored, handled and used according to the manufacturer's recommendations.
- Work with the purchasing department to Identify and purchase detergents that do not contain phosphates. Phosphorus is a nutrient that is harmful to natural bodies of water and cannot be effectively eliminated by most wastewater treatment systems. If the current vendor does not offer phosphate-free or low phosphate products, consider switching to a vendor that does.

6. Kitchen

6.1 Apply best practices in general kitchen operations

- Make sure that all kitchen equipment is turned off when not in use, especially at the end of the workday. This includes hood extractors, exhaust fans, burners, plate warmers, ovens, coffee makers, toasters, and refrigerator/freezer lights.
- Ensure that the cleaning staff turns off any equipment that is left on at the end of the day by the kitchen staff.
- Don't let faucets run for longer than necessary.
- Use dishwashers only to process full loads.
- Train the staff to conserve water and energy, for example by turning off faucets, equipment and burners that are not is use. Employees are generally not aware of the true cost of their actions (e.g., letting an average kitchen faucet run for 1 hour per day consumes 110,000 USG or US$ 1,200 of water per year).[39]
- Use signs to remind the kitchen staff to conserve water, energy, chemicals and materials.
- Recognize staff that follow proper procedures and admonish those that don't.

6.2 Apply best practices in the operation of ovens and top burners

- Turn off burners and stoves when not in use to save energy and reduce heat build-up in the kitchen.
- Make sure the pilot lights work well, otherwise the cooks will leave the burners on continuously.
- Keep the lower edge of the oven door free of food particles so it seals properly.
- Clean the interior oven walls and elements to achieve better heat transfer.
- Check gas burners periodically. If the flame is yellow or uneven, clean the burners with a wire brush and make sure holes are clear. If the condition persists, have maintenance adjust the gas/air mixture of the burners.
- Adjust door hinges, gaskets, and moldings of oven as needed for a tight fit. Try the bill test: close the door on a bill, if it falls to the floor the gasket needs to be repaired or replaced.

6.3 Apply best practices in cooking operations

- Schedule turn-on times for cooking equipment. Turn on only as needed and cook at the lowest temperature that gives satisfactory results. Slow cooking reduces meat shrinkage, retains nutrients and better color in all foods, and is more energy-efficient.

[39] Assuming a faucet flow of 5 USG/min and a water cost of 11.00 US$/1000 USG.

- Use a fryer whenever possible: it is more efficient than frying on a range top. Don't turn on two fryers when one will do.
- Turn the thermostat on the fryer only as high as necessary to reach frying temperatures. In modern high-speed fryers, temperatures from 163°C (325°F) to 177°C (350°F) are ideal. Too high a temperature wastes energy and breaks down the oil.
- Remove all possible water or ice from foods before frying to eliminate oil breakdown and temperature fluctuation.
- Put lids on pots and pans. It saves energy and decreases cooking time.
- Whenever possible, place food close together on the griddle and heat only the portion of griddle being used.
- When using the griddle, heat only to temperature required for food being cooked. Low or medium heat is best.
- Never overheat a griddle in the interest of speed: it wastes energy and could ruin the food.

6.4 Apply best practices in the use and operation of refrigeration equipment

- Consider using plastic strip curtains to reduce the loss of cold air from the walk-in freezers and cold-rooms whenever the doors are opened.
- Don't place hot food in a cooling unit, but let it cool (in accordance with safe food handling practices) before refrigerating or freezing.
- Cover all liquids stored in the refrigerator: moisture from uncovered liquid forces the compressor to work harder and waste energy.
- Arrange all items stored in freezers and refrigerators conveniently. Clearly label stored items. Tape a diagram showing location of items to the outside of refrigerator and freezer doors.
- Place frequently used items at front of each unit to reduce the length of time the doors are open.
- Avoid using walk-in coolers for items such as individual salads, which require frequent door openings.
- Close ice maker storage bins after each use.
- Consolidate food where possible to reduce the number of refrigerators and freezers in use. Full units use energy more efficiently than partially full ones.
- Periodically inspect refrigerator and freezer doors to make sure they seal correctly and are free from ice build-up.
- Keep the lights in walk-in refrigerators and freezers off except when in use. Lights produce unwanted heat and force the units to work harder than necessary.
- Keep refrigerator and freezer cooling coils free from excessive ice build-up.
- Ensure that the condenser coils of freezers, refrigerators and ice makers are clean.
- Monitor refrigerator and freezer temperature set-points. Watch for problems or high temperatures which may indicate excessive door openings, damaged door seals, etc.

- Check compressor for leaks and level of refrigerant.

6.5 Apply best practices in baking and roasting operations

- Begin the day's baking or roasting with foods that require the lowest oven temperature. Starting out at a high temperature and then letting the oven cool down wastes energy.
- Plan baking and roasting so that foods requiring the same temperature are cooked at the same time.
- Maintain a baking and roasting schedule to ensure full use of oven capacity, and to help reduce operating hours.
- Load and unload ovens quickly, and don't open the door during operation - every second the oven door is open, the temperature drops about ten degrees. Also, food cooks faster and loses less moisture if the oven door is kept closed.
- When pre-heating, set the thermostat at the desired temperature: the oven won't heat any faster at a higher setting, and it wastes energy.

6.6 Reduce the amount of water that is used to wash down the kitchen

A property can waste a lot of water by washing down its kitchen with a hose more often than necessary. In order to conserve water, a property should:

- use buckets and a mops for the daily cleaning of the kitchen;
- hose down the floors only during the weekly detailed cleaning of the kitchen; and
- equip all kitchen hoses trigger nozzles.

6.7 Thaw frozen meat in refrigerators rather than under running water

Frozen meats are often thawed under warm running water in hotel kitchens. This practice needlessly wastes water and energy, and should be replaced by thawing meats in a refrigerator or cooler. If, in an emergency, frozen items must be thawed under running water, the staff should make sure that the faucet output is low and that the water flowing from the faucet is cool.

6.8 Reduce the volume of solid waste generated by the kitchen

In order to reduce the volume of solid waste produced by its kitchen, the property should ideally implement the following recommendations.

- Minimize the use of single-use items in the kitchen such as doilies, disposable aprons and cook caps.
- Donate unserved food to a local charity.
- Collect separately food waste and scraps, and donate this material to a local farmer who can use it as pig feed.

- If the food waste cannot be used as animal feed, collect separately the vegetable and fruit waste from the pantry and other kitchen areas and send it to the compost pile.
- Install bins in key locations to collect the items that can be reused or recycled by the property, such as crocus bags, glass bottles and jars, plastic bottles and containers, steel and aluminum cans.

6.9 Reduce the amount of oil and fat discharged to the kitchens' grease traps

The property should consider implementing the following options.

- If the service is available locally, give the used oil from the fryers to an oil-recycling company.
- Place oil and grease containers in a convenient location close to the ranges, and ask the kitchen staff to drain excess oil or grease from their pans in these containers. The collected cooking oil should be sent to the “used oil” drum and the grease discarded along with the general garbage (grease should never be added to the “used oil” drum).
- Ask the stewards to scrape the oil and grease from pans and skillets before washing them. The material scraped off the pans and skillets should be discarded along with the general garbage.

By maximizing the recovery of grease and oil from the kitchens, the property will:

- reduce the amount of detergent, water and energy consumed in the pot sinks;
- reduce the amount of work and chemicals used to clean the kitchen's drain pipes and grease traps; and
- improve the performance of the property’s wastewater treatment or disposal system.

6.10 Practice proper food safety procedures[40]

- Keep hot foods hot (140° F or higher) and cold foods cold (41° F or below) at all times. Remember that milk and milk products, poultry, fish, shellfish, meat, and many salads and salad dressings are potentially hazardous food. If these foods are not handled properly and kept at safe temperatures, they will spoil very quickly and may cause someone to get sick.
- Keep all foods covered or otherwise protected from contamination while being sorted, handled or prepared.
- Have all staff wash their hands thoroughly before beginning work, before handling potentially hazardous foods, and after going to the bathroom or performing any task that would result in soiled hands.
- Check refrigerators frequently for cleanliness and proper temperature. The temperature should never get above 41° F.
- Wash thoroughly in clean water all fruits and vegetables intended to be eaten raw.

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[40] Source: *“Do's and Don'ts" for Food Handlers*, Pennsylvania Department of Agriculture, Bureau of Food Safety and Laboratory Services.

- Clean and sanitize, prior to use, all choppers, grinders, slicing machines, cutting blocks, knives, and any other surface that comes in contact with potentially hazardous foods.
- Have staff wear suitable hair restraints to keep hair out of food.
- Keep storage rooms clean.
- Place all wet garbage and refuse containing food wastes in leak-proof containers with fly-tight covers.
- Keep shoes, handbags, and other personal items out of the kitchen and food preparation areas.
- Encourage staff to use a utensil or other suitable equipment to handle food whenever possible instead of their hands.
- Don't thaw frozen foods at room temperature. Thaw them in the refrigerator, under cool, potable running water, or by cooking.
- Don't line refrigerator shelves with newspaper, foil, or any other material. Air circulation in refrigerators is essential to proper operation.
- Don't allow unnecessary items and objects to accumulate. Throw away, or store elsewhere, all nonessential items; they only make cleaning the kitchen and storage areas more difficult.
- Don't allow vegetables, fruits, or other containers of food to stand on the floor. Dampness or spillage will spoil the foods, and the presence of these materials on the floor hinders cleaning.
- Don't let spatterings of grease collect on stoves, floors, or walls. Other dirt soon sticks to this and you have a mess which takes time and energy to remove.
- Don't let staff wash their hands in utensil-washing sinks or food preparation sinks.

7. Restaurants and bars

7.1 Avoid the use of disposable food service items

Many properties use lots of disposable containers and utensils for food service, especially for staff meals and special events such as beach parties, buffets, cookouts and picnics. Although this may provide a marginal level of convenience for F&B staff, it generally costs the property a good deal more than using durable and reusable food service items. The property could reduce costs and its generation of waste by minimizing the use of disposable food service items. In order to achieve this goal, the F&B Manager, in conjunction with purchasing staff, should:

Figure 7.1 – Examples of disposable food service items.

- identify the disposable food service items currently used by the property;
- devise ways to eliminate or minimize the use of these disposable items;
- look at the costs of the disposable items and evaluate the possibility to replace them with reusable items; and
- monitor the use and prevent the overuse of disposable items.

Consider, for example, the following alternatives to disposable food service items used by many properties.

Item	Possible alternatives
Paper cocktail napkins	► Replace with reusable coasters.
Straws	► Discontinue the practice of automatically giving out straws with all drinks. Give straws out only with blended drinks. ► Place straw dispensers on the bars and let the guest pick-up their own straws. ► Give straws to guests only upon request.
Disposable plastic cups	► Replace with durable plastic cups.
Disposable lunch boxes, plates and cutlery	► Use durable plates and cutlery in all parts of the hotel, including in the staff canteen.
Sternos (or Handy Fuel)	► Replace the solid fuel canisters with refillable alcohol burners. ► Use electric elements or gas burners to heat up the buffet warmers.

7.2 Purchase food items in bulk and avoid the use of single-serving items

Whenever possible, the property should purchase its food items in bulk or large portions rather than single-serving packages or small containers. Purchasing food items in bulk reduces the amount of packaging waste generated by the property and saves money. Ideally, only seldom-used products that can spoil quickly should be purchased in small portions or containers.

Consider the following issues:

- Packaging alone (e.g., bottles, cardboard boxes, cans and containers) can account for up to 40% of a hotel's waste stream.
- Products sold in small or single-serving packages are significantly more expensive than products sold in bulk or larger portions.
- Bulk sugar, cream, and butter can be presented more elegantly than single-serving portions.

Figure 7.1 - Refillable sugar and cream dispensers at a five star hotel.

8. Water sports and pools

8.1 Apply water conservation measures in pool operations and maintenance

The typical 1.5-HP centrifugal pumps that are used in many medium-size swimming pools can produce a flow of 70 to 90 USG/min. Given their high capacity, these pumps can waste a surprisingly large volume of water if they are used to backwash or rinse the sand filters more often or for longer than necessary. For example, operating a typical 1.5-HP pool pump for only 1 minute each day to needlessly backwash or rinse a sand filter could waste from 25,500 to 32,800 USG of water over the course of a year. Unfortunately, since most pools are not equipped with water meters and pool maintenance operations seem to be relatively harmless,[41] hotels are generally not aware of how much water and money their pools are actually wasting.

In order to conserve water in its pool maintenance operations, a property should ideally observe the following practices.

- Don't backwash sand filters more often than indicated by the pressure buildup in the filter (this is the main reason why most pool filters come equipped with a pressure gauge). In most cases, pool filters should be backwashed when the pressure at the inlet of the filter increases by 10 psi (69 kPa) over the clean filter pressure (i.e., the inlet pressure measured when the pump is turned on right after the filter has been backwashed). In pools with light to medium bather loads, the pressure in the sand filters generally increases by as little as 2 to 3 psi each day, meaning that these filters should be backwashed only every 3 to 5 days.[42]

  Backwashing sand filters more often than necessary actually decreases their performance, because the backwash flow disturbs the structure of the sand bed and eliminates the impurities that are stuck to the grains of sand and help capture the fine particles contained in the pool water. According to The Complete Swimming Pool Reference:[43] "... dirt in the filter helps trap dirt that comes from the pool. Backwashing too often will keep the sand too clean and allow dirt to pass through the filter bed." The common practice of backwashing pool filters every day is therefore both wasteful and counterproductive.

  Impact of inefficient backwashing practices

  A study conducted by PA Consulting Group at a 100-room tourist hotel revealed that it could save 760,000 USG or US$ 8,000 of water per year simply by backwashing its sand filters based on need rather than on a fixed daily schedule.

  Putting in place this practice required no capital investment and only a minimum amount of training for the pool operator.

- Base the duration of the filter backwash step on the quality of the water discharged from the filter rather than on a fixed length of time (e.g., 10 minutes). The operator should end the backwash step as soon as the water discharged from the filter becomes

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[41] Sand filters and pool pumps are generally housed in "out-of-the-way" mechanical rooms and discharge their waste flows directly to a drain or sump. Therefore, unlike the readily visible irrigation sprinklers or dripping faucets, pool equipment can waste a huge amount of water without ever being noticed.

[42] The property should be aware of and respect the backwashing procedures recommended by the manufacturer of its pool filters. Backwashing and maintenance instructions are often printed right on the body of the sand filter. It should be noted that most manufacturers recommend that their filters be backwashed at least every 5 to 7 days, even if they have not reached the recommended pressure buildup.

[43] The Complete Swimming Pool Reference, Mosby Lifeline Books, St. Louis, 1994.

relatively clean. Extending the backwash operation beyond this point wastes water and provides no additional benefit.

The filter drain pipe should be equipped with a device that allows the operator to gauge the clarity of the water discharged during the backwash step. Examples of such devices include a piece of transparent pipe, a transparent "button" or sight glass, or faucet that can be opened during the backwash operation.

- After backwashing the filter, use a very short rinse step to purge the slightly turbid water that remains in the pipes and at the bottom of the filter at the end of the backwash step. Although equipment manufacturers generally recommend that the filter be rinsed for 30 seconds or less, many pool operators rinse the filters for 2 to 5 minutes.
- Don't purge water from the pool unless there is a good reason to do so. For example, some pool operators routinely set the filter valve on "waste" when vacuuming the pool in order to avoid clogging the filter with the dirt that is sucked out by the vacuum head.[44] This practice wastes a lot of water and should therefore be used only in extreme cases (e.g., when there is so much dirt at the bottom of the pool that the water sucked out by the vacuum head would immediately clog the sand filter).
- Train the pool operator. Although not difficult, pool care and maintenance is certainly not an intuitive skill. Therefore, an operator that is not aware of the basic concepts of pool water chemistry and maintenance will never be able to effectively carry out his/her responsibilities, and a pool that is maintained by a poorly trained operator will invariably consume more water and chemicals than necessary.

[44] When the filter valve is set on "waste", all of the water that is sucked out of the pool by the pump bypasses the filter and is directly discharged to the drain.

9. Grounds and beach

9.1 Apply water conservation measures in irrigation

The audits conducted by the EAST project in Negril and Montego Bay, Jamaica, have shown that irrigation can often account for more than 25% of the total volume of water consumed by hotels, even though these two locations receive a fair amount of rain (57 inches/year in Negril and 41 inches/year in Montego Bay). The large impact that irrigation can have on water use in a hotel is evident in the following graph, which shows the relationship between the monthly water consumption of a Montego Bay property and local rainfall. In this particular case, the property's monthly water use curve is almost the mirror image of the monthly rainfall curve, and its water consumption during the rainiest months is nearly 50% lower than that during the driest months.

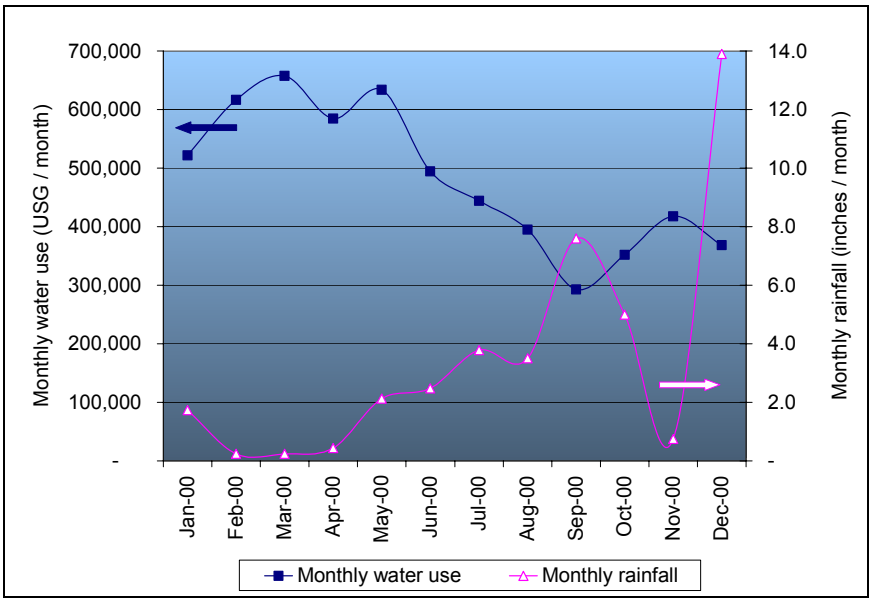

Figure 9.1 - Relationship between total water use in a 50-room Montego Bay hotel and local rainfall. It should be noted that the occupancy at this property was fairly constant and, therefore, changes in occupancy cannot explain the large variations in water use shown in this graph.

Irrigation is therefore a very expensive activity for many hotels, yet few of them take action to effectively monitor and control their use of irrigation water. For example, out of 25 properties assessed by the EAST project in Jamaica, only two of them had water meters on their irrigation lines and could measure how much water was used in their gardens.

In order to conserve water in its irrigation operations, a property should ideally implement the following measures.

1) Monitor the use of irrigation water

Install water meters on the irrigation system or on the water lines that are used to irrigate the grounds. Read these meters regularly and use the collected data to track the amount of water consumed in the gardens and to ensure that the grounds staff uses water efficiently.

2) Use efficient irrigation systems in areas that are regularly watered

As shown in the following table, the efficiency with which irrigation water is used can vary widely depending on the type of irrigation process used. Water use can be reduced by more than 35% by switching from sprinkler irrigation to drip irrigation in garden beds and areas planted with trees, shrubs and flowers.

Irrigation system	Efficiency
Manual application with hoses	Highly variable but generally low
Sprinklers	65 to 80%
Drip and bubbler irrigation	80 to 90%

Hotels should also consider replacing movable sprinkler systems with fixed or pop-up sprinklers. Although the actual efficiency of the sprinklers remains the same, fixed sprinklers are easier to control and thus allow a property to increase the efficiency of its irrigation operations. For example, fixed sprinklers can be easily operated at night, when evaporation losses are low, and cycled (i.e., turned on/off) to reduce water runoff and improve the penetration of the water into the soil.

3) Use plants that are well suited to the local weather conditions and precipitation

The type of plants and vegetation that are used in a garden have an enormous impact on its irrigation needs. Properties, especially those located in drier areas, should therefore carefully consider the water needs of plants before they are widely introduced into their gardens. To illustrate this point, consider the dry-climate water requirements of three common grass varieties[45] and the possible impact of planting the wrong type of grass in a large hotel garden.

- St Augustine - 50 inches/year (31 USG/ft^2.year)
- Bermuda - 40 inches/year (25 USG/ft^2.year)
- Buffalo - 20 inches/year (12.5 USG/ft^2.year)

Grass is notorious for its high irrigation needs and should be used sparingly in all locations where there is not enough rainfall to sustain the lawns during most of the year. Grass can be replaced by many varieties of groundcovers, which generally are far more exotic to the guests and consume much less water. All experienced gardeners are able to easily identify which plants are appropriate to the area's climate and which are not. Their advice should be taken into account when designing landscaping layouts and selecting the plants that will be introduced in the gardens.

4) Cycle the sprinklers to avoid water run-off and ponding

Many sprinkler systems deliver water at too high a rate to avoid run-off before adequately wetting the soil. Any water that is unable to seep into the soil eventually "runs" off to the nearest low point, which can be a gutter, a sidewalk or simply a low spot in the lawn. Excessive run-off prevents the efficient use of irrigation water and can create muddy areas where turf diseases thrive, mosquitoes breed and mowers leave ruts.

Run-off occurs because the sprinklers put out more water in a given amount of time than the soil can absorb. This problem can be solved by turning off the sprinklers as soon as the soil is saturated and water starts to run-off. Once the water has soaked into the soil (generally after 1 hour), the sprinklers can be turned on until run-off occurs once again. This run-stop-wait cycle, or cycling of the sprinklers, should continue until the soil is saturated to a sufficient depth. Almost all sprinkler systems need to be cycled for proper irrigation.

[45] Source: Banks, S., Heinichen, R., 1997, Rainwater Collection, Tank Town Publishing, Springs, Texas.

Sprinklers can either be cycled manually or with a timed irrigation control system, which consists of a central control unit that regulates the operation of the irrigation valve through control wires. Timed controllers can generally be retrofitted on most existing irrigation systems.

5) Reduce evaporation losses

Irrigate during the coolest hours of the day (preferably from sunset to sunrise) to minimize the loss of irrigation water by evaporation.

6) Use compost

The use of compost on lawns and garden beds increases the water retention capacity of the soil and reduces irrigation needs.

7) Use mulch

Cover the ground in flower or garden beds with mulch or coarse compost. A layer of mulch or compost keeps the ground cooler, lowers surface evaporation, reduces irrigation needs, and slows down the growth of weeds.

8) Group plants that have similar water needs

Garden bed that contain only drought resistant plants can be watered much less frequently than garden beds that contain a mixture of drought tolerant and non-drought tolerant plants.

9.2 Irrigate the grounds with graywater or treated wastewater

The volume of water discarded as graywater or wastewater[46] by an average hotel is generally sufficient to meet all its irrigation needs. However, if these waste flows are to be reused for irrigation they must be collected, treated and handled properly to avoid endangering the health of the staff and guests, especially that of the children who will invariably explore every corner of a hotel's gardens. The degree to which the waste flows must be treated prior to use for irrigation depends largely on the manner in which the irrigation water is applied to the grounds.

Surface irrigation: If waste flows are used for surface irrigation (i.e., sprinklers, manually operated hoses, bubblers or drip irrigation emitters which apply the water directly onto the soil) they must previously undergo a fairly intensive and comprehensive treatment. Poorly treated and disinfected wastewater/graywater poses a serious health hazard. Unfortunately, these hazards are not limited to the duration of the irrigation operations, but can persists for weeks because most wastewater/graywater pathogens can survive in soil for long periods of time.

The health risks associated with surface irrigation with wastewater/graywater are particularly severe if sprinklers are used to apply the irrigation water. The high pressure at the sprinkler's nozzle pulverizes

[46] Graywater consists of all the lower-strength wastewater flows that are produced by a hotel, and excludes the high-strength wastewater flows (or blackwater) produced by toilets, urinals, kitchen sinks and bar sinks. Graywater comes mainly from face basins, showers, tubs, laundry washers and pool filters, and generally accounts for more than 50% of the total volume of wastewater produced by a hotel. It is important to note that, although graywater is much cleaner than blackwater, it is not free of fecal coliforms and disease causing organisms and therefore must be handled with care.

The term wastewater is used to designate the mixed sewage produced by a hotel, which consists of blend of graywater and blackwater. It is generally assumed that the amount of wastewater produced by a hotel is equal to approximately 90% of its indoor water use.

some of the water, and the resulting mist can easily travel and carry disease causing organisms (pathogens) for hundreds of yards, especially in strong winds. Thus if wastewater or graywater is to be used in sprinkler irrigation it must first be treated, filtered and chlorinated in order to reduce its content of organic material, suspended solids and pathogens. For example, many states in the US require that any treated wastewater or graywater that is used to spray irrigate unrestricted areas, such as hotel gardens, should have a chlorine contact time of at least 30 minutes, a free chlorine residual of 1 to 3 mg/liter, and fewer than 25 fecal coliforms per 100 ml.

This degree of treatment requires a fairly sophisticated wastewater treatment system[47] and a tight quality control that is generally beyond the reach of most small hotels. Therefore, the use of treated graywater or wastewater for sprinkler irrigation should be considered only by hotels that already have or are planning to build a wastewater treatment plant, or by hotels that are located in areas where water is scarce or very expensive. Furthermore, even if the waste flows are properly treated and disinfected, hotels should still take a few basic precautions when using these flows for irrigation. For example:

- Irrigation should ideally be carried out at night to minimize the likelihood that guests and staff members will come into contact with the irrigation water.
- Sprinkler systems should not be used to apply treated wastewater/graywater during periods of high winds.

Subsurface irrigation: Since graywater contains few suspended solids and is less hazardous than mixed sewage or blackwater, it is ideally suited for use in subsurface irrigation of garden beds, trees and shrubs. A graywater collection and irrigation system is relatively simple and typically consists of the following components:

- Piping to convey the graywater from the sources (e.g., showers, bath tubs, sinks and laundry washers) to the storage tank. The collection of graywater is typically done by gravity.
- A filter bag or another simple filtration device to remove the larger suspended solids that are contained in the graywater (e.g., hairs, lint, pieces of paper or fabric).
- A storage tank equipped with a vent and an overflow pipe.
- A centrifugal pump to move the graywater from the storage tank to the irrigation system (typically a 1 to 2-HP pump);
- A filter to protect the irrigation system against blockages (e.g., a stainless steel cartridge filter that can be periodically removed and cleaned).
- A network of irrigation pipes and subsurface emitters. It is important to note that the irrigation emitters should be coarse and large enough to minimize clogging problems. Some hotels use a simpler "subsurface" irrigation system composed of a network of slotted pipe that distribute the irrigation water directly onto the soil but under a thick layer of mulch.

[47] The septic tanks that are used in conjunction with tile fields or soakaway pits by many hotels in the Caribbean produce a low quality effluent that cannot be used for sprinkler or surface irrigation.

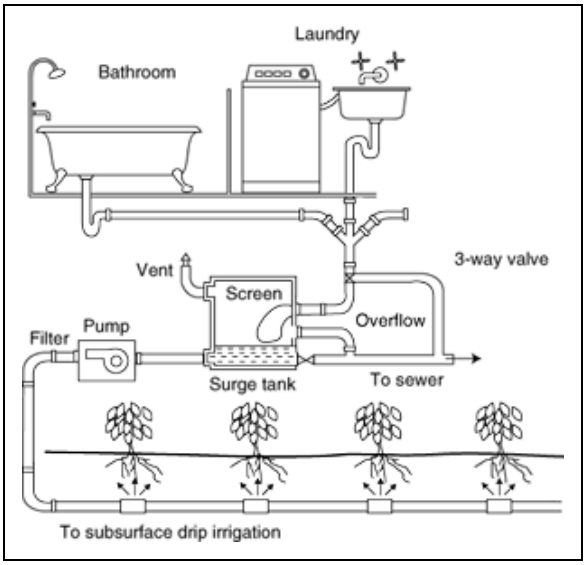

Figure 9.2 - Typical layout of a graywater collection and irrigation system (www.homeenergy.org).

Any property that is interested in starting a graywater irrigation system should first consult some of the helpful graywater texts that are available on the market, including Art Ludwig's "Create an Oasis with Graywater," "Building Professional's Graywater Guide" and "Branched Drain Graywater Systems." These books cost less than US$ 15 each and can be ordered through the Internet at www.amazon.com, www.thenaturalhome.com or www.realgoods.com.

9.3 Utilize the landscaping to reduce cooling loads

A well designed landscaping scheme can reduce air conditioning costs by 15 to 50%. In addition to reducing direct solar gains, shading and evapotranspiration from trees can also reduce surrounding air temperatures by up to 9°F.

Landscaping should ideally be used not only to shade the walls and roofs of buildings, but also the surrounding areas and paved surfaces. However, the landscaping should not block airflow around or through buildings, nor restrict airflow through a/c condensers.

9.4 Keep plants trimmed around outdoor light fixtures and a/c condensers

Gardeners should periodically trim the vegetation that grows around outdoor light fixtures and a/c condensers to prevent it from blocking the light produced by the lamps and allow proper airflow through the condensers.

9.5 Reduce the number of plastic bags used by the grounds staff

The property should consider implementing the following recommendations to reduce the number of plastic bags used by the Grounds Department.

- Use durable bags, containers or wheelbarrows instead of disposable plastic bags to collect yard waste.

- Install garbage bins that have a durable plastic core instead of disposable plastic liners in all garden areas that receive mainly dry waste.
- Do not remove and change the plastic liners from the garden garbage bins unless they are nearly full or contain putrescible/noxious waste.

Figure 9.3 – Avoid the use of plastic bags for collecting yard waste.

9.6 Start a composting program

Composting is the natural decomposition of biodegradable organic material, such as yard waste and vegetable and fruit waste, by bacteria and other naturally occurring microorganisms. The end product of this process is a black, crumbly, earthy material, which can be used as a soil conditioner or a slow-release fertilizer for plants and lawns. Composting is a simple process that requires only a modest amount of effort and can yield great benefits. For instance:

- The use of compost increases the soil's capacity to retain moisture and thus reduces irrigation requirements.
- The use of compost can virtually eliminate the need for synthetic fertilizers. This has been achieved by several Jamaican properties that have participated in the EAST program.
- A composting program significantly reduces the volume of waste produced by a property.
- Composting may allow the property to reduce its waste handling costs.

Some of the key features of a composting programs are discussed in the following sections.

9.6.1 Keep different waste streams separate

The key to a successful composting program is separating compostable materials (e.g., yard waste, vegetable cuttings, fruit peels) from non-compostable waste (e.g., plastics, meat and fatty food waste, metals) as they are generated, and keeping them separate. It is much easier to keep wastes separate from the beginning than to separate them after they are mixed.

This is a challenge at most properties because it requires cooperation and support of many departments. Many composting programs fail because nobody is given the responsibility to make sure wastes are properly

Figure 9.3 - Avoid mixing non-compostable wastes such as plastics and metal with compostable waste.

separated, and because the staff fails to dispose of the compostable wastes and non-compostable wastes in the appropriate containers.

The composting program should first be set up to process easily compostable wastes, such as yard waste. The more problematic wastes, such as kitchen vegetable waste and fruit peels, should be added to the compost program only after the yard waste composting program has been successfully established. If a property wishes to collect compostable material from the kitchen, it should place special “compostable waste bins” in the areas of the kitchen where most fruits and vegetables are processed. The property should define exactly who has responsibility for emptying the kitchen bin each day.

9.6.2 Composting systems

Composting is the optimization of environmental factors (water, pH, oxygen, temperature, etc.) to accelerate the rate of decomposition of biodegradable organic waste. There is a range of methods for composting, from simple “no-tech” methods, to windrow methods, to specialized vessels or bins that accelerate the composting process. Generally, the simpler methods are cheaper and slower, while the more engineered systems are faster, require less space, and afford more control over the composting process, reducing risks of odors.

The various composting methods are described below:

Piles: This method involves simply gathering compostable waste to an area where it will slowly decompose over a period of several years. Although it is not technically composting because environmental conditions are not optimized for decomposition, it is a valid and economical option.

Yard waste can be dumped in piles, but should not be bagged. In addition, the treatment area should not become a dumping ground for non-compostable wastes. Contamination with undesirable materials (chemicals, plastics, coated paper products, etc.) renders the compost unusable.

Windrows: Where composting space is limited, or organic waste is generated at a sufficient rate, faster and more ‘space-efficient’ techniques are desirable. This involves regulating moisture content, oxygen levels, and temperature, through the basic windrow method. Composting via the windrow method yields useable compost in about 12 months, depending on climate and starting materials. In tropical climates, the process could be even faster.

The basic windrow method requires a front-end loader to form composting material into windrows (elongated piles about 3-4 meters wide by 2-3 meters high), and periodically turn them, the rate of decomposition is determined by the frequency of turning. Turning the piles once a week can reduce the cycle time to 6 months.

Forced aeration methods: If available space is limited, and cycle times of less than 6 months are desirable, forced aeration methods can consistently maintain near-optimal levels of temperature and oxygen (whereas the rate of decomposition in windrows declines rapidly in between turnings). Forced air methods reduce odors, as anaerobic (oxygen free) conditions are minimized, and odor-causing materials are rapidly degraded. Forced air methods use perforated pipes and either a forced draft fan or an induced draft fan. These may be desirable in cases where odors are a problem, space is limited, or the treatment area is located near areas of the property frequented by guests.

Open bin systems: Open bin systems consist of barriers on the sides of compost piles to keep them from spreading out too much. These systems consist of one, two or three adjacent bins. The advantage of having more than one bin is that one can have a bin for the pile being built (as ingredients are accumulated over a period of time) and another one (or more) for a pile already built that is in a more advanced stage of decomposition.

Commercially available in-vessel composting systems: In-vessel composting systems afford an even higher level of control over the composting process. These systems often are powered to shred and mix the materials, and some have biofitration systems for removing odors and liquid wastes to the sewer or holding tank. Because of this, these systems may be desirable in situations where the treatment area is very close to facilities used by guests.

The cost of these systems can be quite high, and they are somewhat small, but these factors are balanced out by the speed at which drum/tumbler systems can generate finished compost. Under ideal circumstances, compost may be finished in three weeks in a rotating drum composter.

9.6.3 Choosing the right composting system[48]

Several other factors should be considered when choosing the system for composting. These include:

Area requirements: A minimum of one hectare is required per 1600-2100 cubic meters (one acre per 3000-4000 cubic yards) for the treatment area using no-tech or windrow methods (less for engineered systems).

Buffer zone: An adequate buffer zone between composting activities and areas frequented by guests or the general public will reduce odor, noise, dust, and visual impacts. For windrow and no-tech methods, the treatment area should be at least 50 meters away from public or guest areas, and 500 meters away from sensitive areas such as streams, schools, hospitals, residential areas, restaurants, etc…Less buffer is required for forced air and in-vessel methods

Slope and grading: Treatment areas should not be located on sloped areas, as these are susceptible to erosion and are more difficult to maintain. Treatment areas should not be sited where runoff will reach lakes or streams.

Soil porosity: avoid locating the treatment area on impervious soil (such as clay) or rock, as this will hinder aeration of the system.

Water supply: treatment area should have easy access to water, to maintain moisture levels between 40% and 60%. Too much moisture causes anaerobic conditions, while too little causes the material to dry out and the rate of decomposition decreases dramatically.

No-tech treatment systems are not appropriate for large volumes of food and beverage wastes, as significant odor problems can result.

Forced air methods are not appropriate for composting large amounts of grass clippings, which tend to block the perforations of piping and reduce efficiency. These methods also require electrical power at the treatment area, which should be considered.

9.6.4 Tips for successful composting[49]

Air: Composting microbes are aerobic -- they can't do their work well unless they are provided with air. Without air, anaerobic (non-air needing) microbes take over the pile, causing odors. For this reason, it's important to make sure that there are plenty of air passageways into the compost. Some compost ingredients, such as green grass clippings or wet leaves, mat down very easily into slimy layers that air cannot get through. Other ingredients, such as straw, don't mat down easily and are very helpful in allowing air into the center of a pile. To make sure that the compost has adequate aeration, thoroughly

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[48] Excerpts from: *Cornell Composting Fact Sheet*, Tom Richard, Ithaca NY, nd.

[49] Adapted from *How to Compost,* Eric S. Johnson, 1996.

break up or mix in any ingredients that might mat down and exclude air. Turn the compost on a regular basis to get air into it, which means completely breaking it apart with a spade or garden fork and then piling it back together in a more 'fluffed-up' condition.

Water: Ideally, compost should be about as moist as a wrung-out sponge to fit the needs of composting microbes. At this moisture level, there is a thin film of water coating every particle in the pile, making it very easy for microbes to live and disperse themselves throughout the compost. If the compost is drier than this, it won't be very good microbial habitat, and composting will be slowed significantly. If the compost pile is a great deal wetter, the sodden ingredients will be so heavy that they will tend to mat down and exclude air from the pile, again slowing the composting process (and perhaps creating anaerobic odor problems). When using dry ingredients, such as brown leaves or straw, moisten them as they are added to the pile. Kitchen fruit and vegetable wastes generally have plenty of moisture, as do fresh green grass clippings and garden thinnings. Watch out for soggy piles in wet climates (a tarp may help to keep rain off during wet weather). In dry climates, it may be necessary to water your pile occasionally to maintain proper moisture.

The shape of a compost pile has an important effect on moisture content. Scooping out the top of the pile to create a concave shape will maximize water absorption, so that rainfall can help replenish the moisture that is lost from the piles as steam. However, if the pile is overly saturated, anaerobic odors and leachate will be produced. Therefore, in prolonged wet conditions, the pile should be shaped to form a peak that will minimize absorption by shedding water. Both of these shapes are illustrated.

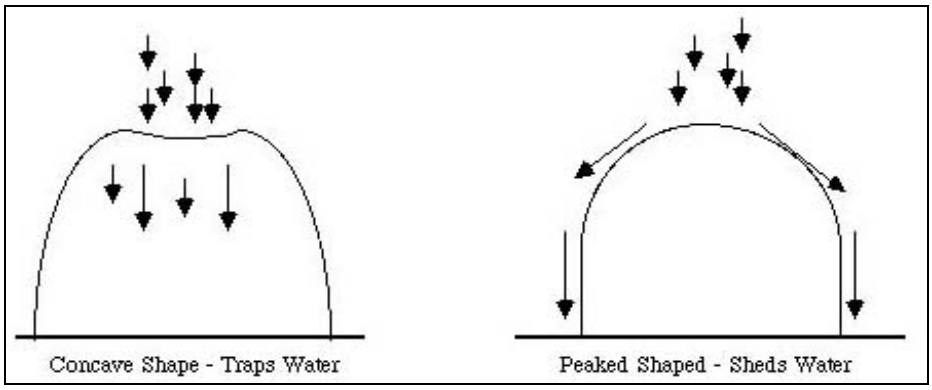

Figure 9.4 - The shape of a compost pile affects the amount of moisture it retains.

Water can be added to the compost pile in various ways. Hosing yard waste as the windrow is turned or turning it on a rainy day can help get water into the pile. Overhead sprinklers on a concave shaped pile also work well. By applying water slowly, it is more likely to infiltrate the pile, rather than running off the surface. Another method uses a drilled pipe as an injection probe, delivering pressurized water from a water truck to the center of the pile where it can be readily absorbed. As a rule of thumb, dry leaves initially need about 20 gallons of water for every cubic yard of leaves. [50]

Food: In broad terms, there are two major kinds of food that composting microbes need.

'Browns' are dry and dead plant materials such as straw, dry brown weeds, autumn leaves, and wood chips or sawdust. Because they tend to be dry, browns often need to be moistened before they are put into a compost system.

'Greens' are fresh (and often green) plant materials such as green weeds from the garden, kitchen fruit and vegetable scraps, green leaves, coffee grounds and tea bags, fresh horse manure, etc. A good mix of

[50] Tom Richard, Cornell Composting Fact Sheet, Ithaca NY, nd.

browns and greens is the best nutritional balance for the microbes. This mix also helps out with the aeration and amount of water in the pile. Browns, for instance, tend to be bulky and promote good aeration. Greens, on the other hand, are typically high in moisture, and balance out the dry nature of the browns. At table showing what to compost and what not to compost is shown below.

What to compost	What NOT to compost
▶ grass/lawn clippings ▶ hay ▶ kitchen wastes ▶ leaves ▶ manure ▶ straw ▶ weeds and other garden wastes ▶ wood chips and sawdust	▶ chemically-treated wood products ▶ diseased plants ▶ human wastes ▶ meat, bones, and fatty food wastes ▶ pernicious weeds ▶ vacuum dust bags ▶ dog and cat feces

9.6.5 Odor control[51]

Odor is a potential problem for all types of composting systems. Sources of odors include various compounds that may be present in composted organic wastes (such as dimethyl disulfide, ammonia, and hydrogen sulfide). These odors can be produced during different stages of the composting process: conveying, mixing processing, curing, or storage. Some tips on reducing odor are below.

- If using the windrow method, form materials into windrows promptly and make sure windrows are small enough to ensure that oxygen can penetrate from the outside and guard against the formation of a foul-smelling anaerobic core but large enough for the interior to reach optimal temperatures.
- For an aerated pile composting system, the pile height should be limited to 9 feet high.
- Provide aeration by regularly turning the piles. Because turning can release odors, however, determine wind direction first to prevent odors from being carried to areas frequented by guests.
- Break down piles that are wet and odorous and spread them for drying. Mixing in dried compost or dry yard waste also can help.
- Cover compost piles with a roof to help control temperature and moisture levels.
- Avoid standing pools of water or pending through proper grading and drainage.

9.7 Minimize the use of chemicals in grounds operations

- Use compost to reduce the need for chemical fertilizers.
- Identify and maximize use of plants that are naturally pest resistant.

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[51] Adapted from *Composting of yard Trimmings and Municipal Solid Waste, U.S. Environmental Protection Agency, 1994.*

- Practice companion gardening to reduce pesticide and fertilizer needs.
- When using chemicals, make sure to use the right chemical for the right job, and make sure staff are trained to apply them safely and effectively.
- Identify and practice alternative forms of pest control (see below)

9.8 Prevent pest and infestation problems before they occur

Preventing problems with pests is much easier (and cheaper) than controlling them once they are present. Consider the following alternative pest control and prevention strategies below.

- Identify and eliminate potential areas for feeding, breeding and nesting for pests (e.g. insects and rodents)
- Store garbage and food waste in secure containers (cans and dumpsters) that seal properly
- Fix leaky drains and garbage disposals, keep areas under sinks and around garbage bins and dumpsters as clean as possible
- Remove clutter in and large piles of debris such as abandoned appliances and construction materials
- Remove ground cover along edges of buildings
- Seal cracks and holes in building foundation, exterior walls and siding, roof, and around pipes
- Ensure that doors, windows and screens seal/fit tightly
- Eliminate standing water

9.9 Reduce the amount of beach sand removed due to beach raking and debris removal

Many properties remove large amounts of sand from their beach as a result of beach raking and debris removal activities. Properties should strive to minimize the amount of sand lost from the beach and swimming area by implementing the measures described below.

- Rake the beach as “lightly” as possible.
- If possible, rake the beach when the sand is dry.
- Collect the leaves and seaweed in a mesh bag and shake the bag to remove the sand. If the leaves and seaweed are wet, let them dry in the bag before shaking the sand out.

Figure 9.5 - Minimize the loss of sand on the beach caused by current debris removal practices.

9.10 Practice grass-cycling

This natural recycling of grass is achieved by leaving the grass clippings on the lawn to decompose. By adopting this practice the property will return the nutrients contained in the clippings back into the ground, and reduce the volume of waste generated in its gardening operations.